Clutha District Council

Project Number: 6-CO082.00

Mt Cooee Landfill Development Plan and Resource Recovery Centre

Geotechnical Factual Report

5 April 2023

wsp

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Document History and Status

Revision	Date	Author	Reviewed by	Approved by	Status
1	20/12/2022	C. Hall & A. Stimpson	N. Taghipouran	C. Fox	DRAFT
2	31/03/2023	A. Stimpson	N. Taghipouran	C. Fox	Final

Revision Details

Revision	Details
1	Draft – Pending Laboratory Testing Results
2	Final

Contents

List of Appendices

Disclaimers and Limitations

This report **('Report')** has been prepared by WSP exclusively for the Clutha District Council **('Client')** in relation to the Mt Cooee Landfill Development Plan and Resource Recovery Centre project. The scope of this report is to present the findings from geotechnical investigation undertaken as part of the project to inform the Development Plan and Resource Recovery Centre for the landfill **('Purpose')** in accordance with the Short Form Agreement dated 11/11/2021. The findings in this Report are based on and subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

In preparing the Report, WSP has relied upon data, surveys, analyses, designs, plans and other information **('Client Data')** provided by or on behalf of the Client. Except as otherwise stated in the Report, WSP has not verified the accuracy or completeness of the Client Data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this Report are based in whole or part on the Client Data, those conclusions are contingent upon the accuracy and completeness of the Client Data. WSP will not be liable in relation to incorrect conclusions or findings in the Report should any Client Data be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

1 Introduction

WSP have been engaged by the Clutha District Council (CDC) provide engineering services for the renewal and development of the Mt Cooee Landfill ('landfill') in Balclutha. The scope of services was presented in the WSP Offer of Service dated 6 August 2021.

As part of the project, WSP undertook deep ground Investigations in October and November 2022 to inform ground and groundwater variability across the site. This report presents a summary of the factual results from these investigations.

2 Site Description

The Mt Cooee Landfill site (the 'site') is situated on the Kaitangata Highway in the outskirts of Balclutha. The site encompasses Lot 1 (4.3 ha) and Lot 2 (11.4 ha) on the property DP 12203 and has a total area of approximately 12.8 hectares. The approximate location of the site relative to Balclutha is shown on Figure 1 below.

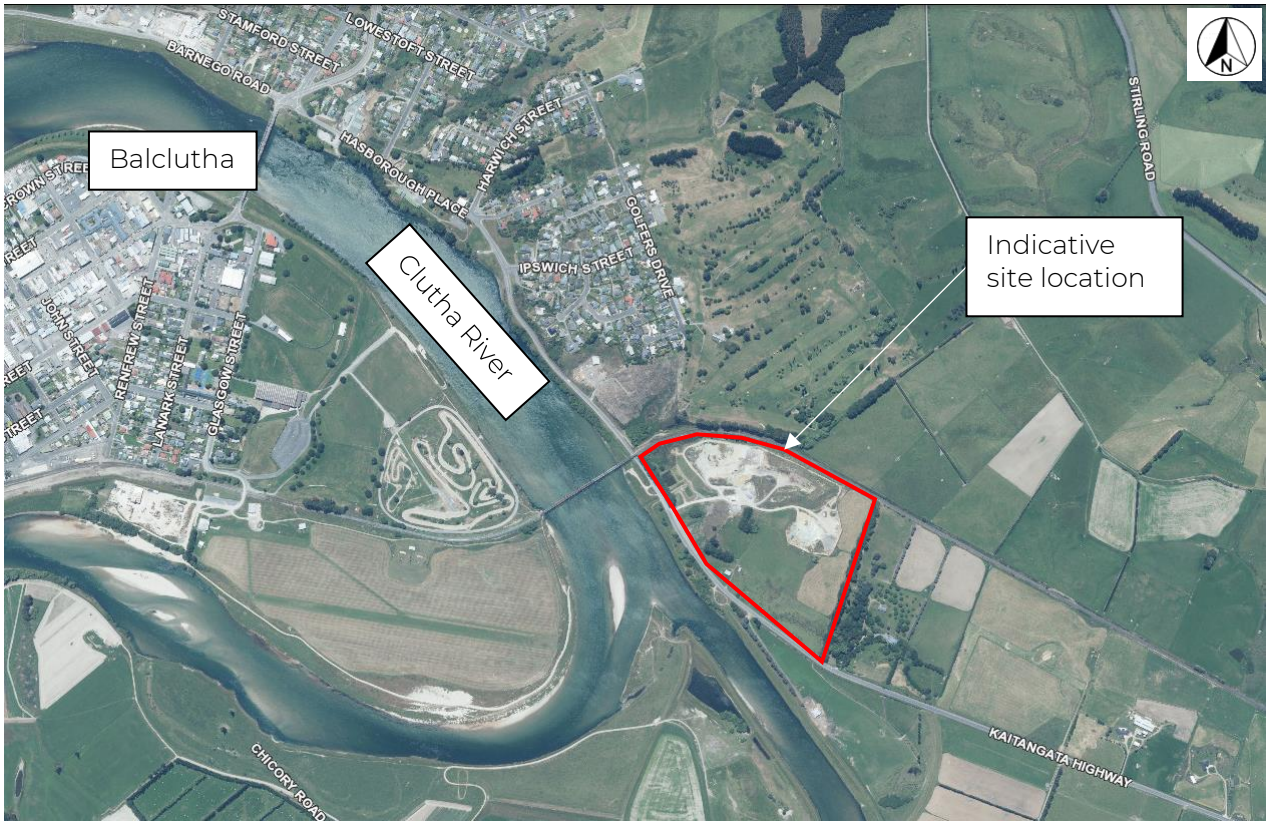


Figure 1: Approximate Location of the Site (Courtesy of the CDC Map Viewer).

The site consists of a gently sloping valley that drops southwest towards the Clutha River. The site is bounded by the Dunedin – Invercargill rail line to the north and the Katitangata Highway to the south. The Highway runs adjacent to the Clutha River. The site adjoins private farmland to the east, from which it is screened by a windbreak of large macrocarpa trees. Access to the site is via a driveway off the Kaitangata Highway.

The area to the east of the site is rural land, with the nearest dwelling roughly 150 m from the site boundary. The Balclutha Golf Course is situated across the rail line to the north of the site.

The landfill has been operating circa 1985 and was originally developed by filling in the shallow valley, commencing from the downstream end and working up the valley. The landfill is currently used for sanitary waste, including municipal waste, contaminants and hazardous waste. The

existing landfill is now nearing closure design level and therefore requires upgrading and reconsenting to continue operation as the main landfill in Balclutha. The proposed expansion area extends to the south and east of the exisitng landfill, to within 15 m of the eastern boundary (refer Appendix A).

3 Geotechnical Investigations

Site-specific ground investigations were undertaken across the site between 11 October and 3 November 2022. The investigation points were spread across the site to assess the nature and variability of the ground conditions and allow groundwater and gas monitoring through installation of piezometers.

The investigations included the following:

- A total of ten machine boreholes (BH1 to BH10) to target depths ranging between 3.0 m and 11.6 m below ground level (bgl) for geotechnical and hydrogeological purposes. Drilling was undertaken using the rotary coring method in both soils and in rock. Boreholes were terminated upon proving a sufficient thickness of bedrock or reaching the target depth.
- Installation of standpipe piezometers in BH1 to BH6 for groundwater monitoring purposes.
- Installation of a standpipe in BH10 for ground gas monitoring.

The approximate locations of the machine boreholes are presented on the Site Plan – Appendix A.

3.1 Machine Borehole

Ten machine boreholes (BH01 to BH10) were drilled by McMillan Drilling between 11 October and 3 November 2022. The purpose of the boreholes to retrieve core for visual logging and samples for laboratory testing.

BH1 was drilled near the existing oxidation ponds and is utilised as for both geotechnical and hydrogeological purposes.

BH2 was drilled north of the rail line and serves as a shallow groundwater well.

BH3 to BH5 were drilled to the southeast of the site and serve as shallow groundwater monitoring wells.

BH6 to BH10 were drilled at the location of the proposed landfill development site. BH6 has a shared purpose as a geotechnical investigation borehole and shallow groundwater monitoring well. BH7 to BH10 are primarily for geotechnical purposes.

Details of the machine boreholes are presented in Table 1.

Table 1: Details of the machine boreholes

BH ID	Approximate Location	Northing [1] (m)	Easting[1] (m)	Approximate Borehole Depth (m bgl)
BH1	30m west of Kaitangata Highway, south of oxidation ponds	757426	359516	11.6
BH2	North of site, north side of railway	757579	359724	6.0
BH3	Western area of site, 15m north-east of Kaitangata Highway	757247	359607	4.5
BH4	South-east corner of site	757137	359866	5.5
BH5	Southern area of site, 80m north-east of Kaitangata Highway	757198	359758	3.0
BH6	Middle of site, southwest of proposed landfill expansion	757293	359788	9.45
BH7	Eastern most corner of site, 20m south of railway	757393	359969	6.0
BH8	Eastern area of site, 80m north of BH06	757367	359799	4.3
BH9	Eastern area of site, middle of proposed landfill expansion	757344	359852	6.9
BH10	Eastern edge of site, 20m from boundary	757308	359932	10.0

[1] The co-ordinates are based on the North Taieri Circuit 2000 grid system and estimated using a high accuracy survey and a hand-held GPS system (BH8 and BH9), with estimated accuracy of +/-5m.

Standard Penetration Tests (SPTs) were undertaken at 1.0 m intervals within rock and soils throughout BH1, BH6, BH7, BH9 and BH10 in general accordance with ASTM D1586-11 (2011). The un-corrected SPT N-values are recorded in the borehole logs.

The recovered soils and rock were logged by a WSP Engineering Geologist. Logging was undertaken in accordance with the New Zealand Geotechnical Society Guideline (NZGS, 2005).

Upon completion of drilling, standpipe piezometers were installed within BH1 to BH6 and BH10 to allow ongoing groundwater and ground gas monitoring. The piezometer details are presented in the borehole logs in Appendix B. The remaining boreholes were backfilled with bentonite, gravel and grout.

Bulk and intact soil and rock samples were collected from the machine boreholes for laboratory testing.

The machine borehole logs and photographs are presented in Appendix B.

3.2 Groundwater

Groundwater was observed at depths ranging between approximately 1.23 m and 5.55 m bgl within the machine boreholes during the investigation. These are recorded on the borehole logs in Appendix B.

Before completion of drilling, falling head testing was completed in rock in BH6 (at 7.7 m – 9.0 m bgl) and BH9 (at 4.6 m to 6.9 m bgl) to inform the rock permeability. The testing data is included in Appendix B.

Several rounds of piezometer monitoring have been completed between October and November 2022, with the results recorded in Table 2 below.

Table 2: Piezometer details

Borehole ID	Piezometer Response Zone (m bgl)	Groundwater Level (m bgl)	Measurement Date	Measurement Time
BH1	7.7 – 11.6	2.06	31/10/2022	3:13pm
		2.26	29/11/2022	1:58pm
		2.7	01/02/2023	3:05pm
		2.61	09/03/2023	11:00am
BH2	0.5 – 4.5	0.73	31/10/2022	3:06pm
		2.80	9/11/2022	1:25pm
		1.03	29/11/2022	3:00pm
BH3	0.5 – 2.8	1.66	31/10/2022	1:30pm
		1.73	9/11/2022	11:23am
		1.89	30/11/2022	9:10am
		2.36	01/02/2023	1:56pm
		Dry	09/03/2023	1:15pm
BH4	0.5 – 5.5	2.48	31/10/2022	1:43pm
		2.92	9/11/2022	10:10am
		3.05	29/11/2022	1:25pm
		3.91	01/02/2023	2:20pm
		4.05	09/03/2023	12:54pm
BH5	0.45 – 1.8	0.62	31/10/2022	1:47pm
		0.56	9/11/2022	10:15am
		0.94	29/11/2022	1:12pm
		Dry	01/02/2023	2:26pm
BH6	0.5 – 3.5	2.30	31/10/2022	1:38pm
		Dry	9/11/2022	10:00am
		Dry	29/11/2022	1:00pm
		Dry	01/02/2023	2:13pm

4 Laboratory Testing

4.1 Soil Samples

Laboratory testing was undertaken by the WSP Laboratory (based in Christchurch) on selected soil samples recovered from BH1, BH8, and BH10. The purpose of the testing was to assess the soil properties, in particular susceptibility to liquefaction. Testing includes the following:

- Atterberg Limits in accordance with NZS 4402: 1986: Test 2.1 - Test 2.5.
- Particle Size Distribution (PSD) in accordance with NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)

- Uniaxial Compressive Strength (UCS) testing of intact rock core samples in accordance with ASTM D7012 – Test C (previously ASTM D2938).

Details of the Atterberg Limits and PSD testing samples are presented in Tables 3 and 4 below. The complete lab testing results are available in Appendix C of this report.

Table 3: Summary of Particle Size Distribution test results

Borehole ID	Sample Depth (m BGL)	Sample Description*	Clay %	Silt %	Sand %	Gravel %
BH1	2.0 – 2.45	Sandy SILT with trace clay	5	66	29	0
	5.0 – 5.45	SILT with some clay and minor sand	21	69	10	0

* Sample descriptions are based on visual inspection of materials on site.

Table 4: Summary of Atterberg Limits test results

Borehole ID	Sample Depth (m BGL)	Sample Description*	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Natural Water Content (%)
BH1	2.0 – 2.45	Sandy SILT with trace clay	40	NP**	NP**	29.8
	5.0 – 5.45	SILT with some clay and minor sand	39	25	14	34.2

* Sample descriptions are based on visual inspection of materials on site.
** NP = Non plastic (unable to roll a thread to specified dimensions).

4.2 Rock Samples

Unconfined Compressive Strength (UCS) testing was undertaken by the WSP Laboratory (based in Christchurch) on selected rock samples recovered from BH8 and BH10. The purpose of the testing was to confirm the strength and properties of the bedrock underlying the site. Testing was undertaken in accordance with ASTM D7012 – Test C.

Rock sample details are presented in Table 5 below. The lab testing results are available in Appendix C of this report.

It should be noted that the UCS strength usually refers to the intact strength of a rock, but this is not the case for these test results. During testing the rock samples broke along existing, weathered defects and not through fresh rock, therefore, the test results are assumed to more closely estimate *rock mass* strength, not *intact rock* strength.

Table 5: Summary of rock samples for UCS testing

Borehole ID	Sample Depth (m bgl)	Rock Description	Unconfined Compressive Strength (MPa) *
BH8	0.6 – 0.8	Moderately weathered, weak SANDSTONE	3.1
	2.1 – 2.4	Slightly weathered, moderately strong SANDSTONE	6.7
BH10	5.6 – 5.9	Slightly weathered, weak to moderately strong SANDSTONE	2.0

* The results are indicative of rock mass strength and not intact rock strength, due to sample failure on existing weathered surfaces

References

ASTM, 2011. ASTM D1586-11, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. ASTM International, West Conshohocken, PA.

ASTM D7012 – Test C. Determination of the Uniaxial Compressive Strength (UCS) of Intact Rock Core Specimens (previously ASTM D2938).

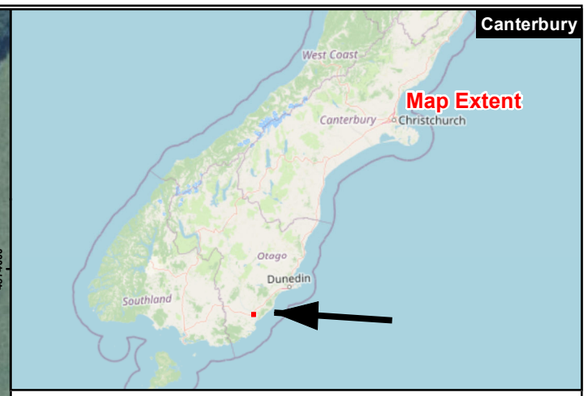
GNS Science, New Zealand Geology Web Map accessed 12 December 2022. http://data.gns.cri.nz/geology/

NZGS, 2005. Field Description of Soil and Rock. Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes. New Zealand Geotechnical Society.

NZS4402, 1986, Test 2.8.4. Particle Size Distribution (PSD) Washed Grading & Hydrometer Method).

NZS4402, 1986, Test 2.1 - Test 2.5. Determination of Atterberg Limits.

Appendix A
Site Plan



LEGEND

- Proposed New Shallow Groundwater Well
- Proposed Shared Hydro/Geotech Borehole
- Proposed Geotechnical Boreholes
- Existing Groundwater Monitoring Well
- Sediment Pond Monitoring Site
- Surface Water Monitoring Site
- Oxidation Ponds
- Pump Station
- Royds Boreholes (1993)
- Proposed Fill Area Expansion

ISSUED FOR COMMENT

DRAFT

NOTES

1. Map image: © OpenStreetMap (and) contributors, CC-BY-SA Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors
2. Schematic only, not to be interpreted as an engineering design or construction drawing.

0 50 100
Meters

REFERENCE SCALE: 1:2,200 (at A3)

PROJECTION: NZGD 2000 New Zealand Transverse Mercator

CLIENT
CLUTHA DISTRICT COUNCIL

PROJECT
MT COOEE LANDFILL DEVELOPMENT PLAN

TITLE
MT COOEE PROPOSED DRILLING PLAN

CONSULTANT
wsp

YYYY-MM-DD	2022-07-06
PREPARED	KC

PROJECT NO.	REPORT	REV.	FIGURE
6-CO082.00	N/A	N/A	**01**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM A3

0 25mm

Appendix B
Machine Borehole Logs and Photographs

Borehole No. BH1

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350038 E 4873817 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m
Location:	30m west of Kaitangata Hwy, south of oxidation ponds Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 11.6 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL, grass, trace rootlets and trace fine quartz gravel. 0.40-0.50m - Woody organics present.											RC	80					Cement seal
Alluvium	Silty CLAY with trace gravel and rootlets, dark grey, homogenous. Soft to firm, moist, high plasticity. Gravel; coarse, subangular. Core loss.	8	1															
	Sandy SILT, light brown to brown, homogenous. Firm, moist to dry, low plasticity, micaceous. Sand; fine.				6	3// 1/2/1/2						SPT	100					
	Silty CLAY with trace sand and gravel, light brown with dark grey and brown specks, homogenous. Firm, moist, high plasticity. Gravel; fine, subangular. Sand; fine to coarse. 1.50m - Orange mottle.										Lab: 1.8 - 3.0m PSD and Atterberg Limits	RC	100					
	Sandy SILT, brown, homogenous. Firm, dry, low plasticity. Sand; fine. 1.80m - Becomes light brown.		2		5	2// 1/1/1/2						SPT	100					31/10/2022
	Silty fine to coarse SAND with trace rootlets, brown, homogenous. Loose, moist, micaceous. Silt; low plasticity.											RC	100					
	Becomes light grey to grey with trace of orange mottles, homogenous. Dry to moist, non-plastic, micaceous.	6	3								2.85-3.00m - Broken during removal from core catcher							
					7	2// 1/2/2/2						SPT	100					
	Silty CLAY with trace sand, light grey with orange mottles throughout, homogenous. Soft to firm, moist, high plasticity, micaceous. Sand; fine to medium. 3.50m - Becomes firm.											RC	100					
	3.90m - Becomes light grey with trace orange mottles (less than above), homogenous.		4															
	Sandy SILT, light brownish grey, homogenous. Soft, non-plastic dry. Sand; fine to medium.				6	2// 2/1/2/1						SPT	100					
	Silty CLAY, light greenish grey, homogenous. Soft to firm, moist, high plasticity.										Lab: 4.4 - 6.1m PSD and Atterberg Limits	RC	100					
		4	5															
					1	0// 0/0/0/1						SPT	100					
	5.45-5.65m - Becomes light greyish green with trace green sandy laminations. 5.65-6.00m - Green sandy lenses. Becomes greenish grey.											RC	100					
		6																
					60+	13// 9/22/22/7 for 20mm						SPT	100					9/03/2023
	Silty CLAY with trace gravel and sand, dark grey with orange mottles, homogenous. Very soft, moist to wet, high plasticity. Gravel; fine to coarse, subangular to angular. Sand; fine to medium, subangular to subrounded.											RC	100					
Caples Terrane	Slightly weathered, highly fractured, light brownish grey, fine fabric SANDSTONE; moderately strong; very closely spaced joints and white veins. Recovered as: sandy GRAVEL with some silt, light brown. Gravel and sand; fine to coarse, subangular. 7.50-8.00m - Gravel becomes; fine to coarse, coarser gravel is angular to subangular, finer gravel is rounded to subrounded.	2	7								6.70-9.35m - Rock broken up by drilling.							
					60+	12// 14/46 for 75mm						SPT	100					
												RC	100				SWL 2.35m	
		8			60+	60 for initial 110mm	MS	SW	VC			SPT	100					
	Slightly weathered, highly fractured, light bluish grey, fine fabric SANDSTONE; moderately strong; closely spaced joints and white veins. Recovered as: Fine to coarse GRAVEL with minor sand, light greyish brown. Very dense, well graded, non-plastic. Gravel; coarser gravel is angular to subangular, finer gravel is rounded to subrounded. Sand; medium to coarse, rounded. 9.17-9.35m - Recovered as: fine to coarse GRAVEL with minor cobbles, light grey. Very dense, well graded. Gravel; subangular, Greywacke, mm-scale white veins. Cobbles: max 80mm.	0	9									RC	100	0				
					60+	60 for initial 105mm			VC C VC		Lab: 9.0 - 11.0m UCS testing 9.17-9.35m - Rock broken up by drilling. Any matrix appears to be lost due to drilling.	SPT	100	0				
							S		C			RC	100	0				50 mm slotted pipe (3.0 m L)

Rotary cored

PQ size wireline (85 mm nom. dia. core)

50 mm Blank pipe (8.2 m L) with grout backfill

BOREHOLE SOIL/ROCK LOG A4 - WSP MT COOEE BOREHOLE LOGS - V0.3.GPJ WSP-OPUS2019_VER11X.GDT 30/3/23

Notes:

SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	19/10/2022	*Finished:*	20/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH1

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350038 E 4873817 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m
Location:	30m west of Kaitangata Hwy, south of oxidation ponds Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 11.6 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Caples Terrane	Slightly weathered, fractured, light grey, fine fabric SANDSTONE; strong; white veins smooth and tight aperture. Recovered as: COBBLES, with some gravel and sand. Well graded. Cobbles and gravel; angular to subangular. Sand; fine to medium.*(continued)* 10.11-11.00m - Thinly laminated veins throughout. Veins are mostly white, some are greenish white. Apertures extremely closely spaced, very narrow. 10.40-10.60m - Heavily veined. Minor sand. 10.80-11.00m - Angular GRAVEL and COBBLES.	-2 / 11		60+	60 for initial 105mm	S	SW	VC			SPT	100	0	Rotary cored			
								C			RC	100	0				
								VC									
				60+	60 for initial 95mm			C			SPT	100	0				
								VC			RC	100	0				
	END OF BOREHOLE AT 11.6m - Target Depth Reached	12															
		-4 / 13															
		14															
		-6 / 15															
		16															
		-8 / 17															
		18															
		-10 / 19															

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 19/10/2022
Finished: 20/10/2022
Drilling Co.: McMillan Drilling
Drilling Rig: Hanjin D&B-8D - track
Logged by: C. Hall
Checked by: C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH1

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350038 E 4873817 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	11.6 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m	*Inclination:*	Vertical
Location:	30m west of Kaitangata Hwy, south of oxidation ponds Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH1.1
BH1 Box 1: 0.0m - 2.4m

Photo BH1.2
BH1 Box 2: 2.4m - 4.45m

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	19/10/2022	*Finished:*	20/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH1

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350038 E 4873817 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	11.6 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m	*Inclination:*	Vertical
Location:	30m west of Kaitangata Hwy, south of oxidation ponds Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH1.3
BH1 Box 3: 4.45m - 7.0m

Photo BH1.4
BH1 Box 4: 7.0m - 9.35m

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	19/10/2022	*Finished:*	20/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

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Scale 1:50 @ A4

Borehole No. BH1

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350038 E 4873817 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	11.6 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m	*Inclination:*	Vertical
Location:	30m west of Kaitangata Hwy, south of oxidation ponds Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH1.5
BH1 Box 5: 9.35m - 11.0m

Photo BH1.6
BH1 Box 6: 11.0m - 11.6m

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	19/10/2022	*Finished:*	20/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH1 (ROYDS)

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	Not established
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 116.39 m
Location:	Near Clutha River Bridge Mt Cooee Landfill, Balclutha	*Datum:*	

Depth: 15 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL with some fine gravel.	116															
Tuapeka Group Greywacke	Light grey moderate to widely jointed GREYWACKE. [TUAPEKA GROUP GREYWACKE] - weathered, fractured zone at top of layer - very hard - some quartz filled joints	1												Rotary open hole			4/03/2001 Slotted pipe
		2															
		114															
		3															
		4															
		112															
		5															
		6															
		110															
		7															
		8															
		108															
		9															

BOREHOLE SOIL/ROCK LOG A4 - WSP MT COOEE BOREHOLE LOGS - V0.3.GPJ WSP-QPUS2019_VER11X.GDT 30/3/23

Notes:

Air Rotary drilling method. 150mm diameter.
Taken from Royds Garden Ltd borehole records.

Started: 28/01/1994 *Finished:* 28/01/1994

Drilling Co.: *Drilling Rig:*

Logged by: *Checked by:*

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH1 (ROYDS)

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	Not established
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 116.39 m
Location:	Near Clutha River Bridge Mt Cooee Landfill, Balclutha	*Datum:*	

Depth: 15 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Tuapeka Group Greywacke	Light grey moderate to widely jointed GREYWACKE. [TUAPEKA GROUP GREYWACKE] - weathered, fractured zone at top of layer - very hard - some quartz filled joints*(continued)*	106 / 11 / 12 / 104 / 13 / 14 / 102 / 15												Rotary open hole			Slotted pipe
	END OF BOREHOLE AT 15m	16 / 100 / 17 / 18 / 98 / 19															

Notes:
Air Rotary drilling method. 150mm diameter.
Taken from Royds Garden Ltd borehole records.

Started: 28/01/1994
Finished: 28/01/1994
Drilling Co.:
Drilling Rig:
Logged by:
Checked by:

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH2

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350241 E 4873978 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 16 m
Location:	North of site, north side of railway Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 6 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL.																	
Alluvium	GRAVEL with minor sand, brownish grey. Loose. Gravel; fine to coarse, subrounded, sandstone. Clay/silt/sand matrix inferred washed away. 0.70m - Some matrix present at 0.7m Core loss.	14	1									RC	55	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)	SWL 1.00m	13/10/2022 Cement seal 50 mm slotted pipe (3.0 m L) Grout
Alluvium	Gravelly CLAY with some silt and minor sand, brown. Homogenous, soft, moist, high plasticity. Gravel; fine to coarse, angular, well graded. Core loss.	13	2									RC	45	0				
Caples Terrane	Completely weathered grey and orange/brown, fine fabric SANDSTONE. Extremely weak. Recovered as: SILT with minor gravel and some sand and clay. Homogenous, stiff to very stiff, moist, low plasticity. Gravel; fine to medium, subangular. Sand; fine. Core loss.	12	3 4				EW W EW	CW SW CW	EC VC EC			RC	80	0				
Caples Terrane	Moderately weathered greenish grey, fine fabric SANDSTONE. Very weak to weak. Completely weathered grey and orangeish brown, indistinctly bedded SANDSTONE. Extremely weak. Residual soil recovered as: SILT with some clay. Homogenous, stiff to very stiff, moist, and low plasticity. Moderately weathered greenish grey, indistinctly bedded SANDSTONE. Very weak to weak.	10	5 6				EW W VW W	CW HW MW	EC C VC C VC			RC	100	30				
	END OF BOREHOLE AT 6m - Target Depth Reached	8	7 8 9															
		6																

Notes:

Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 18/10/2022 *Finished:* 19/10/2022

Drilling Co.: McMillan Drilling *Drilling Rig:* Hanjin D&B-8D - track

Logged by: N. Ahern *Checked by:* C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH2

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350241 E 4873978 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	6 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 16 m	*Inclination:*	Vertical
Location:	North of site, north side of railway Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH2.1
BH2 Box 1: 0.0m - 4.2m

Photo BH2.2
BH2 Box 2: 4.2m - 6.0m

Notes:
Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	18/10/2022	*Finished:*	19/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	N. Ahern	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH2 (ROYDS)

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	Not established
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 109.29 m
Location:	Near gate to landfill Mt Cooee Landfill, Balclutha	*Datum:*	

Depth: 9.5 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL with some fine gravel.																
Pleistocene Glacial Deposits	Grey brown mottle yellow brown sandy silty fine GRAVEL.	1 108															
Tuapeka Group Greywacke	Light grey moderate to widely jointed GREYWACKE. - Weathered, fractured zone at top of layer - Very hard - Some quartz filled joints	2 3 106 4 5 104 6 7 102 8 9 100												Rotary open hole			
	END OF BOREHOLE AT 9.5m																

Notes:
Air Rotary drilling method. 150mm diameter.
Taken from Royds Garden Ltd borehole records.

Started: 30/01/1994
Finished: 30/01/1994
Drilling Co.:
Drilling Rig:
Logged by:
Checked by:

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH3

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350135 E 4873642 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 11 m
Location:	Western area of site, 15m north-east of Kaitangata Hwy Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 4.5 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL.																	
Alluvium	SILT with some clay and minor sand, grey/dark brown, homogenous. Soft, moist, low plasticity. Sand; fine to medium.																	
	Clayey SILT with minor sand, light brownish orange. Homogenous, soft, moist, with low to medium plasticity. Sand; fine.																	
Caples Terrane	0.90-0.92m - Cobble of moderately weathered, light brown massive SANDSTONE. Weak.	10	1				EW	CW	EC			RC	100		Rotary cored	PQ size wireline (85 mm nom. dia. core)		Cement seal
	Completely weathered, brownish orange, fine fabric SANDSTONE. Extremely weak. Recovered as: sandy SILT with minor clay, brownish orange, homogenous. Stiff, dry to moist, low plasticity. Sand; fine to medium.								C									Blank (1.5 m L)
	Highly weathered orange/brown, fine fabric SANDSTONE. Very weak. Recovered as: sandy GRAVEL with some cobbles and minor silt and clay, homogenous. Gravel; fine to coarse, subrounded. Cobbles; max 100mm, subrounded. Sand; fine to coarse.		2				VW	HW	EC			RC	65	0				31/10/2022
	Core loss.	8	3						C		2.40-2.50m - Core broken during removal from catcher.							1/02/2023
	Moderately weathered dark green/orange, fine fabric SANDSTONE. Weak. Orange staining on all joint faces. Recovered as: COBBLES with minor gravel. Cobbles; max 100mm, mostly subangular with some subrounded (due to drilling). Gravel; medium to coarse, subangular.						W	MW	VC		3.00-4.30m - Possible weaker material washed out by drilling.	RC	80	0				Bentonite
			4						C									50 mm slotted pipe (1.0 m L)
	Core loss.								VC								SWL 1.60m	
	END OF BOREHOLE AT 4.5m - Target Depth Reached	6	5															
			6															
		4	7															
			8															
		2	9															

Notes:
Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 11/10/2022 *Finished:* 12/10/2022
Drilling Co.: McMillan Drilling *Drilling Rig:* Hanjin D&B-8D - track
Logged by: N. Ahern *Checked by:* C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH3

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350135 E 4873642 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	4.5 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 11 m	*Inclination:*	Vertical
Location:	Western area of site, 15m north-east of Kaitangata Hwy Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH3.1
BH3 Box 1: 0.0m - 3.0m

Photo BH3.2
BH3 Box 2: 3.0m - 4.5m

Notes:
Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	11/10/2022	*Finished:*	12/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	N. Ahern	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH4

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350398 E 4873540 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m
Location:	South-east corner of site Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 5.5 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL with roots and grass.																	
Caples Terrane	Sandy GRAVEL with trace rootlets, light brown to grey. Loosely packed, well graded, non-plastic. Gravel; angular to subangular, greywacke. Sand; fine to coarse, subrounded. 0.50-0.80m - Gravel; subangular to subrounded. Coarse sand; subangular to angular. Core loss.	8	1								0.15-3.70m - Assumed some fines or weaker seams were present but these have been washed away by drilling.	RC	53	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)	SWL 2.30m	Blank 1m Cmt. seal
	Slightly weathered to moderately weathered, highly fractured, orangish brown, fine fabric SANDSTONE; extremely weak; extremely closely spaced tight white veins; extremely weathered defects. Recovered as: COBBLES with some gravel and trace silt and rootlets, orangey brown to grey. Cobbles and gravel; fine to coarse. Cobbles; max 100mm, subangular. Sand; fine to coarse, subangular to subrounded. Silt; dark grey, lensoidal. 2.20-2.40m - Trace pockets of dark grey silt. Core loss.	6	2				EW	MW	EC		1.50-5.50m - Fracturing due to drilling	RC	40	0				31/10/2022
	Slightly weathered to moderately weathered, highly fractured, dark grey SILTSTONE. Very weak, bedding is thinly laminated. Recovered as: Sandy GRAVEL with some cobbles and silt, dark grey with some orange and white veins. Sand; fine to coarse, angular to subangular. Gravel and cobbles; fine to coarse, subangular. Cobbles; max 60mm. Fines; non-plastic. Core loss.	4	3				VW	MW	EC			RC	80	0				
	Slightly weathered, highly fractured, dark bluish grey, fine fabric SILTSTONE. Weak. Mm scale mostly closed and oxidised defects. Recovered as: COBBLES with some gravel and trace silt, dark bluish grey with orange staining. Cobbles and gravel; fine to coarse, subangular. Cobbles; max 150mm. Sand; fine to coarse, subangular to subrounded. 5.00m - Slickenslides on one piece of gravel.	4	5				W	SW	VC	50 / 45	4.10m - J, 50° 4.20m - J, 45°	RC	100	0				09/03/2023
	END OF BOREHOLE AT 5.5m - Target Depth Reached	0	6 7 8 9															50 mm slotted pipe (4.5 m L)

BOREHOLE SOIL/ROCK LOG A4 - WSP MT COOEE BOREHOLE LOGS - V0.3.GPJ WSP-OPUS2019_VER11X.GDT 30/3/23

Notes:

Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	27/10/2022	*Finished:*	27/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH4

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350398 E 4873540 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	5.5 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m	*Inclination:*	Vertical
Location:	South-east corner of site Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH4.1
BH4 Box 1: 0.0m to 3.8m

Photo BH4.2
BH4 Box 2: 3.8m - 5.5m

Notes:
Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	27/10/2022	*Finished:*	27/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH5

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350288 E 4873598 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 7 m
Location:	Southern area of site, 80m north-east of Kaitangata Hwy Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 3 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL with some grass and rootlets and minor quartz sand.																	
Alluvium	Silty CLAY with trace sand, orangish brown, homogenous. Firm to stiff, moist, high plasticity. Sand; medium.																	
Alluvium	Silty CLAY with minor sand, light greyish orange with minor white specks and orange mottle, homogenous. Stiff, moist, high plasticity. 0.90m - Becomes orange. Soft to firm.	6	1								Lab: 0.4 - 1.1m PSD and permeability testing.	RC	100	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)	SWL 2.30m	31/10/2022; Blank pipe 0.9 m; Slotted pipe 0.6 m; Grout
Caples Terrane	Highly weathered, brownish orange, fine fabric indistinctly bedded SANDSTONE. Weak to very weak; orange defects. 1.20m - Becomes moderately weathered to slightly weathered. 1.80-2.00m - Grades into slightly weathered.						VW	HW / SW	VC		Lab: 1.1 - 2.6m UCS testing.							
Caples Terrane	Moderately weathered, greenish grey, fine fabric indistinctly bedded SANDSTONE. Weak to very weak; orange staining along open defects.	4	2				W	MW / SW	C / VC	J10	2.15m - J, 10° 2.50m - J, 10°	RC	100	17				
	END OF BOREHOLE AT 3m - Target Depth Reached		3						C		2.90-3.00m - Core broken during removal from catcher.							
			4															
		2	5															
			6															
		0	7															
			8															
		-2	9															

Notes:

Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 17/10/2022 *Finished:* 18/10/2022

Drilling Co.: McMillan Drilling *Drilling Rig:* Hanjin D&B-8D - track

Logged by: C. Hall *Checked by:* C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH5

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350288 E 4873598 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	3 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 7 m	*Inclination:*	Vertical
Location:	Southern area of site, 80m north-east of Kaitangata Hwy Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH5.1
BH5 Box 1: 0.0m to 2.2m

Photo BH5.2
BH5 Box 2: 2.2m to 3.0m

Notes:
Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	17/10/2022	*Finished:*	18/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH6

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350315 E 4873694 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 21 m
Location:	Middle of site, southwest of excavation Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 9.45 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL with some grass and rootlets, dark brown. 0.20m - Becomes orangish brown.																	
Caples Terrane	Moderately weathered, light brownish orange, highly fractured, SANDSTONE. Moderately strong. Recovered as: gravelly COBBLES with some sand. Cobbles; angular, max 100mm. Gravel; medium to coarse, angular. Core loss.	20	1				MS	MW	VC			RC	73		Rotary cored	PQ size wireline (85 mm nom. dia. core)		50 mm blank pipe (1.0 m L)
	Highly weathered, light brownish orange, highly fractured SANDSTONE. Weak. Recovered as: Sandy GRAVEL with some clay, orangish brown. Gravel; fine to coarse, subangular. Fines; high plasticity.		2		56	15// 10/13/15/18	W	HW	EC			SPT	100					
	2.30m - Re-drilled cobble. Core loss.	18	3									RC	38					
	Moderately weathered, light grey to dark grey, highly fractured SANDSTONE. Moderately strong. Recovered as: GRAVEL with some sand, light grey to dark grey. Gravel; fine to coarse, subangular.				60+	17// 14/16/21/9 for 25mm	MS	MW	VC			SPT	100					
	Core loss.		4									RC	38					
	Completely weathered, greenish grey, fine fabric SILTSTONE. Extremely weak. Recovered as: clayey SAND with trace silt. Sand; fine to medium. Fines; high plasticity. 4.95-5.25m - Lenses of silty CLAY, greenish grey, homogenous. Soft, moist, high plasticity.	16	5		60+	15// 13/26/21 for 45mm	EW	CW	EC			SPT	100				SWL 2.20m	
	Moderately weathered, greenish grey, highly fractured fine fabric, indistinctly bedded SANDSTONE. Weak. Recovered as: sandy GRAVEL with some clay, bluish green. Gravel; medium to coarse. Fines; high plasticity.						W	MW										
	Slightly weathered greenish blue, massive SILTSTONE. Weak to moderately strong. 5.70-5.90m - Moderately weathered, highly fractured along defects. Defects; open or extremely closed spaced and closed. 6.45-6.55m - Pockets of silty SAND with pockets of clay, bluish green, homogenous. Loose, non-plastic. 6.55-7.20m - Black stained defects throughout.		6		60+	15// 20/24/16 for 50mm	MS	SW MW SW	C VC EC		Lab: 5.3 - 9.45m UCS testing.	RC	100					
	Moderately weathered greenish blue, fine fabric SILTSTONE. Weak; black stained defects. Recovered as: COBBLES with some gravel and silt. Cobbles and gravel; angular. Gravel; medium to coarse. 7.00-7.20m - Grades into completely weathered rock. 7.20-7.50m - Recovered as: sandy GRAVEL with some silt, dark greenish grey to black. Loose, non-plastic. Gravel; fine to coarse, subrounded Siltstone.	14	7		60+	36// 48/12 for 35mm			C EC			SPT	100	0				
	8.25m - Becomes slightly weathered, minor fractures, weak to moderately strong. Defects; closed aperture. Grainsize grading larger from Siltstone to Sandstone. 8.75-9.00m - Recovered as: sandy GRAVEL with some silt, dark greenish blue, homogenous. Loose. Gravel; highly weathered. 9.00-9.45m - Recovered as: silty SAND, greenish yellow, homogenous. Soft to firm, low plasticity. Sand; fine to medium.	12	8 9		60+	19// 22/38 for 75mm	W	CW MW SW HW	EC C EC			RC SPT	100 93	0 0			SWL 4.96m	Grout
	END OF BOREHOLE AT 9.45m - Target Depth Reached																	

31/10/2022

50 mm slotted pipe (1.5 m L)

BOREHOLE SOIL/ROCK LOG A4 - WSP MT COOEE BOREHOLE LOGS - V0.3.GPJ WSP-OPUS2019_VER11X.GDT 30/3/23

Notes:

SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Waiting on core box photos to calcuate RQD
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	12/10/2022	*Finished:*	18/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH6

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350315 E 4873694 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	9.45 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 21 m	*Inclination:*	Vertical
Location:	Middle of site, southwest of excavation Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH6.1
BH6 Box 1: 0.0m to 4.5m

Photo BH6.2
BH6 Box 2: 4.5m to 6.8m

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Waiting on core box photos to calcuate RQD
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	12/10/2022	*Finished:*	18/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH6

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350315 E 4873694 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	9.45 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 21 m	*Inclination:*	Vertical
Location:	Middle of site, southwest of excavation Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH6.3
BH6 Box 3: 6.8m to 9.45m

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Waiting on core box photos to calcuate RQD
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	12/10/2022	*Finished:*	18/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH7

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350492 E 4873800 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 25 m
Location:	Eastern most corner of site, 20m south of railway Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 6 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL.																	
Caples Terrane	Moderately weathered light grey to light brown with orange mottle, fine fabric SANDSTONE. Weak to moderately strong. Recovered as: gravelly COBBLES with some sand. Cobbles and gravel; angular. Gravel; medium, subrounded. 0.20-0.70m - Coarse to fine gravel, sandy silty matrix inferred fines washed away. Core loss.	24	1				W	MW	EC / VC		0.20-6.00m - Fractures opened by drilling.	RC	75	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)		Surrounding ground collapse
	Highly weathered, light brown with orange mottle, highly fractured, fine fabric SANDSTONE. Strong. Recovered as: Gravelly COBBLES. Gravel and cobbles; angular. 1.00-2.00m - Sand/silt matrix inferred washed away. 1.55m - Becomes completely weathered.				60	31// 34/26	S	HW	VC			RC	85	0				
	Slightly weathered light grey with some orange mottle, fractured, fine fabric SANDSTONE. Moderately strong.		2				MS	SW	C / VC	40	2.40m - J, 40°	RC	100	30				
	2.70-2.90m - Moderately fractured same materials as above, rootlets present. 2.90-3.20m - Recovered as: silty SAND, brownish orange. Loosely packed, dry to moist, low plasticity.	22	3								2.90-3.00m - Core broken during removal from catcher. Core inferred to be baked during drilling.							Gravel
	Moderately weathered dark grey with light brown and orange mottle, fractured, interbedded SANDSTONE and SILTSTONE. Sst = strong, siltst = weak. 3.60-4.05m - Becomes moderately thickly bedded and more mudstone dominant.						W	MW	VC / C / VC			RC	100	10				
	4.05-4.20m - Recovered as: medium to fine gravel with some silt and sand, greenish grey. Loosely packed, moist. Silt; low plasticity.		4								4.00-4.20m - Core broken during removal from catcher.							
	Slightly weathered dark grey with orange mottle, fractured, indistinctly bedded SILTSTONE. Moderately strong. 4.30-4.70m - Discontinuities: extremely closely spaced very narrow to closely spaced closed aperture. 4.90-5.20m - Discontinuities: becomes thinly bedded, thinly laminated, sub-horiztonal planar bedding. 5.20-5.40m - Orange staining increasing. 5.40-5.55m - Minor orange mottle.	20	5				MS / W	SW / MW	C	40 / 60	5.30m - J, 60° 5.31m - J, 40°	RC	80	0			SWL 5.05m	
	Core loss.																	
	END OF BOREHOLE AT 6m - Target Depth Reached	18	6 7 8 9															

BOREHOLE SOIL/ROCK LOG A4 - WSP MT COOEE BOREHOLE LOGS - V0.3.GPJ WSP-OPUS2019_VER11X.GDT 30/3/23

Notes:

SPT hammer energy ratio 91%
Geotechnical borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	1/11/2022	*Finished:*	1/11/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	N. Ahern	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH7

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350492 E 4873800 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	6 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 25 m	*Inclination:*	Vertical
Location:	Eastern most corner of site, 20m south of railway Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH7.1
BH7 Box 1: 0.0m to 3.0m

Photo BH7.2
BH7 Box 2: 3.0m to 6.0m

Notes:
SPT hammer energy ratio 91%
Geotechnical borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	1/11/2022	*Finished:*	1/11/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	N. Ahern	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH8

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350323 E 4873768 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 16 m
Location:	Eastern area of site, 80m north of BH06 Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 4.3 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Caples Terrane	Moderately weathered dark grey to greenish grey with white specks, highly fractured SANDSTONE. Weak. Recovered as: coarse to fine gravel, with some sand. Gravel; subangular. Sand; coarse. 0.20-0.40m - Becomes completely weathered.	14	1				W	MW	EC		Lab: 0.0 - 2.8m UCS testing. 0.40m - Vein, N	RC	100	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)	SWL 0.60m	Grout
	Slightly weathered greenish grey with white specks, coarse grained, veined, indistinctly bedded SANDSTONE. Weak to moderately strong. 1.25-1.50m - Crushed zone. Recovered as: coarse to fine GRAVEL with minor sand. Gravel; angular. Sand; coarse. 1.50m - Becomes light greenish grey and coarse-grained.		2				VW MS	SW	W EC	Vein80	1.25m - CZ 1.50m - Vein, 80°, MW							
	2.50-4.30m - Crushed zone. Recovered as: COBBLES with some gravel and minor silt and sand. Cobbles and gravel; subangular, strong. Sand; fine to medium. 2.70-2.85m - Becomes moderately weathered. Very weak. Recovered as: COBBLES with some gravel and sand. Cobbles and gravel; subangular. Core loss.		3						C	Vein75	2.00m - Vein, 75°, N	RC	95	60				
							VW	HW	VC		2.50m - CZ							
	Moderately weathered greenish grey with minor white specks, coarse grained highly fractured, indistinctly bedded SANDSTONE. Very weak. Recovered as: COBBLES with some gravel and sand. Cobbles and gravel; subangular.	12	4				VW	HW	VC		3.05m - Vein, VN 3.10-4.10m - Highly factured insitu rock. Disturbed on removal from core catcher.	RC	90	53				
	END OF BOREHOLE AT 4.3m - Target Depth Reached		5															
		10	6															
			7															
		8	8															
			9															
			6															

Notes:
Geotechnical borehole
Elevation is estimated from Google Earth
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 3/11/2022
Finished: 3/11/2022
Drilling Co.: McMillan Drilling
Drilling Rig: Hanjin D&B-8D - track
Logged by: N. Ahern
Checked by: C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH8

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350323 E 4873768 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	4.3 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 16 m	*Inclination:*	Vertical
Location:	Eastern area of site, 80m north of BH06 Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH8.1
BH8 Box 1: 0.0m to 2.1m

Photo BH8.2
BH8 Box 2: 2.1m to 4.3m

Notes:
Geotechnical borehole
Elevation is estimated from Google Earth
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	3/11/2022	*Finished:*	3/11/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	N. Ahern	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH9

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350377 E 4873747 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 20 m
Location:	Eastern area of site, middle of excavation Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 6.9 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Caples Terrane	Highly weathered to completely weathered light grey with some orange mottles, slightly interbedded SANDSTONE and SILTSTONE. Weak to moderately strong; bedding is thinly laminated and gently inclined, smooth undulating.						W	HW	EC			RC	60	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)		Grout
	Recovered as: cobbly GRAVEL with minor trace sand and silt. Cobbles; subangular to subrounded (possibly due to drilling). Gravel; fine to coarse, angular.		1		60+	42// 60 for 25mm												
	Core loss.											SPT	100					
	HW to CW interbedded SANDSTONE and SILTSTONE. As above.						W	HW	EC									
	Core loss.	18	2									RC	47	0				
	HW to CW interbedded SANDSTONE and SILTSTONE. As above.						W	HW	EC			RC	30	0				
	Core loss.		3									RC	0	0				
		16	4															
	Slightly weathered, dark grey with yellowy white veins, interbedded SANDSTONE and SILTSTONE. Moderately strong to strong. Bedding is thinly laminated, undulating smooth, very narrow to closed, fine grained. Veining is stepped.				60+	5// 1/46 for 25mm	EW	CW	EC			SPT	100					
							MS	SW	C									
	4.50-4.70m - Completely weathered. Recovered as: silty SAND with minor gravel and cobbles, dark grey. Moist. Sand; coarse to medium. Gravel; fine to coarse, subangular. Silt; non-plastic.		5				S	SW	EC C EC VC		5.10-5.25m - Broken to gravel by drilling. 5.40-5.50m - Broken to gravel by drilling.	RC	100	50			SWL 1.70m	
	Slightly weathered, light bluish grey with minor white specks, indistinctly interbedded, fine fabric SANDSTONE and SILTSTONE. Strong. 5.90m - Becomes light grey and moderately strong.	14	6				MS		C C C EC	J35 J40	5.90m - J, 35°, SL, clean 6.00m - J, 40°, SL, clean 6.20-6.60m - Broken to gravel by drilling.	RC	100	0				
	Core loss.																SWL 0.00m	
	END OF BOREHOLE AT 6.9m - Target Depth Reached		7															
		12	8															
			9															
			10															

Notes:

SPT hammer energy ratio 91%
Geotechnical borehole
Elevation is estimated from Google Earth
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 2/11/2022 *Finished:* 3/11/2022

Drilling Co.: McMillan Drilling *Drilling Rig:* Hanjin D&B-8D - track

Logged by: N. Ahern *Checked by:* C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH9

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350377 E 4873747 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	6.9 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 20 m	*Inclination:*	Vertical
Location:	Eastern area of site, middle of excavation Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH9.1
BH9 Box 1: 0.0m to 5.5m

Photo BH9.2
BH9 Box 2: 5.5m to 6.9m

Notes:
SPT hammer energy ratio 91%
Geotechnical borehole
Elevation is estimated from Google Earth
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	2/11/2022	*Finished:*	3/11/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	N. Ahern	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH10

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350458 E 4873714 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 26 m
Location:	Eastern edge of site, 20m from boundary Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 10 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL with grass and rootlets.																	
Fill	Clayey SILT with trace gravel, light brown with black specks, homogenous. Firm to stiff, moist, low plasticity. 0.65m - Becomes brownish orange and firm.											RC	100	0				
Caples Terrane	Completely weathered brownish orange highly fractured, fine fabric SANDSTONE. Extremely weak. Recovered as: SILT with some clay and trace gravel, homogenous. Firm, moist, low plasticity. Minor rootlets present. Gravel corestones are very weak. 1.42-2.75m - Remoulds to: clayey SAND with minor silt and gravel, orangish brown, homogenous. Moist, low plasticity. Gravel; fine to coarse, HW - CW Sandstone, very weak. Sand; medium to coarse, angular to subangular. Fines; Soft.	1			22	6// 5/5/6/6	EW	CW	EC			SPT	100	0				
			2									RC	100	0				
		24			57	13// 10/15/14/18						SPT	100	0				
	2.45-2.75m - Trace rootlets.											RC	100	0				
	Grading to highly weathered, dark brown with orange weathering and white specks, fractured, fine fabric SANDSTONE. Extremely weak. Recovered as: sandy GRAVEL with minor silt. Moist, non-plastic. Gravel; fine to coarse, angular to subangular. Sand; fine to coarse.		3		60+	21// 17/20/23 for 70mm						SPT	100	0				
	Highly weathered, dark orangish brown highly fractured SANDSTONE. Very weak to weak. Recovered as: Sandy GRAVEL with some cobbles and minor silt. Low plasticity. Gravel; fine to medium, angular to subangular. Sand; fine to coarse, angular to subangular.	22	4				VW	HW				RC	100	0			SWL nilm	
					57	18// 12/12/16/17						SPT	100	0				
	Moderately weathered, orangish brown fractured SANDSTONE. Weak. Recovered as: gravelly COBBLES with some sand. Cobbles and gravel; fine to coarse, cobbles max 100mm, subangular. Sand; medium to coarse, rounded.						W	MW	VC			RC	100	0				
	Slightly weathered, orangish brown with oxidised defects, fractured SANDSTONE. Moderately strong. Discontinuities; very closely spaced closed joints, cross-cutting and sub-vertical, rough to smooth planar.		5		60+	27// 51/9 for 5mm	MS	SW		J70 J60	5.30m - J, 70° 5.40m - J, 60°	SPT	100	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)		50 mm blank pipe (1.0 m L) 9/11/2022 9/03/2023 50 mm slotted pipe (9.0 m L)
	5.60-5.70m - Highly fractured zone. Weak.						W	HW	EC			RC	100	0				
		20	6				MS	SW	VC	J60 J70	6.00m - J, 60°							
	6.10-6.15m - Crushed zone. Recovered as: sandy medium GRAVEL with minor silt. Subrounded.						VW	HW	EC		6.10m - CZ							
									VC		6.11m - J, 70° 6.15m - J, 70°	RC	100	0				
			7				MS	SW	C	J50 J70 J50	6.60-6.70m - Core broken during removal from catcher. 6.85m - J, 50° 6.85m - J, 70°							
	7.20-7.90m - Highly fractured zone.									J40	6.95m - J, 50° 7.20m - J, MN, silica coated	RC	100	8				
										J30 J30	7.30m - J, 40° 7.60m - J, 30°							
							W	MW	VC		7.75m - J, 30°							
	7.90-8.50m - Recovered as: COBBLES with some gravel and sand. Cobbles and gravel; angular to subangular, weak to very weak. 8.20-8.30m - Well-rounded coarse sized gravel.	18	8								7.90-8.80m - Disturbed on removal from core catcher.							
												RC	75	0				
	8.60-8.80m - Crushed zone. Recovered as: GRAVEL with some sand and minor silt. Gravel; fine to medium, subangular.						EW	CW	EC		8.60m - CZ							
	Core loss.		9								9.00m - B, PL, silica coated							
	Slightly weathered, light and dark grey fractured and indistinctly bedded SILTSTONE. Moderately strong.						MS	MW	VC									
	9.50-9.60m - Crushed zone. Recovered as: GRAVEL with some sand. Gravel and sand; fine to coarse, subangular.									J45	9.50m - CZ 9.51m - J, 45°	RC	95	0				
	9.60-9.85m - Dark grey. Green and white vein						S	SW	C		9.70m - B, ST, limonite stained							
			16															

Notes:

SPT hammer energy ratio 91%
Geotechnical borehole
Core loss placed at end of run by default
123mm OD Rotary Coring
SWL 'nilm' indicates dry well measurement

Started: 28/10/2022 *Finished:* 31/10/2022
Drilling Co.: McMillan Drilling *Drilling Rig:* Hanjin D&B-8D - track
Logged by: C. Hall *Checked by:* C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH10

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350458 E 4873714 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 26 m
Location:	Eastern edge of site, 20m from boundary Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 10 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
	precipitation. Defects are subvertical. Core loss.																	
	END OF BOREHOLE AT 10m - Target Depth Reached																	

Notes:
SPT hammer energy ratio 91%
Geotechnical borehole
Core loss placed at end of run by default
123mm OD Rotary Coring
SWL 'nilm' indicates dry well measurement

Started: 28/10/2022 *Finished:* 31/10/2022
Drilling Co.: McMillan Drilling *Drilling Rig:* Hanjin D&B-8D - track
Logged by: C. Hall *Checked by:* C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH10

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350458 E 4873714 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	10 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 26 m	*Inclination:*	Vertical
Location:	Eastern edge of site, 20m from boundary Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH10.1
BH10 Box 1: 0.0m to 2.5m

Photo BH10.2
BH10 Box 2: 2.5m to 5.0m

Notes:
SPT hammer energy ratio 91%
Geotechnical borehole
Core loss placed at end of run by default
123mm OD Rotary Coring
SWL 'nilm' indicates dry well measurement

Started:	28/10/2022	*Finished:*	31/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH10

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350458 E 4873714 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	10 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 26 m	*Inclination:*	Vertical
Location:	Eastern edge of site, 20m from boundary Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH10.3
BH10 Box 3: 5.0m to 7.2m

Photo BH10.4
BH10 Box 4: 7.2m to 10.0m

Notes:
SPT hammer energy ratio 91%
Geotechnical borehole
Core loss placed at end of run by default
123mm OD Rotary Coring
SWL 'nilm' indicates dry well measurement

Started:	28/10/2022	*Finished:*	31/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

McMILLAN Drilling

SITE INVESTIGATION PERMEABILITY TEST

Job: 20957	
Test: BH06	
Location: Mt Cooee Land fill, Balclutha.	N:
Client: W.S.P Dunedin.	Crew: Kortni.M, Ben.W — E:
Date: 13/10/22	Rig: 272 — Elevation:

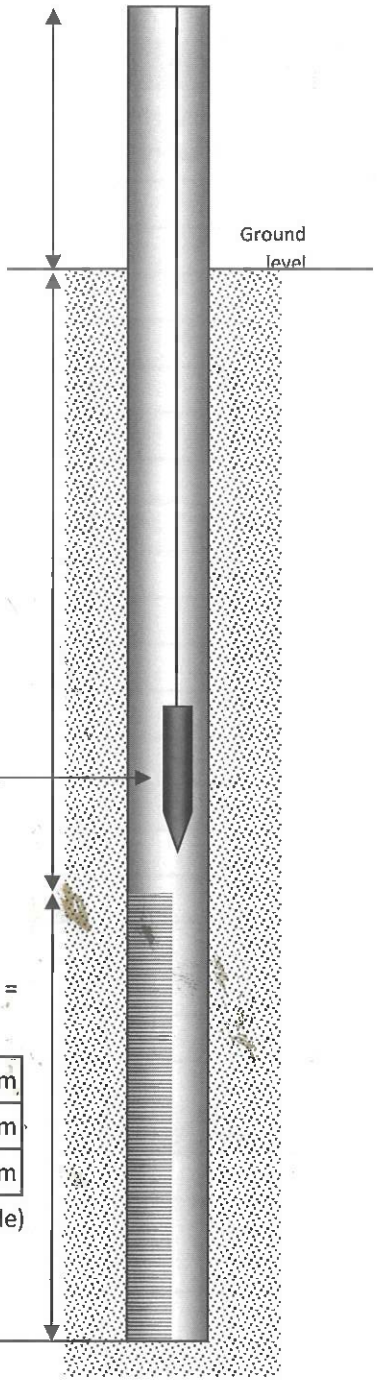
Casing used:

- ☐ 2 ¾"DT — 70mm OD, 55mm ID
- ☐ 3 ½"DT — 90mm OD, 76mm ID
- ☑ ~~DT45~~ PQ — 114mm OD, 95mm ID
- ☐ DT60 — 152mm OD, 134mm ID
- ☐ Other — mm OD, mm ID

Water level before test = 4.96 m below top of casing

Test start time: 12:30

Test end time: 14:00



Height of casing above ground level = 1.0m

Depth of (blank) casing below ground level = 7.70m

Transducer depth below top of casing = X

Height of screen (if any) =

- ☐ spike = 0.525m
- ☐ other = m
- OD = mm
- ID = mm
- ☑ no screen (open hole)

Bottom of hole below ground level = 9.0mbgl

FALLING HEAD - MANUAL READINGS		
Time	Water level below top of casing (m)	Remarks
10 sec	0.820	
20 sec	0.990	
30 sec	1.06	
1 min	1.07	
2 min	1.07	
3 min	1.08	
4 min	1.095	
5 min	1.10	
10 min	1.14	
15 min	1.19	
20 min	1.23	
25 min	1.27	
30 min	1.31	
35 min	1.35	
40 min	1.38	
45 min	1.41	
50 min	1.44	
55 min	1.48	
1 hour	1.50	
90 mins	1.70	

CONSTANT HEAD - WATER ADDED	
Initial vol.	m³
Final vol.	m³

V. 2 - 30/08/2021

McMILLAN Drilling

SITE INVESTIGATION
PERMEABILITY TEST

Job: #20957			
Test: BH09			
Location: Mt Cooee Landfill.		N:	
Client: W.S.P "Dunedin"	Crew: Kortni.M / Ben.W	E:	
Date: 03/11/22	Rig: 272	Elevation:	

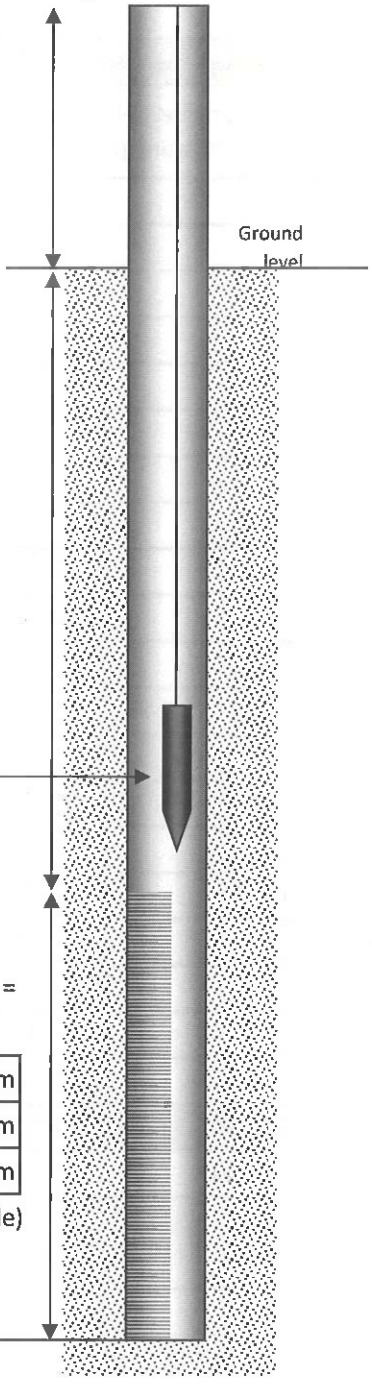
Casing used:

- ☐ 2 ¾"DT — 70mm OD / 55mm ID
- ☐ 3 ½"DT — 90mm OD / 76mm ID
- ☐ DT45 — 114mm OD / 95mm ID
- ☐ DT60 — 152mm OD / 134mm ID
- ☑ Other — PQ 122.60 mm OD / mm ID

Water level before test = 1.0 m below top of casing

Test start time: 14:30

Test end time: 15:00



Height of casing above ground level = 1.0

Depth of (blank) casing below ground level = 4.60

Transducer depth below top of casing = X

Height of screen (if any) =

- ☐ spike = 0.525m
- ☐ other = m
- OD = mm
- ID = mm
- ☐ no screen (open hole)

Bottom of hole below ground level = 6.90mbgl

FALLING HEAD - MANUAL READINGS		
Time	Water level below top of casing (m)	Remarks
10 sec	1.0m	
20 sec	1.0m	
30 sec	1.0m	
1 min	1.0m	
2 min	1.0m	
3 min	1.0m	
4 min	1.0m	
5 min	1.0m	
10 min	1.0m	
15 min	1.0m	
20 min	1.0m	
25 min	1.0m	
30 min	1.0m	
35 min		
40 min		
45 min		
50 min		
55 min		
1 hour		

CONSTANT HEAD - WATER ADDED	
Initial vol.	m³
Final vol.	m³

V. 2 - 30/08/2021

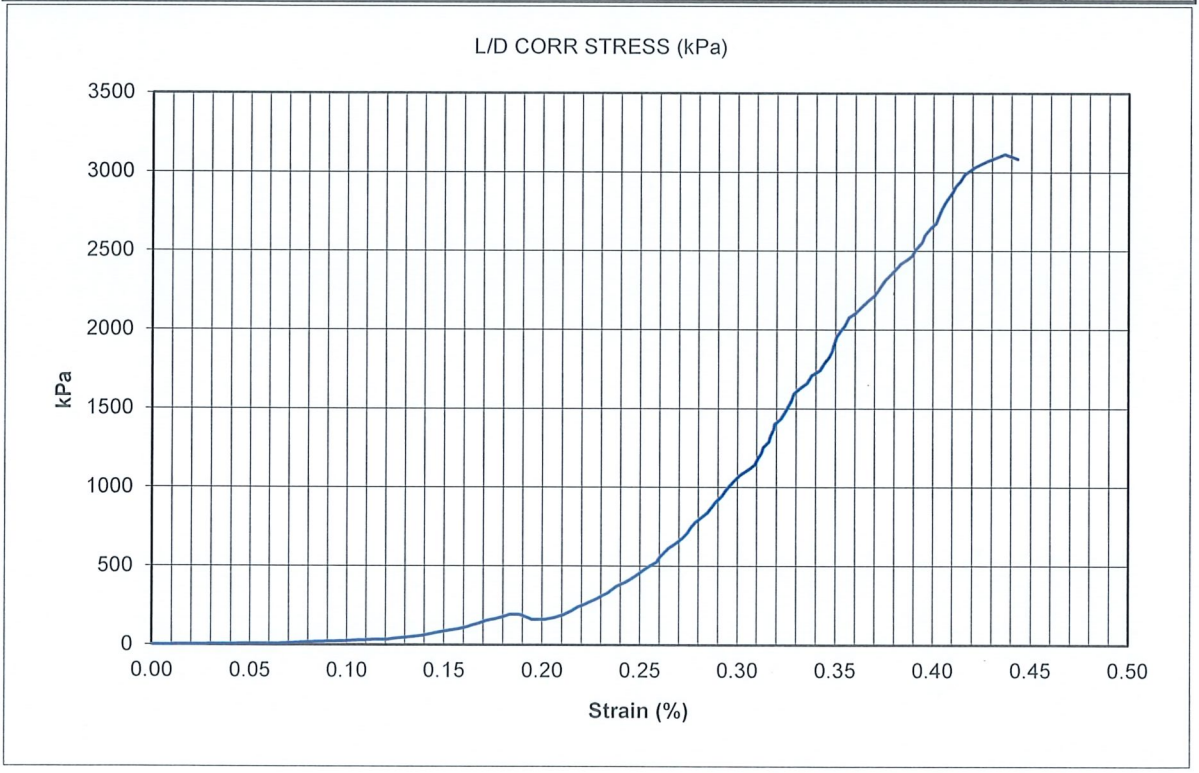
Appendix C
Laboratory Testing Results

UNCONFINED COMPRESSIVE STRESS ON ROCK

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Client ref :	Scott Kvick
Sampled by :	Scott Kvick
Date Sampled:	13 December 2022
Sampling method :	Rotary Core Drill
Sample condition :	Damp as received
Sample description :	Sandstone
Source:	BH08 0.6-0.8m

Project No:	**6-CO082.00/231A**
Lab ref No:	**CH9589/3**
Client Ref:	**Scott Kvick**

Sample ID	**CH9589/3**
Bulk Density t/m³	**2.39**
Water Content %	**8.3**
Dry Density t/m³	**2.20**
Max Stress kPa	**3115.01**
Strain at Failure %	**0.44**



Test Methods

Uniaxial Compression Test : International Society for Rock Mechanics, Part 1 Suggested Method for Determination of the Uniaxial Compres Strength of Rock Materials. (Not IANZ Accredited)

Water Content : NZS 4402:1986 Test 2.1

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

IANZ Approved Signatory :

Designation : *Laboratory Manager*

Date : 11 January 2023

WSP New Zealand Limited
Christchurch Laboratory
Quality Management Systems Certified to ISO 9001

52C Hayton Rd, Wigram
PO Box 1482, Christchurch Mail Centre, Christchurch 8140, New Zealand

Telephone +64 3 343 0739
Facsimile
Website www.wsp.com/nz

UNCONFINED COMPRESSIVE STRESS ON ROCK

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Client ref :	Scott Kvick
Sampled by :	Scott Kvick
Date Sampled:	13 December 2022
Sampling method :	Rotary Core Drill
Sample condition :	Damp as received
Sample description :	Sandstone
Source:	BH08 2.1-2.4m

Project No:	**6-CO082.00/231A**
Lab ref No:	**CH9589/4**
Client Ref:	**Scott Kvick**

Sample ID	**CH9589/4**
Bulk Density t/m³	**2.42**
Water Content %	**6.6**
Dry Density t/m³	**2.27**
Max Stress kPa	**6659.64**
Strain at Failure %	**0.47**

Test Methods

Uniaxial Compression Test : International Society for Rock Mechanics, Part 1 Suggested Method for Determination of the Uniaxial Compres Strength of Rock Materials. (Not IANZ Accredited)

Water Content : NZS 4402:1986 Test 2.1

ACCREDITED IANZ TESTING LABORATORY

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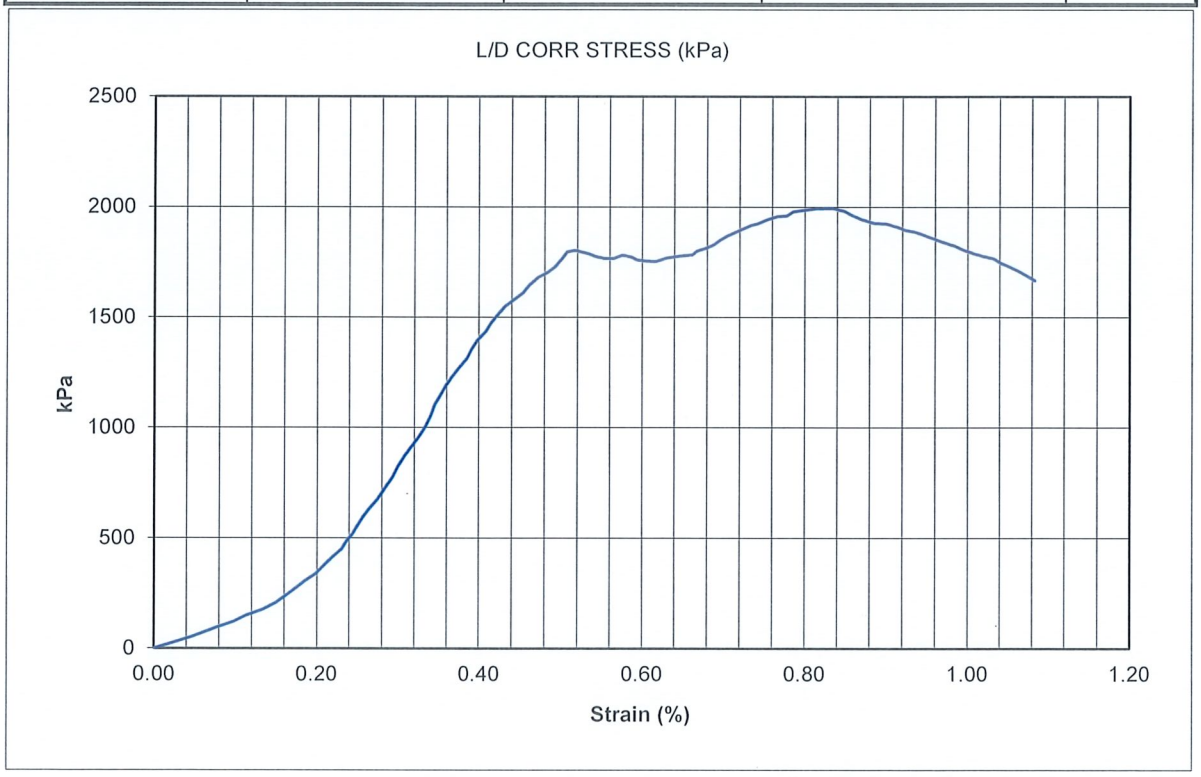
UNCONFINED COMPRESSIVE STRESS ON ROCK

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Client ref :	Scott Kvick
Sampled by :	Scott Kvick
Date Sampled:	13 December 2022
Sampling method :	Rotary Core Drill
Sample condition :	Damp as received
Sample description :	Sandstone
Source:	BH10 5.6-5.9m

Project No:	**6-CO082.00/231A**
Lab ref No:	**CH9589/5**
Client Ref:	**Scott Kvick**

Sample ID	**CH9589/5**
Bulk Density t/m³	**2.39**
Water Content %	**7.8**
Dry Density t/m³	**2.22**
Max Stress kPa	**1994.60**
Strain at Failure %	**0.82**



Test Methods

Uniaxial Compression Test : International Society for Rock Mechanics, Part 1 Suggested Method for Determination of the Uniaxial Compres Strength of Rock Materials. (Not IANZ Accredited)

Water Content : NZS 4402:1986 Test 2.1

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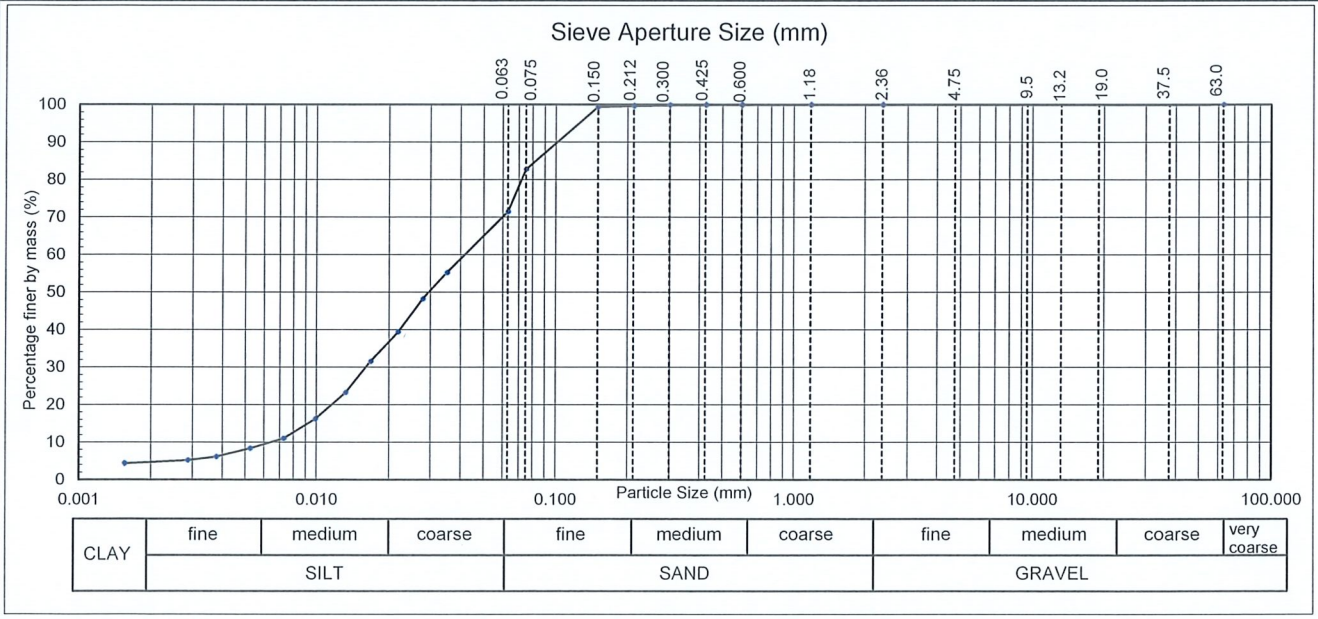
PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)
TEST REPORT

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Client/Sample Ref :	Scott Kvick
Contractor :	WSP Dunedin
Borehole No:	BH01 Depth: 2.0-2.45m metres
Sampled by :	Scott Kvick
Date received :	15 December 2022
Sampling method :	NZS 4402: 1986 (Fine)
Sample condition :	Damp as received
Sample description :	Sandy SILT with trace clay
Solid Particle Density (t/m^3):	2.68 Assumed
Water Content (as received):	29.8 %

Project No:	6-CO082.00/231A
Lab Ref No:	CH9589/1
Client Ref:	Scott Kvick

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	--	0.300	100	0.0351	55	0.0073	11
37.5	--	2.36	100	0.212	100	0.0277	48	0.0052	8
19.0	--	1.18	100	0.150	99	0.0219	39	0.0038	6
13.2	--	0.600	100	0.075	83	0.0168	32	0.0029	5
9.5	--	0.425	100	0.063	71	0.0132	23	0.0016	4
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					0.0099	16		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

Date Tested: 19 December 2022

Date Reported: 10 January 2023

IANZ Approved Signatory

Designation : *Laboratory Manager*

Date : 10 January 2023

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PLASTICITY INDEX FOR AGGREGATES
TEST REPORT

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Contractor :	WSP Dunedin
Sampled by :	Scott Kvick
Date sampled :	13 December 2022
Sampling method :	NZS 4402: 1986 (Fine)
Sample description :	Sandy SILT with trace clay
Sample condition :	As Received
Source :	BH01 2.0-2.45m

Project No :	6-CO082.00/231A
Lab Ref No :	CH9589/1
Client Ref No :	Scott Kvick

Test Results	
Client Ref No :	Scott Kvick
Cone penetration limit :	40
Plastic limit :	Unable to Roll Threads
Plasticity index :	NP
Sample fraction :	Fraction passing 425µm test sieve
As received water content :	29.8

Test Methods	
Water Content	NZS 4407 : 2015 Test 3.1
Cone Penetration	NZS 4407 : 2015 : Test 3.2
Plastic Limit	NZS 4407 : 2015 : Test 3.3
Plasticity Index	NZS 4407 : 2015 : Test 3.4

Date tested : 21 December 2022
Date reported : 10 January 2023

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full
All information supplied by Client

IANZ Approved Signatory

Designation : *Laboratory Manager*
Date : 10 January 2023

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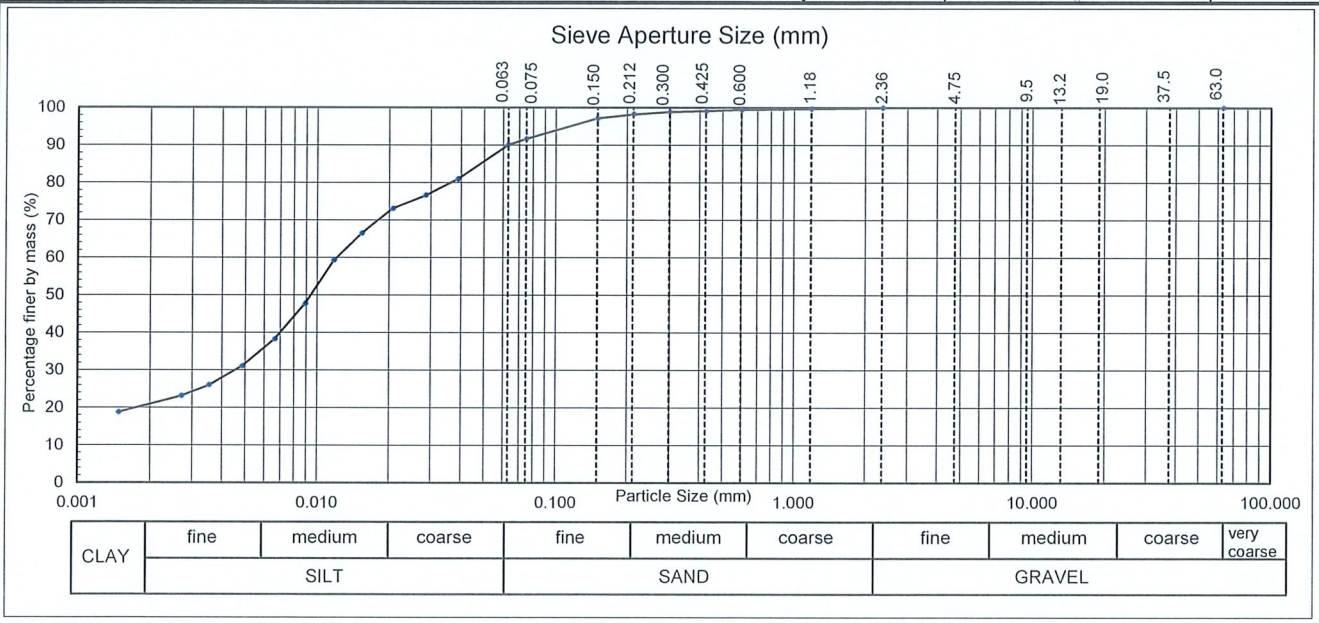
PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)
TEST REPORT

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Client/Sample Ref :	Scott Kvick
Contractor :	WSP Dunedin
Borehole No:	BH01 Depth: 5.0-5.45 metres
Sampled by :	Scott Kvick
Date received :	15 December 2022
Sampling method :	NZS 4402: 1986 (Fine)
Sample condition :	Damp as received
Sample description :	SILT with some clay and minor sand
Solid Particle Density (t/m^3):	2.68 Assumed
Water Content (as received):	34.2 %

Project No:	6-CO082.00/231A
Lab Ref No:	CH9589/2
Client Ref:	Scott Kvick

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	--	0.300	99	0.0387	81	0.0066	38
37.5	--	2.36	100	0.212	98	0.0284	77	0.0049	31
19.0	--	1.18	100	0.150	97	0.0207	73	0.0035	26
13.2	--	0.600	99	0.075	92	0.0153	67	0.0027	23
9.5	--	0.425	99	0.063	90	0.0117	59	0.0015	19
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					0.0089	48		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

This report may only be reproduced in full

Date Tested: 19 December 2022

Date Reported: 10 January 2023

IANZ Approved Signatory

Designation : *Laboratory Manager*

Date : 10 January 2023

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PLASTICITY INDEX FOR SOILS
TEST REPORT

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Contractor :	WSP Dunedin
Sampled by :	Scott Kvick
Date sampled :	13 December 2022
Sampling method :	NZS 4402: 1986 (Fine)
Sample description :	SILT with some clay and minor sand
Sample condition :	As Received
Sample reference:	BH01 5.0-5.45m
Sample depth:	5.0-5.45m

Project No :	6-CO082.00/231A
Lab Ref No :	CH9589/2
Client Ref No :	Scott Kvick

Test Results	
Liquid Limit :	39
Plastic Limit :	25
Plasticity Index :	14
Natural Water Content :	34.2

Test Methods		Notes
Liquid Limit	NZS 4402 : 1986, Test 2.2	Materials used: Fraction passing 425µm test sieve
Plastic Limit	NZS 4402 : 1986, Test 2.3	
Plasticity Index	NZS 4402 : 1986, Test 2.4	
Water Content	NZS 4402 : 1986, Test 2.1	All information supplied by Client

Date tested : 21 December 2022
Date reported : 10 January 2023

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IANZ Approved Signatory

Designation : *Laboratory Manager*
Date : 10 January 2023

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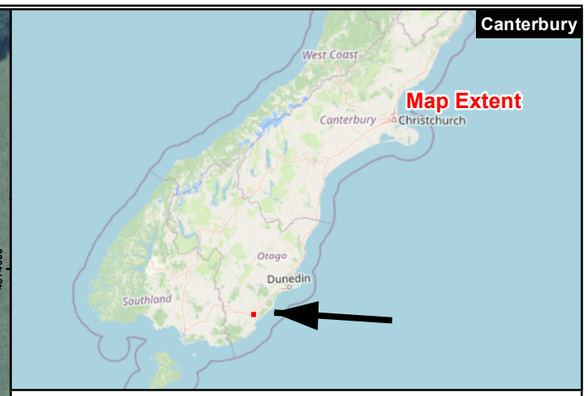


LEGEND

- Proposed New Shallow Groundwater Well
- Proposed Shared Hydro/Geotech Borehole
- Proposed Geotechnical Boreholes
- Existing Groundwater Monitoring Well
- Sediment Pond Monitoring Site
- Surface Water Monitoring Site
- Oxidation Ponds
- Pump Station
- Royds Boreholes (1993)
- Proposed Fill Area Expansion

ISSUED FOR COMMENT

DRAFT

NOTES

1. Map image: © OpenStreetMap (and) contributors, CC-BY-SA Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors
2. Schematic only, not to be interpreted as an engineering design or construction drawing.

0 50 100
Meters

REFERENCE SCALE: 1:2,200 (at A3)

PROJECTION: NZGD 2000 New Zealand Transverse Mercator

CLIENT
CLUTHA DISTRICT COUNCIL

PROJECT
MT COOEE LANDFILL DEVELOPMENT PLAN

TITLE
MT COOEE PROPOSED DRILLING PLAN

CONSULTANT
wsp

YYYY-MM-DD	2022-07-06
PREPARED	KC

PROJECT NO.	REPORT	REV.	FIGURE
6-CO082.00	N/A	N/A	**01**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM A3

0 25mm

Borehole No. BH1

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350038 E 4873817 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m
Location:	30m west of Kaitangata Hwy, south of oxidation ponds Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 11.6 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL, grass, trace rootlets and trace fine quartz gravel. 0.40-0.50m - Woody organics present.											RC	80					Cement seal
Alluvium	Silty CLAY with trace gravel and rootlets, dark grey, homogenous. Soft to firm, moist, high plasticity. Gravel; coarse, subangular. Core loss.	8	1															
	Sandy SILT, light brown to brown, homogenous. Firm, moist to dry, low plasticity, micaceous. Sand; fine.				6	3// 1/2/1/2						SPT	100					
	Silty CLAY with trace sand and gravel, light brown with dark grey and brown specks, homogenous. Firm, moist, high plasticity. Gravel; fine, subangular. Sand; fine to coarse. 1.50m - Orange mottle.										Lab: 1.8 - 3.0m PSD and Atterberg Limits	RC	100					
	Sandy SILT, brown, homogenous. Firm, dry, low plasticity. Sand; fine. 1.80m - Becomes light brown.		2		5	2// 1/1/1/2						SPT	100					31/10/2022
	Silty fine to coarse SAND with trace rootlets, brown, homogenous. Loose, moist, micaceous. Silt; low plasticity.											RC	100					
	Becomes light grey to grey with trace of orange mottles, homogenous. Dry to moist, non-plastic, micaceous.	6	3								2.85-3.00m - Broken during removal from core catcher							
					7	2// 1/2/2/2						SPT	100					
	Silty CLAY with trace sand, light grey with orange mottles throughout, homogenous. Soft to firm, moist, high plasticity, micaceous. Sand; fine to medium. 3.50m - Becomes firm.											RC	100					
	3.90m - Becomes light grey with trace orange mottles (less than above), homogenous.		4															
	Sandy SILT, light brownish grey, homogenous. Soft, non-plastic dry. Sand; fine to medium.				6	2// 2/1/2/1						SPT	100					
	Silty CLAY, light greenish grey, homogenous. Soft to firm, moist, high plasticity.										Lab: 4.4 - 6.1m PSD and Atterberg Limits	RC	100					
		4	5															
					1	0// 0/0/0/1						SPT	100					
	5.45-5.65m - Becomes light greyish green with trace green sandy laminations. 5.65-6.00m - Green sandy lenses. Becomes greenish grey.											RC	100					
		6																
					60+	13// 9/22/22/7 for 20mm						SPT	100					9/03/2023
	Silty CLAY with trace gravel and sand, dark grey with orange mottles, homogenous. Very soft, moist to wet, high plasticity. Gravel; fine to coarse, subangular to angular. Sand; fine to medium, subangular to subrounded.											RC	100					
Caples Terrane	Slightly weathered, highly fractured, light brownish grey, fine fabric SANDSTONE; moderately strong; very closely spaced joints and white veins. Recovered as: sandy GRAVEL with some silt, light brown. Gravel and sand; fine to coarse, subangular. 7.50-8.00m - Gravel becomes; fine to coarse, coarser gravel is angular to subangular, finer gravel is rounded to subrounded.	2	7								6.70-9.35m - Rock broken up by drilling.							
					60+	12// 14/46 for 75mm						SPT	100					
												RC	100				SWL 2.35m	
		8			60+	60 for initial 110mm	MS	SW	VC			SPT	100					
	Slightly weathered, highly fractured, light bluish grey, fine fabric SANDSTONE; moderately strong; closely spaced joints and white veins. Recovered as: Fine to coarse GRAVEL with minor sand, light greyish brown. Very dense, well graded, non-plastic. Gravel; coarser gravel is angular to subangular, finer gravel is rounded to subrounded. Sand; medium to coarse, rounded. 9.17-9.35m - Recovered as: fine to coarse GRAVEL with minor cobbles, light grey. Very dense, well graded. Gravel; subangular, Greywacke, mm-scale white veins. Cobbles: max 80mm.	0	9									RC	100	0				
					60+	60 for initial 105mm			VC C VC		Lab: 9.0 - 11.0m UCS testing 9.17-9.35m - Rock broken up by drilling. Any matrix appears to be lost due to drilling.	SPT	100	0				
							S		C			RC	100	0				50 mm slotted pipe (3.0 m L)

Rotary cored

PQ size wireline (85 mm nom. dia. core)

50 mm Blank pipe (8.2 m L) with grout backfill

BOREHOLE SOIL/ROCK LOG A4 - WSP MT COOEE BOREHOLE LOGS - V0.3.GPJ WSP-OPUS2019_VER11X.GDT 30/3/23

Notes:

SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	19/10/2022	*Finished:*	20/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH1

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350038 E 4873817 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m
Location:	30m west of Kaitangata Hwy, south of oxidation ponds Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 11.6 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Caples Terrane	Slightly weathered, fractured, light grey, fine fabric SANDSTONE; strong; white veins smooth and tight aperture. Recovered as: COBBLES, with some gravel and sand. Well graded. Cobbles and gravel; angular to subangular. Sand; fine to medium.*(continued)* 10.11-11.00m - Thinly laminated veins throughout. Veins are mostly white, some are greenish white. Apertures extremely closely spaced, very narrow. 10.40-10.60m - Heavily veined. Minor sand. 10.80-11.00m - Angular GRAVEL and COBBLES.	-2 / 11		60+	60 for initial 105mm	S	SW	VC			SPT	100	0	Rotary cored			
								C			RC	100	0				
								VC									
				60+	60 for initial 95mm			C			SPT	100	0				
								VC			RC	100	0				
	END OF BOREHOLE AT 11.6m - Target Depth Reached	12															
		-4 / 13															
		14															
		-6 / 15															
		16															
		-8 / 17															
		18															
		-10 / 19															

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 19/10/2022
Finished: 20/10/2022
Drilling Co.: McMillan Drilling
Drilling Rig: Hanjin D&B-8D - track
Logged by: C. Hall
Checked by: C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH1

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350038 E 4873817 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	11.6 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m	*Inclination:*	Vertical
Location:	30m west of Kaitangata Hwy, south of oxidation ponds Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH1.1
BH1 Box 1: 0.0m - 2.4m

Photo BH1.2
BH1 Box 2: 2.4m - 4.45m

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	19/10/2022	*Finished:*	20/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH1

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350038 E 4873817 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	11.6 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m	*Inclination:*	Vertical
Location:	30m west of Kaitangata Hwy, south of oxidation ponds Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH1.3
BH1 Box 3: 4.45m - 7.0m

Photo BH1.4
BH1 Box 4: 7.0m - 9.35m

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	19/10/2022	*Finished:*	20/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH1

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350038 E 4873817 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	11.6 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m	*Inclination:*	Vertical
Location:	30m west of Kaitangata Hwy, south of oxidation ponds Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH1.5
BH1 Box 5: 9.35m - 11.0m

Photo BH1.6
BH1 Box 6: 11.0m - 11.6m

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	19/10/2022	*Finished:*	20/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH1 (ROYDS)

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	Not established
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 116.39 m
Location:	Near Clutha River Bridge Mt Cooee Landfill, Balclutha	*Datum:*	

Depth: 15 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL with some fine gravel.	116															
Tuapeka Group Greywacke	Light grey moderate to widely jointed GREYWACKE. [TUAPEKA GROUP GREYWACKE] - weathered, fractured zone at top of layer - very hard - some quartz filled joints	1												Rotary open hole			4/03/2001 Slotted pipe
		2															
		114															
		3															
		4															
		112															
		5															
		6															
		110															
		7															
		8															
		108															
		9															

BOREHOLE SOIL/ROCK LOG A4 - WSP MT COOEE BOREHOLE LOGS - V0.3.GPJ WSP-QPUS2019_VER11X.GDT 30/3/23

Notes:

Air Rotary drilling method. 150mm diameter.
Taken from Royds Garden Ltd borehole records.

Started: 28/01/1994 *Finished:* 28/01/1994

Drilling Co.: *Drilling Rig:*

Logged by: *Checked by:*

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH1 (ROYDS)

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	Not established
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 116.39 m
Location:	Near Clutha River Bridge Mt Cooee Landfill, Balclutha	*Datum:*	

Depth: 15 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Tuapeka Group Greywacke	Light grey moderate to widely jointed GREYWACKE. [TUAPEKA GROUP GREYWACKE] - weathered, fractured zone at top of layer - very hard - some quartz filled joints*(continued)*	106 / 11 / 12 / 104 / 13 / 14 / 102 / 15												Rotary open hole			Slotted pipe
	END OF BOREHOLE AT 15m	16 / 100 / 17 / 18 / 98 / 19															

Notes:
Air Rotary drilling method. 150mm diameter.
Taken from Royds Garden Ltd borehole records.

Started: 28/01/1994
Finished: 28/01/1994
Drilling Co.:
Drilling Rig:
Logged by:
Checked by:

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH2

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350241 E 4873978 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 16 m
Location:	North of site, north side of railway Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 6 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL.																	
Alluvium	GRAVEL with minor sand, brownish grey. Loose. Gravel; fine to coarse, subrounded, sandstone. Clay/silt/sand matrix inferred washed away. 0.70m - Some matrix present at 0.7m Core loss.	14	1									RC	55	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)	SWL 1.00m	13/10/2022 Cement seal 50 mm slotted pipe (3.0 m L) Grout
Alluvium	Gravelly CLAY with some silt and minor sand, brown. Homogenous, soft, moist, high plasticity. Gravel; fine to coarse, angular, well graded. Core loss.	13	2									RC	45	0				
Caples Terrane	Completely weathered grey and orange/brown, fine fabric SANDSTONE. Extremely weak. Recovered as: SILT with minor gravel and some sand and clay. Homogenous, stiff to very stiff, moist, low plasticity. Gravel; fine to medium, subangular. Sand; fine. Core loss.	12	3 4				EW W EW	CW SW CW	EC VC EC			RC	80	0				
Caples Terrane	Moderately weathered greenish grey, fine fabric SANDSTONE. Very weak to weak. Completely weathered grey and orangeish brown, indistinctly bedded SANDSTONE. Extremely weak. Residual soil recovered as: SILT with some clay. Homogenous, stiff to very stiff, moist, and low plasticity. Moderately weathered greenish grey, indistinctly bedded SANDSTONE. Very weak to weak.	10	5 6				EW W VW W	CW HW MW	EC C VC C VC			RC	100	30				
	END OF BOREHOLE AT 6m - Target Depth Reached	8	7 8 9															
		6																

Notes:

Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 18/10/2022 *Finished:* 19/10/2022

Drilling Co.: McMillan Drilling *Drilling Rig:* Hanjin D&B-8D - track

Logged by: N. Ahern *Checked by:* C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH2

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350241 E 4873978 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	6 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 16 m	*Inclination:*	Vertical
Location:	North of site, north side of railway Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH2.1
BH2 Box 1: 0.0m - 4.2m

Photo BH2.2
BH2 Box 2: 4.2m - 6.0m

Notes:
Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	18/10/2022	*Finished:*	19/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	N. Ahern	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH2 (ROYDS)

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	Not established
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 109.29 m
Location:	Near gate to landfill Mt Cooee Landfill, Balclutha	*Datum:*	

Depth: 9.5 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL with some fine gravel.																
Pleistocene Glacial Deposits	Grey brown mottle yellow brown sandy silty fine GRAVEL.	1 108															
Tuapeka Group Greywacke	Light grey moderate to widely jointed GREYWACKE. - Weathered, fractured zone at top of layer - Very hard - Some quartz filled joints	2 3 106 4 5 104 6 7 102 8 9 100												Rotary open hole			
	END OF BOREHOLE AT 9.5m																

Notes:
Air Rotary drilling method. 150mm diameter.
Taken from Royds Garden Ltd borehole records.

Started: 30/01/1994
Finished: 30/01/1994
Drilling Co.:
Drilling Rig:
Logged by:
Checked by:

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH3

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350135 E 4873642 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 11 m
Location:	Western area of site, 15m north-east of Kaitangata Hwy Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 4.5 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL.																	
Alluvium	SILT with some clay and minor sand, grey/dark brown, homogenous. Soft, moist, low plasticity. Sand; fine to medium.																	
	Clayey SILT with minor sand, light brownish orange. Homogenous, soft, moist, with low to medium plasticity. Sand; fine.																	
Caples Terrane	0.90-0.92m - Cobble of moderately weathered, light brown massive SANDSTONE. Weak.	10	1				EW	CW	EC			RC	100		Rotary cored	PQ size wireline (85 mm nom. dia. core)		Cement seal
	Completely weathered, brownish orange, fine fabric SANDSTONE. Extremely weak. Recovered as: sandy SILT with minor clay, brownish orange, homogenous. Stiff, dry to moist, low plasticity. Sand; fine to medium.								C									Blank (1.5 m L)
	Highly weathered orange/brown, fine fabric SANDSTONE. Very weak. Recovered as: sandy GRAVEL with some cobbles and minor silt and clay, homogenous. Gravel; fine to coarse, subrounded. Cobbles; max 100mm, subrounded. Sand; fine to coarse.		2				VW	HW	EC			RC	65	0				31/10/2022
	Core loss.	8	3						C		2.40-2.50m - Core broken during removal from catcher.							1/02/2023
	Moderately weathered dark green/orange, fine fabric SANDSTONE. Weak. Orange staining on all joint faces. Recovered as: COBBLES with minor gravel. Cobbles; max 100mm, mostly subangular with some subrounded (due to drilling). Gravel; medium to coarse, subangular.						W	MW	VC		3.00-4.30m - Possible weaker material washed out by drilling.	RC	80	0				Bentonite
			4						C									50 mm slotted pipe (1.0 m L)
	Core loss.								VC								SWL 1.60m	
	END OF BOREHOLE AT 4.5m - Target Depth Reached	6	5															
			6															
		4	7															
			8															
		2	9															

Notes:
Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 11/10/2022 *Finished:* 12/10/2022
Drilling Co.: McMillan Drilling *Drilling Rig:* Hanjin D&B-8D - track
Logged by: N. Ahern *Checked by:* C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH3

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350135 E 4873642 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	4.5 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 11 m	*Inclination:*	Vertical
Location:	Western area of site, 15m north-east of Kaitangata Hwy Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH3.1
BH3 Box 1: 0.0m - 3.0m

Photo BH3.2
BH3 Box 2: 3.0m - 4.5m

Notes:
Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	11/10/2022	*Finished:*	12/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	N. Ahern	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH4

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350398 E 4873540 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m
Location:	South-east corner of site Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 5.5 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL with roots and grass.																	
Caples Terrane	Sandy GRAVEL with trace rootlets, light brown to grey. Loosely packed, well graded, non-plastic. Gravel; angular to subangular, greywacke. Sand; fine to coarse, subrounded. 0.50-0.80m - Gravel; subangular to subrounded. Coarse sand; subangular to angular. Core loss.	8	1								0.15-3.70m - Assumed some fines or weaker seams were present but these have been washed away by drilling.	RC	53	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)	SWL 2.30m	Blank 1m Cmt. seal
	Slightly weathered to moderately weathered, highly fractured, orangish brown, fine fabric SANDSTONE; extremely weak; extremely closely spaced tight white veins; extremely weathered defects. Recovered as: COBBLES with some gravel and trace silt and rootlets, orangey brown to grey. Cobbles and gravel; fine to coarse. Cobbles; max 100mm, subangular. Sand; fine to coarse, subangular to subrounded. Silt; dark grey, lensoidal. 2.20-2.40m - Trace pockets of dark grey silt. Core loss.	6	2				EW	MW	EC		1.50-5.50m - Fracturing due to drilling	RC	40	0				31/10/2022
	Slightly weathered to moderately weathered, highly fractured, dark grey SILTSTONE. Very weak, bedding is thinly laminated. Recovered as: Sandy GRAVEL with some cobbles and silt, dark grey with some orange and white veins. Sand; fine to coarse, angular to subangular. Gravel and cobbles; fine to coarse, subangular. Cobbles; max 60mm. Fines; non-plastic. Core loss.	4	3				VW	MW	EC			RC	80	0				
	Slightly weathered, highly fractured, dark bluish grey, fine fabric SILTSTONE. Weak. Mm scale mostly closed and oxidised defects. Recovered as: COBBLES with some gravel and trace silt, dark bluish grey with orange staining. Cobbles and gravel; fine to coarse, subangular. Cobbles; max 150mm. Sand; fine to coarse, subangular to subrounded. 5.00m - Slickenslides on one piece of gravel.	4	5				W	SW	VC	50 / 45	4.10m - J, 50° 4.20m - J, 45°	RC	100	0				09/03/2023
	END OF BOREHOLE AT 5.5m - Target Depth Reached	0	6 7 8 9															50 mm slotted pipe (4.5 m L)

BOREHOLE SOIL/ROCK LOG A4 - WSP MT COOEE BOREHOLE LOGS - V0.3.GPJ WSP-OPUS2019_VER11X.GDT 30/3/23

Notes:

Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	27/10/2022	*Finished:*	27/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH4

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350398 E 4873540 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	5.5 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 9 m	*Inclination:*	Vertical
Location:	South-east corner of site Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH4.1
BH4 Box 1: 0.0m to 3.8m

Photo BH4.2
BH4 Box 2: 3.8m - 5.5m

Notes:
Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	27/10/2022	*Finished:*	27/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH5

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350288 E 4873598 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 7 m
Location:	Southern area of site, 80m north-east of Kaitangata Hwy Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 3 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL with some grass and rootlets and minor quartz sand.																	
Alluvium	Silty CLAY with trace sand, orangish brown, homogenous. Firm to stiff, moist, high plasticity. Sand; medium.																	
Alluvium	Silty CLAY with minor sand, light greyish orange with minor white specks and orange mottle, homogenous. Stiff, moist, high plasticity. 0.90m - Becomes orange. Soft to firm.	6	1								Lab: 0.4 - 1.1m PSD and permeability testing.	RC	100	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)	SWL 2.30m	31/10/2022; Blank pipe 0.9 m; Slotted pipe 0.6 m; Grout
Caples Terrane	Highly weathered, brownish orange, fine fabric indistinctly bedded SANDSTONE. Weak to very weak; orange defects. 1.20m - Becomes moderately weathered to slightly weathered. 1.80-2.00m - Grades into slightly weathered.						VW	HW / SW	VC		Lab: 1.1 - 2.6m UCS testing.							
Caples Terrane	Moderately weathered, greenish grey, fine fabric indistinctly bedded SANDSTONE. Weak to very weak; orange staining along open defects.	4	2				W	MW / SW	C / VC	J10	2.15m - J, 10° 2.50m - J, 10°	RC	100	17				
	END OF BOREHOLE AT 3m - Target Depth Reached		3						C		2.90-3.00m - Core broken during removal from catcher.							
			4															
		2	5															
			6															
		0	7															
			8															
		-2	9															

Notes:

Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 17/10/2022 *Finished:* 18/10/2022

Drilling Co.: McMillan Drilling *Drilling Rig:* Hanjin D&B-8D - track

Logged by: C. Hall *Checked by:* C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH5

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350288 E 4873598 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	3 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 7 m	*Inclination:*	Vertical
Location:	Southern area of site, 80m north-east of Kaitangata Hwy Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH5.1
BH5 Box 1: 0.0m to 2.2m

Photo BH5.2
BH5 Box 2: 2.2m to 3.0m

Notes:
Shallow groundwater well
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	17/10/2022	*Finished:*	18/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH6

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350315 E 4873694 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 21 m
Location:	Middle of site, southwest of excavation Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 9.45 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL with some grass and rootlets, dark brown. 0.20m - Becomes orangish brown.																	
Caples Terrane	Moderately weathered, light brownish orange, highly fractured, SANDSTONE. Moderately strong. Recovered as: gravelly COBBLES with some sand. Cobbles; angular, max 100mm. Gravel; medium to coarse, angular. Core loss.	20	1				MS	MW	VC			RC	73		Rotary cored	PQ size wireline (85 mm nom. dia. core)		50 mm blank pipe (1.0 m L)
	Highly weathered, light brownish orange, highly fractured SANDSTONE. Weak. Recovered as: Sandy GRAVEL with some clay, orangish brown. Gravel; fine to coarse, subangular. Fines; high plasticity.		2		56	15// 10/13/15/18	W	HW	EC			SPT	100					
	2.30m - Re-drilled cobble. Core loss.	18	3									RC	38					
	Moderately weathered, light grey to dark grey, highly fractured SANDSTONE. Moderately strong. Recovered as: GRAVEL with some sand, light grey to dark grey. Gravel; fine to coarse, subangular.				60+	17// 14/16/21/9 for 25mm	MS	MW	VC			SPT	100					
	Core loss.		4									RC	38					
	Completely weathered, greenish grey, fine fabric SILTSTONE. Extremely weak. Recovered as: clayey SAND with trace silt. Sand; fine to medium. Fines; high plasticity. 4.95-5.25m - Lenses of silty CLAY, greenish grey, homogenous. Soft, moist, high plasticity.	16	5		60+	15// 13/26/21 for 45mm	EW	CW	EC			SPT	100				SWL 2.20m	
	Moderately weathered, greenish grey, highly fractured fine fabric, indistinctly bedded SANDSTONE. Weak. Recovered as: sandy GRAVEL with some clay, bluish green. Gravel; medium to coarse. Fines; high plasticity.						W	MW										
	Slightly weathered greenish blue, massive SILTSTONE. Weak to moderately strong. 5.70-5.90m - Moderately weathered, highly fractured along defects. Defects; open or extremely closed spaced and closed. 6.45-6.55m - Pockets of silty SAND with pockets of clay, bluish green, homogenous. Loose, non-plastic. 6.55-7.20m - Black stained defects throughout.		6		60+	15// 20/24/16 for 50mm	MS	SW MW SW	C VC EC		Lab: 5.3 - 9.45m UCS testing.	RC	100					
	Moderately weathered greenish blue, fine fabric SILTSTONE. Weak; black stained defects. Recovered as: COBBLES with some gravel and silt. Cobbles and gravel; angular. Gravel; medium to coarse. 7.00-7.20m - Grades into completely weathered rock. 7.20-7.50m - Recovered as: sandy GRAVEL with some silt, dark greenish grey to black. Loose, non-plastic. Gravel; fine to coarse, subrounded Siltstone.	14	7		60+	36// 48/12 for 35mm			C EC			SPT	100	0				
	8.25m - Becomes slightly weathered, minor fractures, weak to moderately strong. Defects; closed aperture. Grainsize grading larger from Siltstone to Sandstone. 8.75-9.00m - Recovered as: sandy GRAVEL with some silt, dark greenish blue, homogenous. Loose. Gravel; highly weathered. 9.00-9.45m - Recovered as: silty SAND, greenish yellow, homogenous. Soft to firm, low plasticity. Sand; fine to medium.	12	8 9		60+	19// 22/38 for 75mm	W	CW MW SW HW	EC C EC			RC SPT	100 93	0 0			SWL 4.96m	Grout
	END OF BOREHOLE AT 9.45m - Target Depth Reached																	

31/10/2022

50 mm slotted pipe (1.5 m L)

BOREHOLE SOIL/ROCK LOG A4 - WSP MT COOEE BOREHOLE LOGS - V0.3.GPJ WSP-OPUS2019_VER11X.GDT 30/3/23

Notes:

SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Waiting on core box photos to calcuate RQD
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	12/10/2022	*Finished:*	18/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH6

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350315 E 4873694 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	9.45 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 21 m	*Inclination:*	Vertical
Location:	Middle of site, southwest of excavation Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH6.1
BH6 Box 1: 0.0m to 4.5m

Photo BH6.2
BH6 Box 2: 4.5m to 6.8m

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Waiting on core box photos to calcuate RQD
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	12/10/2022	*Finished:*	18/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH6

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350315 E 4873694 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	9.45 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 21 m	*Inclination:*	Vertical
Location:	Middle of site, southwest of excavation Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH6.3
BH6 Box 3: 6.8m to 9.45m

Notes:
SPT hammer energy ratio 91%
Shared Hydro / Geotech borehole
Waiting on core box photos to calcuate RQD
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	12/10/2022	*Finished:*	18/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH7

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350492 E 4873800 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 25 m
Location:	Eastern most corner of site, 20m south of railway Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 6 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL.																	
Caples Terrane	Moderately weathered light grey to light brown with orange mottle, fine fabric SANDSTONE. Weak to moderately strong. Recovered as: gravelly COBBLES with some sand. Cobbles and gravel; angular. Gravel; medium, subrounded. 0.20-0.70m - Coarse to fine gravel, sandy silty matrix inferred fines washed away. Core loss.	24	1				W	MW	EC / VC		0.20-6.00m - Fractures opened by drilling.	RC	75	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)		Surrounding ground collapse
	Highly weathered, light brown with orange mottle, highly fractured, fine fabric SANDSTONE. Strong. Recovered as: Gravelly COBBLES. Gravel and cobbles; angular. 1.00-2.00m - Sand/silt matrix inferred washed away. 1.55m - Becomes completely weathered.				60	31// 34/26	S	HW	VC			RC	85	0				
	Slightly weathered light grey with some orange mottle, fractured, fine fabric SANDSTONE. Moderately strong.		2				MS	SW	C / VC	40	2.40m - J, 40°	RC	100	30				
	2.70-2.90m - Moderately fractured same materials as above, rootlets present. 2.90-3.20m - Recovered as: silty SAND, brownish orange. Loosely packed, dry to moist, low plasticity.	22	3								2.90-3.00m - Core broken during removal from catcher. Core inferred to be baked during drilling.							Gravel
	Moderately weathered dark grey with light brown and orange mottle, fractured, interbedded SANDSTONE and SILTSTONE. Sst = strong, siltst = weak. 3.60-4.05m - Becomes moderately thickly bedded and more mudstone dominant.						W	MW	VC / C / VC			RC	100	10				
	4.05-4.20m - Recovered as: medium to fine gravel with some silt and sand, greenish grey. Loosely packed, moist. Silt; low plasticity.		4								4.00-4.20m - Core broken during removal from catcher.							
	Slightly weathered dark grey with orange mottle, fractured, indistinctly bedded SILTSTONE. Moderately strong. 4.30-4.70m - Discontinuities: extremely closely spaced very narrow to closely spaced closed aperture. 4.90-5.20m - Discontinuities: becomes thinly bedded, thinly laminated, sub-horiztonal planar bedding. 5.20-5.40m - Orange staining increasing. 5.40-5.55m - Minor orange mottle.	20	5				MS / W	SW / MW	C	40 / 60	5.30m - J, 60° 5.31m - J, 40°	RC	80	0			SWL 5.05m	
	Core loss.																	
	END OF BOREHOLE AT 6m - Target Depth Reached	18	6 7 8 9															

BOREHOLE SOIL/ROCK LOG A4 - WSP MT COOEE BOREHOLE LOGS - V0.3.GPJ WSP-OPUS2019_VER11X.GDT 30/3/23

Notes:

SPT hammer energy ratio 91%
Geotechnical borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	1/11/2022	*Finished:*	1/11/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	N. Ahern	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH7

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350492 E 4873800 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	6 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 25 m	*Inclination:*	Vertical
Location:	Eastern most corner of site, 20m south of railway Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH7.1
BH7 Box 1: 0.0m to 3.0m

Photo BH7.2
BH7 Box 2: 3.0m to 6.0m

Notes:
SPT hammer energy ratio 91%
Geotechnical borehole
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	1/11/2022	*Finished:*	1/11/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	N. Ahern	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH8

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350323 E 4873768 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 16 m
Location:	Eastern area of site, 80m north of BH06 Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 4.3 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Caples Terrane	Moderately weathered dark grey to greenish grey with white specks, highly fractured SANDSTONE. Weak. Recovered as: coarse to fine gravel, with some sand. Gravel; subangular. Sand; coarse. 0.20-0.40m - Becomes completely weathered.	14	1				W	MW	EC		Lab: 0.0 - 2.8m UCS testing. 0.40m - Vein, N	RC	100	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)	SWL 0.60m	Grout
	Slightly weathered greenish grey with white specks, coarse grained, veined, indistinctly bedded SANDSTONE. Weak to moderately strong. 1.25-1.50m - Crushed zone. Recovered as: coarse to fine GRAVEL with minor sand. Gravel; angular. Sand; coarse. 1.50m - Becomes light greenish grey and coarse-grained.		2				VW MS	SW	W EC	Vein80	1.25m - CZ 1.50m - Vein, 80°, MW							
	2.50-4.30m - Crushed zone. Recovered as: COBBLES with some gravel and minor silt and sand. Cobbles and gravel; subangular, strong. Sand; fine to medium. 2.70-2.85m - Becomes moderately weathered. Very weak. Recovered as: COBBLES with some gravel and sand. Cobbles and gravel; subangular. Core loss.		3						C	Vein75	2.00m - Vein, 75°, N	RC	95	60				
							VW	HW	VC		2.50m - CZ							
	Moderately weathered greenish grey with minor white specks, coarse grained highly fractured, indistinctly bedded SANDSTONE. Very weak. Recovered as: COBBLES with some gravel and sand. Cobbles and gravel; subangular.	12	4				VW	HW	VC		3.05m - Vein, VN 3.10-4.10m - Highly factured insitu rock. Disturbed on removal from core catcher.	RC	90	53				
	END OF BOREHOLE AT 4.3m - Target Depth Reached		5															
		10	6															
			7															
		8	8															
			9															
			6															

Notes:
Geotechnical borehole
Elevation is estimated from Google Earth
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 3/11/2022
Finished: 3/11/2022
Drilling Co.: McMillan Drilling
Drilling Rig: Hanjin D&B-8D - track
Logged by: N. Ahern
Checked by: C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH8

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350323 E 4873768 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	4.3 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 16 m	*Inclination:*	Vertical
Location:	Eastern area of site, 80m north of BH06 Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH8.1
BH8 Box 1: 0.0m to 2.1m

Photo BH8.2
BH8 Box 2: 2.1m to 4.3m

Notes:
Geotechnical borehole
Elevation is estimated from Google Earth
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	3/11/2022	*Finished:*	3/11/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	N. Ahern	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH9

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350377 E 4873747 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 20 m
Location:	Eastern area of site, middle of excavation Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 6.9 m

Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
Caples Terrane	Highly weathered to completely weathered light grey with some orange mottles, slightly interbedded SANDSTONE and SILTSTONE. Weak to moderately strong; bedding is thinly laminated and gently inclined, smooth undulating.						W	HW	EC			RC	60	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)		Grout
	Recovered as: cobbly GRAVEL with minor trace sand and silt. Cobbles; subangular to subrounded (possibly due to drilling). Gravel; fine to coarse, angular.		1		60+	42// 60 for 25mm												
	Core loss.											SPT	100					
	HW to CW interbedded SANDSTONE and SILTSTONE. As above.						W	HW	EC									
	Core loss.	18	2									RC	47	0				
	HW to CW interbedded SANDSTONE and SILTSTONE. As above.						W	HW	EC			RC	30	0				
	Core loss.		3									RC	0	0				
		16	4															
	Slightly weathered, dark grey with yellowy white veins, interbedded SANDSTONE and SILTSTONE. Moderately strong to strong. Bedding is thinly laminated, undulating smooth, very narrow to closed, fine grained. Veining is stepped.				60+	5// 1/46 for 25mm	EW	CW	EC			SPT	100					
							MS	SW	C									
	4.50-4.70m - Completely weathered. Recovered as: silty SAND with minor gravel and cobbles, dark grey. Moist. Sand; coarse to medium. Gravel; fine to coarse, subangular. Silt; non-plastic.		5				S	SW	EC C EC VC		5.10-5.25m - Broken to gravel by drilling. 5.40-5.50m - Broken to gravel by drilling.	RC	100	50			SWL 1.70m	
	Slightly weathered, light bluish grey with minor white specks, indistinctly interbedded, fine fabric SANDSTONE and SILTSTONE. Strong. 5.90m - Becomes light grey and moderately strong.	14	6				MS		C C C EC	J35 J40	5.90m - J, 35°, SL, clean 6.00m - J, 40°, SL, clean 6.20-6.60m - Broken to gravel by drilling.	RC	100	0				
	Core loss.																SWL 0.00m	
	END OF BOREHOLE AT 6.9m - Target Depth Reached		7															
		12	8															
			9															
			10															

Notes:

SPT hammer energy ratio 91%
Geotechnical borehole
Elevation is estimated from Google Earth
Core loss placed at end of run by default
123mm OD Rotary Coring

Started: 2/11/2022 *Finished:* 3/11/2022

Drilling Co.: McMillan Drilling *Drilling Rig:* Hanjin D&B-8D - track

Logged by: N. Ahern *Checked by:* C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH9

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350377 E 4873747 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	6.9 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 20 m	*Inclination:*	Vertical
Location:	Eastern area of site, middle of excavation Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH9.1
BH9 Box 1: 0.0m to 5.5m

Photo BH9.2
BH9 Box 2: 5.5m to 6.9m

Notes:
SPT hammer energy ratio 91%
Geotechnical borehole
Elevation is estimated from Google Earth
Core loss placed at end of run by default
123mm OD Rotary Coring

Started:	2/11/2022	*Finished:*	3/11/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	N. Ahern	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH10

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350458 E 4873714 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 26 m
Location:	Eastern edge of site, 20m from boundary Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 10 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
TS	TOPSOIL with grass and rootlets.																	
Fill	Clayey SILT with trace gravel, light brown with black specks, homogenous. Firm to stiff, moist, low plasticity. 0.65m - Becomes brownish orange and firm.											RC	100	0				
Caples Terrane	Completely weathered brownish orange highly fractured, fine fabric SANDSTONE. Extremely weak. Recovered as: SILT with some clay and trace gravel, homogenous. Firm, moist, low plasticity. Minor rootlets present. Gravel corestones are very weak. 1.42-2.75m - Remoulds to: clayey SAND with minor silt and gravel, orangish brown, homogenous. Moist, low plasticity. Gravel; fine to coarse, HW - CW Sandstone, very weak. Sand; medium to coarse, angular to subangular. Fines; Soft.	1			22	6// 5/5/6/6	EW	CW	EC			SPT	100	0				
			2									RC	100	0				
		24			57	13// 10/15/14/18						SPT	100	0				
	2.45-2.75m - Trace rootlets.											RC	100	0				
	Grading to highly weathered, dark brown with orange weathering and white specks, fractured, fine fabric SANDSTONE. Extremely weak. Recovered as: sandy GRAVEL with minor silt. Moist, non-plastic. Gravel; fine to coarse, angular to subangular. Sand; fine to coarse.		3		60+	21// 17/20/23 for 70mm						SPT	100	0				
	Highly weathered, dark orangish brown highly fractured SANDSTONE. Very weak to weak. Recovered as: Sandy GRAVEL with some cobbles and minor silt. Low plasticity. Gravel; fine to medium, angular to subangular. Sand; fine to coarse, angular to subangular.	22	4				VW	HW				RC	100	0			SWL nilm	
					57	18// 12/12/16/17						SPT	100	0				
	Moderately weathered, orangish brown fractured SANDSTONE. Weak. Recovered as: gravelly COBBLES with some sand. Cobbles and gravel; fine to coarse, cobbles max 100mm, subangular. Sand; medium to coarse, rounded.						W	MW	VC			RC	100	0				
	Slightly weathered, orangish brown with oxidised defects, fractured SANDSTONE. Moderately strong. Discontinuities; very closely spaced closed joints, cross-cutting and sub-vertical, rough to smooth planar.		5		60+	27// 51/9 for 5mm	MS	SW		J70 J60	5.30m - J, 70° 5.40m - J, 60°	SPT	100	0	Rotary cored	PQ size wireline (85 mm nom. dia. core)		50 mm blank pipe (1.0 m L) 9/11/2022 9/03/2023 50 mm slotted pipe (9.0 m L)
	5.60-5.70m - Highly fractured zone. Weak.						W	HW	EC			RC	100	0				
		20	6				MS	SW	VC	J60 J70	6.00m - J, 60°							
	6.10-6.15m - Crushed zone. Recovered as: sandy medium GRAVEL with minor silt. Subrounded.						VW	HW	EC		6.10m - CZ							
									VC		6.11m - J, 70° 6.15m - J, 70°	RC	100	0				
			7				MS	SW	C	J50 J70 J50	6.60-6.70m - Core broken during removal from catcher. 6.85m - J, 50° 6.85m - J, 70°							
	7.20-7.90m - Highly fractured zone.									J40	6.95m - J, 50° 7.20m - J, MN, silica coated	RC	100	8				
										J30 J30	7.30m - J, 40° 7.60m - J, 30°							
							W	MW	VC		7.75m - J, 30°							
	7.90-8.50m - Recovered as: COBBLES with some gravel and sand. Cobbles and gravel; angular to subangular, weak to very weak. 8.20-8.30m - Well-rounded coarse sized gravel.	18	8								7.90-8.80m - Disturbed on removal from core catcher.							
												RC	75	0				
	8.60-8.80m - Crushed zone. Recovered as: GRAVEL with some sand and minor silt. Gravel; fine to medium, subangular.						EW	CW	EC		8.60m - CZ							
	Core loss.		9								9.00m - B, PL, silica coated							
	Slightly weathered, light and dark grey fractured and indistinctly bedded SILTSTONE. Moderately strong.						MS	MW	VC									
	9.50-9.60m - Crushed zone. Recovered as: GRAVEL with some sand. Gravel and sand; fine to coarse, subangular.									J45	9.50m - CZ 9.51m - J, 45°	RC	95	0				
	9.60-9.85m - Dark grey. Green and white vein						S	SW	C		9.70m - B, ST, limonite stained							
			16															

Notes:

SPT hammer energy ratio 91%
Geotechnical borehole
Core loss placed at end of run by default
123mm OD Rotary Coring
SWL 'nilm' indicates dry well measurement

Started: 28/10/2022 *Finished:* 31/10/2022
Drilling Co.: McMillan Drilling *Drilling Rig:* Hanjin D&B-8D - track
Logged by: C. Hall *Checked by:* C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH10

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350458 E 4873714 N
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM
Project No.:	6-CO082.00	*R.L.:*	Approx. 26 m
Location:	Eastern edge of site, 20m from boundary Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016

Depth: 10 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING	ROCK DEFECT SPACING	DEFECT DIP (degrees 0–90)	DEFECTS / NOTES / OTHER TESTS	CORE: SAMPLE TYPE	CORE: TCR (%)	CORE: RQD (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	INSTALLATION DETAILS
	precipitation. Defects are subvertical. Core loss.																	
	END OF BOREHOLE AT 10m - Target Depth Reached																	

Notes:
SPT hammer energy ratio 91%
Geotechnical borehole
Core loss placed at end of run by default
123mm OD Rotary Coring
SWL 'nilm' indicates dry well measurement

Started: 28/10/2022 *Finished:* 31/10/2022
Drilling Co.: McMillan Drilling *Drilling Rig:* Hanjin D&B-8D - track
Logged by: C. Hall *Checked by:* C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH10

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350458 E 4873714 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	10 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 26 m	*Inclination:*	Vertical
Location:	Eastern edge of site, 20m from boundary Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH10.1
BH10 Box 1: 0.0m to 2.5m

Photo BH10.2
BH10 Box 2: 2.5m to 5.0m

Notes:
SPT hammer energy ratio 91%
Geotechnical borehole
Core loss placed at end of run by default
123mm OD Rotary Coring
SWL 'nilm' indicates dry well measurement

Started:	28/10/2022	*Finished:*	31/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH10

Project:	Mt Cooee Landfill - Development Plan	*Coordinates:*	1350458 E 4873714 N		
Client:	Clutha District Council (CDC)	*Ref. Grid:*	NZTM	*Depth:*	10 m
Project No.:	6-CO082.00	*R.L.:*	Approx. 26 m	*Inclination:*	Vertical
Location:	Eastern edge of site, 20m from boundary Mt Cooee Landfill, Balclutha	*Datum:*	NZ Vertical Datum 2016		

PHOTOGRAPHS

Photo BH10.3
BH10 Box 3: 5.0m to 7.2m

Photo BH10.4
BH10 Box 4: 7.2m to 10.0m

Notes:
SPT hammer energy ratio 91%
Geotechnical borehole
Core loss placed at end of run by default
123mm OD Rotary Coring
SWL 'nilm' indicates dry well measurement

Started:	28/10/2022	*Finished:*	31/10/2022
Drilling Co.:	McMillan Drilling	*Drilling Rig:*	Hanjin D&B-8D - track
Logged by:	C. Hall	*Checked by:*	C. Parkes

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

McMILLAN Drilling

SITE INVESTIGATION PERMEABILITY TEST

Job: 20957	
Test: BH06	
Location: Mt Cooee Land fill, Balclutha.	N:
Client: W.S.P Dunedin.	Crew: Kortni.M, Ben.W — E:
Date: 13/10/22	Rig: 272 — Elevation:

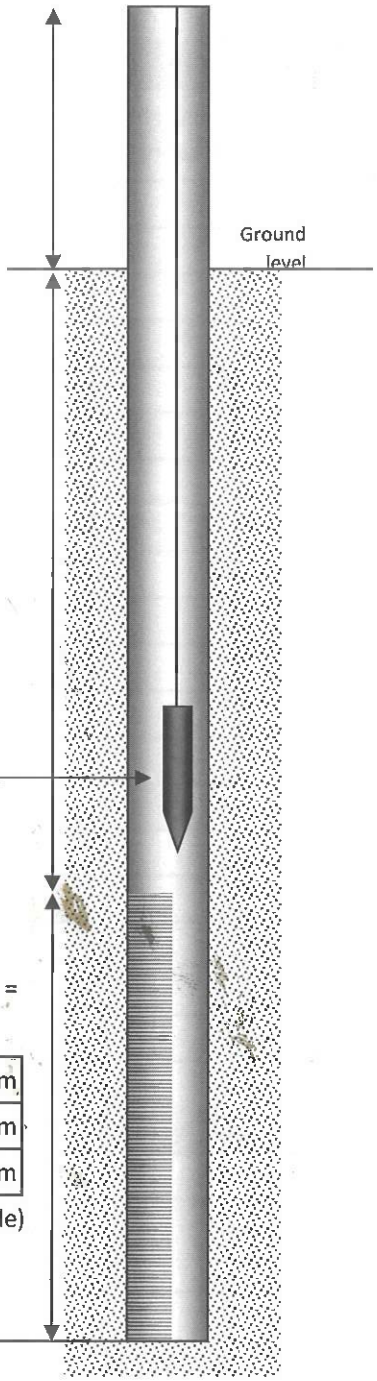
Casing used:

- ☐ 2 ¾"DT — 70mm OD, 55mm ID
- ☐ 3 ½"DT — 90mm OD, 76mm ID
- ☑ ~~DT45~~ PQ — 114mm OD, 95mm ID
- ☐ DT60 — 152mm OD, 134mm ID
- ☐ Other — mm OD, mm ID

Water level before test = 4.96 m below top of casing

Test start time: 12:30

Test end time: 14:00



Height of casing above ground level = 1.0m

Depth of (blank) casing below ground level = 7.70m

Transducer depth below top of casing = X

Height of screen (if any) =

- ☐ spike = 0.525m
- ☐ other = m
- OD = mm
- ID = mm
- ☑ no screen (open hole)

Bottom of hole below ground level = 9.0mbgl

FALLING HEAD - MANUAL READINGS		
Time	Water level below top of casing (m)	Remarks
10 sec	0.820	
20 sec	0.990	
30 sec	1.06	
1 min	1.07	
2 min	1.07	
3 min	1.08	
4 min	1.095	
5 min	1.10	
10 min	1.14	
15 min	1.19	
20 min	1.23	
25 min	1.27	
30 min	1.31	
35 min	1.35	
40 min	1.38	
45 min	1.41	
50 min	1.44	
55 min	1.48	
1 hour	1.50	
90 mins	1.70	

CONSTANT HEAD - WATER ADDED	
Initial vol.	m³
Final vol.	m³

V. 2 - 30/08/2021

McMILLAN Drilling

SITE INVESTIGATION
PERMEABILITY TEST

Job: #20957			
Test: BH09			
Location: Mt Cooee Landfill.		N:	
Client: W.S.P "Dunedin"	Crew: Kortni.M / Ben.W	E:	
Date: 03/11/22	Rig: 272	Elevation:	

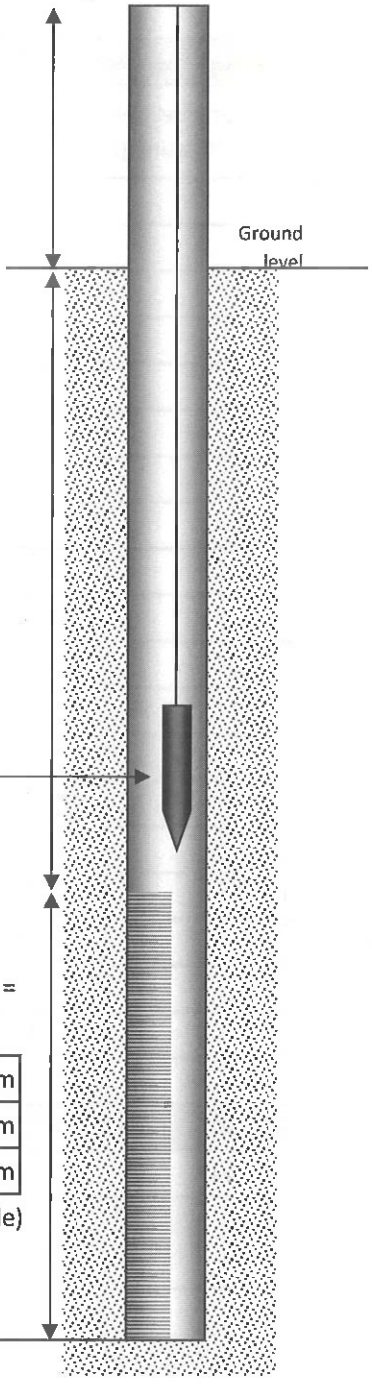
Casing used:

- ☐ 2 ¾"DT — 70mm OD / 55mm ID
- ☐ 3 ½"DT — 90mm OD / 76mm ID
- ☐ DT45 — 114mm OD / 95mm ID
- ☐ DT60 — 152mm OD / 134mm ID
- ☑ Other — PQ 122.60 mm OD / mm ID

Water level before test = 1.0 m below top of casing

Test start time: 14:30

Test end time: 15:00



Height of casing above ground level = 1.0

Depth of (blank) casing below ground level = 4.60

Transducer depth below top of casing = X

Height of screen (if any) =

- ☐ spike = 0.525m
- ☐ other = m
- OD = mm
- ID = mm
- ☐ no screen (open hole)

Bottom of hole below ground level = 6.90mbgl

FALLING HEAD - MANUAL READINGS		
Time	Water level below top of casing (m)	Remarks
10 sec	1.0m	
20 sec	1.0m	
30 sec	1.0m	
1 min	1.0m	
2 min	1.0m	
3 min	1.0m	
4 min	1.0m	
5 min	1.0m	
10 min	1.0m	
15 min	1.0m	
20 min	1.0m	
25 min	1.0m	
30 min	1.0m	
35 min		
40 min		
45 min		
50 min		
55 min		
1 hour		

CONSTANT HEAD - WATER ADDED	
Initial vol.	m³
Final vol.	m³

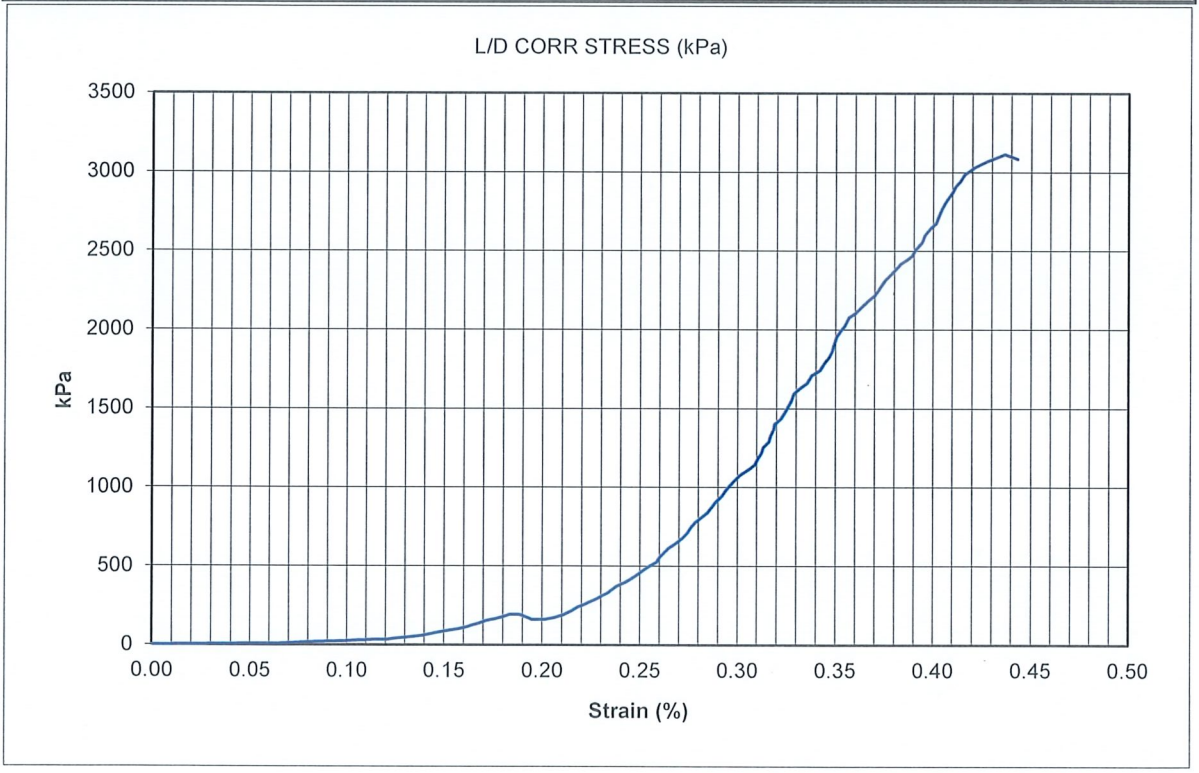
V. 2 - 30/08/2021

UNCONFINED COMPRESSIVE STRESS ON ROCK

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Client ref :	Scott Kvick
Sampled by :	Scott Kvick
Date Sampled:	13 December 2022
Sampling method :	Rotary Core Drill
Sample condition :	Damp as received
Sample description :	Sandstone
Source:	BH08 0.6-0.8m

Project No:	**6-CO082.00/231A**
Lab ref No:	**CH9589/3**
Client Ref:	**Scott Kvick**

Sample ID	**CH9589/3**
Bulk Density t/m³	**2.39**
Water Content %	**8.3**
Dry Density t/m³	**2.20**
Max Stress kPa	**3115.01**
Strain at Failure %	**0.44**



Test Methods

Uniaxial Compression Test : International Society for Rock Mechanics, Part 1 Suggested Method for Determination of the Uniaxial Compres Strength of Rock Materials. (Not IANZ Accredited)

Water Content : NZS 4402:1986 Test 2.1

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

IANZ Approved Signatory :

Designation : *Laboratory Manager*

Date : 11 January 2023

WSP New Zealand Limited
Christchurch Laboratory
Quality Management Systems Certified to ISO 9001

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PO Box 1482, Christchurch Mail Centre, Christchurch 8140, New Zealand

Telephone +64 3 343 0739
Facsimile
Website www.wsp.com/nz

UNCONFINED COMPRESSIVE STRESS ON ROCK

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Client ref :	Scott Kvick
Sampled by :	Scott Kvick
Date Sampled:	13 December 2022
Sampling method :	Rotary Core Drill
Sample condition :	Damp as received
Sample description :	Sandstone
Source:	BH08 2.1-2.4m

Project No:	**6-CO082.00/231A**
Lab ref No:	**CH9589/4**
Client Ref:	**Scott Kvick**

Sample ID	**CH9589/4**
Bulk Density t/m³	**2.42**
Water Content %	**6.6**
Dry Density t/m³	**2.27**
Max Stress kPa	**6659.64**
Strain at Failure %	**0.47**

Test Methods

Uniaxial Compression Test : International Society for Rock Mechanics, Part 1 Suggested Method for Determination of the Uniaxial Compres Strength of Rock Materials. (Not IANZ Accredited)

Water Content : NZS 4402:1986 Test 2.1

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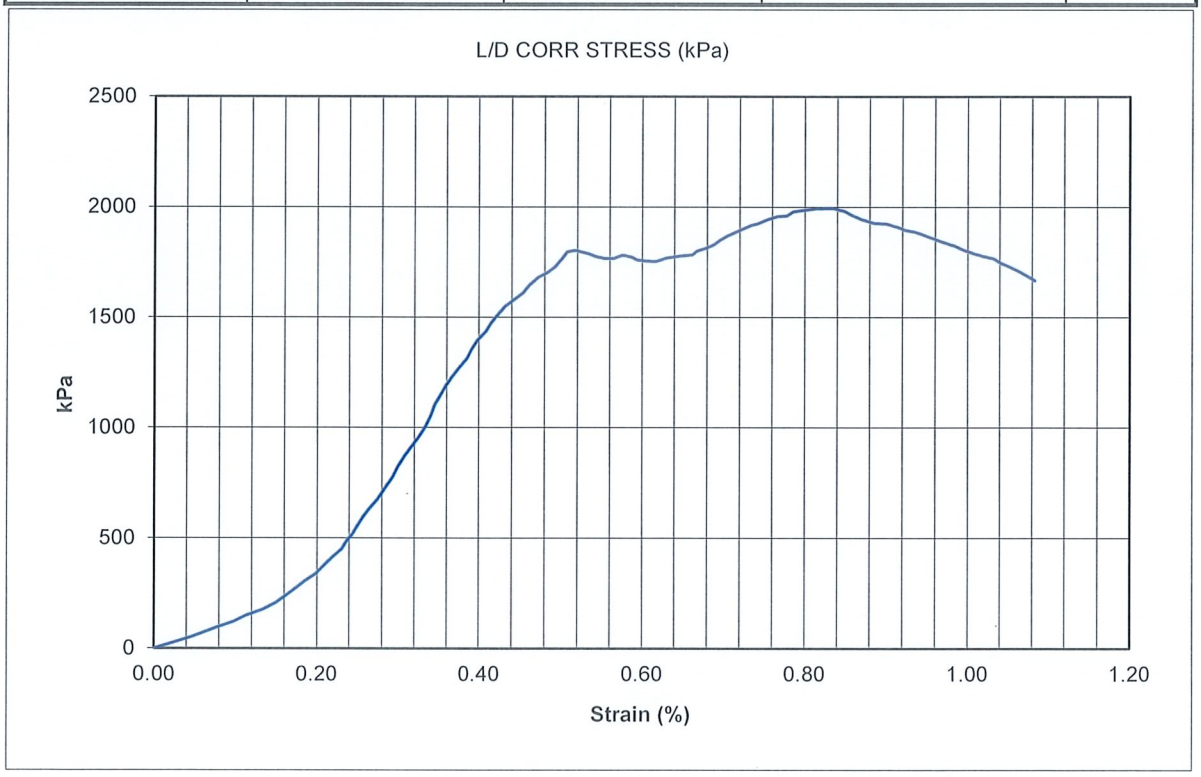
UNCONFINED COMPRESSIVE STRESS ON ROCK

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Client ref :	Scott Kvick
Sampled by :	Scott Kvick
Date Sampled:	13 December 2022
Sampling method :	Rotary Core Drill
Sample condition :	Damp as received
Sample description :	Sandstone
Source:	BH10 5.6-5.9m

Project No:	**6-CO082.00/231A**
Lab ref No:	**CH9589/5**
Client Ref:	**Scott Kvick**

Sample ID	**CH9589/5**
Bulk Density t/m³	**2.39**
Water Content %	**7.8**
Dry Density t/m³	**2.22**
Max Stress kPa	**1994.60**
Strain at Failure %	**0.82**



Test Methods

Uniaxial Compression Test : International Society for Rock Mechanics, Part 1 Suggested Method for Determination of the Uniaxial Compres Strength of Rock Materials. (Not IANZ Accredited)

Water Content : NZS 4402:1986 Test 2.1

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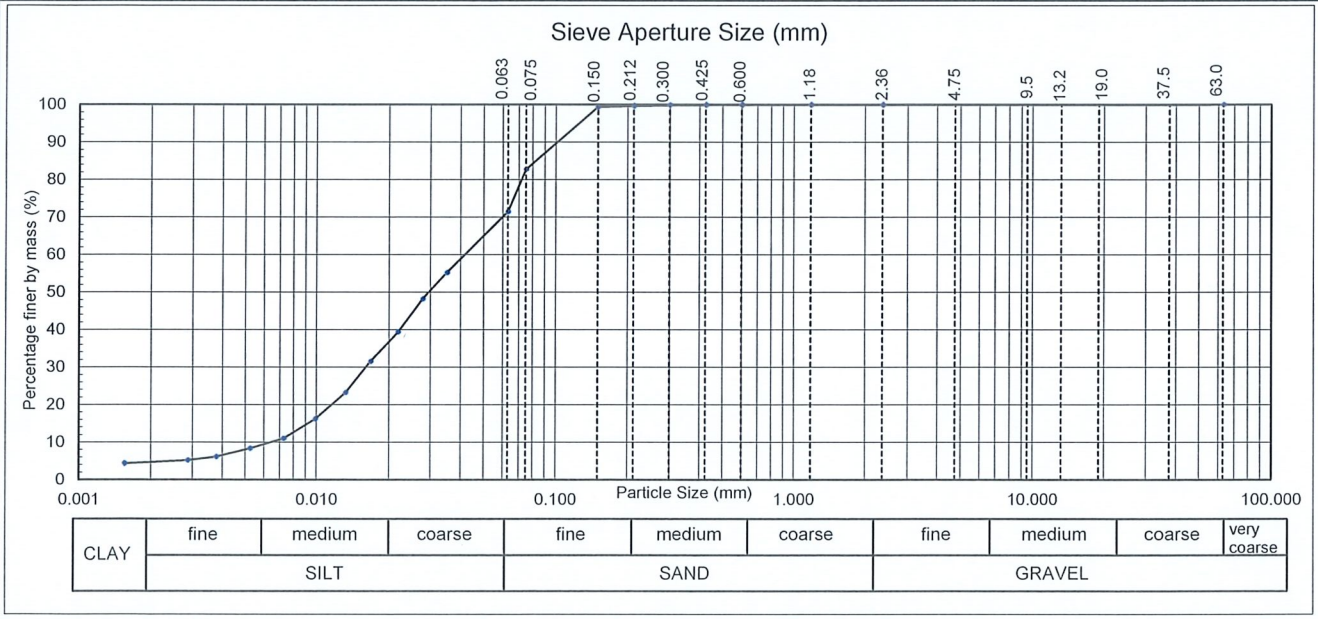
PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)
TEST REPORT

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Client/Sample Ref :	Scott Kvick
Contractor :	WSP Dunedin
Borehole No:	BH01 Depth: 2.0-2.45m metres
Sampled by :	Scott Kvick
Date received :	15 December 2022
Sampling method :	NZS 4402: 1986 (Fine)
Sample condition :	Damp as received
Sample description :	Sandy SILT with trace clay
Solid Particle Density (t/m^3):	2.68 Assumed
Water Content (as received):	29.8 %

Project No:	6-CO082.00/231A
Lab Ref No:	CH9589/1
Client Ref:	Scott Kvick

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	--	0.300	100	0.0351	55	0.0073	11
37.5	--	2.36	100	0.212	100	0.0277	48	0.0052	8
19.0	--	1.18	100	0.150	99	0.0219	39	0.0038	6
13.2	--	0.600	100	0.075	83	0.0168	32	0.0029	5
9.5	--	0.425	100	0.063	71	0.0132	23	0.0016	4
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					0.0099	16		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

Date Tested: 19 December 2022

Date Reported: 10 January 2023

IANZ Approved Signatory

Designation : *Laboratory Manager*

Date : 10 January 2023

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

WSP
Christchurch (Hayton Rd)
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Christchurch, New Zealand

Telephone +64 3 343 0739
Website www.wsp.com/nz

PLASTICITY INDEX FOR AGGREGATES
TEST REPORT

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Contractor :	WSP Dunedin
Sampled by :	Scott Kvick
Date sampled :	13 December 2022
Sampling method :	NZS 4402: 1986 (Fine)
Sample description :	Sandy SILT with trace clay
Sample condition :	As Received
Source :	BH01 2.0-2.45m

Project No :	6-CO082.00/231A
Lab Ref No :	CH9589/1
Client Ref No :	Scott Kvick

Test Results	
Client Ref No :	Scott Kvick
Cone penetration limit :	40
Plastic limit :	Unable to Roll Threads
Plasticity index :	NP
Sample fraction :	Fraction passing 425µm test sieve
As received water content :	29.8

Test Methods	
Water Content	NZS 4407 : 2015 Test 3.1
Cone Penetration	NZS 4407 : 2015 : Test 3.2
Plastic Limit	NZS 4407 : 2015 : Test 3.3
Plasticity Index	NZS 4407 : 2015 : Test 3.4

Date tested : 21 December 2022
Date reported : 10 January 2023

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full
All information supplied by Client

IANZ Approved Signatory

Designation : *Laboratory Manager*
Date : 10 January 2023

ACCREDITED IANZ TESTING LABORATORY

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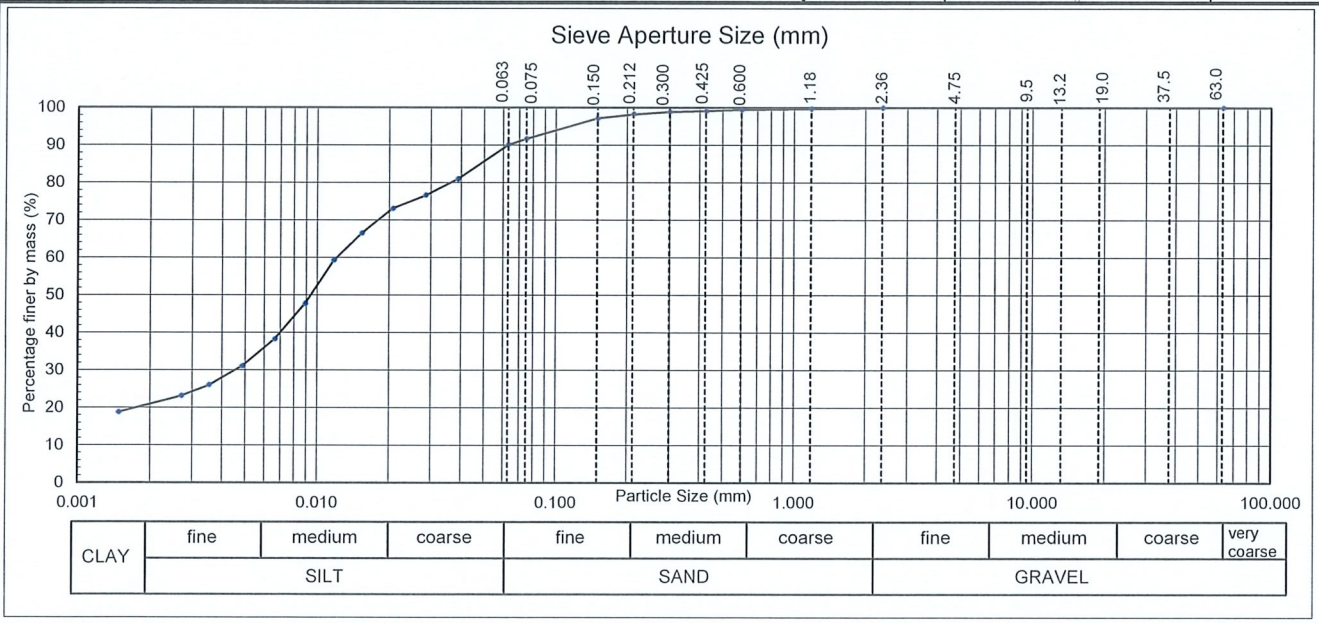
PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)
TEST REPORT

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Client/Sample Ref :	Scott Kvick
Contractor :	WSP Dunedin
Borehole No:	BH01 Depth: 5.0-5.45 metres
Sampled by :	Scott Kvick
Date received :	15 December 2022
Sampling method :	NZS 4402: 1986 (Fine)
Sample condition :	Damp as received
Sample description :	SILT with some clay and minor sand
Solid Particle Density (t/m^3):	2.68 Assumed
Water Content (as received):	34.2 %

Project No:	6-CO082.00/231A
Lab Ref No:	CH9589/2
Client Ref:	Scott Kvick

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	--	0.300	99	0.0387	81	0.0066	38
37.5	--	2.36	100	0.212	98	0.0284	77	0.0049	31
19.0	--	1.18	100	0.150	97	0.0207	73	0.0035	26
13.2	--	0.600	99	0.075	92	0.0153	67	0.0027	23
9.5	--	0.425	99	0.063	90	0.0117	59	0.0015	19
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					0.0089	48		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

This report may only be reproduced in full

Date Tested: 19 December 2022

Date Reported: 10 January 2023

IANZ Approved Signatory

Designation : *Laboratory Manager*

Date : 10 January 2023

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

WSP
Christchurch (Hayton Rd)
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PO Box 1482, Christchurch Mail Centre, 8140,
Christchurch, New Zealand

Telephone +64 3 343 0739
Website www.wsp.com/nz

PLASTICITY INDEX FOR SOILS
TEST REPORT

Project :	Material Investigation
Location :	Mt Cooee Landfill
Client :	Clutha District Council
Contractor :	WSP Dunedin
Sampled by :	Scott Kvick
Date sampled :	13 December 2022
Sampling method :	NZS 4402: 1986 (Fine)
Sample description :	SILT with some clay and minor sand
Sample condition :	As Received
Sample reference:	BH01 5.0-5.45m
Sample depth:	5.0-5.45m

Project No :	6-CO082.00/231A
Lab Ref No :	CH9589/2
Client Ref No :	Scott Kvick

Test Results	
Liquid Limit :	39
Plastic Limit :	25
Plasticity Index :	14
Natural Water Content :	34.2

Test Methods		Notes
Liquid Limit	NZS 4402 : 1986, Test 2.2	Materials used: Fraction passing 425µm test sieve
Plastic Limit	NZS 4402 : 1986, Test 2.3	
Plasticity Index	NZS 4402 : 1986, Test 2.4	
Water Content	NZS 4402 : 1986, Test 2.1	All information supplied by Client

Date tested : 21 December 2022
Date reported : 10 January 2023

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IANZ Approved Signatory

Designation : *Laboratory Manager*
Date : 10 January 2023

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