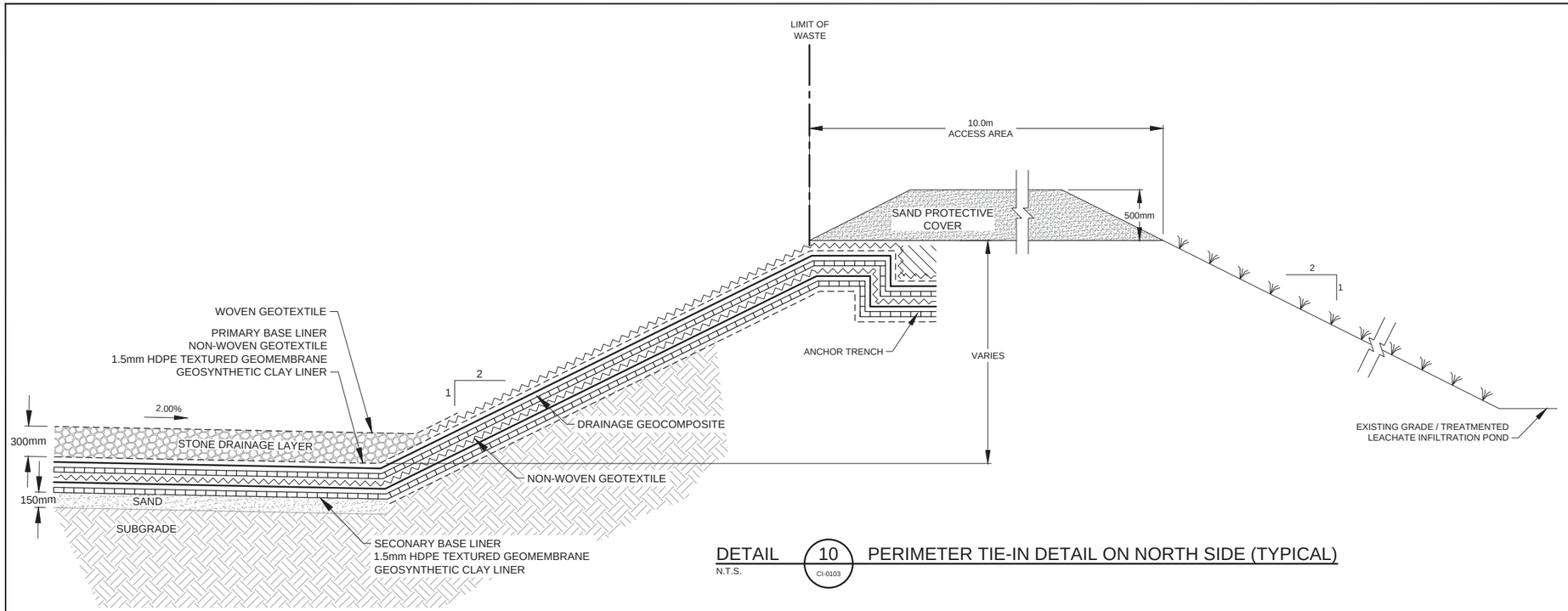
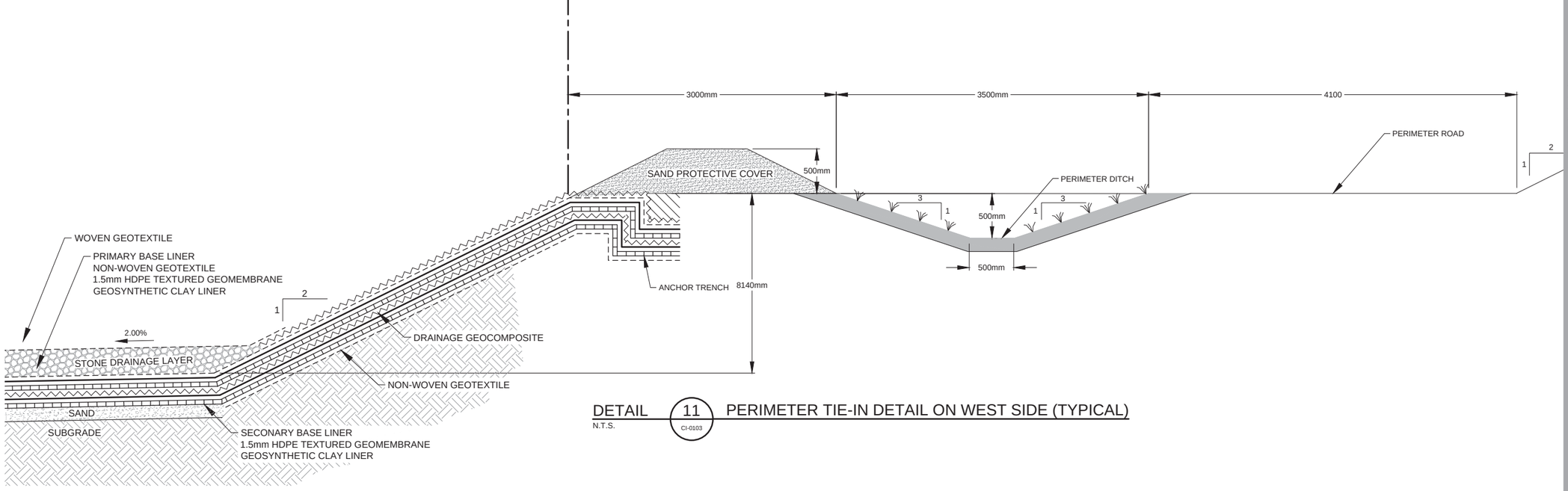


DETAIL 10 PERIMETER TIE-IN DETAIL ON NORTH SIDE (TYPICAL)
N.T.S. CI-0103



DETAIL 11 PERIMETER TIE-IN DETAIL ON WEST SIDE (TYPICAL)
N.T.S. CI-0103

DRAFT

GHD
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Bar is 25mm on original size sheet
0 25mm

No.	Issue	Checked	Approved	Date
Author	T.WAGSTAFF	Designer		
Drafting		Design		
Check		Check		
Project Manager		Project Director		

Client
UPLAND EXAVATING LTD.
CAMPBELL RIVER, B.C.

Project
STAGE 1 WEST
DETAILED DESIGN

Date 2022-05-06
Scale N.T.S.
Project No. 11222680
Title PERIMETER TIE-IN DETAILS
Size ANSI D
Status Code
Sheet No. CI-0502
Sheet 1 of 10

APPENDIX C

Cell 1 East & Ponds
Construction Report

Cell 1 East & Ponds Construction Report

Northwin Landfill

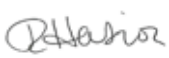
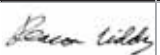
Upland Excavating Ltd.

19 October 2021

GHD Limited 735
138 East 7th Avenue, Suite 100
Vancouver, BC V5T 1M6, Canada

Printed date	19/10/2021 6:26:00 PM
Last saved date	19 October 2021 6:26 PM
File name	RPT-02 Cell 1 East & Ponds Construction Report
Author	David Barbour
Project manager	Deacon Liddy
Client name	Upland Excavating Ltd.
Project name	Cell 1 East & Pond
Document title	Cell 1 East & Ponds Construction Report | Northwin Landfill
Revision version	Rev [00]
Project number	11223708

Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
Final	00	David Barbour	Roxy Hasior		Deacon Liddy		Oct 19, 2021

Contents

Appendix index

1. Introduction

The Northwin Landfill (Landfill or Site) is owned by Upland Excavating Ltd. (Upland) and operated by Northwin Environmental (Northwin). The Site has an area of approximately 48 hectares (ha) and is located at civic address 7295 and 7311 Gold River Highway, Campbell River, BC, approximately 7 kilometers (km) southwest of Campbell River city centre. The Site operates as a sand, gravel and rock quarry and a waste management facility.

This Construction Report (Report) documents the construction of Cell 1 East, as well as the civil construction for the leachate treatment pond, the treated effluent holding pond and infiltration pond (collectively, ponds) carried out by Upland Contracting Ltd. (Contractor), Northwin and other contractors hired by Upland.

The Report has been prepared by GHD for Upland for submission to the Ministry of Environment and Climate Change Strategy (ENV) in accordance with Section 2.4 and 2.11 of the Landfill's OC and satisfies the requirements of the Landfill Criteria for Municipal Solid Waste (Second Edition), BC Ministry of Environment, June 2016 (the Criteria):

Construction report(s) shall be prepared after the construction and/or significant modification of landfill facilities. Construction report(s) shall demonstrate the landfill has been constructed in accordance with the plans and reports and confirm that the geologic conditions encountered are as expected and used in a Groundwater and Surface water impact assessment. Construction report(s) shall include all inspection and quality assurance/quality control testing results, and as-built record drawings showing the lines, grades, and as-built elevations of the landfill.

Upland, as the OC holder retained GHD to act as the Qualified Professional (QP) for this project scope. In this capacity, GHD designed the civil work for Cell 1 East and the ponds and carried out inspections during construction.

1.1 Project Scope

Cell 1 East is the first landfill cell and establishes the initial footprint of the Landfill. In accordance with the 2021 Design Operations and Closure Plan (DOCP) for the Landfill and the detailed design, the Cell 1 East base is double liner system and includes a leak detection layer. Leachate generated from the landfill will be collected within the cell and conveyed to the leachate treatment system. The leachate treatment system is batch treatment system and includes the leachate collection system, aerated equalization pond, a treated leachate holding pond and an infiltration pond.

The composite double liner system for Cell 1 East is comprised of a primary and secondary base liner. The primary base liner refers to the composite liner system that consists of an HDPE geomembrane liner and geosynthetic clay liner (GCL) which underlies the leachate collection system, and the secondary base liner refers to the composite liner system comprised from of an HDPE geomembrane liner and GCL which underlies the leak detection system.

The leachate collection system includes perforated leachate collection pipes within a stone drainage blanket sloped towards the leachate sump, with the following components:

- 300 mm thick, 50 mm diameter, clear, round stone drainage blanket, with minimal fines
- Perforated leachate collection pipes (LCP) with minimum diameter of 200 mm
- Maximum 15 m lateral spacing between leachate collection pipes (LCP) running south to north
- Maximum 50 m drainage path for leachate to travel before it is intercepted by the LCPs
- Clean-outs at each end of the LCPs
- Leachate collection header pipe at the east end of the Landfill running towards the leachate collection sump at a minimum slope of 2 percent

- Leachate sump at elevation 161.1 m AMSL with two leachate sump riser pipes with minimum diameters of 600 mm

The aerated equalization pond, also referred to as the leachate treatment pond is double lined with HDPE and includes a leak detection system. The treated leachate holding pond is double lined with coated woven polyethylene and includes a leak detection system. The infiltration pond is unlined and allows treated effluent to infiltrate into the aquifer underlying the site.

2. Construction Narrative

The following sections provide the construction narrative for Cell 1 East and ponds. Record Drawings are provided in Appendix A.

Construction activities began on March 19, 2021 and were complete on October 19, 2021.

In general, construction generally progressed as follows:

- Site preparation and excavation
- Leachate treatment pond double liner installation
- Cell 1 East double liner installation
- Cell 1 East leachate collection system
- Treated leachate effluent holding pond double liner installation

2.1 Site Preparation & Excavation

Site preparation and excavation activities included construction of berms around the Cell 1 East perimeter, excavation of the Cell 1 East base, excavation of the infiltration pond and placement of the Cell 1 East sand cushion in preparation for liner placement.

Construction activities began with the construction of the east and north Cell 1 East berms on March 19th. The north and east Berm were built in 300 mm lifts. GHD and McElhanney (geotechnical subcontractor) witnessed compaction activities and, with the Contractor established the minimum number of passes with the compactor required to ensure compaction criteria were met. McElhanney performed density testing on March 22 to confirm the compaction results.

Excavation of Cell 1 East to subgrade contours began on April 7 and continued through May 7th. A 150 mm protective layer of screened sand was placed and compacted with a vibrator packer.

Excavation of the leachate treatment pond began after the Landfill earthworks were complete. The excavation was below grade and did not require construction of any structural berms, so no compaction testing was required.

2.2 Leachate Treatment Pond Composite Double Liner

Joe Cassidy (Liner Installer) was hired as an independent contractor to oversee the geosynthetic installation. Mr. Cassidy is an experienced liner installer with over thirty years of experience in the industry. Several experienced liner technicians were also hired for the installation and worked alongside Upland's (the Contractor's) employees with Mr. Cassidy overseeing the work. The geosynthetic installation crew mobilized to site on July 28th and the installers met with GHD to confirm QA/QC requirements.

Deployment of geotextile on the leachate treatment pond slopes and GCL began on July 29th. GHD carried out a daily site inspection each day that geosynthetics were being installed until completion to verify that QC requirements were being met.

The first roll of Geomembrane was deployed on July 30th. GHD witnessed roll deployment and field sheer and peel tests. The Liner Installer performed QC on the liner and provided documentation to GHD for review. Results of the Liner Installers QA/QC are found in Appendix E. During installation, two destructive tests were collected of the Geomembrane, one from the primary and one for the secondary layer and sent to a lab for peel and sheer testing.

This exceeded the minimum requirement of one destructive test per 300 m of seaming and the results from the tests were acceptable.

Installation of Geosynthetics were completed in the leachate treatment pond on August 6th. On that date David Barbour (GHD), Terry Stuart (Upland) and Joe Cassidy (Liner Installer) inspected each panel for defects and were satisfied that no defects were found.

2.3 Cell 1 East - Composite Double Liner

Installation of geosynthetics in the Cell 1 East began on August 9th by the same personnel that installed the leachate treatment pond geosynthetics with Mr. Cassidy's oversight. Similarly, GHD inspected the bedding sand before the first roll of GCL was deployed and made inspections each day the geosynthetics were placed. The QA/QC program for the construction of the base liner systems included non-destructive testing of each seam. Details of the QA/QC program are described in Section 3.

The geosynthetic deployment began with the GCL being installed on the floor of the landfill cell near the toe of the North Berm. Rolls were deployed using an excavator in the east/west direction working from the north end of the landfill to the south. The seams of the GCL were overlapped, with the crew using factory provided indicating lines that marked the minimum overlap. The seams were heat seamed shortly after the GCL deployment. In general, the geomembrane was installed on top of the GCL as soon as the width of GCL panels would allow. This process continued until the primary GCL and geomembrane layer was installed across the landfill floor.

Geocomposite installation began after the primary geomembrane installation on the landfill floor. The geocomposite was installed with panels in the same east-west direction starting near the north toe working south. A skid-steer with smooth rubber tracks was used to deploy the geocomposite on the liner while an excavator held the rolls. GHD observed the procedures being followed by the operators and determined they were acceptable to avoid damage to the liner. The deployment procedure involved using a leaf blower to remove any debris from the area being driven on, having a spotter observe the geomembrane between the skid-steer tracks and the geo-composite, and skid steer operator never turning the equipment on the exposed geomembrane. Nylon cable ties were applied at 1.5 m intervals at the edge netting and the overlapping geotextile was heat seamed.

As the geocomposite was being placed on the base of the landfill, the crew began deploying non-woven geotextile on the slopes of the landfill. The geotextile rolls were held with an excavator while the crew placed the material manually on the slopes. The geotextile was heat seamed shortly after deployment. The GCL was placed on the slopes after the geotextile using the same method. GCL was heat seamed shortly after it was placed and covered with the second layer of Geomembrane. The primary layer of GCL and geomembrane was completed and tied into the geosynthetics on the floor of the landfill before the secondary containment layers were installed. The same procedures were followed to install the secondary geosynthetics. The smooth tracked skid steer was used to pull the geosynthetics on the base of the landfill and while the excavator held the rolls and materials were pulled by hand down the slopes. Installation of geosynthetics was completed on August 27th with the final placement of non-woven geotextile on the floor of the landfill.

2.4 Leachate Collection System

The Contractor began installing the leachate collection pipes and stone drainage layer after completion of the geosynthetics. To facilitate installation over the liner system, the contractor initially placed the stone drainage layer in 3 rows of 900 mm high lifts to form roadways from the west to the east side of the landfill cell. The material was hauled with rock trucks and placed with an excavator. Traffic cones were used for visual aids to ensure the minimum 900mm depth of material was placed. After the drain rock roads were built the contractor fused and placed perforated leachate collection pipe on the base of the landfill. A Caterpillar D5 dozer was then used to spread the drain rock in 300 mm lifts across the floor of the landfill. The contractor placed woven geotextile on top of the drain rock, completing the leachate collection system installation.

GHD made regular site inspections during the installation of the leachate collection system.

2.5 Treated Effluent Pond Double Liner

The treated effluent pond was constructed with a double layer of coated woven polyethylene and geocomposite leak detection system between the two layers. Construction commenced on Oct 15th with placement of the protective geotextile and was completed on October 19th. A leak detection sump was installed with a 50 mm HDPE perforated riser pipe.

2.6 Close-Out

GHD performed a final inspection of the Cell 1 East Works on October 5th and created a deficiency list which was provided to the Contractor. All deficiencies were addressed to the satisfaction of GHD and Upland by October 15th. The completion of the treated effluent pond double liner was inspected on October 19th. No deficiencies were found at the time.

3. Construction Quality Assurance & Quality Control

GHD carried out regular daily inspections throughout the duration of the construction to assure construction quality and quality control (QA/QC). The QA/QC program included soil density testing for compaction, product data review and geosynthetics installation QA/QC according to the design specifications.

McElhanney performed density testing with a nuclear densometer with GHD present on March 22, 2021 while fill material was being placed on the North and East Berms. Results of the test results along with the sieve analysis of the material placed are provided in Appendix C. The results of the testing were reviewed by GHD, and a procedure was established to ensure minimum density requirements would be exceeded during the placement of fill on the berms

A photo log with select photographs from throughout the construction is provided in Appendix B. Appendix C provides the material test results. Product data and submittal review logs are provided in Appendix D. Appendix E provides geosynthetics QA/QC information including the results of destructive and non-destructive quality testing. GHD's notes from select field inspections during liner installation are included in Appendix F.

3.1 Earthworks QA/QC

During site preparation and excavation activities, GHD carried out daily inspections to confirm that materials were installed according to design specifications. Inspection activities included:

- Observation of proof rolling during construction of the north and east berms
- Observation of compaction effort with McElhanney to establish minimum number of passes with the compactor required to ensure compaction criteria were met
- Confirmation that the onsite stockpiled clean screened sand was acceptable for the GCL protection layer.
- Witnessing dozer equipped with a laser level placing 150 mm screened sand and vibrator packer compacting the sand to ensure adequate protective layer

3.2 Leachate Collection System & Leak Detection Piping

QA/QC activities carried out during leachate collection system installation include the following:

- Daily inspection to witness placement of materials
- Review of submittals for pipe materials
- Review of results of sieve analysis performed on samples of drain rock material collected by Contractor. A total of 4 samples were collected and analysed.

3.3 Geosynthetics QA/QC

The Geosynthetic Installer performed QA/QC according to the design specification on all geomembrane installed. QC included performing field sheer and peel on a test weld before welding began and whenever conditions changed, pressure testing each welded seam, recording roll number and location of each panel placed, location of each repair. After each repair was made the weld was tested with a vacuum box.

GHD collected samples of welds at intervals less than 300 m of seams. The samples were sent to a lab for peel and sheer testing and the results were reviewed by GHD.

4. Conformance with Design

In general, the construction of the Cell 1 East landfill cell and ponds was carried out according to the design and specifications prepared by GHD. The below documents conformance with the original design.

4.1 Earthworks

Construction of the berms and sub-base excavations for Cell 1 East, the leachate infiltration pond and the leachate treatment pond conform with the design. No field adjustments were made for the earthworks portion.

4.2 Leachate Collection System & Leak Detection Piping

A field adjustment was made to the 300 mm HDPE leak detection system riser (see Appendix A). Adjustments from design included wrapping the perforated portion of the pipe in geo-composite and placing sandbags on the east side of the pipe to secure the pipe in place. Wrapping the pipe in geo-composite ensured there was hydraulic connectivity around the pipe. GHD witnessed the sand being placed in the leak detection portion of the sump and observed that the sump would function as intended with the modifications made. (Aug. 25 field notes)

The leak detection ports were installed differently than designed by GHD. No depression was established beneath the leak detection port as shown in Appendix A. Without the depression, the leak detection pipe could not be buried in sand as originally designed. Instead, two layers of geocomposite were installed on top of the leak detection pipe to prevent the GCL layer from deflecting around the pipe and to ensure a hydraulic connection (Field Notes Aug 21 & 23). This change was approved by GHD.

The results of the sieve analysis performed on drain rock showed fines content above the design specification for 3 out of the 4 samples. The fines content was less than or equal to 1% for all samples and the material was accepted by GHD.

The two north most leachate collection pipes on the west transition berm had perforations installed at approximately 90 degrees from the intended orientation. The Contractor provided camera footage of the inside of the pipe for GHD to review and it was determined that the perforations are orientated in the intended direction a short distance into the landfill.

4.3 Geosynthetics

Construction of the geosynthetics for Cell 1 East and the leachate treatment pond were completed according to design.

The treated effluent holding pond was originally designed to have a single HDPE liner, however the liner system design was substituted for a double coated woven polyethylene liner with a geocomposite leak detection system (double liner). The substitution was accepted by GHD on the basis that the base liner material is acceptable for the application of the pond usage. Further, the performance of the primary liner can be monitored using the leak detection layer and replaced with little effort in the future.

5. Certification

This construction report dated October 19, 2021, demonstrates that the Cell 1 East and Ponds have been constructed in accordance with OC and the most recent DOCP, with the changes noted below and approved by the undersigned during construction. Qualified Professionals completed inspections before and during construction of Cell 1 East and the Ponds.

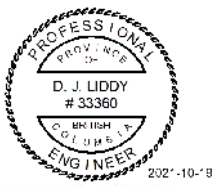
This construction report includes the information described in Section 10.2 Construction Report(s) of the Landfill Criteria and Section 2.11 of the OC, specifically:

- Changes from the original design that were approved during construction
- As-built record drawings of Cell 1 East and the Ponds
- All inspection and testing reports
- Quality control and quality testing results
- Soil test data including field and laboratory testing

As per Section 2.11 of the OC, with the submission of this report on October 19, 2021, waste discharge to Cell 1 East may commence 30 days after the date of this report (November 18, 2021).

All of Which is Respectfully Certified and Submitted by:

GHD



Deacon Liddy, P.Eng.

David Barbour, P.Eng.

Roxy Hasior, P. Eng

Appendices

Appendix A

Record Drawings

UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

NEW LANDFILL (NORTHWIN LANDFILL)
AS-BUILT RECORD DRAWINGS
OCTOBER 2021

LOCATION MAP

DRAWING LIST

DWG. No.	DRAWING TITLE
GN-0001	COVER
CI-0002	BASE OF LINER (TOP OF SAND)
CI-0003	TOP OF DRAINAGE LAYER
CI-0004	DETAILS - LINER DETAILS
CI-0005	DETAILS - LEACHATE COLLECTION SUMP
CI-0006	DETAILS - LEACHATE LEAK DETECTION SUMP
CI-0007	DETAILS - LEACHATE COLLECTION SYSTEM
CI-0008	DETAILS - PERIMETER TIE-IN DETAILS
CI-0009	DETAILS - LEACHATE TREATMENT AND EFFLUENT STORAGE PONDS DETAILS

ISSUED FOR RECORD

GHD Ltd.
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N

0 250 500 750m

Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
AS-BUILT
RECORD DRAWINGS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR RECORD	T.W.	R.H.	10-19-2021

Drawn T.WAGSTAFF	Designer S.KEMP
Drafting Check S.KEMP	Design Check R.HASIOR
Project Manager D. LIDDY	Date Oct 19, 2021
This document shall not be used for construction unless signed and sealed for construction.	Scale 1:25000
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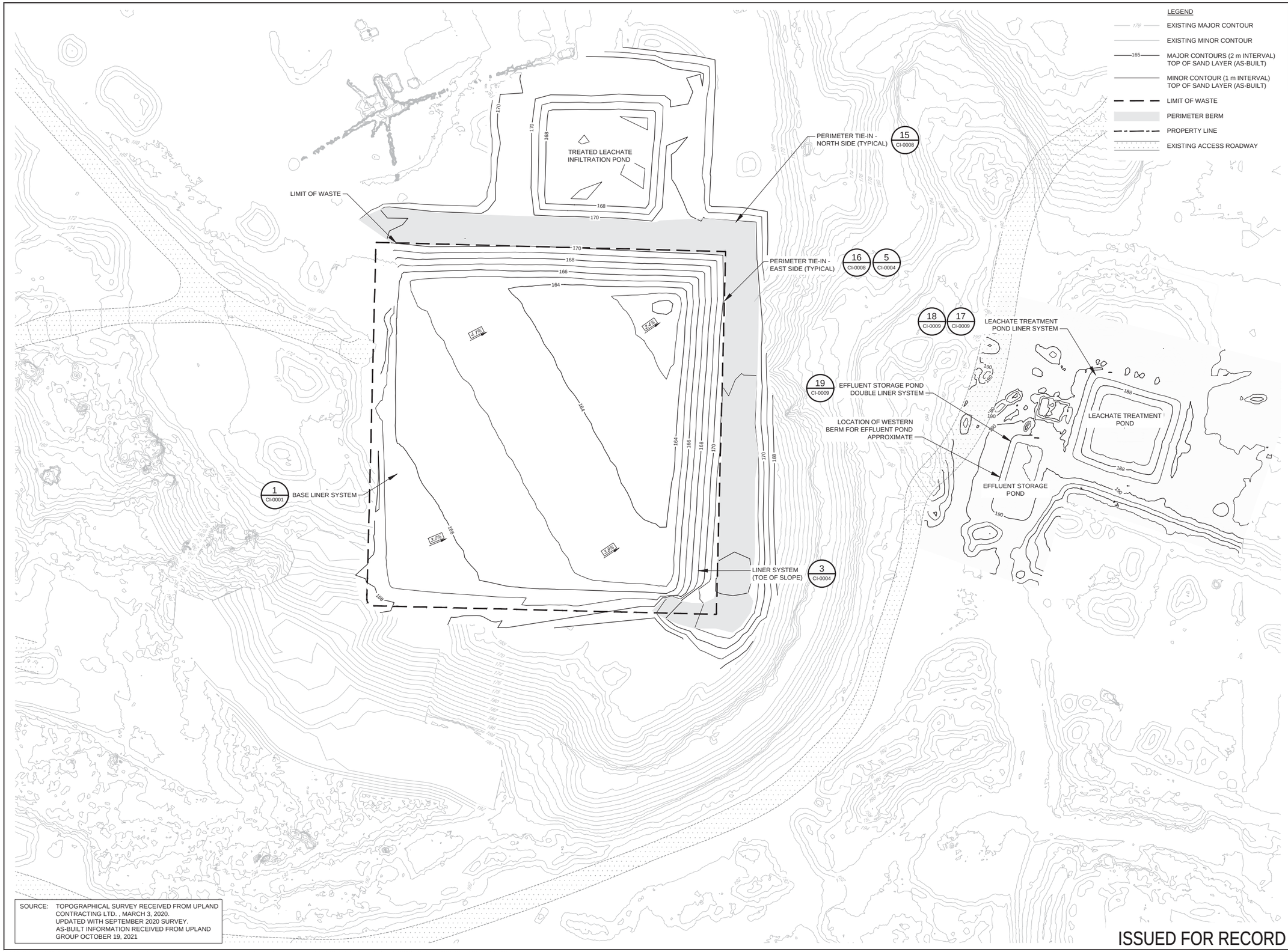
Project No. 11222680

Title
COVER

Sheet No.
GN-0001

Sheet 1 of 9



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PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
D. J. LIDDY
33360
2021-10-19

N
0 6 12 18m

Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
AS-BUILT
RECORD DRAWINGS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR RECORD	T.W.	R.H.	10-19-2021

Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 20, 2021
This document shall not be used for construction unless signed and sealed for construction.		Scale	1:600
Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

Project No. 11222680

Title
BASE OF LINER
(TOP OF SAND)

Sheet No.
CI-0002

Sheet 2 of 9

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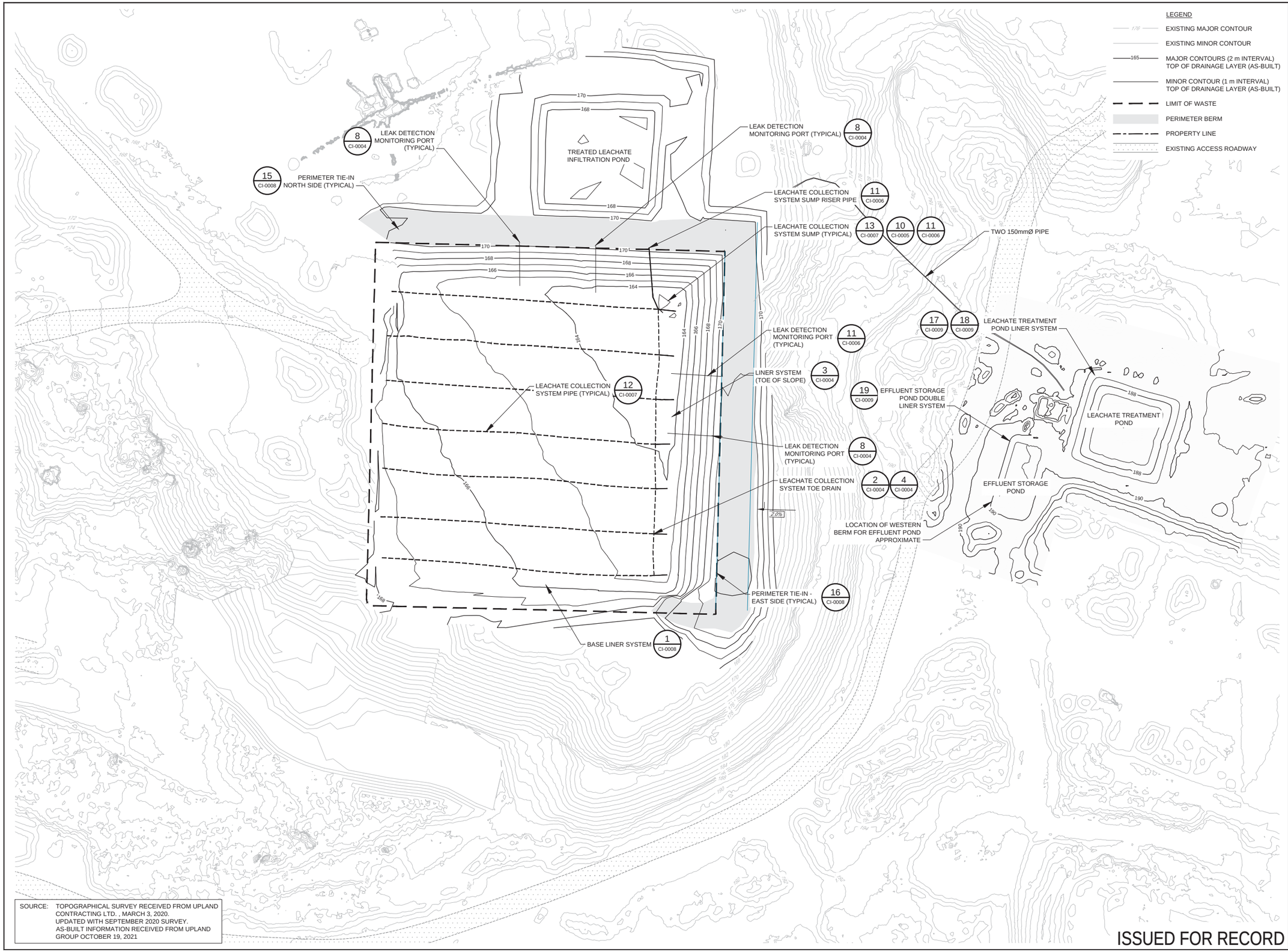

SOURCE: TOPOGRAPHICAL SURVEY RECEIVED FROM UPLAND CONTRACTING LTD. , MARCH 3, 2020.
UPDATED WITH SEPTEMBER 2020 SURVEY.
AS-BUILT INFORMATION RECEIVED FROM UPLAND GROUP OCTOBER 19, 2021

ISSUED FOR RECORD

GHD Ltd.
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PROFESSIONAL ENGINEER
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D. J. LIDDY
33360
2021-10-19

Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
AS-BUILT
RECORD DRAWINGS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR RECORD	T.W.	R.H.	10-19-2021

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Drafting Check S.KEMP	Design Check R.HASIOR
Project Manager D. LIDDY	Date October 20, 2021
This document shall not be used for construction unless signed and sealed for construction.	Scale 1:600
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Project No. 11222680

Title
TOP OF DRAINAGE LAYER

Sheet No.
CI-0003

Sheet 3 of 9

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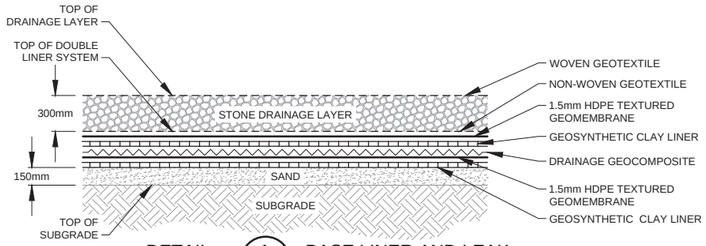

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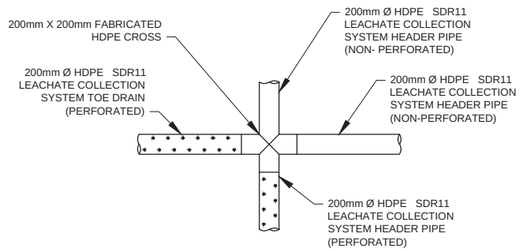

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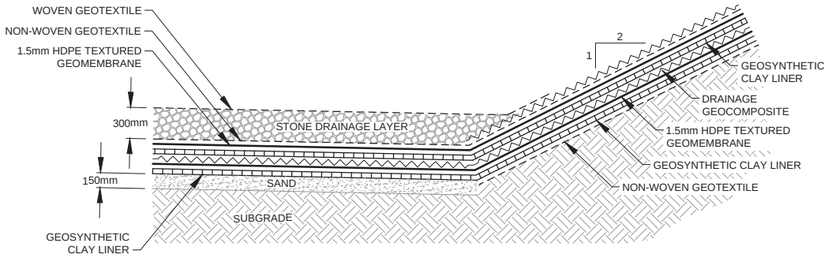

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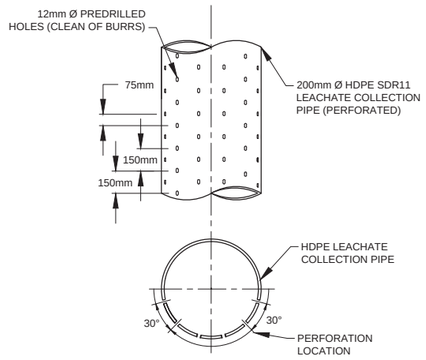

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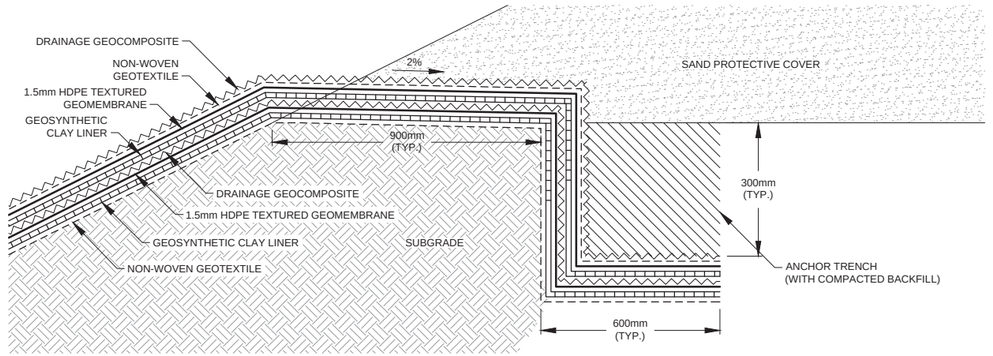

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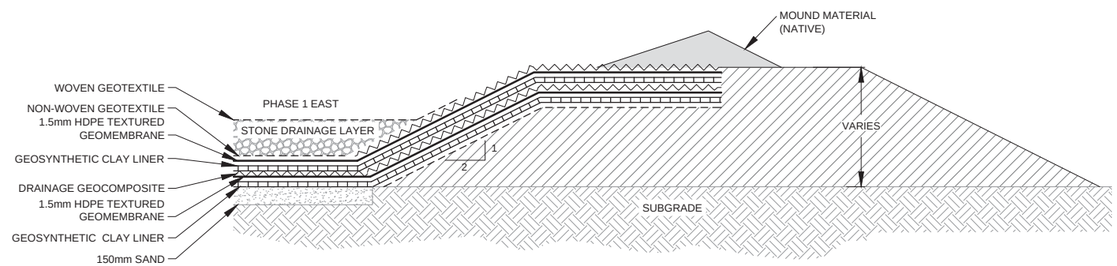
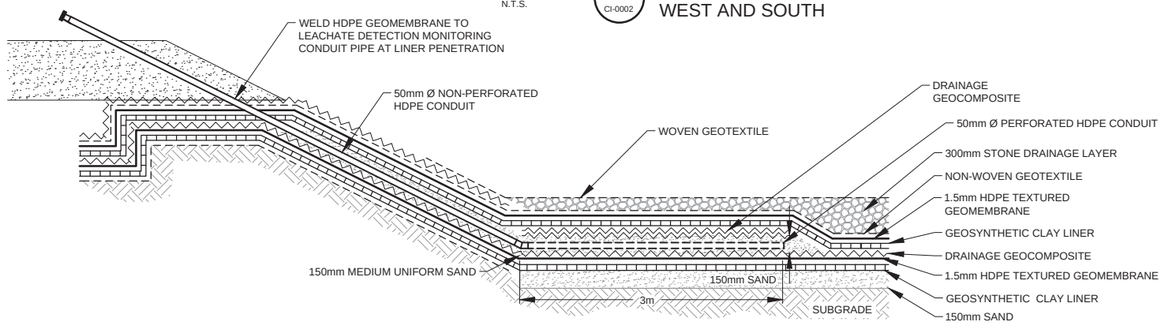
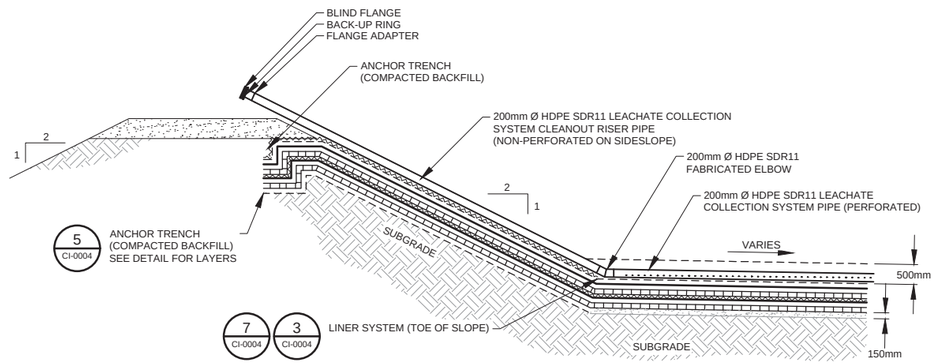


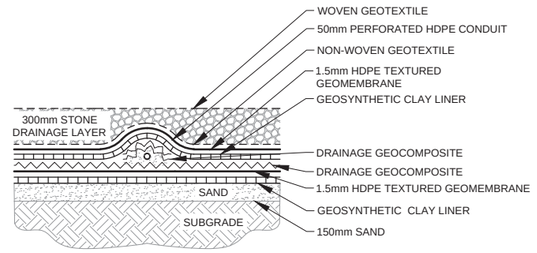
DETAIL 6 (CI-0002) — N.T.S. — TRANSITION BERM WEST AND SOUTH



DETAIL 8 (CI-0003) — N.T.S. — LEAK DETECTION DETECTION PORT (TYP.) PROFILE



DETAIL 7 (CI-0002) — 1:75 — LEACHATE COLLECTION SYSTEM CLEANOUT RISER PIPE (TYPICAL)



DETAIL 9 (CI-0003) — 1:25 — LEAK DETECTION MONITORING PORT (TYP.) CROSS-SECTION

ISSUED FOR RECORD

GHD Ltd.
138 EAST 7TH AVENUE, SUITE 100
VANCOUVER, BRITISH COLUMBIA V5T 1M6 CANADA
T 1 604 214 0510 F 1 604 214 0525 W www.ghd.com

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — D. J. LIDDY # 33360 — 2021-10-19

Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
AS-BUILT
RECORD DRAWINGS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR RECORD	T.W.	R.H.	10-19-2021

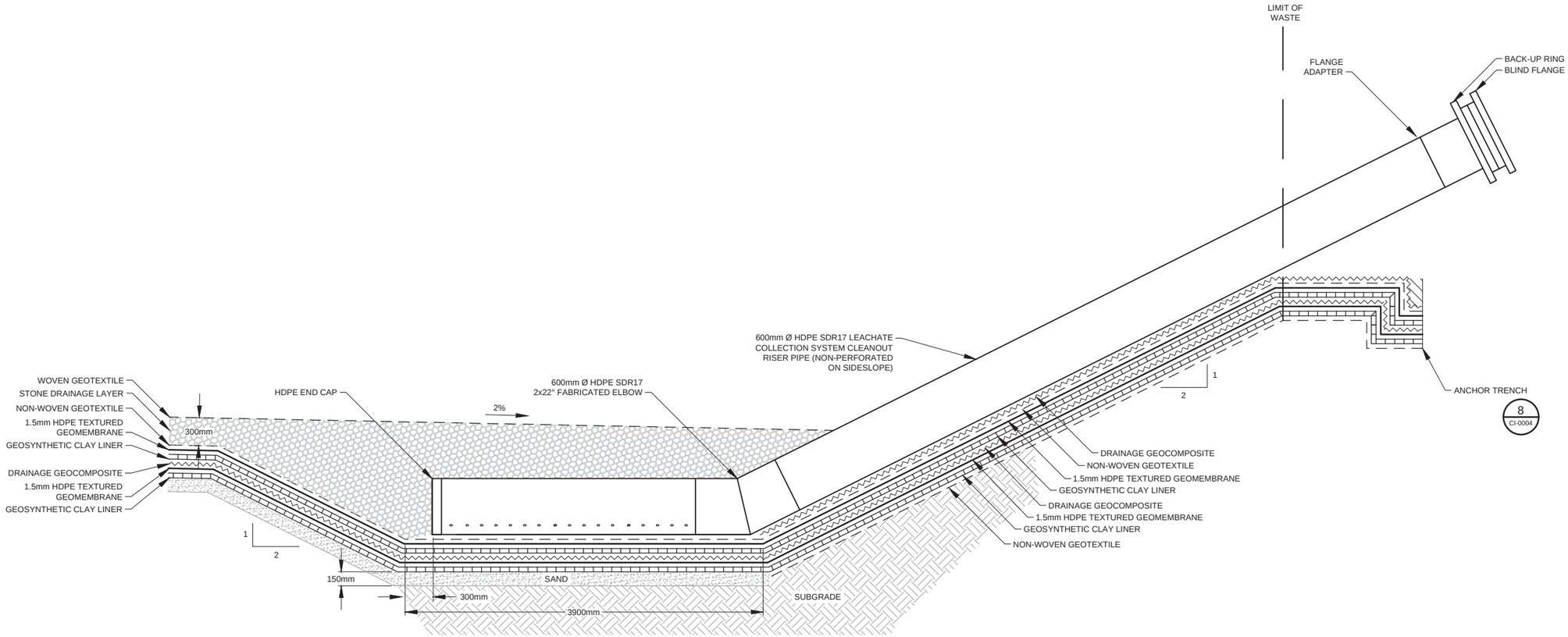
Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 19, 2021
This document shall not be used for construction unless signed and sealed for construction.		Scale	AS SHOWN
Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

Project No. 11222680

Title
DETAILS
LINER DETAILS

Sheet No.
CI-0004

Sheet 4 of 9



DETAIL 10 (CI-0003) N.T.S. — LEACHATE COLLECTION SYSTEM SUMP, SUMP RISER PIPE, AND LEACHATE LEVEL MONITORING PIPE

ISSUED FOR RECORD

GHD Ltd.
138 EAST 7TH AVENUE, SUITE 100
VANCOUVER, BRITISH COLUMBIA V5T 1M6 CANADA
T 1 604 214 0510 **F** 1 604 214 0525 **W** www.ghd.com

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — D. J. LIDDY # 33360 — 2021-10-19

Client: UPLAND EXCAVATING LTD. CAMPBELL RIVER, B.C.

Project: AS-BUILT RECORD DRAWINGS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR RECORD	T.W.	R.H.	10-19-2021

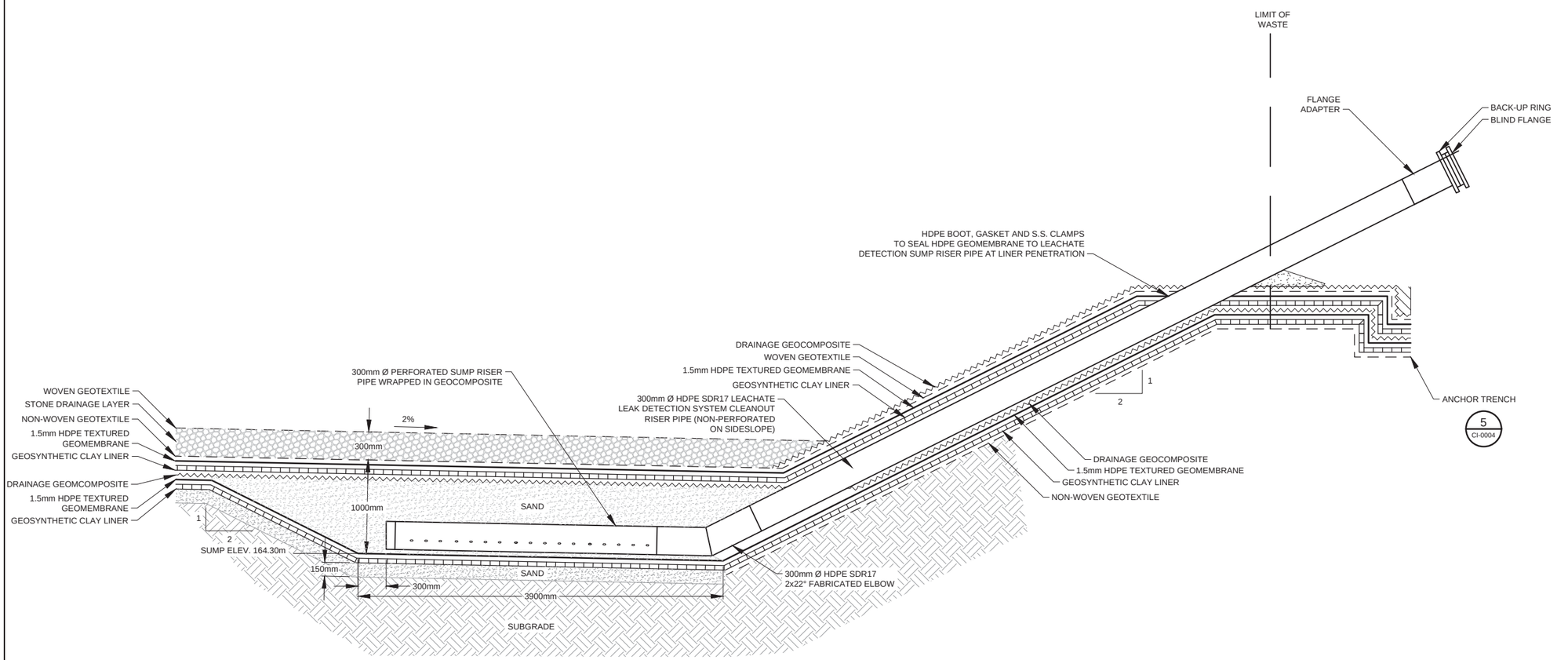
Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 19, 2021
This document shall not be used for construction unless signed and sealed for construction.		Scale	AS SHOWN
Original Size: ANSI D		Bar is 20mm on original size drawing: 0 — 20mm	

Project No. 11222680

Title: DETAILS LEACHATE COLLECTION SUMP

Sheet No. CI-0005

Sheet 5 of 9



DETAIL 11 LEACHATE LEAK DETECTION SUMP, SUMP RISER PIPE
N.T.S. CI-0003

ISSUED FOR RECORD

GHD Ltd.
138 EAST 7TH AVENUE, SUITE 100
VANCOUVER, BRITISH COLUMBIA V5T 1M6 CANADA
T 1 604 214 0510 **F** 1 604 214 0525 **W** www.ghd.com

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
D. J. LIDDY
33360
2021-10-19

Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
AS-BUILT
RECORD DRAWINGS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR RECORD	T.W.	R.H.	10-19-2021

Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 20, 2021
This document shall not be used for construction unless signed and sealed for construction.		Scale	AS SHOWN

Original Size
ANSI D

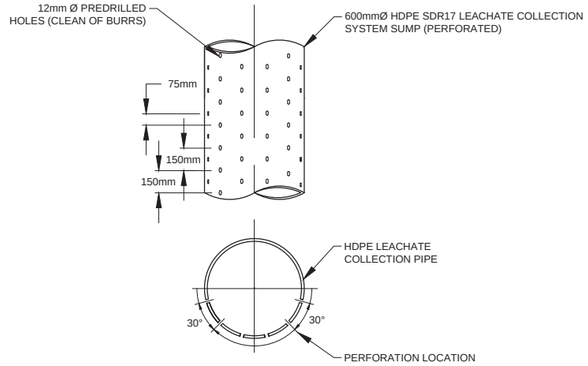
Bar is 20mm on original size drawing
0 20mm

Project No. 11222680

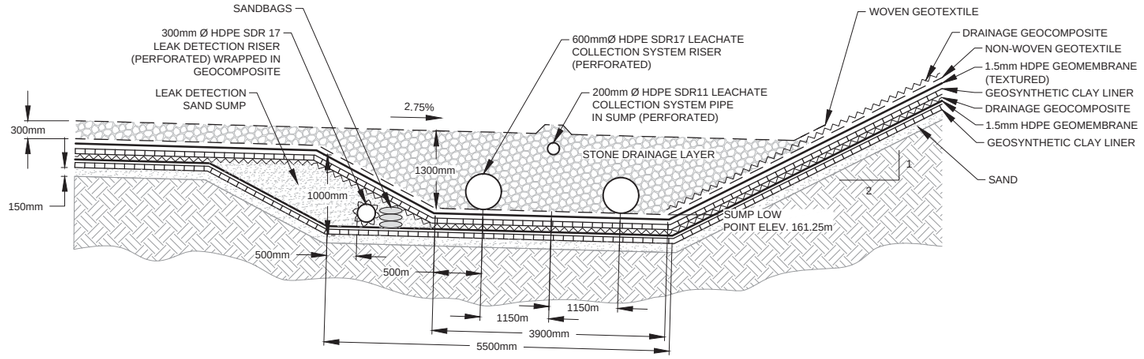
Title
DETAILS
LEACHATE LEAK
DETECTION SUMP

Sheet No.
CI-0006

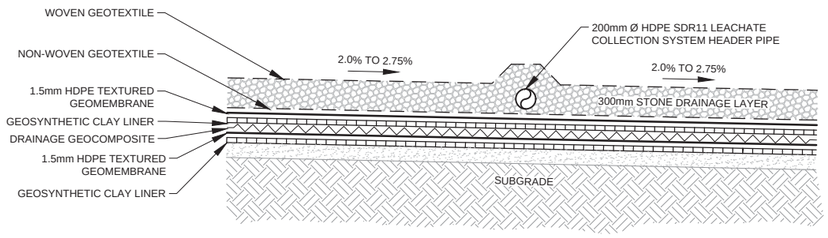
Plot Date: 20 October 2021 - 12:27 AM Plotted By: Tyler Wagstaff CAD File: N:\CA\Vancouver\Projects\663\11222680\Digital_Design\ACAD\Sheets\11222680-GHD-RPT 2\11222680-GHD-0000-DWG-CI-0005.dwg



DETAIL 12 (CI-0003) 600mmØ LEACHATE COLLECTION SYSTEM SUMP PIPE PERFORATIONS
NTS



DETAIL 13 (CI-0003) LEACHATE COLLECTION SYSTEM SUMP
1:50



DETAIL 14 (CI-0003) LEACHATE COLLECTION SYSTEM TOE DRAIN/ LEACHATE COLLECTION SYSTEM PIPE
1:30

ISSUED FOR RECORD

GHD Ltd.
138 EAST 7TH AVENUE, SUITE 100
VANCOUVER, BRITISH COLUMBIA V5T 1M6 CANADA
T 1 604 214 0510 **F** 1 604 214 0525 **W** www.ghd.com

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
D. J. LIDDY
33360
2021-10-19

Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
AS-BUILT
RECORD DRAWINGS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR RECORD	T.W.	R.H.	10-19-2021

Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 19, 2021
This document shall not be used for construction unless signed and sealed for construction.		Scale	AS SHOWN

Original Size
ANSI D

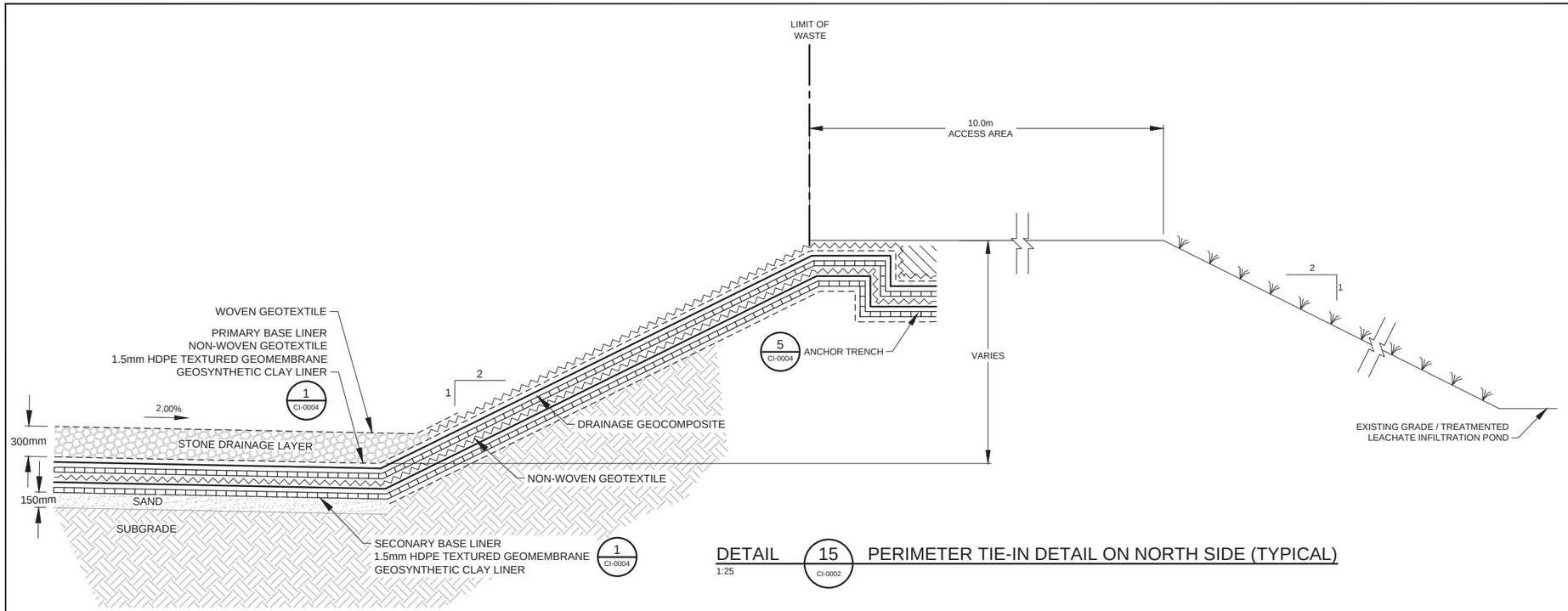
Bar is 20mm on original size drawing
0 20mm

Project No. 11222680

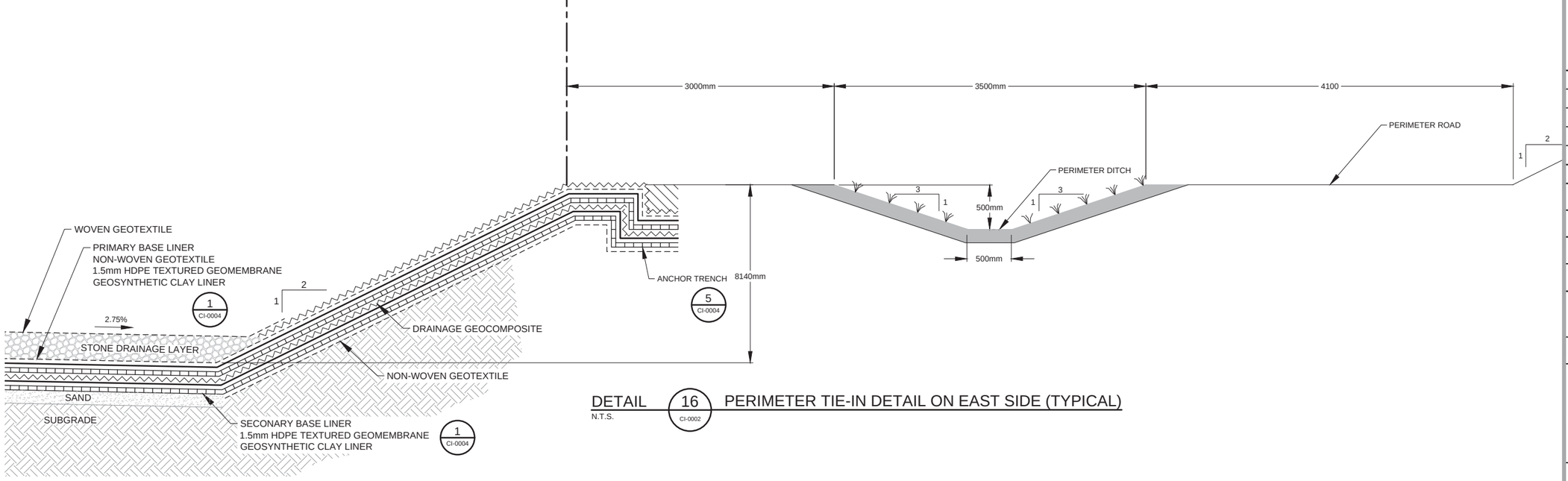
Title
DETAILS
LEACHATE COLLECTION
SYSTEM

Sheet No.
CI-0007

Plot Date: 19 October 2021 - 11:11 PM Plotted By: Tyler Wagstaff CAD File: N:\CA\Vancouver\Projects\663\11222680\Digital_Design\ACAD\Sheets\11222680-GHD-RPT 2\11222680-GHD-0000-DWG-CI-0005.dwg



DETAIL 15 CI-0002 PERIMETER TIE-IN DETAIL ON NORTH SIDE (TYPICAL)
1:25



DETAIL 16 CI-0002 PERIMETER TIE-IN DETAIL ON EAST SIDE (TYPICAL)
N.T.S.

ISSUED FOR RECORD

GHD Ltd.
138 EAST 7TH AVENUE, SUITE 100
VANCOUVER, BRITISH COLUMBIA V5T 1M6 CANADA
T 1 604 214 0510 **F** 1 604 214 0525 **W** www.ghd.com

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
D. J. LIDDY
33360
2021-10-19

Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
AS-BUILT
RECORD DRAWINGS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR RECORD	T.W.	R.H.	10-19-2021

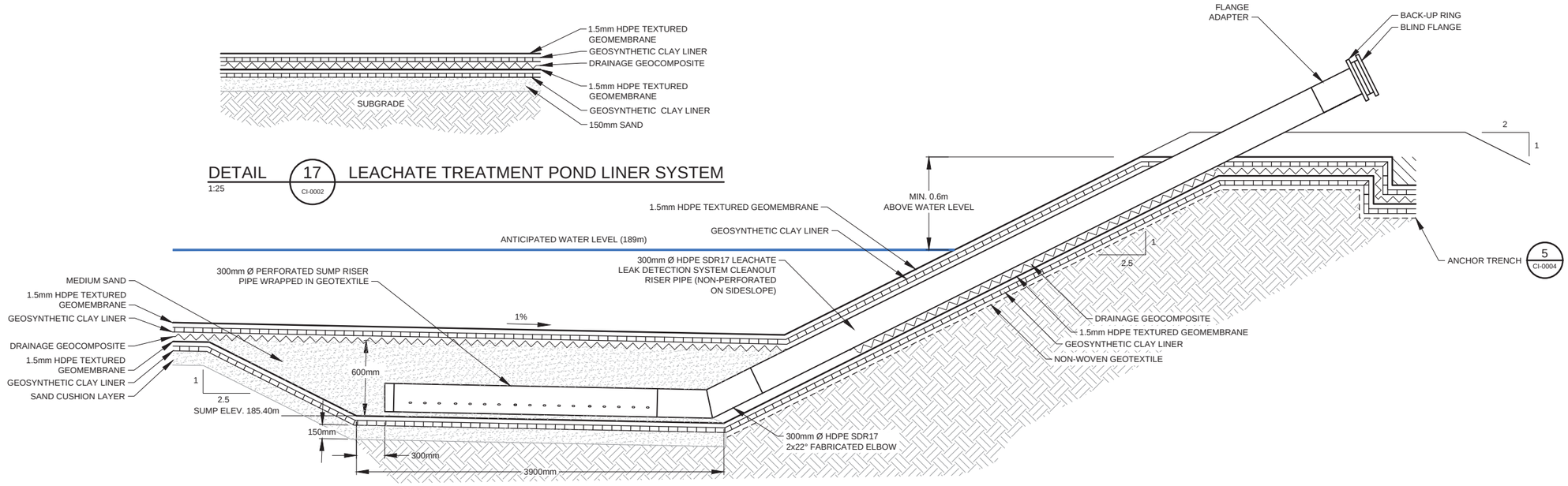
Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 19, 2021
This document shall not be used for construction unless signed and sealed for construction.		Scale	AS SHOWN
Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

Project No. 11222680

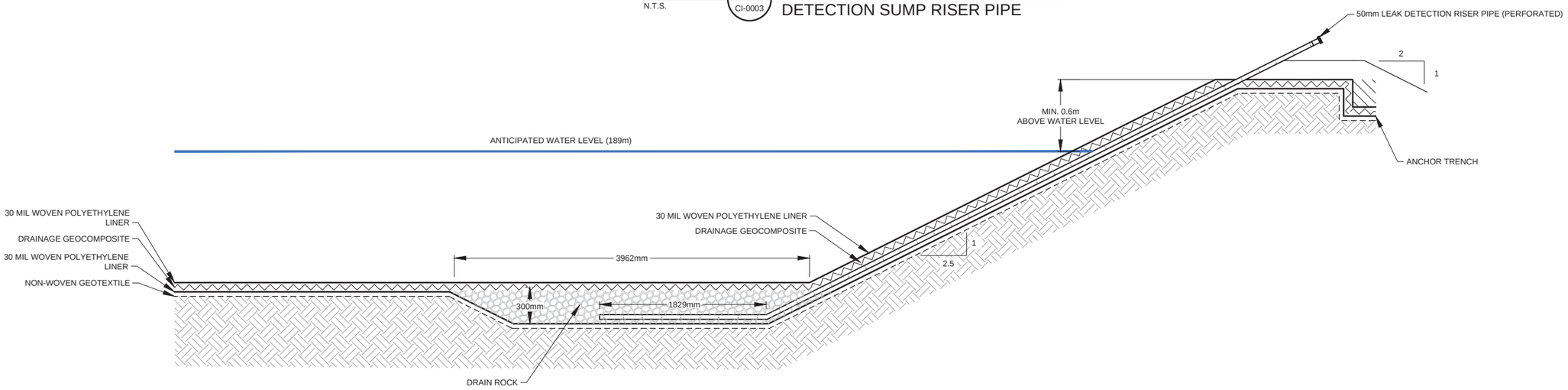
Title
DETAILS
PERIMETER TIE-IN DETAILS

Sheet No.
CI-0008

Sheet 8 of 9



DETAIL 17 CI-0002 — LEACHATE TREATMENT POND LINER SYSTEM
1:25



DETAIL 18 CI-0003 — LEACHATE TREATMENT POND LEAK DETECTION SUMP RISER PIPE
N.T.S.

DETAIL 19 CI-0003 — EFFLUENT STORAGE POND DOUBLE LINER & LEAK DETECTION
N.T.S.

ISSUED FOR RECORD

GHD Ltd.
138 EAST 7TH AVENUE, SUITE 100
VANCOUVER, BRITISH COLUMBIA V5T 1M6 CANADA
T 1 604 214 0510 F 1 604 214 0525 W www.ghd.com

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — D. J. LIDDY # 33360
2021-10-19

Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
AS-BUILT
RECORD DRAWINGS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR RECORD	T.W.	R.H.	10-19-2021

Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 19, 2021
This document shall not be used for construction unless signed and sealed for construction.		Scale	AS SHOWN
Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

Project No. 11222680

Title
LEACHATE TREATMENT AND EFFLUENT STORAGE PONDS, TREATED LEACHATE INFILTRATION POND AND LYSIMETER DETAILS

Sheet No.
CI-0009

Sheet 9 of 9

Plot Date: 19 October 2021 - 11:14 PM
Plotted By: Tyler Wagstaff
CAD File: N:\CA\Vancouver\Projects\663\11222680\Digital_Design\ACAD\Sheets\11222680-GHD-RPT 2\11222680-GHD-0000-DWG-CI-0007.dwg

Appendix B

Photograph Log

Site Photographs

Photo 1 *Leachate Treatment Pond Excavation*

Photo 2 *Leachate Treatment Pond Excavation Complete*

Photo 3 *Leachate Treatment Pond GCL Installation*

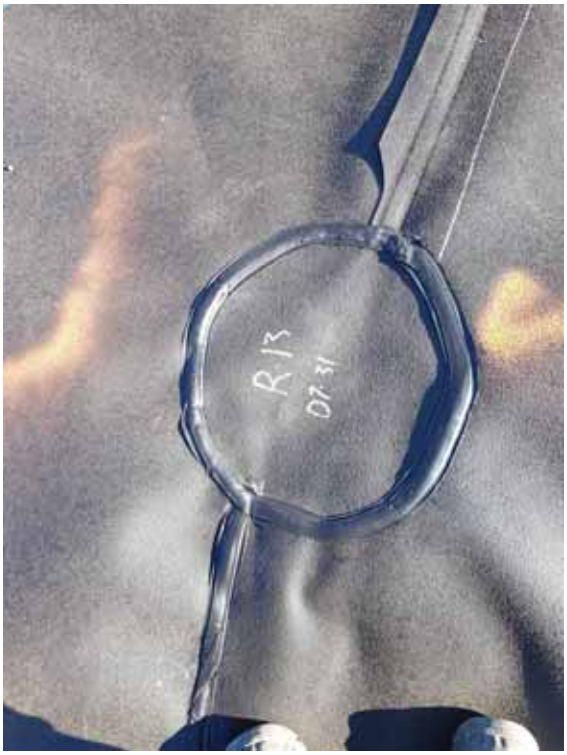


Photo 4 *Leachate Treatment Pond Typical Repair*

Photo 5 *HDPE Fusion Machine*

Photo 6 *Leachate Treatment Pond GCL Placement*

Photo 7 *Leachate Treatment Pond Geomembrane Deployment*

Photo 8 *Leachate Treatment Pond Geomembrane Installation Complete*

Photo 9 *Treated Effluent Holding Pond Geotextile*

Photo 10 *Treated Effluent Holding Pond Leak Detection*

Site Photographs

Photo 1 *Constructing East and West Berm*

Photo 2 *Constructing West Berm*

Photo 3 Placing Bedding Sand

Photo 4 Field Tensiometer

Photo 5 Field Tensiometer

Photo 6 Sub-base Before GCL Installation

Photo 7 GCL Installation

Photo 8 Typical Geomembrane Tag

Photo 9 *Primary Geomembrane Installation*

Photo 10 *Typical Destructive Samples of Geomembrane Seams for Lab Testing*

Photo 11 *Primary Geomembrane*

Photo 12 *Drainage Geocomposite on top of Primary Geomembrane*

Photo 13 Typical Drainage Geocomposite Cable Ties

Photo 14 Installing Geomembrane on North Berm

Photo 15 Installing GCL on top of Geocomposite

Photo 16 Leachate Sump with Primary Geomembrane

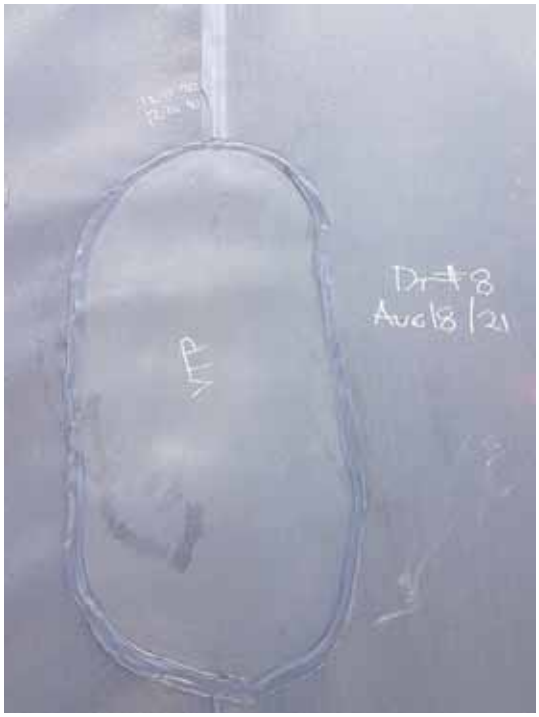


Photo 17 Typical Geomembrane Repair

Photo 18 Geomembrane Seam Pressure Test

Photo 19 HDPE Pipe Fusion Machine

Photo 20 Deploying Geomembrane on North Berm

Photo 21 Leachate Sump with Leak Detection Riser

Photo 22 Seaming Geocomposite above Sump

Photo 23 Complete Installation of Geosynthetics

Photo 24 Initial Placement of Drainage Layer in 900 mm Lifts

Photo 25 Completing Third 900 mm Drainage Layer Lift

Photo 26 Infiltration Pond

Photo 27 Spreading 300 mm of Drainrock

Photo 28 Typical Geomembrane Penetration Boot

Appendix C

Material Test Results

McElhanney Ltd.
1196 Dogwood Street
Campbell River, BC
Tel: (250) 287-7799

Report of:

Field Density Report
Nuclear Densometer

ASTM Ref: *D6938*

Project: Upland Pit Berm
Client: Upland Contracting Ltd.

Project Number: 2221-49292-00
Report Date: March 22, 2021
Report Number: 1

Test Date: March 22, 2021

Material Description: Proctor #5 - 75mm Pitrun

Project Specific Location: Landfill Berm in Pit #1

Tested By: JDC
Specification: 95%
ASTM: D698 *(D698 Standard, D1557 Modified)*

Test No.	Test Location	Elevation (m)	Test Depth (mm)	Proctor No.	Field Dry Density (kg/m^3)	Percent Moisture (%)	Max. Proctor Dry Density (kg/m^3)	Optimum Moisture (%)	Percent Compact. (%)	Spec. (%)
	South end of berm Multiple passes									
1	SEE MAP OF BERM	Subbase	300	1	2234	4.7	2260	8.0	99%	95%
2	SEE MAP OF BERM	Subbase	300	1	2350	4.1	2260	8.0	104%	95%
3	SEE MAP OF BERM	Subbase	300	1	2269	4.7	2260	8.0	100%	95%
4	SEE MAP OF BERM	Subbase	300	1	2223	5.1	2260	8.0	98%	95%
	North end of berm after 6 passes									
5	SEE MAP OF BERM	Subbase	300	1	2280	5.3	2260	8.0	101%	95%
6	SEE MAP OF BERM	Subbase	300	1	2270	5.3	2260	8.0	100%	95%
	North end of berm after another 4 passes									
7	SEE MAP OF BERM	Subbase	300	1	2221	5.0	2260	8.0	98%	95%
8	SEE MAP OF BERM	Subbase	300	1	2248	5.3	2260	8.0	99%	95%
9	SEE MAP OF BERM	Subbase	300	1	2345	3.5	2260	8.0	104%	95%
	North end of berm after another 4 passes									
10	SEE MAP OF BERM	Subbase	300	1	2323	4.8	2230	8.0	104%	95%
11	SEE MAP OF BERM	Subbase	300	1	2192	5.4	2230	8.0	98%	95%

Comments:

Reviewed by:

McElhanney Ltd.
1196 Dogwood Street
Campbell River, BC
Tel: (250) 287-7799

Report of:

Field Density Report
Nuclear Densometer

ASTM Ref: *D6938*

Project: Upland Pit Berm
Client: Upland Contracting

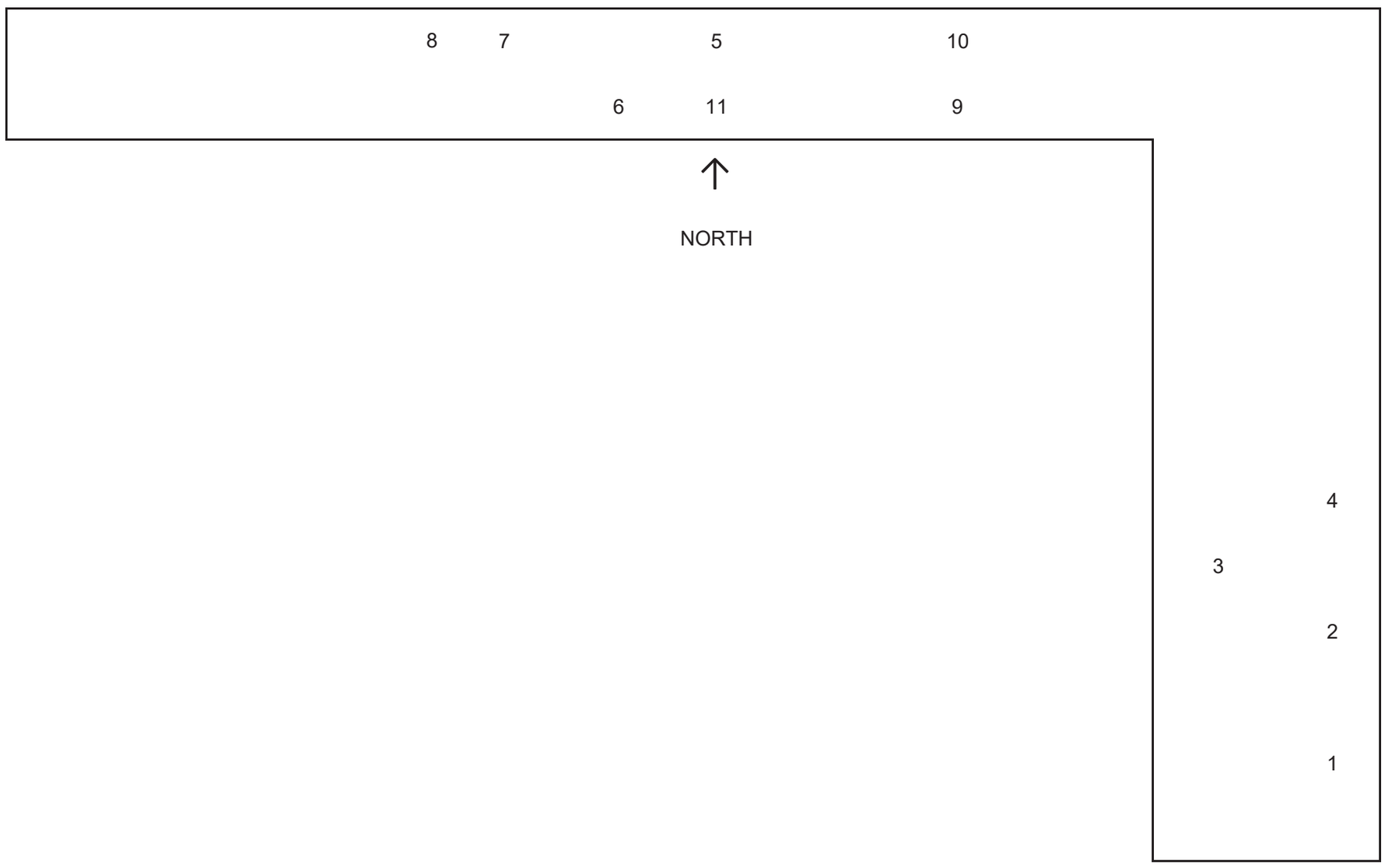
Project Number: 2221-49292-00
Report Date: March 22, 2021
Report Number: 1

Test Date: March 22, 2021

Material Description: Proctor #5 - 75mm Pitrun

Project Specific Location: Landfill Berm in Pit #1

Tested By: JDC
Specification: 95%
ASTM: D698 *(D698 Standard, D1557 Modified)*



Comments:

Reviewed by:

McElhanney Ltd.
1211 Ryan Road
Courtenay, BC

MOISTURE - DENSITY RELATIONSHIP REPORT

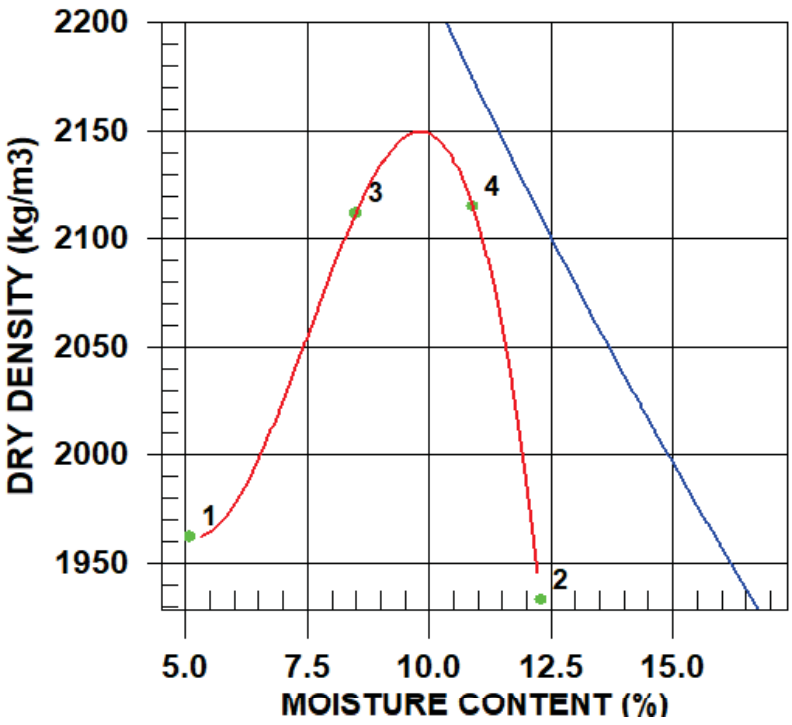
PROJECT NO. 2221-49292-08
CLIENT Upland Contracting Ltd.
C.C.

TO
Upland Contracting Ltd.
7295 Gold River Hwy.
Campbell River, BC
V9H 1P1

PROJECT Upland Misc 2020 — Campbell River
CONTRACTOR — Campbell River

PROCTOR NO. 5 DATE TESTED 24-Mar-2021 DATE RECEIVED 24-Mar-2021 DATE SAMPLED 22-Mar-2021

INSITU MOISTURE	7.0 %	COMPACTION STANDARD	Standard Proctor, ASTM D698
SAMPLED BY	JC	COMPACTION PROCEDURE	C: 152.4mm Mold, Passing 19mm
TESTED BY	TI	RAMMER TYPE	Automatic
SUPPLIER	Upland Contracting Ltd.	PREPARATION	Moist
SOURCE	Upland Pit #1	OVERSIZE CORRECTION METHOD	ASTM 4718
MATERIAL IDENTIFICATION		RETAINED 19mm SCREEN	20.0 %
MAJOR COMPONENT	PIT RUN	OVERSIZE SPECIFIC GRAVITY	2.85
SIZE	75MM	TOTAL NUMBER OF TRIALS	4
DESCRIPTION			
ROCK TYPE			



TRIAL NUMBER	WET DENSITY (kg/m3)	DRY DENSITY (kg/m3)	MOISTURE CONTENT (%)
1	2062	1962	5.1
2	2171	1933	12.3
3	2291	2112	8.5
4	2346	2115	10.9

ZERO AIR VOIDS CURVE FOR ESTIMATED SPECIFIC GRAVITY OF 2.85	MAXIMUM DRY DENSITY (kg/m3)	OPTIMUM MOISTURE CONTENT (%)
CALCULATED	2150	10.0
OVERSIZE CORRECTED	2260	8.0

COMMENTS
Lab ID: 21-086
Corresponds With: Sieve #26

 29-Mar-2021 McElhanney Ltd.

Reviewed By: _____

McElhanney Ltd.
1211 Ryan Road
Courtenay, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2221-49292-08
CLIENT Upland Contracting Ltd.
C.C.

TO
Upland Contracting Ltd.
7295 Gold River Hwy.
Campbell River, BC
V9H 1P1

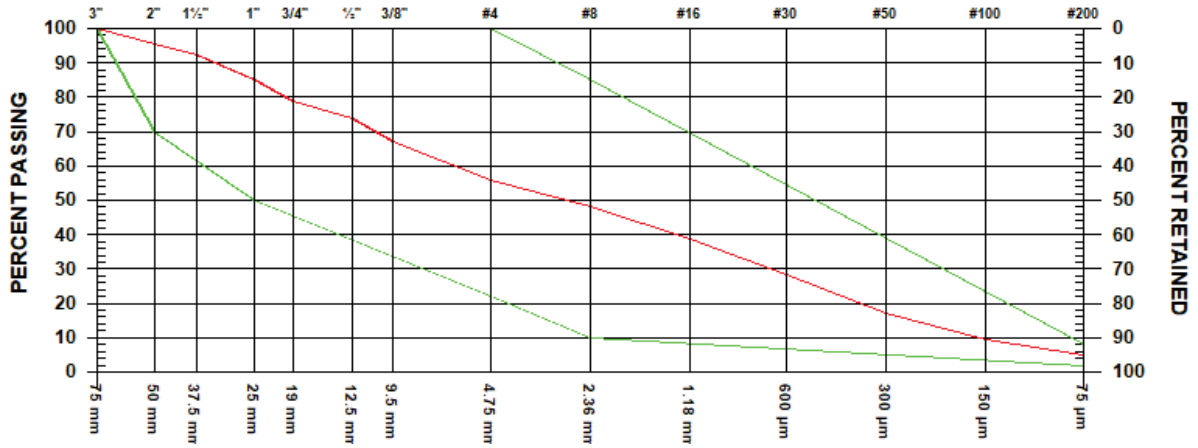
PROJECT Upland Misc 2020 — Campbell River
Campbell River

CONTRACTOR

SIEVE TEST NO. 26 DATE RECEIVED 24-Mar-2021 DATE TESTED 24-Mar-2021 DATE SAMPLED 22-Mar-2021

SUPPLIER Upland Contracting Ltd.
SOURCE Upland Pit #1
SPECIFICATION MMCD 2.3.1 Pit Run Gravel
MATERIAL TYPE Pit Run

SAMPLED BY JC
TESTED BY TI
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm	100.0	100.0-100.0
2"	50 mm	95.7	70.0-100.0
1 1/2"	37.5 mm	92.3	
1"	25 mm	85.2	50.0-100.0
3/4"	19 mm	78.9	
1/2"	12.5 mm	73.7	
3/8"	9.5 mm	67.3	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	56.1	22.0-100.0
No. 8	2.36 mm	48.0	10.0-85.0
No. 16	1.18 mm	38.7	
No. 30	600 µm	28.5	
No. 50	300 µm	17.2	
No. 100	150 µm	9.3	
No. 200	75 µm	5.0	2.0-8.0

MOISTURE CONTENT 7.0%

COMMENTS
Lab ID: 21-086
Corresponds With: Proctor #5

 29-Mar-2021 McElhanney Ltd.

Reviewed By: _____

McElhanney Ltd.
1211 Ryan Road
Courtenay, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2221-49292-08
CLIENT Upland Contracting Ltd.
C.C.

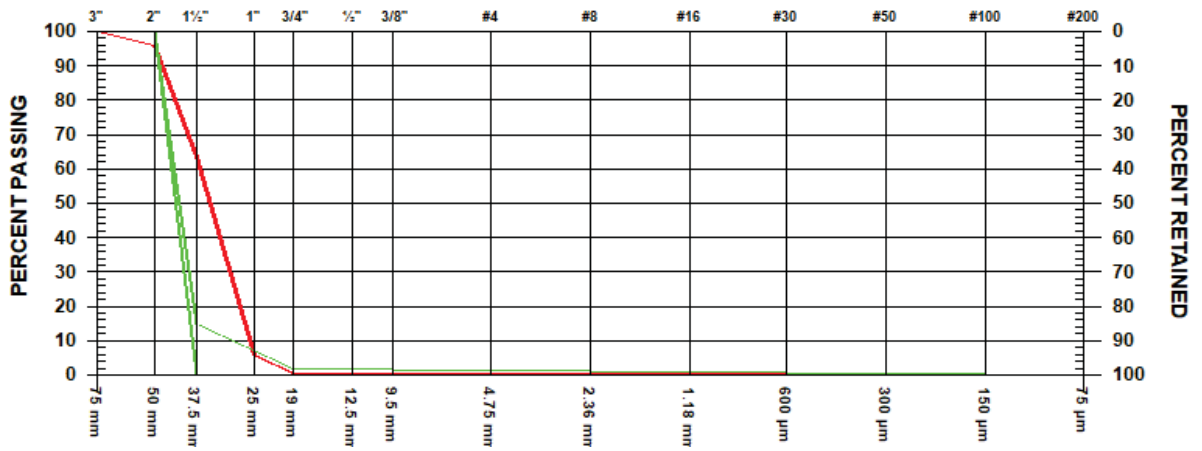
TO
Upland Contracting Ltd.
7295 Gold River Hwy.
Campbell River, BC
V9H 1P1

PROJECT Upland Misc 2020 — Campbell River
CONTRACTOR — Campbell River

SIEVE TEST NO. 31 DATE RECEIVED 24-Sep-2021 DATE TESTED 27-Sep-2021 DATE SAMPLED 09-Sep-2021

SUPPLIER Upland Contracting Ltd.
SOURCE Upland Pit #1
SPECIFICATION Stone Drainage Layer
MATERIAL TYPE 1-2" Drain Rock

SAMPLED BY Client
TESTED BY JY
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm	100.0	
2"	50 mm	96.0	100.0-100.0
1 1/2"	37.5 mm	63.6	0.0-15.0
1"	25 mm	5.8	
3/4"	19 mm	0.4	0.0-2.0
1/2"	12.5 mm	0.4	
3/8"	9.5 mm	0.4	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	0.4	
No. 8	2.36 mm	0.4	
No. 16	1.18 mm	0.4	
No. 30	600 µm	0.4	
No. 50	300 µm	0.3	
No. 100	150 µm	0.2	
No. 200	75 µm	0.1	

MOISTURE CONTENT 4.3%

COMMENTS
Sample ID: #21-420A

 29-Sep-2021 McElhanney Ltd. Reviewed By:

McElhanney Ltd.
1211 Ryan Road
Courtenay, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2221-49292-08
CLIENT Upland Contracting Ltd.
C.C.

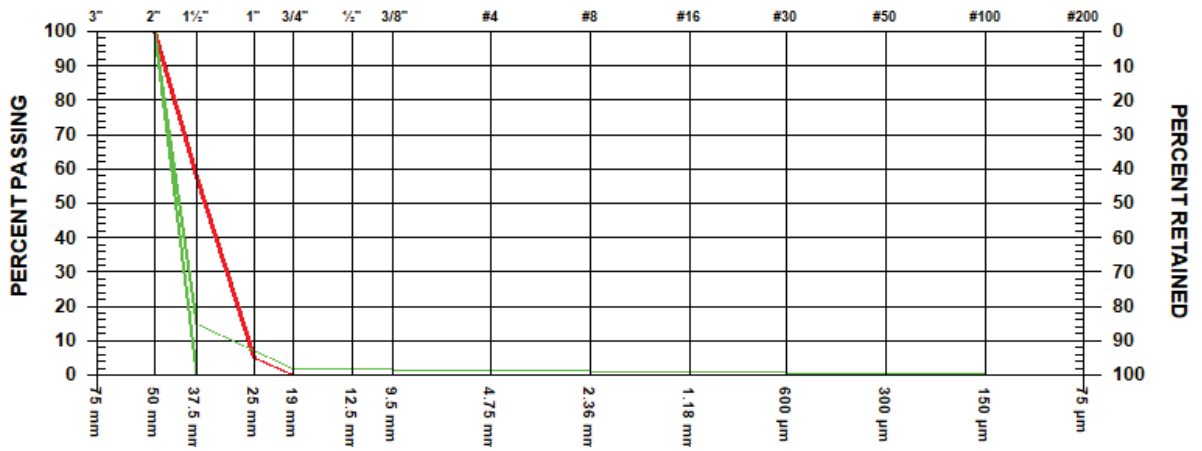
TO
Upland Contracting Ltd.
7295 Gold River Hwy.
Campbell River, BC
V9H 1P1

PROJECT Upland Misc 2020 — Campbell River
CONTRACTOR — Campbell River

SIEVE TEST NO. 32 DATE RECEIVED 24-Sep-2021 DATE TESTED 27-Sep-2021 DATE SAMPLED 07-Sep-2021

SUPPLIER Upland Contracting Ltd.
SOURCE Upland Pit #1
SPECIFICATION Stone Drainage Layer
MATERIAL TYPE 1-2" Drain Rock

SAMPLED BY Client
TESTED BY JY
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm	100.0	
2"	50 mm	100.0	100.0-100.0
1 1/2"	37.5 mm	57.5	0.0-15.0
1"	25 mm	4.8	
3/4"	19 mm	0.1	0.0-2.0
1/2"	12.5 mm	0.1	
3/8"	9.5 mm	0.1	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	0.1	
No. 8	2.36 mm	0.1	
No. 16	1.18 mm	0.1	
No. 30	600 µm	0.1	
No. 50	300 µm	0.1	
No. 100	150 µm	0.1	
No. 200	75 µm	0.1	

MOISTURE CONTENT 1.7%

COMMENTS
Sample ID: #21-420B

 29-Sep-2021 McElhanney Ltd. Reviewed By:

McElhanney Ltd.
1211 Ryan Road
Courtenay, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2221-49292-08
CLIENT Upland Contracting Ltd.
C.C.

TO
Upland Contracting Ltd.
7295 Gold River Hwy.
Campbell River, BC
V9H 1P1

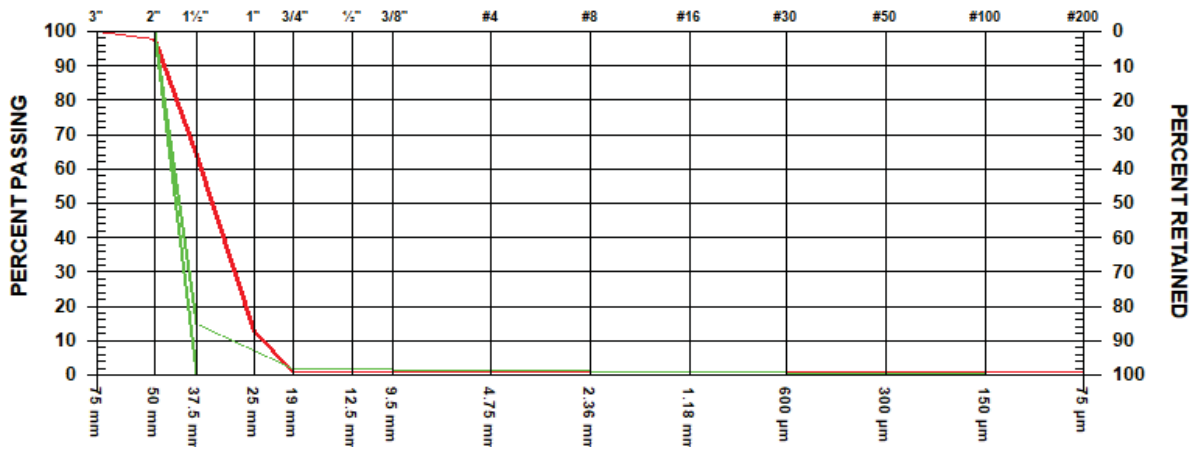
PROJECT Upland Misc 2020 Campbell River
Campbell River

CONTRACTOR

SIEVE TEST NO. 33 DATE RECEIVED 24-Sep-2021 DATE TESTED 27-Sep-2021 DATE SAMPLED 07-Sep-2021

SUPPLIER Upland Contracting Ltd.
SOURCE Upland Pit #1
SPECIFICATION Stone Drainage Layer
MATERIAL TYPE 1-2" Drain Rock

SAMPLED BY Client
TESTED BY JY
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm	100.0	
2"	50 mm	97.7	100.0-100.0
1 1/2"	37.5 mm	64.1	0.0-15.0
1"	25 mm	12.4	
3/4"	19 mm	1.0	0.0-2.0
1/2"	12.5 mm	1.0	
3/8"	9.5 mm	1.0	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	1.0	
No. 8	2.36 mm	1.0	
No. 16	1.18 mm	0.9	
No. 30	600 µm	0.9	
No. 50	300 µm	0.9	
No. 100	150 µm	0.9	
No. 200	75 µm	0.9	

MOISTURE CONTENT 3.1%

COMMENTS
Sample ID: #21-420C

 29-Sep-2021 McElhanney Ltd. Reviewed By:

Appendix D

Product Data

Submittal Transmittal Form

DATE: May 3, 2021 GHD PROJECT NO.: 088877

PROJECT NAME: Northwin Landfill Phase 1 East CONTRACT NO.:

CONTRACTOR: Upland Contracting Ltd.

Certification By Contractor:

I hereby represent that I have satisfied CONTRACTOR's obligations under the Contract Documents including but not limited to review and approval, verification of products required, field dimensions, adjacent construction work, and coordination of information with respect to CONTRACTOR's review and approval of that submittal.	Contractor's Signature or Stamp

Contractor Submittal No.: 001 -1

GHD Submittal No.: 001 -1

Spec Section No./Drawing No.:

Page No.	Item No.	Description
		Bentomat DN (Geosythetic clay liner) SKAPS W13 (Woven Geotextile) SKAPS GE200 (Non-woven Geotextile) Interdrain GM (Drainage Geocomposite) Alvatech (Geomembrane)

Submittal Type:

- ☐ A - Test Results and/or Certificates
- ☒ B - Manufacturer's Literature or Data
- ☐ C - Shop Drawings
- ☐ D - Operation & Maintenance Instructions
- ☐ E - Samples
- ☐ F - Alternative Product Supporting Data
- ☐ G - Administrative (Schedules, etc.)

Notes: **Bolded** text show updates from Submittal 001.

Review Comments:

- Bentomat DN
  - Peel strength Spec: 2100 N/m, Sumbittal: 610 N/m
  - **Based on manufacture provided information and supported by GRI-GCL3-Spec SI (attached) Bentomat DN is accepted**
- Skaps W315
  - Puncture strength: Spec ASTM D4833, Submittal ASTM 6241
  - **ASTM 6241 acceptable for testing puncture strength of geotextile**
- Skaps GE200
  - Puncture strength Spec: 2420 N , Submittal 1.99 kN
  - **Puncture strength was reviewed and found to be acceptable**
  - Puncture strength Spec: ASTM D4833, Submittal ASTM 6241
  - **ASTM D6241 is acceptable for testing puncture strength of geotextile**
- Alvatech
  - Tensile and elongation strength Spec test method: ASTM D638, Submittal ASTM D 6693 **Acceptable test method supported by GRI-HDPE-Spec (attached)**
  - Carbon black content: Spec test method: ASTM D1603, Submittal ASTM 4218 **Acceptable test method supported by GRI-HDPE-Spec (attached)**
  - Asperity height: GRI test method GM12, Submittal ASTM D7466 **Acceptable test method supported by GRI-HDPE-Spec (attached)**

REVIEWED BY:

REVIEWED BY: David Barbour

SUBMITTAL REVIEW

GHD Submittal No. **001-1**
Contractor Submittal No.
Contract No.

ENGINEER's review is for the sole purpose of ascertaining conformance with general design concepts expressed in the Contract Documents and in no way constitutes approval of the detail design inherent in CONTRACTOR's Submittal responsibility for which remains solely with CONTRACTOR submitting same. Review does not authorize changes to Contract Documents.

- [x] Reviewed
- [ ] Reviewed as Noted
- [ ] Revise and Resubmit
- [ ] Not Subject to Review
- [ ] Other

Name: **David Barbour**

Signed: D Barbour

Date: **May 3, 2021**

BENTOMAT® DN CERTIFIED PROPERTIES

CETCO® Bentomat® DN is a reinforced geosynthetic clay liner (GCL) consisting of a layer of sodium bentonite between two polypropylene nonwoven geotextiles, which are needle-punched together.

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY	CERTIFIED VALUES
Nonwoven Base Geotextile Mass/Area[1]	ASTM D5261	200,000 ft^2 (20,000 m^2)	6.0 oz/yd^2 (203 g/m^2) min.
Nonwoven Cap Geotextile Mass/Area[1]	ASTM D5261	200,000 ft^2 (20,000 m^2)	6.0 oz/yd^2 (203 g/m^2) min.
Bentonite Moisture Content[2]	ASTM D2216	1 per 50 tonnes	12% max.
Bentonite Swell Index[2]	ASTM D5890	1 per 50 tonnes	24 mL/2g min.
Bentonite Fluid Loss[2]	ASTM D5891	1 per 50 tonnes	18 mL max.
Bentonite Mass/Area[3]	ASTM D5993	40,000 ft^2 (4,000 m^2)	0.75 lb/ft^2 (3.7 kg/m^2) min.
Total Mass/Area[3]	ASTM D5993	40,000 ft^2 (4,000 m^2)	0.83 lb/ft^2 (4.1 kg/m^2) min.
GCL Moisture Content	ASTM D5993	40,000 ft^2 (4,000 m^2)	35% max.
GCL Grab Strength[4]	ASTM D6768	200,000 ft^2 (20,000 m^2)	50 lbs/in (8.8 kN/m) min.
GCL Peel Strength	ASTM D6496	40,000 ft^2 (4,000 m^2)	3.5 lbs/in (610 N/m) min.
GCL Hydraulic Conductivity[5]	ASTM D5887	250,000 ft^2 (25,000 m^2)	5 x 10^{-11} m/s max.
GCL Index Flux[5]	ASTM D5887	250,000 ft^2 (25,000 m^2)	1 x 10^{-8} $m^3/m^2/s$ max.
GCL Hydrated Internal Shear Strength[6]	ASTM D6243	1,000,000 ft^2 (100,000 m^2)	500 psf (24 kPa) typ.@ 200 psf (9.6 kPa)

Notes:

[1] Geotextile property tests performed on the geotextile components before they are incorporated into the finished GCL product.

[2] Bentonite property tests performed before the bentonite is incorporated into the finished GCL product.

[3] Reported at 0% moisture content.

[4] All tensile strength testing is performed in the machine direction using ASTM D6768.

[5] Index flux and hydraulic conductivity testing with deaired distilled/deionized water at 80 psi (550 kPa) cell pressure, 77 psi (530 kPa) headwater pressure and 75 psi (515 kPa) tailwater pressure.

[6] Peak values measured at 200 psf (9.6 kPa) normal stress for a specimen hydrated for 48 hours. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

TR 401 BDN-3.5lb/in-D5889/GRI-GCL3
05/2018

www.CETCO.com | contact@cetco.com

MINERALS TECHNOLOGIES CETCO®

Table 1(a) – Specification for Geosynthetic Clay Liners (GCLs)

Property	ASTM Test Method	Reinforced GCL			Non-Reinforced GCL			Testing Frequency
		GT-Related	GT Polymer Coated	GM-GF Related	GT-Related	GT Polymer Coated	GM-GF Related	
Clay (as received)								
swell index (ml/2g)	D5890	24	24	24	24	24	24	50 tonnes
fluid loss (ml)(1)	D5891	18	18	18	18	18	18	50 tonnes
Geotextiles (as received)								
cap fabric (nonwoven) - mass/unit area (g/m^2)(2)	D5261	200	200	200	100	100	n/a/100	20,000 m^2
cap fabric -(woven) - mass/unit area (g/m^2)	D5261	100	100	100	100	100	100	20,000 m^2
carrier fabric (nonwoven composite) - mass/(g/m^2)(2)	D5261	200	200	200	100	100	n/a/100	20,000 m^2
carrier fabric (woven) - mass/unit area (g/m^2)	D5261	100	100	100	-	-	-	20,000 m^2
coating - mass/unit area (g/m^2)(3)	D5261	n/a	200	n/a	n/a	200	n/a	4,000 m^2
Geomembrane/Geofilm (as received)								
thickness(4) (mm)	D5199/D5994	n/a	n/a	0.40/0.50/0.10	n/a	n/a	0.40/0.75/0.10	20,000 m^2
density (g/cc)	D1505/D792	n/a	n/a	0.92	n/a	n/a	0.92	20,000 m^2
break tensile strength, MD&XMD (kN/m)	D6693	n/a	n/a	n/a	n/a	n/a	6.0	20,000 m^2
break tensile strength, MD (kN/m)	D882	n/a	n/a	2.5	n/a	n/a	2.5	20,000 m^2
GCL (as manufactured)								
mass of GCL (g/m^2)(5)	D5993	4000	4050	4100	4000	4050	4100	4,000 m^2
mass of bentonite (g/m^2)(5)	D5993	3700	3700	3700	3700	3700	3700	4,000 m^2
moisture content(1) (%)	D5993	35	35	35	35	35	35	4,000 m^2
tensile str., MD (kN/m)	D6768	4.0	4.0	4.0	4.0	4.0	4.0	20,000 m^2
peel strength (N/m)	D6496	360	360	360	n/a	n/a	n/a	4,000 m^2
permeability(1) (m/sec), "or"	D5887	5×10^{-11}	n/a	n/a	5×10^{-11}	n/a	n/a	25,000 m^2
flux(1) ($m^3/sec\text{-}m^2$),	D5887	1×10^{-8}	n/a	n/a	1×10^{-8}	n/a	n/a	25,000 m^2
GCL permeability(1),(6),(7),(8) ($m^3/m^2/s$) (max. at 35 kPa)	D6766	1×10^{-7}	n/a	n/a	1×10^{-7}	n/a	n/a	yearly
Component Durability								
geotextile and reinforcing yarns (9) (% strength retained)	See § 5.6.2	65	65	n/a	65	65	n/a	yearly
geomembrane	See § 5.6.3	n/a	n/a	GM Spec(10)	n/a	n/a	GM Spec(10)	yearly
geofilm/polymer treated(9) (% strength retained)	See § 5.6.4	n/a	85	80	n/a	85	80	yearly

n/a = not applicable with respect to this property

(1) These values are maximum (all others are minimum).

(2) For both cap and carrier fabrics for nonwoven reinforced GCLs; one, or the other, must contain a scrim component of mass ≥ 100 g/m^2 for dimensional stability. This only applies to GM/GCL composites which are exposed to the atmosphere for several months or longer so as to mitigate panel separation.

(3) Calculated value obtained from difference of coated fabric to as-received fabric.

(4) First value is for smooth geomembrane; second for textured geomembrane; third for geofilm.

(5) Mass of the GCL and bentonite is measured after oven drying per the stated test method.

(6) Value represents GCL permeability after permeation with a 0.05 M calcium chloride solution; for termination criterion see § 5.6.1.

(7) The specimen is saturated with DI water until steady flow is obtained. $CaCL_2$ saturation at 0.05 M added after, minimum flow conditions exist as per the standard requirement.

(8) Test should be run on the pure bentonite only. Not on polymer modified bentonites.

(9) Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60°C for 50 days tested per ASTM D5035.

(10) Durability criteria should follow the appropriate specification for the geomembrane type used; i.e., GRI GM-13 for HDPE, GRI GM-17 for LLDPE or GRI GM-18 for fPP.

Sales Office:
Engineered Synthetic Products, Inc.
Phone (770) 564-1857
Fax (770) 564-1818
www.espgeosynthetics.com

Geotextile Product Description Sheet

SKAPS W315

SKAPS woven geotextile fabrics are woven polypropylene materials offering optimum performance when used in stabilization applications. Produced from first quality raw materials, they provide the perfect balance of strength and separation in styles capable of functioning exceptionally well in a wide range of performance requirements. Unless indicated below, all listed properties are Minimum Average Roll Values:

PROPERTY	TEST METHOD	UNIT	M.A.R.V. (Minimum Average Roll Value)
Weight	ASTM D 5261	oz/sy (g/m^2)	6.3 (214)
Grab Tensile	ASTM D 4632	lbs (kN)	315 (1.40)
Grab Elongation	ASTM D 4632	%	15
Trapezoid Tear Strength	ASTM D 4533	lbs (kN)	120 (.533)
CBR Puncture Resistance	ASTM D 6241	lbs (kN)	1000 (4.45)
Permittivity*	ASTM D 4491	sec^{-1}	0.05
Water Flow*	ASTM D 4491	gpm/sf (l/min/m^2)	4 (163)
AOS*	ASTM D 4751	US Sieve (mm)	40 (.425)
UV Resistance	ASTM D 4355	%/hrs	70/500

* At the time of manufacturing. Handling, storage, and shipping may change these properties.

PACKAGING	
Roll Dimensions (W x L) – ft	12.5 x 360 / 17.5 x 258
Square Yards Per Roll	500
Estimated Roll Weight - lbs	210

SKAPS Industries,
316 S. Holland Dr., Pendergrass, GA 30567,
Phone: (706)-693-3440, Fax (706)-693-3450,
www.skaps.com

Made in U.S.A.

SKAPS GE-200 is a needle-punched nonwoven geotextile made of 100% polypropylene staple fibers, which are formed into a random network for dimensional stability. SKAPS GE-200 resists ultraviolet deterioration, rotting, biological degradation, naturally encountered basics and acids. Polypropylene is stable within a pH range of 2 to 13.

DOWNLOAD DATA SHEET

SKAPS GE-200 conforms to the physical property values listed below:

Property	**Method**	**English (MARV^2)**	**Metric (MARV^2)**
Weight	ASTM D 5261	20 oz/yd^2	675 g/m^2
Grab Tensile Strength	ASTM D 4632	450 lbs	1.99 kN
Grab Elongation	ASTM D 4632	50%	50%
Trapezoid Tear Strength	ASTM D 4533	125 lbs	0.55 kN
CBR Puncture Resistance	ASTM D 6241	1437 lbs	1.67 kN
UV Resistance	ASTM D 4355	70%/500 hrs.	70%/500 hrs.

INTERDRAIN GM & GMG 30.8

Drainage Geocomposite

High-density polyethylene (HDPE) geonet with one or two polypropylene (PP) geotextiles heat laminated, respectively. The geonet is made with 2 overcrossed strands, whose geometry creates channels with a high flow capacity, also under high pressures and at very low gradients.

FUNCTIONS:
DRAINAGE, FILTRATION, SEPARATION and PROTECTION.

MAIN USES:
Landfill cappings, new landfills, water reservoirs, horizontal drainage in embankments and platforms of roads, railways, trams and other trafficked areas, retaining structures, bridges, foundations, basements, canals, cut-and-cover tunnels, tunnels and other underground structures, gardens and sport fields.

Properties	Values	Units	Qualifiers	Standards
Geonet [1]				
Polymer		High-density polyethylene (HDPE)		
Carbon black	2	%	Min	ASTM D4218
Density	0,94	g / cm³	Min	ASTM D1505
Thickness	300 (7,6)	mil (mm)	MAV	ASTM D5199
Transmissivity, MD	8×10^{-3}	m² / s [2]	MARV	ASTM D4716 [3]
Tensile strength, MD	75 (13,1)	lb / in (kN / m)	Min	ASTM D7179
Geotextile [1]				
Polymer		Polypropylene (PP)		
Mass per unit area	8 (270)	oz / yd² (g / m²)	MARV	ASTM D5261
CBR Puncture	600 (2.670)	lb (N)	MARV	ASTM D6241
AOS	80 (180)	US Sieve (µm)	MaxARV	ASTM D4751
Grab strength	225 (1.000)	lb (N)	MARV	ASTM D4632
Grab elongation	50	%	MARV	ASTM D4632
Tear strength	90 (400)	lb (N)	MARV	ASTM D4533
Permeability	100 (4.074)	gal / ft²·min (l / m²·min)	MARV	ASTM D4491
Permittivity	1,26	s^{-1}	MARV	ASTM D4491
UV resistance	70	% ret. 500h	MARV	ASTM D4355
Drainage geocomposite				
Ply adhesion, MD	1 (178)	lb / in (g / cm)	Min	ASTM D7005
Transmissivity, MD (SS)	3×10^{-3}	m² / s [2]	MARV	ASTM D4716 [3]
Transmissivity, MD (DS)	9×10^{-4}	m² / s [2]	MARV	ASTM D4716 [3]
Remarks				
- Standard roll format is 12,5 feet (3,8 meters) wide.				
- Has a geotextile overlap at one side, which eases the installation and prevents soil intrusion.				
- Has to be covered within 14 days after installation.				

[1] Geonet and geotextile listed properties are prior to lamination
[2] 10^{-3} m² / s = l / m·s
[3] Transmissivity measured under an hydraulic gradient of 0.1, normal load of 10,000 psf (480 kPa), water at 70 °F (21 °C) between HDPE plates (H/H) for 15 minutes

MD : Machine Direction (longitudinal)
SS : Single-Sided Geocomposite
DS : Double-Sided Geocomposite
MARV : Minimum Average Roll Value
MAV : Minimum Average Value
Min : Minimum Value
MAX : Maximum Value
MaxARV : Maximum Average Roll Value

CE Certificate of conformity
0099/CPR/A42/0124
0099/CPR/A42/0127

January 2020

ALVATECH FIX
High-Density Polyethylene Waterproofing Geomembrane

ALVATECH FIX is manufactured by SOTRAFA (Almería – Spain), a company of the Armando Alvarez Group.

ALVATECH FIX is a High-Density Polyethylene liner, structured on one (FIX 1F) or both sides (FIX 2F), available in 7.5 m and manufactured with the latest cast system technology.

SOTRAFA certifies that HDPE Geomembrane Alvatech FIX, satisfactorily meets Standard GRI GM-13.

PROPERTIES	UNIT	GEOMEMBRANE ALVATECH FIX 1F – 2F			Test Method
		Geo. 1.5	Geo. 2.0	Geo. 2.5	
Thickness (minimum average)		**1.50** (±5%)	**2.00** (±5%)	**2.50** (±5%)	
• Lowest individual for 8 out of 10 values	mm	-10%	-10%	-10%	ASTM D 5994
• Lowest individual for any of the 10 values		-15%	-15%	-15%	
Asperity Height (2)	mm	**≥ 0.80** (≥ 0,40)			ASTM D7466
Density with Carbon Black	g/cm^3	**≥ 0.940**			ASTM D 1505
Yield Strength (1)	kN/m	**24** (≥ 22)	**32** (≥ 29)	**40** (≥ 37)	
Break Strength (1)	kN/m	**19** (≥ 16)	**26** (≥ 21)	**32** (≥ 26)	ASTM D 6693
Yield Elongation (1)	%	**13** (≥ 12)	**13** (≥ 12)	**13** (≥12)	Type IV
Break Elongation (1)	%	**150** (≥ 100)	**200** (≥ 100)	**200** (≥ 100)	
Tear Resistance (1)	N	**200** (≥ 187)	**270** (≥ 249)	**335** (≥ 311)	ASTM D 1004
Puncture Resistance (2)	N	**450** (≥400)	**600** (≥534)	**750** (≥667)	ASTM D 4833
Stress Crack Resistance (SP-NCTL) (3)	h	**≥ 500**			ASTM D 5397
Carbon Black					
Carbon Black Content	%	**2 - 3**			ASTM D 4218
Carbon Black Dispersion	Category	**1 - 2**			ASTM D 5596
Oxidative Induction Time (4)					
Standard OIT	min	**≥ 100**			ASTM D 3895
--- or ---					
HPOIT		**≥ 400**			ASTM D 5885
OVEN AGEING AT 85 º C (4)					ASTM D 5721
Standard OIT - % Retained after 90 days	% retained	**≥ 55**			ASTM D 3895
--- or ---					
HPOIT - % Retained after 90 days		**≥ 80**			ASTN D 5885
U.V. RESISTANCE					ASTM D7238
High Pressure OIT - % Retained after 1600hours	% retained	**≥ 50**			ASTM D5885

(1) Both directions (machine direction and cross machine direction) (2) Both sides. (3) SP-NTCL must be evaluated in the smooth area.

(4) Sotrafa reserves the right to evaluate the antioxidant content with one or any other oxidation induction method.

All the values are nominal. Those values between parentheses are the minimum ones required by the norm GM-13.

SOTRAFA, El Ejido (Almería) Spain, www.sotrafageo.com
Telf: 0034 950 40 56 00 Fax: 0034 950 40 56 21 geo@sotrafa.com

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) - mils	D 5994	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	per roll
• lowest individual for 8 out of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
• lowest individual for any of the 10 values - %		-15	-15	-15	-15	-15	-15	-15	
Asperity Height mils (min. ave.) - mils	D 7466	16	16	16	16	16	16	16	every 2nd roll *(1)*
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	200,000 lb
Tensile Properties (min. ave.) *(2)*	D 6693								20,000 lb
• yield strength - lb/in.	Type IV	63	84	105	126	168	210	252	
• break strength - lb/in.		45	60	75	90	120	150	180	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		100	100	100	100	100	100	100	
Tear Resistance (min. ave.) - lb	D 1004	21	28	35	42	56	70	84	45,000 lb
Puncture Resistance (min. ave.) - lb	D 4833	45	60	75	90	120	150	180	45,000 lb
Stress Crack Resistance *(3)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM10
Carbon Black Content (range) - %	D 4218 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	20,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(6)*									200,000 lb
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(6), (7)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(8)*	D 7238								
(a) Standard OIT (min. ave.)	D 8117	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 5885	50	50	50	50	50	50	50	

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

(3) SP-NCTL per ASTM D5397 Appendix, is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

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GRI - GM13 Standard Specification*

Standard Specification for

"Test Methods, Test Properties and Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes" SM

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

*This GRI standard specification is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version and it is kept current on the Institute's Website <<geosynthetic-institute.org>>.

values for test indicated, may be necessary under conditions of a particular application.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1603 Test Method for Carbon Black in Olefin Plastics
D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397 Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6370 Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
D 7466 Test Method for Measuring the Asperity Height of Textured Geomembranes
D 8117 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by Differential Scanning Calorimetry

2.2 GRI Standards

GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet

2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

Nominal - Representative value of a measurable property determined under a set of conditions, by which a product may be described. Abbreviated as nom. in Tables 1 and 2.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet (see Note 6)

Note 6: The minimum average value of asperity height does not represent an expected value of interface shear strength. Shear strength associated with geomembranes is both site-specific and product-specific and should be determined by direct shear testing using ASTM D5321/ASTM D6243 as prescribed. This testing should be included in the particular site's CQA conformance testing protocol for the geosynthetic materials involved, or formally waived by the Design Engineer, with concurrence from the Owner prior to the deployment of the geosynthetic materials.

Note 7: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 8: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.) - mils	D5199	nom.	nom.	nom.	nom.	nom.	nom.	nom.	per roll
• lowest individual of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	200,000 lb
Tensile Properties *(1)* (min. ave.)	D 6693								20,000 lb
• yield strength - lb/in.	Type IV	63	84	105	126	168	210	252	
• break strength - lb/in.		114	152	190	228	304	380	456	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		700	700	700	700	700	700	700	
Tear Resistance (min. ave.) - lb	D 1004	21	28	35	42	56	70	84	45,000 lb
Puncture Resistance (min. ave.) - lb	D 4833	54	72	90	108	144	180	216	45,000 lb
Stress Crack Resistance *(2)* - hr.	D5397 (App.)	500	500	500	500	500	500	500	per GRI-GM10
Carbon Black Content (range) - %	D 4218 *(3)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)*									200,000 lb
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(5), (6)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(7)*	D 7238								
(a) Standard OIT (min. ave.)	D 8117	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50	50	50	50	50	50	50	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC) UNITS

Table 1(b) – High Density Polyethylene (HPDE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness - (min. ave.) - mm	D5199	nom.	nom.	nom.	nom.	nom.	nom.	nom.	per roll
• lowest individual of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	90,000 kg
Tensile Properties *(1)* (min. ave.)	D 6693								9,000 kg
• yield strength - kN/m	Type IV	11	15	18	22	29	37	44	
• break strength - kN/m		20	27	33	40	53	67	80	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		700	700	700	700	700	700	700	
Tear Resistance (min. ave.) - N	D 1004	93	125	156	187	249	311	374	20,000 kg
Puncture Resistance (min. ave.) - N	D 4833	240	320	400	480	640	800	960	20,000 kg
Stress Crack Resistance *(2)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM-10
Carbon Black Content (range) - %	D 4218 *(3)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	9,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)*									90,000 kg
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(5), (6)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(7)*	D 7238								
(a) Standard OIT (min. ave.)	D 8117	N. R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50	50	50	50	50	50	50	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) - mils	D 5994	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	per roll
• lowest individual for 8 out of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
• lowest individual for any of the 10 values - %		-15	-15	-15	-15	-15	-15	-15	
Asperity Height mils (min. ave.) - mils	D 7466	16	16	16	16	16	16	16	every 2nd roll *(1)*
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	200,000 lb
Tensile Properties (min. ave.) *(2)*	D 6693								20,000 lb
• yield strength - lb/in.	Type IV	63	84	105	126	168	210	252	
• break strength - lb/in.		45	60	75	90	120	150	180	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		100	100	100	100	100	100	100	
Tear Resistance (min. ave.) - lb	D 1004	21	28	35	42	56	70	84	45,000 lb
Puncture Resistance (min. ave.) - lb	D 4833	45	60	75	90	120	150	180	45,000 lb
Stress Crack Resistance *(3)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM10
Carbon Black Content (range) - %	D 4218 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	20,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(6)*									200,000 lb
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(6), (7)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(8)*	D 7238								
(a) Standard OIT (min. ave.)	D 8117	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 5885	50	50	50	50	50	50	50	

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

(3) SP-NCTL per ASTM D5397 Appendix, is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC UNITS)

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness (min. ave.) - mm	D 5994	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	per roll
• lowest individual for 8 out of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
• lowest individual for any of the 10 values - %		-15	-15	-15	-15	-15	-15	-15	
Asperity Height mils (min. ave.) - mm	D 7466	0.40	0.40	0.40	0.40	0.40	0.40	0.40	every 2nd roll *(1)*
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	90,000 kg
Tensile Properties (min. ave.) *(2)*	D 6693								9,000 kg
• yield strength - kN/m	Type IV	11	15	18	22	29	37	44	
• break strength - kN/m		8	10	13	16	21	26	32	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		100	100	100	100	100	100	100	
Tear Resistance (min. ave.) - N	D 1004	93	125	156	187	249	311	374	20,000 kg
Puncture Resistance (min. ave.) - N	D 4833	200	267	333	400	534	667	800	20,000 kg
Stress Crack Resistance *(3)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM10
Carbon Black Content (range) - %	D 4218 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	9,000 kg
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(6)*									90,000 kg
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(6), (7)*	D 5721								per each formulation
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(8)*	D 7238								per each formulation
(a) Standard OIT (min. ave.)	D 8117	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 5885	50	50	50	50	50	50	50	

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(3) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Adoption and Revision Schedule
for
HDPE Specification per GRI-GM13

"Test Methods, Test Properties, Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.
Revision 7:	February 20, 2006: Added Note 6 on Asperity Height clarification with respect to shear strength.
Revision 8:	Removed recommended warranty from specification.
Revision 9:	June 1, 2009: Replaced GRI-GM12 test for asperity height of textured geomembranes with ASTM D 7466.
Revision 10	April 11, 2011: Added alternative carbon black content test methods
Revision 11	December 13, 2012: Replaced GRI-GM11 with the equivalent ASTM D 7238.
Revision 12	November 14, 2014: Increased minimum acceptable stress crack resistance time from 300 to 500 hours. Also, increased asperity height of textured sheet from 10 to 16 mils (0.25 to 0.40 mm).
Revision 13	November 4, 2015: Removed Footnote (1) on asperity height from tables.
Revision 14	January 6, 2016: Removed Trouser Tear from Note 5.
Revision 15:	September 9, 2019: Editorial update to harmonize tables.
Revision 16:	March 17, 2021: Updated Standard OIT Test from ASTM D3895 to D8117

Submittal Transmittal Form

DATE: May 3, 2021 GHD PROJECT NO.: 088877

PROJECT NAME: Northwin Landfill Phase 1 East CONTRACT NO.:

CONTRACTOR: Upland Contracting Ltd.

Certification By Contractor:

I hereby represent that I have satisfied CONTRACTOR's obligations under the Contract Documents including but not limited to review and approval, verification of products required, field dimensions, adjacent construction work, and coordination of information with respect to CONTRACTOR's review and approval of that submittal.	Contractor's Signature or Stamp

Contractor Submittal No.: 002

GHD Submittal No.: 002

Spec Section No./Drawing No.:

Page No.	Item No.	Description
		Perforated HDPE Pipe

Submittal Type:

- ☐ A - Test Results and/or Certificates
- ☒ B - Manufacturer's Literature or Data
- ☐ C - Shop Drawings
- ☐ D - Operation & Maintenance Instructions
- ☐ E - Samples
- ☐ F - Alternative Product Supporting Data
- ☐ G - Administrative (Schedules, etc.)

Notes:

Review Comments:

SUBMITTAL REVIEW

GHD Submittal No. **002**
Contractor Submittal No.
Contract No.

ENGINEER's review is for the sole purpose of ascertaining conformance with general design concepts expressed in the Contract Documents and in no way constitutes approval of the detail design inherent in CONTRACTOR's Submittal responsibility for which remains solely with CONTRACTOR submitting same. Review does not authorize changes to Contract Documents.

- [x] Reviewed
- [ ] Reviewed as Noted
- [ ] Revise and Resubmit
- [ ] Not Subject to Review
- [ ] Other

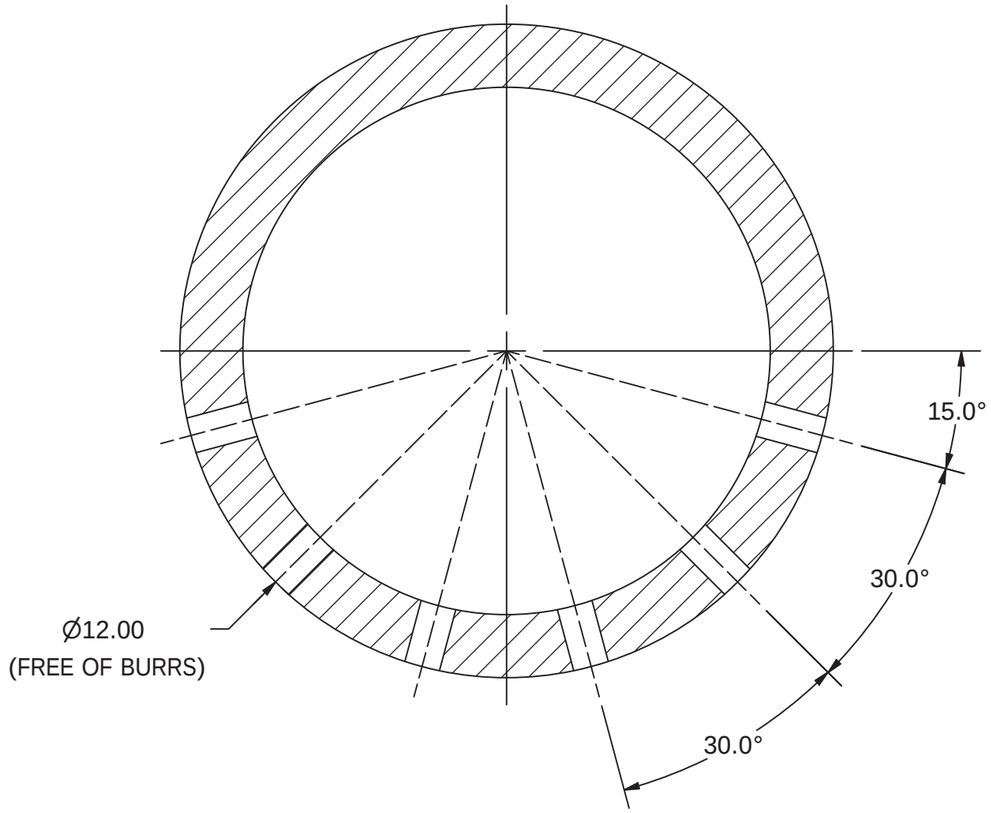
Name: **David Barbour**

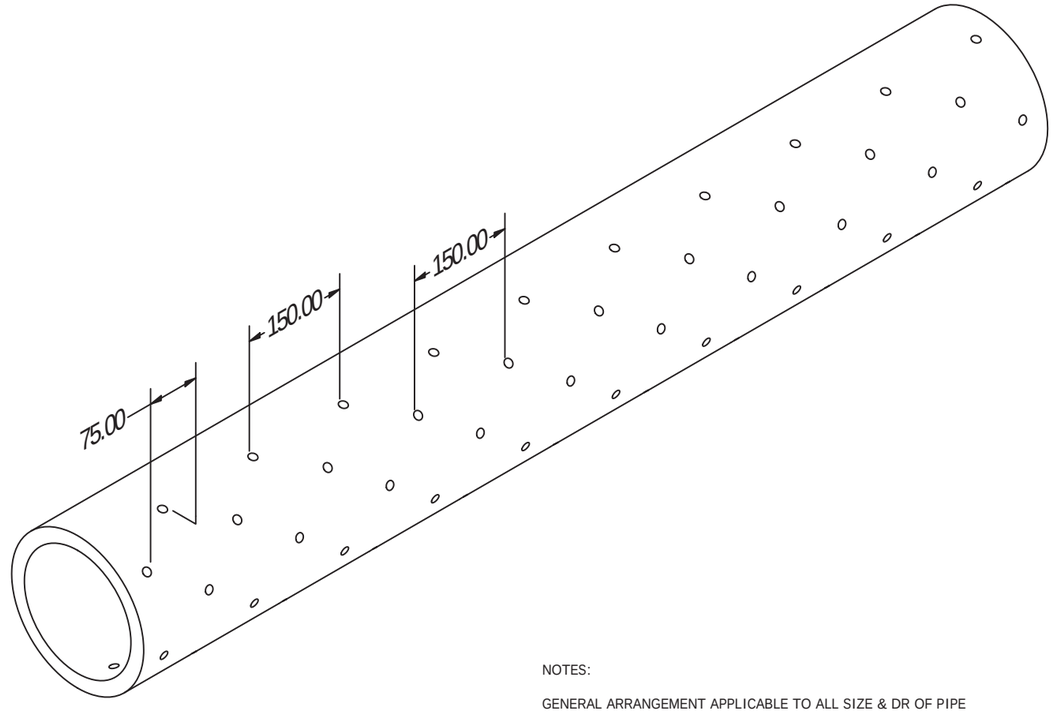
Signed: D Barbour

Date: **May 3, 2021**

REVIEWED BY:

REVIEWED BY: David Barbour





NOTES:

GENERAL ARRANGEMENT APPLICABLE TO ALL SIZE & DR OF PIPE

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED

SHIPPING:
PARTIALLY ASSEMBLED BEFORE SHIPMENT TO SITE. INSTALLATION ON SITE BY OTHERS

DISCLAIMER:
ALL DIMENSIONS APPROXIMATE, SUBJECT TO CHANGE WITHOUT NOTICE
ANGLE TOLERANCE IS ±2° @ 23°C
ALL OTHER DIMENSIONS TO ±25mm" @ 23°C
THIS DRAWING IS ONLY APPLICABLE IF A SIGNED COPY IS REFERENCED AT TIME OF ORDER
SUBJECT TO ICONIX WATERWORKS STANDARD TERMS AND CONDITION

ICONIX waterworks

		DESCRIPTION: Peferated HDPE Pipe General Arrangment
QUOTE#:	SO#:	PROJECT: Campbell River Land Fill
SCALE:NTS	SHEET 1 OF 1	
DRAWING NO:		REV: 0

Submittal Transmittal Form

DATE: May 6, 2021 GHD PROJECT NO.: 088877

PROJECT NAME: Northwin Landfill Phase 1 East CONTRACT NO.:

CONTRACTOR: Upland Contracting Ltd.

Certification By Contractor:

I hereby represent that I have satisfied CONTRACTOR's obligations under the Contract Documents including but not limited to review and approval, verification of products required, field dimensions, adjacent construction work, and coordination of information with respect to CONTRACTOR's review and approval of that submittal.	Contractor's Signature or Stamp

Contractor Submittal No.: 003

GHD Submittal No.: 003

Spec Section No./Drawing No.:

Page No.	Item No.	Description
		WovenSpec

Submittal Type:

- ☐ A - Test Results and/or Certificates
- ☒ B - Manufacturer's Literature or Data
- ☐ C - Shop Drawings
- ☐ D - Operation & Maintenance Instructions
- ☐ E - Samples
- ☐ F - Alternative Product Supporting Data
- ☐ G - Administrative (Schedules, etc.)

Notes:

Review Comments:

SUBMITTAL REVIEW

GHD Submittal No. **003**
Contractor Submittal No.
Contract No.

ENGINEER's review is for the sole purpose of ascertaining conformance with general design concepts expressed in the Contract Documents and in no way constitutes approval of the detail design inherent in CONTRACTOR's Submittal responsibility for which remains solely with CONTRACTOR submitting same. Review does not authorize changes to Contract Documents.

- [x] Reviewed
- [ ] Reviewed as Noted
- [ ] Revise and Resubmit
- [ ] Not Subject to Review
- [ ] Other

Name: **David Barbour**

Signed: D Barbour

Date: **May 6, 2021**

REVIEWED BY:

REVIEWED BY: David Barbour

US 800-277-8298
CAN 866-567-7112

Woven Geotextiles

1. Product Description

Standard woven slit-film polypropylene geotextiles, usually called "wovens" are an economical range of geotextiles that combine high strength with low cost. These materials are made by weaving pre-stressed polypropylene tapes in a simple weave pattern. The resulting fabric has a high strength to weight ratio. Slit-film wovens are primarily used in roadbuilding and embankment construction but can be used in most applications requiring the separation of one type of soil from another. Slit-film wovens help to speed construction with short term reinforcement of the base. Slit film wovens can also be used in sediment control products such as floating silt curtains and silt fence.

2. Technical Data

Materials information is on page 2.

3. Installation

General Installation: Place the roll of woven geotextile at the top of the slope/grade and roll down grade, over lap successive and adjacent rolls by 450mm minimum. Do not allow vehicles to drive directly on the geotextile. Geotextile should be stored such that it is protected from rain and direct sunlight. Geotexile Separation: Ensure subgrade is rolled flat and compacted to engineer's specifications with no sharp objects or protrusions. Install geotextile as per General Installation above.

4. Availability and Cost

Available from Layfield or distributors. Call
425-254-1075 Pacific time
780-453-6731 Mountain time, or
905-761-9123 Eastern time

5. Manufactured For

Layfield USA Corp.
Layfield Canada Ltd.

6. Warranty

Products sold will meet Layfield's published specifications at time of sale. Full warranty details are available from Layfield.

7. Maintenance

Once geotextiles and geogrids are installed and carefully backfilled they do not require ongoing maintenance.

8. Filing Systems

https://www.layfieldgroup.com/Geosynthetics/Geotext-Products/Woven-Geotextiles.aspx

9.

25 Oct. 2011	Woven Geotextiles - US Values[1]			
	ASTM	**LP 200**	**LP 250**	**LP 315**
Grab Tensile (lbs)	D4632	200	250	315
Elongation (%)	D4632	15	15	15
Trapezoid Tear (lbs)	D4533	75	90	120
CBR Puncture Strength (lbs)	D6241	700	900	1000
AOS (sieve size)	D4751	40	40	40
Permittivity (sec^{-1})	D4491	0.05	0.05	0.05
Weight (oz/yd^2) (Typical)	D5261	4.0	5.0	6.3
UV Resistance (500 hrs)	D4355	70	70	70
Roll Size (ft) Typical)		15 x 360 17.5 x 309	15 x 360 17.5 x 309	15 x 300 17.5 x 258
Roll Weight (lbs) (Typical)		205	215	220
Note[1] - The physical properties presented in the table above are Minimum Average Roll Values or otherwise indicated.				

10.

25 Oct 2011	Woven Geotextiles - Metric Values[1]			
	ASTM	**LP 200**	**LP 250**	**LP 315**
Grab Tensile (N)	D4632	889	1110	1400
Elongation (%)	D4632	15	15	15
Trapezoid Tear (N)	D4533	333	400	533
CBR Puncture Strength (N)	D6241	3120	4005	4450
AOS (Microns)	D4751	425	425	425
Permittivity (sec^{-1})	D4491	0.05	0.05	0.05
Weight (g/m^2) (Typical)	D5261	136	170	214
UV Resistance (500 hrs)	D4355	70	70	70
Roll Size (m) (Typical)		4.6 x 110 5.3 x 94	4.6 x 110 5.3 x 94	4.6 x 91 5.3 x 79
Roll Weight (kg) (Typical)		92	97.5	100
Note[1] - The physical properties provided in the table above are Minimum Average Roll Values or otherwise indicated.				

WE PROTECT
www.LayfieldConstructionProducts.com
customerservice@layfieldconstructionproducts.com