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Our ref: 044985

March 02, 2022

Mr. Michael Parker
Vice-President, Canadian Environmental Compliance
Clean Harbors Canada Inc.
4090 Telfer Road
Rural Route #1
Corunna, ON N0N 1G0

Response to Geotechnical Peer Review and Updated Assessment – Cell 20-1 Slope Issue
Clean Harbors Lambton Landfill Site

Dear Mr. Parker

1.0 General

The purpose of this letter is to provide responses to the comments contained in the Thurber Engineering Ltd. letter dated February 2, 2022 and titled "Geotechnical Peer Review, GHD Response Letter of January 28, 2022, Cell 20-1 Slope Stability Issues, Clean Harbors Lambton Landfill Facility, Corunna, Ontario.

Table 1.1 provides the Thurber's comments and GHD responses to these comments. This letter also presents the results of updated slope stability modelling, based on the Thurber comments presented in the above referenced letter, and the laboratory test results for a sample collected of the cement kiln dust (CKD) waste product that will be used for additional buttress construction. The results of the first round of survey data for the survey pins is also presented and discussed below, as well as recommendations for ongoing monitoring of Cell 20-1 excavation slopes.

2.0 Updated Assessment and Discussion of Results

Thurber provided four comments/questions to be responded to in their February 2 letter. The responses and further data requested are presented in the following:

- Figures 1, 2, and 3 – Updated modelling for the North, East, and South slopes.
- Figures 4, 5, and 6- modelling of the same slopes, showing colour shading for the factors of safety (FS) for various potential slip surfaces generated by the model.
- Laboratory Proctor and gradation results for a sample of the CKD waste product collected on February 16, 2022
- Figure 7- Updated Vibrating Wire Piezometric Data
- Figure 8- Cell 20-1 site plan showing all survey points (existing and proposed)
- Table 2.1- initial survey data collected November 30, 2021, and subsequent February 8, 2022 survey.

The updated models were produced using the SEEP/W module of the Geostudio software. This module allows for more precise modelling of the predicted stabilized piezometric surface after completion of excavation, using the updated piezometric data collected from the vibrating wire piezometers at VWP-1 and VWP-2 (presented on Figure 7), and hydraulic permeability estimates for the subsurface units. The FS for the North, East, and South slopes is shown on Figures 1, 2, and 3. GHD and Thurber have agreed that a minimum FS of 1.3 should be targeted for the exposed slopes. The models indicate the following remedial measures are required to meet a minimum FS of 1.3:

- The North and South slopes require additional buttressing with either CKD material or clay to achieve an FS of 1.3. The dimensions and elevations of the required buttressing are shown on Figures 1 and 3.
- The East slope requires raising the water level (flooding) in the base of Cell 20-1 to improve the FS to 1.3. The target water level is 185.3 m asl.

Clean Harbors will be implementing these measures as soon as practically feasible. Placement of additional buttress material will be done with rock trucks, and requires dry subgrade conditions to allow the trucks to get in and out of the Cell safely.

Figures 4, 5, and 6 show additional colour banding for the FS calculated by the model. The colour banding shows ranges for the FS for numerous potential slip surfaces. As can be seen on these figures, the FS increases above the minimum target of 1.3 for deeper slip surfaces.

Thurber suggested that the assumed unit weight value for the available CKD product on site may have been too high in the previous modelling. GHD collected a sample of the CKD product on February 16, and carried out a Proctor and gradation analyses in our Waterloo laboratory. The results of these tests are attached. The maximum dry density for the Proctor test of the CKD sample is 1664 kg/m^3 at 18.6 percent moisture. Assuming a compaction effort of about 92 percent with the rock trucks and dozer equipment, the bulk density of the placed product would be approximately 1820 kg/m^3, which is equivalent to a unit weight of about 18 kN/m^3. This unit weight value has been used in the new models.

Table 2.1 presents the initial survey pin measurements from November 30, 2021, and the measurements collected on February 8, 2022. No significant movements of the survey pins have occurred. However, three of the survey pins have been buried or detroyed. Figure 8 presents the existing and recommended additional survey pin locations. Clean Harbors will have the additional pins installed as soon as practical.

3.0 Recommendations for Future Monitoring

Based on the visual observations to date, survey results, and slope stability modelling, the slopes of Cell 20-1 are considered to be stable in their current state. Clean Harbors will proceed with the recommended buttress construction and flooding of the bottom of the Cell as soon as weather and ground conditions allow this work to be carried out safely. The following recommendations are provided to monitor the ongoing stability of the exposed slopes:

- The new survey pins as shown on Figure 8 should be installed in March. The survey pins should be measured monthly. GHD will review and summarize the data collected.
- The vibrating wire piezometric data should be collected on a quarterly basis. The data will be downloaded from the data loggers in April or May, and then again in the late summer and fall.
- The Geotechnical Engineer will visit the site and conduct a visual inspection of the exposed slopes on a quarterly basis, starting in April or May. These visual inspections will be continued until waste placement has reached an elevation where the exposed slopes are no longer a stability concern (FS greater than 1.5, estimated based on the modelling presented in this letter, approximately when the waste level has reached the upper bench of 190 m asl), confirmed by visual and survey pin monitoring.
- The results of the inspection and data collection will be summarized in Clean Harbor's annual report.

- The VWPs will be decommissioned when the exposed slopes are no longer a stability concern. Decommissioning will consist of removing the data loggers, as these VWPs were installed in fully grouted boreholes.

Regards

March 2, 2022

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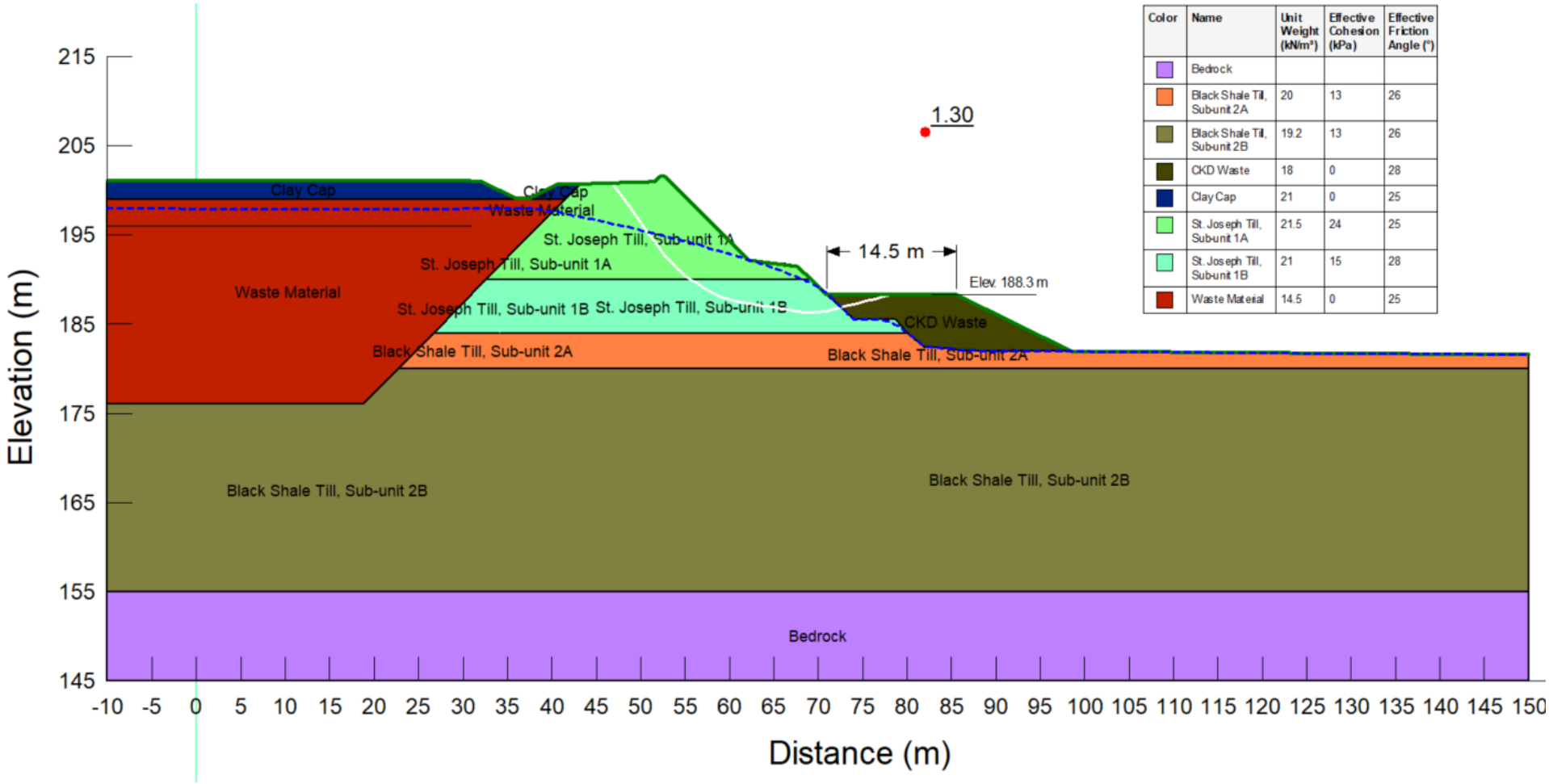
Encl. Figures 1 to 8
Table 1.1 and 2.1
Attachment 1 – CKD Proctor and Gradation Lab Results

Figure 1

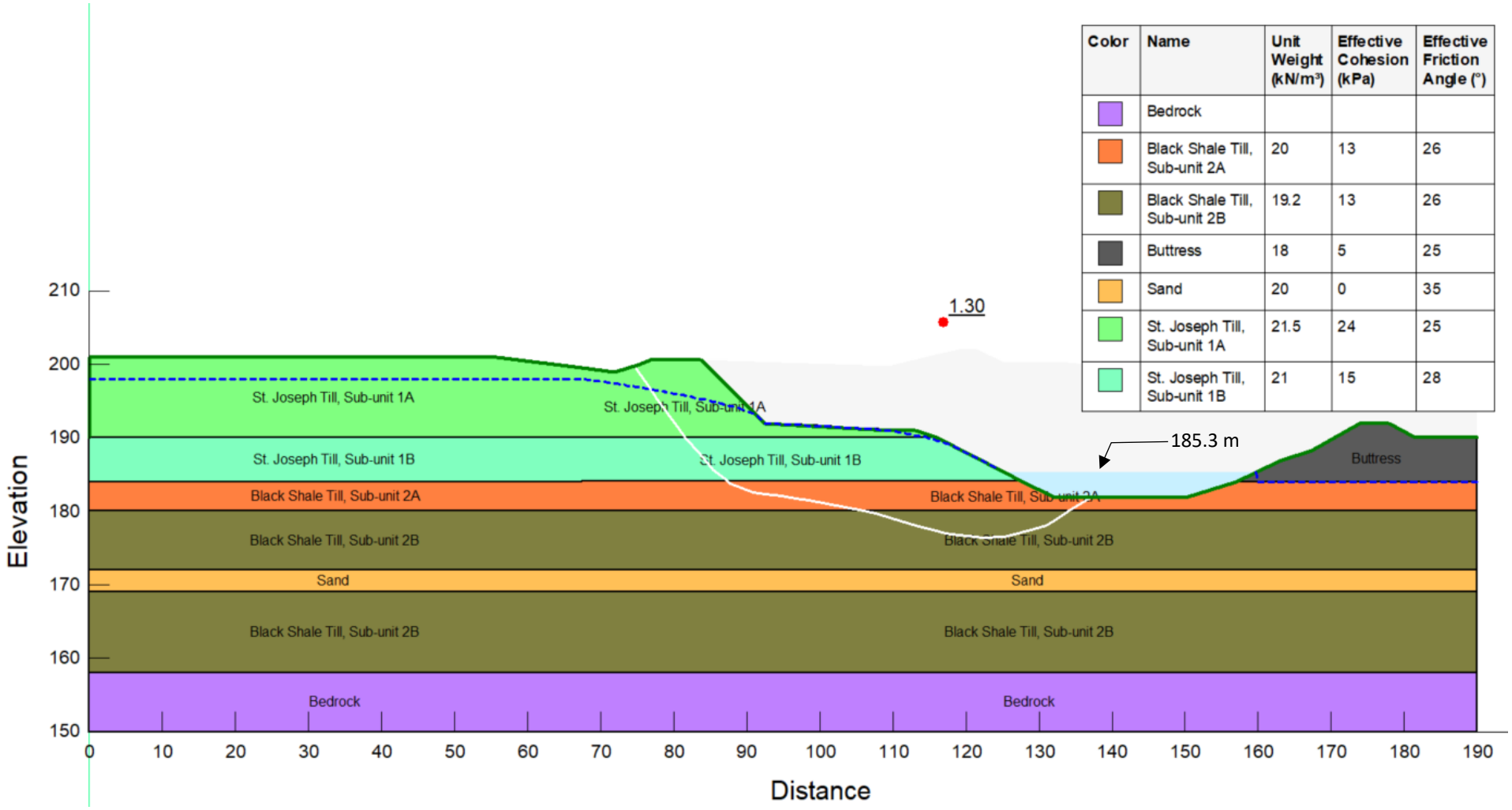
North Slope with CKD Buttress



Client :	Clean Harbors Canada Inc.	
Project :	Cell 20-1 Slope Issues	
Reference :	044985	
Location :	North Slope	
Analysis :	Static Drained	F.S : 1.30

Figure 2

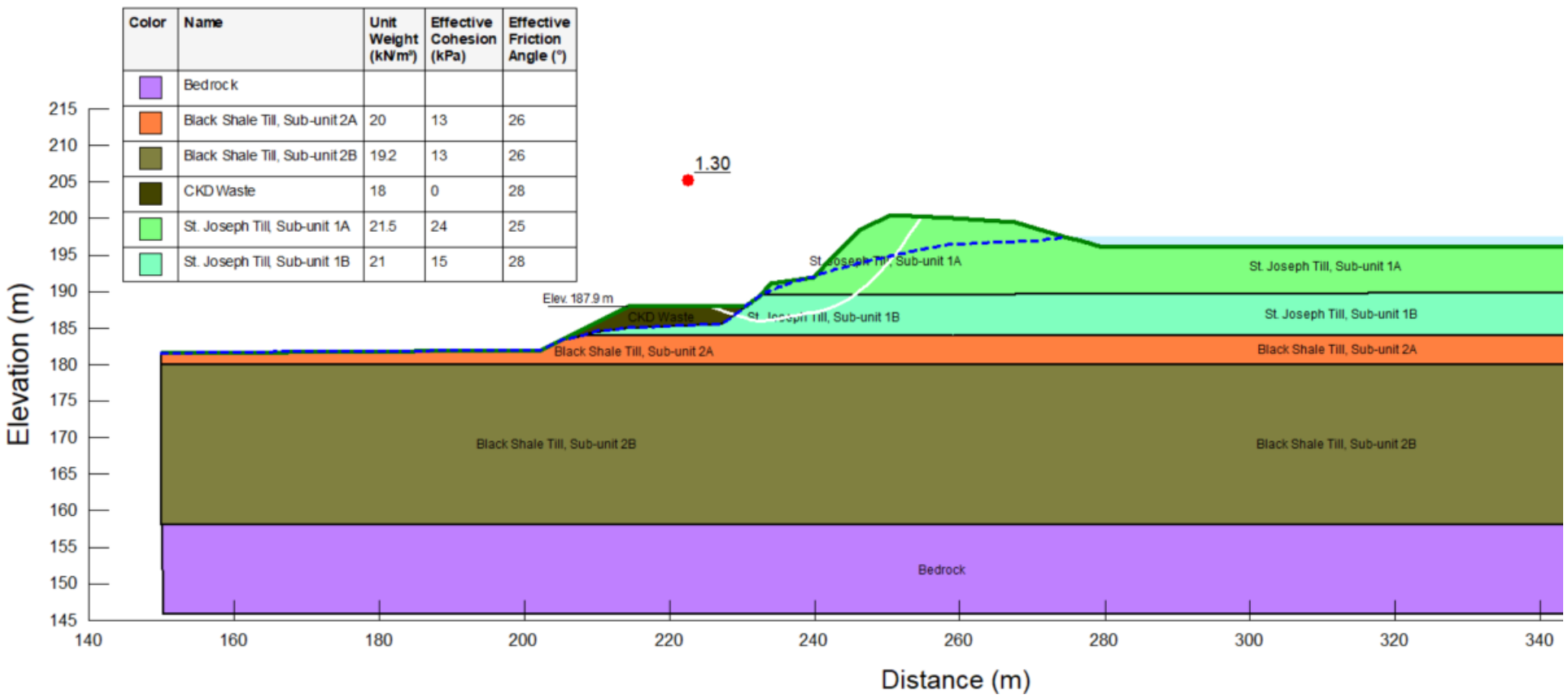
East Slope-Flooded Conditions



Client :	Clean Harbors Canada Inc.	
Project :	Cell 20-1 Slope Issues	
Reference :	044985	
Location :	East Slope	
Analysis :	Static Drained	F.S : 1.30

Figure 3

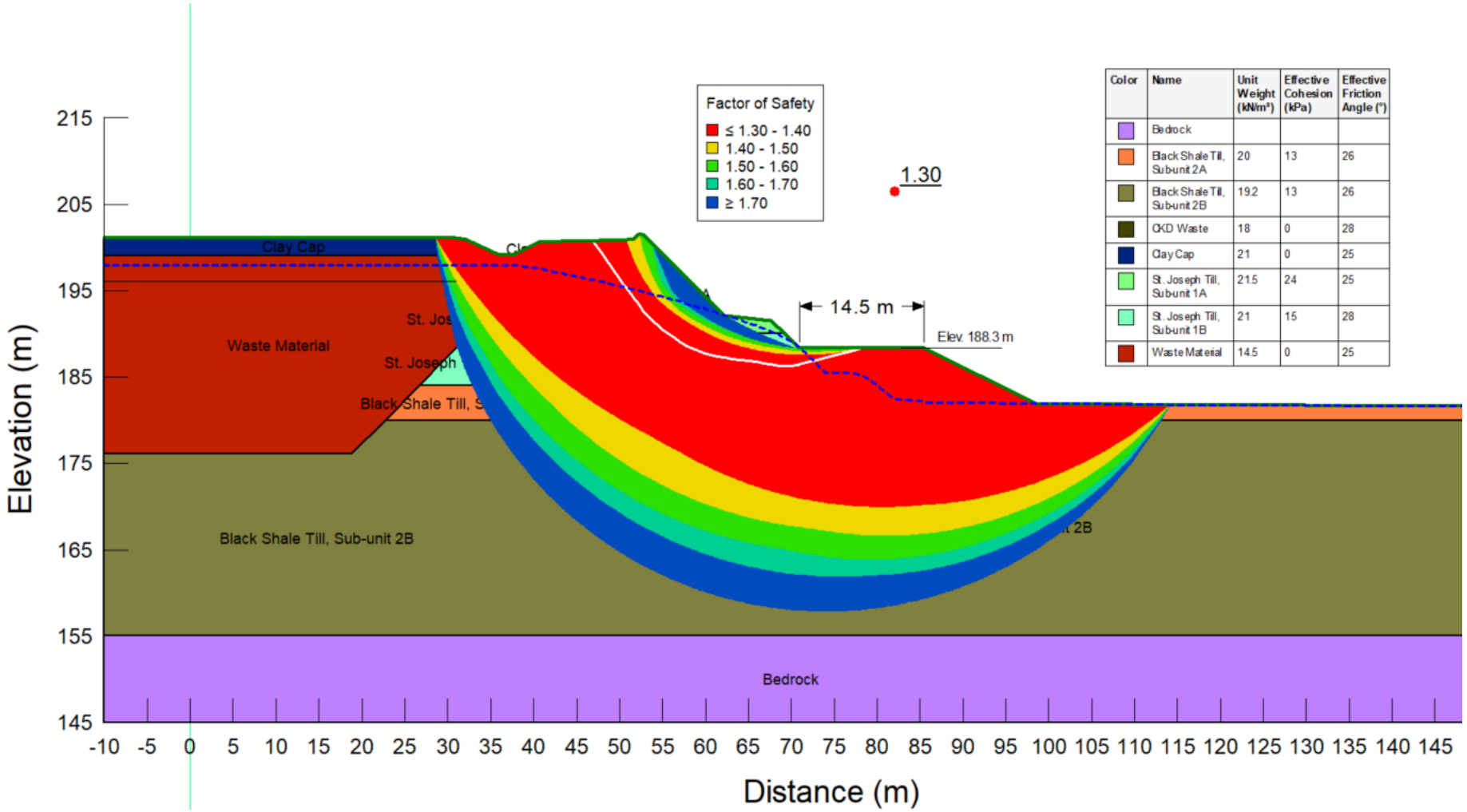
South Slope with CKD Buttress



Client :	Clean Harbors Canada Inc.	
Project :	Cell 20-1 Slope Issues	
Reference :	044985	
Location :	South Slope	
Analysis :	Static Drained	F.S : 1.30

Figure 4

FS Banding- North Slope with CKD Buttress

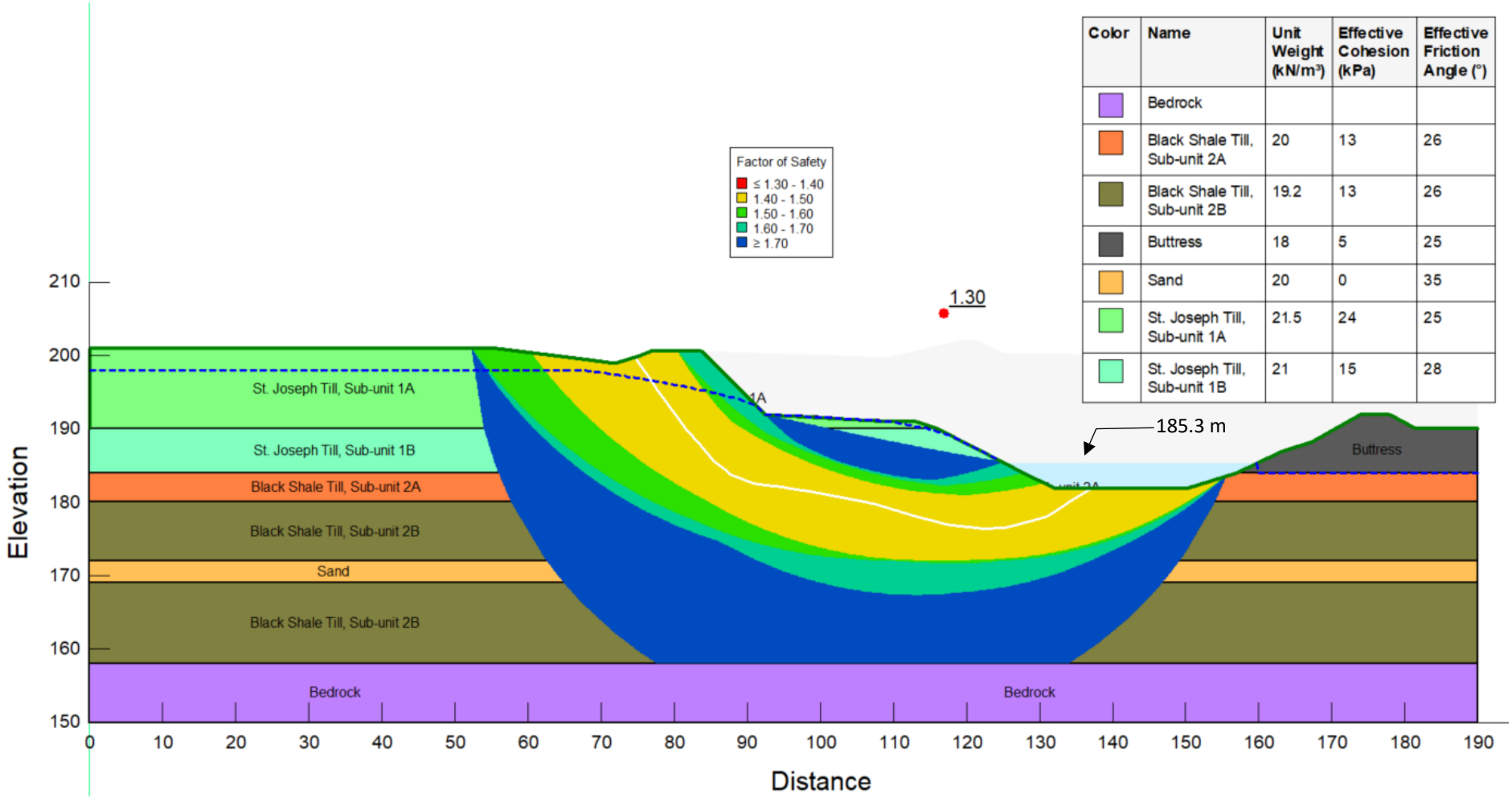


Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock			
	Black Shale Till, Sub-unit 2A	20	13	26
	Black Shale Till, Sub-unit 2B	19.2	13	26
	CKD Waste	18	0	28
	Clay Cap	21	0	25
	St. Joseph Till, Sub-unit 1A	21.5	24	25
	St. Joseph Till, Sub-unit 1B	21	15	28
	Waste Material	14.5	0	25

Client :	Clean Harbors Canada Inc.	
Project :	Cell 20-1 Slope Issues	
Reference :	044985	
Location :	North Slope	
Analysis :	Static Drained	F.S : 1.30

Figure 5

FS Banding- East Slope-Flooded Conditions

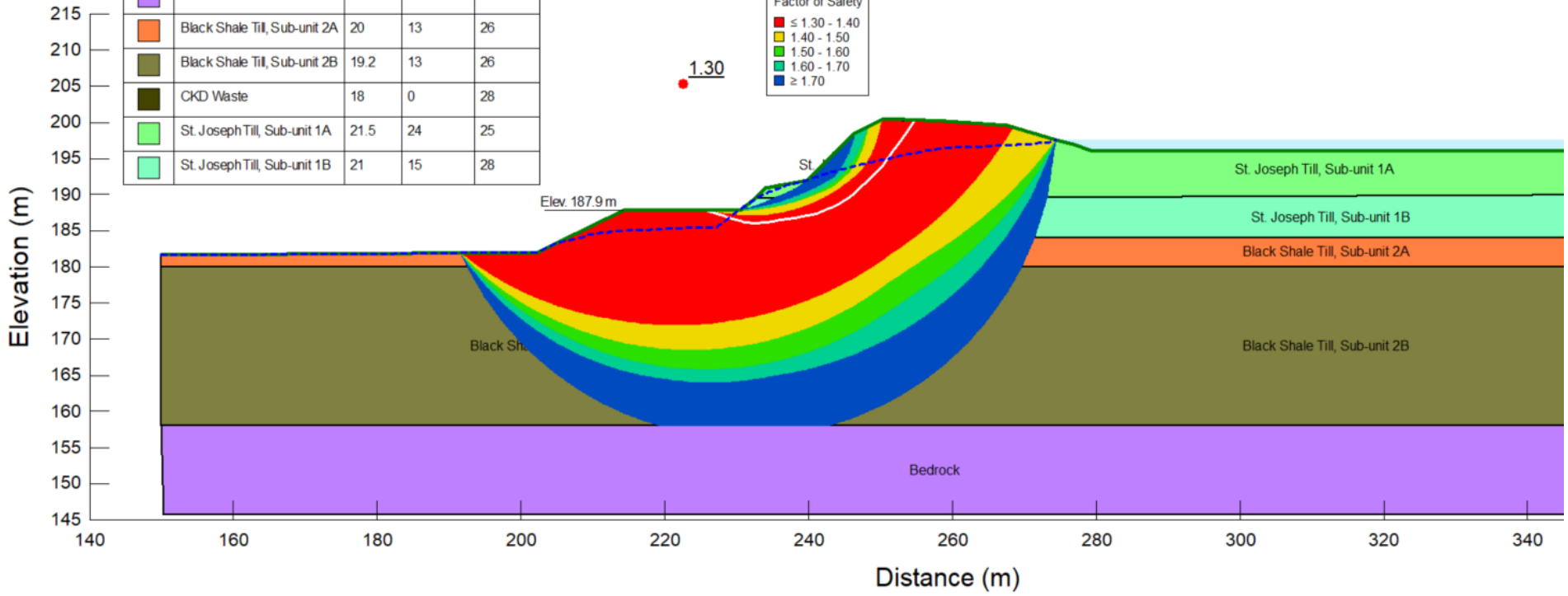


Client :	Clean Harbors Canada Inc.	
Project :	Cell 20-1 Slope Issues	
Reference :	044985	
Location :	East Slope	
Analysis :	Static Drained	F.S : 1.30

Figure 6

FS Banding- South Slope with CKD Buttress

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock			
	Black Shale Till, Sub-unit 2A	20	13	26
	Black Shale Till, Sub-unit 2B	19.2	13	26
	CKD Waste	18	0	28
	St. Joseph Till, Sub-unit 1A	21.5	24	25
	St. Joseph Till, Sub-unit 1B	21	15	28



Client :	Clean Harbors Canada Inc.	
Project :	Cell 20-1 Slope Issues	
Reference :	044985	
Location :	South Slope	
Analysis :	Static Drained	F.S : 1.30

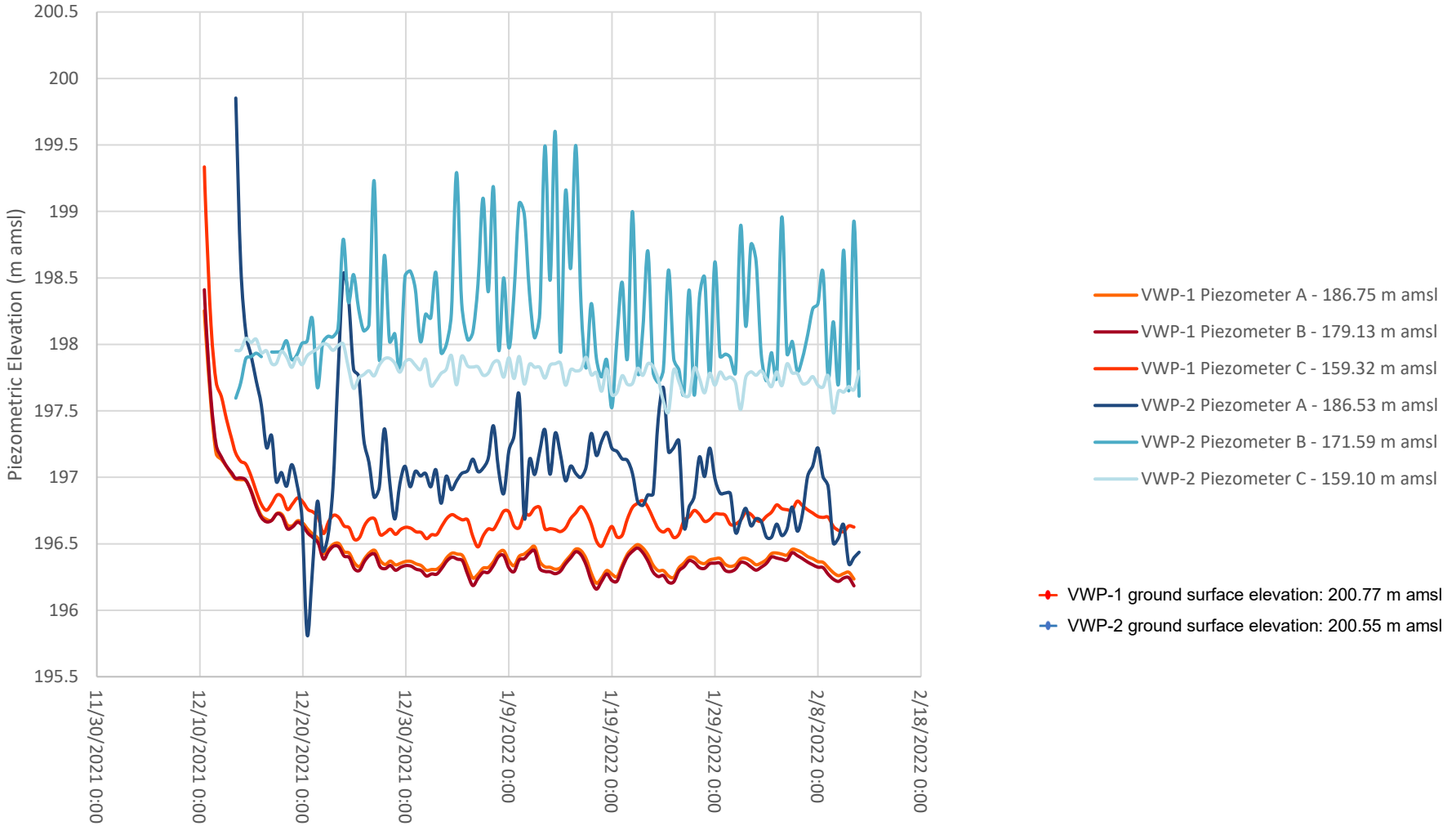


Figure 7 - Vibrating Wire Piezometric Elevation Readings
Cell 20-1 - Clean Harbors Lambton Facility, Corunna, Ontario

LEGEND

CPT-1	CPT - CONE PENETRATION TEST
VWP-01	VWP - VIBRATING WIRE PIEZOMETER
BH1-20 201.56	BH1-20 BOREHOLE (GHD, OCTOBER 2020)
SP1	SP - SURVEY PIN

SOURCE

AERIAL DRONE PHOTO COMPLETED BY GHD OCTOBER 13, 2021

0 10 20 30m

SCALE 1:1000

GHD

CLEAN HARBORS CANADA, INC.
LAMBTON COUNTY, ONTARIO

SURVEY PIN LOCATIONS

Project No. **44985**
Date **March 1, 2022**

Figure 8

Filename: P:\drawings\44000s\44985\44985-LTR\44985-00(LTR015)\44985-00(LTR015)CI-WA002.DWG
Plot Date: 26 January 2022 10:09 PM

Table 1.1
Comment and Response Table – Thurber Peer Review of GHD Response Letter – January 28, 2022
Clean Harbors Lambton Facility – Cell 20-1 Assessment

Identification Number	Peer Review Comment	Response
Section 1 1st Bullet	Instead of modelling the hydrostatic pressure through the permeable zone in the bedrock, GHD has applied it by subdividing the Black Shale Till layer and applying it to the lower subdivision. It is unclear why this was done or how it affects the modelling results, particularly since the Black Shale Till is not a water bearing soil. GHD should provide further description of this aspect of the model.	The updated models were produced using the SEEP/W module of the Geostudio software. This module allows for more precise modelling of the predicted stabilized piezometric surface after completion of excavation, using the updated piezometric data collected from the vibrating wire piezometers at VWP-1 and VWP-2 and hydraulic permeability estimates for the subsurface units.
Section 1 2nd Bullet	GHD should provide figures showing the hydrostatic pressures and pore pressures assumed throughout each modelled area.	Hydrostatic (piezomtric) pressures for each unit were determined using the SEEP/W module.
Section 1 3rd Bullet	Please provide a figure showing the full array of nodes used for modelling each section and the minimum FS calculated for each.	Figures 4, 5, and 6 provides the FS banding for north, east, and south slope models.
Section 1 4th Bullet	In Figure 7, GHD indicates that CKD has a unit weight of 21 kN/m3. Based on our past experience with CKD, this is a very high unit weight. We recommend that this value be confirmed through testing.	A representative sample of CKD was colledcted by GHD and analyzed. The bulk density of the CKD sample was 1820 kg/m^3 and a unit weight of 18 kN/m^3 has been used in the new models.
Section 2 General	In its initial Geotechnical Design Report, GHD identified a minimum Factor of Safety (FS) for slope design should be 1.3. This minimum FS was continued to be utilized by GHD in its two post slope movement reports, GHD Report and GHD Addendum. In its recent response letter, GHD identifies slope FS that are below 1.3 and as low as 1.16. Given the Site history of slope movements, these low FS represent a significant risk that should be mitigated through design and/or monitoring.	The new models show the required buttress stabilization and water flooding to meet the minimum FS of 1.3. These measures will be implemented by Clean Harbors as soon as site conditions allow this work to be completed safely.
Section 2.7, Item 1	We recommend that Clean Harbors develop remedial plans to improve the FS during filling the open landfill cell as soon as possible, given site conditions and weather.	The north and south slopes require additional material to be added at the toe since the critical surface is located above the base of Cell 20-1. The buttress material being proposed is an existing stockpile of CKD material. If there is not sufficient quantity available in the CKD pile, on-site clay material will be used. The material will be installed once conditions at the Site allow for safe access to the bottom of the cell. The eastern portion of Cell 20-1 is proposed to be filled in stages from the south to the north. This will the slopes or sections of the slopes to be filled to a level with waste that will provide a FS of 1.5 or greater.
Section 2.7, Item 2	The proposed slope monitoring program should also be sufficiently robust to detect slope instability for safety and allow for remedial responses, as possible. Particular attention should be given to the potential impacts of the spring thaw, and the implementation of additional monitoring at that time.	The proposed monitoring program is provided in Section 3 of the letter.

Table 2.1

Survey Pin Measurements
Cell 20-1
Clean Harbors Lambton Facility
Corunna, Ontario

Survey Plate/Instrument Location	*November 30, 2021*			*February 8, 2022*						*March 2022 (Pending Survey)*					
	Baseline Readings			*Changes from Baseline Readings*						*Changes from Baseline Readings*					
	Northing	*Easting*	*Top of Stake (masl)*	*Northing*	*Easting*	*Top of Stake (masl)*	*Northing Net Change (m)*	*Easting Net Change (m)*	*Elevation Net Change (m)*	*Northing*	*Easting*	*Top of Stake (masl)*	*Northing Net Change (m)*	*Easting Net Change (m)*	*Elevation Net Change (m)*
SP-1	4747820.703	394229.877	190.208	Buried	Buried	Buried	NA	NA	NA						
SP-2	4747819.805	394205.562	190.133	Buried	Buried	Buried	NA	NA	NA						
SP-3	4747815.917	394159.887	198.189	4747815.873	394159.843	198.263	-0.04	-0.04	0.07						
SP-4	4747848.675	394161.407	198.48	4747848.682	394161.398	198.496	0.01	-0.01	0.02						
SP-5	4747787.792	394162.296	198.471	4747787.782	394162.314	198.452	-0.01	0.02	-0.02						
SP-6	4747710.807	394290.485	200.281	4747710.806	394290.498	200.282	0.00	0.01	0.00						
SP-7	Not Installed	Not Installed	Not Installed	NA	NA	NA	NA	NA	NA						
SP-8	4747814.124	394339.323	200.806	Destroyed	Destroyed	Destroyed	NA	NA	NA						
SP-9	4747905.078	394341.131	200.747	4747905.077	394341.118	200.753	0.00	-0.01	0.01						
SP-10	4747725.921	394336.16	200.518	4747725.917	394336.168	200.517	0.00	0.01	0.00						
SP-11	4747710.489	394198.289	201.124	4747710.516	394198.32	201.159	0.03	0.03	0.03						
SP-12	Not Installed	Not Installed	Not Installed												
SP-13	Not Installed	Not Installed	Not Installed												
SP-14	Not Installed	Not Installed	Not Installed												
SP-15	Not Installed	Not Installed	Not Installed												
SP-16	Not Installed	Not Installed	Not Installed												
SP-17	Not Installed	Not Installed	Not Installed												
SP-18	Not Installed	Not Installed	Not Installed												

Notes:

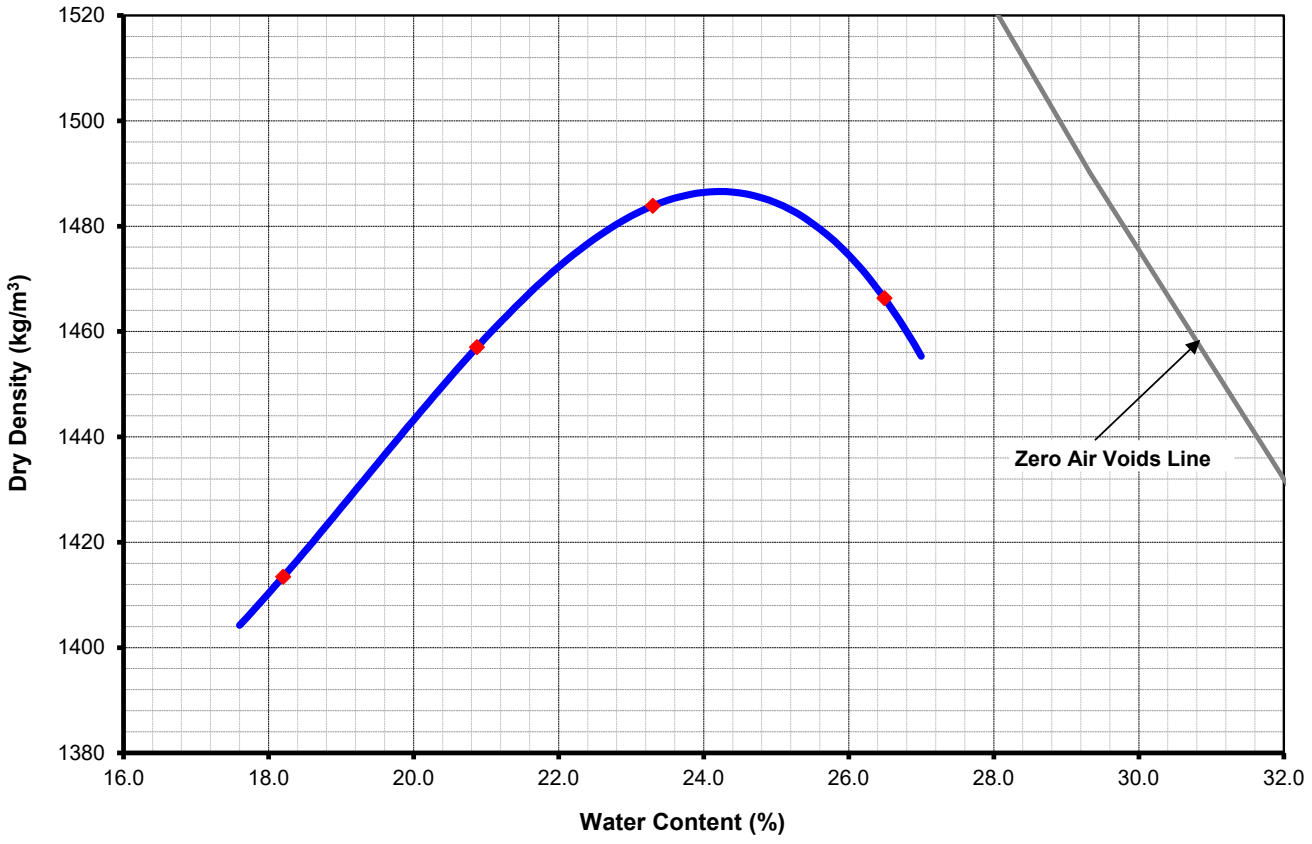
1. Additional Survey Pins SP-7, and SP-12 to SP-18 to be installed in March 2022

Attachment 1

CKD Proctor and Gradation Lab Results

Standard Proctor Test (MTO LS-706)

Client :	Clean Harbors Canada Inc.	**Lab No :**	WLB 1788
Project/Site :	Clean Harbors Lambton Facility 4090 Telfer Road, Corunna, Ontario	**Project No :**	044985-50.6



Prepared Sample:	Dry	x	Moist	--			Assumed G_s:	2.75
LS-706 Test Procedure:	A	x	B	--	C	--	Type of Hammer:	Mechanical
		4.75 mm		9.5 mm		19.0 mm		

Soil Type:	Cement Kiln Dust (CKD)
Material:	--
Proposed Use:	--
Sample Identification:	1
Sample Location:	On-Site Stockpile
Aggregate Supplier / Pit Name:	--
Sample Date:	February 16, 2022
Sampled By:	Mark MacEwen

Max. Dry Density:	**1487**	**kg/m³**
Optimum Moisture:	**24.2**	**%**
% Retained on 4.75 mm:	**23.2**	**%**
Corrected Dry Density:	**1664**	**kg/m³**
Corrected Opt. Moist.:	**18.6**	**%**

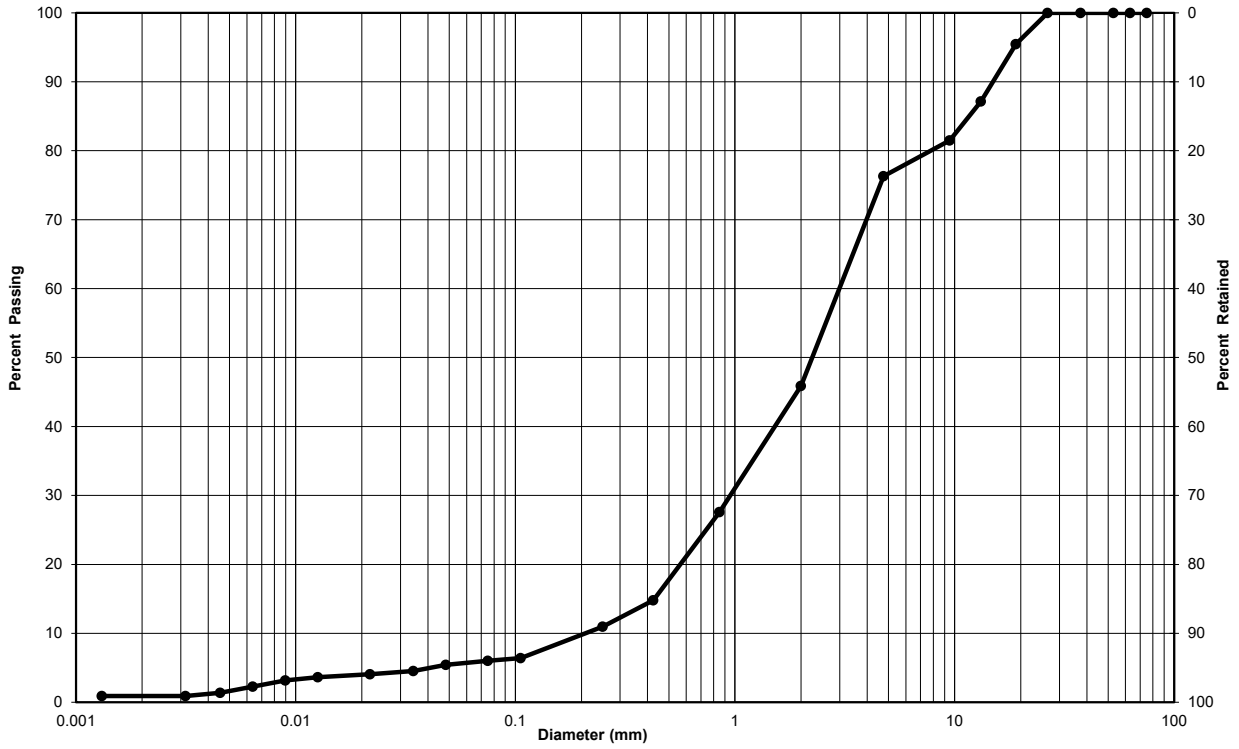
Remarks : **As received moisture = 35.7%**

Performed by :	Akshat Shukla	**Date :**	February 24, 2022
Verified by :	Abdul Hafeez Khan, P.Eng.; Lab. Manager	**Date :**	February 24, 2022

Particle-Size Analysis of Soils
MTO LS-702 (Quality Control)

Client:	Clean Harbors Canada Inc.	**Lab No.:**	WLB 1788
Project, Site:	Clean Harbors Lambton Facility 4090 Telfer Road, Corunna, Ontario	**Project No.:**	044985-50.6

Sample No.:	1	Sampled by:	Mark MacEwen
Proposed use:	--	Date sampled:	February 16, 2022
Location:	On-Site Stockpile	Supplier/Quarry:	CKD Waste Material



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Particle-Size Limits as per USCS (ASTM D-2487)					

Soil Description	Gravel (%)	Sand (%)	Clay & Silt (%)
Cement Kiln Dust Stockpile	24	70	6

Remarks:

Performed by:	Akshat Shukla	**Date:**	February 24, 2022
Verified by:	Abdul Hafeez Khan, P.Eng.; Laboratory Manager	**Date:**	February 24, 2022