

Gleam Hydro (Pty) Ltd
130 Bagley Terrace
Valeriedene
Randburg
2543

20 August 2023
Our Reference: RG/022/316/Report 1
Client Reference: PO0000007

RE: MCCAIN DELMAS - WASTE WATER TREATMENT PLANT (WWTP)
PHASE 1 SHALLOW SURFACE GEOTECHNICAL AND DOLOMITE STABILITY
INVESTIGATIONS

Attention: Mr. Johan Kriek
Email: johan@gleam.co.za

Dear Sir,

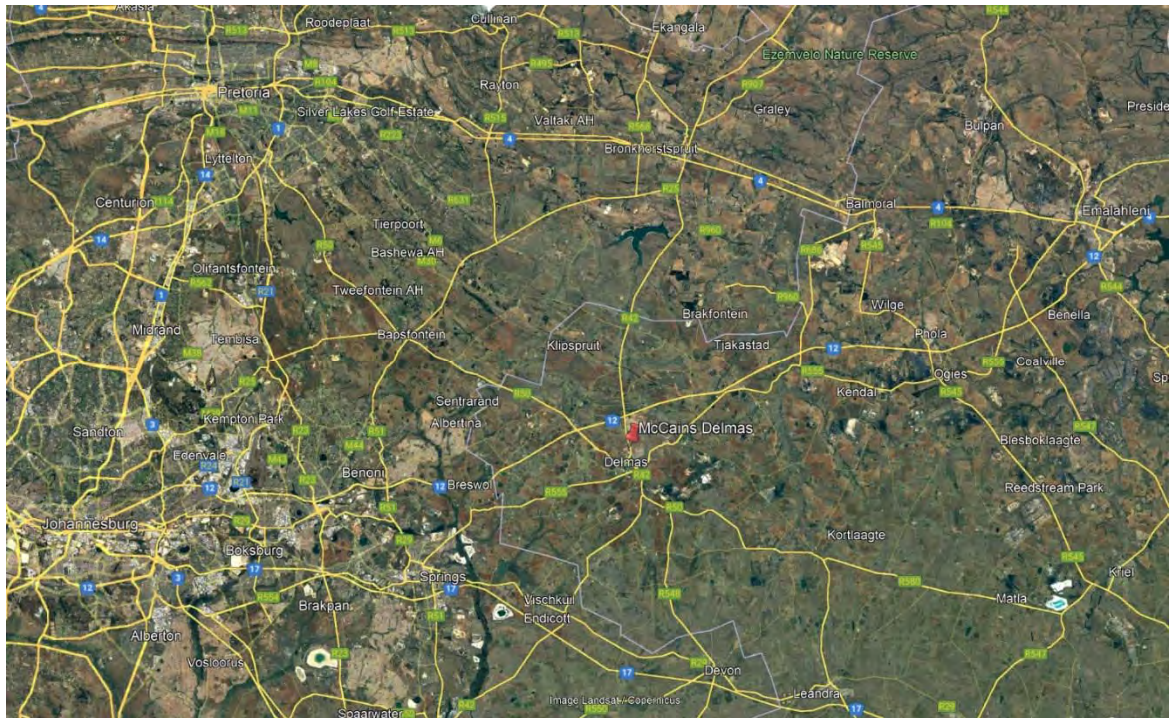
1 Introduction

Rockland Geoscience (Pty) Ltd (Rockland) was appointed by Gleam Hydro (Pty) Ltd (Gleam) in terms of Rockland proposal letter RG/022/316/01, dated 04 June 2022, and Gleam purchase order number PO0000007 dated 05 June 2023, to undertake phase 1 shallow surface geotechnical and dolomite stability investigations for a new Waste Water Treatment Plant (WWTP) at McCain Food SA (Pty) Ltd's (McCain) Delmas plant, near the town of Delmas Mpumalanga Province, South Africa.

This letter report presents the findings of the various investigations, including the results of a desk top study, nine test pits excavated to a maximum depth of about 3m, laboratory tests and five percussion boreholes drilled to a maximum depth of 60m.

2 Site Description

The site is located at McCain's Delmas plant, near the town of Delmas Mpumalanga Province. Refer to Figure 2-1 for the location of the site and Figure 2-2 for a zoomed in image of the site and various test pits and percussion boreholes.

Figure 2-1: Location of the site

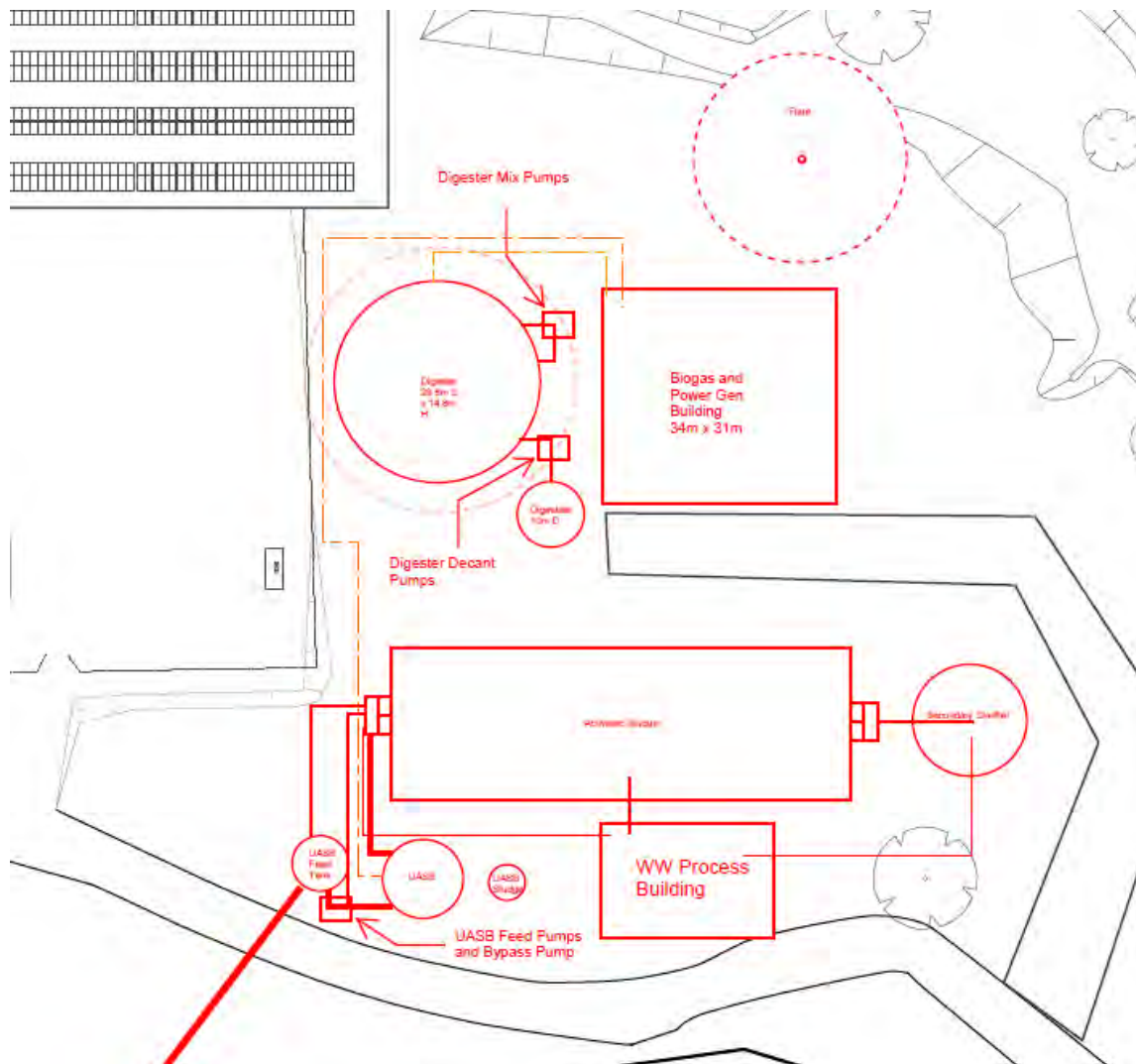
Excerpt taken from Google Earth™

Figure 2-2: Locations of test pits and boreholes

Excerpt taken from Google Earth™

2.1 Proposed development

The proposed development, as extracted from a preliminary WSP layout plan received from Gleam and dated March 2023, is given in the figure below.

Figure 2-3: Proposed WWTP development

The proposed development includes the following elements:

- Digester (29.8m diameter x 14.8m high);
- Digestate (10m diameter);
- Biogas and power Gen building (34m long x 31m wide);
- Secondary clarifier;
- Wastewater process building;
- Activated sludge structure;
- UASB tanks (x3);
- Digester mix and feed pumps;
- UASB feed and bypass pumps.

No foundation details such as dimensions, embedment depths, loads, moments and foundation deflection tolerances were provided.

3 Results of Investigation

3.1 Desk study review

A desk top study review was undertaken of all available geotechnical and geological information pertaining to the site including published geological maps and historical geological and geotechnical reports.

3.1.1 Climate and geomorphology

According to the website <https://en.climate-data.org/africa/south-africa/mpumalanga/delmas-8959/> (2023), the climate at Delmas is warm and moderate with a Köppen-Geiger classification Cwb. Summers are warm and wet while winters are dry and cold with frost common during winter months. The average annual temperature is 16.3 °C and the annual precipitation is about 787 mm.

The site has a Weinert (1978) climatic N value of between 2 and 5. A Weinert N value of 2 – 5 indicates chemical weathering (decomposition) to be dominant over mechanical (disintegration) weathering.

Figure 3-1: Climatic N-Value after Weinert (1978)

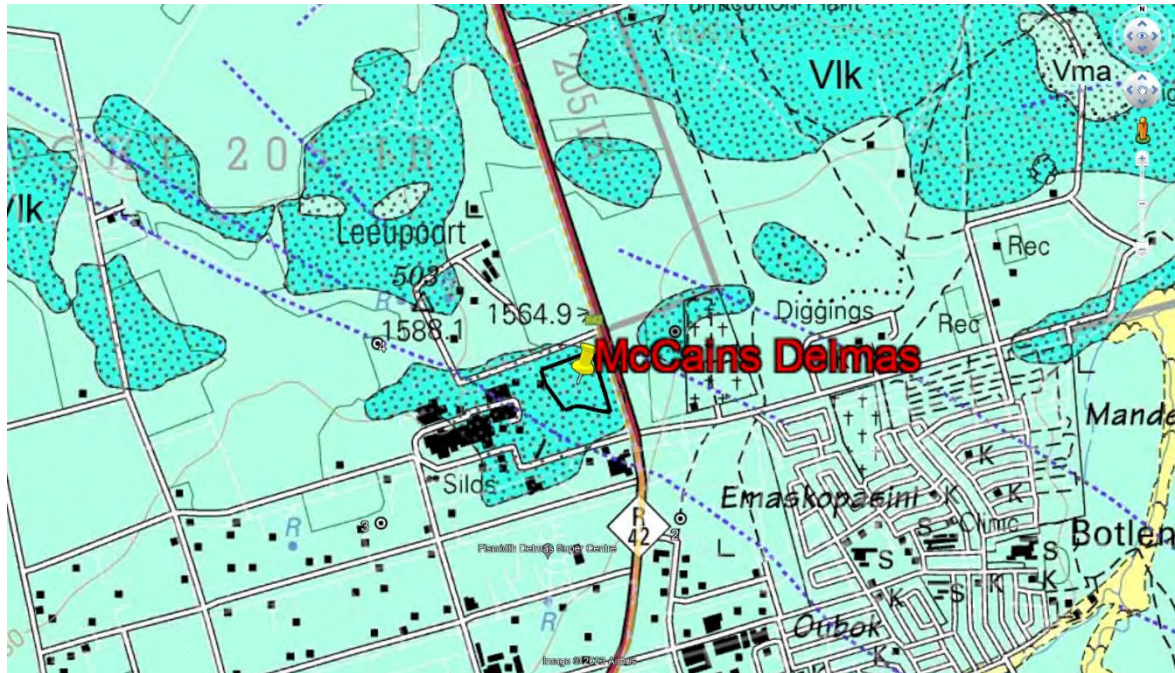


3.1.2 Geology

Regional geology

According to the 1:50 000 geological map 2628BA Delmas (2006), the site is underlain by chert breccia of the Leeuwenkloof Member (Vlk), Eccles Formation, Malmani Subgroup Chuniespoort Group of the Transvaal Supergroup. The Leeuwenkloof member overlies dolomite and chert of the Eccles Formation (Vma). The geological map shows two lineaments, marked in blue dashed lines, (possibly syenite dykes) trending north-east to south-west to the north and south of the site.

Refer to Figure 3-2 below for the 1:50 000 scale geological map 2628AB Delmas superimposed onto a Google Earth backdrop showing the location of McCain's Delmas plant.

Figure 3-2: Regional geology

1:50 000 scale geological map 2628AB Delmas overlain onto Google Earth™

Site specific geology

A search of the Council for Geoscience' (CGS) databank located two historical reports detailing drilling investigations in the vicinity of the new WWTP.

The historical reports include six percussion boreholes (BC1 to BC6), drilled in 2019, 80m to 300 m to the west of the site by JK Developments under direction of consultancy Martin van der Walt Engineering Geologist (van der Walt, 2016), for and on behalf of McCain, and four boreholes (BH1 to BH4) to the south and west of the site, drilled in 2016 by Hennie Erwee Drilling Contractors, under direction of Golder Associates (Nkosi and Marais, 2019) also for and on behalf of McCain. Please refer to Table 3-1 for a list of historical boreholes and to Figure 3-3 below for the locations of boreholes (blue and green pins) relative to the current investigation (yellow and red pins).

The historic investigations revealed a thick surface chert layer overlying dolomite bedrock at depth. Percussion boreholes, BC1 and BC6, intersected a syenite dyke (Van der Walt, 2019).

The soil and rock profiles that were encountered in the historical boreholes are summarised in Table 3-1 and discussed in Section 3.3.

Table 3-1: List of historical percussion boreholes drilled near the site.

BH No	Coordinates (WGS84 LO29)*		
	X-Coordinate	Y-Coordinate	Z-Coordinate
2016 Golder Associates Investigation			
BH1	-31753	-2890856	1565.8
BH2	-31798	-2890891	1567.8
BH3	-31821	-2890927	1568
BH4	-31942	-2890950	1570.3
2019 Martin van Der Walt Engineering Geologist Investigation			
BC1	-32104	-2890753	1577
BC2	-32027	-2890732	1578
BC3	-31973	-2890760	1576.5
BC4	-31931	-2890751	1576
BC5	-31904	-2890819	1573
BC6	-31967	-2890795	1575
BC7	-31970	-2890963	1573

Notes: *X and Y coordinates fixed via hand-held GPS and Z-coordinates derived from Google Earth™

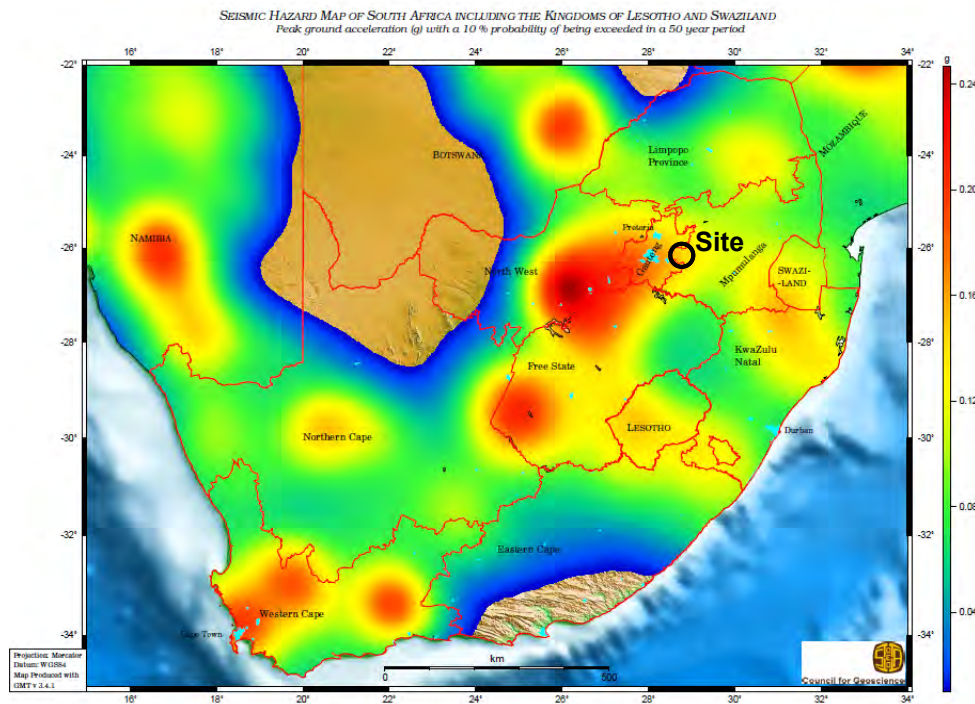
Figure 3-3: Locations of historical boreholes in the vicinity of the site

Excerpt taken from Google Earth™

3.1.3 Seismicity

According to the Council for Geoscience' (CGS) seismic hazard map of South Africa, a copy of which is reproduced in the figure below, the peak ground acceleration (PGA) at the site is about 0.13g with a 10% probability of being exceeded in a 50-year period.

Figure 3-4: Seismic Hazard Map of South Africa (After CGS)



3.2 Test pits

Nine test pits labelled TP1 – TP9, were excavated on 21 June 2023, at the locations given in Figure 3-6 below. The horizons encountered in the test pits are summarised in the table below and the soil profile logs are contained in Appendix A. Images captured of the various test pits are given in Figure 3-5 below.

Test pits were excavated by Komatsu PC200 excavator. Test pits were logged by a registered engineering geologist in accordance with the guidelines given by Brink and Bruin (1990). Representative disturbed soil samples were retrieved from the various horizons encountered in the test pits and submitted to Specialised Testing Laboratory (STL) of Pretoria for laboratory testing.

The majority of the site is overlain by fill comprising very loose to medium dense chert gravel, cobbles, boulders, building rubble and domestic waste in a matrix of silty to clayey sand. The fill is thickest in the vicinity of TP6 – TP9 (1.3m ≥3.4m). The fill was absent from test pits TP3 and TP4 while TP2 only intersected a 0.2m layer of fill.

The fill is underlain by a transported layer (hillwash and colluvium) of very loose to very dense silty to clayey sand with gravel to chert gravel, cobbles and boulders packed in a silty to clayey sand matrix. The transported materials had a slightly pinholed soil structure which is typical of collapsible soils. The transported layer had a thickness of about 1.3m to 2.3m in the test pits.

All test pits except TP7, which was terminated in fill, refused on chert residuum / chert breccia residuum at depths ranging between 1.6m and 2.3m. Chert residuum comprised medium dense to very dense chert cobbles and boulders in a matrix of silty to clayey sand with gravel and was mostly clast supported.

A pebble marker layer, consisting of dense clayey to sandy gravel, separated the overlying transported materials and underlying chert residuum in TP4 and TP5 and had a thickness of 0.3m – 1.0m.

Figure 3-5: Images of the test pits





Figure 3-6: Locations of test pits and boreholes

Excerpt taken from Google Earth™

Table 3-2: Summary of horizons encountered in the test pits.

Test Pit	Depth Interval (m)				Termination Depth (m)	Remarks
	Fill	Hillwash / Colluvium	Pebble Marker	Chert Residuum		
TP1	0.0 - 0.5	-	-	0.5 - 2.1	2.1	Refusal on chert boulders.
TP2	0.0 - 0.2	0.2 - 1.5	-	1.5	1.5	Refusal on chert boulders.
TP3	0.0 - 1.0	1.0 - 2.3	-	2.3	2.3	Refusal on chert boulders.
TP4	-	0.0 - 1.6	1.6 - 1.9	1.9	1.9	Refusal on chert boulders.
TP5	-	0.0 - 1.3	1.3 - 2.3	2.3	2.3	Refusal on chert boulders.
TP6	0.0 - 1.3	-	-	1.3 - 2.0	2.0	Refusal on chert boulders.
TP7	0.0 ≥ 3.4	-	-	-	3.4	No refusal in fill.
TP8	0.0 - 1.6	-	-	1.6	1.6	Refusal on chert boulders.
TP9	0.0 - 2.1	-	-	2.1	2.1	Refusal on chert boulders.

3.3 Percussion drilling

3.3.1 Methodology

Five percussion boreholes, labelled RG1 - RG5, were drilled across the footprint area of the proposed development by JK Development CC between 22 and 23 June 2023. All boreholes were drilled with an 18bar "Thor" rotary percussion rig, drilling 165mm diameter holes.

Chip samples were collected every meter and stored in plastic bags. During drilling, parameters such as sample return, air loss and water strikes were recorded by the drilling team.

Water rest levels were measured at least 24 hours after the completion of the boreholes where possible. Boreholes were backfilled with drill chippings to a depth of 2m below surface and with

concrete to surface followed by the installation of precast concrete plinths across the top of boreholes. Each borehole number was engraved on a metal plate affixed to the top of each concrete plinth.

The chip samples retrieved from the boreholes were logged by an engineering geologist according to the South African National Standard SANS 633:2012 "Soil profiling and rotary percussion borehole logging on dolomite land in Southern Africa for engineering purposes".

3.3.2 Results

The results obtained from the current and historical drilling investigations are summarised in Table 3-3 below. The detailed borehole logs and the driller's field logs are provided in Appendix C and D respectively.

Boreholes RG1, RG2 and RG3, that were drilled on the western portion of the site, intersected fill from surface to depths of between 0.8m and 8m, over hard rock chert breccia to depths of 17m to over 60m (thickness of 15m to more than 60m). Dolomite residuum, comprising weathered dolomite, wad (highly compressible clayey silt derived from decomposition of dolomite), chert and cavities underlie the chert breccia from depths of about 17m to 33m (thickness 5m – 16m).

Cavities were intersected in dolomite residuum in boreholes RG1, RG4 and RG5. RG1 intersected a cavity at 52m - 53m, RG4 at 28m - 29m and 30m - 33m and RG5 at 28m - 32m.

Three boreholes, RG3, RG4 and RG5, intersected hard rock dolomite from depths of 38m, 35m and 36m respectively. RG1 encountered weathered dolomite rock from 53m to its termination depth of 60m, while RG2 failed to intersect dolomite bedrock to its termination depth of 60m.

Based on the results of the boreholes it is postulated that the geological model for the site consists of a hard rock chert breccia cap overlying dolomite residuum comprising weathered chert, shale and clay and characterised by cavities and low-consistency materials which in turn overlies dolomite bedrock. The chert breccia cap comprises competent hard rock chert in the western portion of the site, but thins out towards the east where shallower dolomite residuum is present.

Table 3-3: Summary of horizons encountered in boreholes (current and historical investigations)

BH No	Coordinates (WGS84 LO29)*			Fill (mbgl)	Colluvium/ Hillwash (mbgl)	Residual Syenite (mbgl)	Syenite rock (mbgl)	Residual shale (mbgl)	Chert and Shale (mbgl)	Chert (mbgl)	Chert and Wad (mbgl)	Wad (mbgl)	Cavity (mbgl)	Weathered dolomite (mbgl)	Dolomite (mbgl)	Water level (mamsl)
	X	Y	Z													
Rockland 2023																
RG1	-31789	-2890669	1578	0 - 8						8 - 51			52 - 53	53 - 60		1542
RG2	-31878	-2890654	1579	0 - 2					33 - 36	2 - 33; 36 -60						
RG3	-31845	-2890764	1576	0 - 1					27 - 28	1 -27	28 - 32			32 - 38	38 - 44	
RG4	-31666	-2890773	1565		0 - 2					2 - 17	17 - 28; 29 - 30?		28 - 29; 30 - 33	33 - 35?	35 - 41?	
RG5	-31714	-2890598	1575		0 - 4				4 - 27		27 - 28?		28 - 32	32 - 36?	36 - 42?	
Golder 2016																
BH1	-31753	-2890856	1565.8		0 - 2			13 - 27		2 - 13		27 - 33			33 - 41	
BH2	-31798	-2890891	1567.8		0 - 2			23 - 40	40 - 57	3 - 12					57 - 60	1545.6
BH3	-31821	-2890927	1568		0 - 2			6 - 31 31 - 37 Carb		3 - 6						1541.6
BH4	-31942	-2890950	1570.3		0 - 1.5				21 - 29	1.5 - 21; 29 - 59						1546.4
Martin van der Walt Engineering Geologist 2019																
BC1	-32104	-2890753	1577			0 - 29	29 - 50									
BC2	-32027	-2890732	1578		0 - 1					1 -37						
BC3	-31973	-2890760	1576.5							1 - 33						
BC4	-31931	-2890751	1576		0 - 0.3					0.3 - 30						
BC5	-31904	-2890819	1573		0 - 1					1 - 27						
BC6	-31967	-2890795	1575		0 - 1	1 - 24										
BC7	-31970	-2890963	1573		0 - 1					1 - 25						

*Notes: *Coordinates taken with a hand-held GPS with a positional accuracy of about 4m. Collar elevations (z coordinates) are rough estimates obtained from Google Earth imagery; mbgl = meters below ground level; mamsl = meters above mean sea level*

3.4 Laboratory testing

The soil samples that were retrieved from the test pits were submitted to STL laboratory of Pretoria for the following tests:

- Foundation indicator (particle size analyses including hydrometer and Atterberg Limits);
- Moisture/density relationship at Modified AASHTO compaction effort;
- California Bearing Ratio (CBR);
- pH of soil paste;
- Electrical conductivity of soil paste.

The test results are summarised and discussed in the table and text below and the laboratory certificates are contained in Appendix E.

The following is evident from the table below:

- The hillwash and colluvium samples (TP2 0.2m - 0.7m and TP3 0.1m - 2.3m) contained 54% - 60% gravel, 22% - 24% sand, 22% - 16% silt and 6% - 7% clay and recorded liquid limits of 27% - 29% and plasticity indices of 8% - 9%, grading the samples as clayey sand with gravel (SC) according to the Unified Soil Classification System (USCS). The original USCS grading of GC that was assigned to sample TP3 (0.1m - 2.3m) of SM was revised to SC on the basis that more than 50% of the sample passed the 4.75mm sieve.
- The hillwash and colluvium samples had a low potential expansiveness based on Van der Merwe's (1965) method for heave prediction.
- The hillwash and colluvium samples obtained a pH of 4.9 – 5.2 and an electrical conductivity (EC) of 0.004 – 0.005 S/m or an electrical resistivity (1/EC) of 20 000 to 25 000 Ω .cm.
- COLTO (1998) sets an electrical conductivity limit of < 0.02 S/m and pH limit ≥ 6 to limit attack of cement stabilised layers while EN 12501-2:2003 grades soils with a pH of 4.5 – 5.5 and electrical resistivity of > 5000 Ω .cm as having a medium corrosiveness towards metals. In terms of these limits, the samples are expected to be slightly aggressive towards buried cementitious elements and of medium corrosiveness towards metals. Based on this evaluation buried concrete and metal elements will require appropriate protection against chemical attack.
- Hillwash/colluvium sample TP3 (0.1m - 2.3m) obtained a maximum dry density at the Modified AASHTO energy effort of 2036 kg/m³ at an OMC of 10.7%.
- Hillwash/colluvium sample TP3 (0.1m - 2.3m) grade as a TRH14 G6 material.
- The fill samples contained 53% - 76% gravel, 17% - 32% sand, 5% - 10% silt and 2% - 4% clay and recorded a liquid limit of 22% for sample TP6 (0.2m - 0.5m) while the liquid limit of the other samples could not be determined due to their slightly plastic (SP) character. Sample TP6 (0.2m - 0.5m) obtained a plasticity index of 7%.
- The fill samples grade as silty sand with gravel (SM), silty clayey gravel with sand (GC-GM) and poorly graded gravel with silt and sand (GP-GM) according to the Unified Soil Classification System (USCS).
- The fill samples had a low potential expansiveness based on Van der Merwe's (1965) method for heave prediction.
- The fill sample obtained pH of between 4.7 and 5.7 and electrical conductivity (EC) of 0.011 - 0.028 S/m or an electrical resistivity (1/EC) of between 3571 - 9090 Ω .cm.
- COLTO (1998) sets an electrical conductivity limit of < 0.02 S/m and pH limit ≥ 6 to limit attack of cement stabilised layers while EN 12501-2:2003 grades soils with a pH of 4.5 – 5.5 and an electrical resistivity of < 4500 Ω .cm as highly corrosive towards metals and soils with a pH of 5.5 – 6.0 and an electrical resistivity of 5000 - 10000 Ω .cm as moderately ("medium") corrosiveness. In terms of these limits, the samples are expected to be moderately aggressive

Table 3-4: Summary of index, compaction, strength and chemical test results

Test Pit ID	Depth (m)	Field Description	Atterberg Limits			Grading (%)				GM	USCS	AASHTO	pH	EC (S/m)	PE	Mod AASHTO		CBR (%)						TRH14 G Class
			LL (%)	PI (%0)	LS (%)	Gravel >2.00mm	Sand 2.00-0.06mm	Silt 0.06-0.002mm	Clay <0.002mm							MDD (kg/m³)	OMC (%)	90%	93%	95%	98%	100%	Swell (%)	
TP2	0.2-0.7	Silty gravelly sand. HILLWASH.	29	8	3.5	54	24	16	6	1.91	SC	A-2-4	4.9	0.005	LOW	-	-	-	-	-	-	-	-	-
TP3	0.1-2.3	Gravelly sand with cobbles/ HILLWASH/ COLLUVIUM	27	9	4.5	60	22	11	7	2.09	SC*	A-2-4	5.2	0.004	LOW	2036	10.7	18	23	27	32	35	0	G6
TP6	0.2-0.5	Gravelly sand FILL	22	7	3.5	53	32	10	5	1.95	GC-GM	A-2-4	5.7	0.023	LOW	-	-	-	-	-	-	-	-	-
TP6	0.5-1.3	Sandy gravel with cobbles FILL	CBP	SP	0.5	50	34	12	4	1.93	SM	A-1-b	4.7	0.011	LOW	-	-	-	-	-	-	-	-	-
TP9	0-2.1	Gravelly sand with cobbles FILL	CBP	SP	0.5	76	17	5	2	2.48	GP-GM	A-1-a	5.7	0.028	LOW	2081	8.0	9	20	34	57	73	0	G6

*Notes: LL = Liquid Limit; CBP = Can not be performed; PI = Plasticity Index; LS = Linear Shrinkage; GM = Grading Modulus; USCS = Unified Soil Classification System; AASHTO = American Association of State Highway Transportation Officials; EC = Electrical conductivity ; PE = Potential Expansiveness based on Van der Merwe's (1964) method for heave prediction; MDD = Maximum Dry Density; OMC = Optimum Moisture Content; CBR = California Bearing Ratio; TRH = Technical Recommendations for Highways; *Reclassified*

towards cementitious materials and moderately to highly corrosive towards metals. Based on this evaluation, buried concrete and metal elements will require appropriate protection against chemical attack.

- Fill sample TP9 (0.0m - 2.1m) obtained a maximum dry density at the Modified AASHTO energy effort of 2081 kg/m³ at an OMC of 8%.
- Fill sample TP9 (0.0m - 2.1m) grade as a TRH14 G6 material.

4 Evaluation

4.1 Excavatibility

The test pits were excavated with a 20 tonne Komatsu PC200 excavator. Materials which were excavated efficiently and with ease are considered soft excavation (SANS 1200 D), those in which slow excavation was experienced as intermediate excavation (SANS 1200 D) and those on which excavation plant refused or which experienced very slow, inefficient excavation, as hard rock excavation (SANS 1200 D).

The following SANS 1200 D excavation classes are estimated based on the rate of excavation and penetration attained:

- Hillwash/colluvium = Soft excavation
- Fill = Soft /intermediate/boulder excavation Class A
- Chert residuum with boulders = Hard rock excavation/boulder excavation Class A

Based on the percussion boreholes (RG1) the maximum thickness of the fill is about 8m. Although excavation through fill can generally be classified as soft excavation, the presence of large boulders assign it a boulder excavation Class A.

4.2 Stability of excavations and embankments

The predominantly loose soil profile provides for unstable conditions, which is expected to be especially poor under saturated conditions such as during and following prolonged periods of intense rains. Temporary slopes cut into in situ soils should be battered to 1V:2.5H or shallower.

Embankments constructed from sandy and gravelly fill and transported soils should be battered to 1V:1.5H or shallower.

Where steeper slopes are desired/required the installation of appropriate lateral support is advised.

The designs of permanent slopes/excavations should take account of the dimensions of structures, purpose, their design life and geotechnical material properties of foundations and construction materials.

The stability of excavations in rock, will depend on rock mass strength, the spatial orientation of discontinuities relative to the orientation of excavations and the condition of discontinuities and joint infilling, and is best evaluated on a case by case basis by an experienced geotechnical engineer or engineering geologist.

4.3 Trafficability

The very loose to loose consistency and large percentage over size particles contained within the fill may, however, hinder trafficability and require removal and stockpiling or compaction to improve trafficability during construction.

4.4 Heave/shrinkage

In situ soils have a low potential expansiveness based on Van der Merwe's method (1964) for heave prediction and ground movements due to heave and/or shrinkage are expected to be negligible.

The clayey silt (wad) that was intersected at depth in the percussion boreholes could, however, be moderately to highly expansive, based on past experienced gained by this consultant on other sites underlain by dolomite.

4.5 Aggressiveness/corrosiveness of soils

Based on the results of pH and soil conductivity tests, the fill and transported soils are expected to be moderately aggressive towards cementitious materials and moderately to highly corrosive towards buried metals, and buried concrete and metal elements will require appropriate protection against chemical attack.

4.6 Construction materials

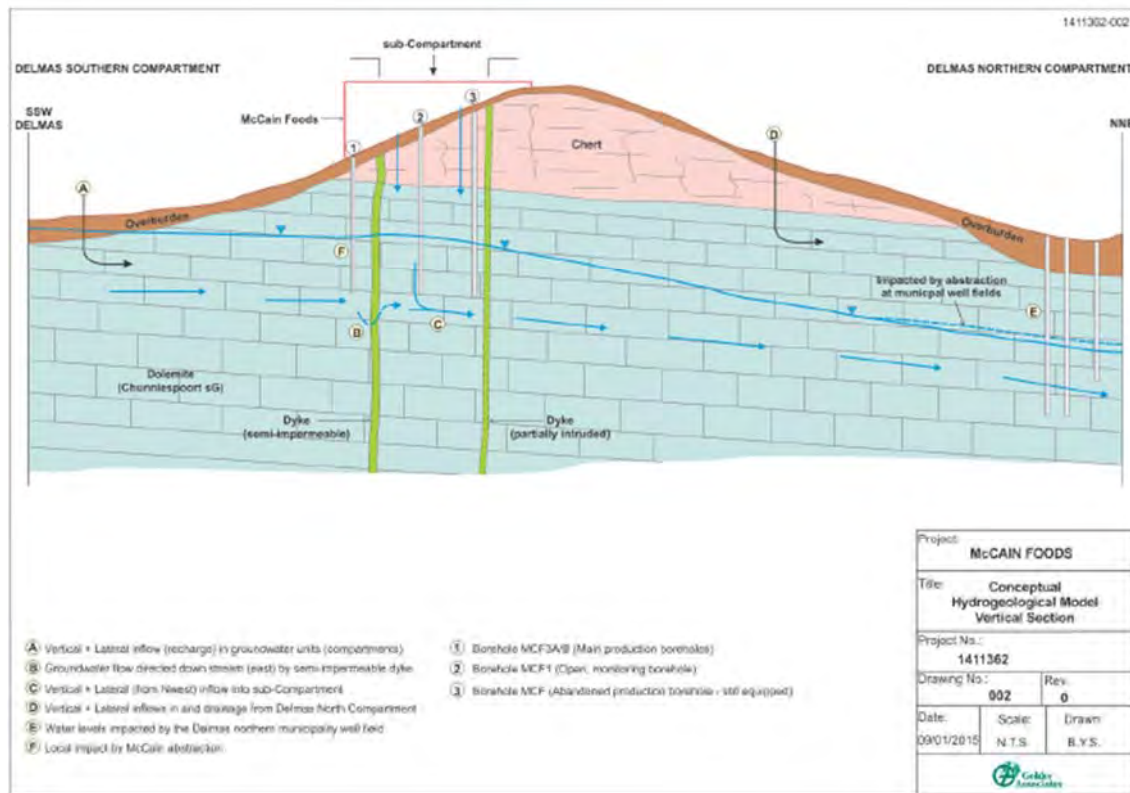
The in situ soils and the fill at the site consist of clayey sand with gravel (SC USCS materials), gravel with silt and sand (GC-GM and GP-GM USCS materials) and cobbles and boulders. Strength tests conducted on samples of hillwash/colluvium and fill, retrieved at shallow depth (>3m), grade these materials as COLTO (1998) G6 material, which are suitable for use in the lower selected layers of pavements and in engineered fills of moderate stiffness.

4.7 Hydrology

The regional hydrology of the area has been described in the 2015 Golder report (Van Wyk and Van der Linde, 2015). The greater Delmas area falls under the DWAF's Delmas Sub-area of the Eastern Dolomite Area (Golder Report: Van Wyk and Van der Linde, 2015) which is further divided into three sub-units by two parallel dykes, namely the Delmas Southern Compartment, Delmas Northern Compartment, and the McCain Food Sub-Compartment (located between the dykes). Displacements along the strikes of the dykes, however, only act as localised groundwater boundaries and the site remains part of the larger Delmas Subarea (Van Wyk and Van der Linde, 2015).

According to Van Wyk and Van der Linde (2015) the regional groundwater flow is towards the north-east and average groundwater elevations at the McCain Delmas site varies between 1540 - 1550 meters above mean sea level (mamsl). See figure 4.1 below for a conceptual hydrological model after Van Wyk and Van der Linde (Golder report, 2015)

Figure 4-1: Conceptual hydrogeological SSW-NNE profile (model) across the McCain Foods Site Area by Golder and Associates (Van Wyk and Van der Linde, 2015)



During the current investigation water strikes were recorded in two boreholes (RG1 and RG2), but water rest levels, measured a minimum of 24 hours after the completion of drilling, were recorded in only one borehole (RG1) at a depth of 36m below ground level (mbgl) or an elevation of 1542 mamsl. Water elevations of about 1541 - 1546 mamsl were recorded during the 2016 Golder dolomite stability investigation (Nkosi and Marais, 2016). Refer to Table 3-3.

The 2016 Golder investigation (Nkosi and Marais, 2016) noted no prominent dewatering at the McCain Delmas site, although dewatering was noted about 3.2km north-west of the site on the farm Leeupoort 205 IR and also at the Delmas northern municipal well field.

No shallow groundwater seepage was intersected in any of the test pits that were excavated during the investigation, but the investigation was undertaken during the dry season, and it is possible that shallow perched water tables may develop on the interface of the transported soils and underlying chert residuum during and after period of intense and sustained rains.

4.8 Dolomite stability analysis

The South African standard for geotechnical investigations on dolomitic land (SANS 1936) requires that the inherent risk of the hazard (being sinkhole and/or doline) developing and potential hazard size be determined for each borehole. This is achieved through assessing each borehole according to the following criteria:

- Nature of blanketing layer;
- Receptacle development;
- Mobilisation and mobilization agencies;
- Maximum potential development space.

These results allow a certain inherent risk characterisation and potential hazard size to be assigned to each borehole. The results of this characterisation are presented in Table 4-1 below. The characterisation was carried out in terms of both dewatering and non-dewatering (ingress) scenarios.

4.8.1 Nature of blanketing layer

The blanketing layer comprises the material overlying the dolomite bedrock. The site is covered by a thick blanketing layer comprising chert breccia with a thickness of about 28m to more than 60m. Shale partings within the chert residuum horizon were encountered in three of the five boreholes that were drilled during the current investigation. Weathered dolomite, wad and cavities were intersected above dolomite bedrock.

Boreholes RG1, RG2 and RG3 intersected fill to a depth of 8m depth, overlying hard rock chert breccia with a thickness of between 28m to more than 60m. Dolomite residuum, comprising weathered dolomite, wad and chert underlie the chert breccia.

High penetration rates, accompanied with soft, compressible material were encountered in RG4 and RG5 below 27m depth. Cavities between 1m and 4m deep were recorded. In borehole RG1 a 1m deep cavity were recorded at 52m and sample loss and air loss were recorded in RG2 between 52m and 59m.

The geological model for the area would thus be interpreted as a chert breccia cap, comprising competent hard rock chert on the western portion of the site, thinning out towards the east where shallower bedrock is present, but comprise dolomite residuum characterised by cavities and low-density material just above the dolomite bedrock.

4.8.2 Receptacle development

Cavities of between 1m and 4m deep were encountered in three boreholes (RG1, RG4 and RG5) it is therefore assumed that receptacles are present within and above the bedrock to be able to receive mobilised materials from overlying horizons.

4.8.3 Mobilisation and mobilisation agencies

In the dolomite context, mobilization is the movement of the blanketing layer by subsurface erosion, slumping, or ravelling by an external agency. Mobilizing agencies include water ingress, either from surface or from leaking underground services, or the lowering of the water table. The chert breccia encountered in the boreholes, with a minimum thickness of 28m, exhibited a low to medium mobilisation potential. The dolomite residuum encountered above dolomite bedrock, especially the wad (clayey silt derived from the decomposition of dolomite) and chert encountered in RG4 and RG5, is considered to have a medium to high mobilisation potential.

For this area the regional water level is at approximately 1545mamsl, within the dolomite residuum and a lowering of the water table is thus expected to have an adverse effect on the mobilisation of the material.

4.8.4 Maximum potential development space (MPDS)

Maximum potential development space (MPDS) is a simplified estimation of the maximum size sinkhole that can be expected to develop in a particular profile, provided that the available space is fully exploited by a mobilizing agency. The available space depends on the depth below ground surface to the throat of a receptacle or disseminated receptacle, and the angle of draw in the various blanketing materials. The thickness of the MPDS is limited by the first layer if bedrock occurs at depths of between 35 to 60m. A sinkhole developing in 35m to 60m of overburden could theoretically have a 35m to 60m diameter if an angle of draw of 45° is assumed. The presence of hard rock chert

breccia and shale would reduce the theoretical angle of draw. The maximum diameter of a sinkhole forming would thus classify as large (i.e. 5>15m diameter).

The risk characterisations show there is a medium risk for the development of small sized (<2m diameter) sinkholes, medium sized (2m<diameter<5m) sinkholes and large sinkholes (5m< diameter <15) and a low risk for doline development for the non-dewatering scenarios.

With the groundwater table within the dolomite residuum, any drawdown of the permanent water table will adversely affect the risk for sinkhole development. The low-density material encountered in RG4 and RG5 indicate a medium to high risk for up to large sinkholes (5m<diameter<15m) and a medium risk for doline development for the dewatering scenarios.

It should be noted that this assessment is based on limited point data and that given the inherent variability of dolomite bedrock the possibility of very large sinkholes developing cannot be excluded.

4.8.5 Risk class

A summary of the risk characterisation for each borehole at the site is given in the table below. An inherent risk classification of Class 4//Class 4 has been assigned to Zone A on the western portion of the site and Class 4a//Class 7 to Zone B on the eastern portion of the site, taking cognizance of the proposed industrial development.

Table 4-1: Summary of horizons encountered in boreholes

BH No	Risk of sinkhole formation				Risk of doline formation	Inherent Risk Class
	Small	Medium	Large	Very large		
	<2m	>2m<5m	>5m<15m	>15m		
RG1	M//M	M//M	M//M	L	L//M	4//4
RG2	M//M	M//M	M//M	L	L//M	4//4
RG3	M//M	M//M	M//M	L	L//M	4//4
RG4	M//H	M//H	M//H	L	L//M	4//7
RG5	M//H	M//H	M//H	L	L//M	4//7

H = High; M = Medium; L = Low; ingress water//dewatering

A dolomite designation D3 is assigned to the site, and it is imperative that stringent precautionary measures be put in place especially in terms of stormwater management and the protection of wet services.

In order to mitigate the potential damage to structures due to sinkhole formation all foundations should be designed to span a sinkhole with a minimum diameter of 5m.

4.9 Geological model

The geological model of the site to a depth of about 60m is given by the plan and sections contained in Appendix A and the stratigraphic sequence arranged from shallowest to deepest is summarised below:

- Fill depth = 0.0m - 8.0m (thickness 0.0m – 8.0m)
- Transported (Hillwash and colluvium) depth = 0.0m - 2.3m (thickness 0.0m – 2.3m)
- Chert residuum depth = 0.5m - 2.3m (thickness 0.0m - 0.7m)
- Chert breccia depth = 0.5m ≥ 60m (thickness 27m ≥ 60m)
- Dolomite residuum (wad, cavities, chert) depth = 17m - 33m (thickness 5m – 16m)
- Weathered dolomite depth = 32m ≥ 60m (thickness 2m > 7m)

- Dolomite bedrock depth = 35m > 60m (thickness >3m)

4.10 Material properties

The fill and transported horizons grade as TRH14 G6 materials. The chert residuum essentially comprises cobbles and boulders in a sandy and gravelly matrix and may conservatively be considered as a rockfill with similar shear strength properties to G6.

The following shear strength parameters are proposed for TRH14 G6 materials based on the relationships proposed by Theyse et al (1996) between shear strength and G1 to G6 TRH14 materials:

TRH14 G6 compacted to 95% of Modified AASHTO maximum dry density (MDD):

$$\phi' = 35^\circ$$

$$c' = 25\text{kPa but assume } 0\text{kPa}$$

$$\gamma = 20\text{kN/m}^3$$

$$E = 60\text{MPa (estimate, assumes compaction to 95% Modified AASHTO MDD)}$$

Chert residuum:

$$\phi' = 35^\circ$$

$$c' = 0\text{kPa}$$

$$\gamma = 20\text{kN/m}^3 \text{ (estimate)}$$

$$E = 80\text{MPa (estimate)}$$

4.10.1 Bearing capacity and settlement

Utilising the formulations as contained in Brinch Hansen (1970), and the shear strength and unit weight parameters quoted in the preceding section, drained bearing capacities were calculated for TRH14 G6 compacted to 95% Modified AASHTO and a range of footing geometries, breadths and embedment depths.

The following assumptions and simplifications were applied to the calculations:

- Foundation materials are isotropic, homogenous and exhibit linear elastic behaviour.
- Only a single layer system was considered.
- Strengths increase with depth, and the founding layer is not underlain by weaker layers within the depth of foundation influence.
- Loads are applied vertically and centrally to loaded areas. No account was taken of inclined loads and/or moments.
- Allowable bearing stresses were calculated by dividing ultimate values by a factor of safety of 1.5.
- The permissible stress method, as opposed to ultimate limit state methods, was utilised as it is felt this approach provides for more tangible results.

The results are contained in Appendix F.

Utilising the E values given in the preceding section and following a simple elastic approach, but excluding the effects of Poisson's ratio and stress reduction with depth, the following immediate (elastic) settlement is predicted beneath an 8m high G6 fill compacted to 95% Mod and subjected to an imposed contact stress of 150kPa (digester tank):

- Settlement = $150\text{kPa}/60\text{MPa} \times 8\text{m} = 20\text{mm}$

Given the mostly non-cohesive nature of soils, the expectation is that the majority of foundation settlement, within the depth of the test pit investigation, of about 3 m, will be due to immediate (elastic) settlement with only minor consolidation and creep, and that the time rate of consolidation will be relatively rapid.

The above approximate analysis assumes elastic (E) stiffness increases with depth and does not take account of potentially compressible materials (wad) and cavities, such as those intersected at a depth of 17m - 41m in borehole RG4.

Large structures such as the digester tank, which has a diameter of about 30m, will stress founding materials to a depth of about 30m, including low stiffness zones such as that intersected in RG4, potentially inducing excessive settlement. In order to derive the stiffness, consolidation and swell properties of materials within the depth of foundation influence of large structures, it is proposed that a supplementary investigation, comprising rotary core drilling combined with SPTs and tube (e.g. Shelby) sampling, be undertaken, during the detailed design phase of the project.

5 Conclusions and Recommendations

This report presents the findings of phase 1 geotechnical and dolomite stability investigations undertaken at the proposed site of a new Waste Water Treatment Plant (WWTP) at McCain Food SA (Pty) Ltd's Delmas plant, Mpumalanga Province, South Africa.

The various investigations included a desk top study, nine test pits excavated to a maximum depth of about 3m, five percussion boreholes drilled to depths of 41m to 60m and laboratory testing of disturbed soil samples.

Test pits investigated shallow (<3m) founding conditions, while percussion boreholes were drilled in an attempt to confirm the presence of and depth to dolomite rock at the site, in order to obtain a qualitative indication of the degree of karst development in dolomite rock beneath the site and the potential for the mobilisation of overlying transported and residual materials into solution cavities.

The following conclusions are drawn and recommendations made:

5.1 Ground profile

- (1) The majority of the site is covered by very loose to medium dense fill, comprising sand and gravel with varying amounts of chert cobbles and boulders. Building rubble and domestic waste are also present.
- (2) The fill is thickest across the south-western part of the site where it attains a thickness of about 1m to 8m.
- (3) The fill is underlain by a transported layer (hillwash and colluvium) consisting of very loose to very dense silty to clayey sand with gravel (hillwash) transitioning with depth to cobbles and boulders packed in a silty to clayey sand matrix (colluvium).
- (4) Transported materials exhibit a slightly pinholed soil structure which is typical of collapsible soils.
- (5) The transported layer has a thickness of about 1.3m to 2.3m.
- (6) Weathered chert residuum comprising medium dense to very dense chert cobbles and boulders in a matrix of silty to clayey sand with gravel underlie the transported layer to a depth of 0.5m to about 2m.
- (7) Hard rock chert breccia underlie the chert residuum to depths of about 20m to over 60m
- (8) Dolomite residuum consisting of chert, wad (compressible clayey silt derived from the decomposition of dolomite) and cavities underlie the chert breccia to a depth of about 33m.

- (9) Cavities were intersected in dolomite residuum in boreholes RG1, RG4 and RG5.
- (10) RG1 intersected a cavity at 52m - 53m, RG4 at 28m - 29m and 30m - 33m and RG5 at 28m - 32m.
- (11) Weathered dolomite underlie dolomite residuum and was intersected in boreholes to depths of 35m to 60m.
- (12) Dolomite bedrock underlies weathered dolomite.

5.2 Seismicity

The peak ground acceleration (PGA) at the site is about 0.13g with a 10% probability of being exceeded in a 50-year period.

5.3 Excavatibility

The following SANS 1200 D excavation classes are estimated based on the rate of excavation and penetration attained:

- Hillwash/colluvium = Soft excavation
- Fill = Soft /intermediate/boulder excavation Class A
- Chert residuum with boulders = Hard rock excavation/boulder excavation Class A

Based on the percussion boreholes (RG1) the maximum thickness of the fill is about 8m. Although excavation through fill can generally be classified as soft excavation, the presence of large boulders assign it a boulder excavation Class A.

5.4 Drilling and blasting

It is recommended that the services of a blasting specialist be retained during the preparation of construction specifications, pricing schedules and contract documentation to ensure prospective contractors price drilling and blasting methods appropriate to site conditions.

5.5 The stability of cuts and embankments

- (1) The predominantly loose soil profile provides for unstable conditions. Temporary slopes cut into in situ soils should be battered to 1V:2.5H or shallower.
- (2) Embankments constructed from sandy and gravelly fill and transported soils should be battered to 1V:1.5H or shallower.
- (3) Where steeper slopes are desired/required the installation of appropriate lateral support is advised.
- (4) The designs of permanent slopes/excavations should take account of the dimensions of structures, purpose, their design life and the geotechnical material properties of foundations and construction materials.
- (5) The stability of excavations in rock, will depend on rock mass strength, the spatial orientation of discontinuities relative to the orientation of excavations and the condition of discontinuities and joint infilling, and is best evaluated on a case by case basis by an experienced geotechnical engineer or engineering geologist.

5.6 Trafficability

The very loose to loose consistency and large percentage over size particles contained within the fill may impede trafficability across the site during construction and may require removal and stockpiling or compaction to improve trafficability during construction.

5.7 Heave/shrinkage

- (1) Fill and transported soils have a low potential expansiveness based on Van der Merwe's method (1964) for heave prediction and ground movements due to heave and/or shrinkage are expected to be negligible for these materials.
- (2) The clayey silt (wad) that was intersected at depth in the percussion boreholes could, however, be moderately to highly expansive based on past experienced gained by this consultant on other sites underlain by dolomite.
- (3) It is recommended that the wad be sampled and tested for expansiveness during the detailed design phase of the project where it is present within the depth of foundation influence of structures.

5.8 Aggressiveness/corrosiveness

- (1) Based on the results of pH and soil conductivity tests, the fill and transported soils are expected to be moderately aggressive towards cementitious elements and moderately to highly corrosive towards buried metals, and buried concrete and metal elements will require appropriate protection against chemical attack.
- (2) Potential protection measures against chemical attack include but are not limited to increasing concrete cover to reinforcement, coating buried concrete surfaces, cathodic protection of steel pipes and addressing stormwater run-off.

5.9 Inundation

- (1) In order to limit inundation at the site, a proper topographical survey of the site, utilising differential GPS and/or total station and appropriate UAV photogrammetric methods, should be conducted to enable the design of appropriate storm and ground water control measures.
- (2) Permanent stormwater control measures typically include one or a combination of the following:
 - a. Constructing a raised terrace;
 - b. Diversion berms and channels,
 - c. Installing buried storm water reticulation (pipes) and sub-soil drainage.
- (3) Temporary stormwater control measures that may be undertaken during construction include:
 - a. Compacting and sealing of all exposed fills and embankments;
 - b. Grading temporary fills to allow free drainage away from the site;
 - c. Constructing diversion berms and earth channels;
 - d. Limiting both the cross sectional and longitudinal slopes of berms and drainage channels;
 - e. Providing adequate provision to dewater inundated excavations as speedily and practicable as possible to limit seepage into surrounding soils, which will increase the risk of slope instability and foundation movements.
 - f. Limiting the length of trenches to lengths which can efficiently accommodate excavation, pipe installation and backfill in a single day.

5.10 Construction materials

The transported (hillwash/colluvium) and fill materials, grade as a COLTO (1998) G6 material, which is suitable for use in the lower selected layers of pavements and in engineered fills of moderate stiffness.

5.11 Hydrology

- (1) Water strikes were recorded in two boreholes (RG1 and RG2), but water rest levels, measured a minimum of 24 hours after the completion of drilling, were recorded in only one borehole (RG1) at a depth of 36m below ground level (mbgl) or an elevation of 1542 mamsl.
- (2) Groundwater elevations of about 1541 - 1546 mamsl were recorded during the 2016 Golder dolomite stability investigation (Nkosi and Marais, 2016).
- (3) No prominent dewatering has taken place at the McCain Delmas site, but the 2016 Golder investigation noted dewatering had taken place about 3.2km north-west of the site on the farm Leeupoort 205 IR and also at the Delmas northern municipal well field.
- (4) No shallow groundwater seepage was intersected in any of the test pits that were excavated during the investigation, but the investigation was undertaken during the dry season, and it is possible that shallow perched water tables may develop on the interface of the transported soils and underlying chert residuum during and after period of intense and sustained rains.

5.12 Dolomite stability

- (1) A dolomite stability assessment of the boreholes characterised the site as having a medium risk for the development of small sized (<2m diameter) sinkholes, medium sized (2m<diameter<5m) sinkholes and large sinkholes (5m< diameter <15) and a low risk for doline development for the **non-dewatering scenario**.
- (2) The low-density material (dolomite residuum containing wad and cavities) encountered in boreholes RG4 and RG5 indicate a medium to high risk for the development of large sinkholes (5m<diameter<15m) and a medium risk for doline development for the **dewatering scenario**.
- (3) An Inherent Risk Class 4//4 are assigned to Zone A and Risk Class 4//7 are assigned to Zone B and a dolomite designation of D3 are assigned to the overall site.
- (4) In order to limit the risk of mobilisation of blanketing materials, stringent precautionary measures and limits should be put in place in terms of stormwater management, the protection of wet services and the dewatering of groundwater.
- (5) In order to mitigate the potential damage to structures due to sinkhole formation all foundations should be designed to span a sinkhole with a minimum diameter of 5m.
- (6) **It should be noted that this assessment is based on limited point data and that given the inherent variability of dolomite bedrock the possibility of very large sinkholes developing cannot be excluded.**

5.13 Founding recommendations

- (1) Given the high percentage sand, gravel and cobbles contained in the soil profile, allowable bearing pressures are expected to be governed by settlement considerations as opposed to the shear strength (ultimate bearing capacity) of soils.
- (2) The low consistency, poor grading and large percentage cobbles and boulders contained in the fill and transported horizons make these horizons vulnerable to large settlements due to settlement under self-weight and foundation loads.
- (3) Moreover the fine grained sandy matrix of transported soils exhibited pinhole voids suggesting a risk of collapse settlement following an increase in soil moisture content and net loading.
- (4) In order to limit foundation settlements to acceptable values, one or a combination of the following foundation solutions are proposed:
 - a. In situ densification of fill and transported soils via appropriate means such as dynamic compaction, impact compaction and rapid impact compaction with latter two options limited to a depth of improvement of about 1m. The presence of large boulders within the soil profile may impede compaction.

- b. Remove fill and transported horizons to chert residuum and replace with TRH14 G6 fill placed in layers after compaction of 150mm.
 - i. Compact each layer to 95% Modified AASHTO MDD -0% +2% of OMC.
 - ii. Confirm the density of each compacted layer by conducting representative nuclear density tests on each layer using representative MDD values throughout.
 - iii. Calibrate a selected number of nuclear moisture contents against moisture contents obtained from laboratory testing and applying the appropriate moisture correction throughout.
 - iv. Fill and transported soils typically grade as TRH14 G6 materials and may be reused in layerworks following removal of oversize particles.
 - v. If fill and transported soils are too coarse to enable conventional compaction control via nuclear density and/or sand replacement tests, construct fill in accordance with a method specification with the appropriate number of passes obtained from a trial section.
 - vi. Found on conventional spread footings placed on/in completed engineered fill.
 - c. Support foundations on percussion (bored) piles installed to competent horizons such as the underlying chert residuum.
 - d. Design all foundations to span a sinkhole with a minimum diameter of 5m.
- (5) Allowable bearing stresses for a range of footing breadths and embedment depths for founding on compacted TRH14 G6 are presented in Appendix F.
 - (6) Total settlement of about 20mm is predicted for a 8m high G6 fill compacted to 95% Modified AASHTO and subjected to a contact stress of 150kPa.
 - (7) Differential settlement may be taken as 75% of total settlements i.e. 15mm.
 - (8) Given the mostly non-cohesive nature of soils, the expectation is that the majority of foundation settlement, within the depth of test pit investigation of about 3m, will be due to immediate (elastic) settlement with only minor time related consolidation and creep, and that the time rate of consolidation will be relatively rapid.
 - (9) The above settlement estimate assumes elastic (E) stiffness increases with depth and does not take account of potentially compressible materials such as wad and cavities that may underlie structures beneath the depth of the test pit investigation of about 3m.
 - (10) Large structures such as the digester tank, which has a planned diameter of about 30m, will stress founding materials to a depth of about 30m, including low stiffness zones that may underlie its footprint potentially inducing excessive settlement.

5.14 Supplementary geotechnical investigation

The foundation assessment provided herein, only applies to the depth of the test pitting investigation of about 3m.

It is recommended that a supplementary geotechnical investigation, comprising rotary core drilling combined with Standard penetration Tests (SPTs) and tube (e.g. Shelby) sampling, be undertaken at the finalised locations of large structures, during the detailed design phase of the project. This will aid in deriving stiffness, consolidation and swell properties of materials within the depth of foundation influence of structures.

The depth to which a supplementary investigation would need to be conducted depends on the locations and dimensions (width) of planned foundations. The site investigation code of practice (2010) of the South African Institution of Civil Engineering's Geotechnical Division recommends geotechnical investigations be advanced to depths double the width of footings or to rock with a consistency of at least soft rock whichever occurs first. Other international codes (e.g. EC7), require investigation to a depth at which the net effective stress due to foundation loading reduces to 20%

of the effective overburden stress.

5.15 Construction monitoring

It is proposed that an experienced engineering geologist or geotechnical engineer inspect the site periodically during the construction phase of the project in order to identify any unforeseen adverse conditions and devise appropriate preventative and/or remedial actions.

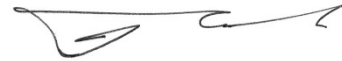
5.16 Dolomite risk management

Irrespective of the design implementation, a site-specific Dolomite risk management plan should be implemented for the site as described by SANS 1936 parts 3 and 4 (2012). The main aim of this will be to eliminate any concentrated water ingress at the site that may trigger sinkhole and/or doline formation. This includes the management of stormwater runoff and installation and maintenance of all wet services.

Yours faithfully,



Gerrie van Jaarsveld *Pri.Sci.Nat*



Ian Deale *Pri.Sci.Nat*

Rockland Geoscience (Pty) Ltd

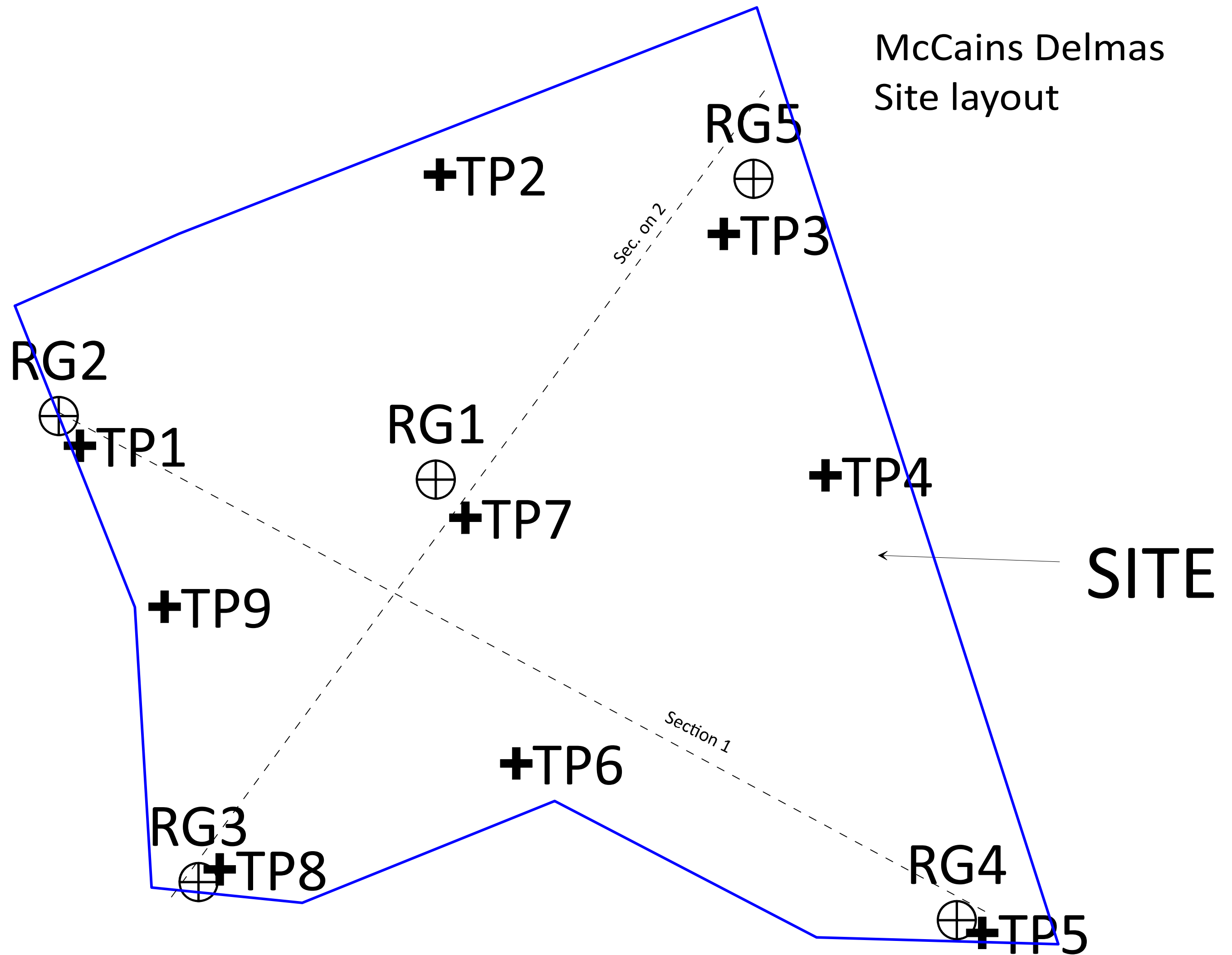
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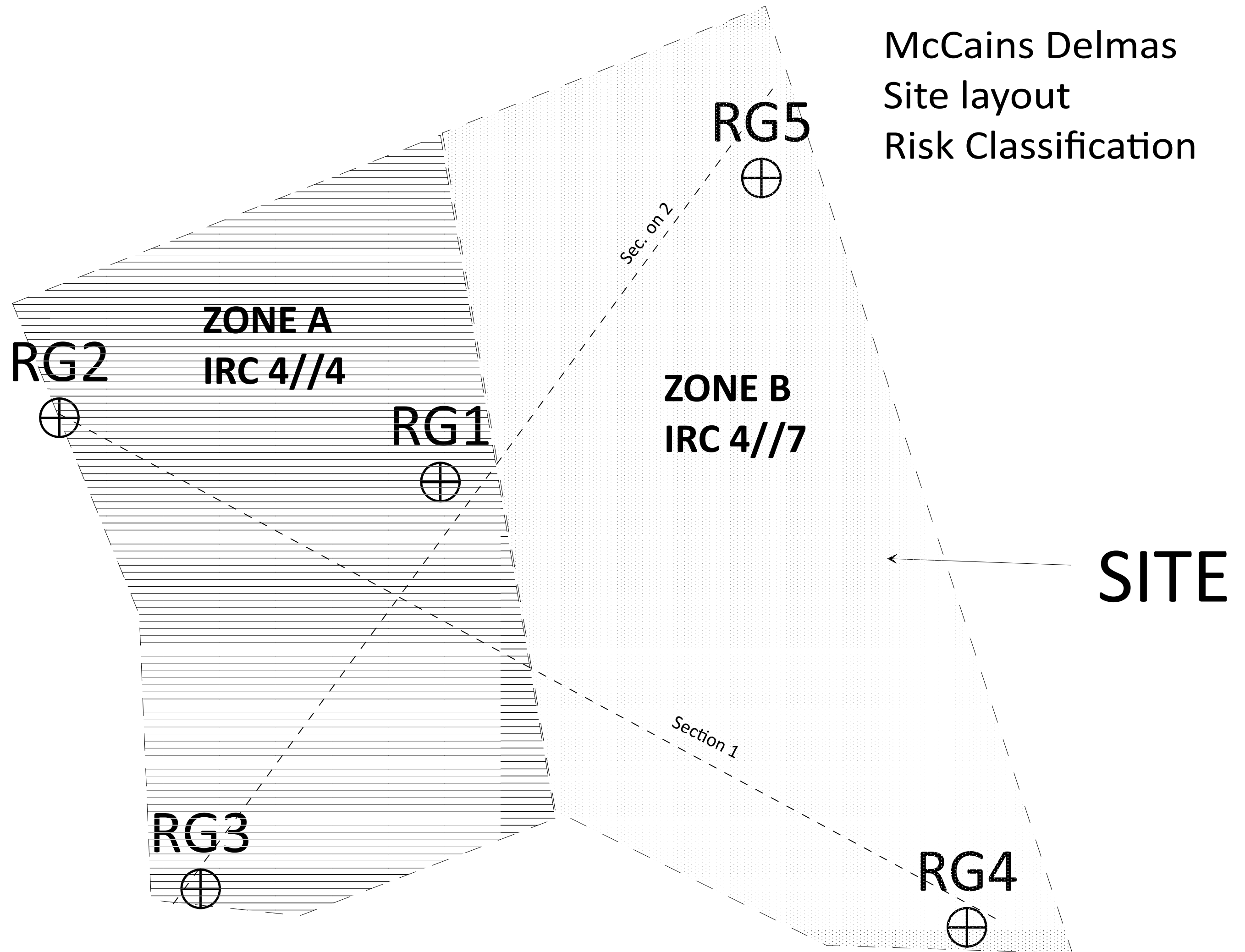
APPENDIX A

SITE LAYOUT DRAWINGS AND SECTIONS

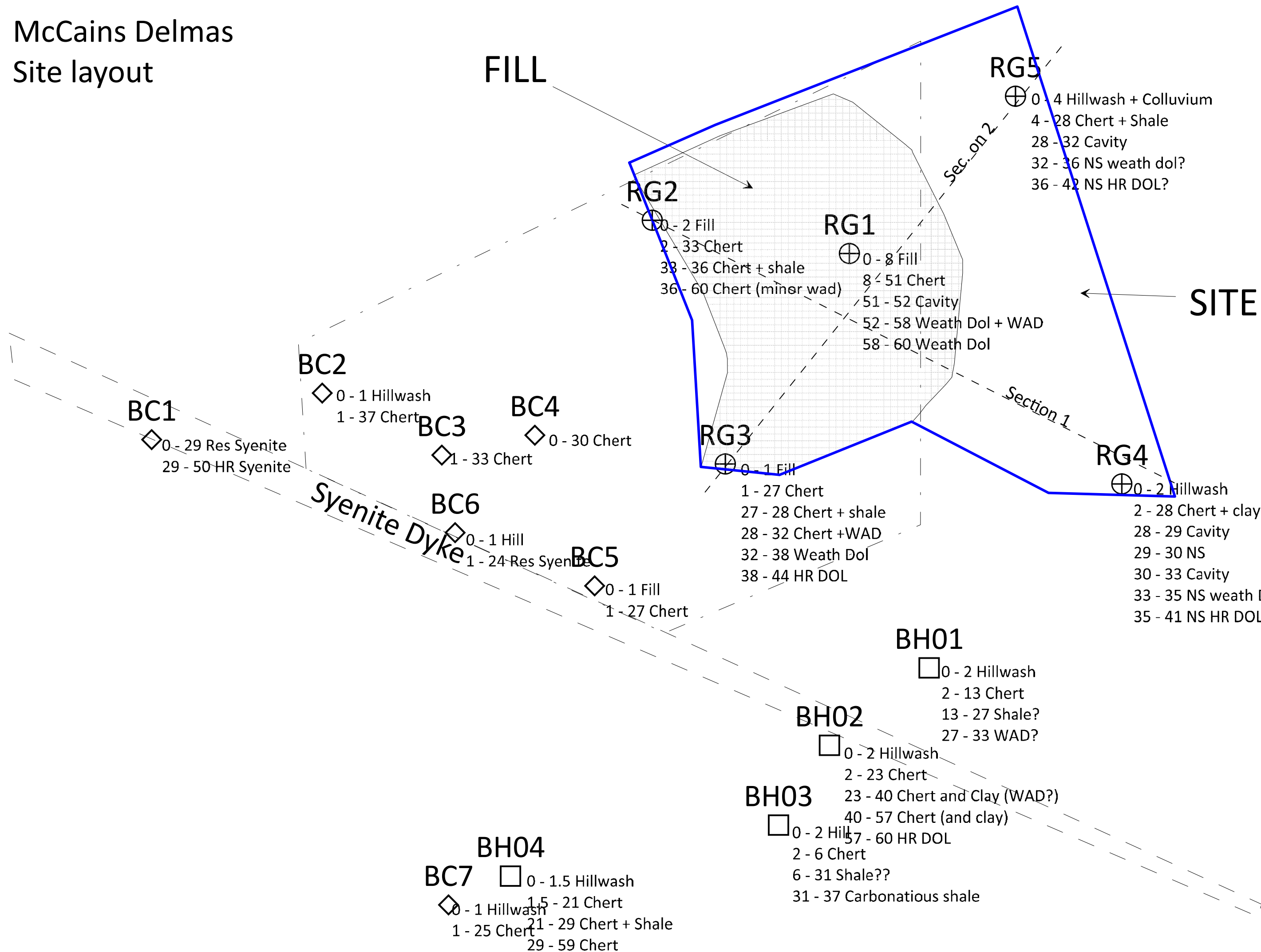
McCains Delmas
Site layout



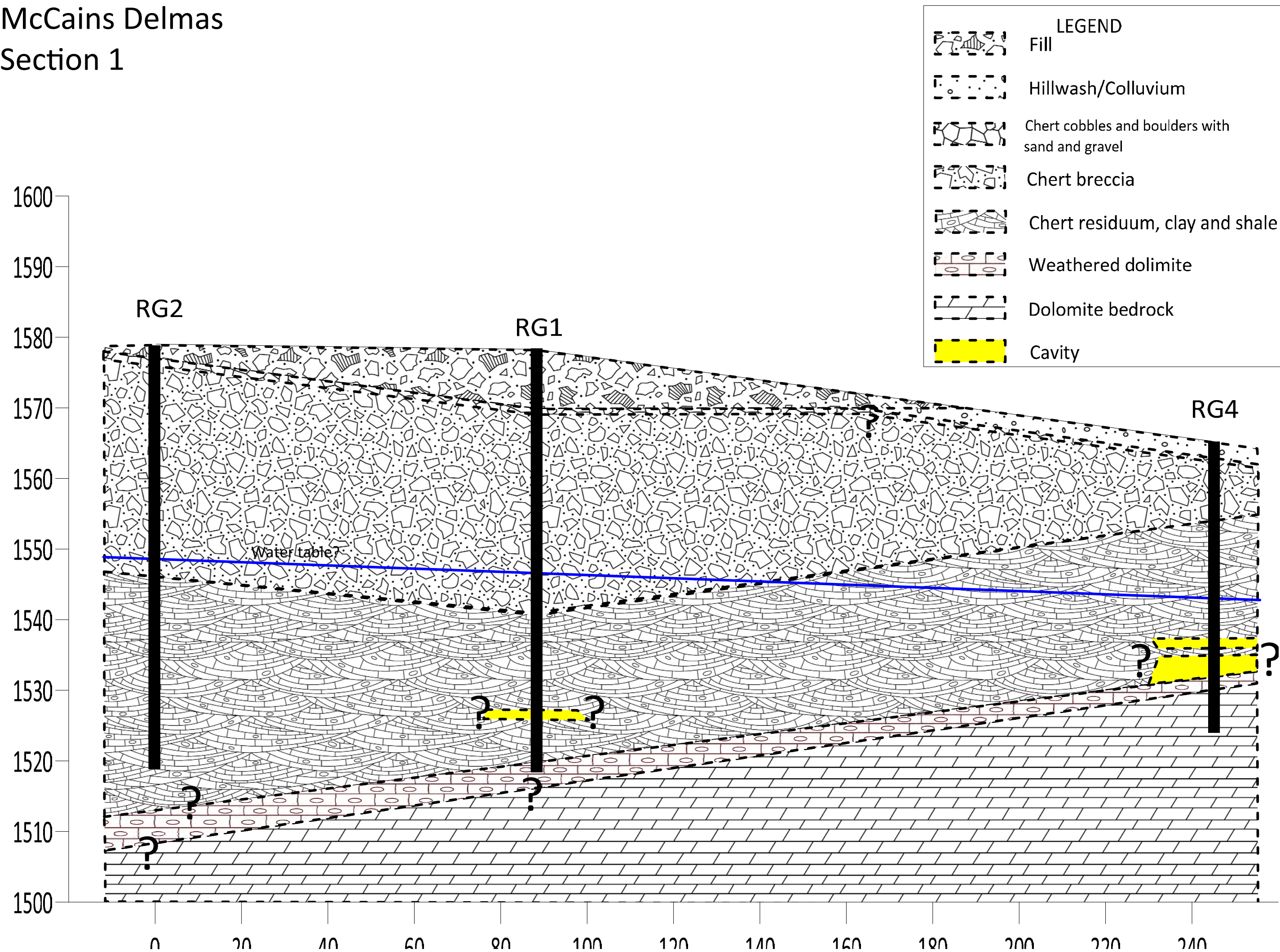
McCains Delmas
Site layout
Risk Classification



McCains Delmas
Site layout

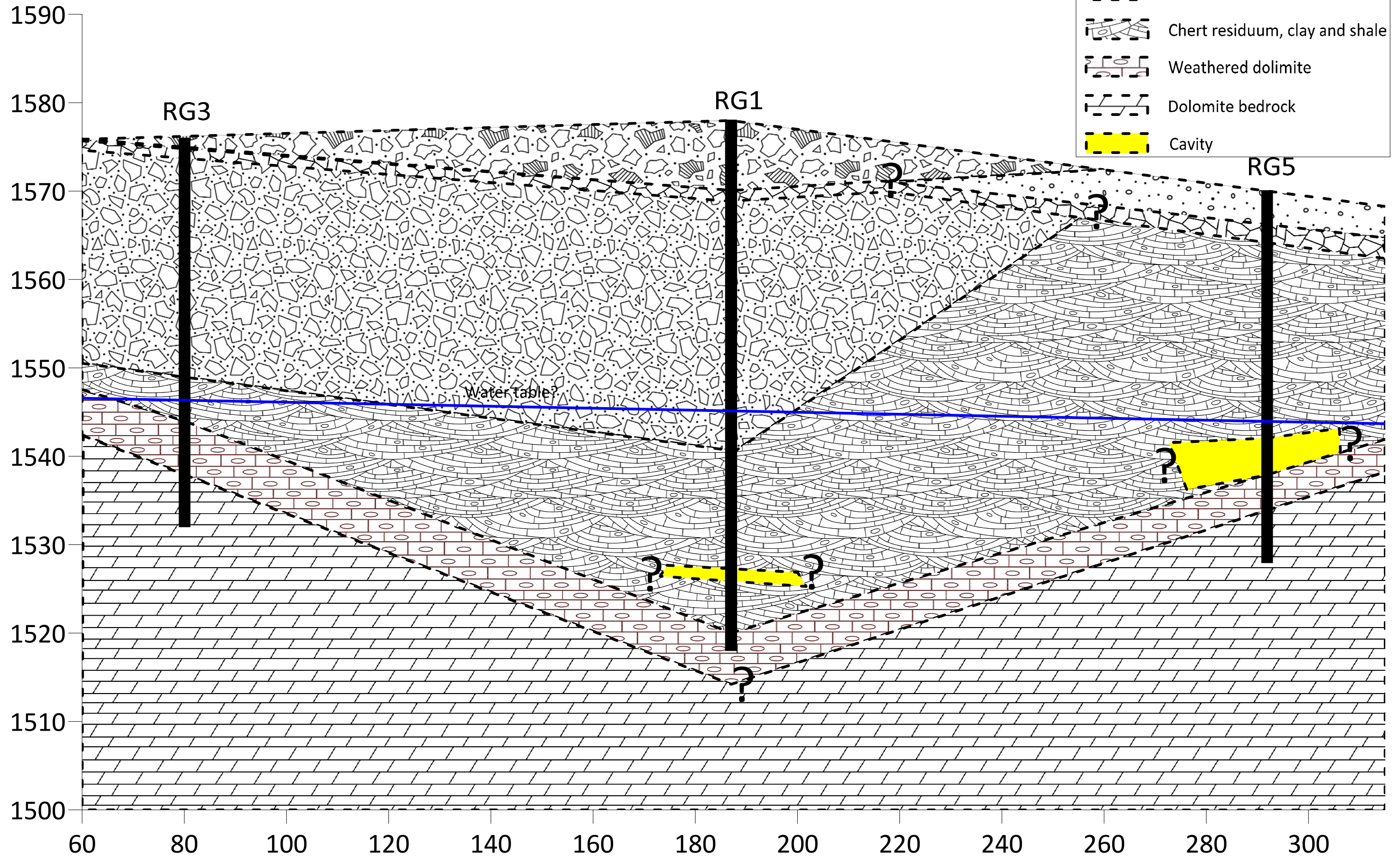


McCains Delmas
Section 1



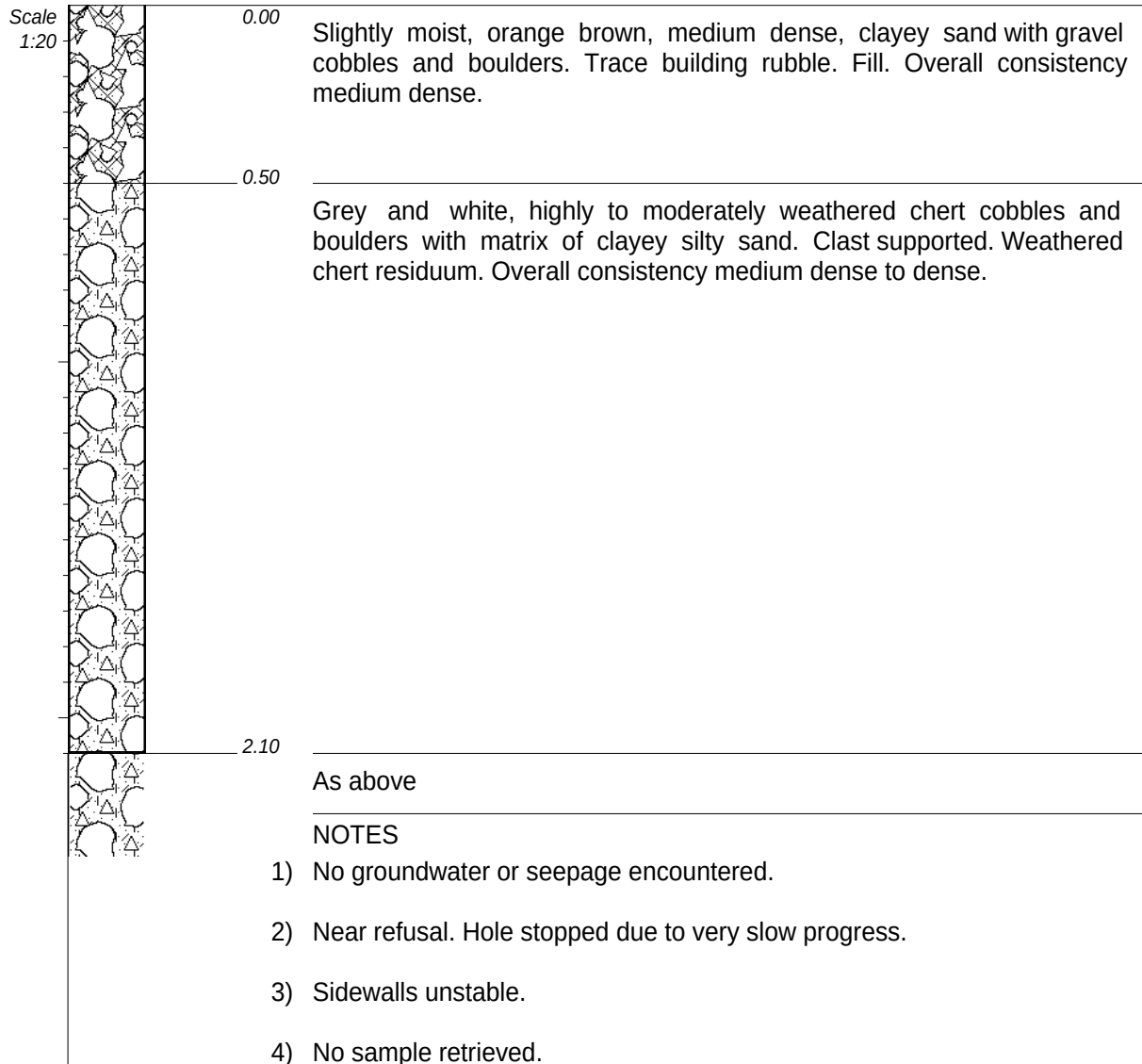
McCains Delmas

Section 2



APPENDIX B

SOIL PROFILES

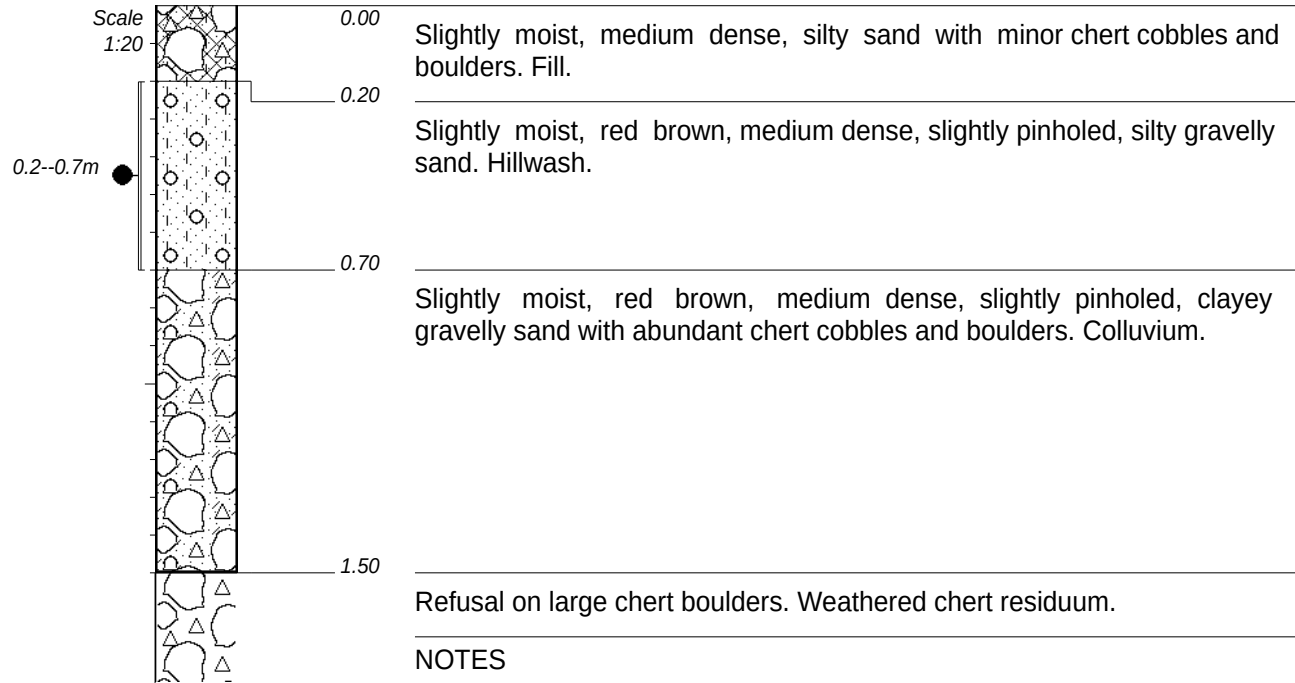


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Y-COORD : 31873

HOLE No: TP01
WGS84 LO29



NOTES

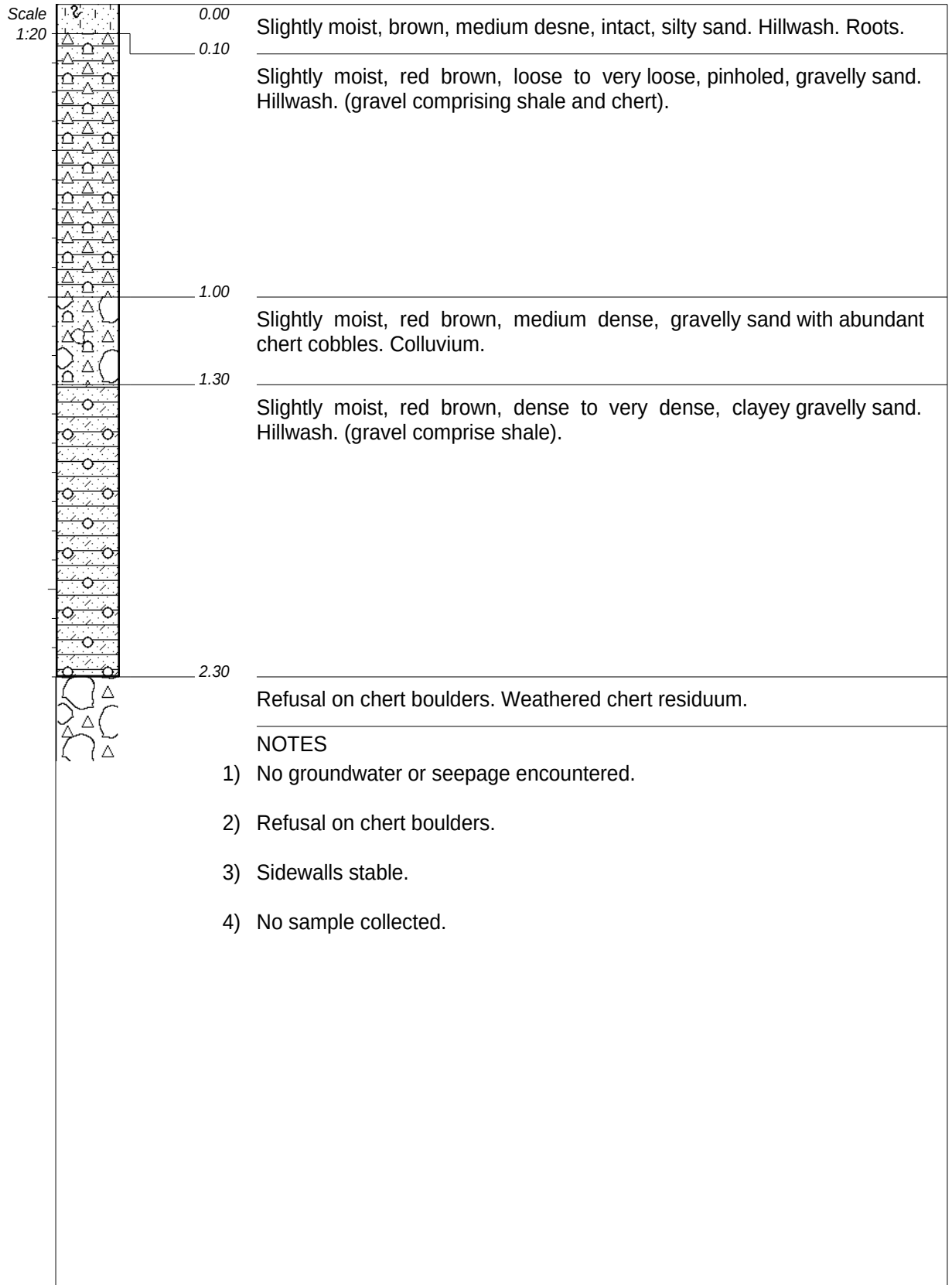
- 1) No groundwater or seepage encountered.
- 2) Refusal on chert boulders.
- 3) Sidewalls stable.
- 4) Disturbed sample 0.2--0.7m.

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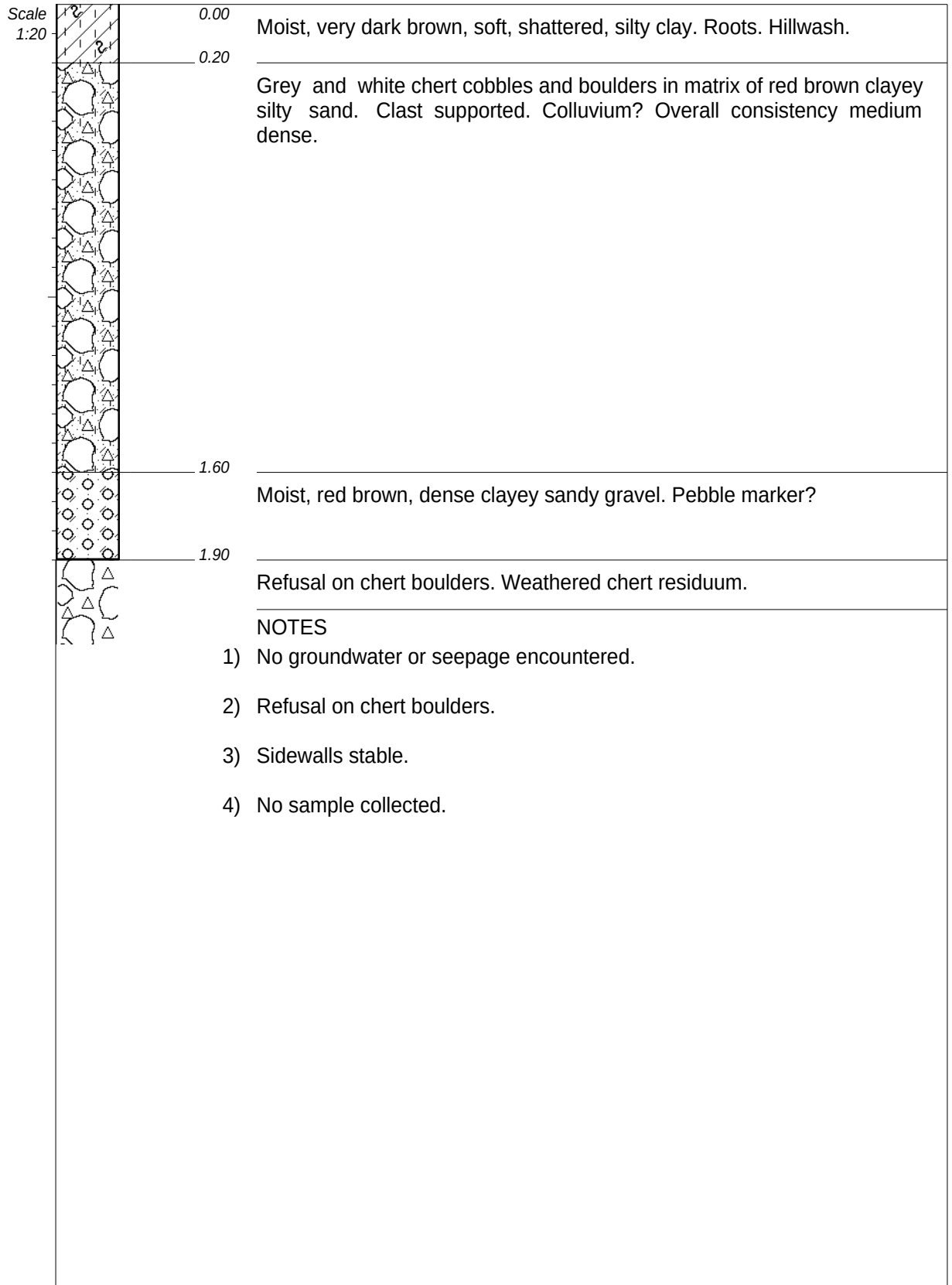


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DATE : 2023/06/21
DATE : 20/08/2023 21:02
TEXT : ..asWWTPlogs20230621.TXT

ELEVATION : 1569
X-COORD : 2890611
Y-COORD : 31721

HOLE No: TP03
WGS84 LO29

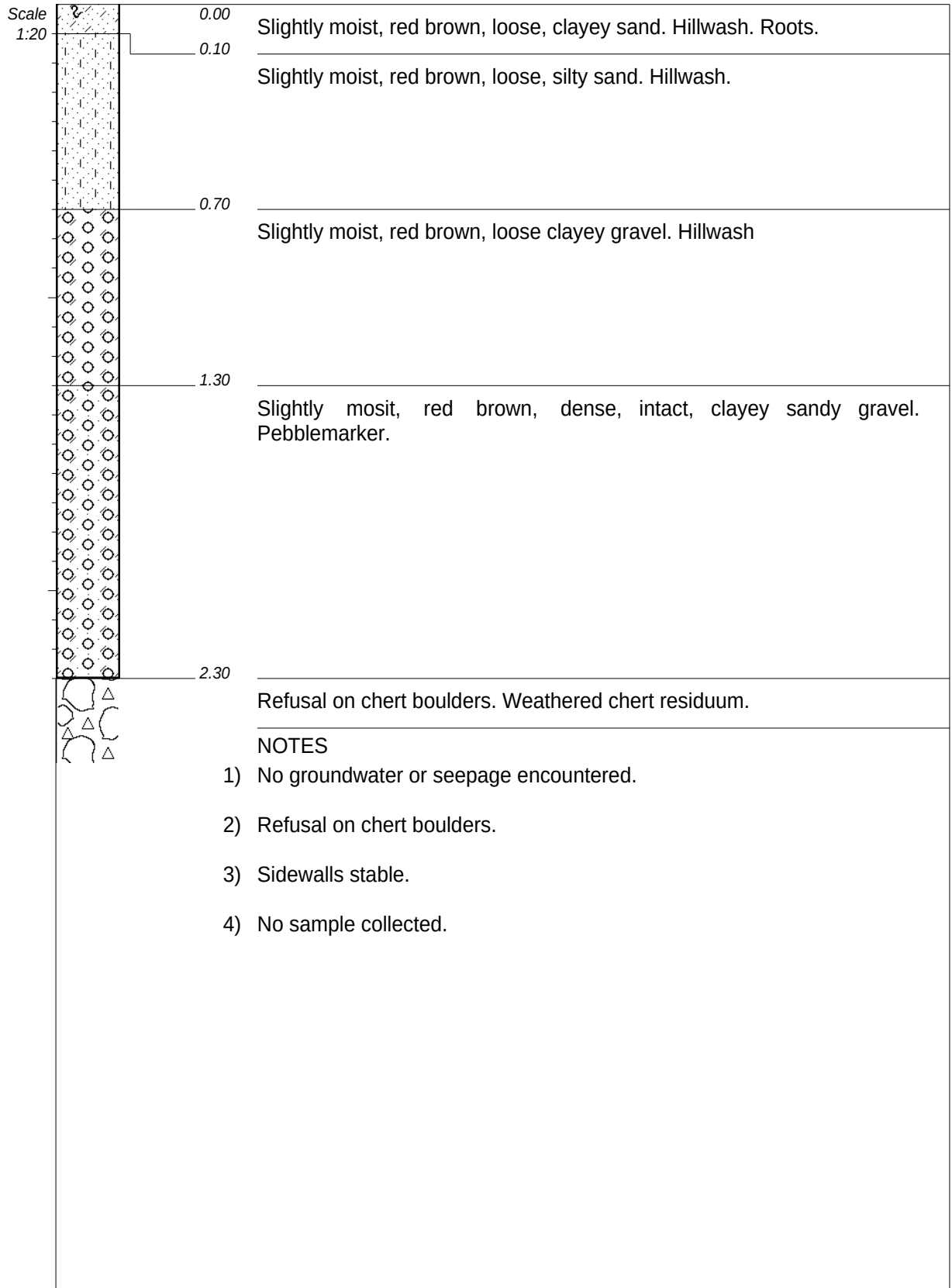


CONTRACTOR : GCL Plant Hire
MACHINE : Komatsu PC200
DRILLED BY :
PROFILED BY : I DEALE
TYPE SET BY : ID
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE : 2023/06/21
DATE : 2023/06/21
DATE : 20/08/2023 21:02
TEXT : ..asWWTPPTlogs20230621.TXT

ELEVATION : 1569
X-COORD : 2890668
Y-COORD : 31697

HOLE No: TP04
WGS84 LO29

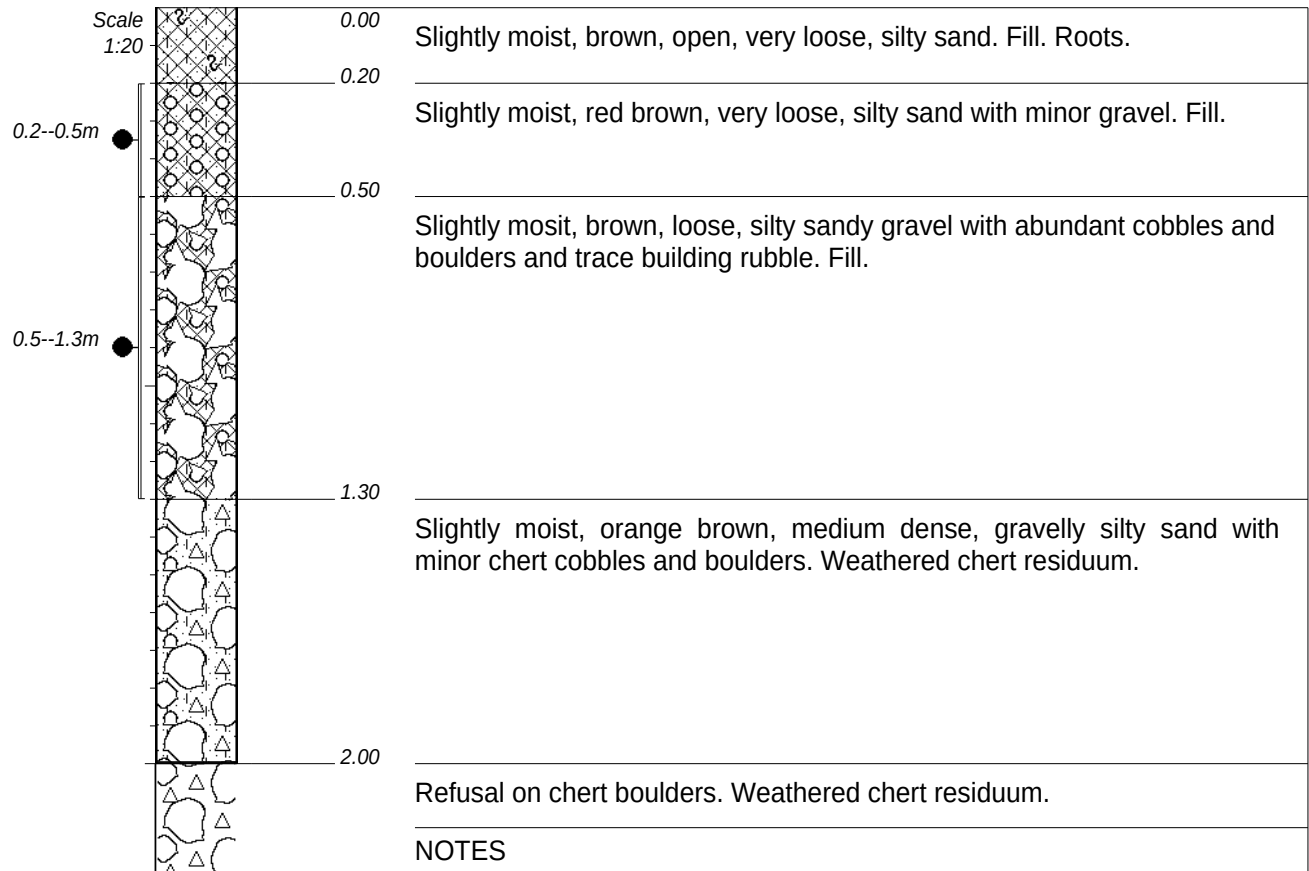


CONTRACTOR : GCL Plant Hire
MACHINE : Komatsu PC200
DRILLED BY :
PROFIED BY : I DEALE
TYPE SET BY : ID
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE : 2023/06/21
DATE : 2023/06/21
DATE : 20/08/2023 21:02
TEXT : ..asWWTPlogs20230621.TXT

ELEVATION : 1563
X-COORD : 2890776
Y-COORD : 31660

HOLE No: TP05
WGS84 LO29



NOTES

- 1) No groundwater or seepage encountered.
- 2) Refusal on chert boulders.
- 3) Sidewalls stable.
- 4) Disturbed sample collected 0.2--0.5m; 0.5--1.3m.

CONTRACTOR : GCL Plant Hire
MACHINE : Komatsu PC200
DRILLED BY :
PROFIED BY : I DEALE
TYPE SET BY : ID
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE : 2023/06/21
DATE : 2023/06/21
DATE : 20/08/2023 21:02
TEXT : ..asWWTPlogs20230621.TXT

ELEVATION : 1570
X-COORD : 2890736
Y-COORD : 31770

HOLE No: TP06
WGS84 LO29

Scale
1:20



0.00

Slightly moist, red and orange brown, gravel cobbles and boulders in matrix of silty and clayey sand with varying amounts of building and domestic rubble. Fill. Overall consistency medium dense with very loose zones.

3.40

No refusal in material as above.

NOTES

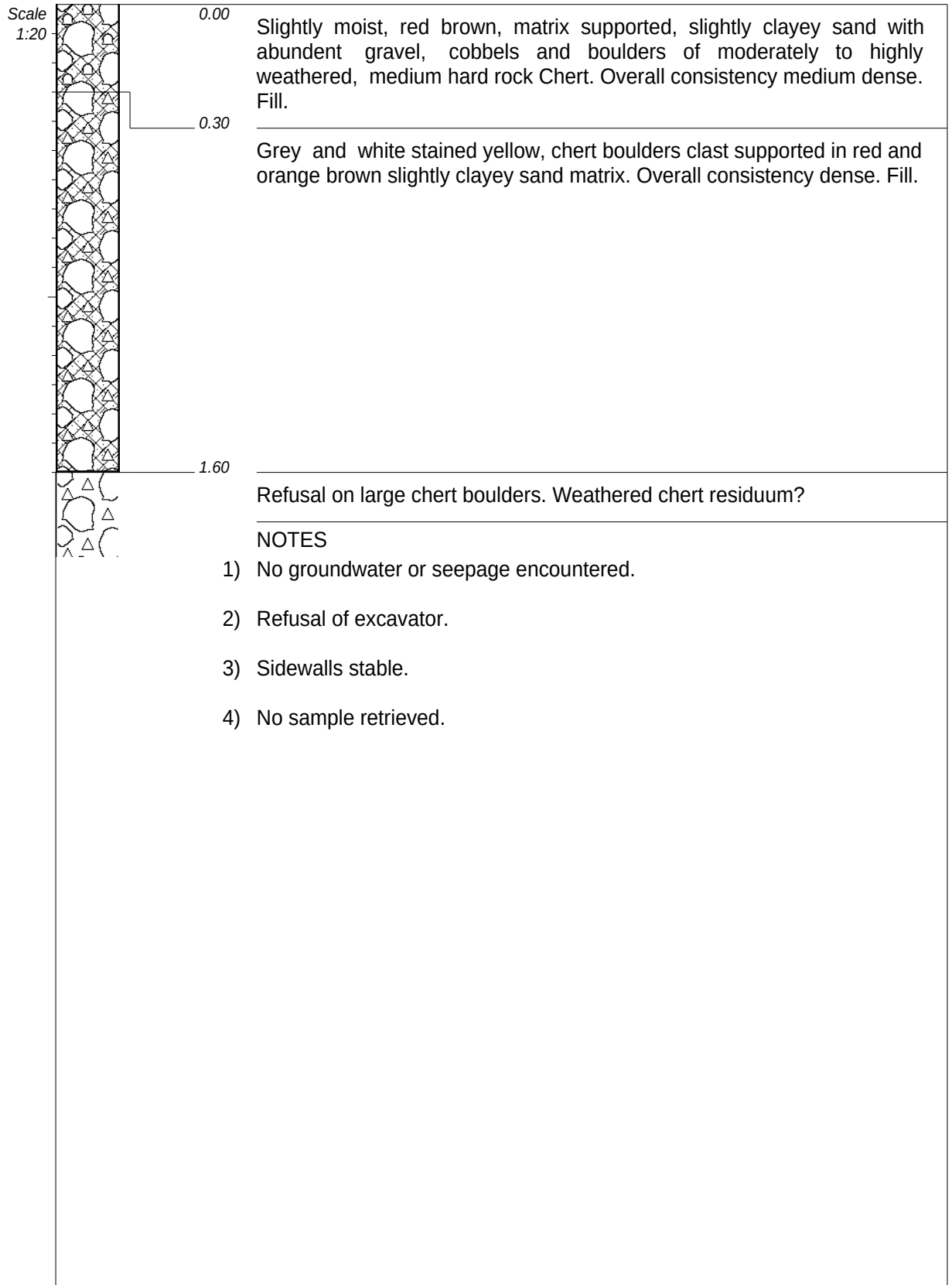
- 1) No groundwater or seepage encountered.
- 2) No refusal of excavator, hole stopped due to collapse of the sidewalls and difficult excavation.
- 3) Sidewalls highly unstable.
- 4) No sample retrieved.

CONTRACTOR : GCL Plant Hire
MACHINE : Komatsu PC200
DRILLED BY :
PROFIED BY : I DEALE
TYPE SET BY : ID
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE : 2023/06/21
DATE : 2023/06/21
DATE : 20/08/2023 21:02
TEXT : ..asWWTPPTlogs20230621.TXT

ELEVATION : 1572
X-COORD : 2890678
Y-COORD : 31782

HOLE No: TP07
WGS84 LO29

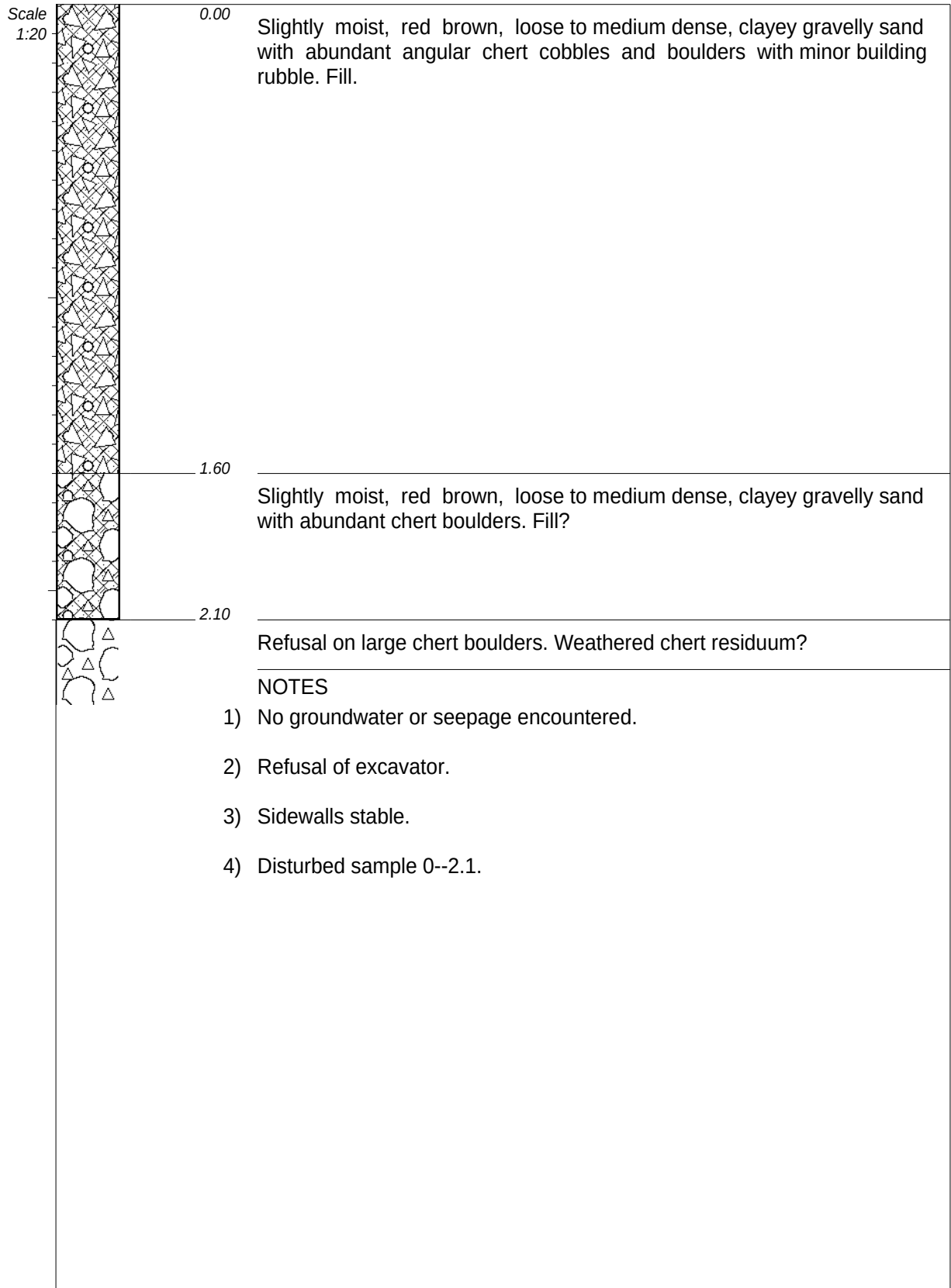


CONTRACTOR : GCL Plant Hire
MACHINE : Komatsu PC200
DRILLED BY :
PROFIED BY : I DEALE
TYPE SET BY : ID
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE : 2023/06/21
DATE : 2023/06/21
DATE : 20/08/2023 21:02
TEXT : ..asWWTPPTlogs20230621.TXT

ELEVATION : 1577
X-COORD : 2890761
Y-COORD : 31840

HOLE No: TP08
WGS84 LO29



CONTRACTOR : GCL Plant Hire
MACHINE : Komatsu PC200
DRILLED BY :
PROFILED BY : I DEALE
TYPE SET BY : ID
SETUP FILE : STANDARD.SET

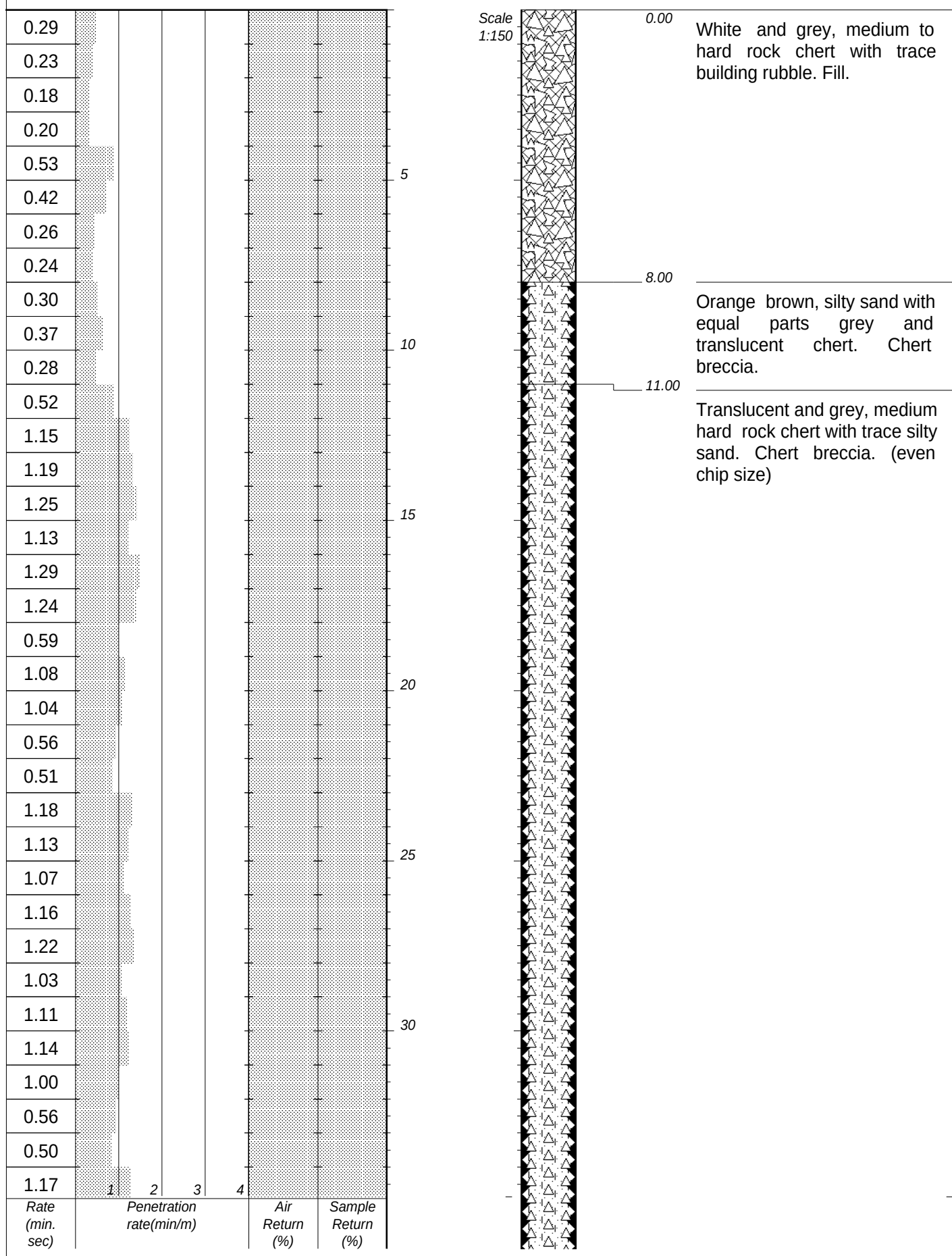
INCLINATION : Vertical
DIAM :
DATE : 2023/06/21
DATE : 2023/06/21
DATE : 20/08/2023 21:02
TEXT : ..asWWTPlogs20230621.TXT

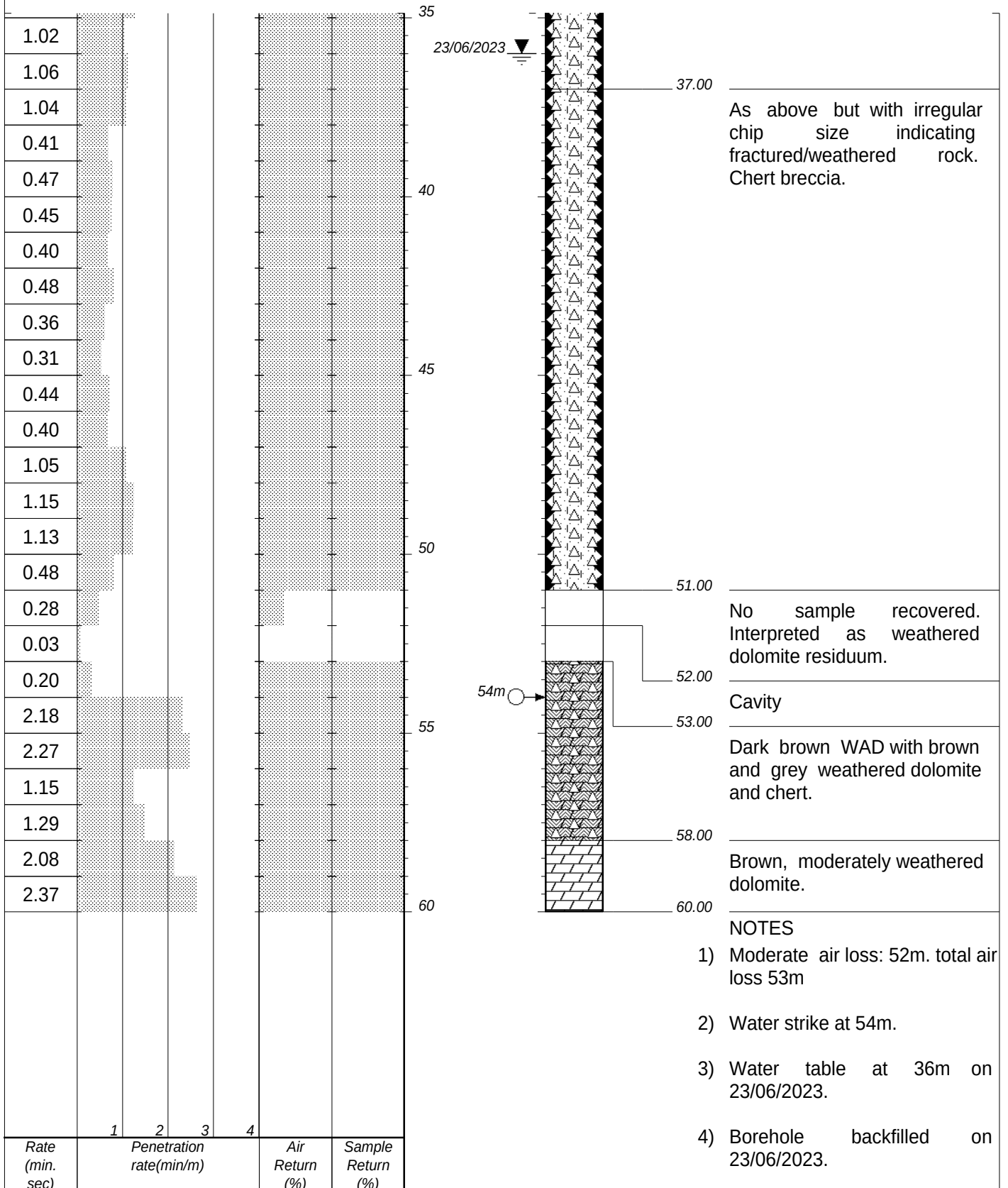
ELEVATION : 1575
X-COORD : 2890699
Y-COORD : 31853

HOLE No: TP09
WGS84 LO29

APPENDIX C

PERCUSSION BOREHOLE LOGS





CONTRACTOR : JK Drilling
MACHINE : THOR 18Bar
DRILLED BY : Patrick
PROFIED BY : I Deale

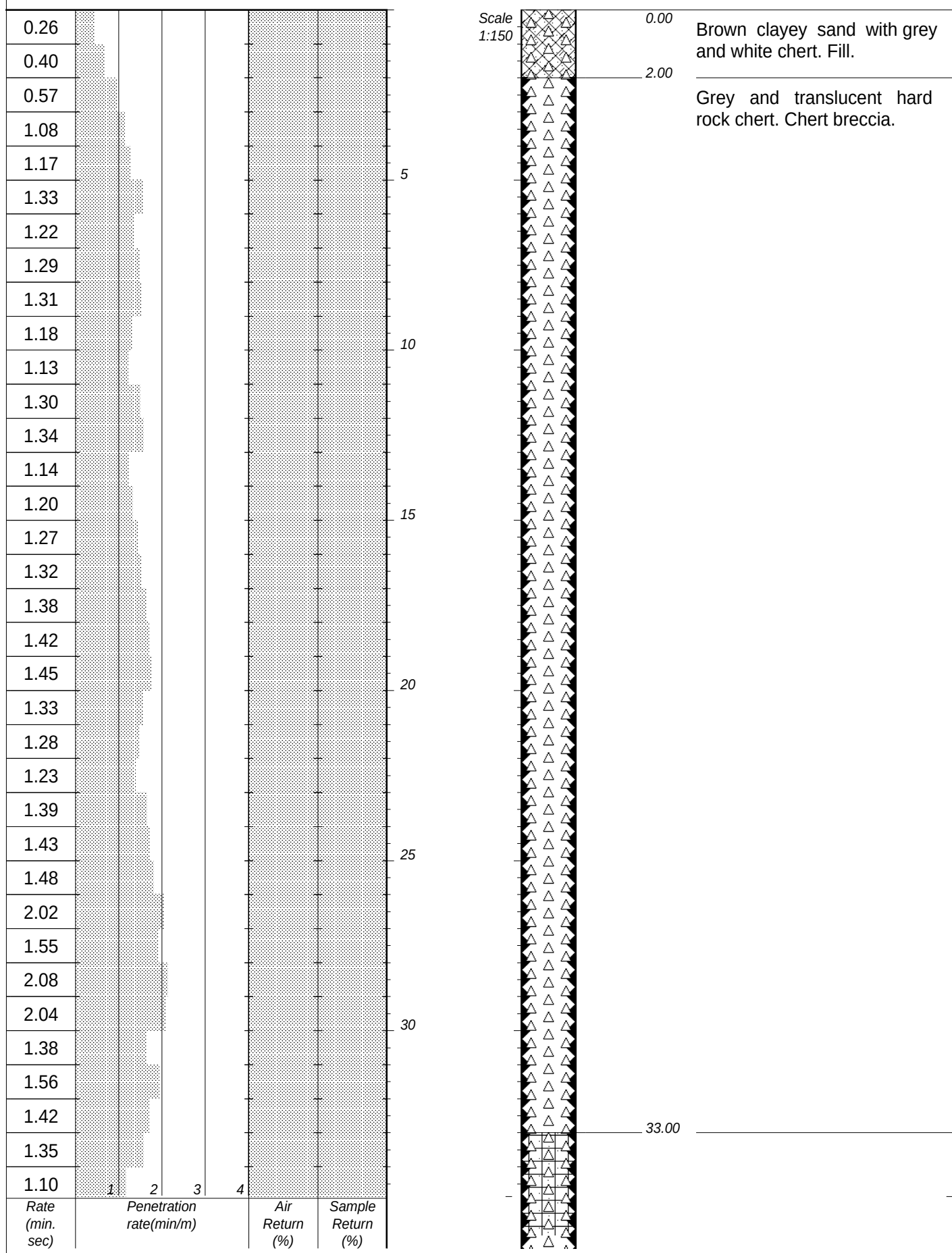
TYPE SET BY : ID
SETUP FILE : CHIP-REV.SET

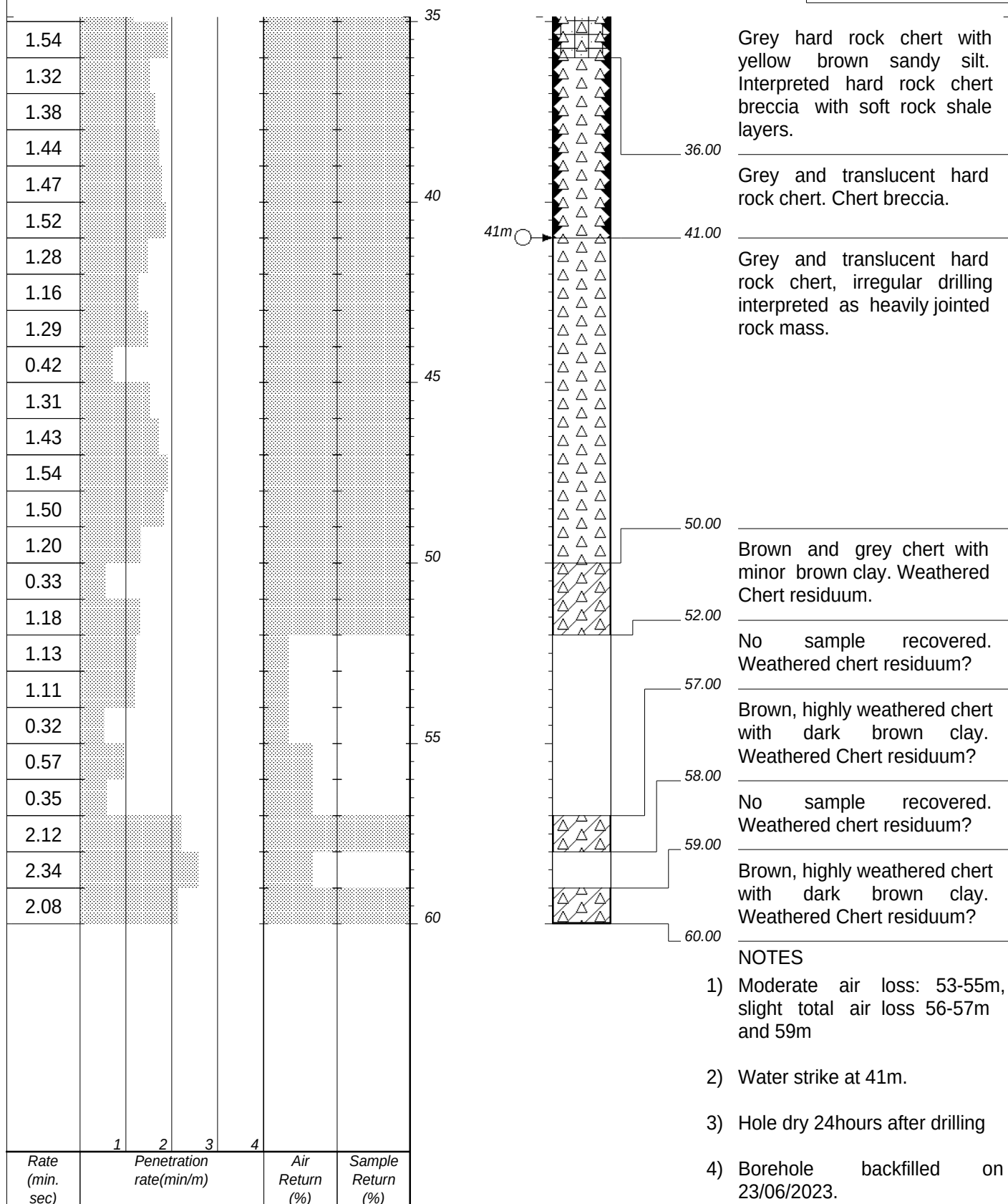
INCLINATION : VERTICAL
DIAM : 165mm
DATE : 2023/06/22
DATE : 2023/06/22

DATE : 20/08/2023 21:03
TEXT : ..DelmasBHlogs20230628.TXT

ELEVATION : 1578
X-COORD : 31789
Y-COORD : 2890669

HOLE No: RG01
Delmas



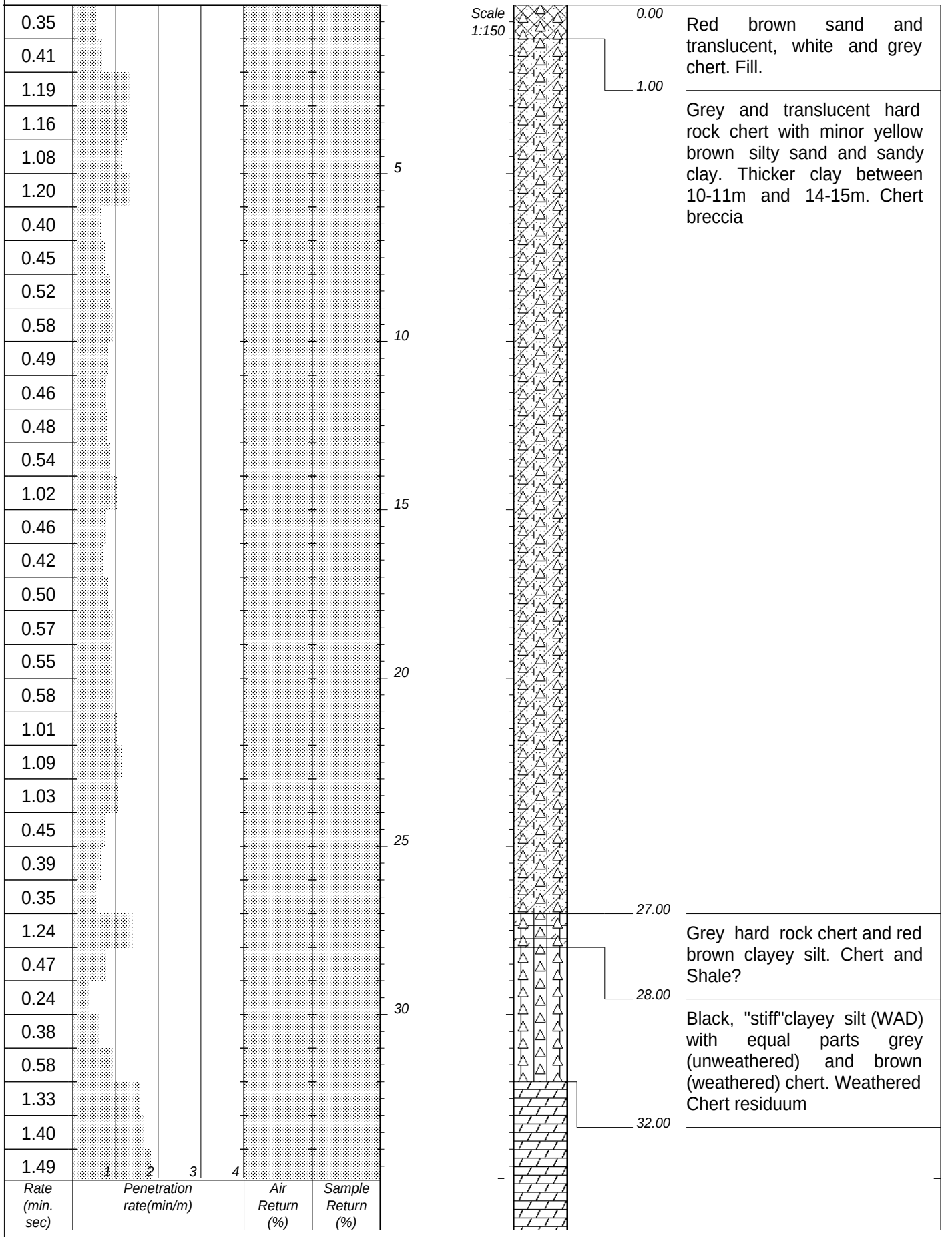


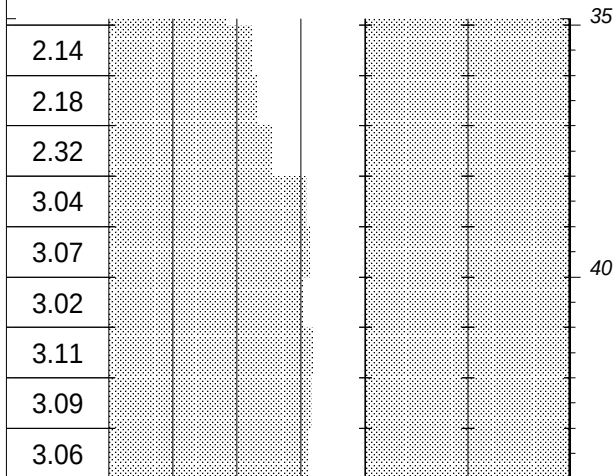
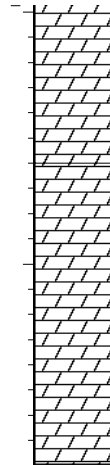
CONTRACTOR : JK Drilling
MACHINE : THOR 18Bar
DRILLED BY : Patrick
PROFIED BY : I Deale
TYPE SET BY : ID
SETUP FILE : CHIP-REV.SET

INCLINATION : VERTICAL
DIAM : 165mm
DATE : 2023/06/22
DATE : 2023/06/22
DATE : 20/08/2023 21:03
TEXT : ..DelmasBHlogs20230628.TXT

ELEVATION : 1579
X-COORD : 31878
Y-COORD : 2890654

HOLE No: RG02
Delmas





Light grey and brown fine grained dolomite. Weathered dolomite.

38.00

Grey hard rock Dolomite bedrock.

44.00

NOTES

- 1) No air or sample loss.
- 2) No water strikes, borehole dry.

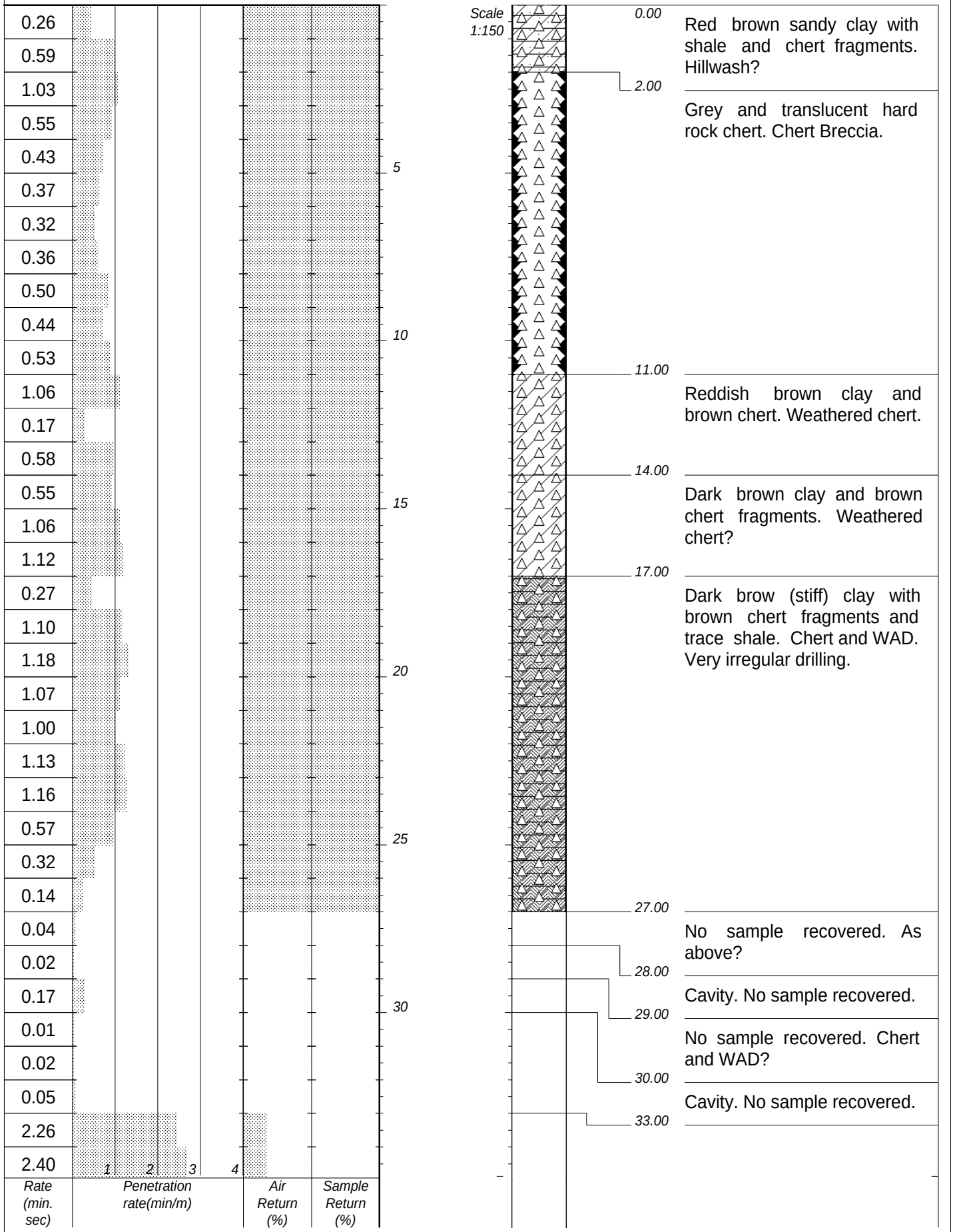
	1	2	3	4	Air Return (%)	Sample Return (%)
Rate (min. sec)						
Penetration rate(min/m)						

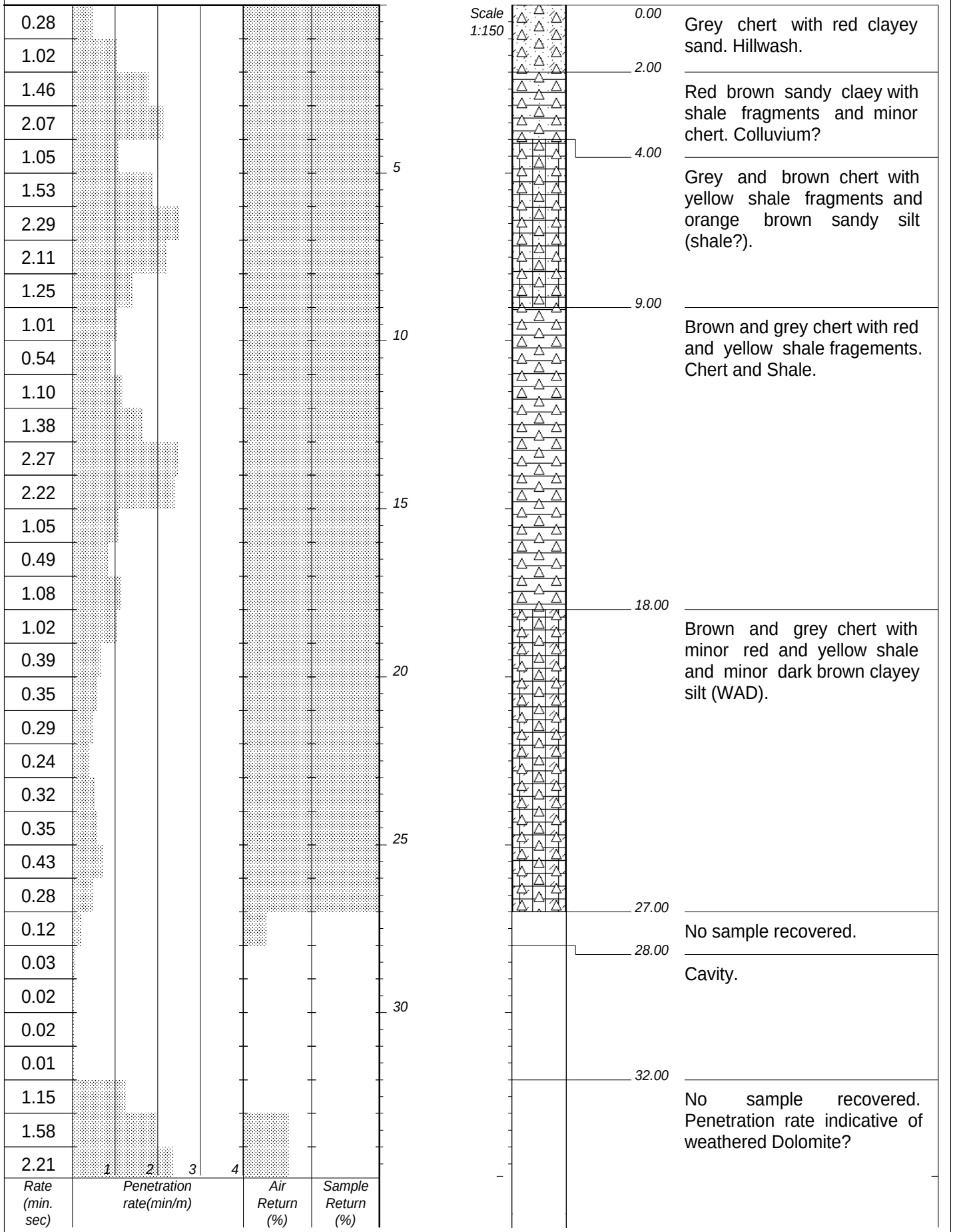
CONTRACTOR : JK Drilling
MACHINE : THOR 18Bar
DRILLED BY : Patrick
PROFIED BY : I Deale
TYPE SET BY : ID
SETUP FILE : CHIP-REV.SET

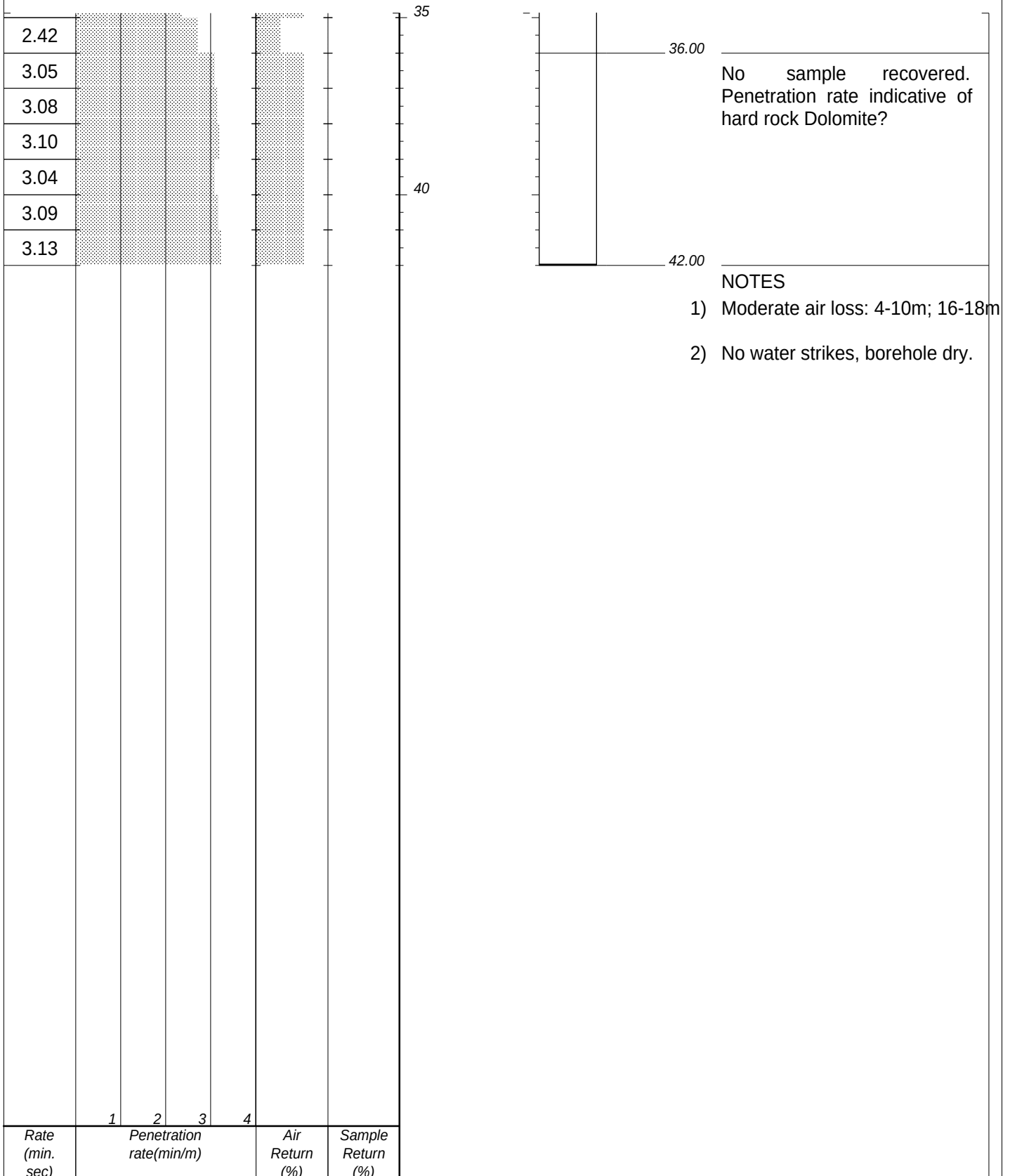
INCLINATION : VERTICAL
DIAM : 165mm
DATE : 2023/06/22
DATE : 2023/06/22
DATE : 20/08/2023 21:03
TEXT : ..DelmasBHlogs20230628.TXT

ELEVATION : 1581
X-COORD : 31845
Y-COORD : 2890764

HOLE No: RG03
Delmas







CONTRACTOR : JK Drilling
MACHINE : THOR 18Bar
DRILLED BY : Patrick
PROFILED BY : I Deale
TYPE SET BY : ID
SETUP FILE : CHIP-REV.SET

INCLINATION : VERTICAL
DIAM : 165mm
DATE : 2023/06/23
DATE : 2023/06/23
DATE : 20/08/2023 21:03
TEXT : ..DelmasBHlogs20230628.TXT

ELEVATION : 1575
X-COORD : 31714
Y-COORD : 2890598

HOLE No: RG05
Delmas

APPENDIX D DRILLERS LOGS

36080

Posbus/PO Box 536
Celtis Ridge
0130

SLAGBOORSTAAT
PERCUSSION BQRE HOLE RECORD

Tel: 012 668 9905/6
Faks/Fax: 012 668 9907
Sel/Cell: 082 554 9443
Email: francois@jayk.co.za

Kliënt: *McCaen*
 Client:
 Projek / Terrein: *Delmas*
 Project / Terrain:
 Gat Nr.: *BH1*
 Hole No.:
 Gatposisie:
 Hole Position:

Totale Diepte: 60M
 Total Depth: _____
 Voering - In & Uit (m): _____
 Casing - In & Out (m): _____
 Voering gelaat (m): _____
 Casing installes (m): _____
 Voering permanent beskadig (m): _____
 Casing permanently damaged (m): _____

Datum: 22-06-2023
Date:
Lugdruk: 18 BAR Lugvolume:
Air Pressure: Air Capacity:
Beiteldeursnee (mm): 16mm
Bit Diameter (mm):
Water aangetref (m):
Water struck (m):
Rusvlak (m):
Rest level (m):

[illegible]

Remarks:

DATA DESCRIBED BY:

OPERATOR:



JK Drilling (Pty) Ltd

36081

GEOLOGICAL DRILLING

SLAGBOORSTAAT

PERCUSSION BORE HOLE RECORD

Posbus/PO Box 536
Celtis Ridge
0130

Tel: 012 668 9905/6
Faks/Fax: 012 668 9907
Sel/Cell: 082 554 9443
Email: francois@jayk.co.za

Kliënt: McCain
Client: McCain
Projek / Terrain: Delmas
Project / Terrain: Delmas
Gat Nr.: BH1
Hole No.: BH1
Gatposisie:
Hole Position:

Totale Diepte:
Total Depth:
Voering - In & Uit (m):
Casing - In & Out (m):
Voering gelaat (m):
Casing installes (m):
Voering permanent beskadig (m):
Casing permanently damaged (m):

Datum: 22-06-2023
Date:
Lugdruk: 18 BAR Lugvolume:
Air Pressure: 18 BAR Air Capacity:
Beiteldeursnee (mm): 165mm
Bit Diameter (mm): 165mm
Water aangetref (m): 54M
Water struck (m): 54M
Rusvlak (m):
Rest level (m):

Diepte Depth (m)	Penetrasie tyd Penetration time min: sek/m	Formasie Formation					Hamer tempo Hammer rate	Lugverlies Air Loss					Vog toestand Moisture condition	Gat val toe Hole collap- sing	Voering Casing	Monster herwinning Sample recovered	OPMERKINGS/REMARKS (bv tipe materiaal / eg. type of material)								
		Holte/Cavity	Baie sag/Very soft	Sag/Soft	Redelik hard/Fairly hard	Solied/Solid		Baie ongereeld/Very irregular	Ongereeld/Irregular	Gereeld/Regular	Geen/None	Effend/Slightly						Medium	Totaal/Total	Water aangetref/Found	Nat/Wet	Klam/Moist	Droog/Dry	Water aangewend/applied	Diepte geïnstalleer Depth installed
31	114																								CHERT
32	100																								11
33	086																								11
34	050																								11
35	117																								11
36	102																								CHERT
37	106																								11
38	104																								11
39	041																								11
40	047																								11
41	045																								CHERT
42	040																								11
43	048																								11
44	036																								11
45	031																								11
46	044																								CHERT
47	040																								11
48	105																								11
49	115																								11
50	113																								11
51	048																								CHERT
52	028																								NO Sample
53	003																								11
54	020																								CHERT/wad
55	218																								CHERT
56	227																								mini dolomite/CHERT
57	115																								11
58	129																								11
59	208																								Dolomite/CHERT
60	237																								Dolomite

Opmerkings:

Remarks:

DATA BESKRYF DEUR:

DATA DESCRIBED BY:

OPERATEUR:

OPERATOR:

Thomas

PATRICK



JK Drilling (Pty) Ltd

36082

GEOLOGICAL DRILLING

SLAGBOORSTAAT

PERCUSSION BORE HOLE RECORD

Posbus/PO Box 536
Celtis Ridge
0130

Tel: 012 668 9905/6
Faks/Fax: 012 668 9907
Sel/Cell: 082 554 9443
Email: francois@jayk.co.za

Klient: McCain
Client: Delmas
Projek / Terrein: BH2
Project / Terrain: BH2
Gat Nr.: BH2
Hole No.: BH2
Gatposisie: BH2
Hole Position: BH2

Totale Diepte: 60M
Total Depth: 60M
Voering - In & Uit (m): 60M
Casing - In & Out (m): 60M
Voering gelaat (m): 60M
Casing installes (m): 60M
Voering permanent beskadig (m): 60M
Casing permanently damaged (m): 60M

Datum: 22-06-2023
Date: 22-06-2023
Lugdruk: 18 BAR
Air Pressure: 18 BAR
Beiteldeursnee (mm): 165mm
Air Capacity: 165mm
Bit Diameter (mm): 165mm
Water aangetref (m): 165mm
Water struck (m): 165mm
Rusvlak (m): 165mm
Rest level (m): 165mm

Diepte Depth (m)	Penetrasie tyd Penetration time min: sek/m	Formasie Formation					Hamer tempo Hammer rate		Lugverlies Air Loss		Vog toestand Moisture condition		Gat val toe Hole collap- sing	Voering Casing	Monster herwinning Sample recovered			OPMERKINGS/REMARKS (bv tipe materiaal / eg. type of material)							
		Holte/Cavity	Bale sag/Very soft	Sag/Soft	Redelik hard/Fairly hard	Solied/Solid	Bale ongereeld/Very irregular	Ongereeld/Irregular	Gereeld/Regular	Geen/None	Effend/Slightly	Medium			Totaal/Total	Water aangetref/found	Nat/Wet		Klam/Moist	Droog/Dry	Water aangewend/applied	Diepte geïnstalleer Depth installed	Goed/Good	Medium	Swak/Poor
																									CO-ORDINATES: LO: Y: 526°07'27.8 X: 6028°40'52.6
0-1	026																								CHERT
1-2	040																								11
2-3	057																								11
3-4	108																								11
4-5	117																								11
5-6	133																								CHERT
6-7	122																								11
7-8	129																								11
8-9	131																								11
9-10	118																								11
10-11	113																								CHERT
11-12	130																								11
12-13	134																								11
13-14	114																								11
14-15	120																								11
15-16	127																								CHERT
16-17	132																								11
17-18	138																								11
18-19	142																								11
19-20	145																								11
20-21	133																								CHERT
21-22	128																								11
22-23	123																								11
23-24	139																								11
24-25	143																								11
25-26	148																								CHERT
26-27	202																								11
27-28	155																								11
28-29	208																								11
29-30	204																								CHERT

Opmerkings:

Remarks:

DATA BESKRYF DEUR:

DATA DESCRIBED BY:

OPERATEUR:

OPERATOR:

Thomas

PATRICK



JK Drilling (Pty) Ltd

36083

GEOLOGICAL DRILLING

SLAGBOORSTAAT

PERCUSSION BORE HOLE RECORD

Posbus/PO Box 536
Celtis Ridge
0130

Tel: 012 668 9905/6
Faks/Fax: 012 668 9907
Sel/Cell: 082 554 9443
Email: francois@jayk.co.za

Kliënt: McCain
Client: _____
Projek / Terrein: Delmas
Project / Terrain: _____
Gat Nr.: BH2
Hole No.: _____
Gatposisie: _____
Hole Position: _____

Totale Diepte: _____
Total Depth: _____
Voering - In & Uit (m): _____
Casing - In & Out (m): _____
Voering gelaat (m): _____
Casing installes (m): _____
Voering permanent beskadig (m): _____
Casing permanently damaged (m): _____

Datum: 22-06-2023
Date: _____
Lugdruk: 18 BAR Lugvolume: _____
Air Pressure: _____ Air Capacity: _____
Beiteldeursnee (mm): 165mm
Bit Diameter (mm): _____
Water aangetref (m): 42M
Water struck (m): _____
Rusvlak (m): _____
Rest level (m): _____

Diepte Depth (m)	Penetrasie tyd Penetration time min: sek/m	Formasie Formation				Hamer tempo Hammer rate	Lugverlies Air Loss				Vog toestand Moisture condition			Gat val toe Hole collap- sing	Voering Casing	Monster herwinning Sample recovered				OPMERKINGS/REMARKS (bv tipe materiaal / eg. type of material)				
		Holte/Cavity	Baie sag/Very soft	Sag/Soft	Redelik hard/Fairly hard	Solied/Solid	Baie ongereeld/Very irregular	Ongereeld/Irregular	Gereeld/Regular	Geen/None	Effend/Slightly	Medium	Totaal/Total	Water aangetref/found	Nat/Wet	Klam/Moist	Droog/Dry	Water aangewend/applied	Diepte geïnstalleer Depth installed	Goed/Good	Medium	Swak/Poor	Geen/None	CO-ORDINATES: LO: _____ Y: _____ X: _____
31	138																							CHERT
32	156																							11
33	142																							11
34	135																							11
35	110																							11
36	154																							CHERT
37	132																							11
38	138																							11
39	144																							11
40	147																							11
41	152																							CHERT
42	128																							11
43	116																							11
44	129																							11
45	042																							11
46	131																							CHERT
47	143																							11
48	154																							11
49	150																							11
50	120																							11
51	033																							CHERT
52	118																							11
53	113																							NO SAMPLE
54	111																							11
55	032																							11
56	057																							11
57	035																							11
58	212																							CHERT
59	234																							NO SAMPLE
59-30	208																							CHERT

Opmerkings:
Remarks:

DATA BESKRYF DEUR: Thomas OPERATEUR: PATRICK
DATA DESCRIBED BY: _____ OPERATOR: _____



JK Drilling (Pty) Ltd

36078

GEOLOGICAL DRILLING

Posbus/PO Box 536
Celtis Ridge
0130

SLAGBOORSTAAT PERCUSSION BORE HOLE RECORD

Tel: 012 668 9905/6
Faks/Fax: 012 668 9907
Sel/Cell: 082 554 9443
Email: francois@jayk.co.za

Kliënt: McCain
Client: _____
Projek / Terrein: Delmas
Project / Terrain: _____
Gat Nr.: _____
Hole No.: BH3
Gatposisie: _____
Hole Position: _____

Totale Diepte: 44M
Total Depth: _____
Voering - In & Uit (m): _____
Casing - In & Out (m): _____
Voering gelaat (m): _____
Casing installes (m): _____
Voering permanent beskadig (m): _____
Casing permanently damaged (m): _____

Datum: 22-06-2023
Date: _____
Lugdruk: 18BAR Lugvolume: _____
Air Pressure: _____ Air Capacity: _____
Beiteldeursnee (mm): _____
Bit Diameter (mm): 165mm
Water aangetref (m): _____
Water struck (m): _____
Rusvlak (m): _____
Rest level (m): _____

Diepte Depth (m)	Penetrasie tyd Penetration time min: sek/m	Formasie Formation					Hamer tempo Hammer rate	Lugverlies Air Loss					Vog toestand Moisture condition	Gat val toe Hole collap- sing	Voering Casing	Monster herwinning Sample recovered				OPMERKINGS/REMARKS (bv tipe materiaal / eg. type of material)				
		Holte/Cavity	Bale sag/Very soft	Sag/Soft	Redelik hard/Fairly hard	Solied/Solid		Bale ongereeld/Irregular	Gereeld/Regular	Geen/None	Effend/Slightly	Medium				Totaal/Total	Water aangetref/found	Nat/Wet	Klam/Moist		Droog/Dry	Water aangewend/applied	Diepte geïnstalleer Depth installed	Goed/Good
0-1	035																							CHERT
1-2	041																							11
2-3	119																							11
3-4	116																							11
4-5	108																							11
5-6	120																							CHERT
6-7	040																							11
7-8	048																							11
8-9	052																							11
9-10	058																							11
10-11	049																							CHERT
11-12	046																							11
12-13	048																							11
13-14	054																							11
14-15	102																							11
15-16	046																							CHERT
16-17	042																							11
17-18	050																							11
18-19	057																							11
19-20	055																							11
20-21	058																							CHERT
21-22	101																							11
22-23	109																							11
23-24	103																							11
24-25	045																							11
25-26	039																							CHERT
26-27	035																							11
27-28	124																							mini SHALE/CHERT
28-29	047																							mini CHERT/wad
29-30	024																							11

Opmerkings:

Remarks:

DATA BESKRYF DEUR:
DATA DESCRIBED BY: THOMAS

OPERATEUR:
OPERATOR: PATRICK



JK Drilling (Pty) Ltd

36079

GEOLOGICAL DRILLING

Posbus/PO Box 536
Celtis Ridge
0130

SLAGBOORSTAAT PERCUSSION BORE HOLE RECORD

Tel: 012 668 9905/6
Faks/Fax: 012 668 9907
Sel/Cell: 082 554 9443
Email: francois@jayk.co.za

Kliënt: McCain
Client: _____
Projek / Terrein: Delmas
Project / Terrain: _____
Gat Nr.: BH3
Hole No.: _____
Gatposisie: _____
Hole Position: _____

Totale Diepte: _____
Total Depth: _____
Voering - In & Uit (m): _____
Casing - In & Out (m): _____
Voering gelaat (m): _____
Casing installes (m): _____
Voering permanent beskadig (m): _____
Casing permanently damaged (m): _____

Datum: 22-06-2008
Date: _____
Lugdruk: 18 BAR Lugvolume: _____
Air Pressure: _____ Air Capacity: _____
Beiteldeursnee (mm): 165mm
Bit Diameter (mm): _____
Water aangetref (m): _____
Water struck (m): _____
Rusvlak (m): _____
Rest level (m): _____

Diepte Depth (m)	Penetrasie tyd Penetration time min: sek/m	Formasie Formation					Hamer tempo Hammer rate	Lugverlies Air Loss					Vog toestand Moisture condition			Gat val toe Hole collap- sing	Voering Casing	Monster herwinning Sample recovered				OPMERKINGS/REMARKS (bv tipe materiaal / eg. type of material)			
		Holte/Cavity	Baie sag/Very soft	Sag/Soft	Redelik hard/Fairly hard	Solied/Solid		Baie ongeregeld/Very irregular	Ongeregeld/Irregular	Geregeld/Regular	Geen/None	Effend/Slightly	Medium	Totaal/Total	Water aangetref/found			Nat/Wet	Klam/Moist	Droog/Dry	Water aangewend/applied		Diepte geïnstalleer Depth installed	Goed/Good	Medium
3-1	038																								CHERT
3-2	058																								CHERT/wad
3-3	133																								Dolomite
3-4	140																								
3-5	149																								
3-6	234																								Soft Dolomite
3-7	218																								
3-8	232																								
3-9	304																								Solid Dolomite
4-10	307																								
4-11	302																								
4-12	311																								
12-13	309																								
12-14	306																								Solid Dolomite
14-15	:																								
15-16	:																								
16-17	:																								
17-18	:																								
18-19	:																								
19-20	:																								
20-21	:																								
21-22	:																								
22-23	:																								
23-24	:																								
24-25	:																								
25-26	:																								
26-27	:																								
27-28	:																								
28-29	:																								
29-30	:																								

Opmerkings:

Remarks:

DATA BESKRYF DEUR:

DATA DESCRIBED BY:

OPERATEUR:

OPERATOR:

Thomas

PATRICK



JK Drilling (Pty) Ltd

36086

GEOLOGICAL DRILLING

Posbus/PO Box 536
Celtis Ridge
0130

SLAGBOORSTAAT PERCUSSION BORE HOLE RECORD

Tel: 012 668 9905/6
Faks/Fax: 012 668 9907
Sel/Cell: 082 554 9443
Email: francois@jayk.co.za

Kliënt: McCain
Client: Delmas
Projek / Terrein: BH4
Project / Terrain: BH4
Gat Nr.: BH4
Hole No.: BH4
Gatposisie:
Hole Position:

Totale Diepte: 41M
Total Depth:
Voering - In & Uit (m):
Casing - In & Out (m):
Voering gelaat (m):
Casing installes (m):
Voering permanent beskadig (m):
Casing permanently damaged (m):

Datum: 23-06-2023
Date:
Lugdruk: 13 BAR Lugvolume:
Air Pressure: 13 BAR Air Capacity:
Beiteldeursnee (mm): 165mm
Bit Diameter (mm):
Water aangetref (m):
Water struck (m):
Rusvlak (m):
Rest level (m):

Diepte Depth (m)	Penetrasie tyd Penetration time min: sek/m	Formasie Formation					Hamer tempo Hammer rate		Lugverlies Air Loss			Vog toestand Moisture condition		Gat val toe Hole collap- sing	Voering Casing	Monster herwinning Sample recovered				OPMERKINGS/REMARKS (bv tipe materiaal / eg. type of material)				
		Holte/Cavity	Baie sag/Very soft	Sag/Soft	Redelik hard/Fairly hard	Solied/Solid	Baie ongeregeld/Very irregular	Ongeregeld/Irregular	Geregeld/Regular	Geen/None	Effend/Slightly	Medium	Totaal/Total	Water aangetref/found	Nat/Wet	Klam/Moist	Droog/Dry	Water aangewend/applied	Diepte geïnstalleer Depth installed	Goed/Good	Medium	Swak/Poor	Geen/None	CO-ORDINATES: LO: Y: X:
0-1	026																							CHERT
1-2	059																							11
2-3	103	clay																						11
3-4	055																							11
4-5	043																							11
5-6	037																							CHERT
6-7	032																							11
7-8	036																							11
8-9	050																							11
9-10	041																							11
10-11	053																							CHERT/clay
11-12	106	clay																						MINI CHERT/clay
12-13	017																							11
13-14	058																							11
14-15	055																							11
15-16	116	clay																						11
16-17	112																							CHERT/clay
17-18	027	clay																						11
18-19	110																							11
19-20	118																							11
20-21	107																							11
21-22	100																							CHERT/clay
22-23	113																							11
23-24	116																							11
24-25	057	clay																						11
25-26	032																							11
26-27	014																							CHERT/clay
27-28	004																							NO SAMPLE
28-29	002																							11
29-30	017																							11

Opmerkings:
Remarks: We used clay cutter from 13m-17m

DATA BESKRYF DEUR: THOMAS OPERATEUR: PATRICK
DATA DESCRIBED BY: OPERATOR:



JK Drilling (Pty) Ltd

36087

GEOLOGICAL DRILLING

Posbus/PO Box 536
Celtis Ridge
0130

SLAGBOORSTAAT PERCUSSION BORE HOLE RECORD

Tel: 012 668 9905/6
Faks/Fax: 012 668 9907
Sel/Cell: 082 554 9443
Email: francois@jayk.co.za

Kliënt: McCain
Client: Delmas
Project / Terrain: BLH4
Gat Nr.: BLH4
Hole No.: BLH4
Gatposisie:
Hole Position:

Totale Diepte:
Total Depth:
Voering - In & Uit (m):
Casing - In & Out (m):
Voering gelaat (m):
Casing installes (m):
Voering permanent beskadig (m):
Casing permanently damaged (m):

Datum: 23-06-2023
Date:
Lugdruk: 18 BAR Lugvolume:
Air Pressure: 18 BAR Air Capacity:
Beiteldeursnee (mm): 165mm
Bit Diameter (mm): 165mm
Water aangetref (m):
Water struck (m):
Rusvlak (m):
Rest level (m):

Diepte Depth (m)	Penetrasie tyd Penetration time min: sek/m	Formasie Formation					Hamer tempo Hammer rate	Lugverlies Air Loss			Vog toestand Moisture condition			Gat val toe Hole collap- sing	Voering Casing	Monster herwinning Sample recovered				OPMERKINGS/REMARKS (bv tipe materiaal / eg. type of material)				
		Holte/Cavity	Bale sag/Very soft	Sag/Soft	Redelik hard/Fairly hard	Solied/Solid		Bale ongereeld/Irregular	Ongereeld/Irregular	Gereeld/Regular	Geen/None	Effend/Slightly	Medium			Totaal/Total	Water aangetref/found	Nat/Wet	Klam/Moist		Droog/Dry	Water aangewend/applied	Diepte geïnstalleer Depth installed	Goed/Good
31	001																							WTO Sample
32	002																							11
33	005																							11
34	2.26																							11
35	2.40																							11
36	3.06																							Solid NO Sample
37	3.12																							11
38	3.08																							11
39	3.04																							11
40	3.07																							11
41	3.03																							Solid NO Sample
11-12	:																							
12-13	:																							
13-14	:																							
14-15	:																							
15-16	:																							
16-17	:																							
17-18	:																							
18-19	:																							
19-20	:																							
20-21	:																							
21-22	:																							
22-23	:																							
23-24	:																							
24-25	:																							
25-26	:																							
26-27	:																							
27-28	:																							
28-29	:																							
29-30	:																							

Opmerkings:

Remarks:

DATA BESKRYF DEUR: THOMAS OPERATEUR: PATRICK
DATA DESCRIBED BY: THOMAS OPERATOR: PATRICK



Posbus/PO Box 536
Celtis Ridge
0130

Tel: 012 668 9905/6
Faks/Fax: 012 668 9907
Sel/Cell: 082 554 9443
Email: francois@jayk.co.za

Kliënt: McCain
Client: McCain
Projek / Terrein: Delmas
Project / Terrain: Delmas
Gat Nr.: BH5
Hole No.: BH5
Gatposisie:
Hole Position:

Totale Diepte: 42M
Total Depth:
Voering - In & Uit (m):
Casing - In & Out (m):
Voering gelaat (m):
Casing installed (m):
Voering permanent beskadig (m):
Casing permanently damaged (m):

Datum: 23-06-2023
Date:
Lugdruk: 18 BAR Lugvolume:
Air Pressure: 18 BAR Air Capacity:
Beiteldeursnee (mm):
Bit Diameter (mm): 165mm
Water aangetref (m):
Water struck (m):
Rusvlak (m):
Rest level (m):

Diepte Depth (m)	Penetrasie tyd Penetration time min: sek/m	Formasie Formation				Hamer tempo Hammer rate	Lugverlies Air Loss	Vog toestand Moisture condition	Gat val toe Hole collap- sing	Voering Casing	Monster herwinning Sample recovered	OPMERKINGS/REMARKS (bv tipe materiaal / eg. type of material)
		Holte/Cavity	Bale sag/Very soft	Sag/Soft	Redelik hard/Fairly hard							
0-1	028											CHERT
1-2	102											CHERT/clay
2-3	146											CHERT/clay
3-4	207											mini clay/CHERT
4-5	105											CHERT/clay
5-6	153											CHERT/clay
6-7	229											CHERT
7-8	211											CHERT
8-9	125											CHERT
9-10	101											CHERT
10-11	094											CHERT
11-12	110											CHERT/clay
12-13	138											CHERT/clay
13-14	227											CHERT
14-15	222											mini chert/clay
15-16	105											CHERT
16-17	049											CHERT
17-18	108											CHERT
18-19	102											CHERT
19-20	039											CHERT
20-21	035											CHERT
21-22	029											CHERT
22-23	024											CHERT
23-24	032											CHERT
24-25	035											CHERT
25-26	043											CHERT
26-27	028											CHERT
27-28	012											NO Sample
28-29	003											CHERT
29-30	002											CHERT

Opmerkings: from 28m-42m NO Sample Return
Remarks: we used 2L Drilling foam

DATA BESKRYF DEUR: Thomas OPERATEUR: PATRICK
DATA DESCRIBED BY:



JK Drilling (Pty) Ltd

36085

GEOLOGICAL DRILLING

SLAGBOORSTAAT

PERCUSSION BORE HOLE RECORD

Posbus/PO Box 536
Celtis Ridge
0130

Tel: 012 668 9905/6
Faks/Fax: 012 668 9907
Sel/Cell: 082 554 9443
Email: francois@jayk.co.za

Kliënt: McCain
Client: McCain
Projek / Terrein: Delmas
Project / Terrain: Delmas
Gat Nr.: BHS
Hole No.: BHS
Gatposisie:
Hole Position:

Totale Diepte:
Total Depth:
Voering - In & Uit (m):
Casing - In & Out (m):
Voering gelaat (m):
Casing installes (m):
Voering permanent beskadig (m):
Casing permanently damaged (m):

Datum: 23-06-2023
Date:
Lugdruk: 18 Bar Lugvolume:
Air Pressure: 18 Bar Air Capacity:
Beiteldeursnee (mm):
Bit Diameter (mm): 165mm
Water aangetref (m):
Water struck (m):
Rusvlak (m):
Rest level (m):

Diepte Depth (m)	Penetrasie tyd Penetration time min: sek/m	Formasie Formation					Hamer tempo Hammer rate	Lugverlies Air Loss					Vog toestand Moisture condition			Gat val toe Hole collap- sing	Voering Casing	Monster herwinning Sample recovered				OPMERKINGS/REMARKS (bv tipe materiaal / eg. type of material)			
		Holte/Cavity	Baie sag/Very soft	Sag/Soft	Redelik hard/Fairly hard	Solied/Solid		Baie ongeregeld/Very irregular	Ongeregeld/Irregular	Geregeld/Regular	Geen/None	Effend/Slightly	Medium	Totaal/Total	Water aangetref/found			Nat/Wet	Klam/Moist	Droog/Dry	Water aangewend/applied		Diepte geïnstalleer Depth installed	Goed/Good	Medium
																									CO-ORDINATES: LO: _____ Y: _____ X: _____
31	0026						✓					✓											✓	NO Sample	
32	0016						✓					✓						✓					✓	11	
33	115						✓					✓						✓					✓	11	
34	158							✓		✓								✓					✓	11	
35	221							✓		✓								✓					✓	11	
36	242							✓				✓						✓					✓	NO Sample	
37	305						✓			✓								✓					✓	NO Sample	
38	308							✓		✓								✓					✓	NO Sample	
39	310							✓		✓								✓					✓	11	
40	304							✓		✓								✓					✓	11	
41	309							✓		✓								✓					✓	11	
42	313							✓		✓								✓					✓	NO Sample	
12-13	:																								
13-14	:																								
14-15	:																								
15-16	:																								
16-17	:																								
17-18	:																								
18-19	:																								
19-20	:																								
20-21	:																								
21-22	:																								
22-23	:																								
23-24	:																								
24-25	:																								
25-26	:																								
26-27	:																								
27-28	:																								
28-29	:																								
29-30	:																								

Opmerkings:

Remarks:

DATA BESKRYF DEUR:
DATA DESCRIBED BY: Thomas

OPERATEUR:
OPERATOR: PATRICK



APPENDIX E

LABORATORY TEST RESULTS



**Specialised
Testing
Laboratory** (Pty) Ltd
Asphalt | Aggregate | Bitumen | Geotechnical

Unit 1, 13 Bloubokkie Street, Koedoespoort 0186

Roelof | 072 674 6343 | roelof@stlab.co.za

Gerle | 082 309 4448 | gerle@stlab.co.za

www.stlab.co.za

Quality | Excellence | On Time

Client Name: Rockland GeoScience
Project Name: McCains Delmas WWTW
Job Number: RGS-29
Date: 2023-07-28
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Reference:
R-STL-011 Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)

Atterberg Limits & Classification

Sample	TP9	TP2	TP6	Sample	TP9	TP2	TP6
Depth (m)	0.0 - 2.1	0.2 - 0.7	0.2 - 0.5	Depth (m)	0.0 - 2.1	0.2 - 0.7	0.2 - 0.5
Lab No	RGS-29-274	RGS-29-275	RGS-29-276	Lab No	RGS-29-274	RGS-29-275	RGS-29-276
53.0	76	91	91	Liquid Limit (%)	-	29	22
37.5	66	91	79	Plastic Limit (%)	-	21	15
26.5	56	84	70	Plasticity Index (%)	SP	8	7
19.0	44	81	64	Linear Shrinkage (%)	0.5	3.5	3.5
13.2	39	81	63	PI of whole sample	-	3	3
9.5	35	80	60				
6.7	31	77	56	% Gravel	76	54	53
4.75	29	71	53	% Sand	17	24	32
2.00	24	46	47	% Silt	5	16	10
1.00	21	40	44	% Clay	2	6	5
0.425	19	36	39	Activity	0.0	1.3	1.4
0.250	17	34	35				
0.150	13	32	28	% Soil Mortar	24	46	47
0.075	9	27	19				
0.060	7	22	15	Grading Modulus	2.48	1.91	1.95
0.050	6	20	13	Moisture Content (%)	3.6	9.7	6.1
0.035	5	16	11	Relative Density (SG)*	2.65	2.65	2.65
0.020	4	12	10				
0.006	3	8	7	Unified (ASTM D2487)	GP-GM	SC	GC-GM
0.002	2	6	5	AASHTO (M145-91)	A - 1 - a	A - 2 - 4	A - 2 - 4

Remarks: *: Assumed
N / T: Not Tested

Although everything possible is done to ensure testing is performed accurately, neither Specialised Testing Laboratory (Pty) Ltd nor any of its directors, managers, employees or contractors can be held liable for any damages whatsoever arising from any error made in performing any tests, nor from any conclusions drawn therefrom. Test results are to be published in full. Samples will be kept for 1 month after the submission of test results due to limited storage space, unless other arrangements are in place. Confidentiality statement: Unless the release of information is required by law or covered by confidentiality agreements all information obtained or created during the performance of laboratory activities will be kept confidential.



**Specialised
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Laboratory** (Pty) Ltd
Asphalt | Aggregate | Bitumen | Geotechnical

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Gerrie | 082 309 4448 | gerrie@stlab.co.za

www.stlab.co.za

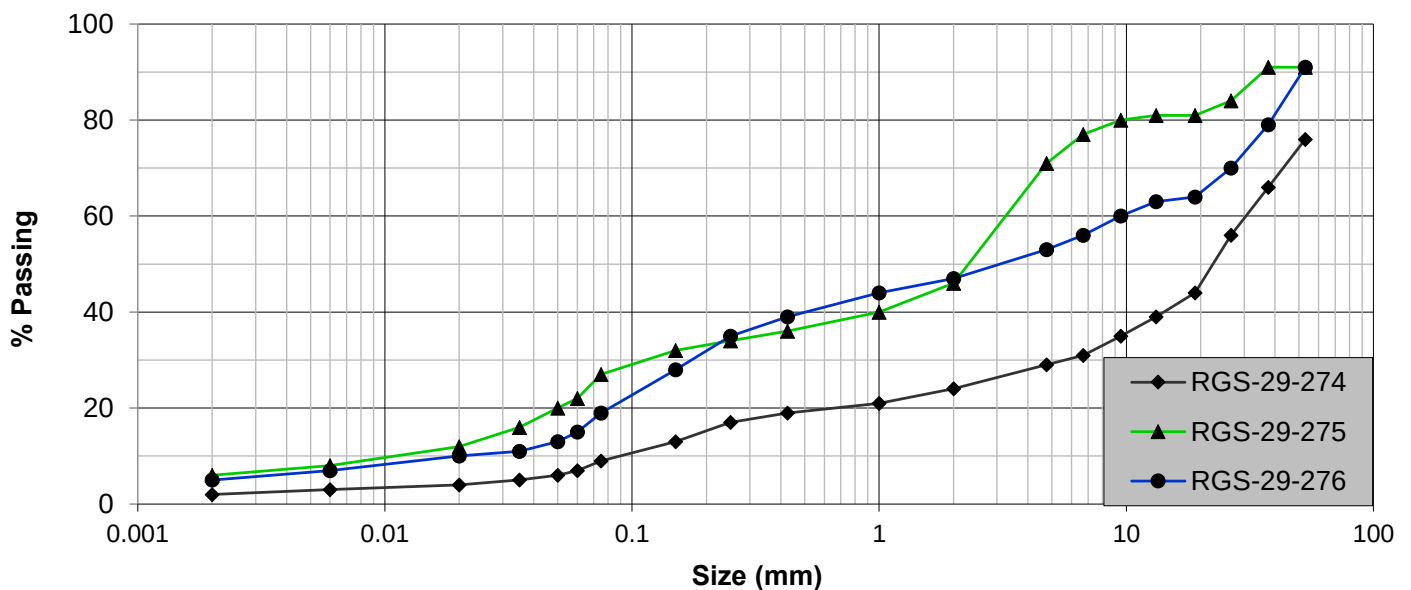
Quality | Excellence | On Time

Client Name: Rockland GeoScience
Project Name: McCains Delmas WWTW
Job Number: RGS-29
Date: 2023-07-28
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

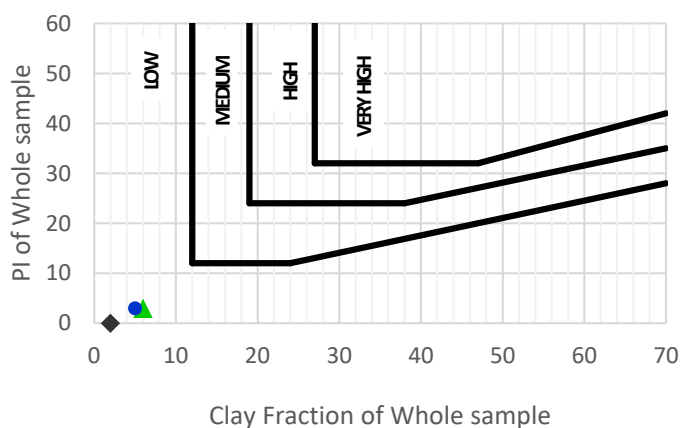
FOUNDATION INDICATOR

Sheet Reference:
R-STL-011 Rev02

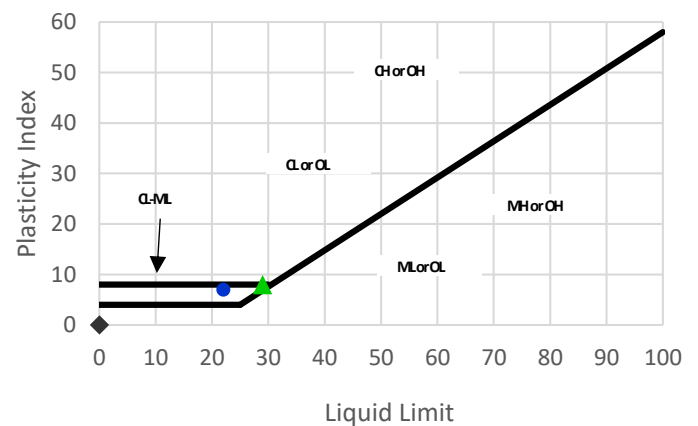
PSD



Potential Expansiveness



Casagrande Plasticity Chart





**Specialised
Testing
Laboratory** (Pty) Ltd
Asphalt | Aggregate | Bitumen | Geotechnical

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Quality | Excellence | On Time

Client Name: Rockland GeoScience
Project Name: McCains Delmas WWTW
Job Number: RGS-29
Date: 2023-07-28
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Reference:
R-STL-011 Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)

Atterberg Limits & Classification

Sample	TP6	TP3		Sample	TP6	TP3	
Depth (m)	0.5 - 1.3	0.1 - 2.3		Depth (m)	0.5 - 1.3	0.1 - 2.3	
Lab No	RGS-29-277	RGS-29-278		Lab No	RGS-29-277	RGS-29-278	
53.0	100	95		Liquid Limit (%)	-	27	
37.5	99	95		Plastic Limit (%)	-	18	
26.5	83	86		Plasticity Index (%)	SP	9	
19.0	76	77		Linear Shrinkage (%)	0.5	4.5	
13.2	74	75		PI of whole sample	-	3	
9.5	71	71					
6.7	66	63		% Gravel	50	60	
4.75	62	56		% Sand	34	22	
2.00	50	40		% Silt	12	11	
1.00	44	36		% Clay	4	7	
0.425	38	32		Activity	0.0	1.3	
0.250	33	29					
0.150	26	24		% Soil Mortar	50	40	
0.075	19	19					
0.060	16	18		Grading Modulus	1.93	2.09	
0.050	15	16		Moisture Content (%)	3.4	9.6	
0.035	12	14		Relative Density (SG)*	2.65	2.65	
0.020	10	11					
0.006	7	9		Unified (ASTM D2487)	SM	GC	
0.002	4	7		AASHTO (M145-91)	A - 1 - b	A - 2 - 4	

Remarks: *: Assumed
N / T: Not Tested

Although everything possible is done to ensure testing is performed accurately, neither Specialised Testing Laboratory (Pty) Ltd nor any of its directors, managers, employees or contractors can be held liable for any damages whatsoever arising from any error made in performing any tests, nor from any conclusions drawn therefrom. Test results are to be published in full. Samples will be kept for 1 month after the submission of test results due to limited storage space, unless other arrangements are in place. Confidentiality statement: Unless the release of information is required by law or covered by confidentiality agreements all information obtained or created during the performance of laboratory activities will be kept confidential.



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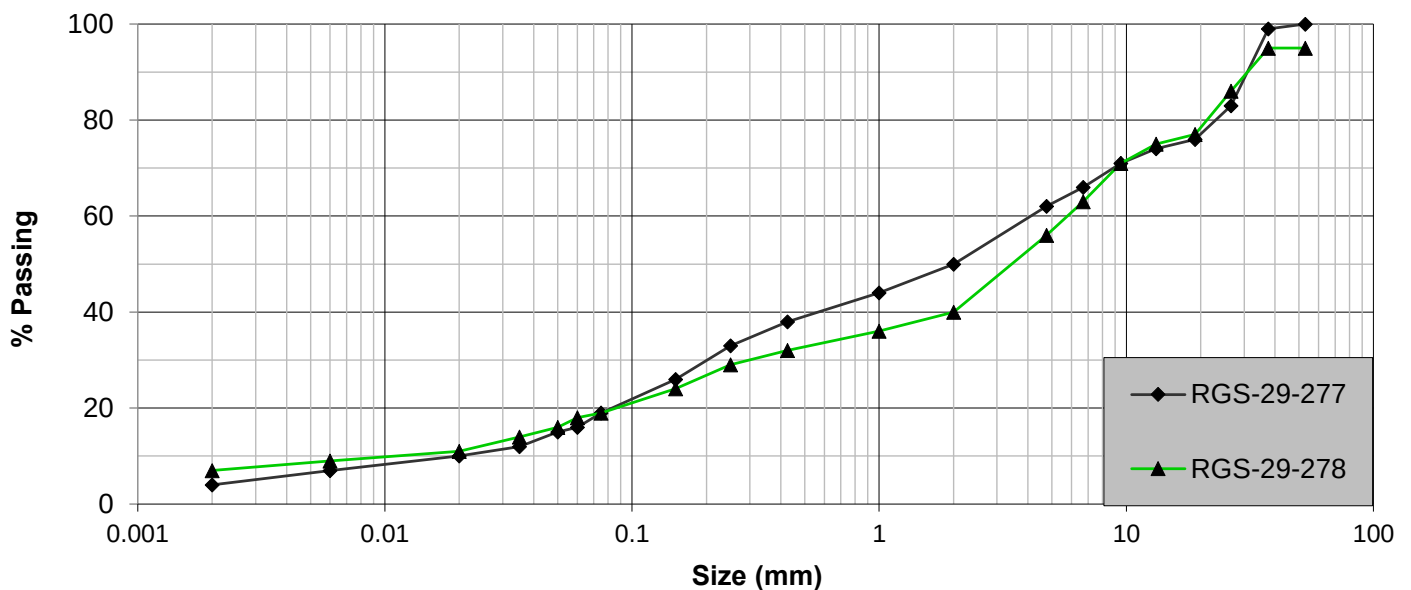
Quality | Excellence | On Time

Client Name: Rockland GeoScience
Project Name: McCains Delmas WWTW
Job Number: RGS-29
Date: 2023-07-28
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

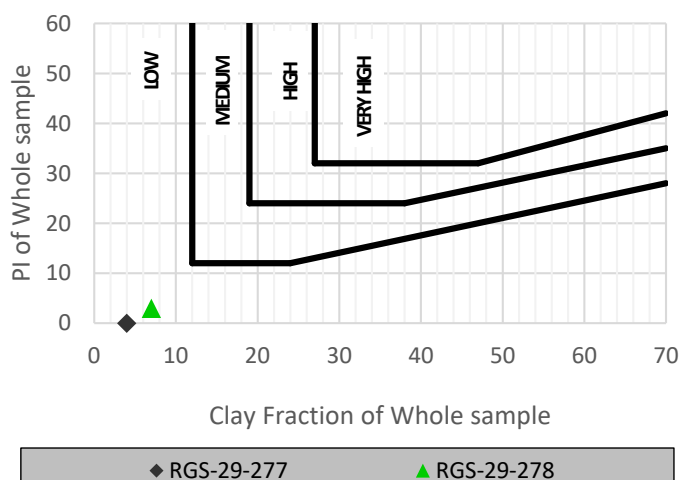
FOUNDATION INDICATOR

Sheet Reference:
R-STL-011 Rev02

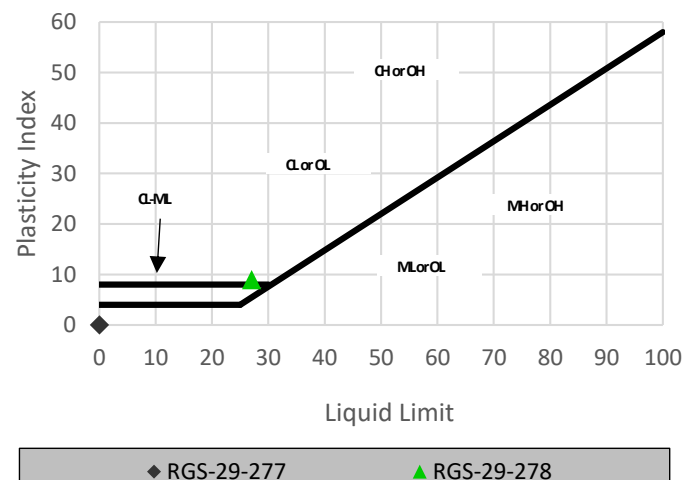
PSD



Potential Expansiveness



Casagrande Plasticity Chart





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Quality | Excellence | On Time

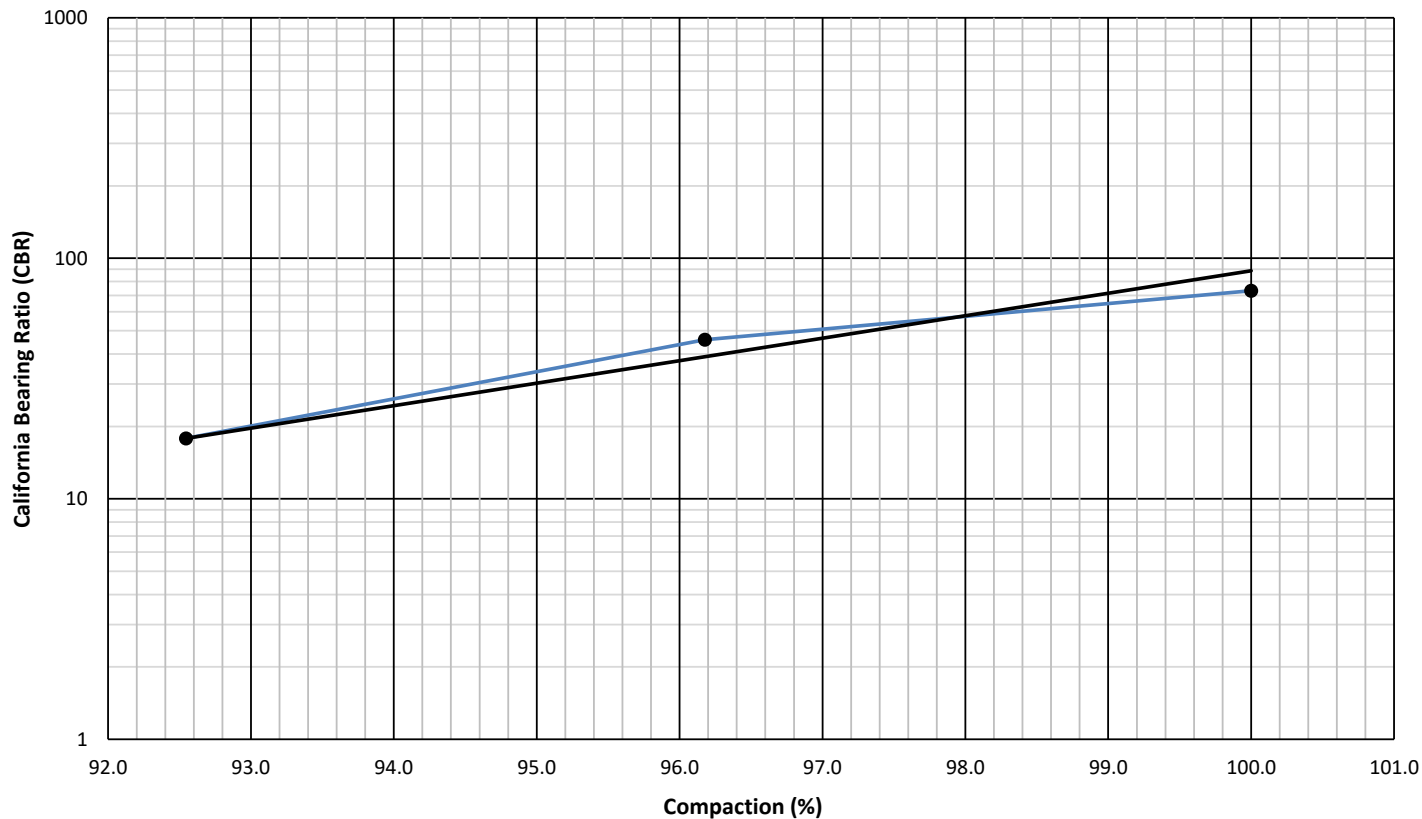
Client Name: Rockland GeoScience
Project Name: McCains Delmas WWTW
Sample: TP9
Depth: (m) 0.0 - 2.1

Job Number: RGS-29
Lab Number: RGS-29-274
Method: SANS 3001 GR40
Date: 28-Jul-23

CALIFORNIA BEARING RATIO

Sheet Reference:
R-STL-014 Rev01

Mod. AASHTO Values		Compaction Data: CBR			Swell	CBR at (mm)			CBR Values	
MDD	OMC	Dry Dens.	MC	Comp.		2.5	5.0	7.5	Compaction (%)	CBR
(kg/m ³)	(%)	(kg/m ³)	(%)	(%)	(%)					
2081	8.0	2066	8.5	100.0	0.0	73	97	106	100	73
									98	57
									97	51
2081	8.0	1987	8.5	96.2	0.0	46	55	54	95	34
									93	20
2081	8.0	1912	8.5	92.5	0.0	18	19	19	90	9



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Quality | Excellence | On Time

Client Name: Rockland GeoScience
Project Name: McCains Delmas WWTW
Sample: TP9
Depth: (m) 0.0 - 2.1

Job Number: RGS-29
Lab Number: RGS-29-274
Method: SANS 3001 GR30
Date: 28-Jul-23

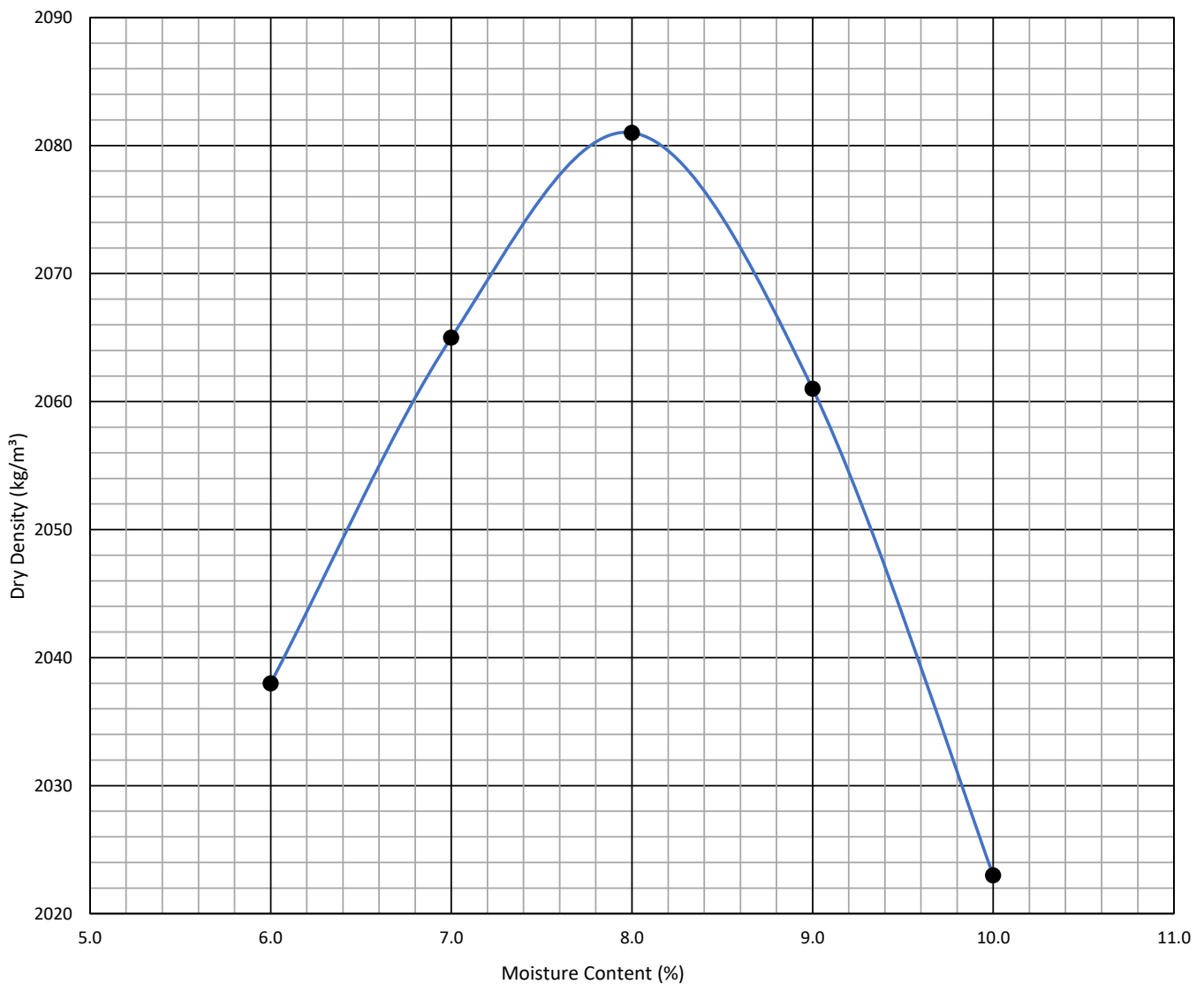
MDD & OMC DETERMINATION (Mod. AASHTO)

Sheet Reference:
R-STL-013 Rev01

Maximum Dry Density: **2081** kg/m³

Optimum Moisture Content: **8.0** %

Moisture Content (%)	6.0	7.0	8.0	9.0	10.0			
Dry Density (kg/m ³)	2038	2065	2081	2061	2023			



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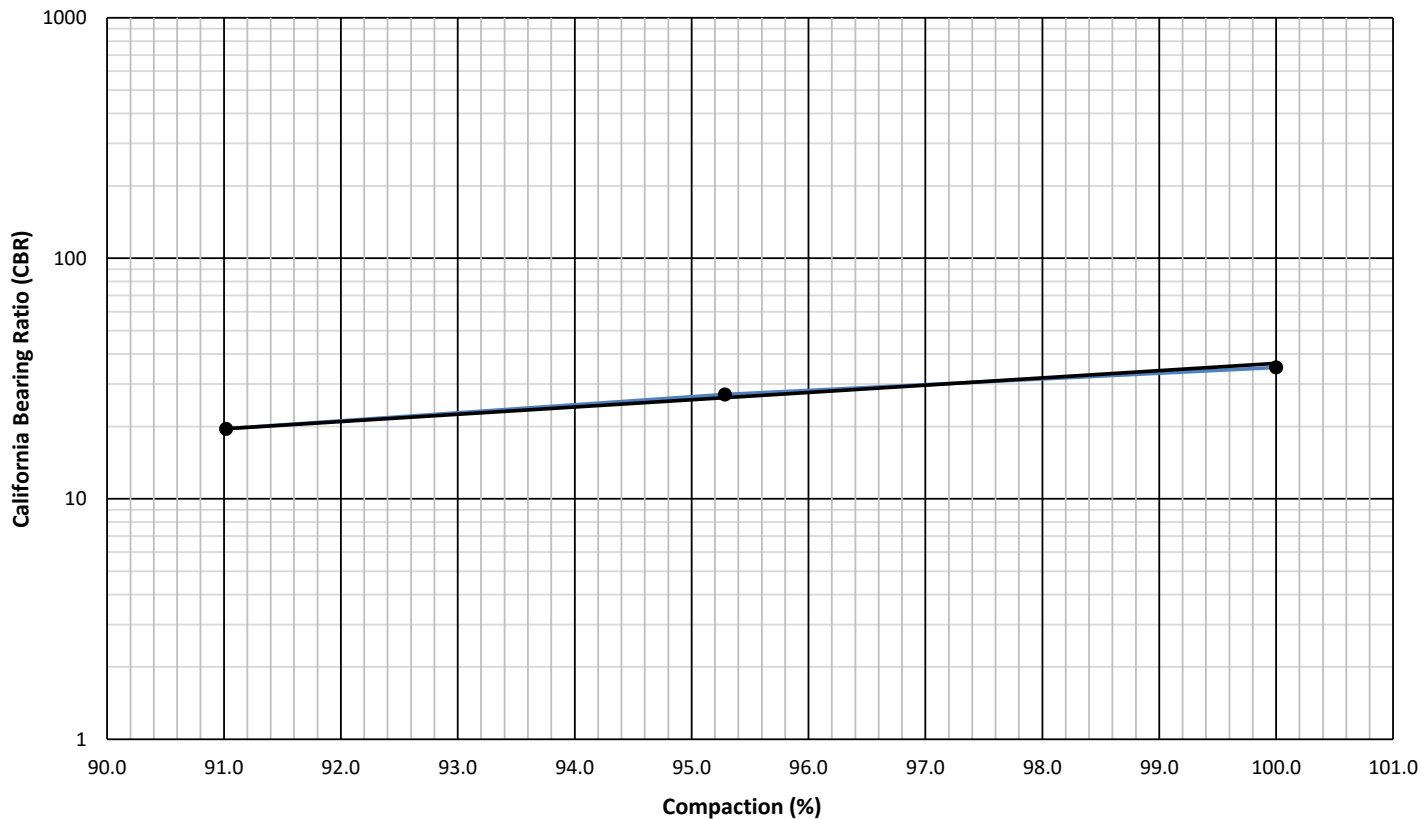
Client Name: Rockland GeoScience
Project Name: McCains Delmas WWTW
Sample: TP3
Depth: (m) 0.1 - 2.3

Job Number: RGS-29
Lab Number: RGS-29-278
Method: SANS 3001 GR40
Date: 28-Jul-23

CALIFORNIA BEARING RATIO

Sheet Reference:
R-STL-014 Rev01

Mod. AASHTO Values		Compaction Data: CBR			Swell	CBR at (mm)			CBR Values	
MDD	OMC	Dry Dens.	MC	Comp.		2.5	5.0	7.5	Compaction (%)	CBR
(kg/m ³)	(%)	(kg/m ³)	(%)	(%)	(%)					
2036	10.7	2015	12.0	100.0	0.0	35	31	29	100	35
									98	32
									97	30
2036	10.7	1920	12.0	95.3	0.0	27	34	36	95	27
									93	23
2036	10.7	1834	12.0	91.0	0.0	20	17	15	90	18



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Client Name: Rockland GeoScience
Project Name: McCains Delmas WWTW
Sample: TP3
Depth: (m) 0.1 - 2.3

Job Number: RGS-29
Lab Number: RGS-29-278
Method: SANS 3001 GR30
Date: 28-Jul-23

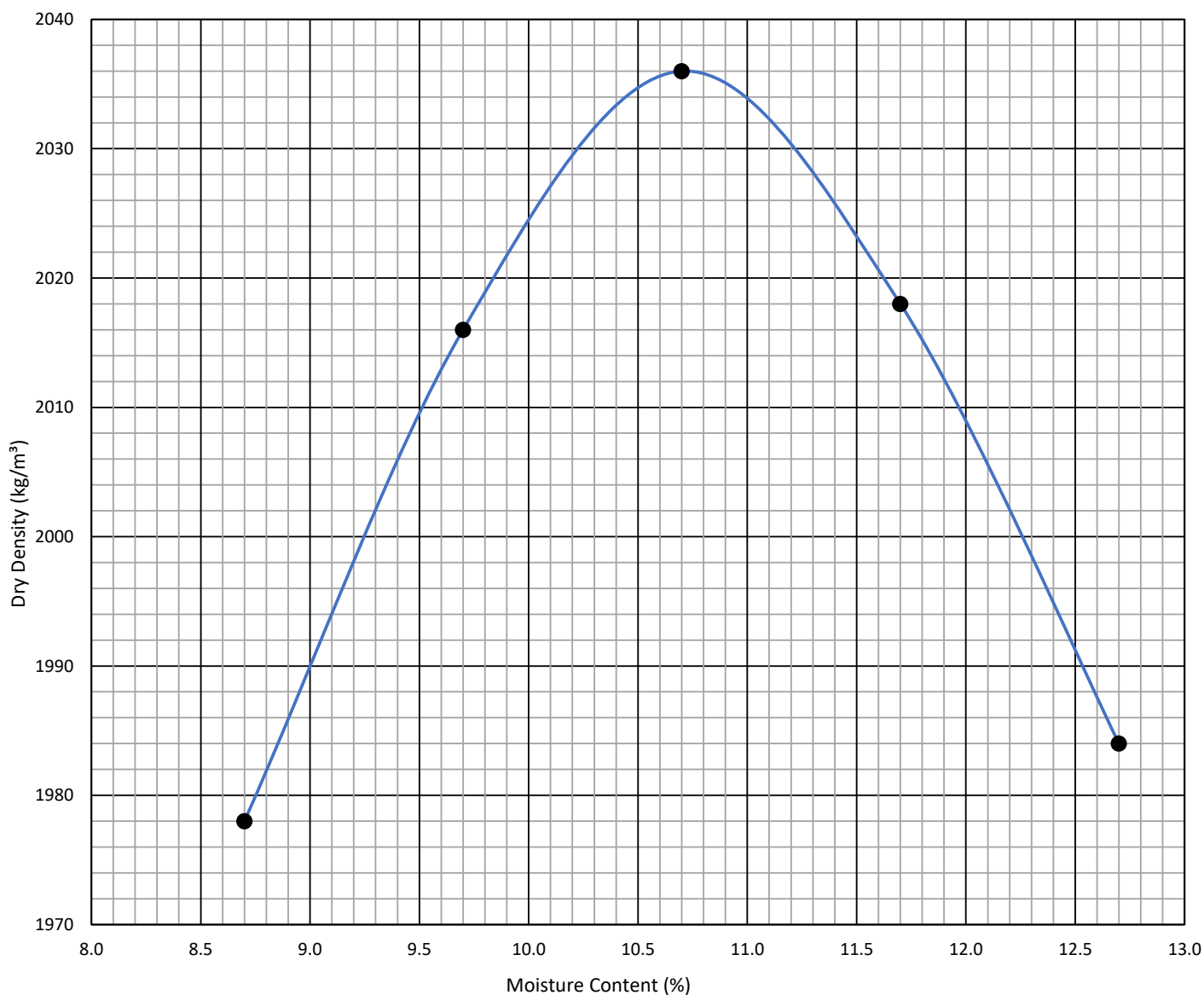
MDD & OMC DETERMINATION (Mod. AASHTO)

Sheet Reference:
R-STL-013 Rev01

Maximum Dry Density: **2036** kg/m³

Optimum Moisture Content: **10.7** %

Moisture Content (%)	8.7	9.7	10.7	11.7	12.7			
Dry Density (kg/m ³)	1978	2016	2036	2018	1984			



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Client Name: Rockland GeoScience
Project Name: McCains Delmas WWTW
Job Number: RGS-29
Date: 28-Jul-23
Method: SANS 3001 GR1, GR3, GR10, GR12 GR20, GR30, GR31, GR40, GR50, GR53, GR54 & BS 1377 (where applicable)

SUMMARY OF TEST DATA

Sheet Reference:
R-STL-038 Rev01

Grading & Hydrometer Analysis (% Passing)

Sample	TP9	TP2	TP6	TP6	TP3			
Depth (m)	0.0 - 2.1	0.2 - 0.7	0.2 - 0.5	0.5 - 1.3	0.1 - 2.3			
Lab No	RGS-29-274	RGS-29-275	RGS-29-276	RGS-29-277	RGS-29-278			
53.0	76	91	91	100	95			
37.5	66	91	79	99	95			
26.5	56	84	70	83	86			
19.0	44	81	64	76	77			
13.2	39	81	63	74	75			
9.5	35	80	60	71	71			
6.7	31	77	56	66	63			
4.75	29	71	53	62	56			
2.0	24	46	47	50	40			
1.0	21	40	44	44	36			
0.425	19	36	39	38	32			
0.250	17	34	35	33	29			
0.150	13	32	28	26	24			
0.075	9	27	19	19	19			
0.060	7	22	15	16	18			
0.050	6	20	13	15	16			
0.035	5	16	11	12	14			
0.020	4	12	10	10	11			
0.006	3	8	7	7	9			
0.002	2	6	5	4	7			
GM	2.48	1.91	1.95	1.93	2.09			

Atterberg Limits

LL (%)	-	29	22	-	27			
PI (%)	SP	8	7	SP	9			
LS (%)	0.5	3.5	3.5	0.5	4.5			

pH & Conductivity

pH	5.7	4.9	5.7	4.7	5.2			
EC (S/m)	0.028	0.005	0.023	0.011	0.004			

MDD / OMC

MDD (kg/m ³)	2081				2036			
OMC (%)	8.0				10.7			

CBR

100%	73				35			
98%	57				32			
97%	51				30			
95%	34				27			
93%	20				23			
90%	9				18			
Swell (%)	0.0				0.0			

UCS (MPa)

100%								
97%								
90%								

COLTO Classification

	G6				G6			
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Remarks:

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APPENDIX F

BEARING CAPACITY CALCULATION

Bearing Capacity Calculations of Shallow Footings (Brinch Hansen, 1970)

Project: McCain Delmas WWTP

Project No: RG/022/316

Date: 18-Aug-23

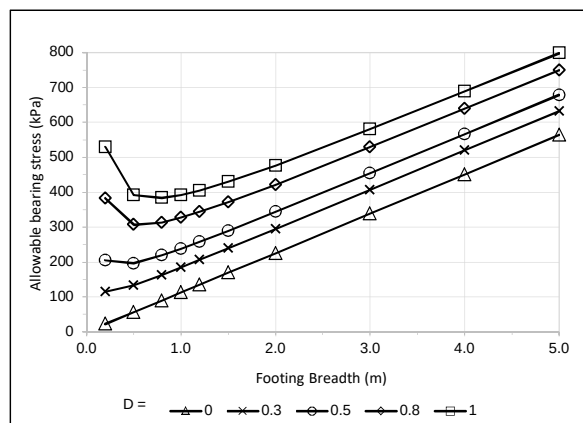
Founding on G6 compacted to 95% Mod AASHTC

Parameters

Factor of Safety (FoS)	3	Depth to water table	10 m
Bulk unit weight (γ)	20 kN/m ³	B/L for strip footing	0.005
Saturated unit weight (γ_{sat})	21 kN/m ³	B/L for rectangular footing	0.5
Friction angle (ϕ')	35 °	B/L for pad footing	1
Cohesion (c')	0 kPa		
Undrained shear strength (c_u)	0 kPa	NMC	

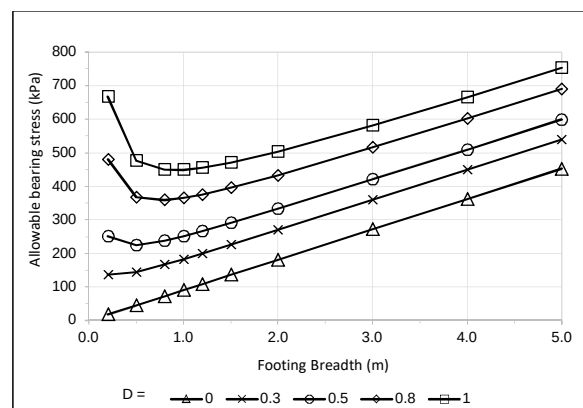
Strip Footing

Footing Breadth (m)	Founding Depth D (m)					
	0.0	0.3	0.5	0.8	1	1.2
	Allowable Bearing Stress (kPa)					
0.2	23	115	205	382	529	698
0.5	56	133	196	307	392	487
0.8	90	163	219	314	384	459
1.0	113	185	238	327	392	462
1.2	135	206	259	344	405	471
1.5	169	239	290	372	430	491
2.0	226	295	344	422	477	534
3.0	339	407	455	529	580	633
4.0	451	519	566	639	688	739
5.0	564	632	678	750	798	848



Rectangular Footing

Footing Breadth (m)	Founding Depth D (m)					
	0.0	0.3	0.5	0.8	1	1.2
	Allowable Bearing Stress (kPa)					
0.2	18	137	252	479	667	885
0.5	45	144	224	367	476	597
0.8	72	166	238	359	449	546
1.0	90	183	251	366	449	538
1.2	109	200	267	376	455	539
1.5	136	226	291	395	470	548
2.0	181	270	333	433	503	576
3.0	271	359	420	515	581	649
4.0	362	449	509	602	666	731
5.0	452	539	599	690	752	816



Pad Footing

Footing Breadth (m)	Founding Depth D (m)					
	0.0	0.3	0.5	0.8	1	1.2
	Allowable Bearing Stress (kPa)					
0.2	14	158	299	578	808	1073
0.5	34	155	253	427	561	709
0.8	54	169	257	405	515	634
1.0	68	181	265	404	506	615
1.2	81	193	275	408	505	607
1.5	102	212	291	419	510	606
2.0	136	244	321	444	529	619
3.0	204	311	386	502	582	665
4.0	271	378	452	565	643	723
5.0	339	446	518	630	706	784

