GOVERNMENT OF NUNAVUT, DEPARTMENT OF COMMUNITY AND GOVERNMENT SERVICES

IGLOOLIK WASTEWATER TREATMENT FACILITY

SEWAGE LAGOON BERM 2022 DAM SAFETY INSPECTION, IGLOOLIK, NUNAVUT

OCTOBER 18, 2022

CONFIDENTIAL

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CONFIDENTIAL

PROJECT NO.: TE0223017
DATE: OCTOBER 2022

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Dear Mr. Marinic:

Subject: Igloolik Lagoon Berm 2022 Dam Safety Inspection

Please find attached the above-mentioned Igloolik Lagoon Berm 2022 Dam Safety Inspection report. This report documents the observations made on the sewage lagoon berms (dams) and provides recommendations to improve safety of the berms. Supporting documents such as dam safety inspection forms and captioned photographs are included to illustrate the work.

Please do not hesitate to contact us should you have any questions with respect to the contents of this report.

Yours truly,
WSP E&I Canada Limited

DRAFT

Jane Doucette, P. Eng.
Senior Geotechnical Engineer, Associate

QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3
Remarks				
Date				
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Authorised by	Jane Doucette, P. Eng			
Signature				
Project number	TE0223017			
Report number				
File reference	TE0223017			

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SUBCONSULTANTS

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1 INTRODUCTION

WSP E&I Canada Limited (WSP) (formerly Wood Environment & Infrastructure Solutions Canada Limited) was retained by the Department of Community and Government Services (DCGS), Government of Nunavut (GN), to carry out a Dam Safety Inspection (DSI) for the sewage lagoon facility in Igloolik, Nunavut. The location of the sewage lagoon facility is shown in Figure 1-1.

This work was carried out in accordance with WSP's proposal #WW-GON-22-01 dated August 22, 2022, prepared in response to the DCGS Request for Proposal (RFP) entitled Igloolik Lagoon Berm Stabilization Assessment – Dam Safety Inspection, received on August 15th, 2022. The proposal was requested under Standing Offer Agreement 2019-74.

Several concerns were documented in the RFP prepared by DCGS. This report presents the observations made during the field visit and provides recommendations to address the issues documented in the RFP and identified during the field inspection.

Figure 1-1: General Site Location for Igloolik Sewage Lagoons
(Figure 2, Operation and Maintenance [O&M] Manual, Reference 4)

2 SCOPE OF WORK FOR DAM SAFETY INSPECTION

The DCGS requires that an assessment of the slope conditions of the interior and exterior berms of Igloolik's sewage lagoon facility (Cells A, B and C) be carried out by completing a DSI. The DSI should follow the requirements of the most recent version of the Canadian Dam Association Dam Safety Guidelines.

The scope of work required by the GN, as included in the RFP, is summarized below.

Dam Safety Inspection

- Review background documents related to the Igloolik sewage lagoons, including the following:
  - EXP Services Inc (EXP) Record Drawing Package.
  - EXP Site Visit Report dated September 24th, 2019.
  - DCGS Visit Report dated August 8th, 2022.
  - Operations and Maintenance Manual, EXP 2021.
  - Design Brief: Optimization of the Wastewater Facility Igloolik, Nunavut, EXP 2014.
  - Geotechnical Investigation, Liquid and Solid Waste Management for Hamlet of Igloolik, Nunavut, Trow 2010.
  - Optimization of the Wastewater Facility in Igloolik, Nunavut, Trow 2010
- Complete a visual assessment of the berms of all three lagoons.
- Complete photographic records which document conditions of the berms.
- Determine whether there is any berm creep/movement (see Scope Assumptions).
- Determine location of leaks through a visual inspection (see Scope Assumptions).
- Interview Hamlet staff about observations of the berm deficiencies.
- Identify any immediate or potential concerns and recommend remedial measures and/or further investigations.
- Prioritize action items.

General Tasks

- Participate in teleconference meetings with DCGS upon request.
- Prepare a draft report for review by DCGS; and
- Submit a Final Report incorporating review comments by DCGS.

Sections 3 through 5 of this report describe the tasks carried out as part of the DSI, including the observations made during the field inspection, and review of available documentation. Sections 6 and 7 discuss the findings and provide recommendations resulting from the DSI.

3 SEWAGE LAGOON DESCRIPTION

3.1 LAGOON CONSTRUCTION AND CONFIGURATION

The sewage lagoon facility is located approximately 1.3 km north of the Hamlet of Igloolik, Nunavut. It consists of 3 cells (Cell A, Cell B, and Cell C). The municipal solid waste and bulk waste sites are situated adjacent to the cells. Figure 1-1 shows the layout of the sewage lagoon facility and associated features.

For ease of identification, the berms of the lagoon cells have been labelled in Figure 3-1 for Cell A and in Figure 3-2 for Cell B and Cell C, and are referred to as such in this DSI report. It is noted that Cell B and Cell C were constructed as replacements for exfiltration cells at the same location. Cell A was constructed as a new waste water storage impoundment at a ne location, just northwest of the original facility.

The current sewage lagoon facility was constructed from 2016 to 2018. Appendix B presents the site layout, cell dimensions, and liner details in a set of record drawings dated September 25, 2018. Table 3-1 summarizes the dimensions and active volumes of the cells (assuming 1 metre (m) of freeboard), which is expected to satisfy the capacity requirement up to 2036 considering the projected increase of population in Igloolik.

The containment berms (dams) have interior side slopes (upstream) with 3 Horizontal to 1 Vertical (3H:1V) slopes, 3.25H:1V exterior slopes (downstream), and crest widths of 4 m and 6 m as per the record drawings (2018) in Appendix B. The three cells are fully lined with a Geosynthetic Clay Liner (GCL) liner embedded 0.45 m below the finished slope grade. The GCL product “Bentomat ST” was used in construction, consisting of a thin layer of sodium bentonite (clay), needle-punched between woven and nonwoven geotextiles. The soil cover over the GCL liner is shown to be 450 mm thick, consisting of 150 mm sand and 300 mm “Granular Ballast”, as shown in the IGL-6 drawing in Appendix B. There is no further detail regarding the grain size of the “Granular Ballast” from the documents currently available to WSP. From the field visual inspection by WSP, the material appears to be sand, some gravel and trace to some silt. Figure 3-3 Provides the detail of the slope and liner configuration per the record drawings.

The record drawing IGL-5 in Appendix B shows details for the lagoon dewatering system. It consists of the inlet pipe into the pump from the lagoon, an outlet pipe from the pump to the drainage trough, and the drainage trough (nestable corrugated steel pipe lengths) that runs along the downstream toe. The drainage trough is perforated to allow leachate to be distributed along the full length. Figure 3-4 shows the cross-section design detail for the trough and a photo of the trough at Cell B.

An emergency overflow spillway was constructed for each of the three cells, as shown on record drawing IGL-3 and IGL-4, and detailed om IGL-6 in Appendix B. The riprap lining the spillway is contained in shallow gabion baskets over non-woven geotextile. The gabion baskets have been placed on both the upstream and downstream slopes, and have been placed on the slope surface (the gabions extend above the adjacent berm slope elevation).

Truck offload chutes were constructed at two location in each of the three cells.

Table 3-1: Sewage Lagoon Facility - Cell Summary

CELL	LENGTH (M)	WIDTH (m)	ACTIVE VOLUME (m^3)	NOTES
Cell A	293	120	53,220	New cell
Cell B	250	83	35,500	Remediated from the pre-existing cells
Cell C	203	86	35,500	Remediated from the pre-existing cells

Note: Data in the table as per the O&M manual (Table 5, Reference 4) and the Record Drawings (Appendix B)

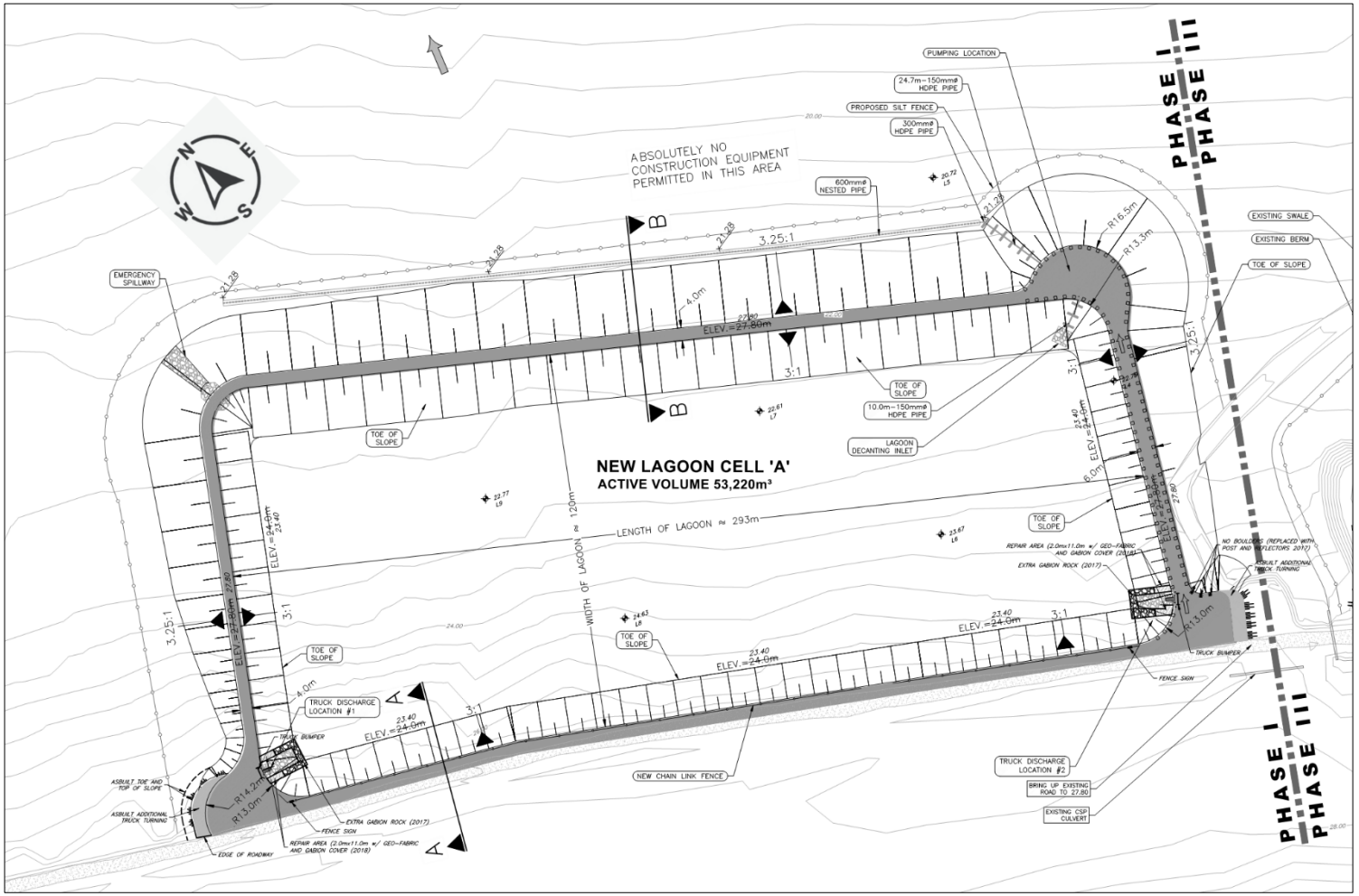
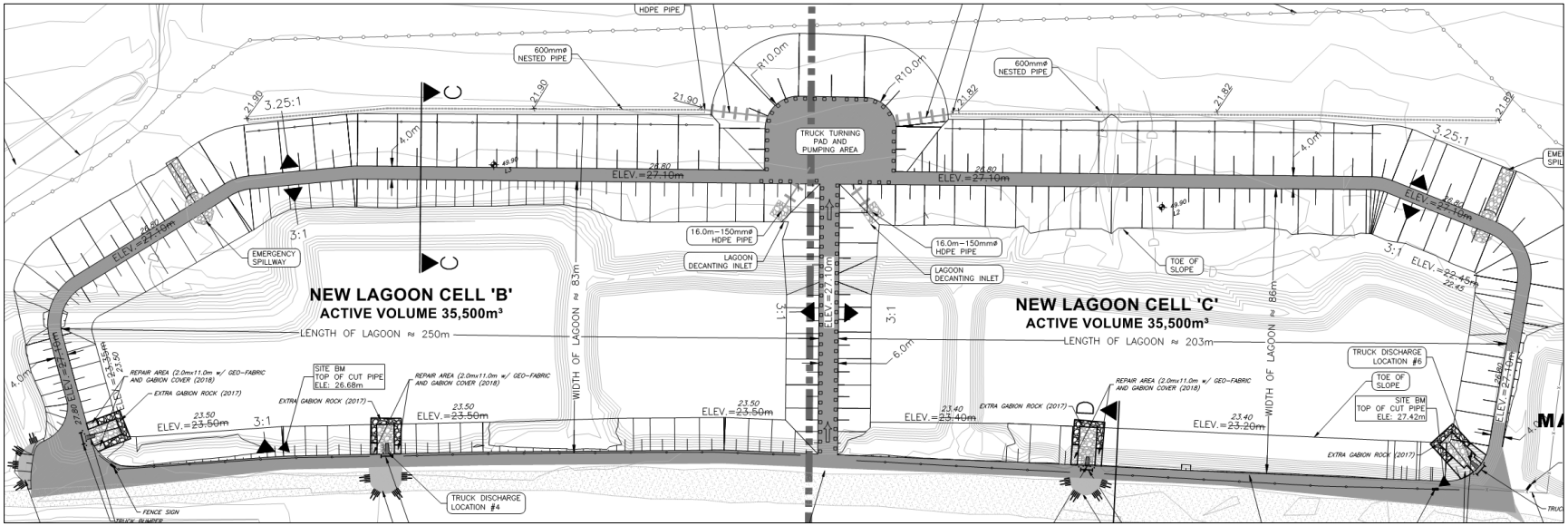
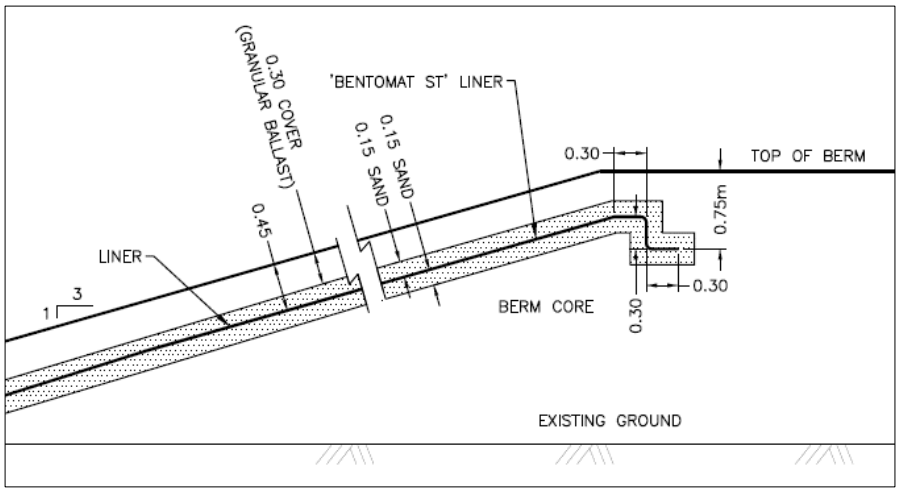


Figure 3-1: Igloolik Sewage Lagoon and Site Features – Cell A
(Excerpt from Record Drawing IGL-4, Sept. 25, 2018, Appendix B)



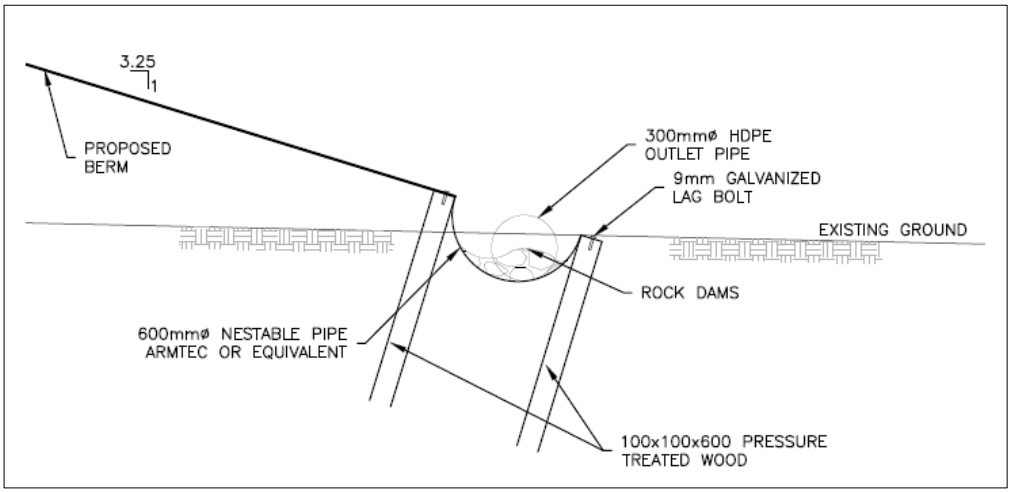
Excerpt from Record Drawing IGL-4, Sept. 25, 2018, Appendix B

Figure 3-2: Igloolik Sewage Lagoon and Site Features – Cell B and Cell C



Excerpt from Record Drawing IGL-5, Sept. 25, 2018, Appendix B

Figure 3-3: Igloolik Sewage Lagoon Facility – Configuration of Lagoon Slope and Liner Detail



(a) Trough Design Detail (Record Drawing IGL-5, Sept. 25, 2018, Appendix B)

(b) Photo of Trough at Cell B

Figure 3-4: Igloolik Sewage Lagoon Facility – Trough at Cell B

3.2 REPORTED ISSUES FROM PREVIOUS INSPECTIONS

There has not been any formal DSI carried out for the Igloolik lagoons previously. The following paragraphs briefly summarize the observations and potential issues from past inspection.

EXP Site Inspection (September 2019)

EXP conducted a site visit on September 24, 2019 (Appendix D), the second year following the completion of infrastructure upgrades of the lagoon facility and reported that the lagoon facility appeared to be functioning as intended, noting the following issues.

- Some cracking in the soil around the lagoon cells, suggesting settlement during freeze-thaw cycles. Photo No.1 in Appendix D shows the cracks near the downstream drainage trough.
- Some erosion near the downstream drainage trough caused by water pumped out of the lagoon. Photo No.3 in Appendix D shows water flows overtopping the trough. The report noted that the pumping setup did not conform to the intended setup and recommended that the operation manual and operation procedures be reviewed. However, no specific recommendations were provided.
- Signs of erosion along the lower portion of the upstream slopes are inferred by WSP, as shown in Photo No.2 from the EXP site review report (2019). It is noted that the issue of upstream slope erosion was not specifically raised in the EXP report.

DCGS Site Inspections (April and August 2022)

In the winter of 2022, Hamlet staff reported apparent sewage seepage through a berm (at Cell B facing the wetlands/ocean) and the situation was identified as an immediate emergency. DCGS staff carried out a facility inspection in April 2022 (Appendix E); they reported that there was no visible sewage exfiltrating/seeping or overflowing the lagoon cells, but that an inspection during the summer months should be carried out. Further discussion about this issue is provided in Section 5.4.3 for the downstream slope condition. It should be noted that the DCGS report mistakenly calls this Cell A; it has been confirmed by the Public Works Director, Mr. Steve Weedmark, that the reported seepage was concern was related to Cell B.

In the summer of 2020, the municipality reported a “breached berm of Cell A facing Cell B”. DCGS staff carried out a facility inspection in August 2022 (Appendix E) and confirmed that there were significant signs of cracked soil and signs of sewage exfiltration in the soil of the Cell A downstream berm slope facing Cell B were reported.

Other observations made by DCGS staff during the August 2022 inspection (Appendix E) were:

- Inspection of the interior berm slopes in Cell A identified a concerning issue of “soil breaking off in a visible three step process and collapsing into the sewage”, and “There is no visible sign of the installed liner”.
- Soil on all three exterior cell berm slopes had some cracks. Suggested possible causes of soil cracking were settlement during freeze-thaw cycles, or improper compaction during the construction.
- Cells B and C had no significant interior berm slope damage.
- There was no visible creeping or sliding soil movement noticed in any of 4 berms that were inspected.
- During the walkthrough, sewage pumping (decanting) was performed from Cell “B”. It was observed that the wastewater pumped out of the lagoon was causing erosion along the trough located on the North side of the lagoon (facing wetland and ocean). **significant washouts** were observed along the troughs.

Summary of Site Inspections

The following summarizes the four (4) main issues identified from the previous observations and inspections:

1. Cell A: soil steps or benches across the interior (upstream) cell slopes. The concern is the berm’s slope stability. Although the issue was raised recently in 2022 by DCGS, it is noted that sign of erosion can be inferred back in 2019 at the upstream slope from an early site review report by EXP (Photo No.2 in Appendix D).
2. Cell A: signs of exfiltration (seepage) in the East Berm, i.e., the berm of the Cell A facing Cell B. No visual signs of the GCL liner. The concern is the risk of uncontrolled release of effluent to the environment

due to liner defect or non-presence. The potential consequence of seepage could be internal erosion, piping, and berm failure.

3. Cell A: major cracks in the exterior (downstream) slope of the East Berm, i.e., the berm of Cell A facing Cell B. The concern is slope instability.
4. Cell B: Significant washouts and erosion along the outlet troughs.

4 REVIEW OF BACKGROUND DOCUMENTS

Table 4-1 provides a summary of the background documents provided by DCGS for review. The following summarizes the main findings from the review of background documents:

- In the 2010 Igloolik Geotechnical Investigation Report (Reference 1) by Trow, the borehole logs for L3 through L9, BH1 and BH2 are missing.
- The construction material specifications or QA/QC documents were not available for review. Typically, the construction specifications define the range of grain sizes of construction material and corresponding compaction efforts.
- The as-built drawings upon completion of construction were not available for review. It is noted that a set of record drawings (Appendix B)was provided but the drawings were not stamped by the design engineer. It is not certain whether the drawings represent the as-built condition of the lagoon facility.
- The Operations and Maintenance (O&M) manual, EXP, 2021 (Reference 4) appears to have some discrepancies, as listed below, and should be updated in the next revision.
  - The contact list in Table 1 on Page 3 needs to be updated. For example, the current Public Works Director is Mr. Steve Weedmark while the contact listed in the table is Mr. Donald Ittusardjut.
  - Some statements in the O&M manual are not consistent with the design document and the record drawings.
    - In the third paragraph on Page 8, it states "All the three berms have impermeable liner installed on the internal slopes and ***keyed into the underlying permafrost***". The design brief (Reference 3) shows that a fully lined lagoon has been adopted in design while the option of a liner installed in the berms keyed into the permafrost liner was **abandoned**. The construction record drawing (IGL-6, 2018) shows that the lagoon cells are fully lined. As such, this statement contradicts the design brief and the record drawings and should be corrected.
    - There appears to be a discrepancy between a statement regarding the spillway and the record drawing. In the second paragraph on Page 10, it states "….. the overflow spillway, which discharges at the elevation of the freeboard of the lagoon cell". The invert of the spillway (the base of the riprap gabion at crest) is about 0.6 m below the crest ground level (see Section A-A and B-B in the Drawing IGL-6 in Appendix B). The freeboard is 1 m below the crest for all three cells (see Section 3.5 in the O&M manual). As such the spillway will discharge only when water level reaches 0.6 m below the crest level instead of 1 m.
    - In the third paragraph on Page 8, it states "The berms have been designed …. with … **a 4 m wide crest"**. However, the record drawings (IGL-3 and IGL-4) show that the crest width is 6 m for the east berm of Cell A and the shared berm of Cell B and Cell C and the other berms have a crest width of 4 m.

Table 4-1: Background Document Review

YEAR	DOCUMENT NAME	NOTES
2010	Geotechnical Investigation, Liquid and Solid Waste Management for Hamlet of Igloolik, Nunavut, March 16, 2010, by Trow (Reference 1)	Geotechnical investigation report includes the data of boreholes and laboratory tests at the lagoon site for Cell A, B, and C. Underlying surficial layers of fill and tundra, the soils in the vicinity of the lagoon facility generally consist of sandy silt to silty sand till, occasional layers of sand and gravel and clayey silt, underlain be shallow bedrock (at between 2.1 to 4.7 m below site grade). The soil were determined to be not ice rich and non-saline. The borehole logs for L3 through L9, BH1 and BH2 are missing from the end of this report. DCGS confirmed that the report was provided as-is and no further revision of this report is available for review.
2010	Igloolik Lagoon Geothermal Report, RevA2 by Naviq Consulting Inc. (Reference 2)	This report provided thermal evaluation and inputs for lagoon design. It indicated that reliance on a frozen core dam concept was not considered to be prudent, and recommended that a liner or other barrier be incorporated into the dam design.
2014	Design Brief: Optimization of the Wastewater Facility Igloolik, Nunavut by Trow (Reference 3)	This report presented a design brief for the rehabilitation and expansion of the existing lagoon facility. It recommended construction of a new lagoon (cell) to the northwest of the existing lagoon facility and rehabilitation of the existing cells. It recommended that the new lagoon cells be fully lined and that they be decanted yearly through a pumping process. The rehabilitated sewage treatment facility would utilize the wetlands between the proposed facility and Foxe Basin to provide additional treatment of the effluent.
2018	Record Drawing Package – Wastewater Treatment Facility, Igloolik, Nunavut, September 25, 2018 by Trow (Appendix B)	The drawing package provided a set of record drawings for the lagoon, likely after the completion of construction. The drawings are not stamped by the design engineer. It is not clear whether the drawings reflect the as-built condition of the lagoon.
2019	Site Visit Report dated September 24th, 2019 by EXP (Appendix D).	Observations and issues documented in this report are summarized in Section 3.2.
2021	Operations and Maintenance Manual, Wastewater Treatment Facility (Sewage Lagoon System), Igloolik, Nunavut by EXP (Reference 4)	The original O&M manual was completed in 2014, and re-submitted and released for comment in 2020 . The present document was updated in 2021.
2022	DCGS Visit Report dated August 8, 2022 (Appendix E)	Observations and potential issues documented during a site visit by DCGS personnel are summarized in Section 3.2. It should be note that the concern raised in the winter of 2022, described as a leak in sewage lagoon Cell B, was mistakenly called Cell A in the DCGS report. This has been confirmed by the Public Works Director, Mr. Steve Weedmark.

5 DAM SAFETY INSPECTION

The field inspection was carried out by Greg Qu, P.Eng. with Mr. Steve Weedmark, the Public Works Director of Igloolik, on September 13 and 14, 2022. The inspection followed the Canadian Dam Association (CDA) Dam Safety Guidelines, other best practices and procedures in the industry and included interviews with the operation personnel whose comments have been incorporated into this report.

The weather conditions during the inspection were cloudy with showers, with air temperature variations between 3 to 7 °C. Over the previous one week, there were light rains and showers at the site.

5.1 ACTIVITIES SINCE PREVIOUS DAM SAFETY INSPECTION

There has been no formal DSI carried out previously for this structure.

5.2 WATER MANAGEMENT OVERVIEW

5.2.1 CLIMATE

The Hamlet of Igloolik is located at 69° 22.8' N and 81° 48.0' on Igloolik Island within the Foxe Basin, immediately east of the Melville Peninsula. It is located in the zone of continuous permafrost. The mean annual ground temperature in Igloolik is approximately -8 ˚C. The long-term mean annual air temperature at the Igloolik airport is -13.1 °C. The freezing index is approximately 5100 °C-days and the thawing index is approximately 400 °C-days. Mean monthly temperatures in December and January are in the order of -30 °C and mean monthly temperatures in June and July are in the order of +5 °C. The active layer is considered to be 1.5 m deep (Reference 2). The average annual rainfall in Iqloolik is 103 mm and the average annual snowfall is 1.8 m (Reference 4).

The average wind speed is about 14.4 km/h. For the winds over 36 km/h (20 knots), west and east winds dominate direction-wise in summer (Reference 5).

5.2.2 SITE WATER MANAGEMENT

The sewage lagoon facility is an annual retention lagoon facility that holds effluent during the year and is then decanted over a period of about 35 days for Cell A and about 20 days for Cell B and Cell C. It was designed so that when the cell effluent level reaches a determined height, it is discharged through a low-level HDPE drainage HDPE pipe, and outfalls to the downstream toe of the berm to a drainage trough. The lagoon is usually decanted in the late summer and early fall, before freeze-up, typically from July to October.

Surface water from snow melt and rain flows from the surrounding high ground (at the south) towards the north (towards the bay). There is a drainage ditch along the south side of the access road to direct runoff water away from the lagoon cells. The south sides of the cells are adjacent to the existing site access road. Some run off from the access road surface (particularly the north portion) may flow toward the cells. Except for the trough along the downstream toe of the north portion of the cells, no other formal surface water management structures are present around the west or east sides of the lagoon cells.

5.3 INSTRUMENTATION

There are currently no monitoring instrumentation installations at this site.

5.4 OBSERVATIONS FROM 2021 DAM SAFETY INSPECTION

5.4.1 GENERAL

A walk-over was carried out to visually assess conditions of the facility from a dam safety standpoint. The visual inspection included, but was not limited to, observing the deficiencies and potential or immediate concerns related to berm safety. In general, the visual inspection involved making observations of slopes, crests, and toes with regard to the integrity of the berm, potential seepage, and associated infrastructures, such as the offloading facilities and drainage troughs.

During the inspection, a decanting operation was underway for Cell B. The lagoon water level condition is summarized below.

- For Cell A, the lagoon water level at the time of the inspection was approximately 2 m below the crest of the dam. Cell A has a 1 m freeboard at maximum operating level (evident by the vegetation growth).
- For Cell B, the lagoon water level was approximately 2.5 m below the crest of the dam. A decanting operation was underway during inspection.
- For Cell C, the lagoon water level was approximately 3.5 m below the crest of the dam. As per the discussion with the operation staff, Cell C had been decanted before the inspection.

Photographs of various views of the lagoon were taken to serve as records of current conditions and reference for comparison with future DSI's. Some specific photos (or images) are referenced in following sections.

The inspection report forms together with photographic records are included in Appendix A. Where the deficiencies are noted, recommendations for remedial actions are provided in the following sections.

5.4.2 CELL A

5.4.2.1 *UPSTREAM SLOPES*

The slope portion below the maximum operating water level showed obvious signs of washout, soil steps and benches for all four berms of Cell A, as shown in the photographs in Figures A2 to A5 in Appendix A.

- The soil steps/benches were generally uniform along in the longitudinal direction, parallel with the alignment of the berms.
- The particle size of the remaining material along the soil steps/benches was generally coarser, indicating that the finer soil particles had been washed out.
- For the north and south berms (long sides), the soil steps/benches were up to about 0.1 m high in the upstream slope. For the east and west berms (shorter sides), the soil steps/benches were up to about 0.2 m to 0.3 high.

No cracks were observed along the upstream slopes.

The portion of the slope above the maximum operation water level (evident by the vegetation growth) was in a good condition.

The slope sections with riprap protection were in a good condition, as shown in the photographs taken near the truck discharge #1 and #2 in Figures A13 and A14 (Appendix A). No benches/steps, washout or other erosion was observed at the upstream slope protected by riprap, with or without gabion.

5.4.2.2 *DOWNSTREAM SLOPES*

In general, the downstream slopes are in a good condition except for the specific issues discussed at the east berm (discussed below). There were no signs of settlement. Some isolated cracks were observed across the downstream slopes, typically located within 3 m to 5 m from the toe of the slope. These cracks are likely due to

frost action. No obvious erosion features were encountered, except for those near the drainage trough, discussed below. Some localized areas of water ponding were found near the toe line. No sinkholes or seepage were observed during the inspection. The ponded water is likely due to runoff from recent rainfall.

Signs of seepage, i.e., a discolored zone, were observed along the east berm, over an area approximately 5 m wide, as shown in Figure A6 in Appendix A. Figure A7 presents a photo showing active seepage on August 29, 2021, which was taken and provided by Mr. Steve Weedmark. The following is a summary of communication with Mr. Steve Weedmark regarding this seepage issue:

- The seepage occurred when the water level reached the maximum operation level.
- The seepage reduced and stopped when the water level dropped by about 150 mm below the maximum operation level.
- No seepage in this area was observed/reported in the past from the completion of construction up until 2021.

Significant cracks were observed on the downstream slope about 60 to 80 m south from the north end of the east berm, as shown in the top photo in Figure A8. They were located within a zone approximately 20 m wide and about 3.5 m away from the toe. The cracks were typically about 50 mm wide, up to 200 mm wide.

There was some localized areas of water ponding at the downstream toe; the water was clear and showed no sign of active seepage or sink holes during inspection. The cracks are possibly due to (1) frost action (freeze/thaw), (2) settlement due to the potential thawing of a local ice rich soil deposit in the foundation after operation of Cell A over time, or (3) soil movement due to insufficient compaction within the identified zone.

5.4.2.3 *CREST*

The crest of the berms is surfaced with road topping. There was no sign of crest settlement or sink holes observed during this inspection. The bollards along the crest of the east berm were in a good condition with no sign of settlement, heaving or deflection, as shown in Figure A3.

5.4.2.4 *OUTLET TROUGH*

Figures A11 to A12 show the general layout and the condition of the drainage trough. A summary of observations made during WSP's inspection are:

- The inlet and outlet pipes were generally in good condition.
- The trough was dry and was not in operation during the inspection.
- There were signs of water flow (evident by discolored zones) towards the east, the opposite direction of the trough, see Photo 1 in Figure A12.
- There was no obvious sign of water near the west end (outlet) of the trough (see Photo 2 in Figure A12), indicating that the decant flow may not always reach the west end to fully utilize the trough.
- Significant erosion (wash-out) was observed below and near the trough (see Photo 3 in Figure A12). The erosion scars below the trough were up to 400 mm deep and 200 mm to 400 mm wide at both upstream and downstream sides. This is possibly due to the localized water flow through the perforations during decanting. Runoff from the downstream slope may also contribute to the erosion at a certain level.
- Some cracks were encountered downstream of the drainage trough within approximately 3 m of the trough (see Photo 4 in Figure A12).

5.4.2.5 *TRUCK DISCHARGE FACILITIES*

The equipment at truck discharge facility #1 and #2 were generally in good condition (see Figures A13 and A14). The upstream slope at these locations is protected by riprap. No sign of benches/steps, washout or other erosion was observed across the upstream slope protected by riprap, with or without gabion.

5.4.3 CELL B

5.4.3.1 *UPSTREAM SLOPES*

The portion of slope below the maximum operating water level showed some signs of minor erosion (see Figures A16 to A22 in Appendix A).

- There were minor soil steps on the slope having a depth of less than 50 mm for the east and west berms. The slopes of the north and south berms showed very minor soil steps of less than 25 mm.

- There were signs of minor washout. The particle size of the material remaining at the soil steps/benches was generally coarser, indicating that some of the finer soil particles had been washed out.
- The washout elevations were generally uniform along in the longitudinal direction, parallel with the alignment of the berms.
- Some isolated cracks were observed at the south side of Cell B near the fence along the access road (see Figure A20). No cracks were noted across the upstream slopes for the other berms. The cracks at the south side of Cell B, are likely, at least partially, due to the traffic and frost action.
- Some minor gullies were observed down the berm slope at the south side of Cell B near the fence along the site access road (see Figure A21).

The slope portion above the maximum operating water level (evident by the vegetation growth) was in a good condition. No sign of erosion, settlement, or cracking was observed during this inspection.

5.4.3.2 *DOWNSTREAM SLOPES*

In general, the downstream slopes are in good condition. There was no sign of sinkholes, active seepage, or settlement. Some isolated cracks were observed along the downstream slopes and were parallel with the longitudinal direction, typically located near the toe, as shown in the photo in Figure A24. No obvious signs of erosion or gullying was noted, except for those near the drainage trough, as discussed in the Trough section below. Some localized water ponding areas were found near the toe line. The ponded water was clear and was likely due to the runoff from recent rainfall.

The incident reported in the winter of 2022 (see Section 3.2) is believed to have been inaccurate based on discussion with Mr. Steve Weedmark during the WSP inspection. The field (Hamlet) staff were concerned that there could be a leak through the berm as they observed that the discharged sewage quickly drained. A follow-up investigation by operation staff suggested that the discharged sewage water likely flowed into the pond covered by snow and ice and there was no sign of seepage and breach at the berms.

5.4.3.3 *CREST*

There was no sign of crest settlement or sinkholes observed during this inspection. The bollards at the crest were in a good condition with no sign of settlement, heaving or deflection, as shown in Figure A23.

5.4.3.4 *OUTLET TROUGH*

A decanting operation was being carried out at Cell B during inspection. Figures A25 to A28 show the conditions of the decanting equipment and facility, including the drainage trough.

- The inlet and outlet pipes were in a good condition, as shown in Figure A25. A 3-inch pump was used for the decanting operation.
- There was water flow and drainage towards the east along the berm toe, and along the berm toe beyond the trough, as shown in Figure A26 and A27. This indicates that there is a poorly sized connection between the trough and the outlet pipe, such that the pipe outflow is overwhelming and overtopping the trough.
- The trough was partially filled with water, approximately one third to one half full. The west, approximately one-third of the trough was dry, as shown in Figure A29. This means that the decant water outlets through the perforations in the base of the trough.
- Significant erosion below and near the trough was observed, shown in Figures A26, A27 and A28. Some water has flowed downstream along the slope below the trough and developed major erosion gullies.
- Some cracks were encountered within approximately 3 m upslope of the drainage trough (Figure A28).
- Some water was ponded near downstream toe. The water is clear. No active seepage or sinkholes were noted.

5.4.3.5 *TRUCK DISCHARGE FACILITIES*

The truck discharge facilities #3 and #4 were generally in a good condition (Figures A30 and A31). Some local riprap damages were noted, possibly due to inappropriate sewage discharge. Repairs should be carried out as part of the routine maintenance program.

5.4.4 CELL C

5.4.4.1 UPSTREAM SLOPES

The upstream slope for Cell C is generally in a good condition, as shown in Figures A33 to A36. Minor washout was observed along the east and west berms (evident by the coarser particles). There was no sign of soil steps, benches, cracks, or settlement.

5.4.4.2 DOWNSTREAM SLOPES

In general, the downstream slopes are in good condition except the area near the drainage trough that exhibits some cracks and erosion. This discussed in the Trough section below. Some localized areas of water ponding were found near the toe line. The water was clear. No sinkholes or active seepage was observed during the inspection.

5.4.4.3 CREST

The crest is in a good condition with no sign of crest movement or sink holes. The bollards at the crest were aligned without any sign of settlement, heaving and deflection, as shown in Figure A23.

5.4.4.4 OUTLET TROUGH

Figures A38 to A40 show the general layout and the detailed condition of the drainage trough. Inspection observations are summarized as follows:

- The inlet and outlet pipes are generally in good conditions. Some debris was observed in the trough.
- The trough was dry and was not in operation during the inspection.
- Some erosion below and near the trough was evident as shown in Figure A40. Some gullies were observed locally near the trough, possibly due to the water overflow from the trough or runoff from the downstream slope.
- Some cracks were noted within about 3 m (upstream) of the drainage trough (Figure A40).
- Some water was ponded near downstream toe. The water is clear. No active seepage or sinkholes were noted.

5.4.4.5 TRUCK DISCHARGE FACILITIES

The equipment at the truck discharge facilities #5 and #6 were generally in a good condition (Figures A13 and A14).

5.4.5 EMERGENCY SPILLWAYS

Figures A44 to A46 show the emergency spillway conditions for Cell A, B, and C respectively. There is no indication of historical overflow through the emergency spillway. The field staff confirmed that the spillway has not been activated since the cells were constructed.

- The spillway is lined with shallow gabion baskets, indicated in the record drawings to be 0.23 m thick.
- Along the crest, the gabions are embedded into the berm with a depression about 100 mm to 300 mm below the adjacent crest level, based on a visual estimate. Considering the thickness of gabion (200 mm to 300 mm), the invert of riprap gabion was inferred to be about 300 mm to 600 mm below the berm crest surface.
- The gabion basket mats were placed on the surface of the upstream and downstream berm slopes (i.e., not embedded). In this way, the riprap placed in the gabions may be less effective in protecting slope material from erosion during emergency use of the spillway.
- The gabion basket mats are in a good condition.

6 DISCUSSION

Section 5 presented observations made during the DSI, and possible issues that were identified. This section discusses potential causes of the key issues identified, using the information gathered from the field inspection, the document review, and site meetings with Mr. Steve Weedmark. The key issues that were identified were:

1. Cell A: Soil steps /benches in the upstream (interior) slope.
2. Cell A: Seepage at the downstream slope of the east berm.

6.1 SOIL STEPS/BENCHES IN UPSTREAM SLOPE OF CELL A

6.1.1 POTENTIAL CAUSES

Potential causes of the soil steps/benches across the upstream slope of cell A were hypothesized. The two potential causes believed to be most likely were wave erosion and permafrost thaw of ice rich foundation materials. Other causes were considered but determined to be unlikely. For example, rapid draw-down was not considered to be credible due to the site-specific conditions (3H:1V berm slope) and operation procedure (decanting over a period of 20 days to lower the water level).

Table 6-1 summarizes relevant site observations evaluated against conditions that would be anticipated to be present for each hypothesized cause. In the table, green indicates that the anticipated conditions were present while red or grey indicates the anticipated conditions were not present. As shown, the wave erosion hypothesis was supported by all observations while the permafrost thaw hypothesis was supported by only one out of six site observations.

As such, it is concluded that the wave erosion is likely the cause of the soil steps/benches across the upstream slopes for Cell A.

6.1.2 POTENTIAL CONSEQUENCE

The erosion of the upstream slope reduces the soil cover thickness over GCL liner. Figure 3-3 shows the soil cover and GCL liner details. The GCL liner requires a minimum soil cover thickness to provide sufficient confining pressure in its normal operation condition. The minimum soil cover is 300 mm as per the manufacturer' guideline applicable for Bentomat ST, i.e., the GCL product used in Igloolik lagoon project (Section 10.4 in Appendix C). Without sufficient soil cover, the permeability of the GCL liner is expected to be negatively impacted as the bentonite in the GCL may not function well with the confining pressure below the minimum requirement.

In summary, the erosion of the upstream slope may lead to defects of the GCL liner due to a reduction of soil cover, and consequently potential leakage.

The current erosion depths were approximately 200 mm to 300 mm across the east and west berms of Cell A after 4 years of operation from 2018 to 2022. Without mitigation, further erosion will continue. At a similar rate the GCL liner could be expected to be fully exposed within the next 3 to 5 years noting that the total soil cover over GCL is about 450 mm thick.

6.1.3 MITIGATION OPTIONS

Table 6-2 summarizes the mitigation options, evaluation and recommendation. It is recommended that a layer of riprap be placed across the upstream slope to protect against wave erosion for Cell A. A hydrology assessment is recommended to quantitively evaluate the need for riprap protection (i.e., size of riprap) as per the typical wind conditions and the dimensions of the cell.

For Cell B, the erosion appears much less severe with a soil cover reduction of between 25 mm and 50 mm. Cell C has no obvious sign of wave erosion. Cell B and Cell C likely do not need mitigation as per the visual observations from the inspection.

If the riprap option is to be adopted, the design of riprap should be carried out by a qualified engineer. The design should follow industry standards regarding riprap gradation, which should be compatible with the underlying berm material. Locally available material should be selected for the use of riprap, given the site is remote. Two stockpiles at Igloolik were inspected for potential source material as riprap; Site A and Site B as shown in the photos in Figure A49 in Appendix A. The figure also shows the coordinates and locations of the two stockpiles. The materials in the stockpiles were the oversized material screened out from the native till for road construction. The materials appear suitable to be considered as riprap from a visual assessment. The riprap design should further verify the suitability of these materials.

6.2 SEEPAGE AT EAST BERM OF CELL A

6.2.1 POTENTIAL CAUSES

Observations of seepage (a discolored zone about 5 m wide) were noted on the downstream slope of the east berm at Cell A. Active seepage was reported and was recorded in a photo in August 2021 at the downstream of the east berm when the water level in Cell A was at the maximum operating level (Section 5). The seepage stopped when the water level dropped by about 150 mm.

The cause of the seepage is likely failure(s) or defect(s) in the GCL liner. The defects are likely located close to the triggering water level in the liner. Given that the seepage was first observed in 2021 (as per the discussion with Mr. Steve Weedmark), the defects in the GCL liner are likely to have developed recently, in the past two years. As discussed in the section above, the defects of the GCL liner may be caused by the severe erosion of the upstream slope and reduction of soil cover on the liner.

Other causes that may be possible but unlikely, include construction issues such as (1) the section of liner at this location was anchored into the berm at a lower elevation than designed, and (2) the liner was not properly installed (sealed) in this section. Given that no seepage issues were observed in the first 3 years from 2018 to 2020, the likelihood of these causes is considered to be low.

6.2.2 POTENTIAL CONSEQUENCE

A potential consequence is that the liner will continue to degrade and seepage may increase, leading to piping, internal erosion, and without mitigation, eventual breach of the berm. An uncontrolled release of effluent, will negatively impact the environment.

6.2.3 MITIGATION OPTIONS

According to the description from Mr. Steve Weedmark, the triggering water level is about 150 mm below the maximum operation water level (i.e., 1 m below the crest). As such, in the short-term, it is recommended to control the water level in Cell A so that it remains below the triggering water level (1.15 m below the crest) with an additional suitable safety margin (0.15 m). Given that the lagoon facility was designed with sufficient capacity for the projected 2036 population (Table 2.1, Reference 3), operation below the seepage triggering level appears achievable if utilizing the full capacity of Cell B and Cell C. The operation and decanting plan may be adjusted accordingly as needed.

Long-term mitigation options include (1) remediation of the defected/failed section of GCL liner, and (2) installation of a separate liner in the berm which will be anchored into permafrost.

The GCL remediation option (Option 1) is expected to consist of the following steps.

1. Expose the GCL liner sections of concern by removing soil cover. The area of repair should cover the identified seepage zone with a reasonable buffer zone at each side to ensure the GCL sections with potential defects are fully repaired.

2. Place additional GCL panels over the existing liner, with bentonite powders at the edges to seal the seams.
3. Carefully place the soil cover over the GCL liner.
4. Place a layer of riprap for wave protection.

The seepage cut-off option (Option 2) includes a cut off barrier installed in the downstream berm to tie in with the permafrost in the foundation. This option is to be evaluated considering the impact of global warming and other details such as a tie-in seal with the existing liner. Other alternatives include cut-off barriers of slurry trench and sheetpiles, which are more costly are not recommended for further assessment.

The mitigation measures should be further evaluated in the detailed design phase to optimize the cost, performance and schedule.

Table 6-1: Evaluation of Potential Causes for Soil Steps Across Upstream Slope of Cell A

RELEVANT OBSERVATIONS	POTENTIAL CAUSE NO.1 WATER WAVE EROSION	POTENTIAL CAUSE NO. 2 PERMAFROST THAW IN FOUNDATION
1. Soil steps/benches were uniform along the longitudinal direction.	Wave erosion would yield uniform soil steps corresponding the water levels	The soil steps would be undulate for this hypothesis.
2. Sign of washout (Coarser particles remained).	Wave action washes out fine material from soil.	Not relevant to this hypothesis.
3. West and east berms were in a worse condition.	Dominant wind gusts in west-east direction in summer, so does the wave action.	The severity of the issue would be random for four berms for this hypothesis.
4. Cell A is the worst for this issue. Less severe issue for Cell B, and the least for Cell C.	The pond area decreases from Cell A, Cell B to Cell C. Wave action depends on the area/fetch of open water.	Cell A is new. Cell B and Cell C are on the previous lagoon site with stabilized thermal region.
5. Bollard posts at crest aligned well, showing no sign of ground movement. No cracks at crest and upstream slope	Wave erosion won't induce global movement of berm.	Differential settlement and lateral movement are expected for this hypothesis.
6. The slope section with riprap protection showed no issue, near the truck discharge locations #1 and #2	Riprap prevented wave erosion for the section of slope.	The same issue would occur regardless of the presence of riprap
Remarks	Likely Case	Unlikely Case

Notes: 1. Green indicates that the conditions anticipated to be present to support the hypothesized cause were present while red or grey indicates the anticipated conditions were not present.

Table 6-2: Mitigation Options for Soil Steps Across Upstream Slope of Cell A

OPTIONS	EVALUATION	RECOMMENDATION
Place riprap protection layer	This will protect the soil from further erosion and minimize the risk of affecting the GCL leading to leakage.	This option is preferred to minimize the risk to a level As Low as Reasonably Practicable (ALRP).
Place a wave break (berm(s) or equivalent placed in the pond to divide the exposed water area into sub-zones) to minimize wave action.	This option is also effective but likely has a higher cost than the riprap option, due to the more construction materials needed. This option may also reduce the operational capacity of Cell A.	This option is not recommended.
Do nothing	Given the current erosion condition (after 4 years of operation), at the same rate the liner could be fully exposed within the next 3 to 5 years. Defects in the GCL liner may further develop, leading to seepage across a larger area. The cost of remediation work will be higher.	This option is not recommended unless the lagoon is to be decommissioned in 5 years.

7 CONCLUSIONS AND RECOMMENDATIONS FROM 2022 DSI

The berms of the Igloolik sewage lagoon facility were inspected and the main findings were documented in Section 5 of this report. In general, Cell B and Cell C are considered to be in a satisfactory condition. Several issues were identified for the berms of Cell A. Section 6 discusses the causes and mitigation options for the two main issues, upstream slope erosion and seepage along a section of the downstream slope of the east berm of Cell A. Recommendations for the continued safe operation of the lagoon facility arising from the 2022 DSI are provided in Table 7-1. As there have been no previous formal DSI's conducted for the sewage lagoon facility, there are no documented issues or recommendations for comparison.

The priority for each recommendation has been assessed based on the following priority scheme:

Priority 1 - A high-probability or actual dam safety issue considered dangerous to life, health, or the environment, or a significant risk of regulatory enforcement.

Priority 2 - If not corrected could likely lead to dam safety issues leading to injury, environmental impact, or significant regulatory enforcement.

Priority 3 - Single deficiencies, or occurrences, or non-conformances that alone would not be expected to result in dam safety issues.

Priority 4 – Further improvements are necessary to meet industry best practices or reduce potential risks or a best management practice.

Table 7-1: Recommendations from 2022 DSI

NO.	ITEM	2022 RECOMMENDATIONS	PRIORITY	TIMEFRAME
1	Soil steps/benches in upstream slope of Cell A	Significant soil steps/benches were reported by DCGS and observed by WSP. The cause of the issue is likely erosion due to wave action. A riprap layer should be designed and placed on the upstream slope to protect the soil from further erosion.	3	1 to 3 years (2023 to 2026)
2	Signs of Seepage at East Berm of Cell A	In the short term, it is recommended to keep the water level in Cell A below the triggering level of seepage (See Section 6.2.3).	2	Summer 2023
		Carry out further investigation and options assessment for either replacement of affected liner panel(s) or embedment of new section of GCL into permafrost, as discussed in Section 6.2.3.	3	1 to 3 years (2023 to 2026)
3	Cracks at downstream slope of East Berm of Cell A (about 60 to 80 m away from the north end).	The cracks in this area should continue to be monitored for change using the reference photos provided in this report. The area near the toe should be inspected regularly for any sign of seepage or sinkholes. A contingency plan should be developed to address the situation where the cracks expand and form a potential slope slough.	4	Annual inspection. Contingency plan in 2023
4	Riprap damage at Truck Discharge Facilities #3 and #4 for Cell B.	Some localized riprap damage was noted, possibly due to inappropriate sewage discharge. Repair should be carried out in the routine maintenance program.	4	2023 Summer
5	Trough	In the short-term, perform regular maintenance to address the erosion near the trough, inspect the trough and repair damage if any.	4	Annually
		For long-term, consider upgrading the drainage system to improve the performance. (1) adjust the gradient of the trough to discharge the decant water in a more uniform way, (2) upgrade the tie-in between the outlet pipe and the trough so as to better direct water into the trough, (3) develop an alternative solution or decant water dispersion.	4	5 to 10 years
6	Spillway	The riprap gabion was placed above the berm surface (not embedded) at both upstream and downstream slopes. Monitor the effectiveness of the emergency spillway if or when it is activated.	4	If spillway is activated
7	Drone survey	A detailed survey (e.g. drone survey) of the sewage lagoon is recommended to be carried out by a Registered Land Surveyor in summer 2023. The purpose of the survey is to (1) establish the as-built condition including the upstream and downstream slope angle, and (2) serve as a reference for comparison with future measurements.	4	2023
8	O&M Manual update	The current Operation and Maintenance (O&M) Manual (2021) needs to be updated, including but limited to the items identified in Section 4.	4	1 to 3 years
9	Monthly inspection and documentation	Monthly inspections should be carried out by the municipality between Spring thaw and Fall freeze each year starting in 2023 by qualified personnel. A template should be developed listing all areas (erosions, seepages, cracks) to be inspected. The inspections should be documented with coordinates, notes and photos, even if these are no obvious changes or unusual conditions noted between inspections.	4	Monthly inspections during warmer months

NO.	ITEM	2022 RECOMMENDATIONS	PRIORITY	TIMEFRAME
10	Dam Safety Inspection	A formal inspection should be carried out annually by a professional engineer as per the requirement of the O&M manual (Section 6.2, page 27, Reference 4).	4	Annual Formal Inspection

8 CLOSING REMARKS

This report has been prepared for the exclusive use of Department of Community and Government Services, Government Nunavut, for specific application to the area within this report. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. WSP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The comments and recommendations related to safety status of the various structures are based on visual observation of the exposed and accessible surfaces of the inspected structures and our experience with performance of similar structures. This report has been prepared in accordance with generally accepted engineering practice, as well as guidelines provided in the CDA guidelines and technical bulletins. No other warranty, expressed or implied, is made.

We trust this report meets your requirements. Please contact the undersigned if you have any questions or comments.

Yours truly,
WSP E&I Canada Limited

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9 REFERENCES

1. Trow Associates Inc., 2010, Geotechnical Investigation, Liquid and Solid Waste Management for Hamlet of lgloolik, Nunavut, March 16, 2010.

2. Naviq Consulting Inc., 2010, Igloolik Lagoon Geothermal Report, RevA2.

3. EXP Services Inc., 2014, Design Brief: Optimization of the Wastewater Facility lgloolik, Nunavut.

4. EXP Services Inc., 2021, Operations and Maintenance Manual, Wastewater Treatment Facility (Sewage Lagoon System), Igloolik, Nunavut.

5. NAV CANADA, 2001, The Weather of Nunavut and The Arctic - Graphic Area Forecast 36 and 37, NAV CANADA.

6. Canadian Dam Association (2013), Dam Safety Guidelines 2007 (Revised 2013). Prepared by the Canadian Dam Association, 2013.

APPENDIX

A DSI CHECKLIST AND SELECTED PHOTOGRAPHS

Igloolik Sewage Lagoon - Cell A

CLIENT
Department of Community and Government Services

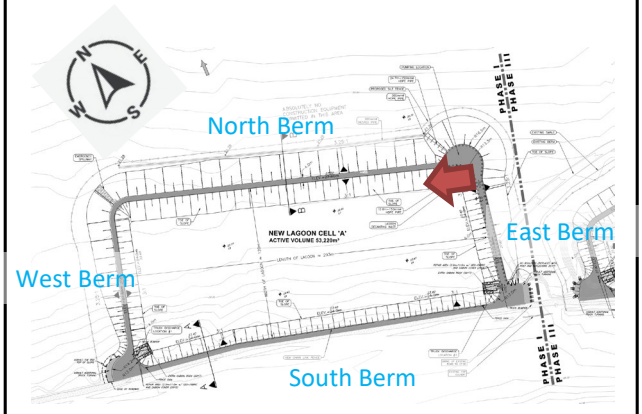
PROJECT
2022 Igloolik Sewage Lagoon Inspection

CONSULTANT

YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A1**



Attributes	
Photograph	A – US –North Berm
Description	View of upstream slope
Observations	The soil step is generally uniform in the longitudinal direction. Soil erosion with steps up to about 0.1 m high. No sign of GCL exposure.
Remarks	There are signs of significant erosions.

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Department of Community and Government Services

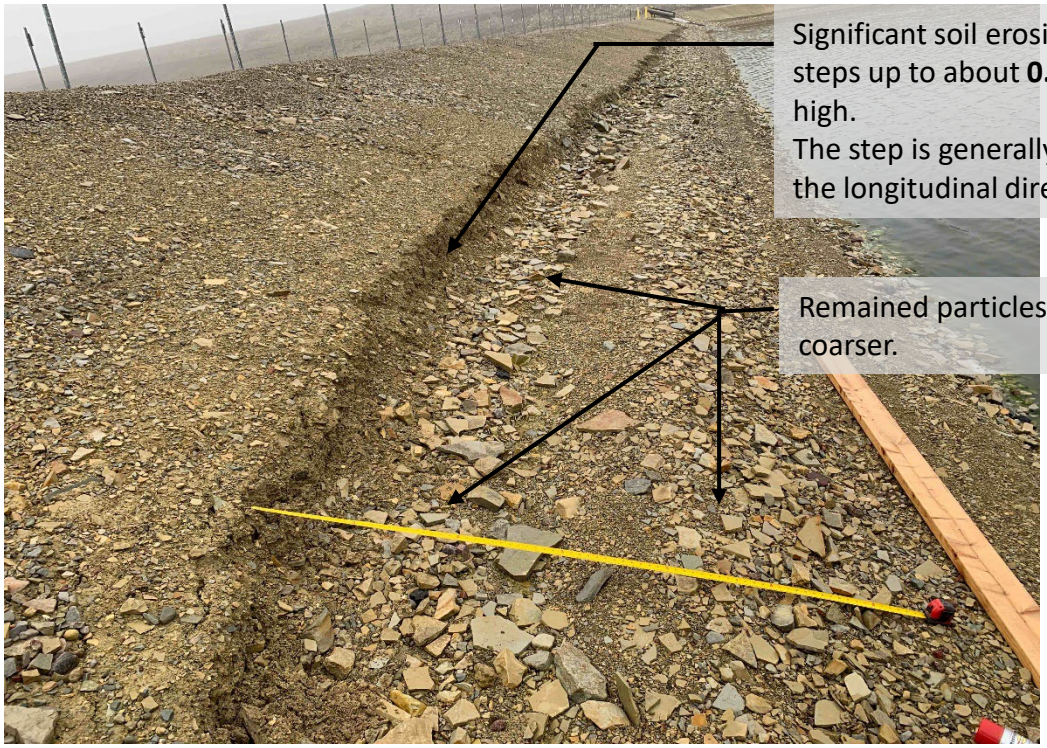
PROJECT
2022 Igloolik Sewage Lagoon Inspection

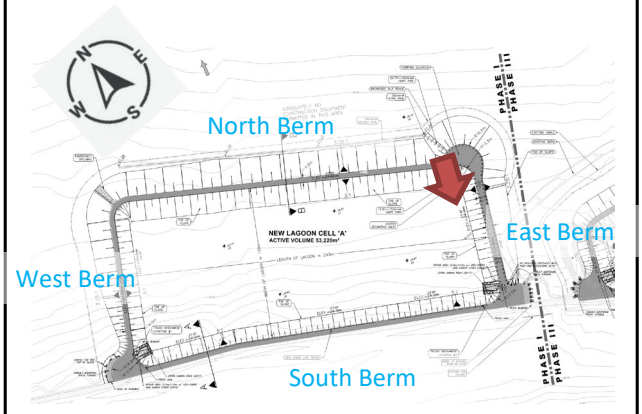
CONSULTANT
wsp

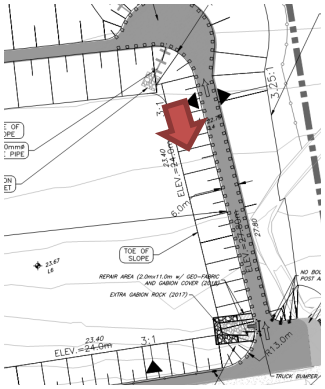
YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A2**







Attributes	
Photograph	A – US –East Berm
Description	View of upstream slope
Observations	Significant soil erosion, with steps up to about 0.2 to 0.3 m high. Steps are generally uniform in the longitudinal direction. Remained particles at steps are coarser in general, indicating finer particles have likely been washed out. No sign of GCL exposure.
Remarks	There are signs of significant erosions.

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

CONSULTANT
wsp

YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
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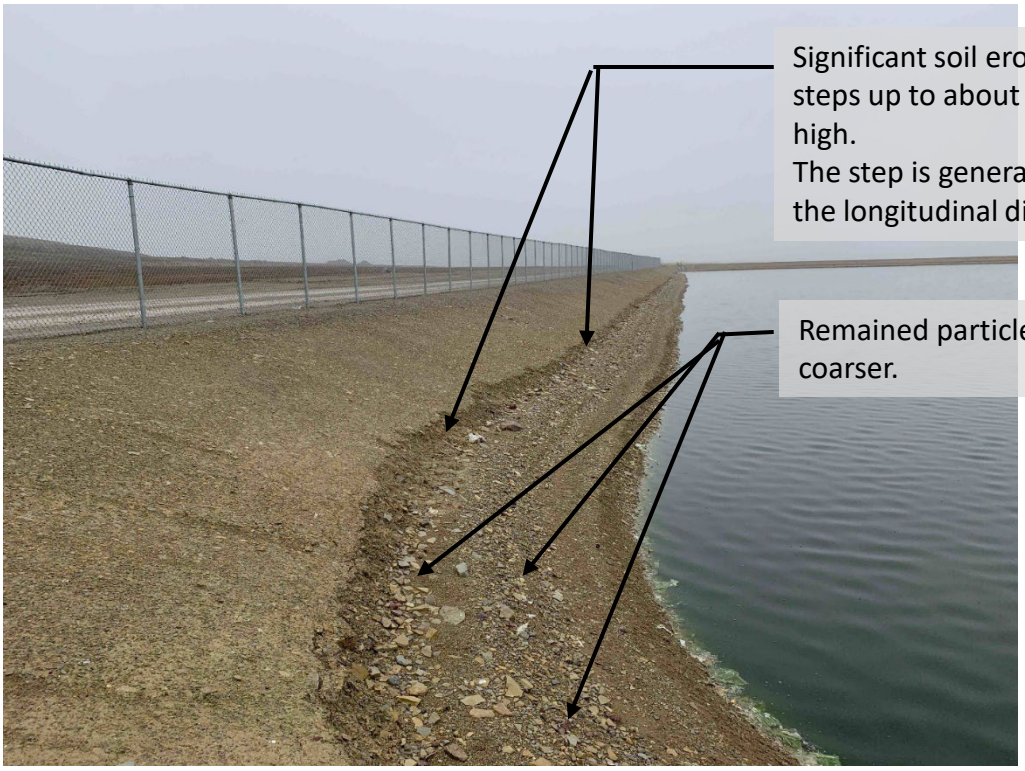

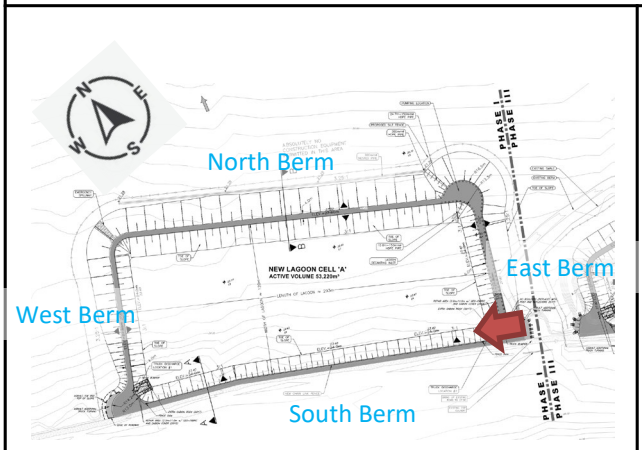

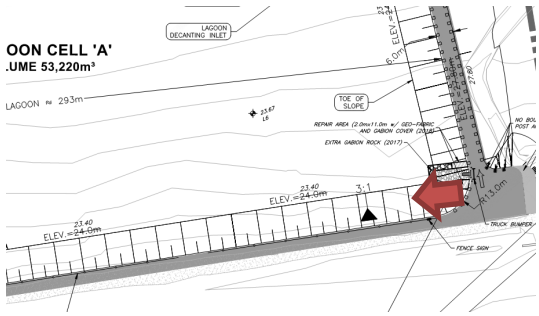

Attributes	
Photograph	A – US –South Berm
Description	View of upstream slope
Observations	Soil erosion, with steps up to about 0.1 to 0.15 m high. Steps are generally uniform in the longitudinal direction. Remained particles at steps are coarser in general, indicating finer particles have likely been washed out. No sign of GCL exposure.
Remarks	There are signs of significant erosions.

CLIENT
Department of Community and Government Services

PROJECT
2022 Igloolik Sewage Lagoon Inspection

CONSULTANT
wsp

YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
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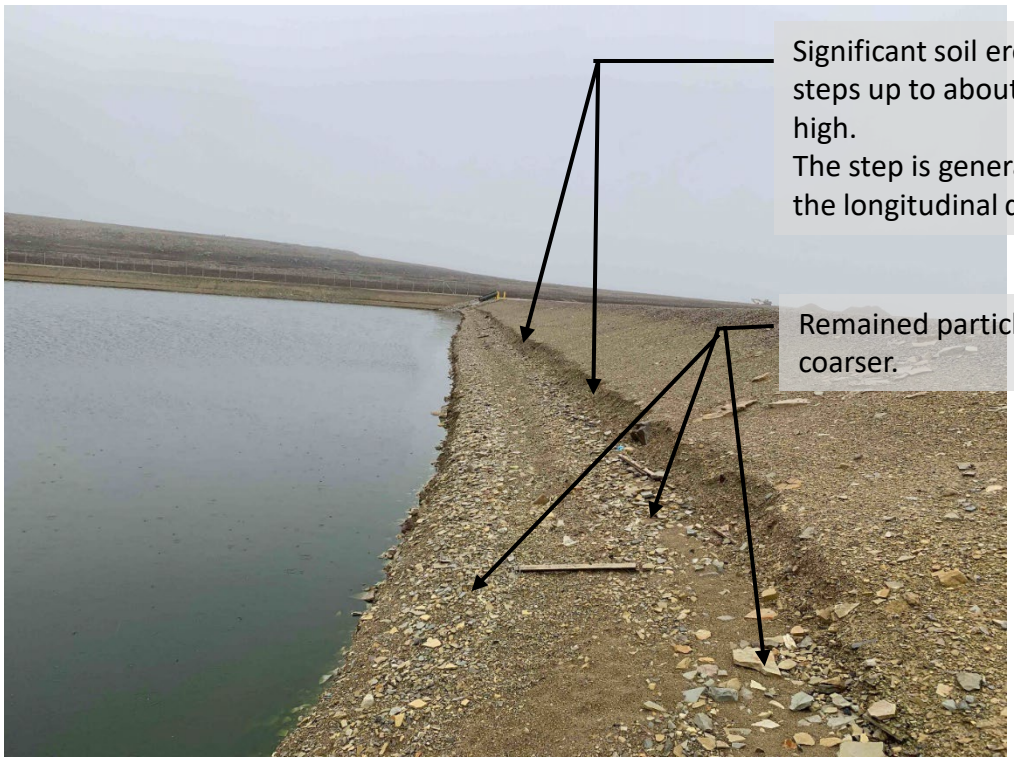
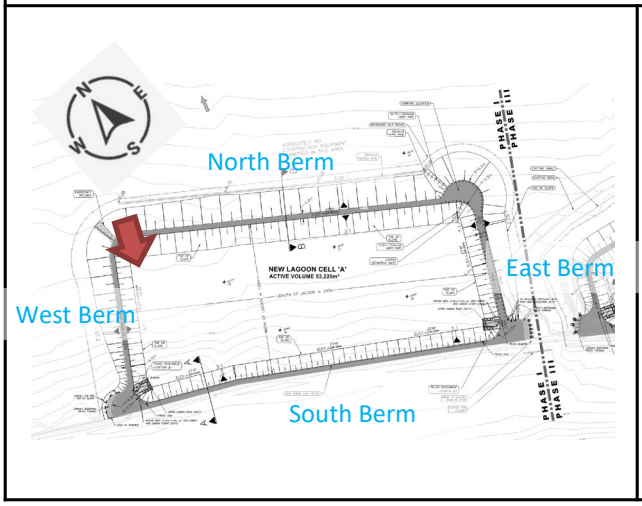
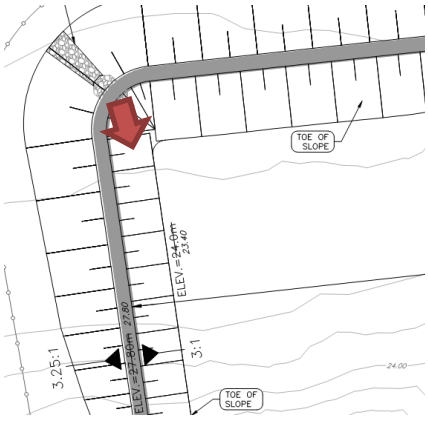
TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A4**







Attributes	
Photograph	A – US –West Berm
Description	View of upstream slope
Observations	Soil erosion, with steps up to about 0.2 to 0.3 m high. Steps are generally uniform in the longitudinal direction. Remained particles at steps are coarser in general, indicating finer particles have likely been washed out. No sign of GCL exposure.
Remarks	There are signs of significant erosions.

CLIENT
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PROJECT
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CONSULTANT
wsp

YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
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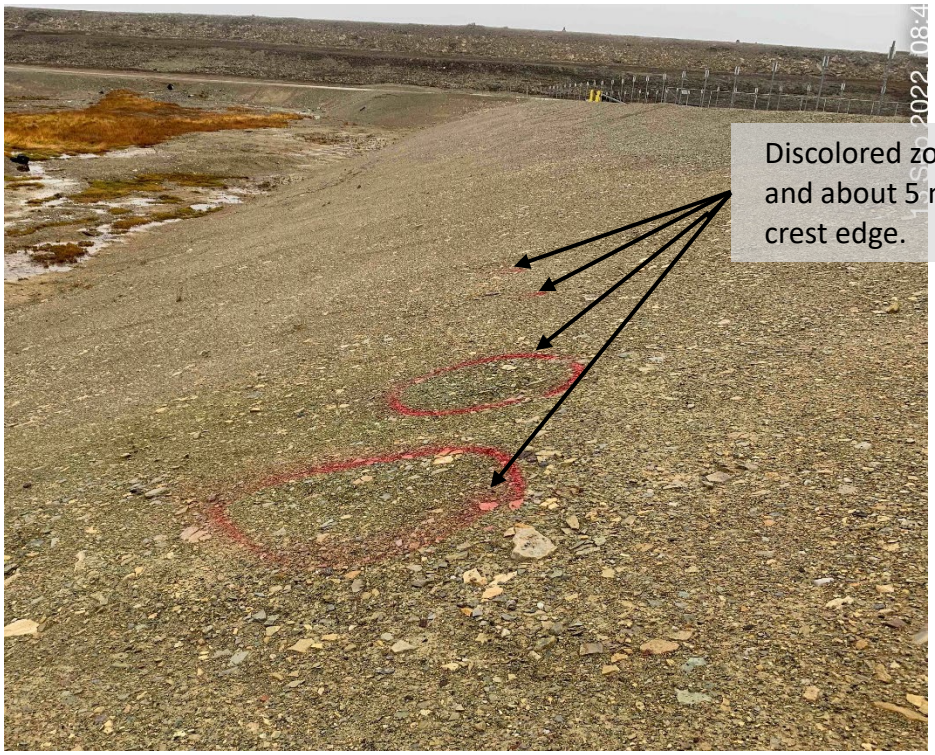
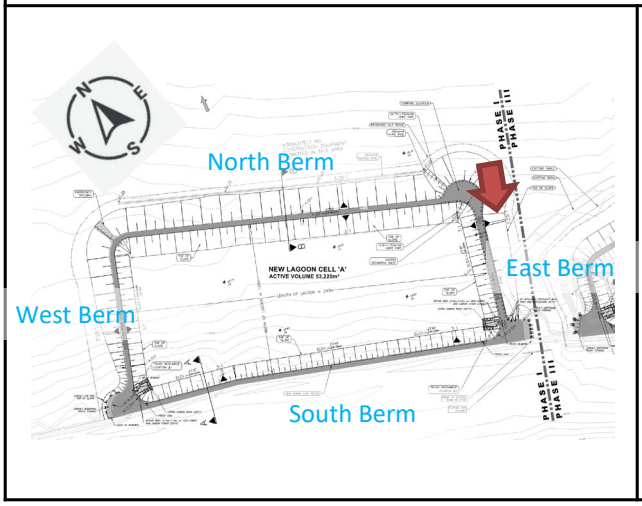
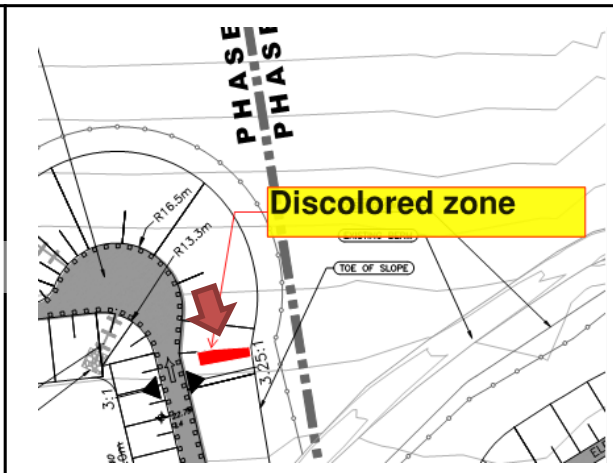
TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A5**







Attributes	
Photograph	A – DS – Seepage at East Berm
Description	View of sign of seepage at downstream slope
Observations	- A discolored zone encountered at downstream slope at east berm. - The discolored zone about 5 m wide and about 5 m distance from the crest edge. The elevation of this zone is about 1.5 m below the crest. - No sign of active seepage / sink holes during inspection.
Remarks	The discolored zone indicates a previous seepage at the downstream slope of East Berm.

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

CONSULTANT
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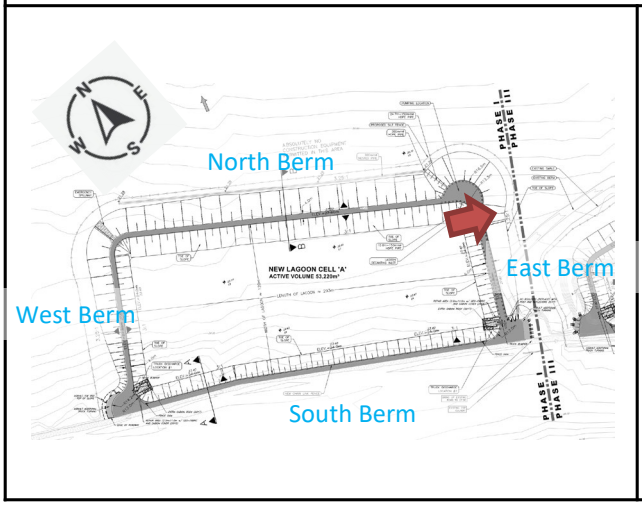
YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

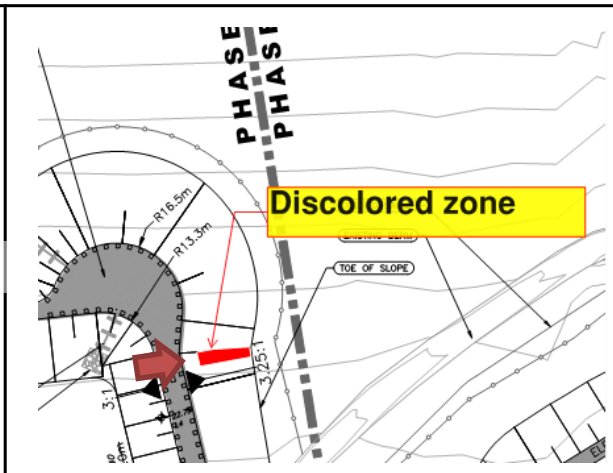
TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A6**

Active seepage zone observed when Cell A had high water level.

Note: Photo was taken by Mr. Steve Weedmark on August 29 2021.





Attributes	
Photograph	A – DS – Seepage at East Berm
Description	View of seepage from downstream slope
Observations	- Active seepage was observed during high water level in Cell A.
Remarks	The photo confirmed the presence of seepage from downstream slope of East Berm.

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2022 Igloolik Sewage Lagoon Inspection

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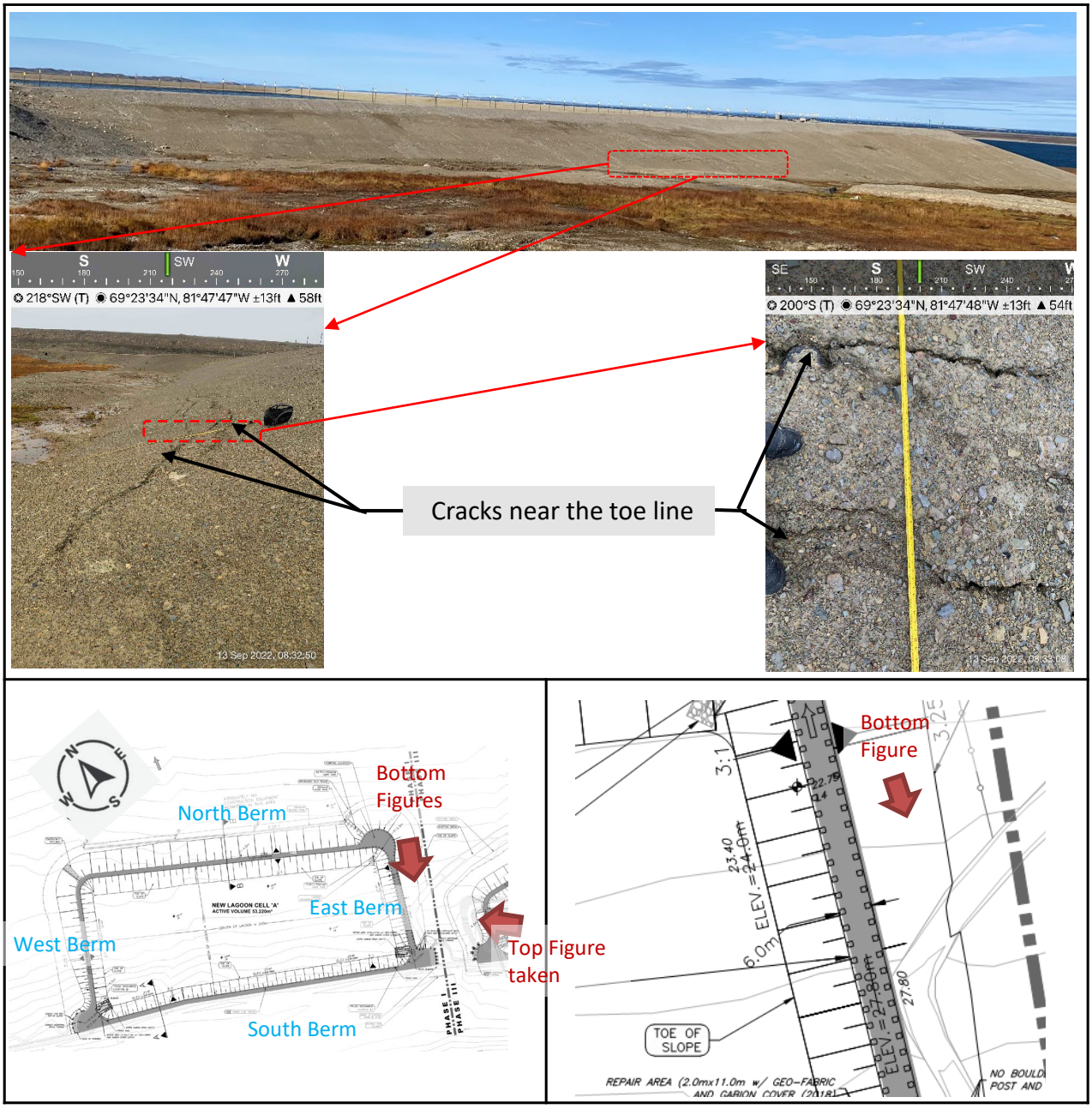
TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A7**



Attributes	
Photograph	A – DS – East Berm
Description	View of cracks at downstream slope
Observations	- Cracks at downstream slope, about 3.5 m away from the toe line. Crack widths about 50 mm, upto 0.2 m. - Water ponding near the toe line are clear. No sign of active seepage / sink holes during inspection.
Remarks	There are a set of cracks near the toe line, possibly due to thermal stabilization at toe or local slope slough.

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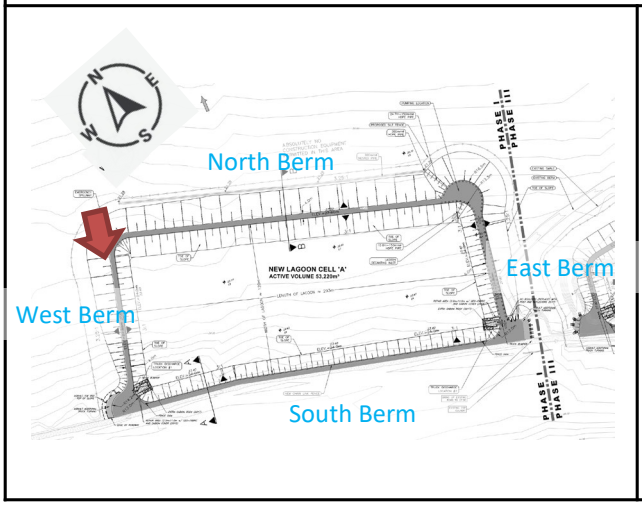
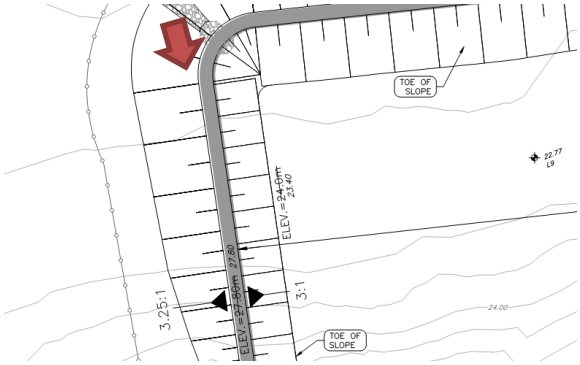
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A8**





Attributes	
Photograph	A – DS- West Berm
Description	View of downstream slope
Observations	No sign of cracks, active seepage, or sink holes. No sign of erosion.
Remarks	The downstream slope is in a good condition.

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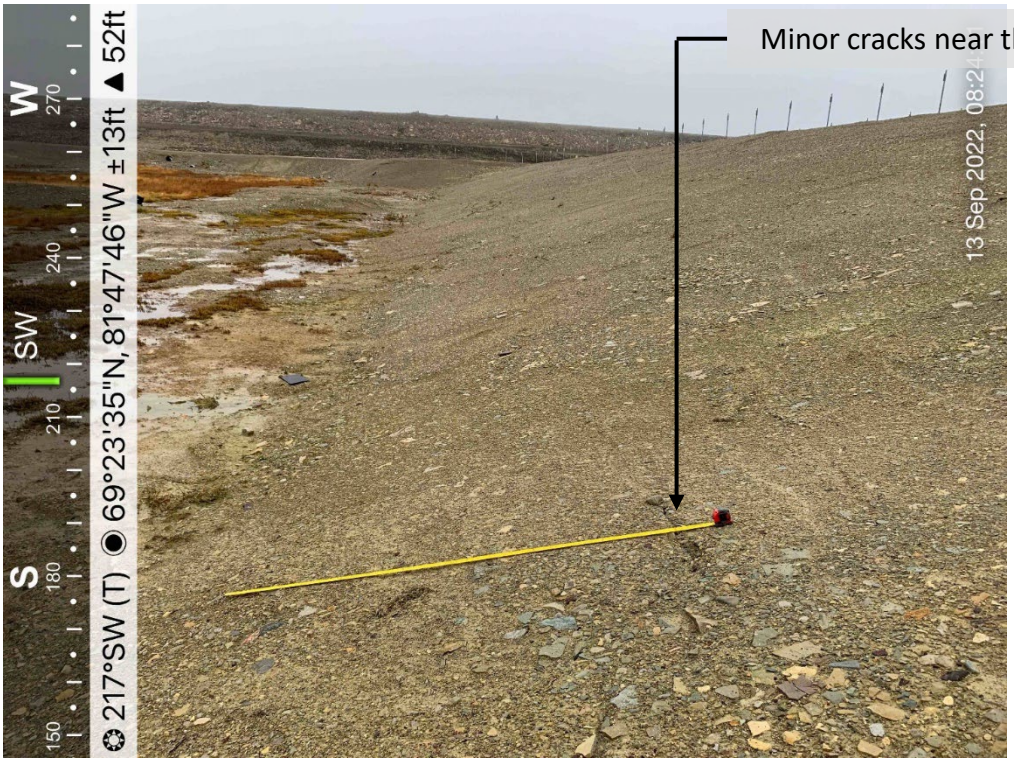
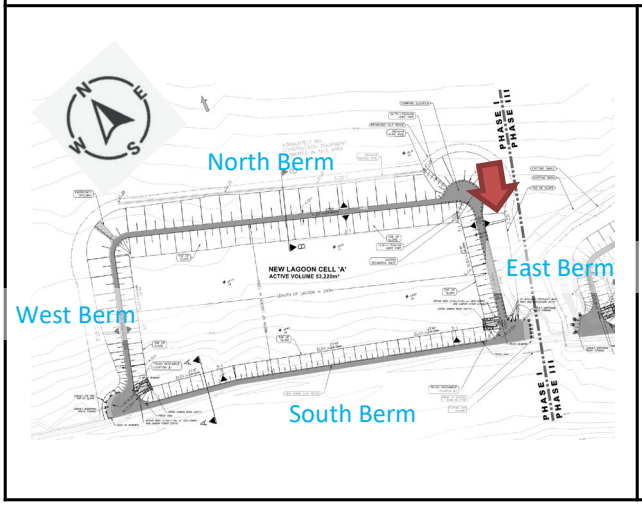
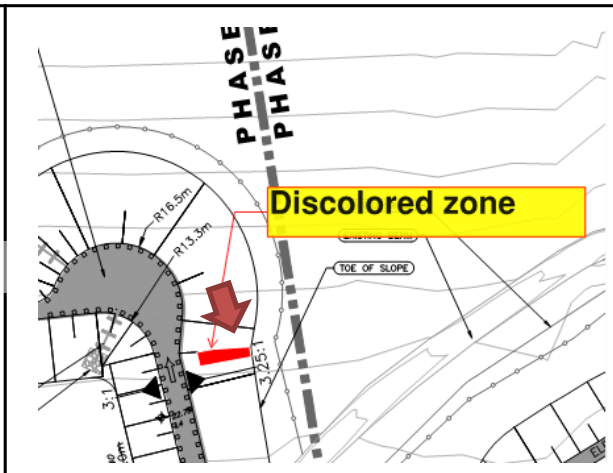
APPROVED	Jane Doucette

TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A9**







Attributes	
Photograph	A – DS – East Berm
Description	View of minor cracks at downstream slope
Observations	-Minor cracks at downstream slope
Remarks	Cracks are minor and isolated.

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

CONSULTANT
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YYYY-MM-DD	2022-09-27
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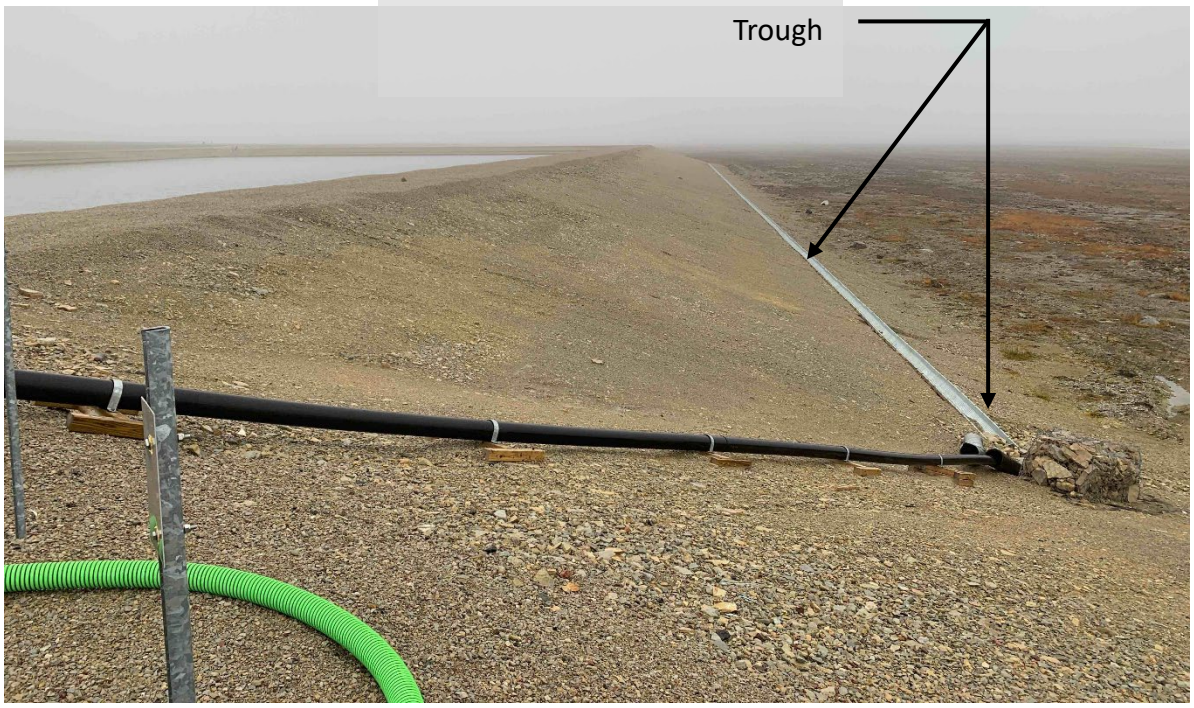
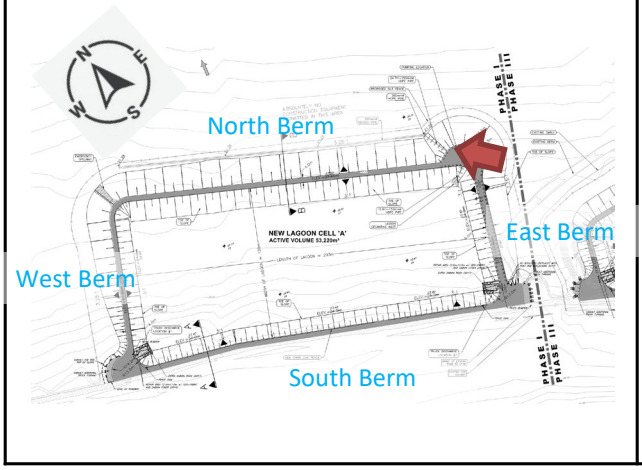
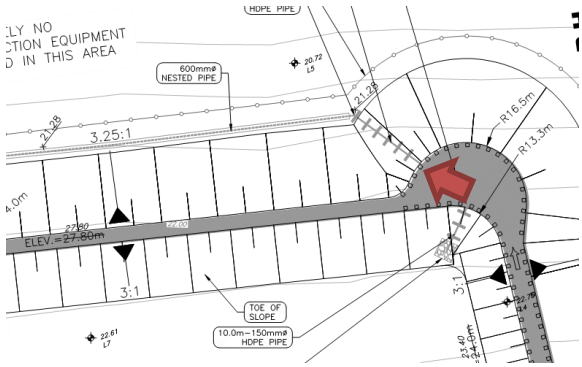
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A10**







Attributes	
Photograph	A – Trough
Description	View of decant pump outlet pipe and trough
Observations	The downstream slope is in a good condition. The outlet pipe is in a good condition
Remarks	N/A

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

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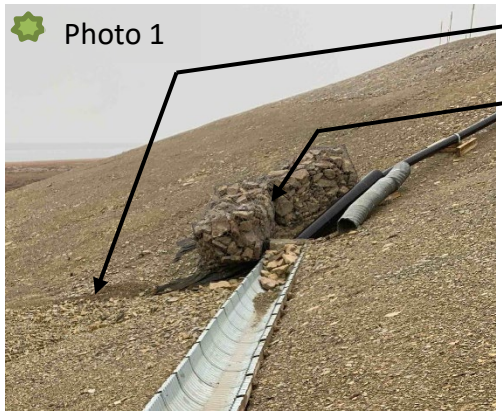
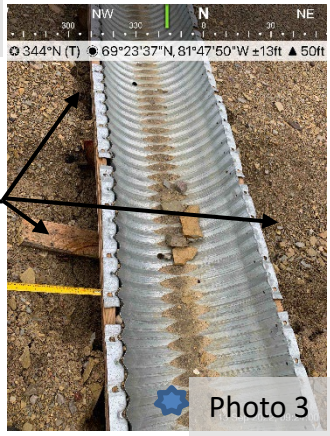
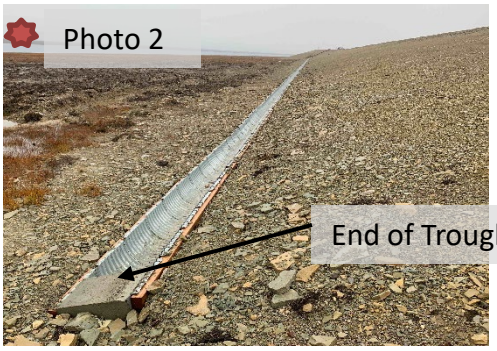
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

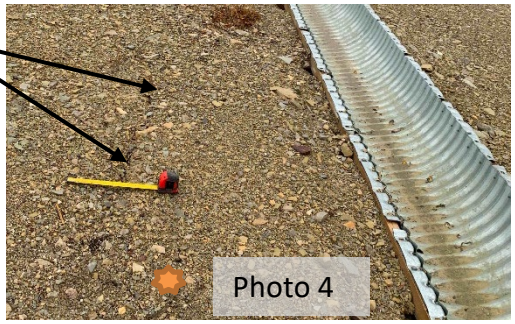
TITLE
Cell A

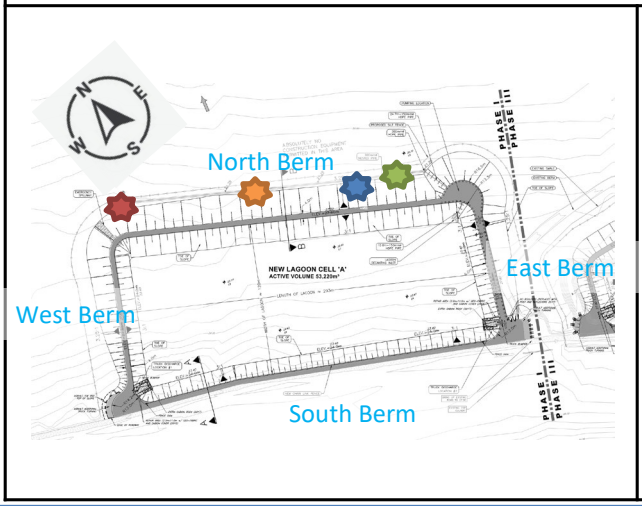
PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A11**

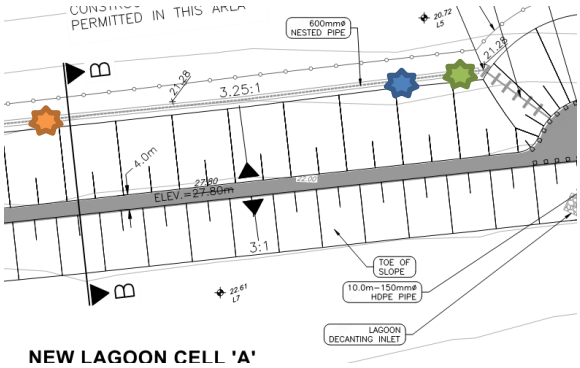












Attributes	
Photograph	A – Trough
Description	View of trough
Observations	Trough is currently not in operation. Dry condition for the trough. (See Photo 1, 2) Erosions below trough up to 0.4 m deep and 0.2 m to 0.4 m wide for both sides. (See Photo 3) Cracks at downstream slope near trough are about 10 to 25 mm (See Photo 4)
Remarks	Significant erosions near the trough. Cracks at downstream slope near trough are local and isolated with a width from 10 mm to 25 mm.

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2022 Igloolik Sewage Lagoon Inspection

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YYYY-MM-DD	2022-09-27
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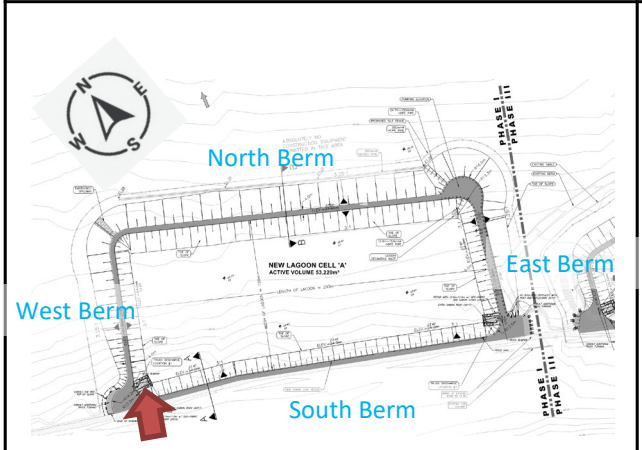
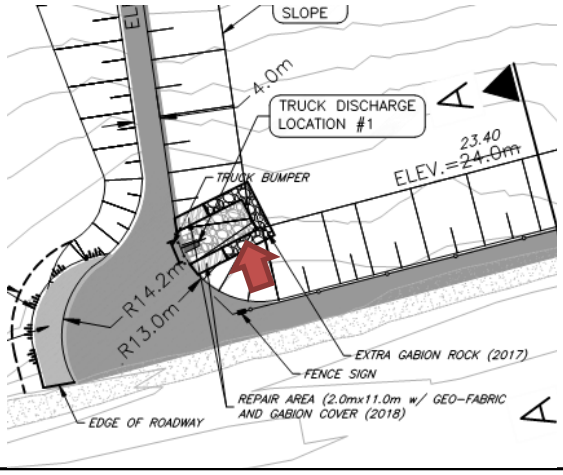
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A12**

No visible sign of issue (benches, wave erosion) for the riprap protected slope section.





Attributes	
Photograph	A – US – West Truck Discharge Facility (#1)
Description	View of upstream slope of West Truck Discharge Facility
Observations	-No visible issue (benches, wave erosion) for the riprap protected slope section, regardless of the presence of gabion box. -Truck Discharge Facility equipment in a good condition.
Remarks	West truck discharge area is in a good condition.

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2022 Igloolik Sewage Lagoon Inspection

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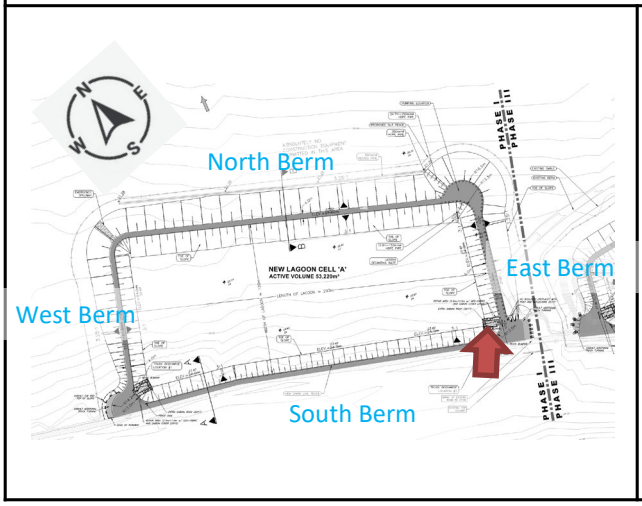
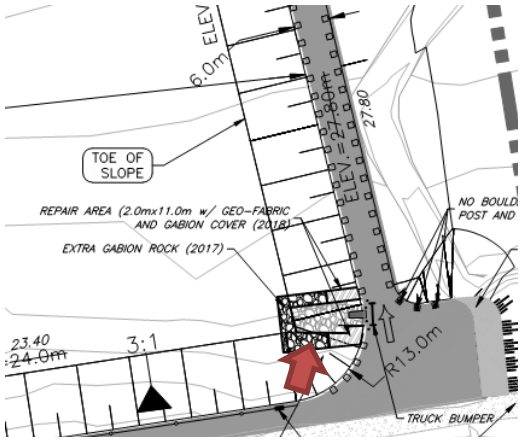
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A13**





Attributes	
Photograph	A – US – East Truck Discharge Facility (#2)
Description	View of upstream slope of East Truck Discharge Facility
Observations	-No visible sign of issue (benches, wave erosion) for the riprap protected slope section, regardless the presence of gabion box. -Truck Discharge Facility equipment in a good condition.
Remarks	East truck discharge area is in a good condition.

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

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YYYY-MM-DD	2022-09-27
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APPROVED	Jane Doucette

TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A14**

Igloolik Sewage Lagoon - Cell B

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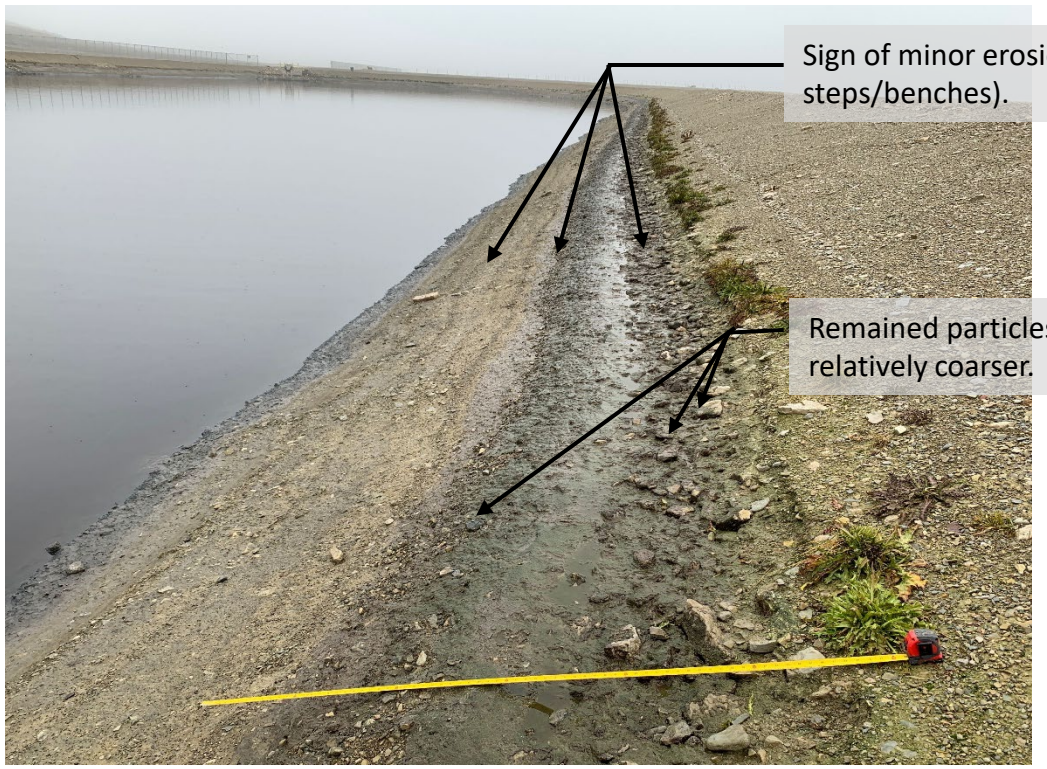
PROJECT
2022 Igloolik Sewage Lagoon Inspection

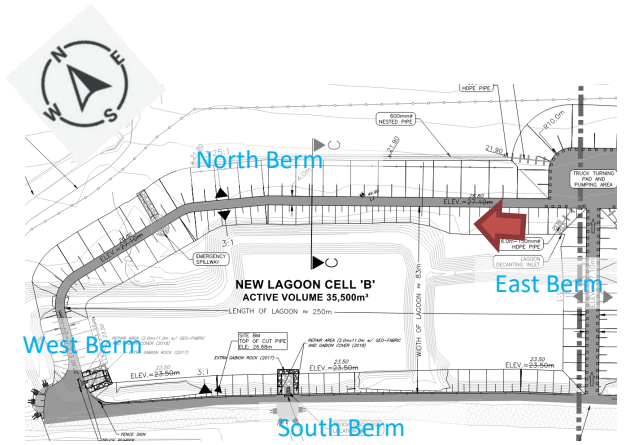
CONSULTANT

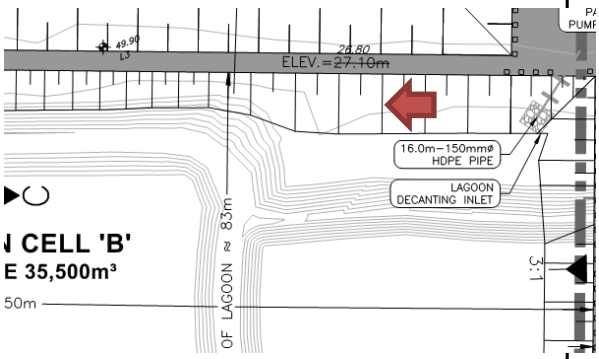
YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A15**







Attributes	
Photograph	B – US –North Berm
Description	View of upstream slope
Observations	Sign of minor erosion, noting coarser particles at upstream slope. No visible soil steps or benches. No sign of GCL exposure.
Remarks	There is signs of minor erosion.

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2022 Igloolik Sewage Lagoon Inspection

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YYYY-MM-DD	2022-09-27
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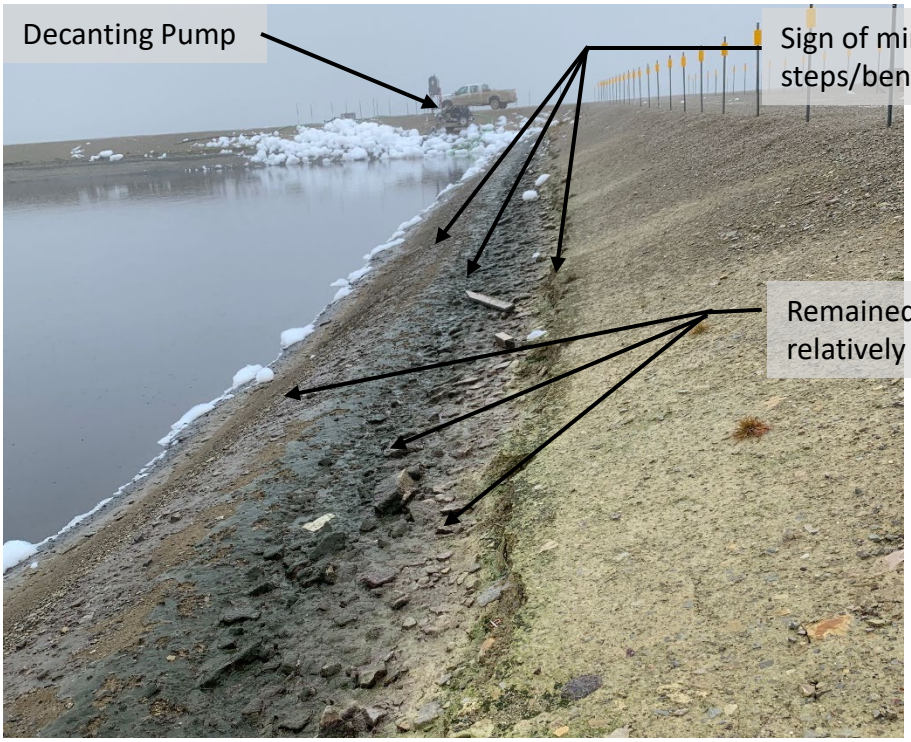
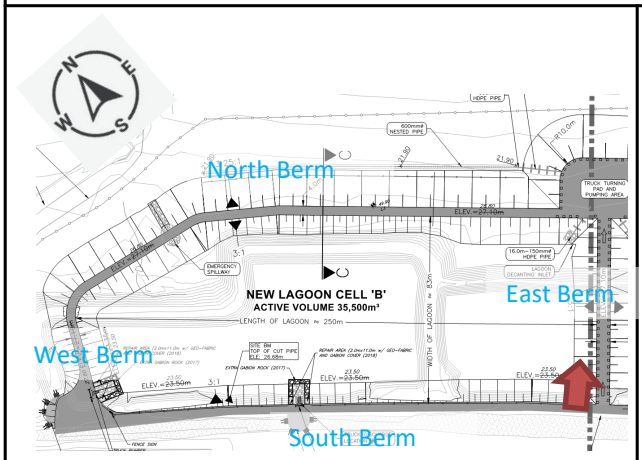
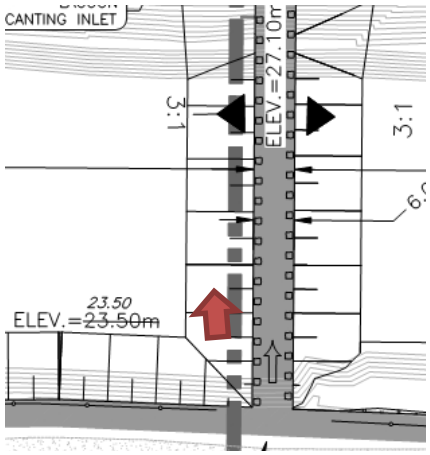
APPROVED	Jane Doucette

TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A16**







Attributes	
Photograph	B – US –East Berm
Description	View of upstream slope
Observations	Sign of minor erosion, noting the coarser particles at upstream slope. No visible soil steps or benches. No sign of GCL exposure.
Remarks	There are signs of minor erosion.

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2022 Igloolik Sewage Lagoon Inspection

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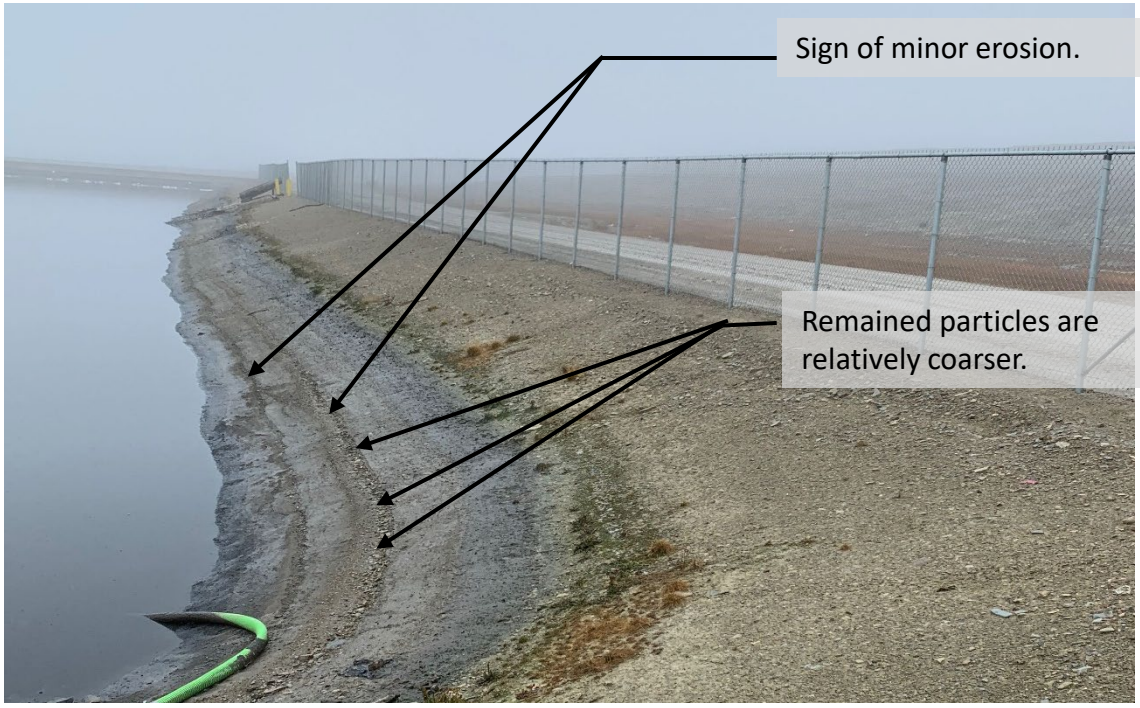
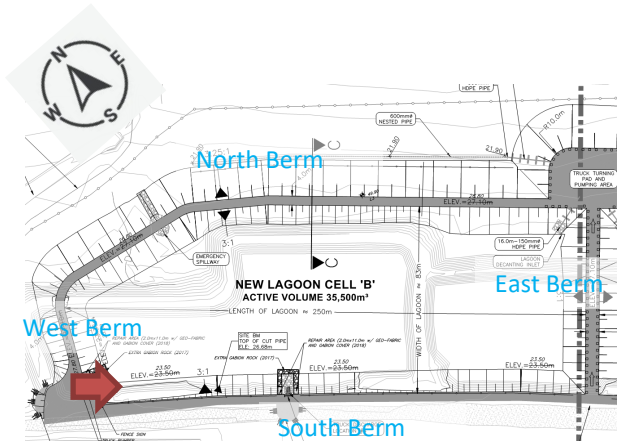
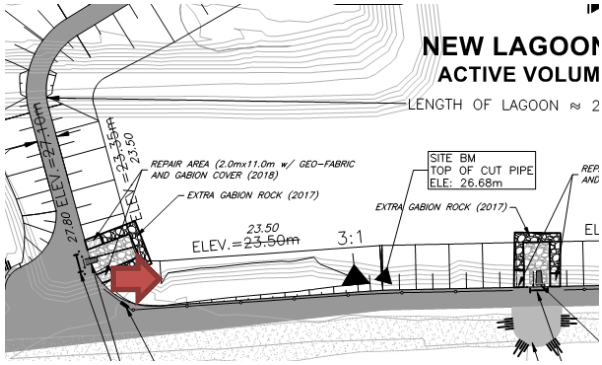
TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A17**







Attributes	
Photograph	B – US –South Berm
Description	View of upstream slope
Observations	Sign of minor erosion, noting coarser particles at upstream slope. No visible soil steps or benches. No sign of GCL exposure.
Remarks	There are signs of minor erosion.

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2022 Igloolik Sewage Lagoon Inspection

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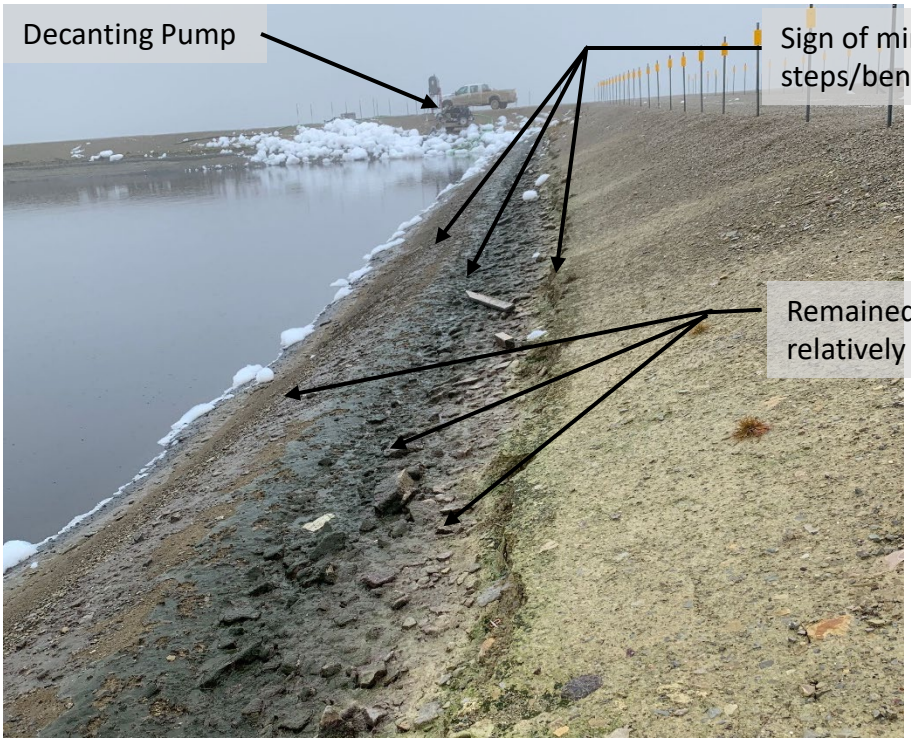
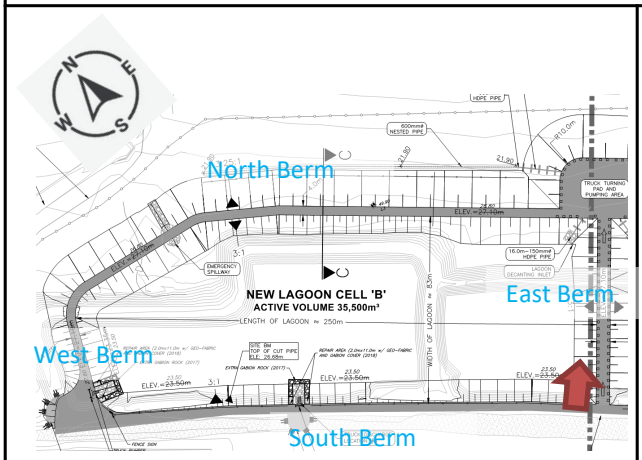
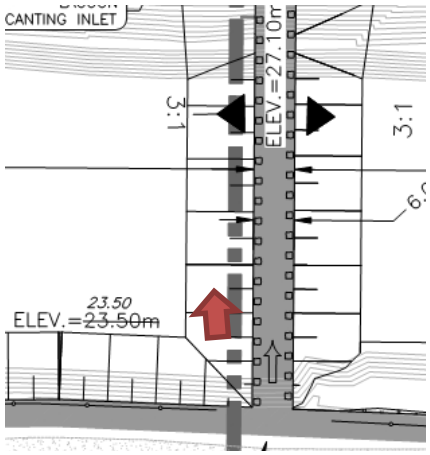
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A18**







Attributes	
Photograph	B – US –East Berm
Description	View of upstream slope
Observations	Sign of minor erosion, noting coarser particles at upstream slope. No visible soil steps or benches. No sign of GCL exposure.
Remarks	There are signs of minor erosion.

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2022 Igloolik Sewage Lagoon Inspection

CONSULTANT
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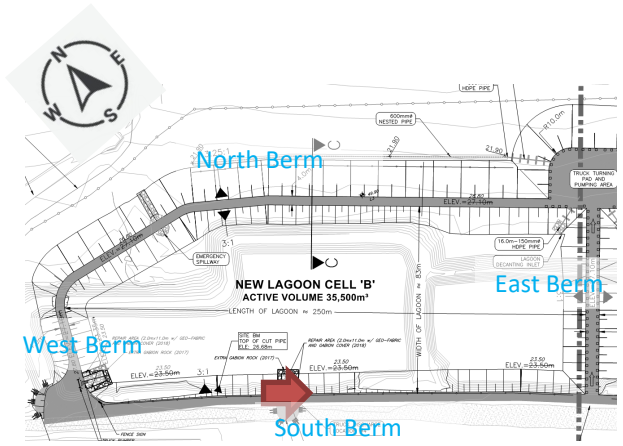
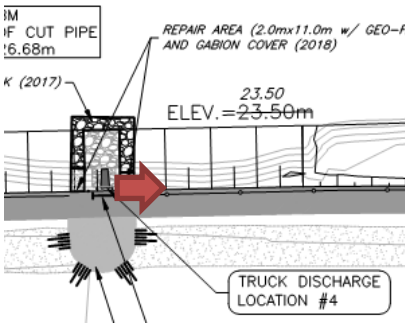
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A19**





Attributes	
Photograph	B – Upstream Slope – South Berm
Description	View of upstream slope
Observations	Minor cracks were observed near crest, parallel with the longitudinal direction.
Remarks	

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2022 Igloolik Sewage Lagoon Inspection

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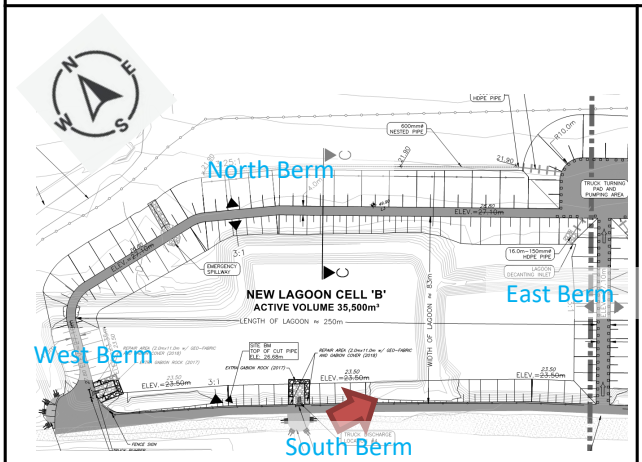
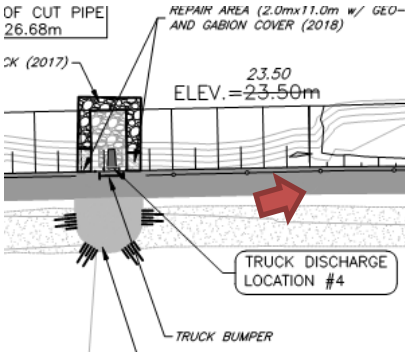
APPROVED	Jane Doucette

TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A20**





Attributes	
Photograph	B – Upstream Slope – South Berm - Minor Gully
Description	View of minor gullies near crest
Observations	Local and isolated gullies.
Remarks	Routine maintenance to address this issue.

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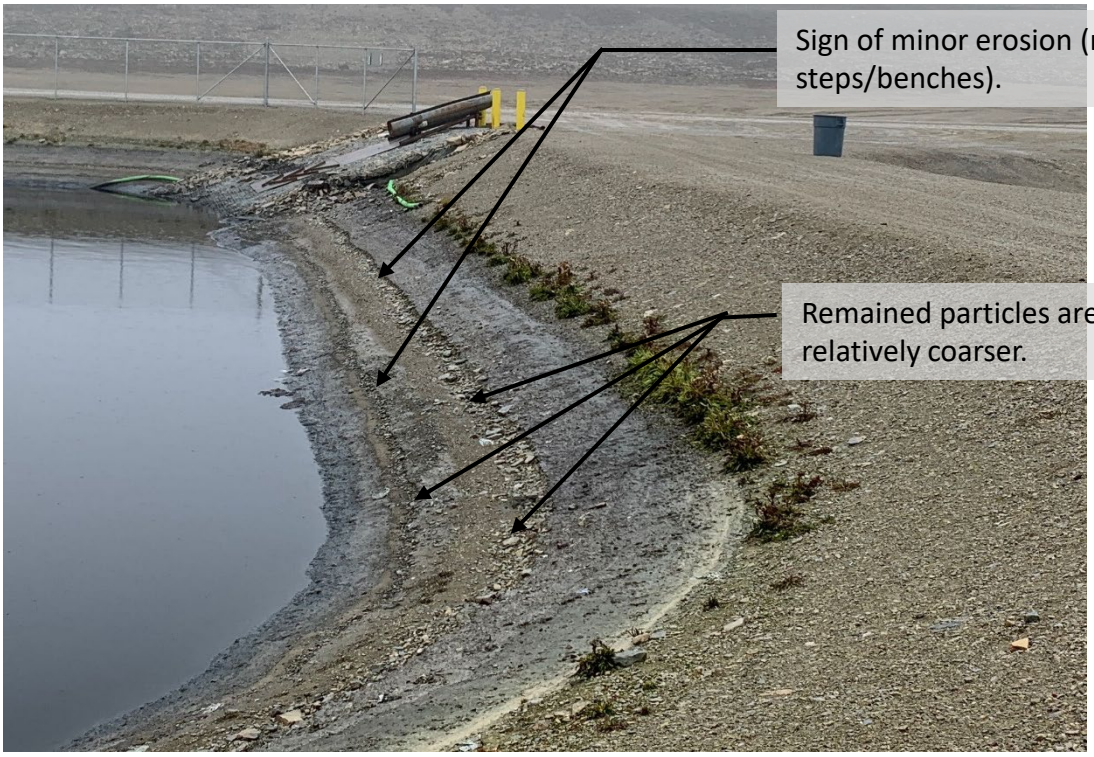
PROJECT
2022 Igloolik Sewage Lagoon Inspection

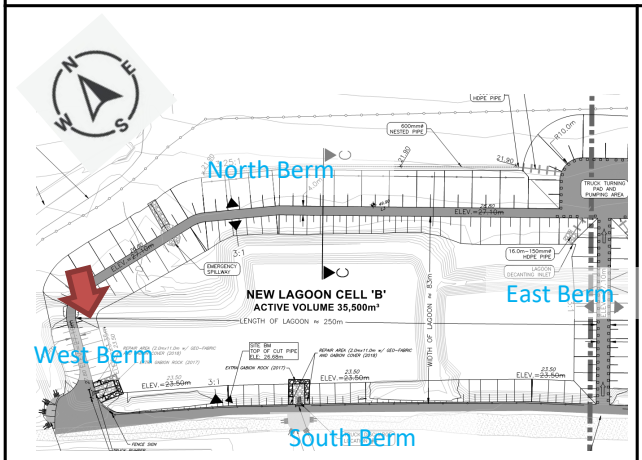
CONSULTANT
wsp

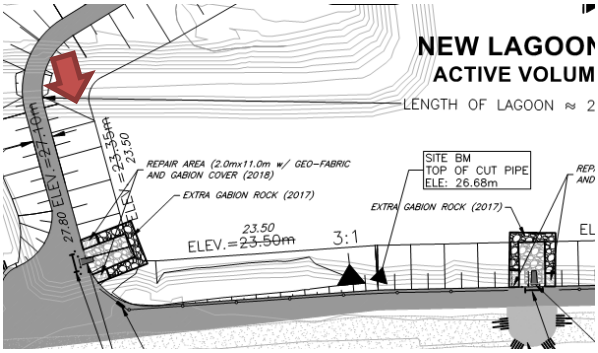
YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A21**







Attributes	
Photograph	B – US –West Berm
Description	View of upstream slope
Observations	Sign of minor erosion, noting coarser particles at upstream slope. No visible soil steps or benches. No sign of GCL exposure.
Remarks	There are signs of minor erosion.

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2022 Igloolik Sewage Lagoon Inspection

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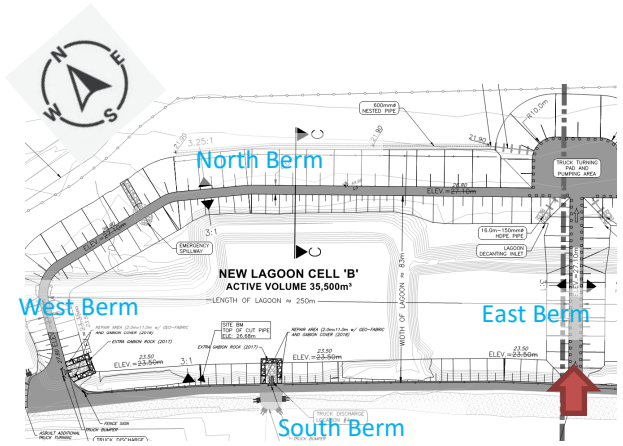
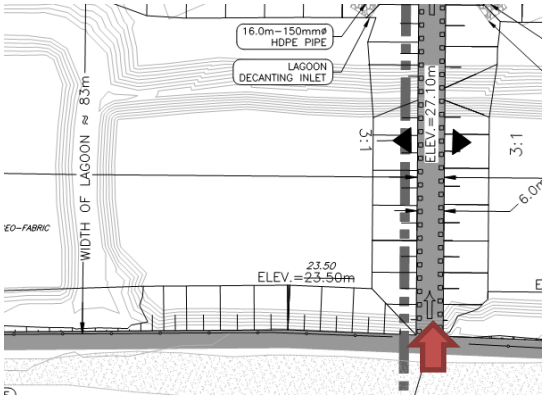
TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A22**





Attributes	
Photograph	C – Crest – West Berm
Description	View of crest
Observations	No signs of settlement, erosion, cracks. Minor ponding water after rainfalls. The bollards at the crest were in a good condition with no sign of settlement and deflection
Remarks	The crest is in a good condition.

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2022 Igloolik Sewage Lagoon Inspection

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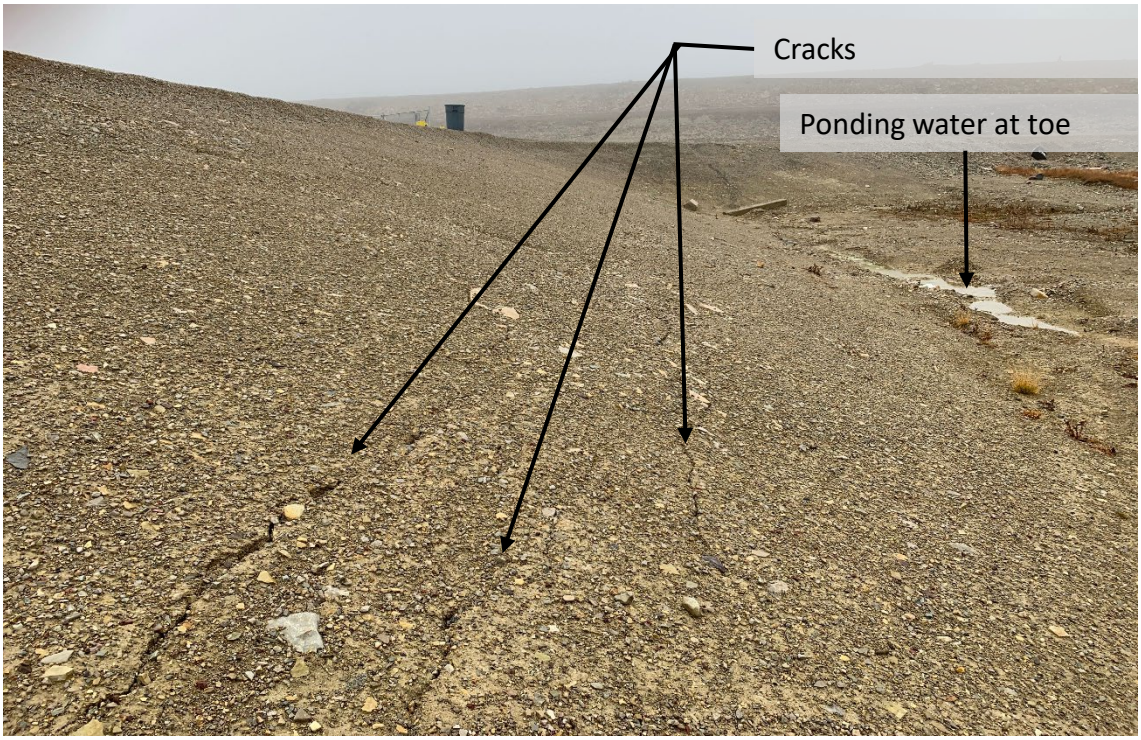
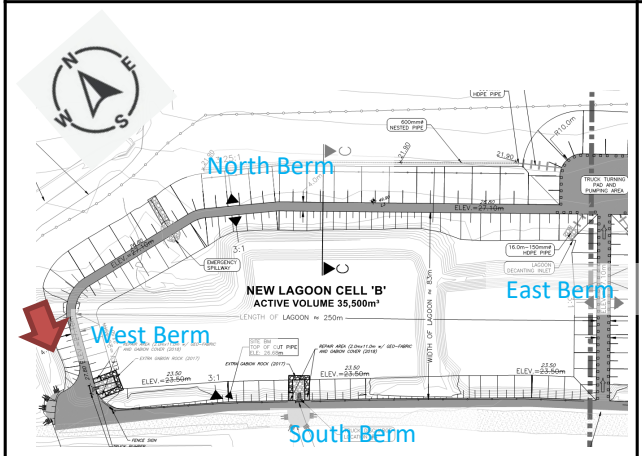
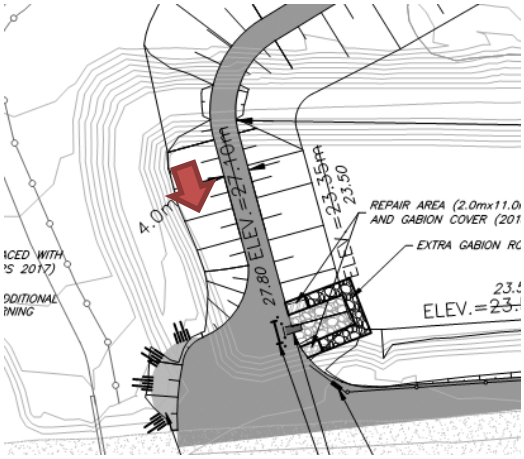
TITLE
Cell B/C

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A23**







Attributes	
Photograph	B – DS Slope – West Berm
Description	View of downstream slope
Observations	Minor cracks at downstream slope. The cracks are generally parallel with the longitudinal direction. Ponding water at toe. The water is clear and there was no sign of active seepage.
Remarks	The downstream slope is in a generally good condition. Some cracks were encountered and are likely due to frost action and/or thermal stabilization after construction.

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2022 Igloolik Sewage Lagoon Inspection

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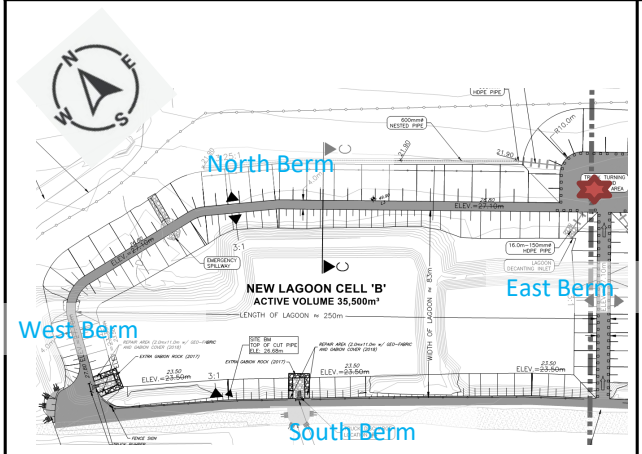
APPROVED	Jane Doucette

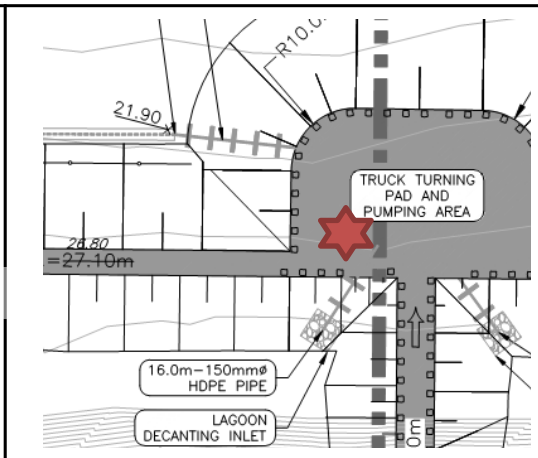
TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A24**

Decanting pump in operation
Downstream - Outlet

Decanting pump in operation
Upstream - Inlet





Attributes	
Photograph	B – Decanting Pump
Description	View of decanting in operation
Observations	Decanting in operation using 3” pump.
Remarks	Decanting operation lasts about 5 days for Cell B

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2022 Igloolik Sewage Lagoon Inspection

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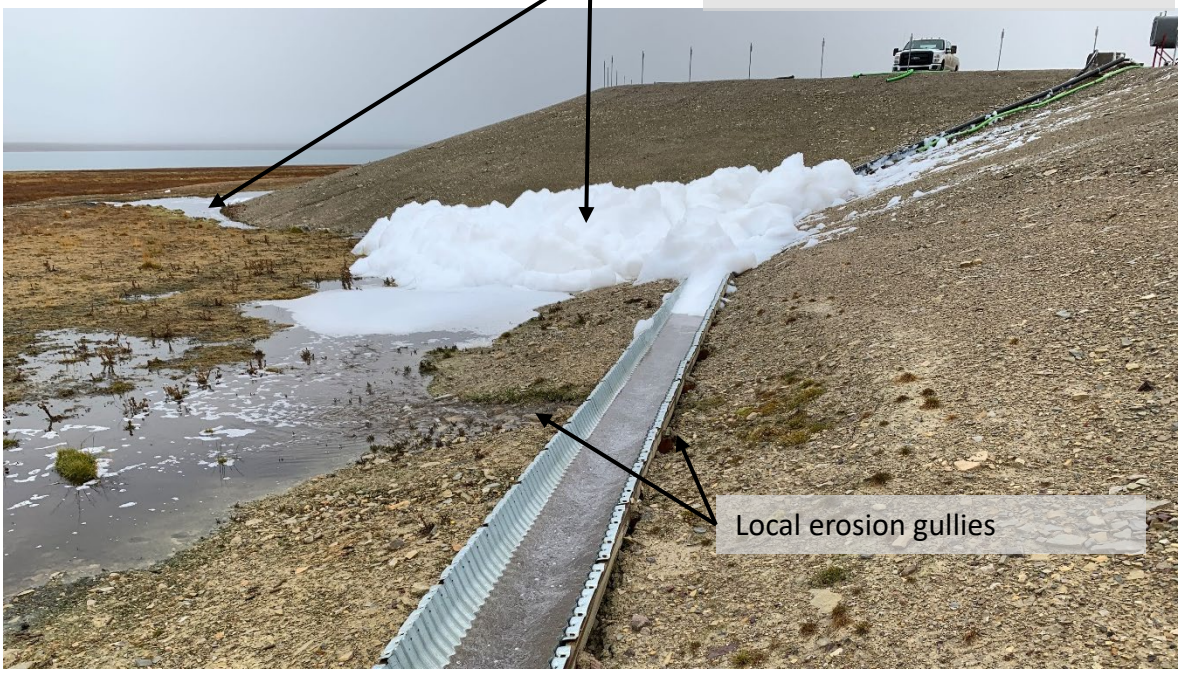
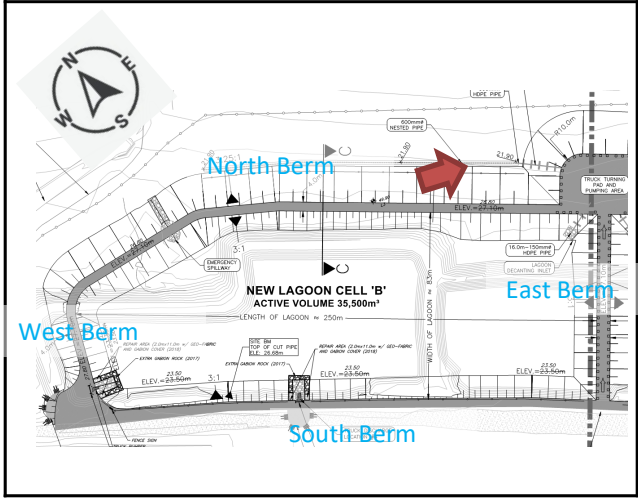
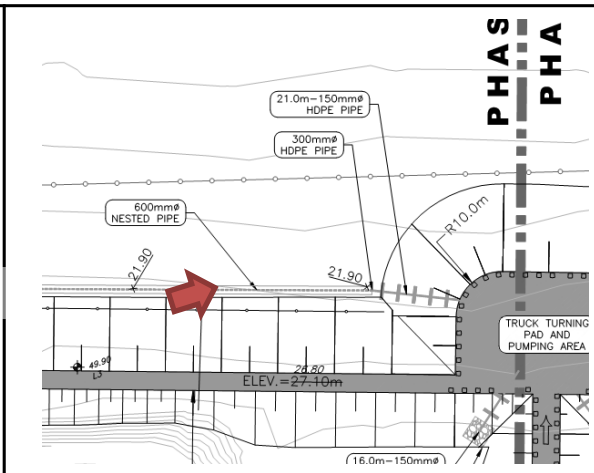
TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A25**







Attributes	
Photograph	B – Trough
Description	View of drainage flow
Observations	Some drainage flow towards east along the toe of berm. Some erosion gullies below and near the trough. Water level in trough is well below the side wall.
Remarks	The trough appears function well to direct the drainage flow as per the design intent.

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

CONSULTANT
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YYYY-MM-DD	2022-09-27
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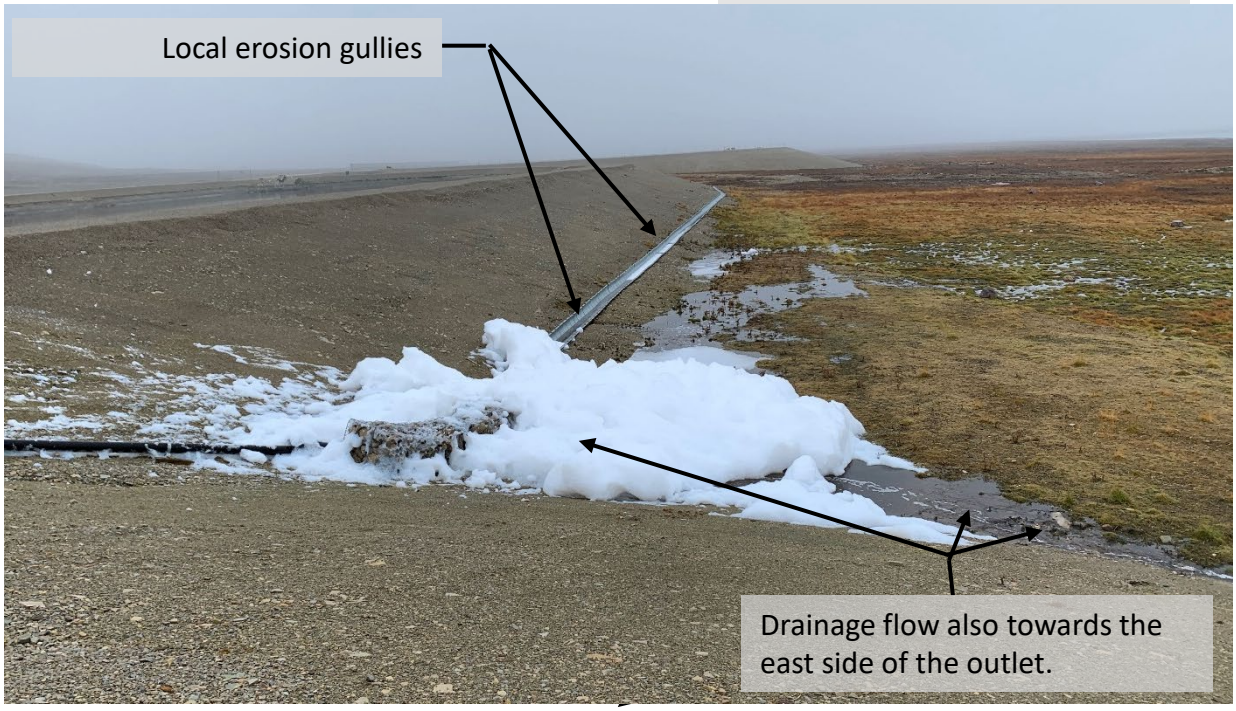
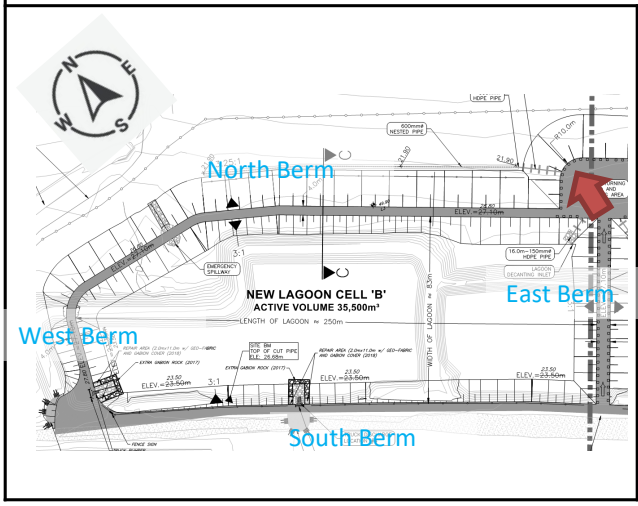
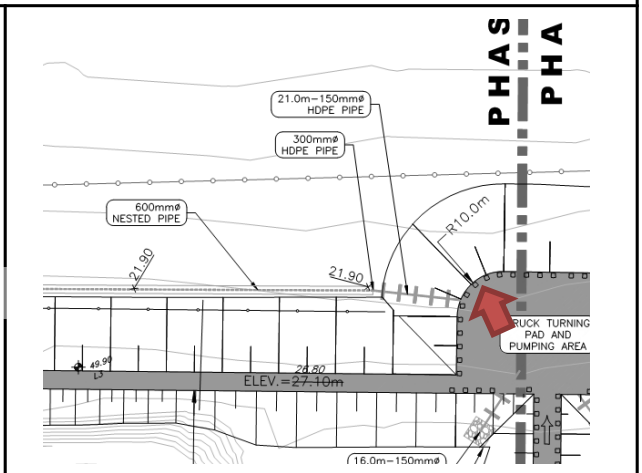
APPROVED	Jane Doucette

TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A26**







Attributes	
Photograph	B – Trough
Description	View of drainage flow
Observations	Some drainage flow towards east along the toe of berm. Some erosion gullies below and near the trough.
Remarks	The tie-in between the trough and outlet pipe may be improved to direct the drainage flow to the trough.

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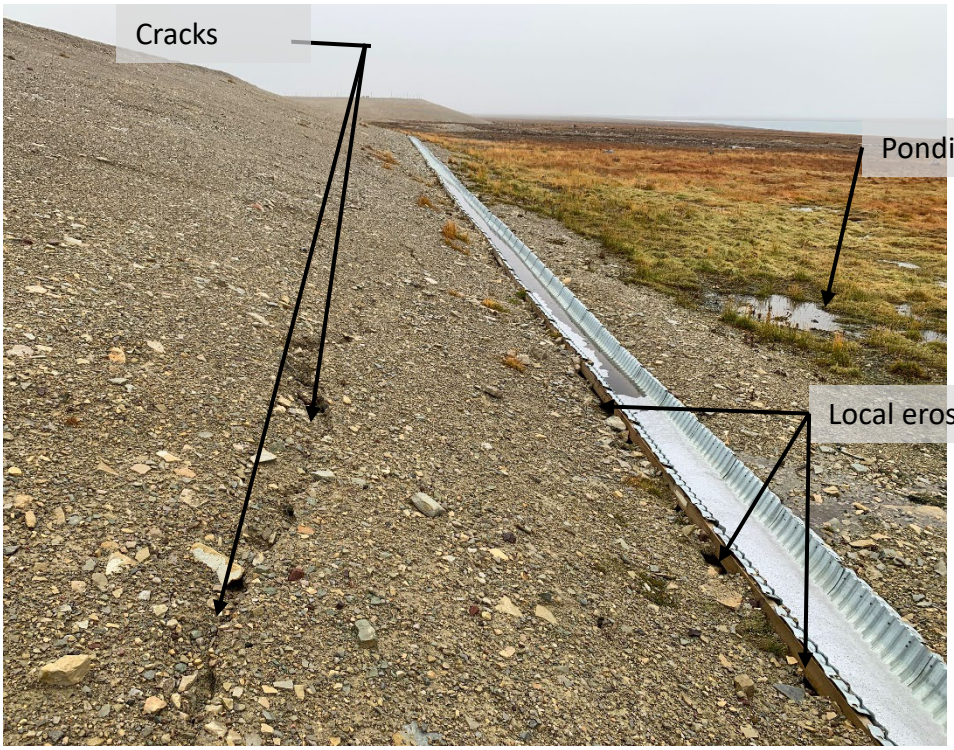
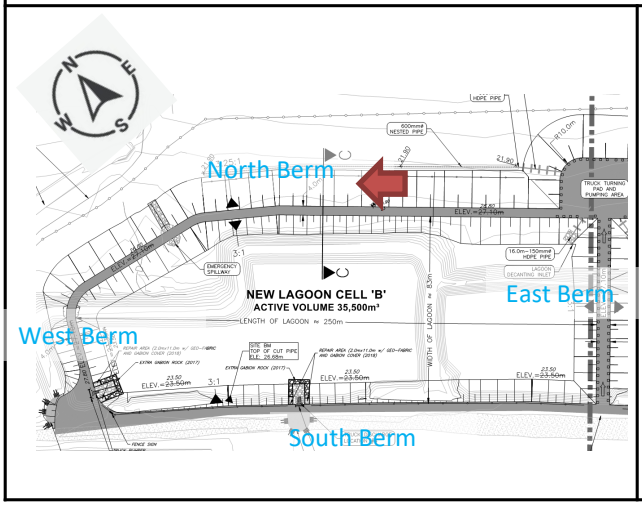
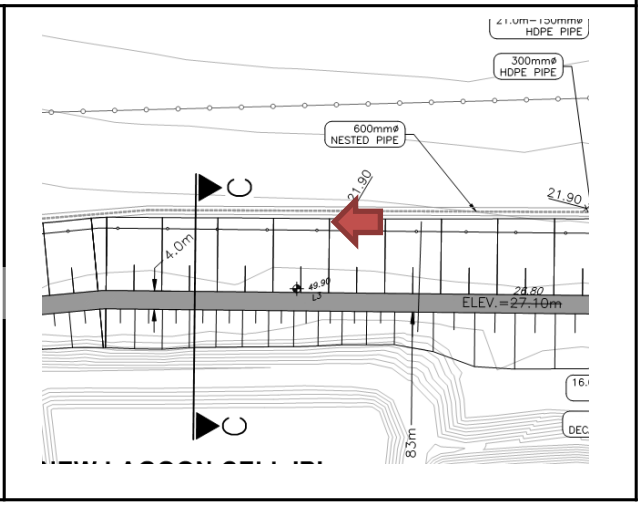
TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A27**







Attributes	
Photograph	B –Trough - North Berm
Description	View of cracks and erosion at downstream slope and trough
Observations	Cracks at d/s slope near the tow trough. Some erosions near the trough. Ponding water near the toe, water is clear and there is no sign of active seepage. Water level in trough is well below the side wall.
Remarks	Signs of erosion near the trough. Cracks observed at d/s slope near the trough.

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2022 Igloolik Sewage Lagoon Inspection

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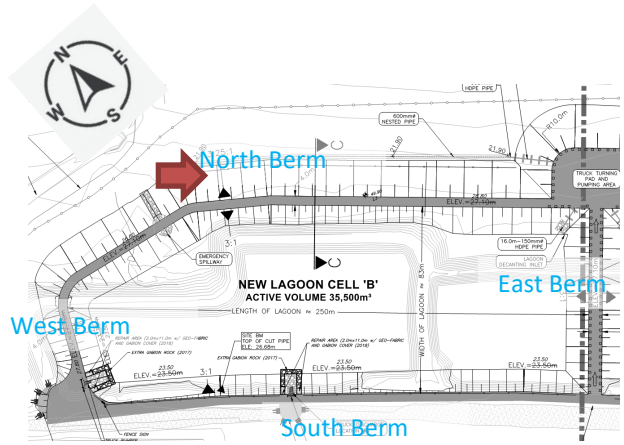
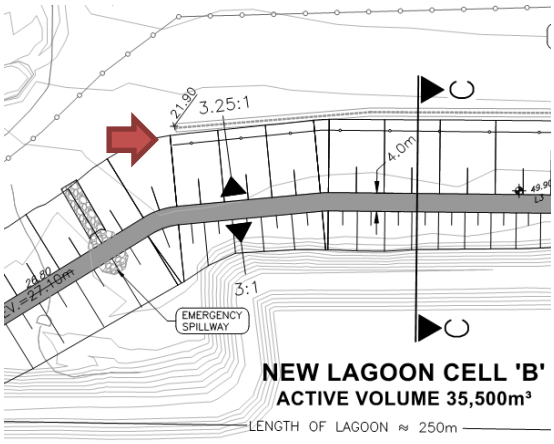
TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A28**

Water level in trough reduced to a dry condition at about 1/3 of the trough

Dry condition at the end of the drainage trough.





Attributes	
Photograph	B –Trough - North Berm
Description	View of trough
Observations	Dry condition was encountered along the westerly one third of the trough.
Remarks	The site grading may cause the dry condition of the trough during decanting.

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2022 Igloolik Sewage Lagoon Inspection

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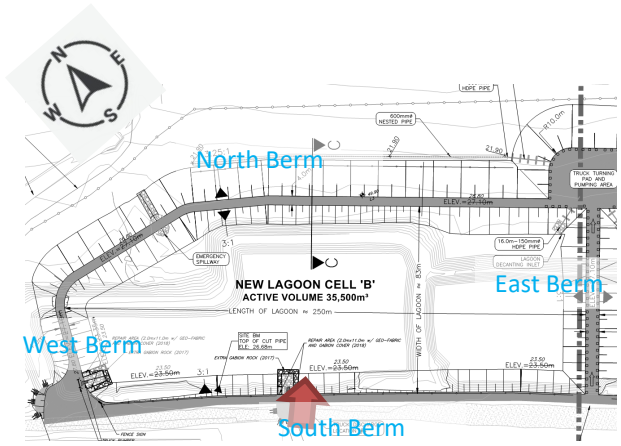
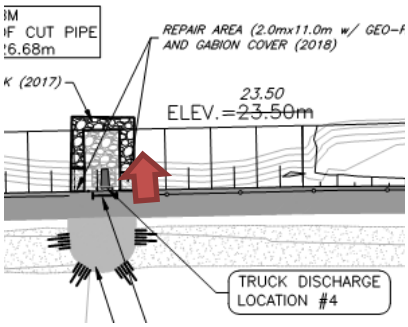
TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A29**





Attributes	
Photograph	B – US –East Truck Discharge Facility (#4) - Local Riprap Damage
Description	View of local riprap damage at upstream slope
Observations	Sign of riprap damage from waste-water dumping. The operation staff indicated that the riprap damage was due to the truck dumping away from the designed location.
Remarks	There are signs of local riprap damage from truck dumping slightly off the designed discharge location.

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

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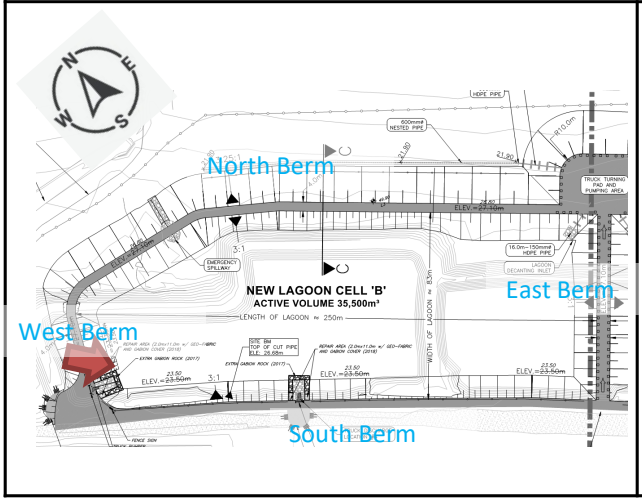
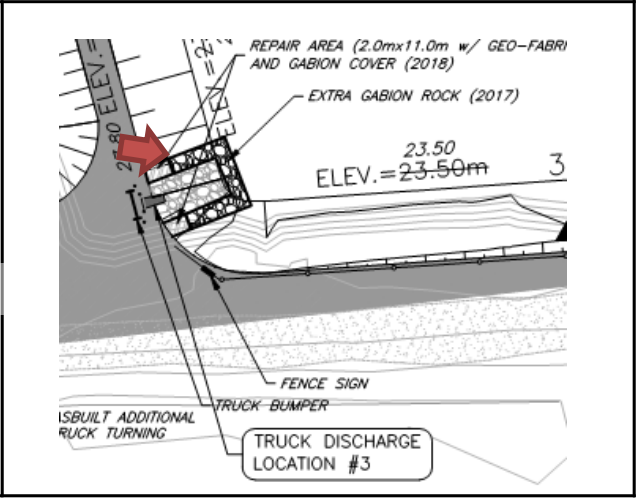
TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A30**





Attributes	
Photograph	B – US –West Truck Discharge Facility (#3) -Local Riprap Damage
Description	View of local riprap damage at upstream slope
Observations	Sign of riprap damage from waste-water dumping. The operation staff indicated that the riprap damage was due to the truck dumping away from the designed location.
Remarks	There are signs of local riprap damage from truck dumping slightly off the designed discharge location.

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

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YYYY-MM-DD	2022-09-27
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TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A31**

Igloolik Sewage Lagoon - Cell C

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

CONSULTANT

YYYY-MM-DD	2022-09-27
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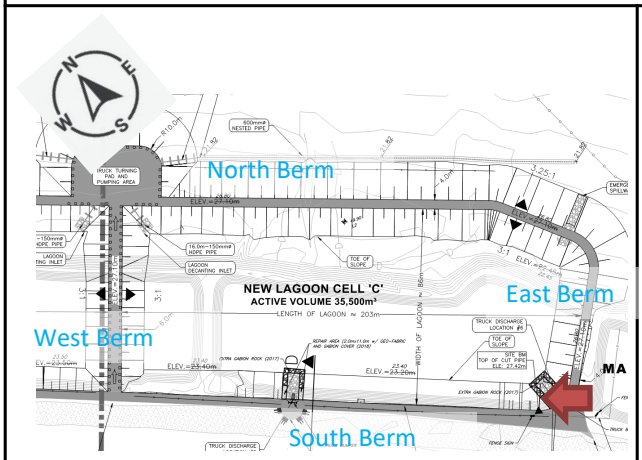
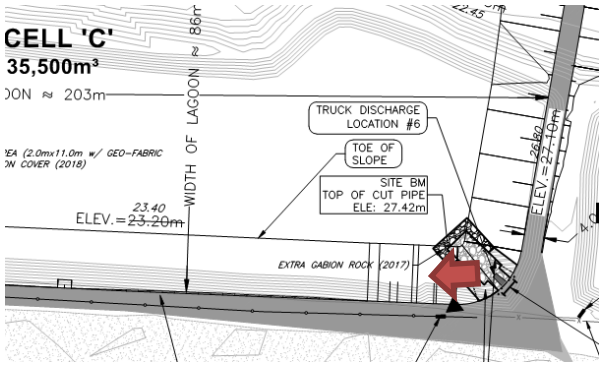
TITLE
Cell □

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A32**





Attributes	
Photograph	C – US –South Berm
Description	View of upstream slope
Observations	No visible signs of erosion such as soil steps or benches.
Remarks	The slope is in a good condition

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

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YYYY-MM-DD	2022-09-27
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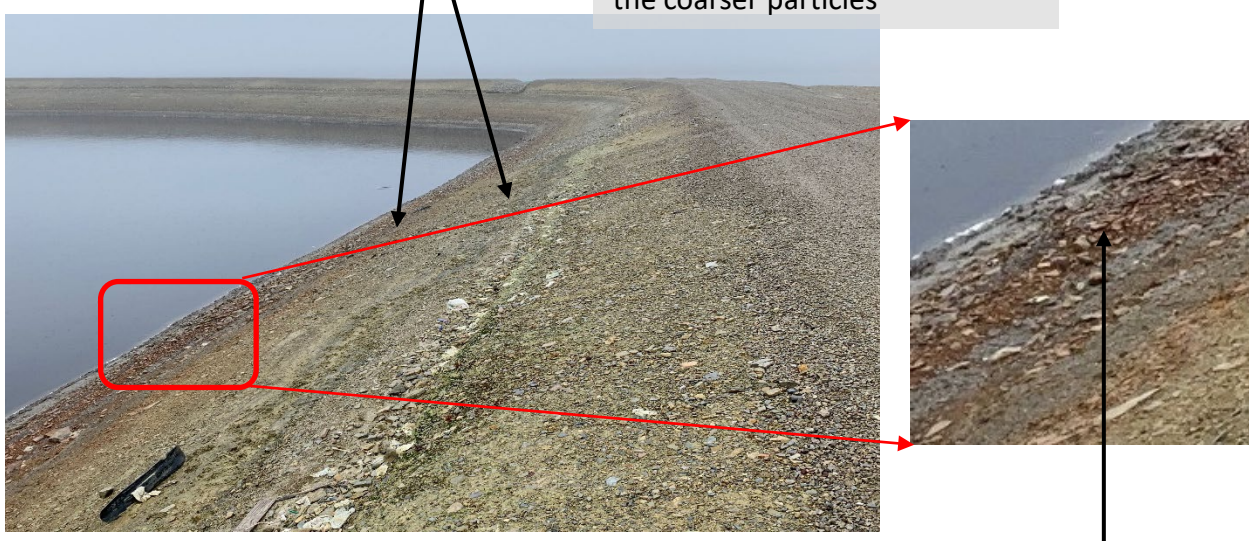
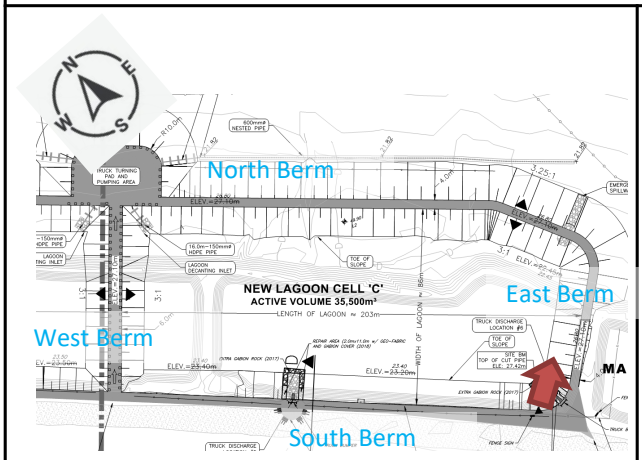
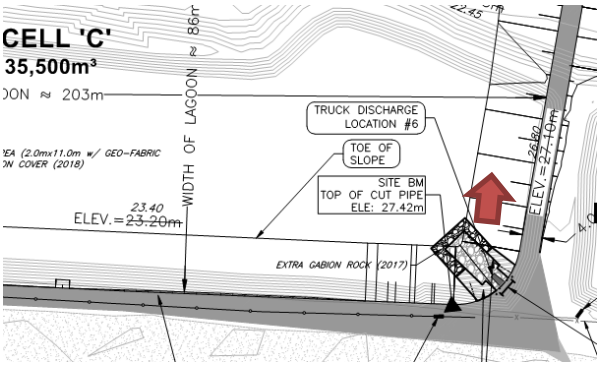
TITLE
Cell C

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A33**







Attributes	
Photograph	C – US – East Berm
Description	View of upstream slope
Observations	No visible signs of significnat erosion such as soil steps or benches. Sign of minor washout, noting the coarser particles.
Remarks	The slope is in a good condition

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2022 Igloolik Sewage Lagoon Inspection

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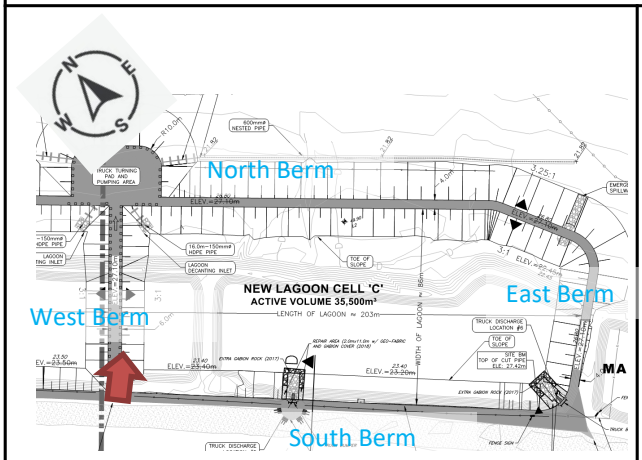
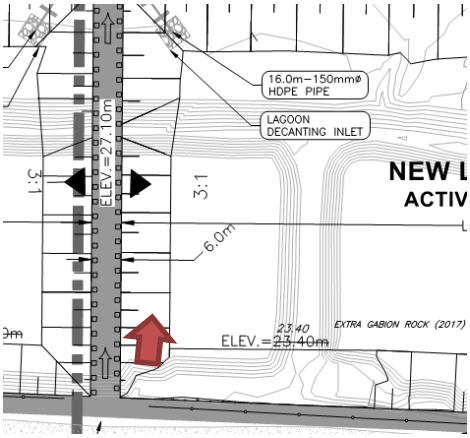
TITLE
Cell C

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A34**

Generally good condition.

Sign of minor washout, noting the coarser particles





Attributes	
Photograph	C – US – West Berm
Description	View of upstream slope
Observations	No visible signs of significnat erosion such as soil steps or benches. Sign of minor washout, noting the coarser particles.
Remarks	The slope is in a good condition

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2022 Igloolik Sewage Lagoon Inspection

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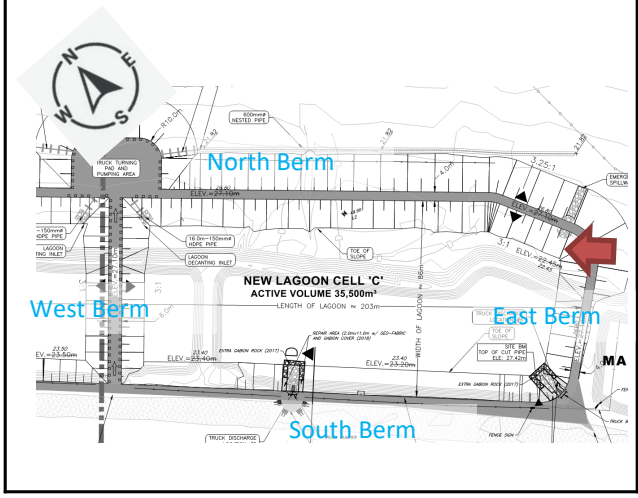
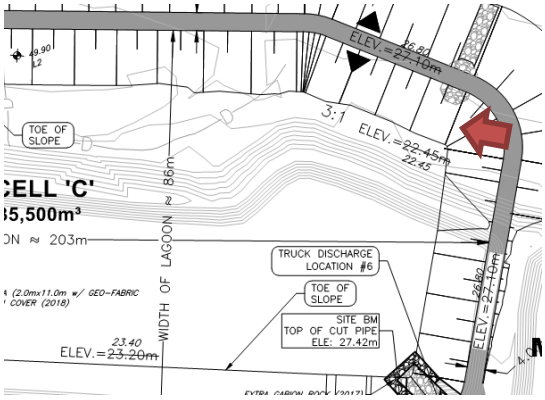
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell C

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A35**





Attributes	
Photograph	C – US – North Berm
Description	View of upstream slope
Observations	No visible signs of erosion.
Remarks	The slope is in a good condition

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2022 Igloolik Sewage Lagoon Inspection

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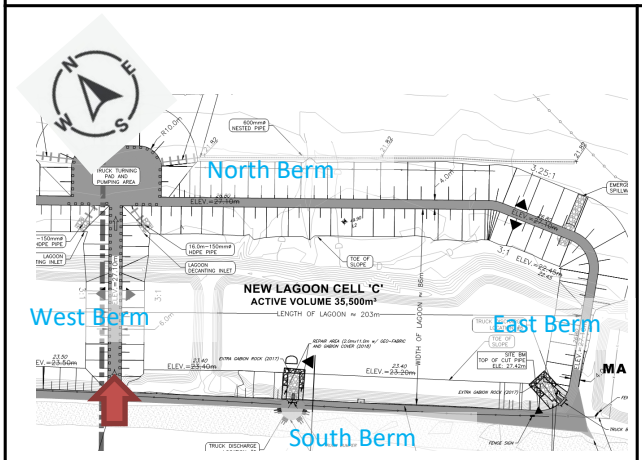
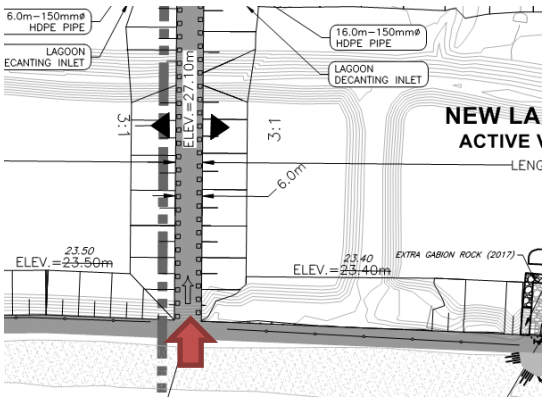
TITLE
Cell C

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A36**

Crest generally in a good condition.





Attributes	
Photograph	C – Crest – West Berm
Description	View of crest
Observations	No signs of settlement, erosion, cracks.
Remarks	The crest is in a good condition.

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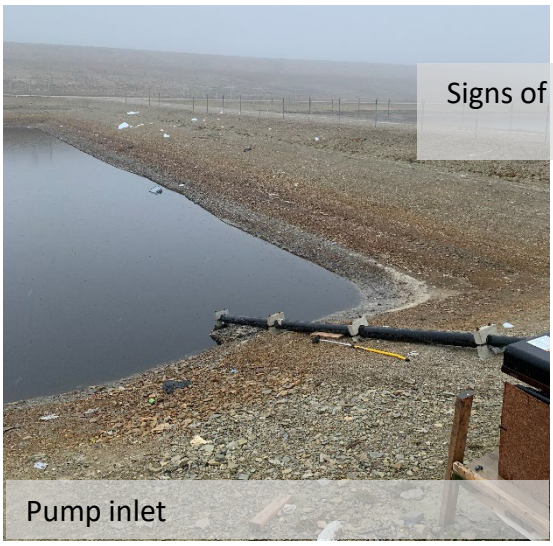
PROJECT
2022 Igloolik Sewage Lagoon Inspection

CONSULTANT
wsp

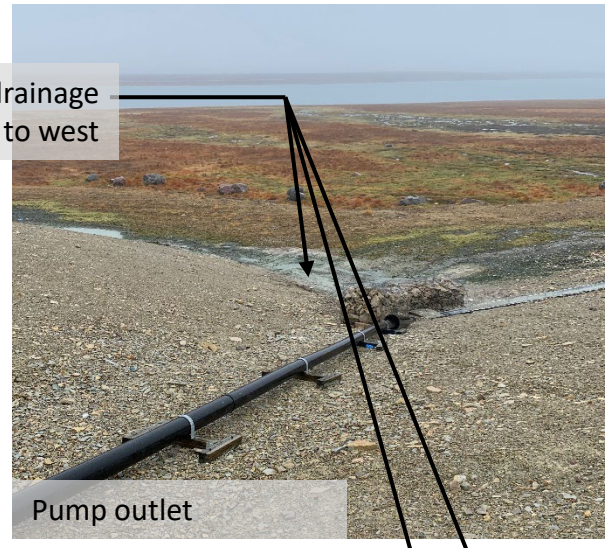
YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell C

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A37**

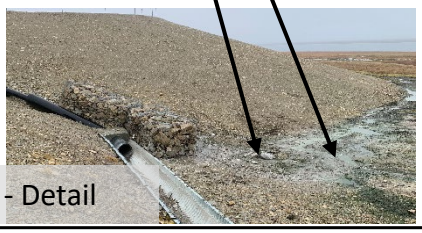


Pump inlet

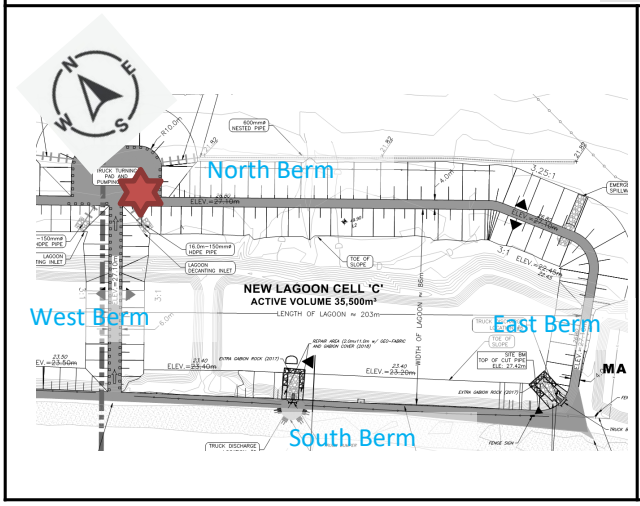


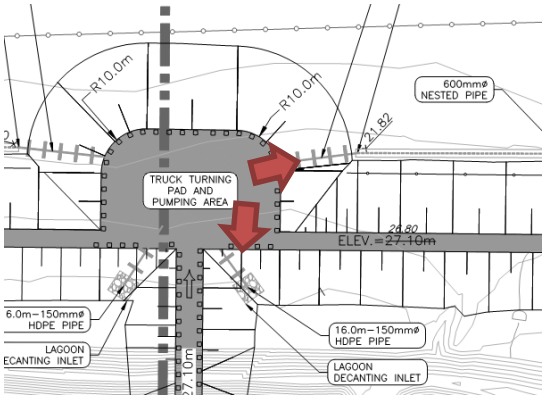
Signs of drainage to west

Pump outlet



Pump outlet - Detail





Attributes	
Photograph	C – Pump – Inlet and outlet at North Berm
Description	View of Inlet and outlet
Observations	Equipment not in operation. Sign of drainage towards west side.
Remarks	The pump equipment appears in a good condition. It indicates that some drainage may flow to west instead following the trough as designed.

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2022 Igloolik Sewage Lagoon Inspection

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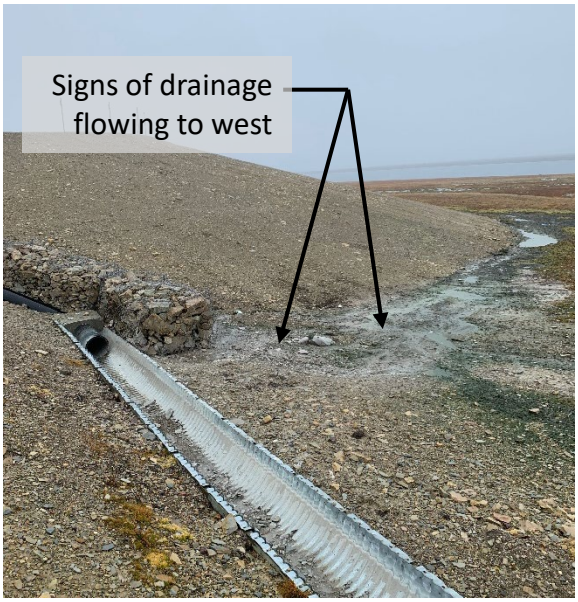
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

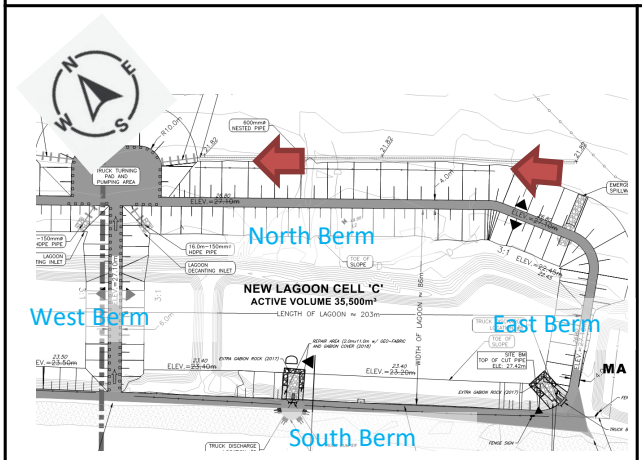
TITLE
Cell C

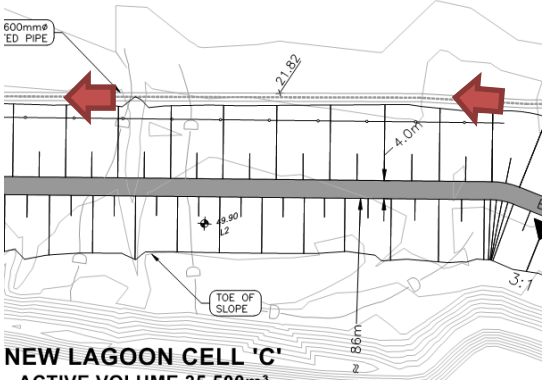
PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A38**

Trough near the outlet (west end)



Trough near the east end





Attributes	
Photograph	C – Trough – North Berm
Description	View of trough
Observations	Trough was dry and was not in operation. Some debris in trough. Signs of drainage to west.
Remarks	Some drainage had flowed to west, not following the trough. Debris in trough should be removed during regular maintenance.

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

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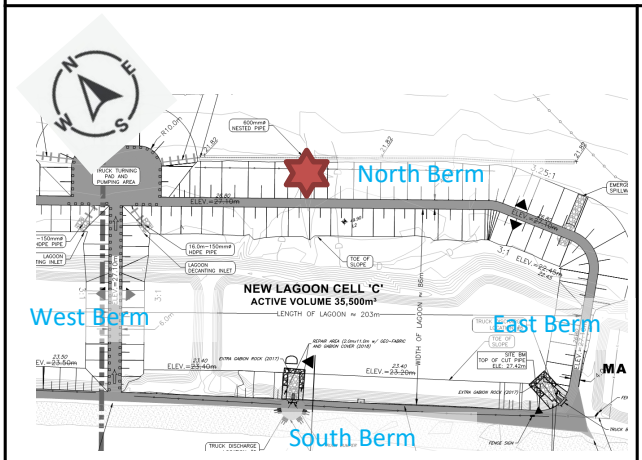
YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

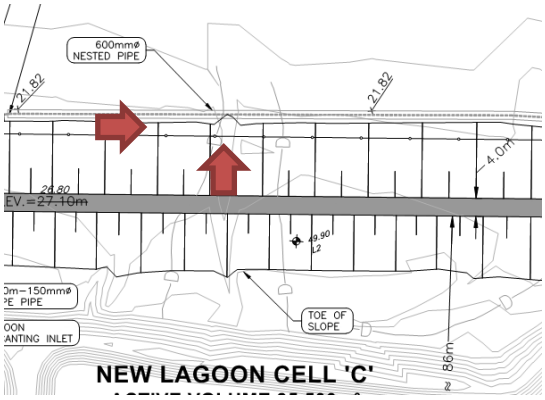
TITLE
Cell C

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A39**

Minor cracks near the toe line

Signs of erosions (e.g. erosion below trough, gullies)





Attributes	
Photograph	C – DS – North Berm
Description	View of downstream slope
Observations	Downstream slope generally in a fair condition. Minor cracks at downstream slope near the toe line. Signs of erosion near the trough.
Remarks	Downstream slope generally in a fair condition. Signs of erosion and soil cracks near the trough.

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

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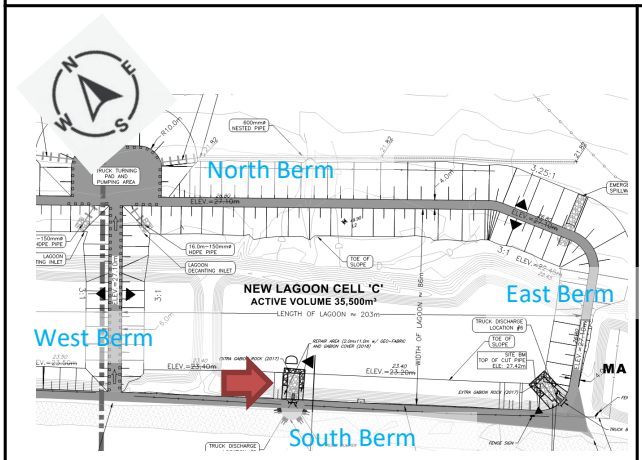
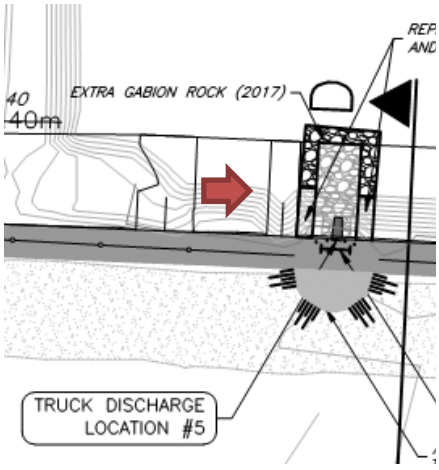
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell C

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A40**





Attributes	
Photograph	C – Truck Discharge Facility (#5)
Description	View of truck discharge area
Observations	Riprap in a good condition. Discharge equipment in a good condition.
Remarks	The area is in a good condition

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

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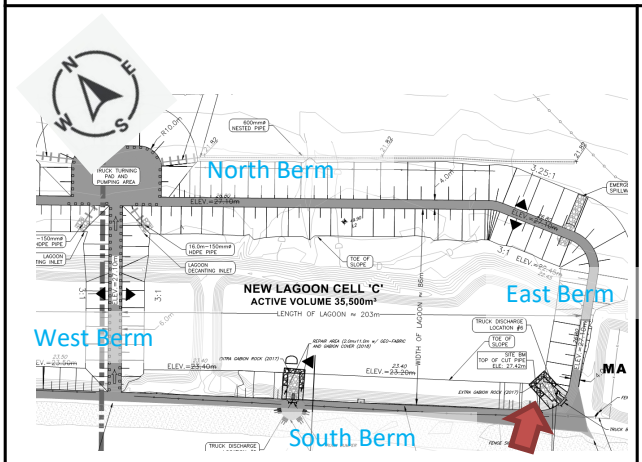
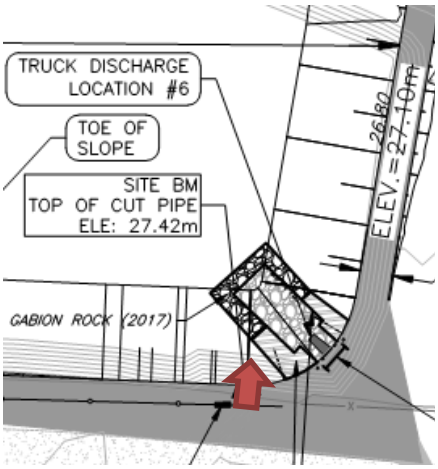
APPROVED	Jane Doucette

TITLE
Cell C

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A41**





Attributes	
Photograph	C – Truck Discharge Facility (#6)
Description	View of truck discharge area
Observations	Riprap in a good condition. Discharge equipment in a good condition.
Remarks	The area is in a good condition

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

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REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell C

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A42**

Spillway

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

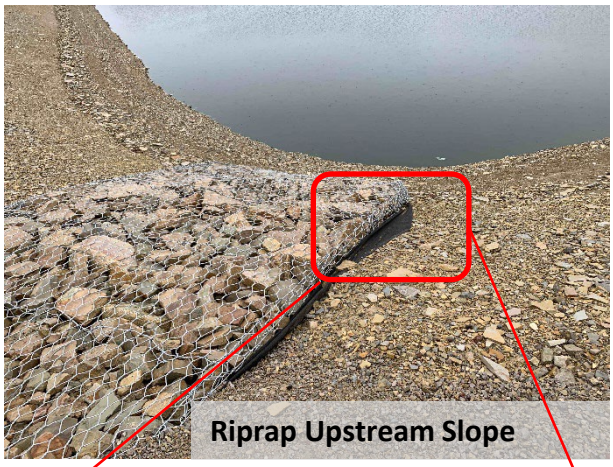
CONSULTANT

YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

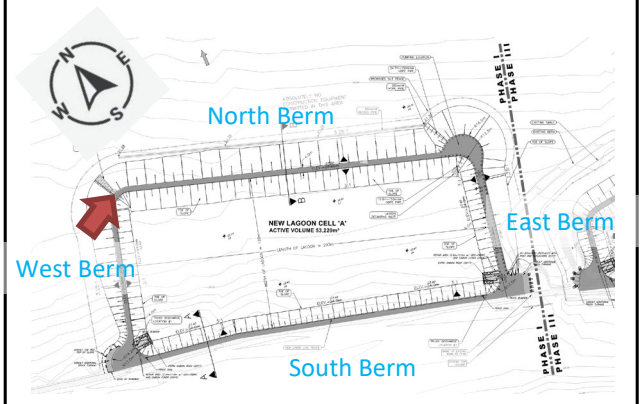
TITLE
Cell A

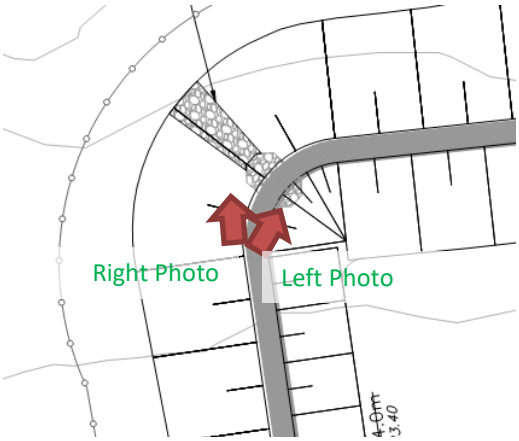
PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A43**

Riprap Downstream Slope



Riprap Upstream Slope





Attributes	
Photograph	A – Spillway
Description	View of spillway
Observations	Riprap at spillway is in good condition. No sign of riprap damage. Riprap baskets are likely placed **above** the slope. The thickness of riprap is about 200 to 250 mm.
Remarks	The riprap was placed above the slope surface at both upstream and downstream. In this way, the riprap may not prevent soil erosion during emergent use of spillway. Similar configuration of spillway with Cell B and Cell C.

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2022 Igloolik Sewage Lagoon Inspection

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YYYY-MM-DD	2022-09-27
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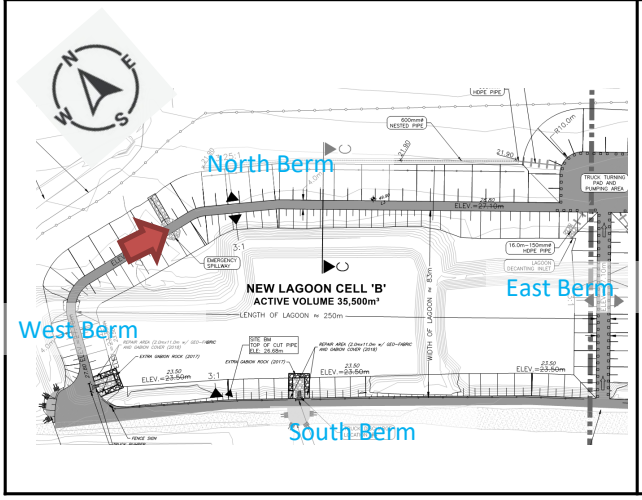
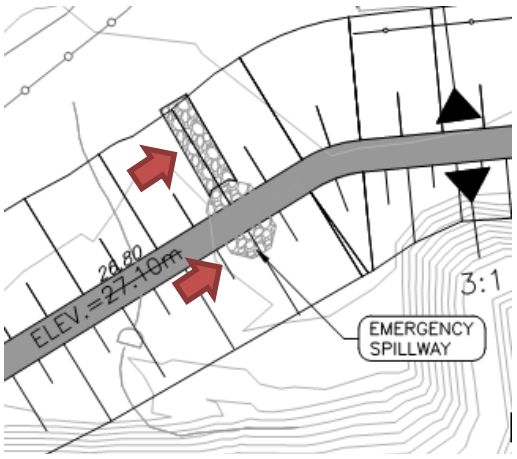
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell A

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A44**





Attributes	
Photograph	B – Spillway
Description	View of spillway – riprap
Observations	Riprap at spillway is in good condition. No sign of riprap damage. Riprap baskets were placed above the slope. Riprap at downstream slope does not extend to the toe.
Remarks	Similar configuration of spillway with Cell A and Cell C.

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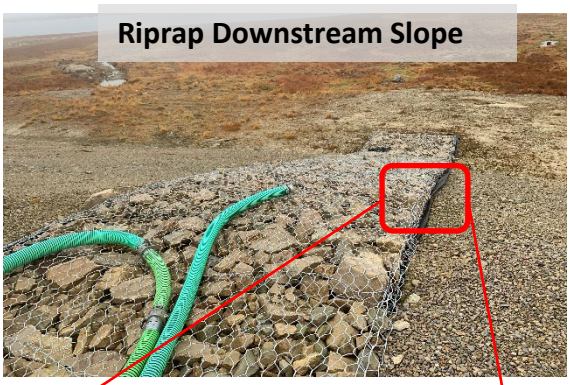
PROJECT
2022 Igloolik Sewage Lagoon Inspection

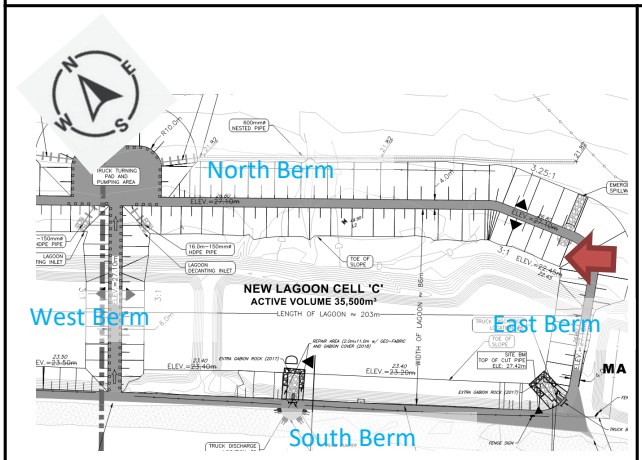
CONSULTANT
wsp

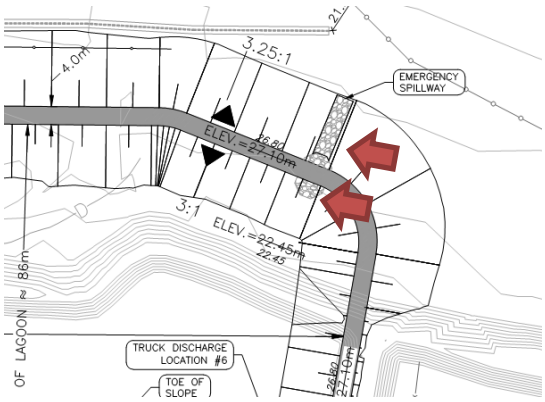
YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell B

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A45**







Attributes	
Photograph	C – Spillway
Description	View of spillway
Observations	Riprap at spillway is in good condition. No sign of riprap damage. Riprap baskets are likely placed above the slope.
Remarks	Similar configuration of spillway with Cell A and Cell B.

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

CONSULTANT
wsp

YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell C

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A46**

Additional Photos

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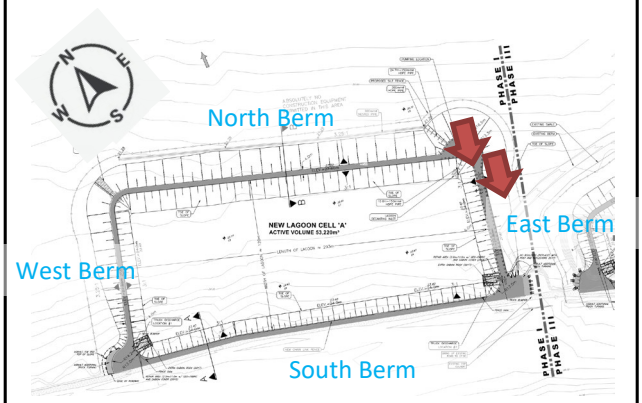
PROJECT
2022 Igloolik Sewage Lagoon Inspection

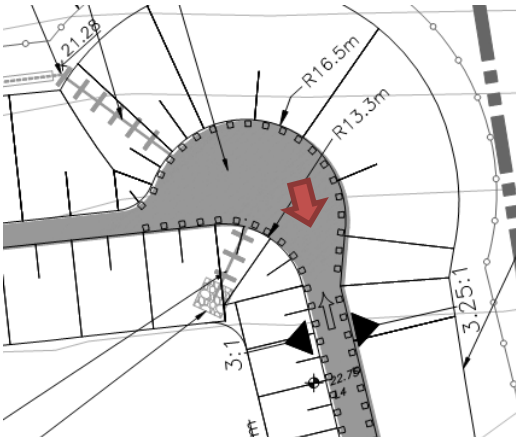
CONSULTANT

YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	1	Rev 0	A47





Attributes	
Photograph	A – Crest of East Berm
Description	View of crest
Observations	The posts aligned with each other well at crest. No sign of movement, deflection or settlement.
Remarks	No sign of settlement or lateral movement

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PROJECT
2022 Igloolik Sewage Lagoon Inspection

CONSULTANT
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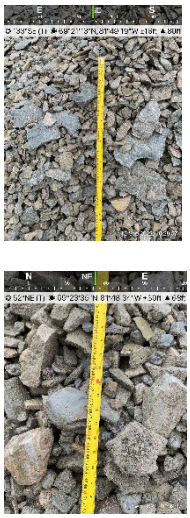
YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
DESIGNED	Greg Qu
REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

TITLE
Cell A

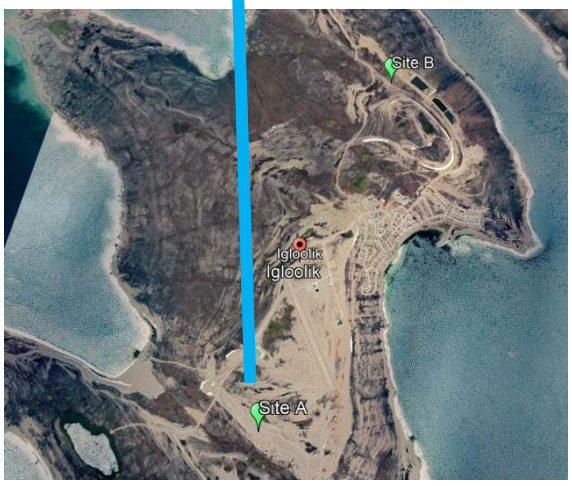
PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A48**

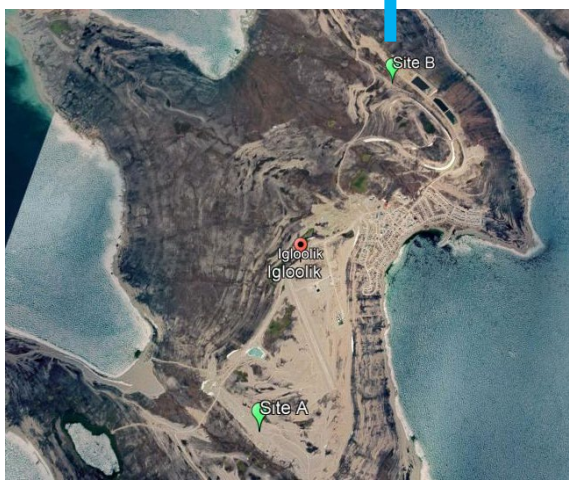
Potential Source for Riprap – Site A

Details



Potential Source for Riprap – Site B





Attributes	
Photograph	Screened (over-sized) stockpile
Description	Material for potential use as riprap prospection materials
Observations	
Remarks	

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2022 Igloolik Sewage Lagoon Inspection

CONSULTANT
wsp

YYYY-MM-DD	2022-09-27
PREPARED	Greg Qu
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REVIEWED	Alex Tchekhovski
APPROVED	Jane Doucette

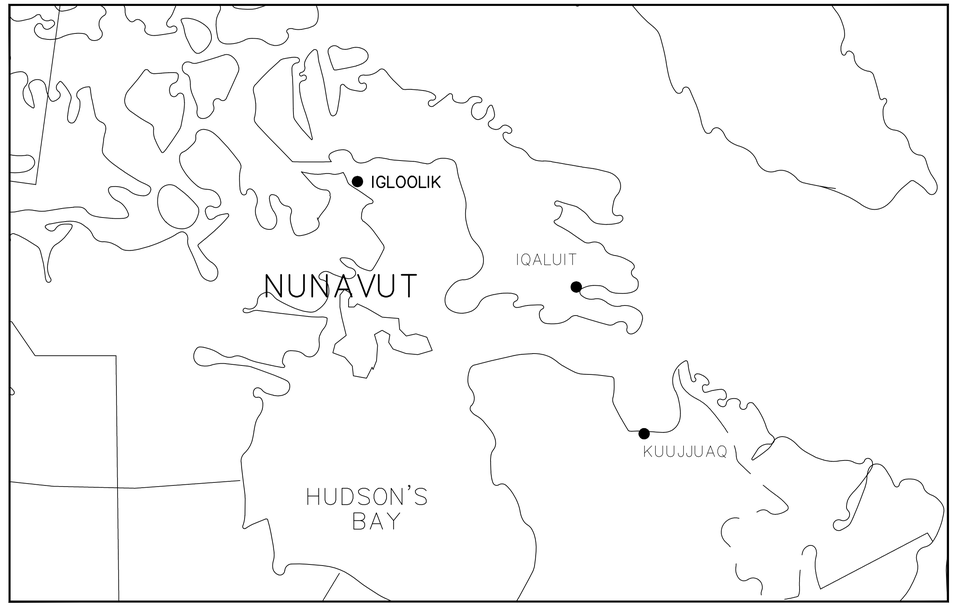
TITLE
Stockpile materials for potential use as riprap

PROJECT NO.	Phase/Task	Rev.	FIGURE
TE0223017	**1**	**Rev 0**	**A49**

APPENDIX

B RECORD DRAWING PACKAGE (SEPTEMBER 25, 2018)

HAMLET OF IGLOOLIK



INDEX OF INCLUDED DRAWINGS

DRAWING NO.	REVISION	DESCRIPTION
		COVER SHEET
OTCD00019838-IGL-1	REV 7	SITE LOCATION PLAN
OTCD00019838-IGL-3	REV 7	PROPOSED FACILITY AND PHASING PLAN
OTCD00019838-IGL-4	REV 9	NEW LAGOON CELL 'A'
OTCD00019838-IGL-5	REV 9	NEW LAGOON CELL 'B' & 'C'
OTCD00019838-IGL-6	REV 7	PUMPING AND DEWATERING DETAILS
OTCD00019838-IGL-7	REV 7	LINER AND SPILLWAY DETAILS
OTCD00019838-IGL-8	REV 7	TRUCK DISCHARGE AND MISC. DETAILS

RECORD
DRAWINGS
DATE: SEPTEMBER 25, 2018

GOVERNMENT OF NUNAVUT
WASTEWATER MANAGEMENT FACILITY

PROJECT OTT-00019838-A0

exp Services Inc.
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Ottawa, ON K2B 8H6
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NOTES

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

RECORD DRAWINGS

DATE: SEPTEMBER 25, 2018

NO.	REVISION DESCRIPTION	DATE	BY	APPD
7	RECORD DRAWINGS	25/09/18	AO	IPC
7	ISSUED FOR CONSTRUCTION	19/09/16	IPC	SLB
6	ISSUED FOR TENDER	27/04/15	IPC	SLB
5	ISSUED FOR NWB REVIEW	27/03/15	IPC	SLB
4	ISSUED FOR 100% REVIEW	05/03/15	IPC	SLB
3	ISSUED FOR 99% REVIEW	19/01/15	IPC	SLB
2	ISSUED FOR 75% REVIEW	21/11/14	IPC	SLB
1	ISSUED FOR REVIEW	13/03/12	MEB	SLB

SCALE: HORZ 1:5000

0 50m 100m 200m HORIZONTAL 1:5,000

DESIGNED BY

REVIEWED BY

CLIENT: GOVERNMENT OF NUNAVUT
DEPARTMENT OF COMMUNITY AND GOVERNMENT SERVICES

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BASEPLAN	exp.
DESIGN	IPC
CHECKED	SLB
CAD	IPC
PROJ. MAN	SLB
APPROVED	SLB

PROJECT: WASTEWATER TREATMENT FACILITY
IGLOOLIK, NUNAVUT

TITLE: SITE LOCATION PLAN

PROJ NO. OTCD00019838A
SURVEY exp.
DATE NOV. 2014
DRAWING NO. IGL–1

NOTES

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RECORD DRAWINGS

DATE: SEPTEMBER 25, 2018

NO.	REVISION DESCRIPTION	DATE	BY	APPD
7	RECORD DRAWINGS	25/09/18	AO	IPC

NO.	REVISION DESCRIPTION	DATE	BY	APPD
7	ISSUED FOR CONSTRUCTION	19/09/16	IPC	SLB
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5	ISSUED FOR NEW REVIEW	27/03/15	IPC	SLB
4	ISSUED FOR 100% REVIEW	05/03/15	IPC	SLB
3	ISSUED FOR 99% REVIEW	19/01/15	IPC	SLB
2	ISSUED FOR 75% REVIEW	21/11/14	IPC	SLB
1	ISSUED FOR REVIEW	13/03/12	MEB	SLB

SCALE: HORZ 1:1500

0 15m 30m 60m
HORIZONTAL 1:1500

DESIGNED BY

REVIEWED BY

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BASEPLAN	exp.
DESIGN	IPC
CHECKED	SLB
CAD	SLB
PROJ. MAN	SLB
APPROVED	SLB

PROJECT: WASTEWATER TREATMENT FACILITY
IGLOOLIK, NUNAVUT

TITLE: PROPOSED FACILITY AND PHASING PLAN

PROJ NO. OTCD00019838A
SURVEY exp.
DATE NOV. 2014
DRAWING NO. IGL–2

Filename: r:\19000\19800\19838 liquid-solid waste mgt igloolik\e - temp working drawings\
Last Saved: 9/25/2018 12:01:24 PM
Last Plotted:9/25/2018 1:08:17 PM Plotted by: OniA
Pen Table:: ----
References:

NOTES
THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

RECORD DRAWINGS

DATE: SEPTEMBER 25, 2018

NO.	REVISION DESCRIPTION	DATE	BY	APPD	NO.	REVISION DESCRIPTION	DATE	BY	APPD
					7	ISSUED FOR CONSTRUCTION	19/09/16	IPC	SLB
					6	ISSUED FOR TENDER	12/11/15	IPC	SLB
					5	ISSUED FOR NWB REVIEW	27/03/15	IPC	SLB
					4	ISSUED FOR 100% REVIEW	05/03/15	IPC	SLB
					3	ISSUED FOR 99% REVIEW	19/01/15	IPC	SLB
9	RECORD DRAWINGS	25/09/18	AO	IPC	2	ISSUED FOR 75% REVIEW	21/11/14	IPC	SLB
8	AS–BUILTS	17/09/18	SAB	IPC	1	ISSUED FOR REVIEW	13/03/12	MEB	SLB

SCALE
HORZ 1:750
HORIZONTAL 1:750

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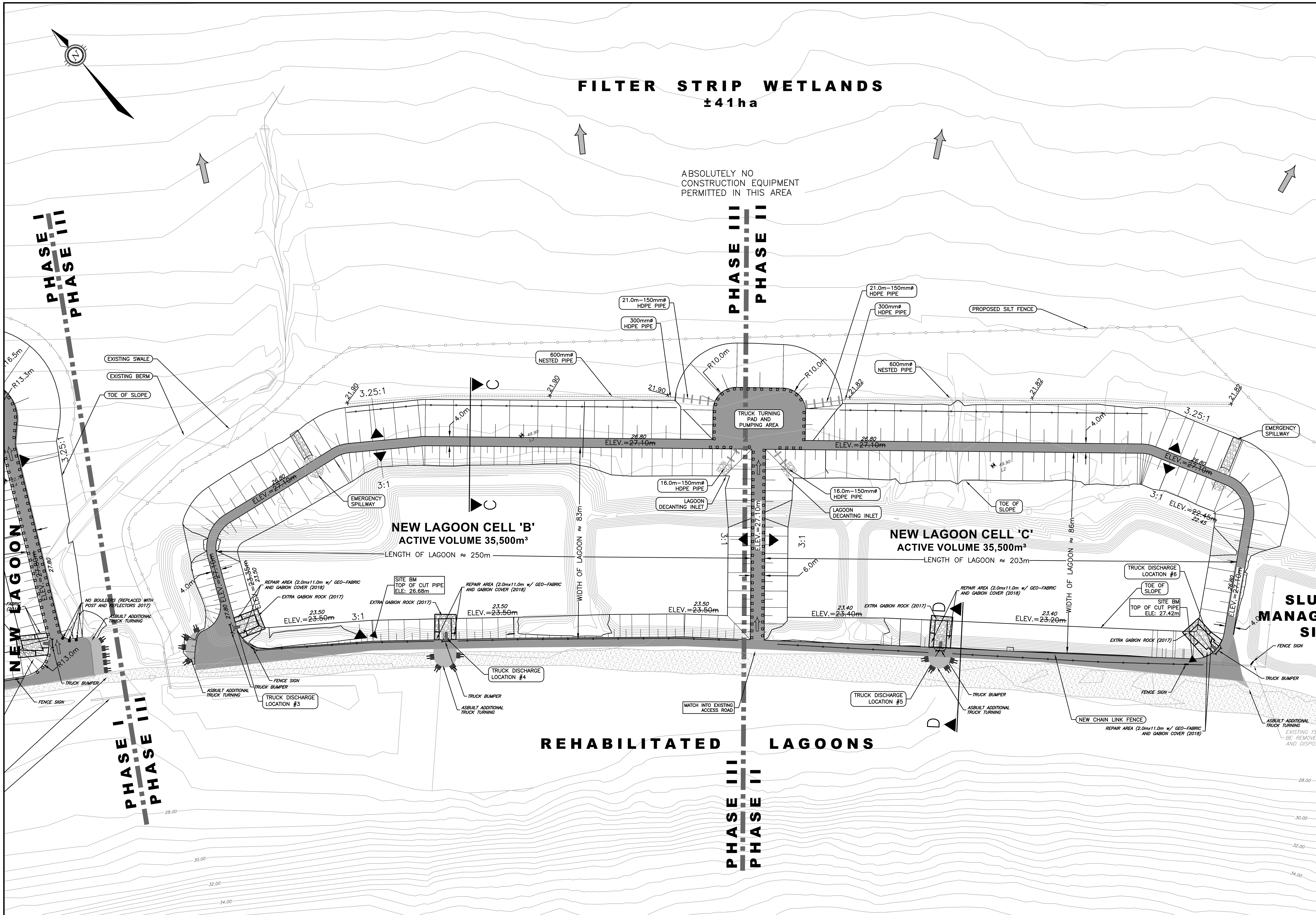
BASEPLAN	exp.
DESIGN	IPC
CHECKED	SLB
CAD	IPC
PROJ. MAN	SLB
APPROVED	SLB

PROJECT
WASTEWATER TREATMENT FACILITY
IGLOOLIK, NUNAVUT

TITLE
NEW LAGOON CELL 'A'
PHASE I

PROJ. NO. OTCD00019838A
SURVEY exp.
DATE NOV. 2014
DRAWING NO. IGL–3



FILTER STRIP WETLANDS
±41ha
ABSOLUTELY NO CONSTRUCTION EQUIPMENT PERMITTED IN THIS AREA
PHASE I
PHASE III
PHASE III
PHASE II
NEW LAGOON
EXISTING SWALE
EXISTING BERM
TOE OF SLOPE
21.0m–150mmø HDPE PIPE
300mmø HDPE PIPE
600mmø NESTED PIPE
PROPOSED SILT FENCE
TRUCK TURNING PAD AND PUMPING AREA
R10.0m
EMERGENCY SPILLWAY
ELEV.=27.10m
3.25:1
3:1
4.0m
6.0m
16.0m–150mmø HDPE PIPE
LAGOON DECANTING INLET
NEW LAGOON CELL 'B'
ACTIVE VOLUME 35,500m³
LENGTH OF LAGOON ≈ 250m
WIDTH OF LAGOON ≈ 83m
NEW LAGOON CELL 'C'
ACTIVE VOLUME 35,500m³
LENGTH OF LAGOON ≈ 203m
WIDTH OF LAGOON ≈ 86m
SITE BM TOP OF CUT PIPE ELE: 26.68m
SITE BM TOP OF CUT PIPE ELE: 27.42m
REPAIR AREA (2.0mx11.0m w/ GEO-FABRIC AND GABION COVER (2018)
EXTRA GABION ROCK (2017)
ELEV.=23.50m
ELEV.=23.40m
ELEV.=23.20m
NO BOULDERS (REPLACED WITH POST AND REFLECTORS 2017)
ASBUILT ADDITIONAL TRUCK TURNING
TRUCK BUMPER
FENCE SIGN
TRUCK DISCHARGE LOCATION #3
TRUCK DISCHARGE LOCATION #4
TRUCK DISCHARGE LOCATION #5
TRUCK DISCHARGE LOCATION #6
MATCH INTO EXISTING ACCESS ROAD
NEW CHAIN LINK FENCE
SLUDGE MANAGEMENT SITE
EXISTING FENCE TO BE REMOVED AND DISPOSED OF
REHABILITATED LAGOONS

LEGEND

- EXISTING SWALE
- GABION MAT
- TOP OF BERM
- TRUCK ROUTE
- DIRECTION OF OVERLAND FLOW (WETLANDS)
- 600mm PERFORATED NESTED PIPE
- EROSION CONTROL – SILT FENCE
- NEW FENCE LOCATION
- 76.58 PROPOSED GRADES
- STONE BOULDERS–SEE DETAIL SHEET FOR SPACING
- 4.0% SLOPE
- EXISTING DITCH LINE

NOTES

DISTANCES AND ELEVATIONS ARE EXPRESSED IN METERS AND ARE HORIZONTAL AT GROUND LEVEL.

ALL GRID REFERENCES REFER TO THE CENTRAL MERIDIAN OF UTM ZONE 17.

ELEVATION DATUM: COORDINATE CONTROL MONUMENT – IGLOOLIK CBM M009001, ELEVATION – 46.74 METERS ABOVE MEAN SEA LEVEL–SEE SITE PLAN FOR LOCATION.

CONTOUR INTERVAL = 0.5m.

THE RE–USE OF BERM MATERIALS FROM THE EXISTING SEWAGE LAGOON SHALL BE ON CONDITION THAT THEY DO NOT POSE UNACCEPTABLE ACUTE HEALTH RISKS TO SITE WORKERS. PRIOR TO RE–USE SAMPLES OF THE BERM MATERIALS SHALL BE SUBMITTED FOR LABORATORY TESTING FOR BACTERIOLOGICAL PATHOGENS (INCLUDING AT A MINIMUM–E.COLI, TOTAL COLIFORMS, AND FECAL COLIFORMS). SITE WORKERS SHOULD USE APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT WHEN HANDLING BERM MATERIALS FROM EXISTING SEWAGE LAGOONS.

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8	AS–BUILTS	17/09/18	SABG	IPC	1	ISSUED FOR REVIEW	13/03/12	MEB	SLB

SCALE: HORZ 1:750

0 5m 10m 30m HORIZONTAL 1:750

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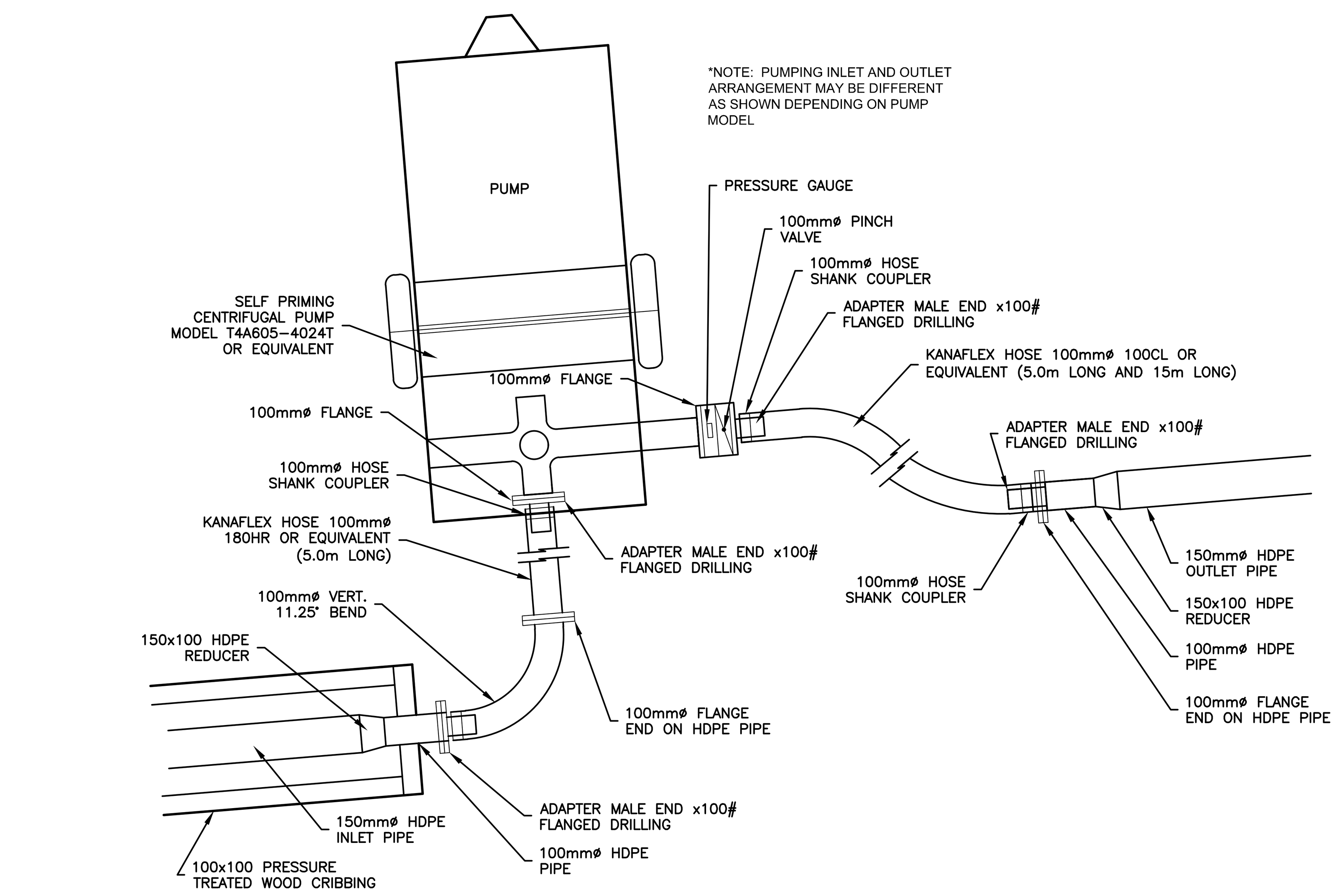
BASEPLAN: exp.
DESIGN: IPC
CHECKED: SLB
CAD: IPC
PROJ. MAN: SLB
APPROVED: SLB

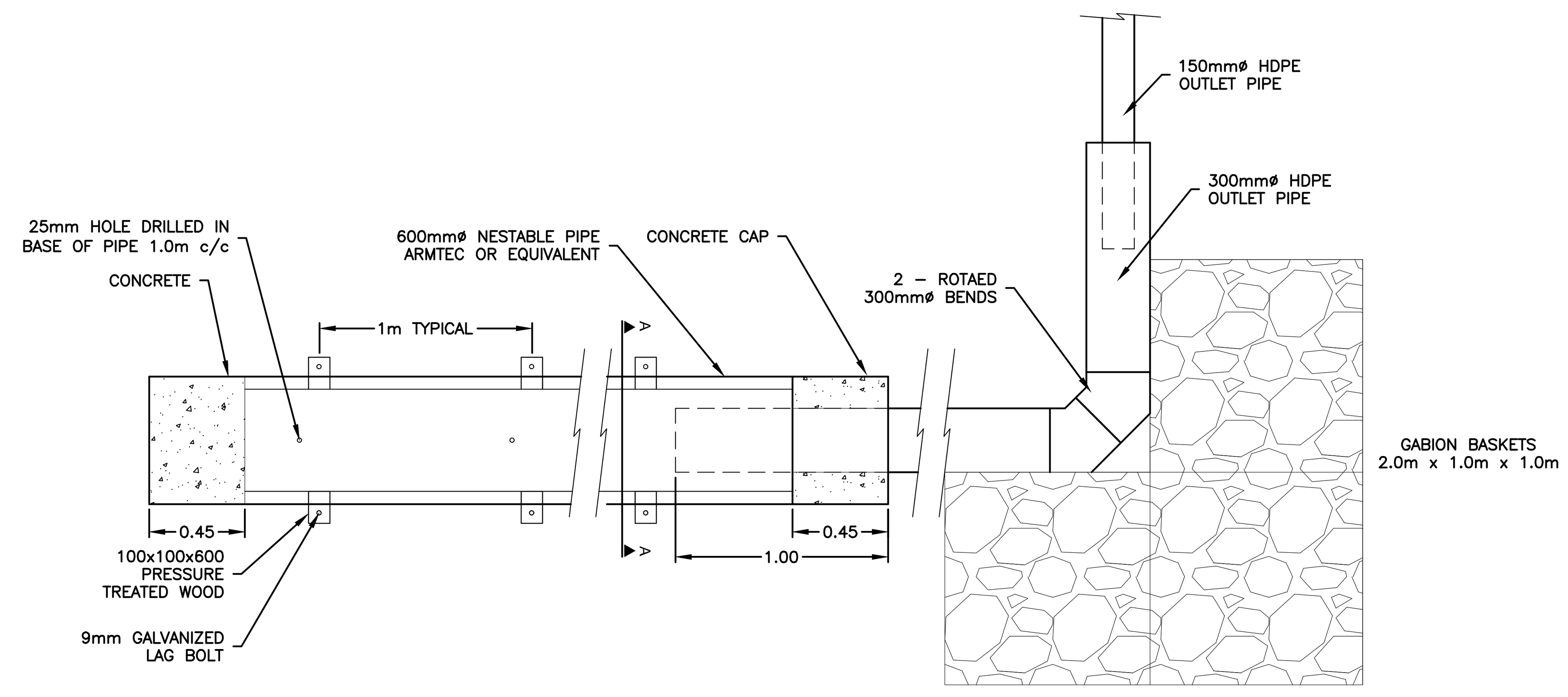
PROJECT: WASTEWATER TREATMENT FACILITY
IGLOOLIK, NUNAVUT

TITLE: NEW LAGOON CELLS 'B' & 'C'
PHASE II & PHASE III

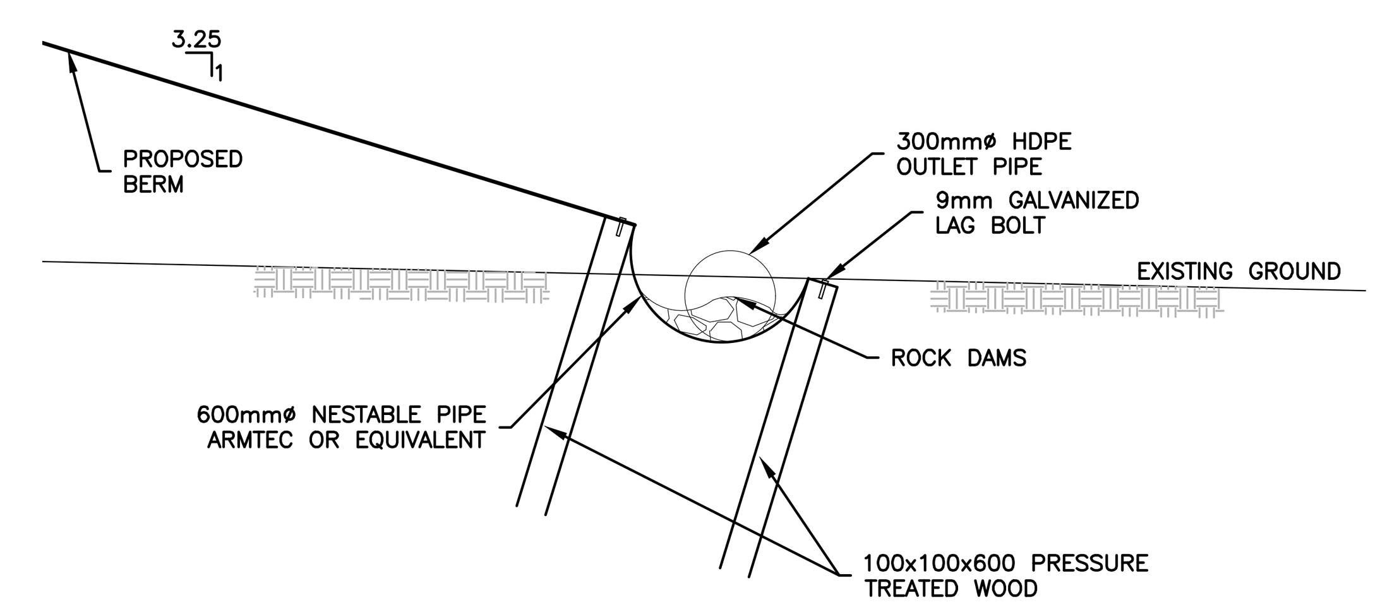
PROJ NO.: OTCD00019838A
SURVEY: exp.
DATE: NOV. 2014
DRAWING NO.: IGL–4



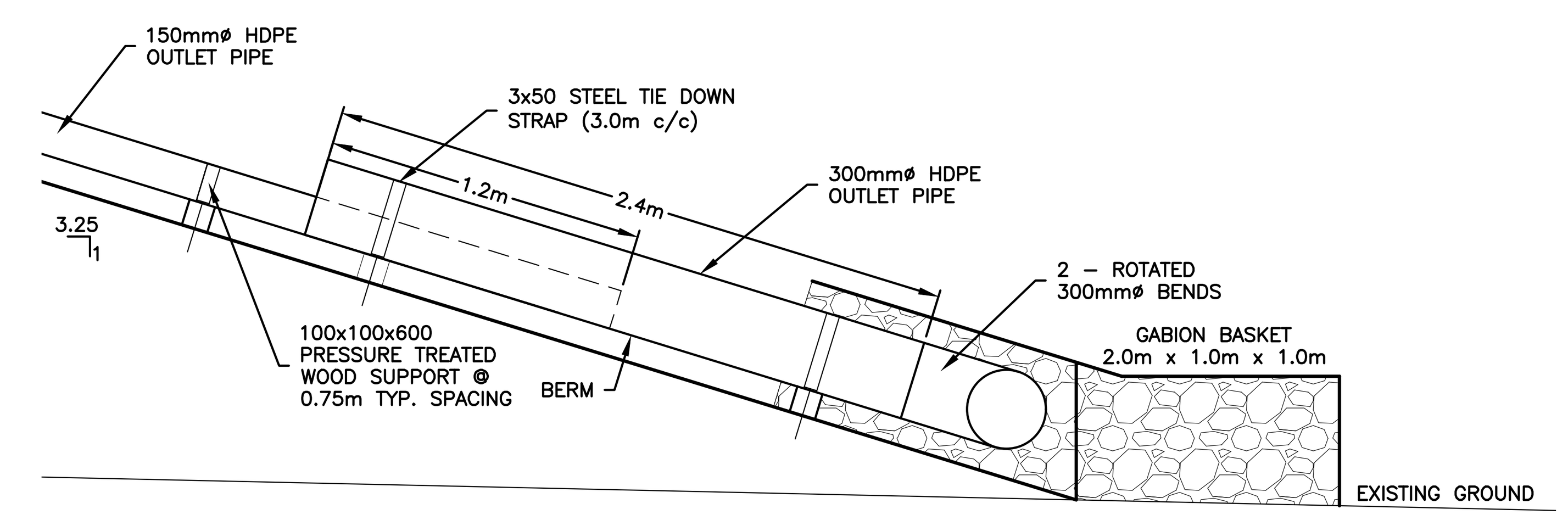
LAGOON DEWATERING PUMP INFRASTRUCTURE PLAN VIEW
1:25



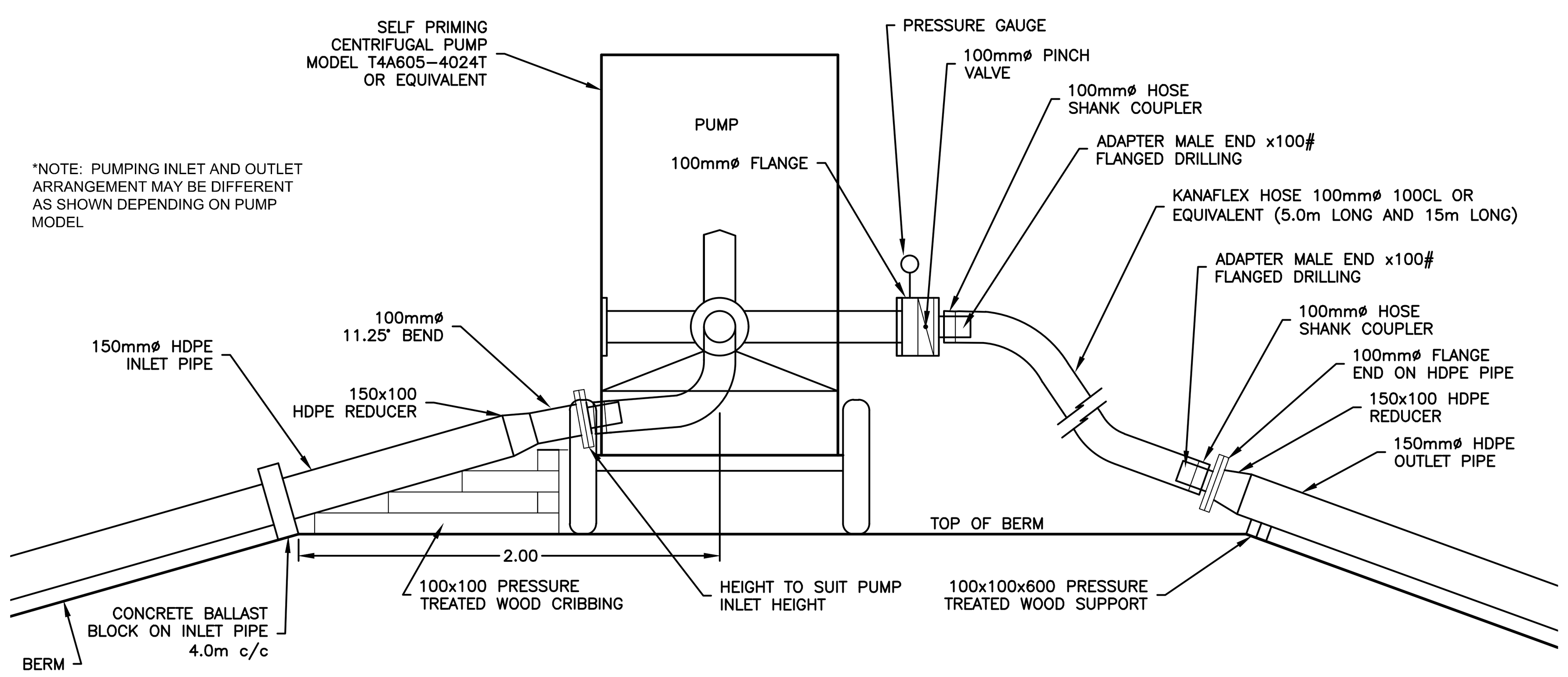
LAGOON DEWATERING OUTLET PLAN VIEW
1:25



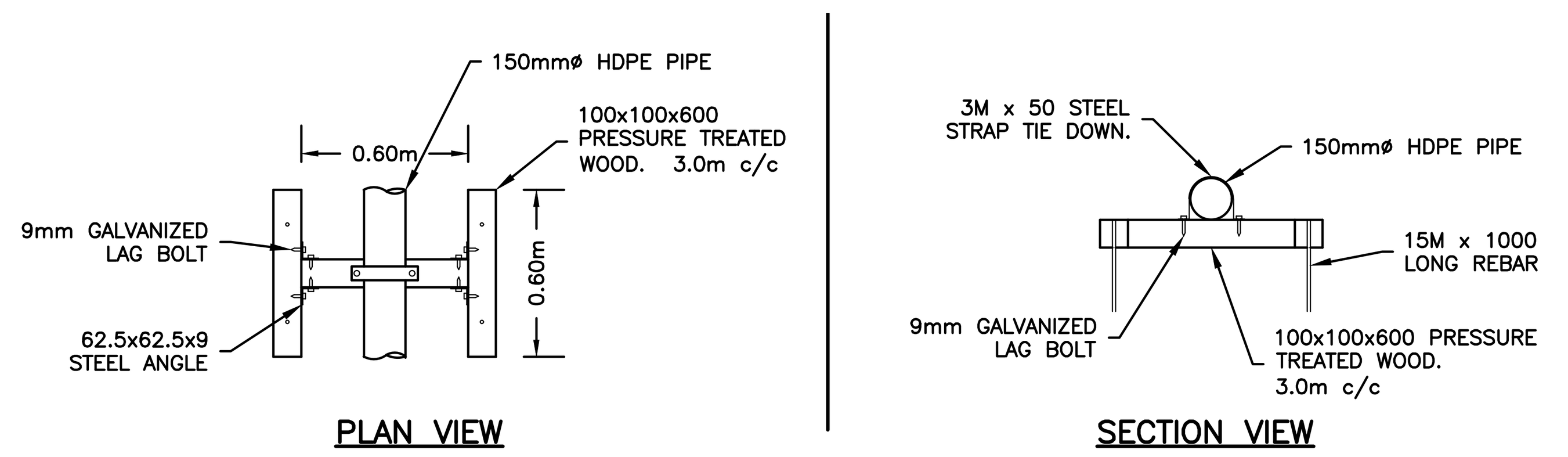
NESTABLE PIPE DETAIL SECTION A–A
1:25



LAGOON DEWATERING OUTLET INFRASTRUCTURE SECTION VIEW
1:25

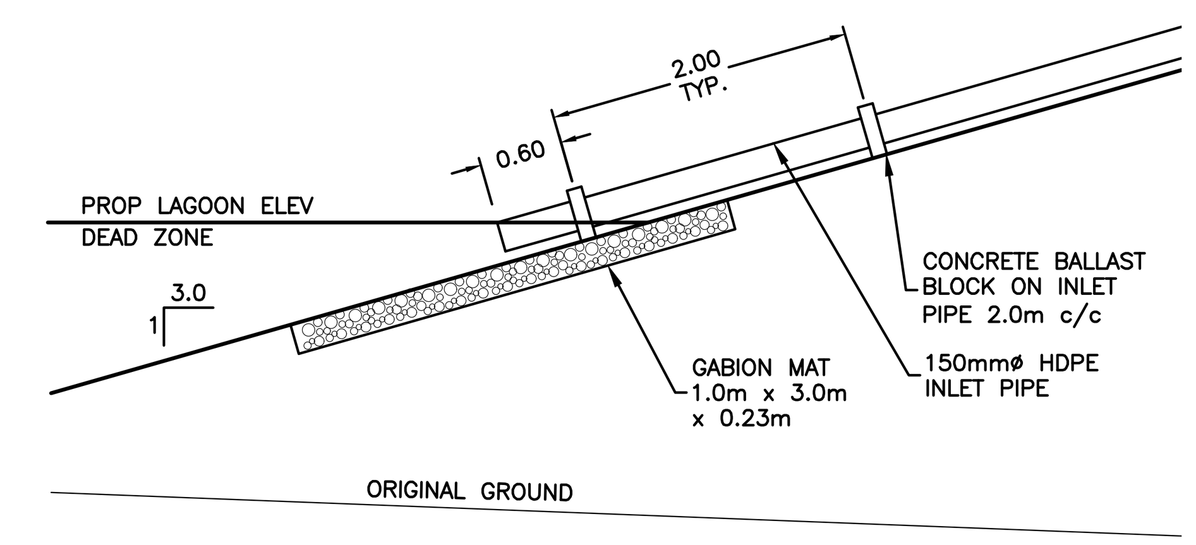


LAGOON DEWATERING PUMP INFRASTRUCTURE
1:25

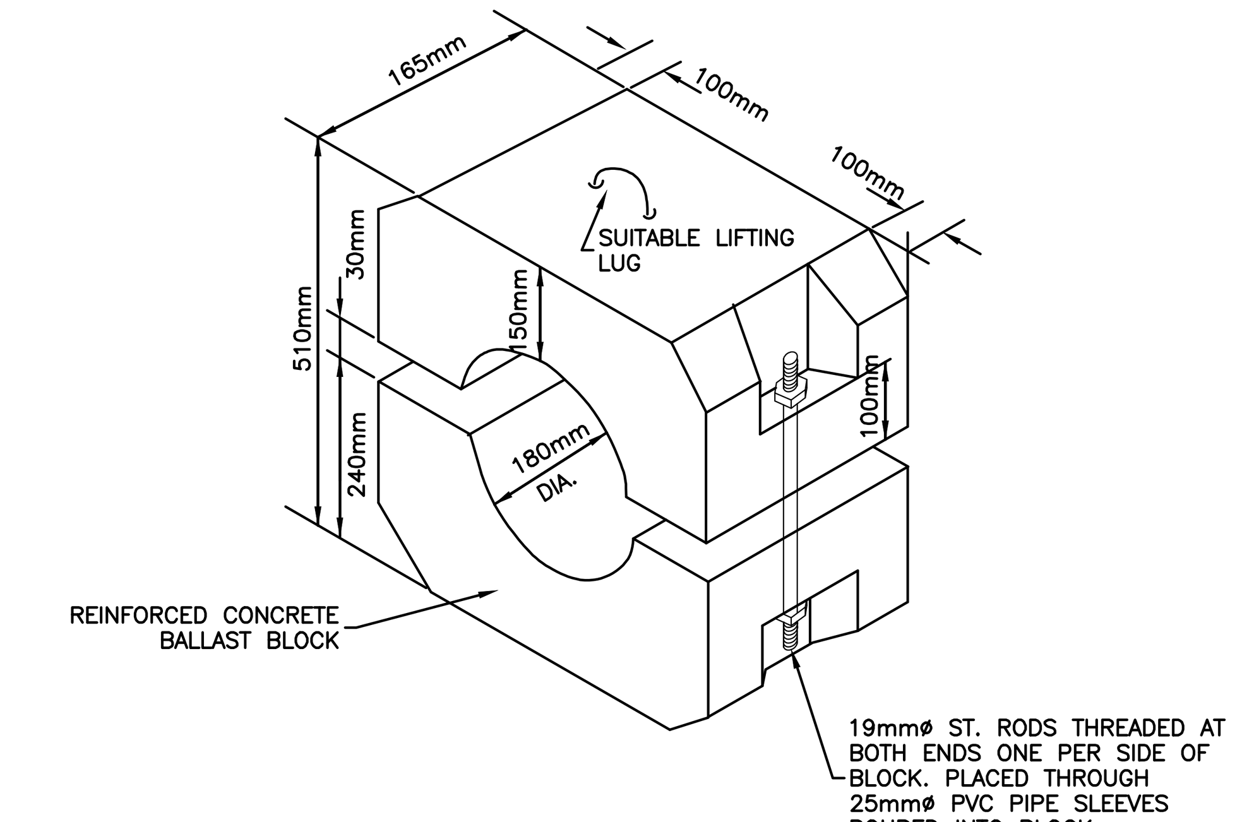


OUTLET PIPE SUPPORT
1:25

	CELL A	CELL B AND C
TOP OF BERM	27.80	27.10
FREEBOARD	1m FROM TOP OF BERM	1m FROM TOP OF BERM
ACTIVE ZONE	VARIES	VARIES
DEAD ZONE	1m FROM BOTTOM OF LAGOON	1m FROM BOTTOM OF LAGOON
BOTTOM OF LAGOON	VARIES	VARIES



LAGOON DEWATERING INLET
1:50



NOTES:

1. CONTRACTOR TO SUBMIT SHOP DRAWINGS FOR CONCRETE BALLAST BLOCKS C/W REINFORCING.
2. CONTRACTOR TO USE 6.25mm THICK NEOPRENE SPONGE PADDING BETWEEN PIPE AND BLOCKS TO PREVENT CONTACT. WIDTH TO BE 180mm.

CONCRETE BALLAST BLOCK
N.T.S

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2	ISSUED FOR 75% REVIEW	21/11/14	IPC	SLB
1	ISSUED FOR REVIEW	13/03/12	SAB	SLB

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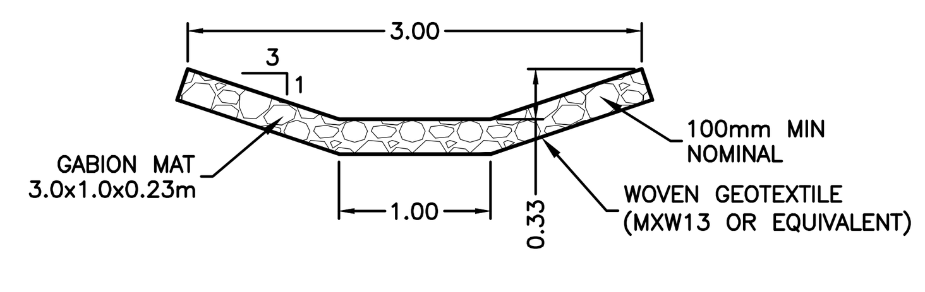
DESIGN	IPC
CHECKED	SLB
CAD	IPC
PROJ. MAN	SLB
APPROVED	SLB

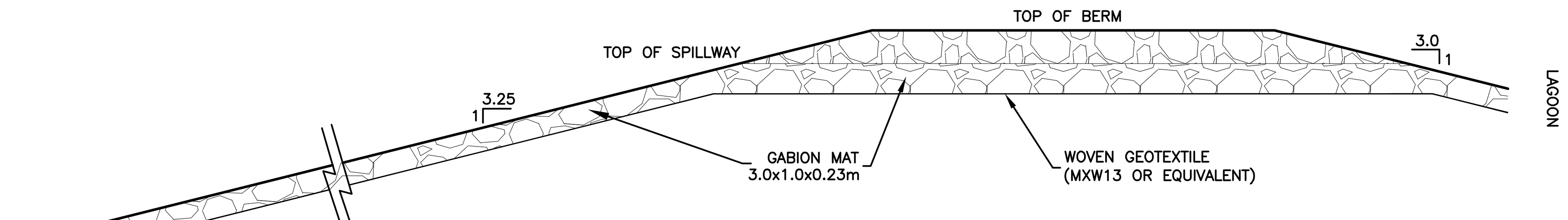
PROJECT
WASTEWATER TREATMENT FACILITY
IGLOOLIK, NUNAVUT

TITLE
DETAIL PLAN
PUMPING AND DEWATERING DETAILS

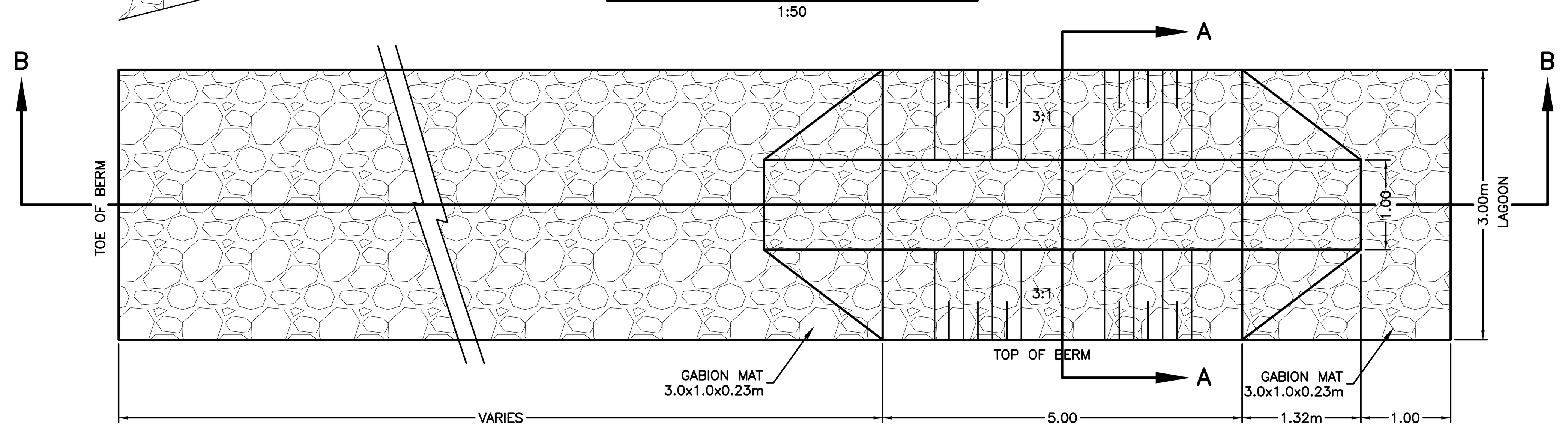
PROJ. NO. OTCD00019838A
SURVEY exp.
DATE NOV. 2014
DRAWING NO. IGL–5



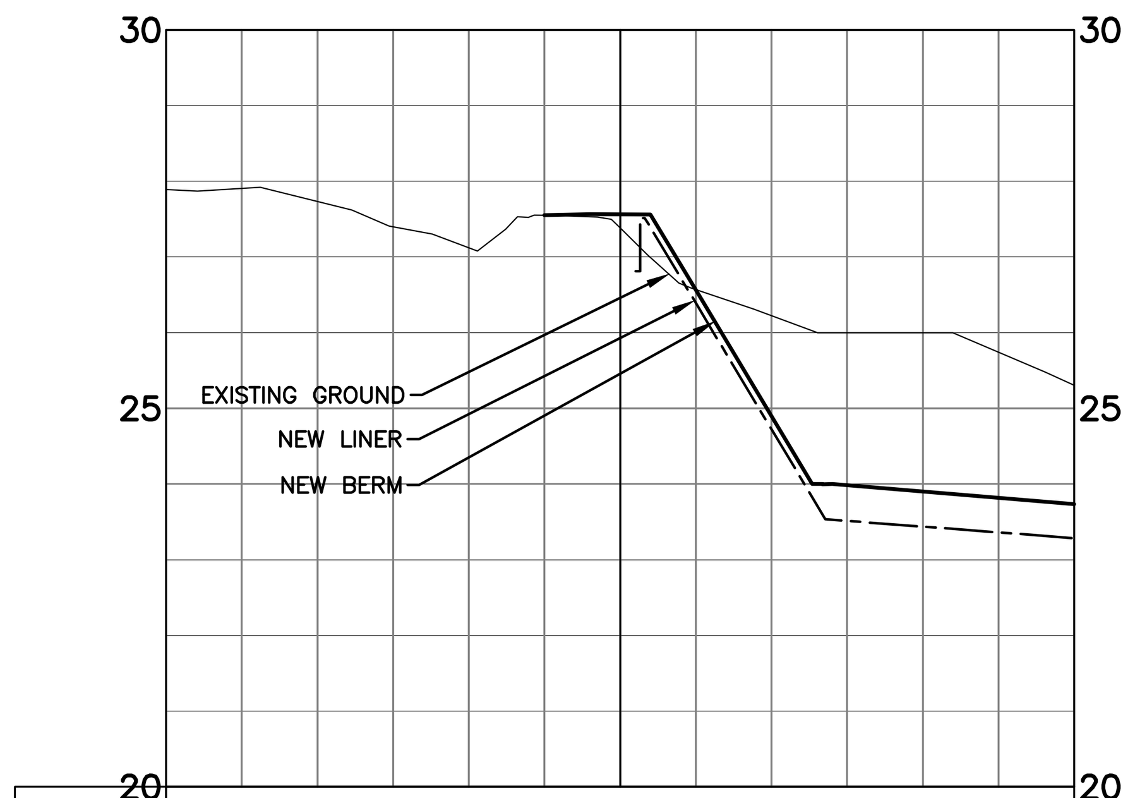
SPILLWAY DETAIL SECTION VIEW A–A
1:50



SPILLWAY BERM SECTION VIEW B–B
1:50

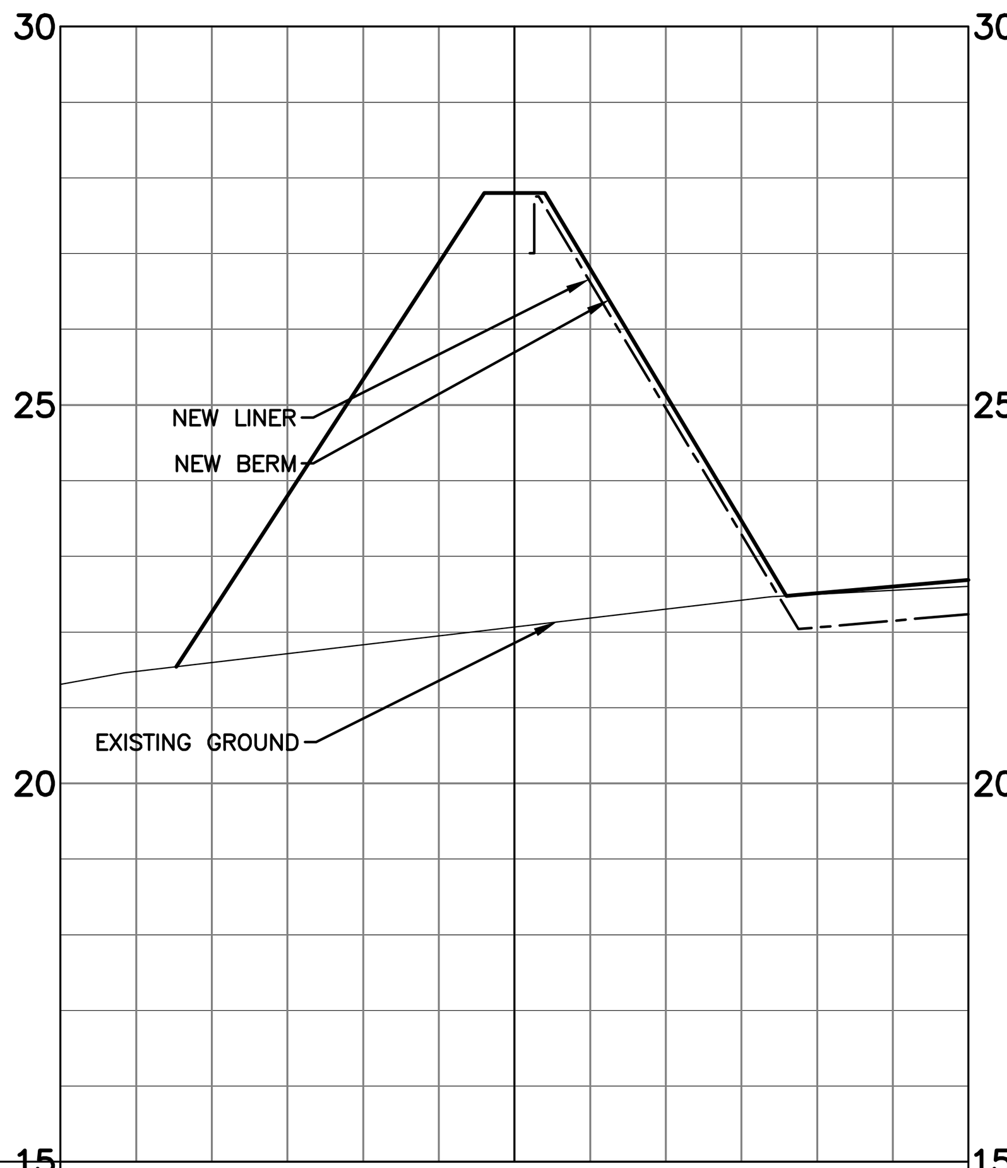


SPILLWAY BERM PLAN VIEW
1:50



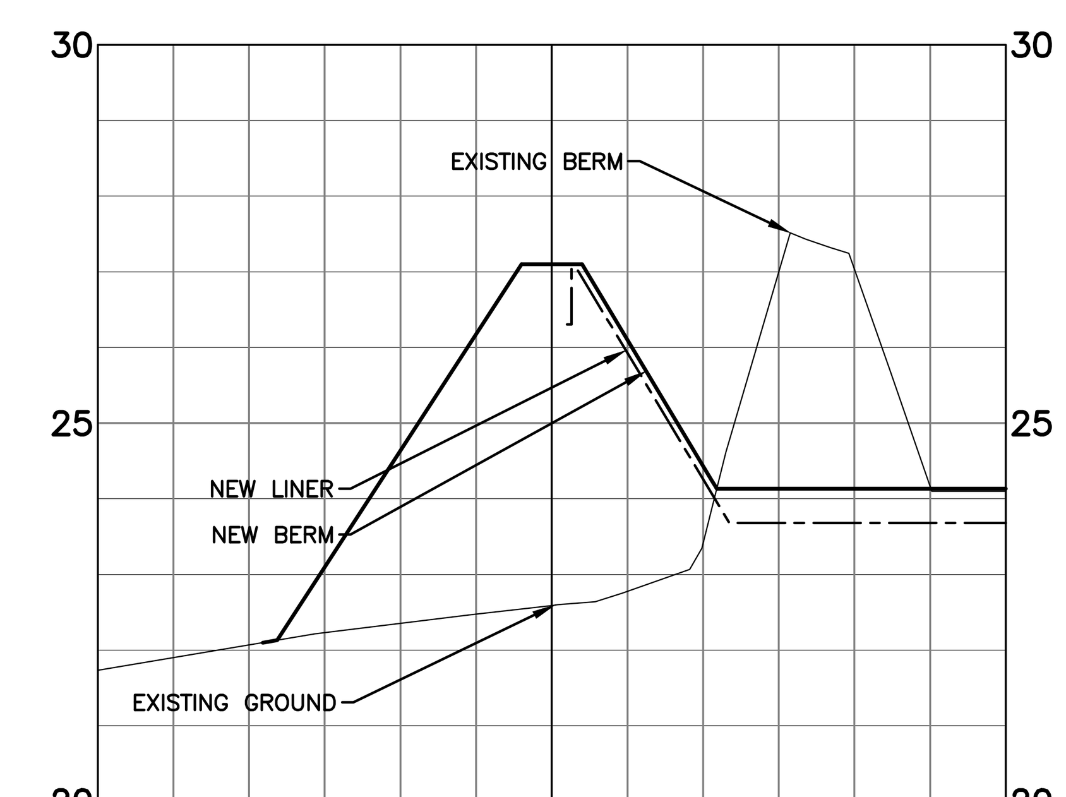
OFFSET	-25	-20	-15	-10	-5	0.00	5	10	15	20	25
PROPOSED ELEVATION					27.56	27.56	26.56	24.90	23.98	23.90	23.82
EXISTING ELEVATION	27.91	27.73	27.40	27.12	27.55	27.38	26.57	26.22	26.00	26.00	25.74

SECTION A (DWG NO. IGL–4 AND IGL–5)
1:500 HORIZ
1:100 VERT



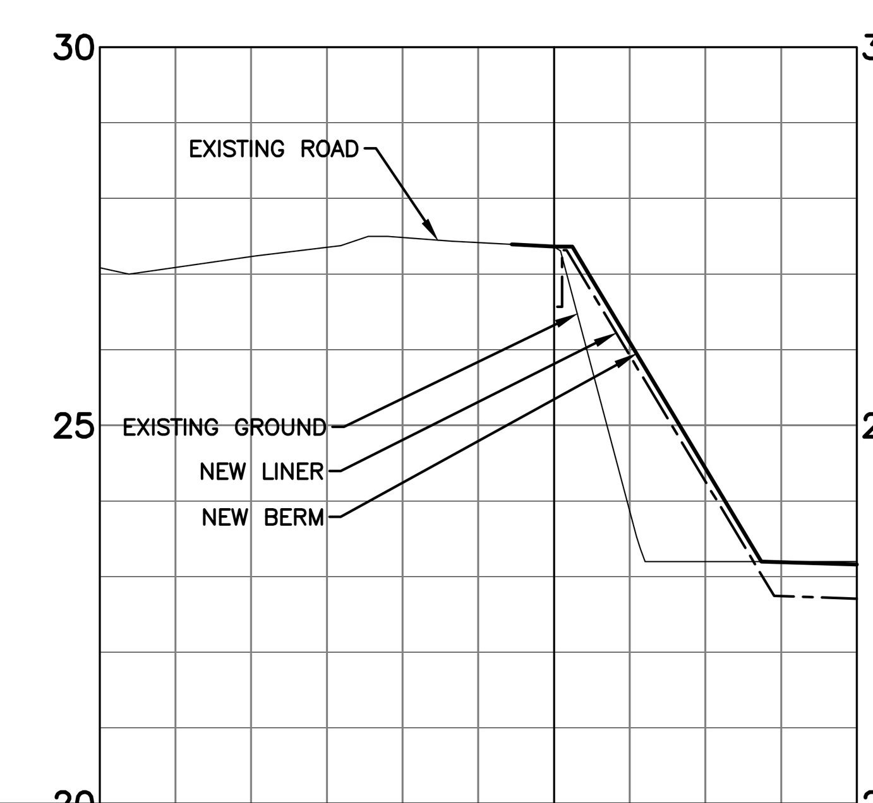
OFFSET	-25	-20	-15	-10	-5	0.00	5	10	15	20	25
PROPOSED ELEVATION		22.26	23.80	25.34	26.88	27.80	26.80	25.13	23.47	22.51	22.60
EXISTING ELEVATION	21.48	21.60	21.71	21.83	21.95	22.07	22.19	22.30	22.42	22.50	22.55

SECTION B (DWG NO. IGL–4 AND IGL–5)
1:500 HORIZ
1:100 VERT



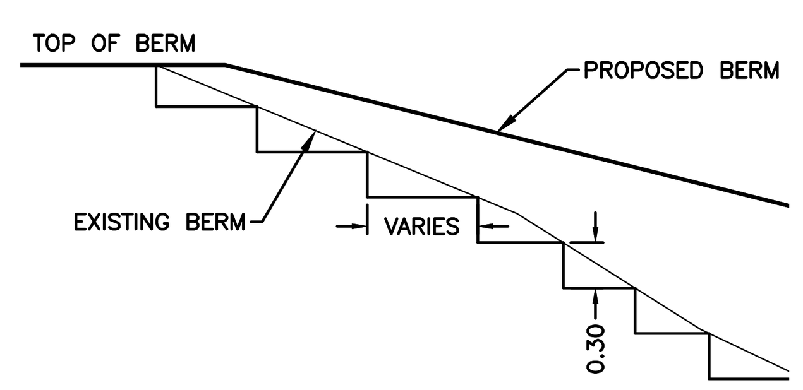
OFFSET	-25	-20	-15	-10	-5	0.00	5	10	15	20	25
PROPOSED ELEVATION		22.07	23.01	24.16	26.06	27.10	26.10	24.43			
EXISTING ELEVATION	21.90	22.07	22.23	22.35	22.47	22.59	22.78	23.41	27.00	27.03	24.17

SECTION C (DWG NO. IGL–4 AND IGL–5)
1:500 HORIZ
1:100 VERT

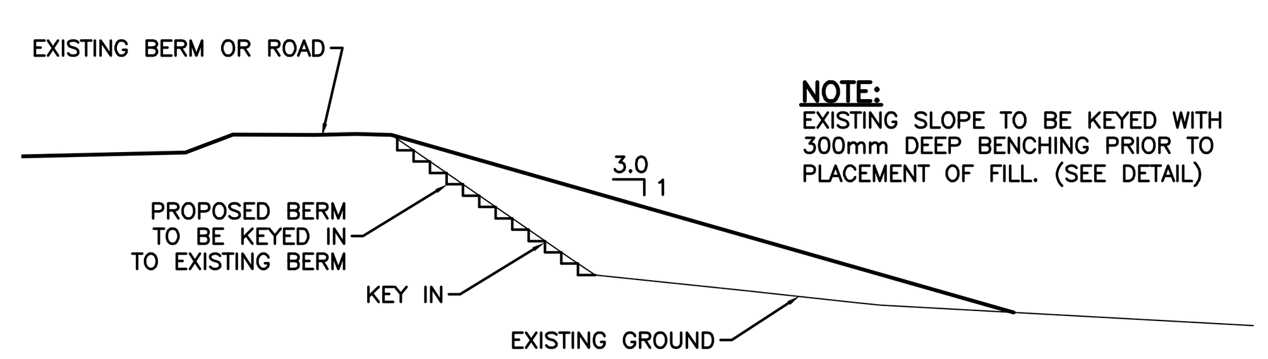


OFFSET	-25	-20	-15	-10	-5	0.00	5	10	15
PROPOSED ELEVATION					27.10	27.10	26.10	24.43	23.19
EXISTING ELEVATION	27.09	27.23	27.35	27.48	27.42	27.36	23.87	23.20	23.20

SECTION D (DWG NO. IGL–5)
1:500 HORIZ
1:100 VERT

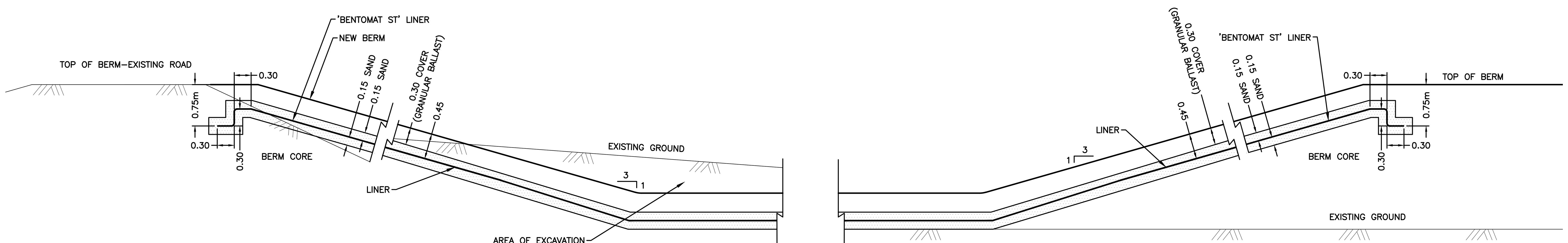


KEY IN DETAIL
1:50



NOTE:
EXISTING SLOPE TO BE KEYED WITH 300mm DEEP BENCHING PRIOR TO PLACEMENT OF FILL. (SEE DETAIL)

EXISTING BERM REHABILITATION DETAIL
1:200



LINER DETAIL
1:50

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1	ISSUED FOR REVIEW	13/03/12	SAB	SLB

SCALE

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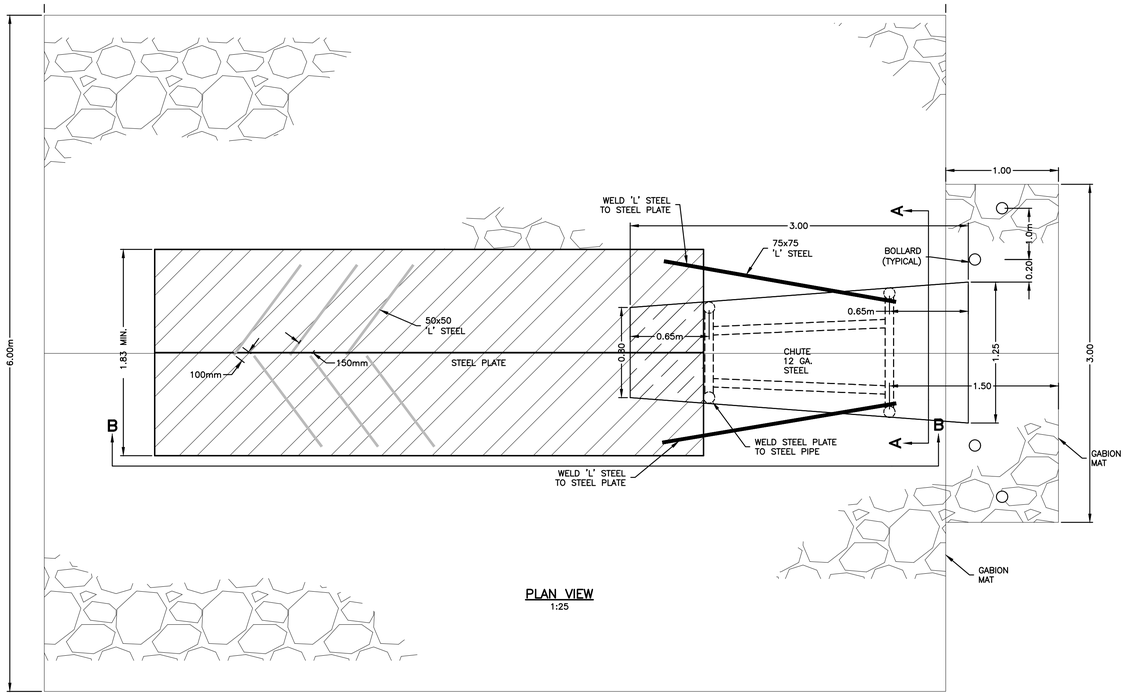
CAD: IPC
PROJ. MAN: SLB
APPROVED: SLB

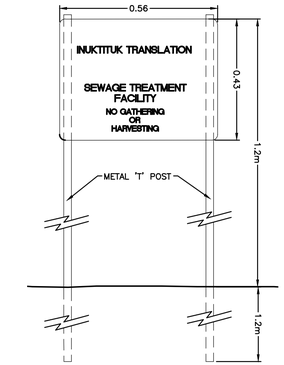
PROJECT
WASTEWATER TREATMENT FACILITY
IGLOOLIK, NUNAVUT

TITLE
DETAIL PLAN
LINER AND SPILLWAY DETAILS AND CROSS SECTIONS

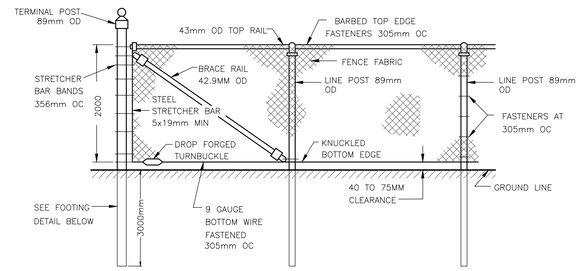
PROJ. NO.: OTCD00019838A
SURVEY: exp.
DATE: NOV. 2014
DRAWING NO.: IGL–6



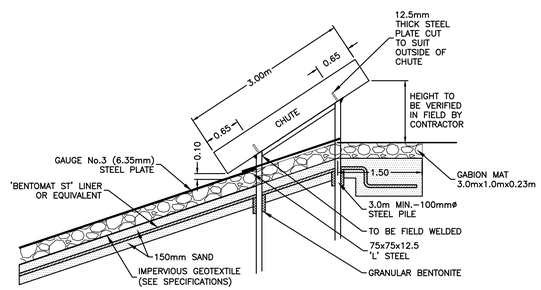
PLAN VIEW
1:25



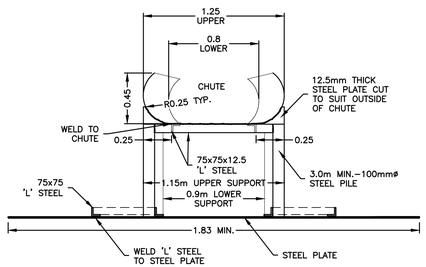
SIGN DETAIL
SCALE 1:10



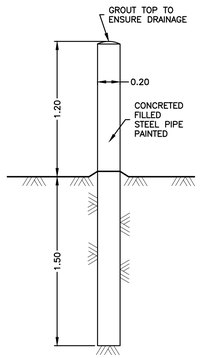
CHAIN LINK FENCE WITH TOP RAIL
N.T.S.



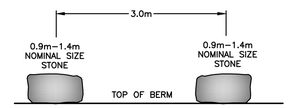
TRUCK DISCHARGE CHUTE SECTION B–B VIEW
1:50



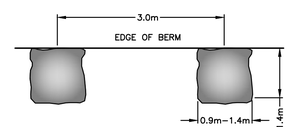
TRUCK DISCHARGE CHUTE SECTION A–A VIEW
1:25



BOLLARD DETAIL
1:25



STONE BARRIER DETAIL SECTION VIEW
N.T.S.



STONE BARRIER DETAIL PLAN VIEW
N.T.S.

NOTES

THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

RECORD DRAWINGS
DATE: SEPTEMBER 25, 2018

NO.	REVISION DESCRIPTION	DATE	BY	APPD
8	RECORD DRAWINGS	25/09/18	AO	IPC

NO.	REVISION DESCRIPTION	DATE	BY	APPD
7	ISSUED FOR CONSTRUCTION	19/09/16	IPC	SLB
6	ISSUED FOR TENDER	12/11/15	IPC	SLB
5	ISSUED FOR NWB REVIEW	27/03/15	IPC	SLB
4	ISSUED FOR 100% REVIEW	05/03/15	IPC	SLB
3	ISSUED FOR 99% REVIEW	19/01/15	IPC	SLB
2	ISSUED FOR 75% REVIEW	21/11/14	IPC	SLB
1	ISSUED FOR REVIEW	13/03/12	SAB	SLB

SCALE

DESIGNED BY

REVIEWED BY

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DEPARTMENT OF COMMUNITY
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PROJECT
WASTEWATER TREATMENT FACILITY
IGLOOLIK, NUNAVUT

PROJ. NO.: OTCD00019838A
SURVEY: exp.
DATE: NOV. 2014

TITLE
DETAIL PLAN
TRUCK DISCHARGE AND MISC. DETAILS

DRAWING NO.: IGL–7

Plot Table: ---
References: Details.dwg, 04-05 - NEW LAGOON.xab,dwg

APPENDIX

C GCL MANUFACTURER'S INSTALLATION GUIDELINES, APPLICABLE FOR BENTOMAT ST

BENTOMAT® INSTALLATION GUIDELINES

GEOSYNTHETIC CLAY LINERS

CETCO®

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GEOSYNTHETIC CLAY LINERS

CONTENTS

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SECTION 1
INTRODUCTION

1.1
This document provides procedures for the installation of CETCO GCLs in a manner that maximizes safety, efficiency, and the physical integrity of the GCL.

1.2
These guidelines are based upon many years of experience at a variety of sites and should be generally applicable to any type of lining project using CETCO GCLs. Variance from these guidelines is at the engineer's discretion.

1.3
The performance of the GCL is wholly dependent on the quality of its installation. It is the installer's responsibility to adhere to these guidelines, and to the project specifications and drawings as closely as possible. It is the engineer's and owner's responsibility to provide construction quality assurance (CQA) for the installation. This will ensure that the installation has been executed properly. This document covers only installation procedures.

1.4
For additional guidance, refer to ASTM D5888 (Standard Guide For Storage and Handling of Geosynthetic Clay Liners) and ASTM D 6102 (Standard Guide For Installation of Geosynthetic Clay Liners).

SECTION 2
EQUIPMENT REQUIREMENTS

2.1
CETCO GCLs are delivered in rolls typically 2,600-2,950 lbs (1180-1340 kg). Roll dimensions and weights will vary with the dimensions of the product ordered. It is necessary to support this weight using an appropriate core pipe, as indicated in Table 1. For any installation, the core pipe must not deflect more than 3 inches (75 mm), as measured from end to midpoint when a full GCL roll is lifted.

2.2
Lifting chains or straps appropriately rated should be used in combination with a spreader bar made from an I-beam, as shown in Figure 1.

2.3
The spreader bar ensures that lifting chains or straps do not chafe against the ends of the GCL roll, allowing it to rotate freely during installation. Spreader bar and core pipe kits are available through CETCO.

2.4
A front end loader, backhoe, dozer, or other equipment can be utilized with the spreader bar and core pipe or slings. Alternatively, a forklift with a "stinger" attachment may be used for on-site handling. A forklift without a stinger attachment should not be used to lift or handle the GCL rolls. Stinger attachments (Figures 2-4) are specially fabricated to fit various forklift makes and models.

Table 1: Core Requirements

Product	Nominal GCL Roll Size Lenth X Diameter	Typical GCL Roll Weight	Interior Core Size	Core Pipe Length x Diameter	Minimum Core Pipe Strength
BENTOMAT DN, SDN	16' x 24" (4.9 m x 610 mm)	2,650 lbs. (1204 kg)	3 3/4" (100 mm)	20' x 3.5" O.D. (6.1 m x 89 mm)	XXH
BENTOMAT ST	16' x 24" (4.9 m x 610 mm)	2,650 lbs. (1204 kg)	3 3/4" (100 mm)	20' x 3.5" O.D. (6.1 m x 89 mm)	XXH
BENTOMAT STM	16' x 32" (4.9 m x 814 mm)	2,500 lbs. (1130 kg)	3 3/4" (100 mm)	20' x 3.5" O.D. (6.1 m x 89 mm)	XXH
BENTOMAT 200R	16' x 24" (4.9 m x 610 mm)	2,650 lbs. (1204 kg)	3 3/4" (100 mm)	20' x 3.5" O.D. (6.1 m x 89 mm)	XXH
BENTOMAT CLT	16' x 26" (4.9 m x 660 mm)	2,650 lbs. (1204 kg)	3 3/4" (100 mm)	20' x 3.5" O.D. (6.1 m x 89 mm)	XXH
BENTOMAT CL	16' x 25" (4.9 m x 635 mm)	2,650 lbs. (1204 kg)	3 3/4" (100 mm)	20' x 3.5" O.D. (6.1 m x 89 mm)	XXH
BENTOMAT 600 CL	16' x 25" (4.9 m x 635 mm)	2,700 lbs. (1227 kg)	3 3/4" (100 mm)	20' x 3.5" O.D. (6.1 m x 89 mm)	XXH

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FIGURE 1 -SPREADER BAR ASSEMBLY

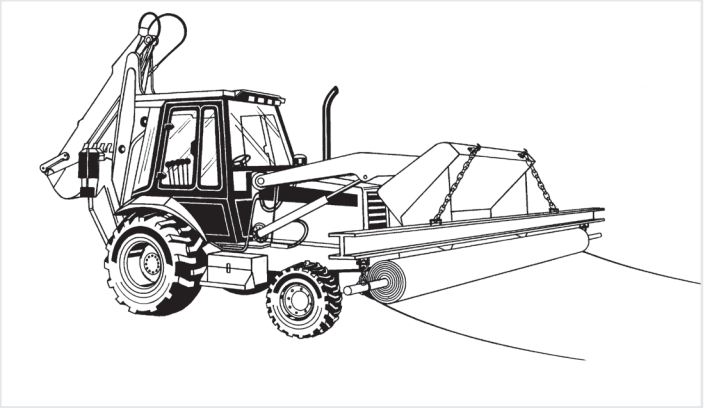
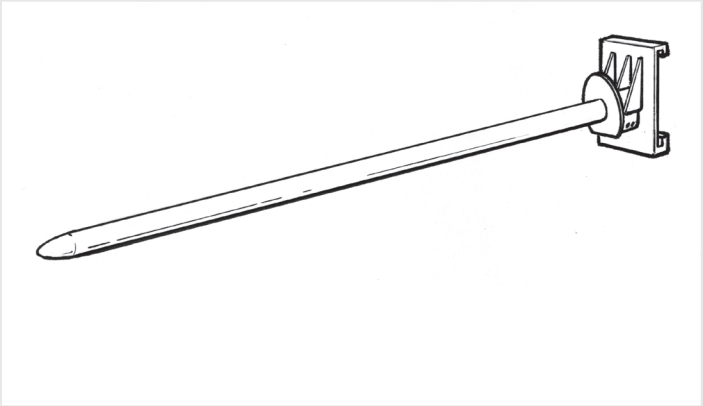


FIGURE 2 - HOOK MOUNT



2.5

When installing over certain geosynthetic materials, a 4 wheel, all-terrain vehicle (ATV) can be used to deploy the GCL. An ATV can be driven directly on the GCL provided that no sudden stops, starts, or turns are made.

2.6

Additional equipment needed for installation of CETCO GCLs includes:

- ► Utility knife and spare blades (for cutting the GCL)
- ► Granular bentonite for end-of-roll GCL seams and for sealing around structures and details
- ► Waterproof tarpaulins (for temporary cover on installed material as well as for stockpiled rolls)
- ► Optional flat-bladed vise grips (for positioning the GCL panel by hand)

2.7

The CETCO EASY ROLLER™ GCL Deployment System is a preferred method of installing geosynthetic clay liners. Use of the EASY ROLLER system eliminates the need for spreader bars and heavy core pipes. Installation speed and worker safety are also significantly increased. For further details, contact CETCO.

FIGURE 3 - FORK MOUNT (WITH FORK POCKETS)

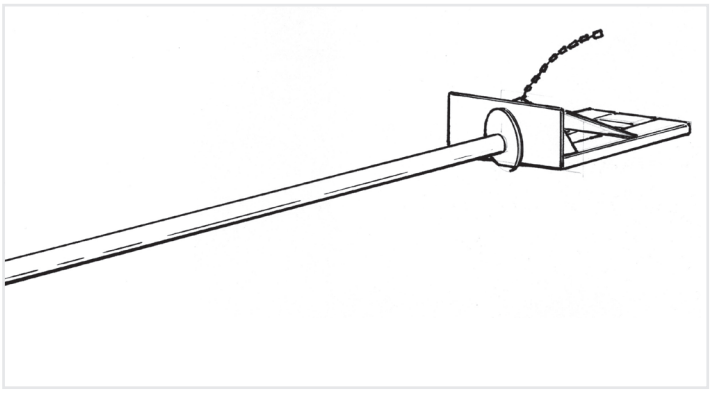
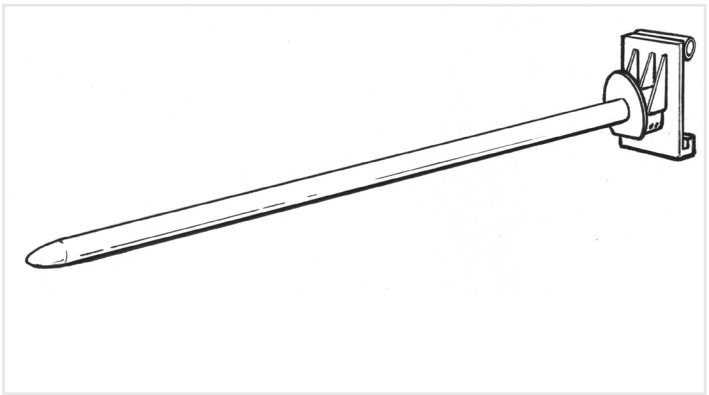


FIGURE 4 - PIN MOUNT



SECTION 3
SHIPPING, UNLOADING, & STORAGE

3.1
All lot and roll numbers should be recorded and compared to the packing list. Each roll of GCL should also be visually inspected during unloading to determine if any packaging has been damaged. Damage, whether obvious or suspected, should be recorded and the affected rolls marked.

3.2
Major damage suspected to have occurred during transit should be reported to the carrier and to CETCO immediately. The nature of the damage should also be indicated on the bill of lading, with specific lot and roll numbers noted. Accumulation of some moisture within roll packaging is normal and does not damage the product.

3.3
The party directly responsible for unloading the GCL should refer to this manual prior to shipment to ascertain the appropriateness of their unloading equipment and procedures. Unloading and on-site handling of the GCL should be supervised.

3.4
In most cases, CETCO GCLs are delivered on flatbed trucks. There are three methods of unloading: core pipe and spreader bar, slings, or stinger bar. To unload the rolls from the flat-bed using a core pipe and spreader bar, first insert the core pipe through the core tube. Secure the lifting chains or straps to each end of the core pipe and to the spreader bar mounted on the lifting equipment. Hoist the roll straight up and make sure its weight is evenly distributed so that it does not tilt or sway when lifted.

3.5
All CETCO GCLs are delivered with two 2'x 12' (50 mm x 3.65 mm) Type V polyester endless slings on each roll. Before lifting, check the position of the slings. Each sling should be tied off in the choke position, approximately one third (1/3) from the end of the roll. Hoist the roll straight up so that it does not tilt or sway when lifted.

3.6
In some cases, GCL rolls will be stacked in three pyramids on flatbed trucks. If slings are not used, rolls will require unloading with a stinger bar and extendible boom fork lift. Spreader bars will not work in this situation because of the limited access between the stacks of GCL. Three types of stingers are available from CETCO, a hook mount, fork mount and pin mount (Figures 2-4). To unload, guide the stinger through the core tube before lifting the GCL roll and removing the truck.

3.7
An extendable boom fork lift with a stinger bar is required for unloading vans. Rolls in the nose and center of the van should first be carefully pulled toward the door using the slings provided on the rolls.

3.8
Rolls should be stored at the job site away from high-traffic areas but sufficiently close to the active work area to minimize handling. The designated storage area should be flat, dry, and stable. Moisture protection of the GCL is provided by its packaging; however, based on expected weather conditions, an additional tarpaulin or plastic sheet may be required for added protection during prolonged outdoor storage.

3.9
Rolls should be stacked in a manner that prevents them from sliding or rolling. This can be accomplished by chocking the bottom layer of rolls. Rolls should be stacked no higher than the height at which they can be safely handled by laborers (typically no higher than four layers of rolls). Rolls should never be stacked on end.

SECTION 4
SUBGRADE PREPARATION

4.1
Subgrade surfaces consisting of granular soils or gravels are not acceptable due to their large void fraction and puncture potential. In applications where the GCL is the only barrier, subgrade soils should have a particle-size distribution of at least 80 percent finer than the #60 sieve (0.25 mm). In other applications, subgrade soils should range between fines and 1 inch (25 mm). In high-head applications (greater than 1 foot or 30.48 cm), CETCO recommends a membrane-laminated GCL (BENTOMAT CLT, BENTOMAT CL, or BENTOMAT 600 CL).

4.2
When the GCL is placed over an earthen subgrade, the subgrade surface must be prepared in accordance with the project specifications. The engineer's approval of the subgrade must be obtained prior to installation. The finished surface should be firm and unyielding, without abrupt elevation changes, voids, cracks, ice, or standing water.

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4.3

The subgrade surface must be smooth and free of vegetation, sharp-edged rocks, stones, sticks, construction debris, and other foreign matter that could contact the GCL. The subgrade should be rolled with a smooth-drum compactor to remove any wheel ruts greater than 1 inch in depth, footprints, or other abrupt grade changes. Furthermore, all protrusions extending more than 0.5 inch (12 mm) from the subgrade surface shall be removed, crushed, or pushed into the surface with a smooth-drum compactor. The GCL may be installed on a frozen subgrade, but the subgrade soil in the unfrozen state should meet the above requirements.

SECTION 5
INSTALLATION

5.1

GCL rolls should be taken to the work area of the site in their original packaging. The orientation of the GCL (i.e., which side faces up) may be important if the GCL has two different types of geosynthetics. Check with the project engineer to determine if there is a preferred installation orientation for the GCL. If no specific orientation is required, allow the roll to unwind from the bottom rather than pulling from the top (Figure 5A). The arrow sticker on the plastic sleeve indicates the direction that the GCL will naturally unroll when placed on the ground (Figure 6). Prior to deployment, the packaging should be carefully removed without damaging the GCL.

5.2

Equipment which could damage the GCL should not be allowed to travel directly on it. Therefore, acceptable installation may be accomplished whereby the GCL is unrolled in front of backwards-moving equipment (Figure 7). If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

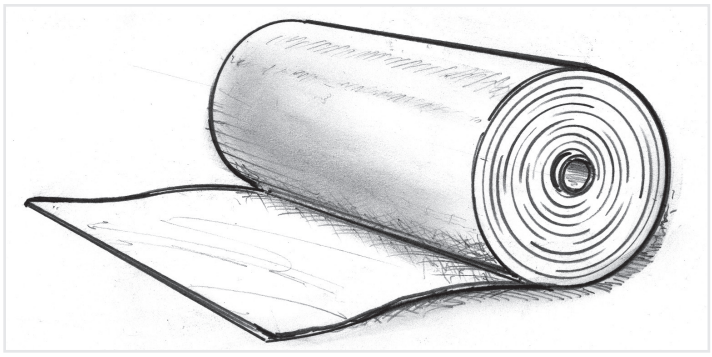
5.3

If sufficient access is available, GCL may be deployed by suspending the roll at the top of the slope, with a group of laborers pulling the material off of the roll, and down the slope (Figure 8).

5.4

GCL rolls should not be released on the slope and allowed to unroll freely by gravity.

FIGURE 5 A & B
"NATURAL' ORIENTATION (5A)



TOP OF THE ROLL (5B)

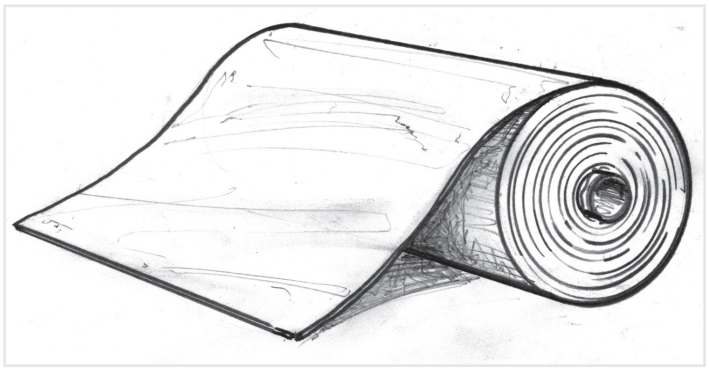


FIGURE 6 - DIRECTION TO UNROLL GCL ON GROUND PER FIGURE 5A

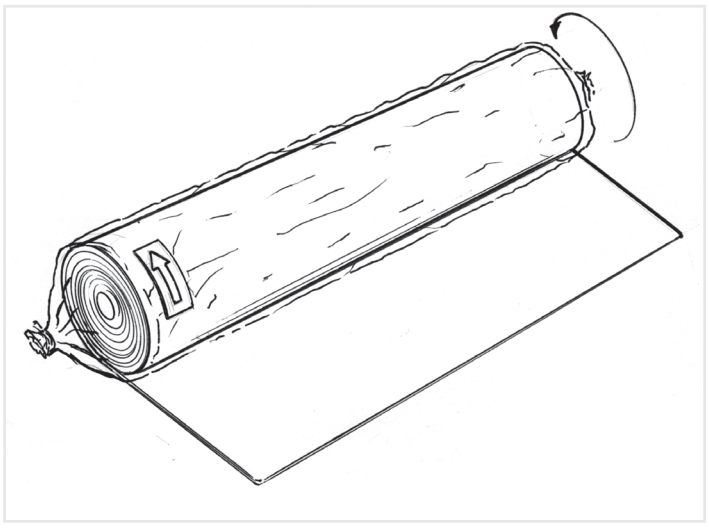


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FIGURE 7 - TYPICAL BENTOMAT® INSTALLATION TECHNIQUE

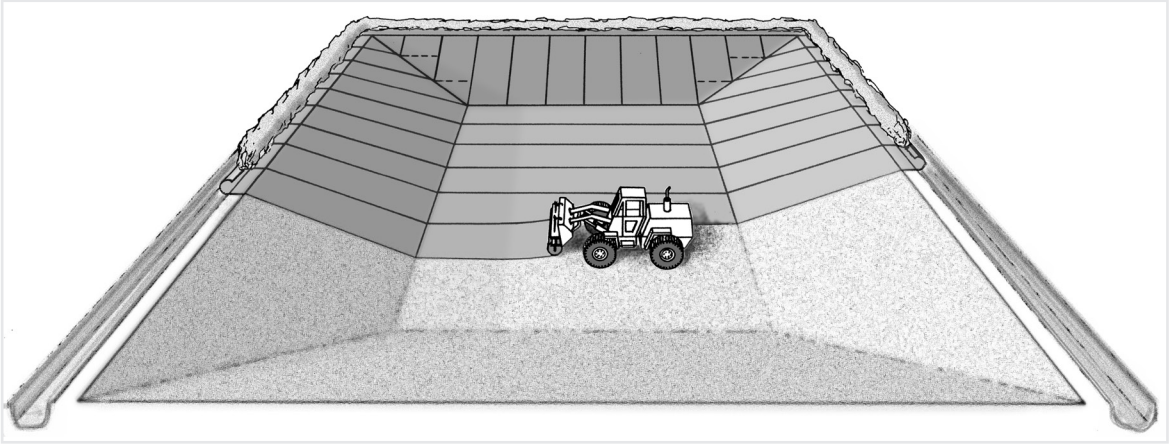
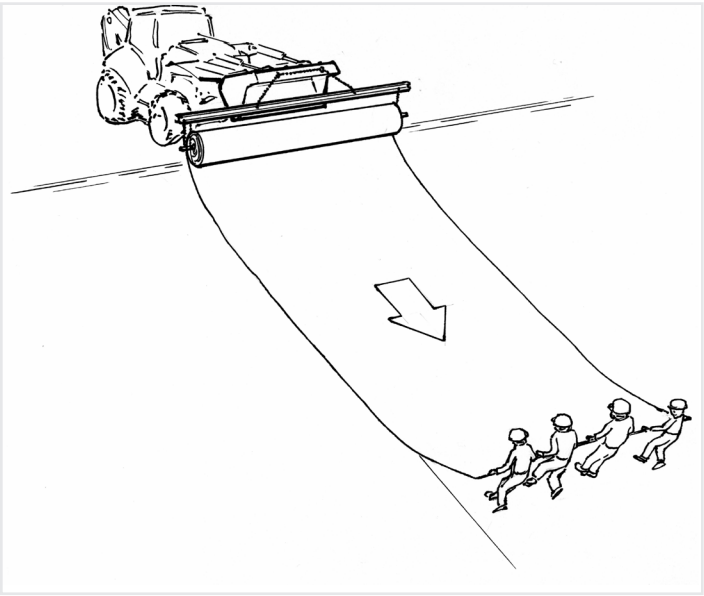


FIGURE 8 - UNROLLING BENTOMAT



5.5

Care must be taken to minimize the extent to which the GCL is dragged across the subgrade to avoid damage to the bottom surface of the GCL. Care must also be taken when adjusting BENTOMAT CLT panels to avoid damage to the geotextile surface of one panel of GCL by the textured sheet of another panel of GCL. A temporary geosynthetic subgrade cover commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

5.6

The GCL should be placed so that seams are parallel to the direction of the slope. End-of-panel seams should also be located at least 3 ft (1 m) from the toe and crest of slopes steeper than 4H:1V. End-of-roll seams on slopes should be used only if the liner is not expected to be in tension.

5.7

All GCL panels should lie flat, with no wrinkles or folds, especially at the exposed edges of the panels. When BENTOMAT geosynthetic clay liners with SUPERGROOVE® is repositioned, it should be gripped inside the SUPERGROOVE by folding the edge.

5.8

The GCL should not be installed in standing water or during rainy weather. Only as much GCL shall be deployed as can be covered at the end of the working day with soil, geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it may be necessary to remove and replace the hydrated material. CETCO recommends that premature hydration be evaluated on a case-by-case basis. The project engineer, CQA inspector, and CETCO TR-312 should be consulted for specific guidance if premature hydration occurs. The type of GCL, duration of exposure, degree of hydration, location in the liner system, and expected bearing loads should all be considered.

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In many instances, a needlepunch reinforced GCL may not require removal/replacement if the following are true:

- The geotextiles have not been separated, torn, or otherwise damaged
- There is no evidence that the needlepunching between the two geotextiles has been compromised
- The GCL does not leave deep indentations when stepped upon
- Overlapped seams with bentonite enhancement (see Section 7) are intact

5.9

For the convenience of the installer, hash marks are placed on BENTOMAT goesynthetic clay liners every 5' (1.5 m) of length.

SECTION 6
ANCHORAGE

6.1

If required by the project drawings, the end of the GCL roll should be placed in an anchor trench at the top of a slope. The front edge of the trench should be rounded to eliminate any sharp corners that could cause excessive stress on the GCL. Loose soil should be removed or compacted into the floor of the trench.

6.2

If a trench is used for anchoring the end of the GCL, soil backfill should be placed in the trench to provide resistance against pullout. The size and shape of the trench, as well as the appropriate backfill procedures should be in accordance with the project drawings and specifications. Typical dimensions are shown in Figure 9.

6.3

The GCL should be placed in the anchor trench such that it covers the entire trench floor but does not extend up the rear trench wall.

6.4

Sufficient anchorage may alternately be obtained by extending the end of the GCL roll back from the crest of the slope, and placing cover soil. The length of this "runout" anchor should be prepared in accordance with project drawings and specifications.

SECTION 7
SEAMING

7.1

GCL seams are constructed by overlapping adjacent panel edges and ends. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. BENTOMAT 200R, BENTOMAT ST, BENTOMAT DN, and BENTOMAT SDN have SUPERGROOVE® which provides self-seaming capabilities in their longitudinal overlaps, and therefore do not require supplemental bentonite. However, for pond applications, supplemental bentonite must be used in longitudinal seams, regardless of the CETCO GCL.

FIGURE 9 - TYPICAL ANCHOR TRENCH DESIGN

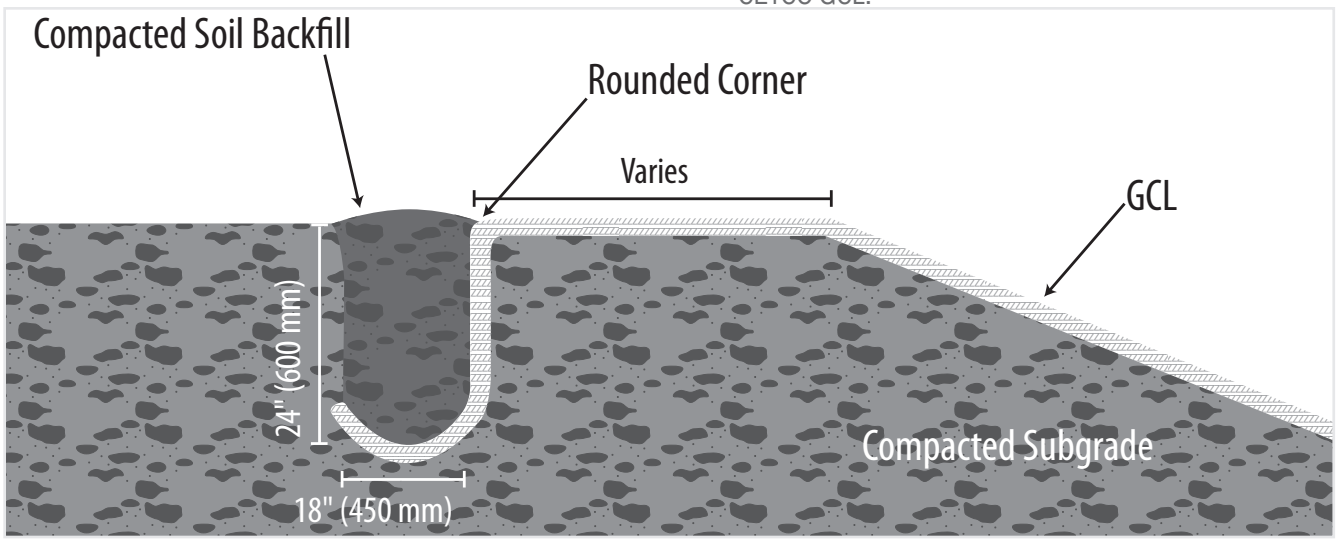

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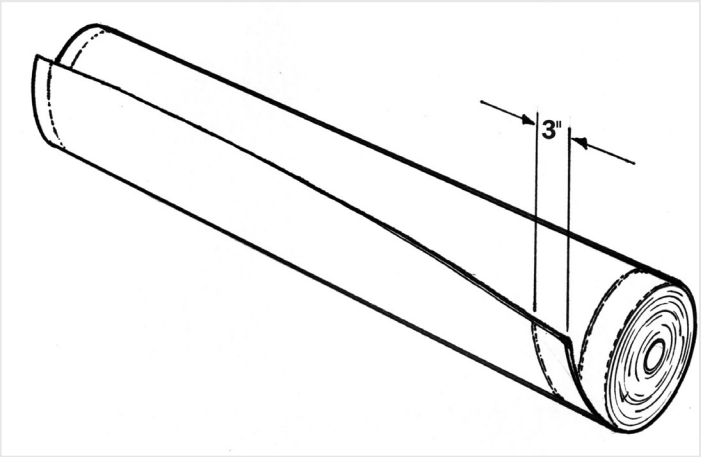
FIGURE 10 - SUPERGROOVE®



7.2

Longitudinal seams should be overlapped a minimum of 6 inches (150 mm) for BENTOMAT geosynthetic clay liners. For high-head applications (greater than 1 foot or 20.48 cm) involving BENTOMAT CL, BENTOMAT CLT, or BENTOMAT 600 CL, a minimum longitudinal seam overlap of 12 inches (300 mm) and supplemental bentonite (per Section 7.6) is recommended.

7.3

End-of-panel overlapped seams should be overlapped 24 inches (600 mm) for BENTOMAT geosynthetic clay liners.

7.4

End-of-panel overlapped seams are constructed such that they are shingled in the direction of the grade to prevent runoff from entering the overlap zone. End-of-panel seams on slopes are permissible, provided adequate slope stability analysis has been conducted (i.e., the GCL is not expected to be in tension). Bentonite-enhanced seams are required for all BENTOMAT end-of-panel overlapped seams.

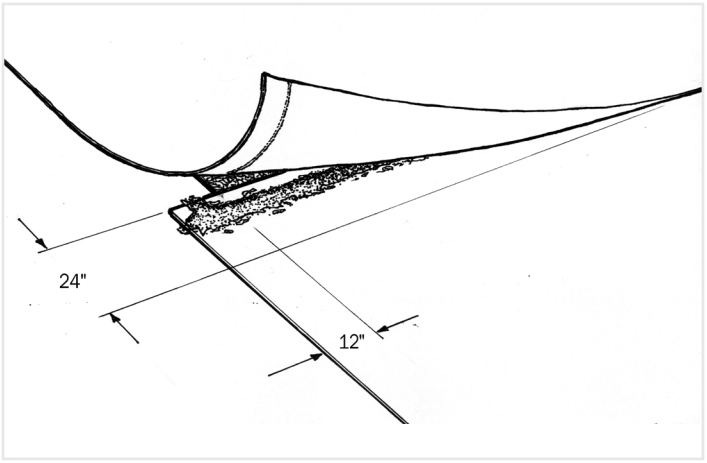
7.5

BENTOMAT end-of-panel, bentonite-enhanced, overlapped seams are constructed first by overlapping the adjacent panels, exposing the underlying panel, and then applying a continuous bead or fillet of granular sodium bentonite 12" from the edge of the underlying panel (Figure 11). The minimum application rate at which the bentonite is applied is one-quarter pound per linear foot (0.4 kg/m).

7.6

If longitudinal bentonite enhanced seams are required for BENTOMAT 200R, BENTOMAT ST, BENTOMAT DN, or BENTOMAT SDN, they are constructed by overlapping the adjacent panels a minimum 6 inches (150 mm), exposing the underlying edge, and applying a continuous bead of granular bentonite approximately 3 inches (75 mm) from the edge. For pond applications involving BENTOMAT CL or BENTOMAT CLT, longitudinal seams are constructed by overlapping adjacent panels by 12 inches (300 mm), exposing the underlying edge, and applying a continuous bead of bentonite approximately 6 inches (150 mm) from the edge. The minimum application rate for the granular bentonite is one quarter pound per linear foot (0.4 kg/m).

FIGURE 11
BENTOMAT END-OF-PANEL OVERLAPPED SEAM



SECTION 8
SEALING AROUND PENETRATIONS AND STRUCTURES

8.1

Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid irregular tearing of the geotextile components of the GCL during the cutting process.

8.2

The GCL should be sealed around penetrations and structures embedded in the subgrade in accordance with Figures 12 through 14. Granular bentonite shall be used liberally (approximately 0.25 lbs/ln. ft. or 0.4 kg/m) to seal the GCL to these structures.

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FIGURE 12 A CROSS-SECTION OF A HORIZONTAL PIPE PENETRATION

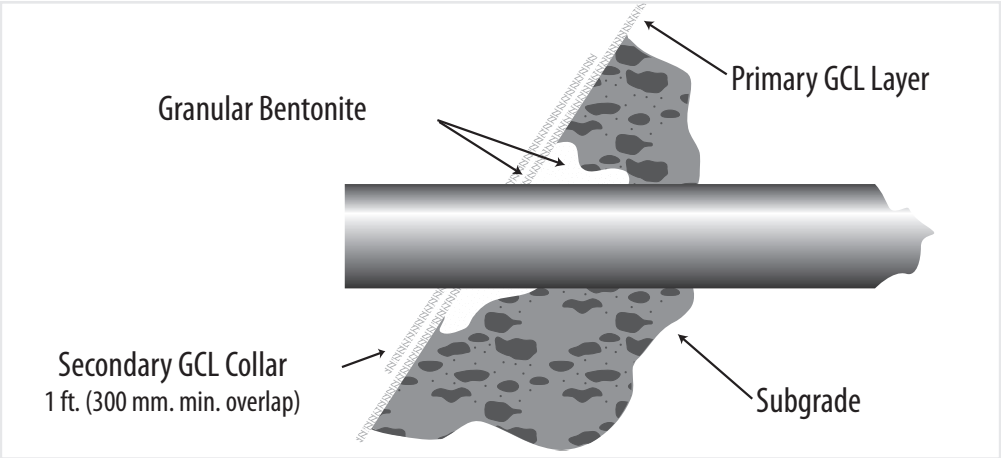


FIGURE 12 B ISOMETRIC VIEW OF A COMPLETED HORIZONTAL PIPE PENETRATION

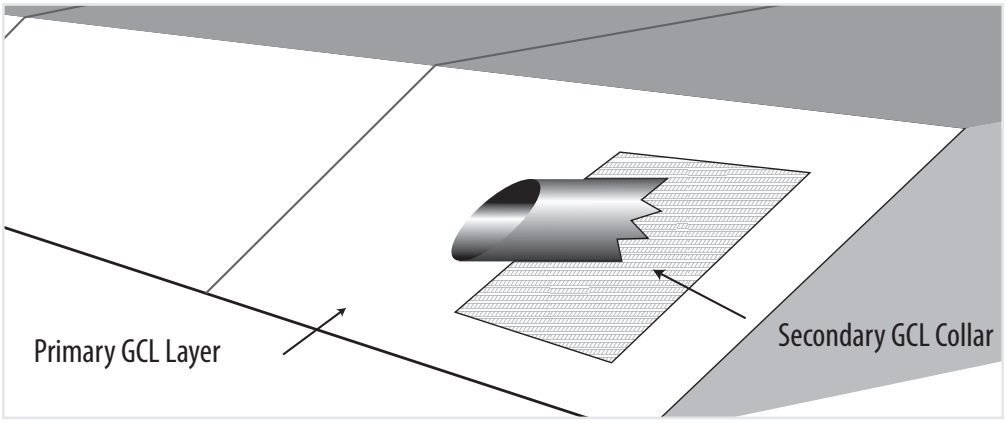


FIGURE 13 A CROSS-SECTION OF A VERTICAL PENETRATION

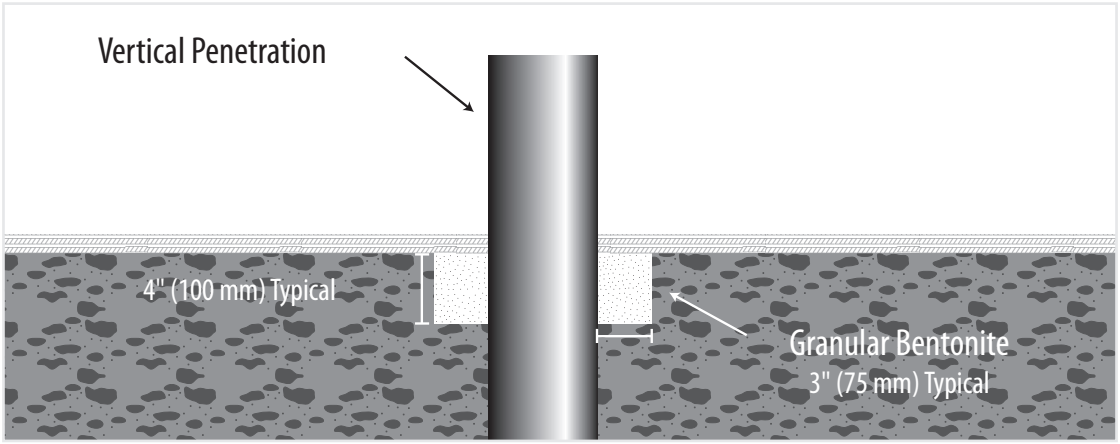


FIGURE 13B ISOMETRIC VIEW OF THE COMPLETED VERTICAL PENETRATION

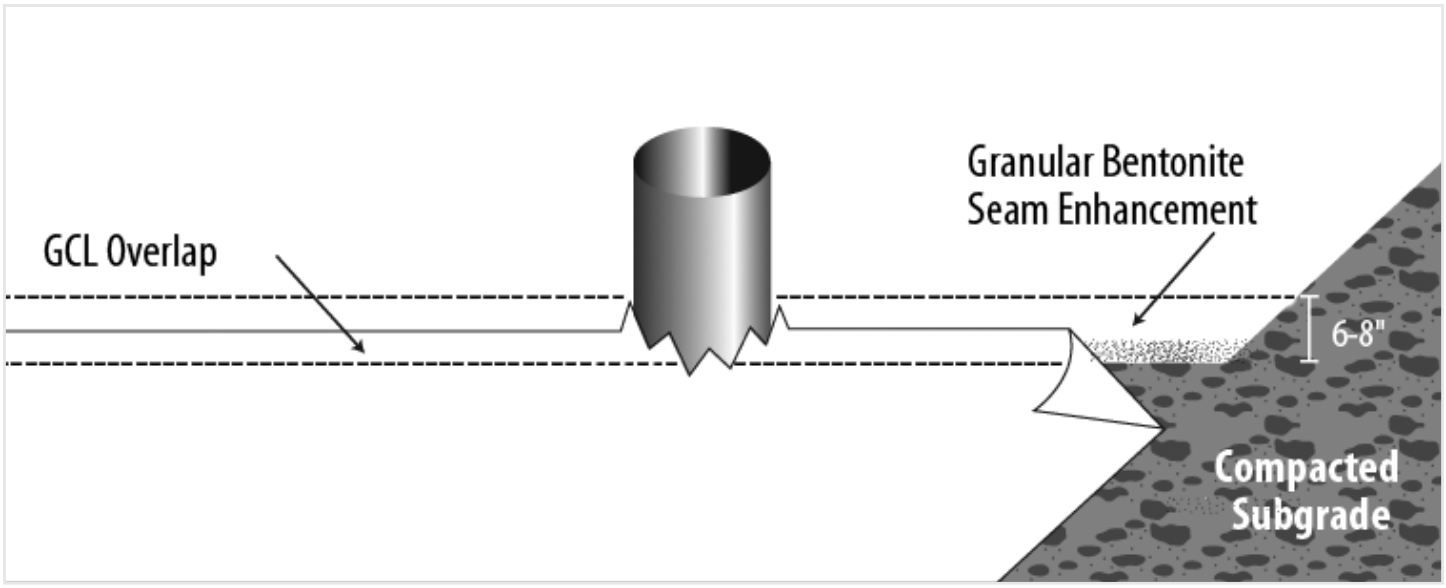
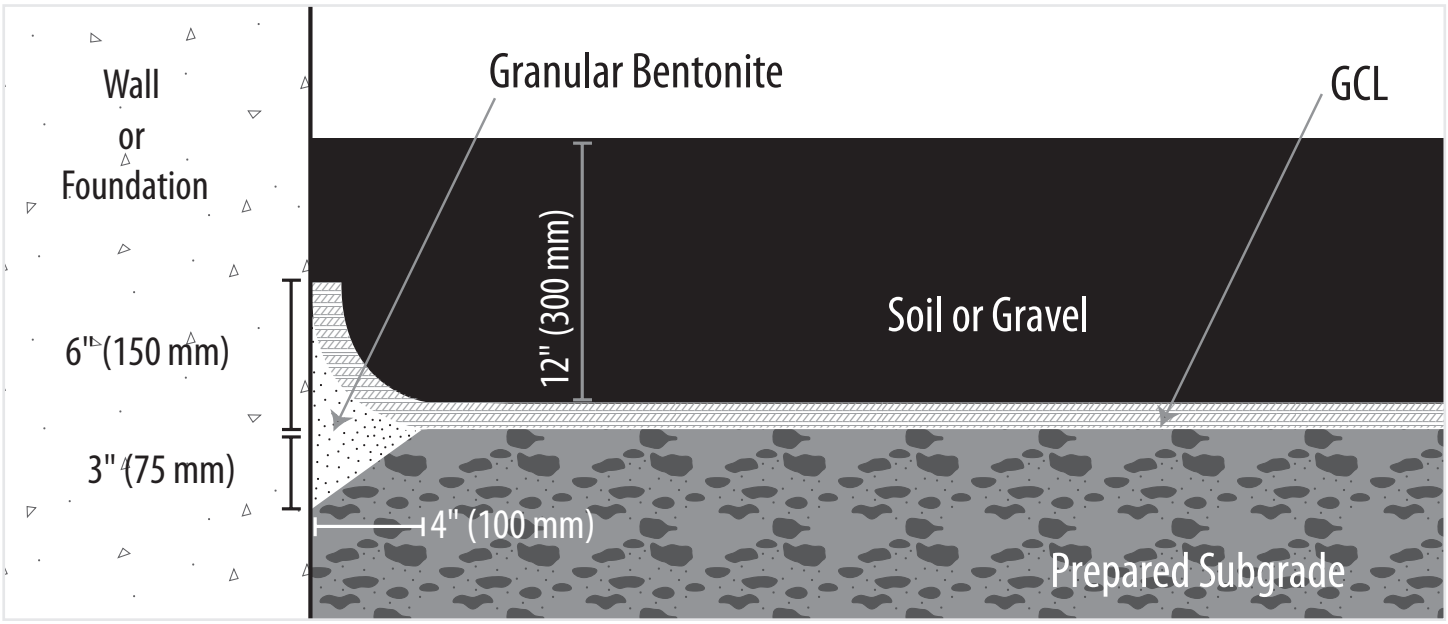


FIGURE 14 CROSS-SECTION OF GCL SEAL AGAINST AN EMBEDDED STRUCTURE OR WALL



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8.3
When the GCL is placed over a horizontal pipe penetration, a "notch" should be excavated into the subgrade around the penetration (Figure 12a). The notch should then be backfilled with granular bentonite. A secondary collar of GCL should be placed around the penetration, as shown in Figure 12b. It is helpful to first trace an outline of the penetration on the GCL and then cut a "star" pattern in the collar to enhance the collar's fit to the penetration. Granular bentonite should be applied between the primary GCL layer and the secondary GCL collar.

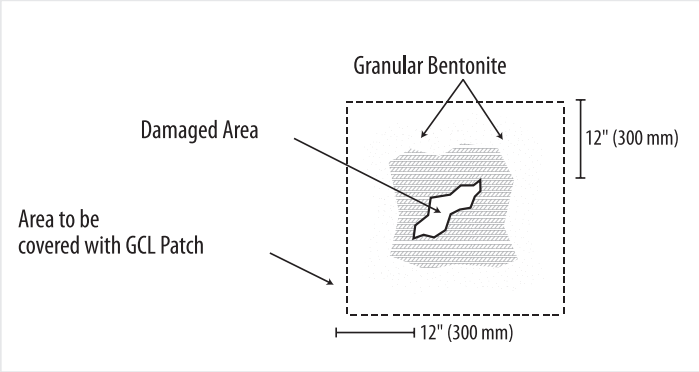
8.4
Vertical penetrations are prepared by notching into the subgrade as shown in Figure 13a. The penetration can be completed with two separate pieces of GCL as shown in Figure 13b. Alternatively, a secondary collar can be placed as shown in Figure 12a or 12b.

8.5
When the GCL is terminated at a structure or wall that is embedded into the subgrade on the floor of the containment area, the subgrade should be notched, as described in Sections 8.3 and 8.4. The notch is filled with granular bentonite; the GCL should be placed over the notch and up against the structure (Figure 14). Connection to the structure can be accomplished by placement of soil or stone backfill in this area. When structures or walls are at the top of a slope, additional detailing may be required. Contact CETCO for specific guidance.

SECTION 9
DAMAGE REPAIR

9.1
If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area (Figure 15). The patch should be cut to size such that a minimum overlap of 12 inches (300 mm) is achieved around all parts of the damaged area. Granular bentonite should be applied around the damaged area prior to placement of the patch. It may be necessary to use an adhesive such as wood glue to affix the patch in place so that it is not displaced during cover placement. Smaller patches may be tucked under the damaged area to prevent patch movement.

FIGURE 15 DAMAGE REPAIR BY PATCHING



SECTION 10
COVER PLACEMENT

10.1
The final thickness of soil cover on the GCL varies with the application. A minimum cover layer must be at least 1 foot (300 mm) thick to provide confining stress to the GCL, eliminate the potential for seam separation and prevent damage by equipment, erosion, etc.

10.2
Cover soils should be free of angular stones or other foreign matter that could damage the GCL. Cover soils should be approved by the engineer with respect to particle size, uniformity, and chemical compatibility. Consult CETCO if cover soils have high concentrations of calcium (e.g. limestone, dolomite, gypsum, seashell fragments).

10.3
Recommended cover soils should have a particle size distribution ranging between fines and 1 inch (25 mm), unless a cushioning geotextile is specified.

10.4
Soil cover shall be placed over the GCL using construction equipment that minimizes stresses on the GCL. A minimum thickness of 1 foot (300 mm) of cover soil should be maintained between the equipment tires/tracks and the GCL at all times during the covering process. In high-traffic areas such as on roadways, a minimum thickness of 2 feet (600 mm) is required.

10.5
Soil cover should be placed in a manner that prevents the soil from entering the GCL overlap zones. Soil cover should be pushed up on slopes, not down slopes, to minimize tensile forces on the GCL.

10.6
When a textured geomembrane is installed over the GCL, a temporary geosynthetic covering known as a slip sheet or rub sheet should be used to minimize friction during placement and to allow the textured geomembranes to be more easily moved into its final position.

10.7
Cyclical wetting and drying of GCL covered only with geomembrane can cause overlap separation. Soil cover should be placed promptly whenever possible. Geomembranes should be covered with a white geotextile and/or operations layer without delay to minimize the intensity of wet-dry cycling. If there is the potential for unconfined cyclic wetting and drying over an extended period of time, the longitudinal seam overlaps should be increased based on the project engineer's recommendation.

10.8
To avoid seam separation, the GCL should not be put in excessive tension by the weight or movement of textured geomembrane on steep slopes. If there is the potential for unconfined geomembrane expansion and contraction over an extended period of time, the longitudinal seam overlaps should be increased based upon the project engineer's recommendation.

SECTION 11
HYDRATION

11.1
Hydration is usually accomplished by natural rainfall and/or absorption of moisture from soil. However, in cases where the containment of non-aqueous liquid is required, it may be necessary to hydrate the covered GCL with water prior to use.

11.2
If manual hydration is necessary, water can be introduced by flooding the covered lined area or using a sprinkler system. If flooding, care must be taken to diffuse the energy of the water discharge so that the cover material is not displaced.

11.3
If the GCL is hydrated when no confining stress is present, it may be necessary to remove and replace the hydrated material.

As discussed in Section 5.8, in many instances a needlepunch reinforced GCL may not require removal/replacement if the following are true:

- The geotextiles have not been separated, torn or otherwise damaged
- There is no evidence that the needlepunching between the two geotextiles has been compromised
- The GCL does not leave deep indentations when stepped upon
- Any overlapped seams with bentonite enhancement (see Section 7) are intact

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APPENDIX

D 2019 SITE REVIEW REPORT FROM EXP

EXP Services Inc.
315-4 Cataraqui St.
Kingston, Ontario K7K 1Z7
Telephone: 613-542-1253
Web Site: www.exp.com

SITE REVIEW REPORT

EXP PROJECT NUMBER:	OTT-00019838-A0
PROJECT NAME:	Igloolik Wastewater Lagoon
OWNER:	Hamlet of Igloolik
CONTRACTOR:	Kudlik Construction

ISSUED BY:	Martin Boissonnault, BScE	**Reviewed By:**	Simon Plourde, P.Eng.
WEATHER:	9°C, Overcast	**DATE OF VISIT**:	September 24, 2019
ITEMS REVIEWED AND INSTRUCTIONS:		Walkthrough of wastewater lagoon	

Martin Boissonnault, (EXP) was on-site to conduct a review of the Igloolik wastewater treatment lagoon, following the infrastructure upgrades completed in 2018. The following was observed and discussed.

1. The lagoon appears to be functioning as intended. The ground around the lagoon was frozen solid at the time of review. No leaks or signs of exfiltration were observed in the soil around the lagoon. The lagoon appears to be retaining the wastewater within the lagoon.
2. The soil around the lagoon cells presents some cracking suggesting settlement during freeze-thaw cycles. This is not expected to impact the lagoon's function. See picture 1
3. The wastewater within one cell of the lagoon was being pumped into the troughs located on the north side of the cell. From there, the water was decanting into the natural wetland and flowing across the wetland before making its way to the ocean. See picture 2 for pumping setup.
4. A truck from the hamlet was dumping waste into the lagoon at the time of review. The dumping chute appeared to be functioning as intended.
5. A total of 108 photos were taken during the walkthrough.
6. During the walkthrough, it was observed that the water being pumped out of the lagoon was causing some erosion. See picture 3. This is not a construction issue, but caused some concern, especially as washouts seem to have occurred in other areas along the trough as well. See picture 4. The pumping setup also does not conform to the intended setup. It is recommended that the Operation Manual be reviewed and operation procedures be amended as required.

Please see below photos of the site (4 photos).

Report by: Reviewed by:

Martin Boissonnault, BScE
Engineering Designer

Simon Plourde, P.Eng.
Project Manager

Photograph #1: Settlement Cracking of the soil around the lagoon.

Photograph #2: Pumping operations.

Photograph #3: Pump outlet.

Figure 4: One of several washouts along the drainage trough.

- END OF REPORT -

APPENDIX

E

2022 SITE REVIEW REPORT FROM DEPARTMENT OF COMMUNITY AND GOVERNMENT SERVICES (DCGS)

SITE REVIEW REPORT

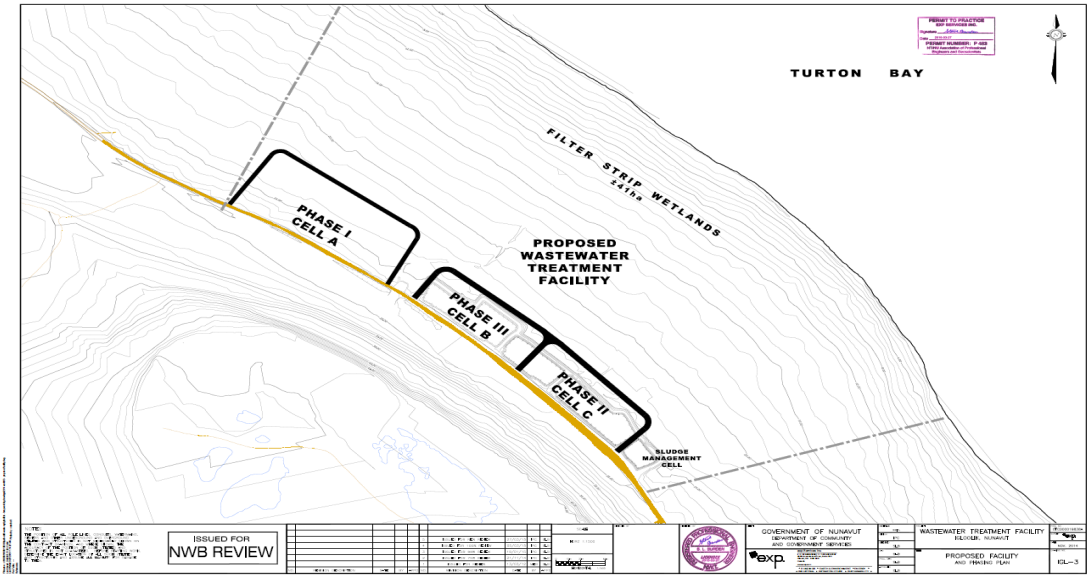
PROJECT NAME: Igloolik Wastewater Lagoon

OWNER: Municipality of Igloolik

CONTRACTOR: KUDLIK CONSTRUCTION

DATE OF VISIT: August 8-10, 2022.

ITEMS REVIEWED AND INSTRUCTIONS: Walkthrough of wastewater lagoon



3 CELL WASTEWATER LOCATION

BACKGROUND AND REPORTED SEWAGE LAGOON "A" ISSUE:

- **CGS's Winter 2022 first emergency visit**

In the winter of 2022, CGS had been notified of a leak in the sewage lagoon cell "A".

Reported leak was described by Hamlet staff, indicating seepage of sewage through the berm of the cell "A" facing wetlands/ocean. Based on Hamlet's Staff report, describing winter sewage seepage through the berm, situation had had been identified as an immediate emergency. CGS's response to identified emergency was immediate- engaging Community Support Engineer. CGS's stuff visited Igloolik on April 20th, 2022.

Upon visiting the sewage lagoon location, and visually inspecting cells A,B and C, attached photos are witnessing there was no visible sewage exfiltrating/seeping/or overflowing the lagoon cells.

April 20th 2022.

As per pictures taken, and visual inspection completed, CGS stuff could not identify or confirm any faulty or concerning issues on either of 3 sewage lagoon cells. CGS rep and Municipality Director of Public Works agreed that summer inspection would be a must to:

Address Municipality 2020 summer report on "breached berm of the cell A facing cell B"

- **CGS's August 8th -10th 2022 inspection report**

CGS revisited troubled cell "A", described by the hamlet staff as "breaching" and in the danger of collapsing berm.

Visual inspection identified:

- Inspection of Interior berms in cell "A" has identified concerning process of soil breaking off in a visible three step process and collapsing into the sewage. As per IFT documents interior berms in contact with sewage should be lined. As per pictures attached, there is no visible sign of the installed liner. Interior berms within Cells B and C had no visible interior berm damages/washouts

Collapsing interior berm soil within cell "A"

- Soil on all three exterior cells berms is experiencing some cracking. Possible causes of soil cracking might be caused by the settlement during freeze-thaw cycles, or improper compaction during the construction.
- **<u>Concerning are observed significant signs of cracked soil and signs of exfiltration in the soil of the lagoon cell "A" facing cell "B"</u>** (Pls see 2 pictures bellow)

- There was no visible creeping or sliding soil movement noticed in any of 4 berms
- During the walkthrough, sewage pumping was performed on cell “B”. It was observed that the wastewater pumped out of the lagoon was causing erosion along the trough located on the North side of the lagoon (facing wetland and ocean). Observed are **<u>significant washouts</u>** along the troughs.
- 

RECOMMENDATION AND NEXT STEP:

- Since there are no as-built records saved for this project, further involvement of the professional geotechnical engineering firm will be required to assess safety and structural integrity of the berms.
- **CGS has secured the funds and has commenced with a hiring process of a professional Geotech firm that will conduct thorough facility inspection during 2022 Summer/Fall construction season. Inspection Findings will define deficiencies and provide Scope of work along with a cost estimate for all construction activates to follow**