Broken Hill Hospital Redevelopment

Results of Geotechnical Investigation

PSM4951-004R REV1 6 October 2023

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1. Introduction

This report presents the results of a geotechnical investigation undertaken for the proposed development at Broken Hill Hospital, located at 176 Thomas Street, Broken Hill NSW (the Site). The purpose of the investigation was to understand the ground conditions within the areas proposed for development and provide geotechnical advice to assist the designers of the new proposed development.

PSM has previously provided a desktop geotechnical study of the Site, PSM4951-003L, dated 21 December 2022.

2. Supplied Documents

To assist us in the investigation, PSM were provided with the following documents:

- Broken Hill Acute Adult Mental Health Unit and Emergency Department - Concept Design Options by STH (dated 12 December 2022)
- Broken Hill Acute Adult Mental Health Unit and Emergency Department – Road Relocation Option by STH (dated 25 January 2023)
- Broken Hill Acute Adult Mental Health Unit and Emergency Department – 'Stage 1' and 'Stage 2' REF Submission by STH (dated 18 August 2023)
- Detail Survey by Monteath & Powys (ref. 22/0418 REV3, dated 9 December 2022)

3. Proposed Development

Based on the documents above, PSM understands the following regarding the Site and proposed development:

- A new mental health unit (MHU), with an area of approximately 1000 m^2, will be developed across the existing hospital carpark.
- A new emergency department (ED), with an area of approximately 700 m^2, will be developed across the existing ambulance bay. The building will be connected to the existing imaging department.
- The MHU and ED will be single storey building, constructed at grade.
- New pavement areas will be developed to provide vehicle access and parking near the new MHU
- Existing services on site include underground drainage lines, gas, water, and sewer mains, and electric and telecommunications cables.

4. Geotechnical Investigation – February 2023

4.1 Fieldwork

The geotechnical investigation was completed over the course of five (5) days of fieldwork, from the 1st to 5th of February 2023. The works was undertaken under the fulltime supervision of a PSM Geotechnical Engineer, who undertook the following:

- Directing borehole drilling and piezometer installation
- Preparing field logs of material encountered in boreholes
- Collecting soil samples for laboratory testing.
- Conducting and directing field tests, including Standard Penetrometer Tests (SPTs) and Point Load Index tests
- Measuring water levels in the piezometers installed
- Reinstating pavements following the completion of boreholes

The works were also undertaken under the fulltime supervision of Rob Sharp and Andrew James of JBS&G.

Over the course of the fieldwork, five (5) boreholes were drilled to a depth of 12 m, using a track-mounted drill rig, and two (2) shallow test pits were dug using hand tools. Cores of bedrock were retrieved from the five boreholes using diamond coring techniques, and point load index testing was undertaken on the recovered rock cores at

approximately 1 m intervals. Appendix A presents the geotechnical borehole logs and core photographs. The depth of the holes was nominated by the Client.

Appendix B presents the results of the point load index tests.

Figure 1 presents a locality plan showing the locations of the boreholes and test pits. Figures 2 to 6 present a selection of photographs taken during fieldwork.

4.2 Groundwater Monitoring Wells

A standpipe piezometer was installed in BH01, BH03 and BH05 to allow ongoing monitoring of groundwater levels. The piezometers were developed by pumping water out and letting the water level recover.

Appendix C presents the piezometer construction records.

4.3 Laboratory testing

4.3.1 Geotechnical Testing

Three (3) bulk soil samples were recovered and sent to a geotechnical laboratory for the following testing:

- Three (3) California Bearing Ratio (CBR) tests were undertaken on 4 day soaked samples compacted to 98% SMDD at OMC with a 4.5 kg surcharge
- Three (3) Particle Size Distribution (PSD) tests
- Three (3) Atterberg Limit Tests

Tables 1, 2 and 3 present the laboratory test results. The laboratory reports for CBR, Atterberg Limits and PSD tests are included in Appendix D, E and F, respectively.

Table 1 - Summary of CBR Test results

Sample ID (Depth)	Material Description	Soaked CBR [%]	OMC [%]	Standard Maximum Dry Density [t/m^3]	Swell [%]
TP01 (0 – 0. 5 m)	Clayey Gravelly SAND	17 [1]	10.1	2.086	0.0
TP02 (0 – 0. 5 m)	Silty Sandy CLAY, trace Gravel	13 [2]	15.5	1.830	0.2
BH03 (0.2 – 0.7 m)	Silty SAND with Gravel	35 [2]	8.1	2.155	0.1

1 At a penetration of 5.0 mm

2 At a penetration of 2.5 mm

Table 2 - Summary of Atterberg Limit Test results

Sample ID (Depth)	Material Description	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
TP01 (0 – 0. 5 m)	Clayey Gravelly SAND	31	13	18
TP02 (0 – 0. 5 m)	Silty Sandy CLAY, trace Gravel	42	14	28
BH03 (0.2 – 0.7 m)	Silty SAND with Gravel	-	-	(Non-Plastic)

Table 3 - Summary of Particle Size Distribution Test Results

Sample ID (Depth)	% Passing 9.5 mm Sieve	% Passing 4.75 mm Sieve	% Passing 1.18 mm Sieve	% Passing 600 µm Sieve	% Passing 212 µm Sieve	% Passing 75 µm Sieve
TP01 (0 – 0. 5 m)	90	79	60	52	38	26
TP02 (0 – 0. 5 m)	96	93	82	76	60	46
BH03 (0.2 – 0.7 m)	91	86	71	65	49	33

4.3.2 Soil Chemistry Testing

Three (3) soil samples were recovered and sent to a NATA accredited analytical laboratory for the following testing:

- Cation Exchange Capacity (CEC) of calcium, magnesium, potassium and sodium
- Exchange sodium percentage
- Salinity (EC 1:5, one part soil to five parts water)
- Soil pH
- Chlorides

- Sulphates.
- Resistivity

Table 4 presents a summary of the results of the analytical soil testing undertaken. Laboratory test reports are included in Appendix D.

Table 4 – Summary of Salinity and Aggressivity Test results

Sample ID (Depth)	Exchangeable Cations [meq/100g]					Exchange Sodium [%]	pH	Electrical Conductivity [µS/cm]	Sulfate [mg/kg]	Chloride [mg/kg]	Resistivity [ohm cm]	Moisture Content [%]
	Ca	Mg	K	Na	CEC							
BH01 (0.3 – 0.5 m)	5.1	4.0	1.0	5.2	15.2	34.3	8.9	1190	1080	1240	840	11.9
BH03 (0.3 – 0.6 m)	2.1	0.9	0.2	0.7	4.0	17.6	9.1	434	330	260	2300	8.8
ED-B4[1] (0.3 – 0.5 m)	3.9	0.9	0.2	<0.2	5.0	<0.2	9.1	137	60	50	7300	7.5

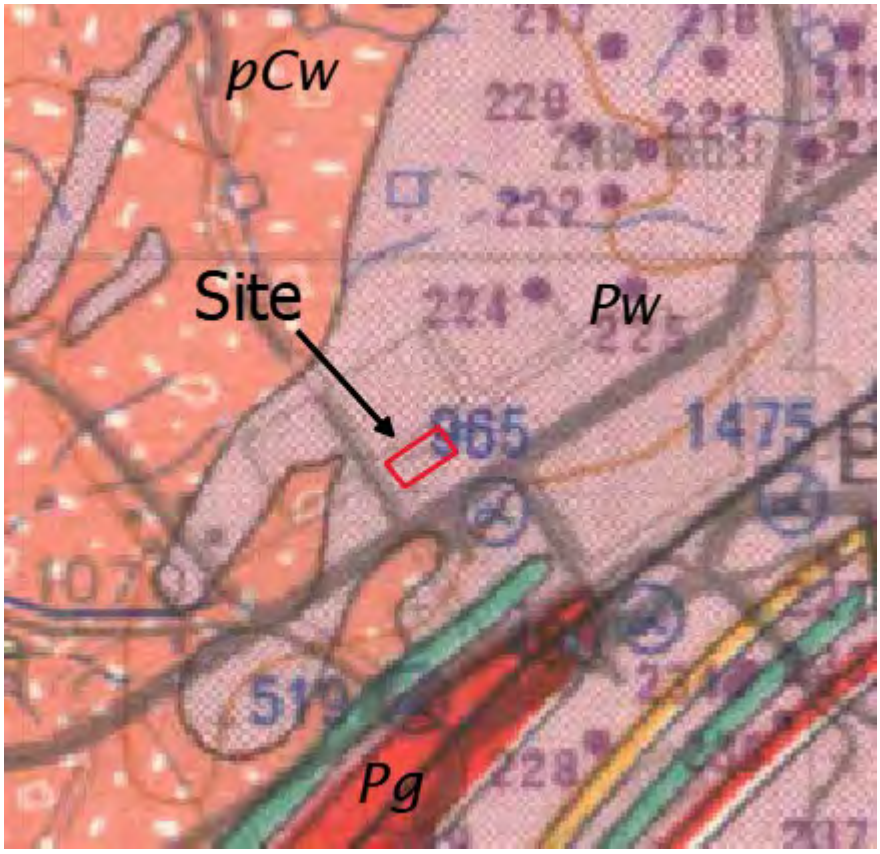
[3] ED-B4 is a JBS&G hand augered hole in the ED area

5. Site Conditions

5.1 Geological Setting

The Broken Hill 1:250,000 Geological Map (1970), shown in Inset 1, indicates that the site is underlain by:

- The Willyama Complex (P_w), which consists of sillimanite gneiss, andalusite-, chiastolite-, mica-, schist, phyllite, quartzite, sandstone, slate



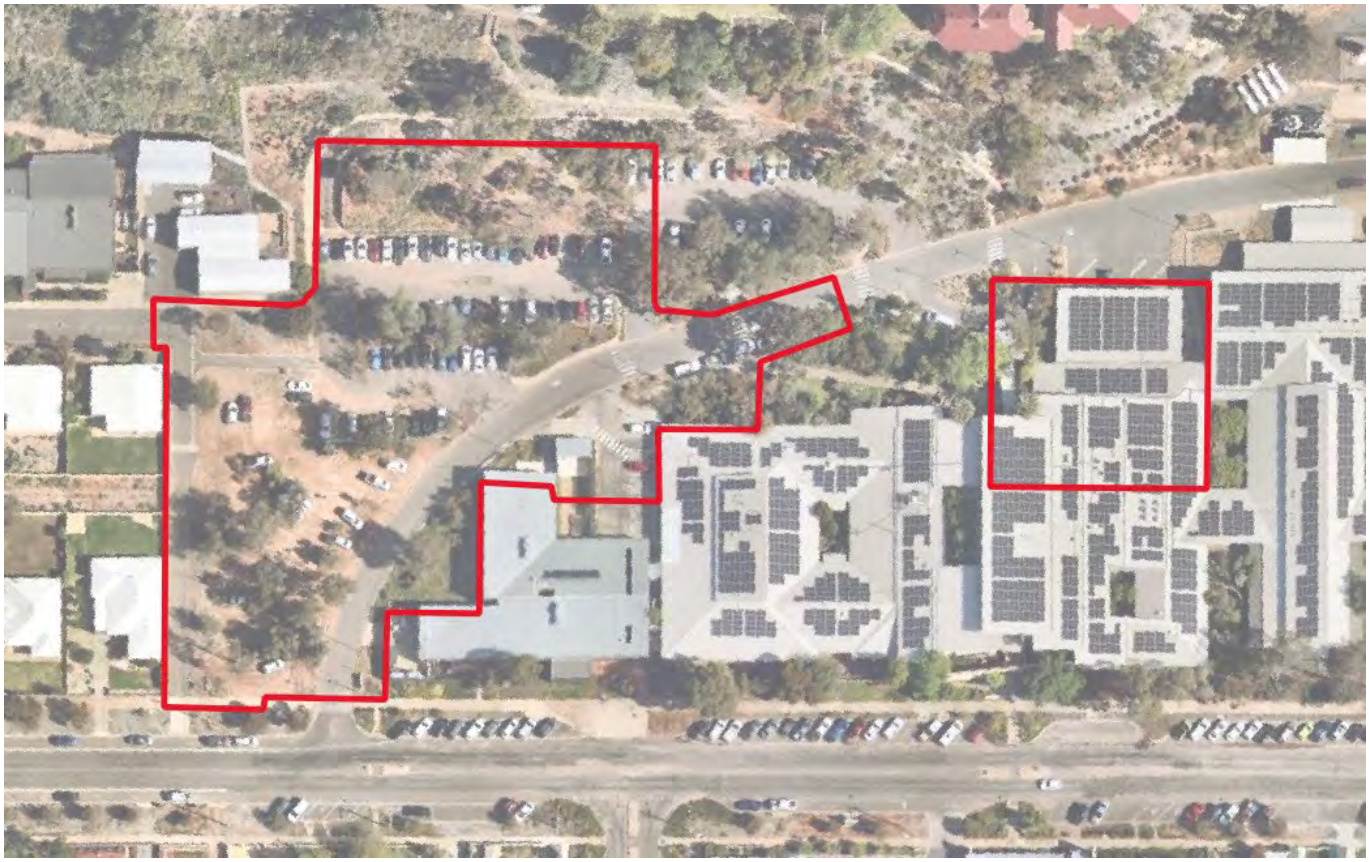
Inset 1: Broken Hill Geological Map (site location marked in red)

5.2 Surface Conditions

The surface in the proposed area (refer Inset 2) for development of the MHU and ED consists of a combination of:

- Asphalt pavement (carpark, hospital internal road, ambulance bay)
- Concrete hardstand areas
- Landscaped areas with bushes and trees
- Existing hospital buildings
- Services (fire hydrant, light poles etc.)

Inset 2 is an aerial photograph showing the current conditions.



Inset 2: Aerial image showing surface condition in proposed areas (outlined in red) for development

5.3 Subsurface Conditions

The subsurface conditions encountered across the site were generally consistent with our desktop study, comprising shallow FILL overlying NATURAL SOIL, overlying BEDROCK. Table 5 presents a summary of the material encountered. Table 6 presents the depth to the top of inferred geotechnical units at each borehole location.

Table 5 – Summary of inferred geotechnical units encountered in boreholes

Unit Name	Approximate Depth to the Top of Unit (m)	Description
PAVEMENT	0.0	Sealed pavement; 60 mm thick Subbase; Sandy GRAVEL; pale grey-brown, angular to sub-angular gravel, well graded, up to 30 mm; fine to coarse grained sand; moist; very dense
FILL	0.16 – 0.2	Gravelly SAND; grey/brown, fine to coarse grained, well graded; angular to subangular gravel, up to 60 mm; moist, medium dense to dense Silty SAND with clay: brown-red, fine to medium grained; medium plasticity clay; moist; dense
NATURAL SOIL	0.3 – 0.5	Gravelly CLAY with sand; red, medium plasticity, stiff to very stiff; angular to subangular gravel, up to 30 mm; fine to coarse grained sand; moist
BEDROCK A (VERY LOW AND LOW STRENGTH)	0.4 - 1.4	GNEISS; pale grey/grey/dark gey/brown/pale brown/pale orange, medium to coarse grained, layered, extremely to highly weathered, very low and low strength
BEDROCK B (MEDIUM STRENGTH OR GREATER)	0.8 – 2.6	GNEISS; pale grey/grey/dark gey/brown/pale brown/pale orange, medium to coarse grained, layered, moderately to slightly weathered, medium to very high strength QUARTZITE; pale grey/grey/dark gey/pale orange/pale green, fine to medium grained, crystalline, massive, moderately to slightly weathered, high to extremely high strength

Table 6 – Depth to top of inferred geotechnical units

BH ID	Approximate Depth to Top of Unit (m)					
	PAVEMENT	FILL	NATURAL SOIL	BEDROCK A	BEDROCK B	END OF HOLE
BH01	0.0	N.E.(1)	0.3	1.4	2.3	12.0
BH02	0.0	0.16	0.5	0.8	2.6	12.0
BH03	0.0	0.2	N.E.	0.7	0.8	12.0
BH04	0.0	0.2	N.E.	0.5	2.6	12.0
BH05	0.0	N.E.	N.E.	0.4	2.0	12.0

1 N.E. = Not Encountered

5.4 Groundwater

Table 7 presents the summary of groundwater measurements recorded during fieldwork. The measurements were recorded at the three (3) newly built standpipe piezometers at BH01, BH03 and BH05.

Given the proximity of the groundwater to the top of the BEDROCK B unit, it is possible that the measured groundwater represents an aquifer perched above the lower permeability unit. Such an aquifer would be expected to be sensitive to rainfall and the resulting water table could be expected to vary due to individual rainfall events and extended periods of dry or wet weather.

Table 7 – Summary of groundwater observations

Borehole ID	3 February 2023		4 February 2023		5 February 2023	
	Depth (m) below ground(1)	RL (m AHD)(2)	Depth (m) below ground	RL (m AHD)	Depth (m) below ground	RL (m AHD)
BH01	-	-	1.1	307.9	-	-
BH03	2.0	307.0	1.8	307.2	-	-
BH05	-	-	2.0	307.0	2.2	306.8

Notes:
1 Measured by using water dipmeter.
2 RL calculated using approximated surface RL from LIDAR topographic data (Source: ELVIS)

6. Salinity and Aggressivity Assessment

6.1 Soil Chemistry

The salinity and aggressivity test results, summarised in Table 4 indicate the following:

- pH of the soil samples analysed was in the range of 8.9 to 9.1, with an average of 9.0.
- The 1:5 soil to water extraction and subsequent electrical conductivity (EC1:5) of the soil samples analysed to be in the range of 137 to 1190 µS/cm
- Concentrations of soluble sulphate in samples analysed was in the range of 60 to 1080 mg/kg
- Concentrations of chlorides in samples analysed was in the range of 50 to 1240 mg/kg.
- Cation Exchange Capacity (CEC) in samples analysed was in the range 4.0 meq/100g to 15.2 meq/100g
- Exchangeable Sodium Percentage (ESP) in samples analysed was in the range of <0.2 % to 34.3 %.

6.2 Salinity Assessment

Site Investigations for Urban Salinity (DLWC 2002)[1] classify soil salinity based on electrical conductivity (EC_e) as per Richards (1954)[2]. The method of conversion from $EC_{1:5}$ to EC_e (electrical conductivity of saturated extract) is based on DLWC (2002) and given by $EC_e = EC_{1:5} \times M$, where M is the multiplication factor based on "Soil Texture Group".

The "Soil Texture Group" of the samples tested has been assessed during our investigation. The salinity classification for the soil samples that were tested are presented in Table 8.

Table 8 – Salinity Classification

Sample ID (Depth)	$EC_{1:5}$ [dS/m]	Soil Texture Group	M	EC_e [dS/m]	Salinity Class
BH01 (0.3 – 0.5 m)	1.19	Medium clays	7	8.3	Very saline
BH03 (0.3 – 0.6 m)	0.43	Sands	17	7.3	Moderately saline
ED-B4[1] (0.3 – 0.5 m)	0.14	Sands	17	2.4	Slightly saline

[3] ED-B4 is a JBS&G hand augered hole in the ED area

It is assessed that the soils on site are classified in a range from "slightly saline" to "very saline".

We have referred to Clause 4.8.2 of Australian Standard AS 3600:2018[3] and note that the assessed soil electrical conductivity (EC_e) to fall on the boundary between "A2" and "B1" exposure classification.

6.3 Corrosivity / Aggressivity

Table 4.8.1 of AS 3600:2018 provides criteria for exposure classification for concrete in sulphate soils based on sulphates in soil and groundwater, and pH of soil. On the basis of the sulphate and pH testing completed we assess the exposure classification for concrete in sulphate soils to be "A1" for the natural soils and "A2" for the fill.

Similarly, Table 6.4.2(C) of Australian Standard AS 2159-2009[4] provides criteria for exposure classification for concrete piles in soil, and here the exposure classification for concrete piles in soils is "Non-aggressive" for the natural soils and "Mild" for the fill.

[1] DLWC (2002) Site Investigations for Urban Salinity. Department of Land and Water Conservation, Sydney.

[2] Richards, L.A. (1954) Diagnosis and improvement of saline and alkali soils. Agricultural handbook 60. U.S. Dept. of Agriculture, Washington D.C., 160 p.

[3] Standards Australia (2018) Concrete Structures, AS 3600:2018, Standards Australia, NSW.

[4] Standards Australia (2009) Piling – Design and Installation, AS 2159-2009, Standards Australia, NSW.

7. Geotechnical Design Advice

7.1 General

The geotechnical design advice provided in the following sections has been prepared based on the expected subsurface conditions described in Section 5.3.

7.2 Site preparation

We understand earthworks is required to prepare the Site for development. For most areas, we expect fill/cuts to be minor (e.g. less than 0.5 m).

We consider the advice in the following sections adequate, assuming any earthworks is undertaken in accordance with a detailed earthworks specification that has been prepare in accordance with the guidelines in AS 3798-2007 "Guidelines on earthworks for commercial and residential developments". Such a specification will also need to comply with any specific council requirements.

In our experience such a detailed specification should include:

- Requirements for stripping of vegetation, TOPSOIL.
- Requirements for proof rolling of the exposed surface particularly where it comprises FILL. The exposed subgrade surface should be proof rolled with a minimum 8 tonne smooth drum non-vibratory roller. A geotechnical engineer should witness the proof rolling and advise the number of passes for each section and identify "soft spots". Any "soft spots" identified should be excavated and replaced with approved material, with a maximum compacted layer thickness of 200 mm.
- Requirements for subgrade preparation. Where surfaces are required to support structures the exposed subgrade surface shall be scarified, and moisture conditioned to a depth of 150 mm and brought to moisture variation of between 2% dry and 2% wet.
- Definition of compaction and moisture variation requirements for new fill to be placed. Typically, we recommend that fill to be placed and compacted to a density ratio of between 98% and 102% (Standard) and moisture variation of between 2% dry and 2% wet.
- Requirements with regards to maximum layer thickness for new fill. Typically, we recommend a maximum compacted layer thicknesses of 200 mm. If larger earthmoving equipment is employed (e.g. 12t rollers or CAT825) the layer thicknesses could be increased to 300 mm.
- Testing requirements. We typically recommend that fill be placed in Lots that are defined as a single layer of ENGINEERED FILL consisting of uniform material which has undergone similar treatment and that each Lot be tested on "a none to fail basis", i.e., if any one test undertaken with a Lot fails, the whole of the Lot shall be reworked and retested. The minimum density testing frequency should be as per AS3798-2007 and as follows:
  - For Lots less than 30 m^3 – 1 test per Lot
  - For Lots between 30 m^3 to 150 m^3 – 2 tests per Lot
  - For Lots greater than 150 m^3 – shall not be less than the greater of:
    - 1 test per 500 m^3 of material placed
    - 3 tests per lot.

Fill placed in accordance with a specification developed in accordance with the above recommendations is referred to herein as ENGINEERED FILL.

7.3 Site Classification

It is understood that the proposed development comprises single storey buildings which may fall within the scope of Australian Standard AS2870-2011[5] "Residential slabs and footings".

We advise the following:

1. In cut areas within the BEDROCK A or BEDROCK B unit, structures that are within the scope of AS2870-2011 be designed for a site classification of Class "A" in accordance with Table 2.1 of AS2870-2011.
2. In cut areas within the NATURAL SOIL unit, structures that are within the scope of AS2870-2011 be designed for a site classification of Class "M" in accordance with Table 2.1 of AS2870-2011.
3. In cut areas within the FILL unit or in new fill areas:
    a. Where existing fill is present the fill cannot be currently considered as "controlled fill" and thus the site is classified as Class P in accordance with AS2870-2011.

b. Where ENGINEERED FILL is placed in accordance with Section 7.2 of this report, the fill can then be considered "controlled fill" and the site can be reclassified from Class P to Class M (subject to confirmation of the source of the fill material).

The civil and structural engineers should consider likely heave / settlement due to the effect of climatic factors in their designs.

We recommend that all structures and services be detailed such that they preclude any local wetting up or drying out of the subgrade after initial equilibrium is reached following construction of the slab and that the subgrade be within Specification at the time of construction of the slab. We note that normal mounding or sagging away from the perimeter of covered areas will still occur and perimeters, or open joints, will still respond to environmental changes.

Careful consideration should be given to differential movements between new structures and existing structures due to reactivity. This is likely to be able to be addressed by means of carefully detailed articulation between the new and existing structures.

7.4 Foundations

7.4.1 Shallow Foundation

It is expected that the foundations used as part of any proposed development at the site would typically include strip, pad, or other shallow footings.

Pad footings can be proportioned on the basis of an allowable bearing pressure (ABP) for centric vertical loads provided in Table 9.

We note that an allowable bearing pressure (ABP) is not a soil property. It depends on many factors such as the size of the footings, the embedment depth, the load direction and eccentricity, the stiffness of the footing, the adopted factor of safety (FOS), as well as the soil properties. As footings get bigger or deeper the capacity increases rapidly, and as the load gains eccentricity or becomes inclined, the capacity reduces rapidly.

When assessing the settlement of the shallow footings, the designer needs to consider the additional ground settlement due to the total building load on both shallow and deeper units. The differential settlement due to the building load and differing founding conditions shall also be assessed. Foundation conditions at the proposed shallow pad footing should be inspected by a suitably qualified geotechnical engineer prior to the pouring of concrete.

The BEDROCK A and BEDROCK B parameters provided are for the weakest rock encountered in the two units. High and very high strength rock masses within BEDROCK B are present at shallow depths in places and at deeper depths at all borehole locations. Higher bearing capacities than those provided in Table 9 are achievable for these higher strength rock masses within BEDROCK B. If this is required, further advice should be sought from PSM.

[5] Standards Australia (2011) Residential slabs and footings, AS 2870-2011, Standards Australia, NSW.

Table 9 - Foundation Parameters of the inferred Geotechnical Units

	Bulk unit weight (kN/m^3)	Soil effective strength parameters		Ultimate bearing pressure under vertical centric loading [2] (kPa)	Allowable bearing pressure under vertical centric loading [3] (kPa)	Ultimate Shaft Adhesion (kPa)	Elastic parameters	
		c' (kPa)	*ϕ'* (deg)				Young's Modulus (MPa)	Poisson's Ratio
ENGINEERED FILL, NATURAL SOIL	18	0	30	300[1]	100	N/A	10	0.3
BEDROCK A	25	-	-	3000	1000	150	100	0.25
BEDROCK B	25	-	-	20000	6000	800	500	0.2

1 Pad footings in soil units should have a minimum horizontal dimension of 1.0 m and a minimum embedment depth of 0.5 m.

2 Ultimate bearing pressure values occur at large settlement (>5% of minimum footing dimensions)

3 Allowable bearing pressure to cause settlement of <1% of minimum footing dimension.

7.4.2 Piles

Piled foundations should be within the BEDROCK units.

Piles should be designed in accordance with the requirements in AS 2159 (2009), *Piling – Design and Installation*. The parameters provided in Table 9 may be adopted in the design of piles founded in the BEDROCK units.

The foundation designer should note the following with regards to the pile design:

- The ABP needs to be confirmed by a geotechnical engineer through pile inspections prior to pouring concrete. This is particularly important where BEDROCK B parameters are adopted.
- Under permanent load, the contribution of side adhesion for soil units should be ignored.
- Pile settlement can be checked using the recommended elastic parameters in Table 9.
- Where adjacent foundation details differ (e.g., pile and pad, differing loads or ground conditions), differential settlement should also be assessed.

With regards to the pile design, we recommend that:

- A basic geotechnical strength reduction factor, Φ_{gb} = 0.56 (AS2159 CL. 4.3.2) be adopted for a high redundancy system for an assessed average risk rating (ARR) between 3.0 and 3.5. This should be reviewed to suit the specific design and appropriate pile testing proposed by the structural / pile designers in accordance with the requirements of AS2159
- It may be possible to increase the pile reduction factors, if the details of the proposed pile installation procedures indicate a high level of quality control with regards to concrete placement, base cleanliness, etc
- If a geotechnical strength reduction factor, Φ_g = 0.40 is adopted then no pile testing will be required (AS2159 Clause 8.2.4 (b)).

Where the pile is sized using the allowable bearing capacity in Table 9. (i.e., assuming all the serviceability load is carried by the base), the settlement would be expected to be less than 1% of the pile diameter plus elastic shortening of the pile itself.

7.5 Excavation

We expect excavations will occur for the proposed development. In particular, for development of the proposed 'Stage 2' carpark, located north of the MHU.

Excavation of FILL and NATURAL units is expected to be achievable using conventional earth moving equipment (e.g., large dozers, excavators, ripper etc.). Excavation of BEDROCK units will require use of rock breaking equipment (impact hammers and rock saws). We note that some of the BEDROCK B unit is high and very high strength and excavation with rock saws and large impact hammers is likely to be very slow. Similarly, the construction of bored piles within the BEDROCK B unit would be expected to encounter very difficult drilling conditions with the use of coring tools likely to be required.

It is our experience that excavatability is heavily dependent on factors such as the experience of the operator, the plant used and the area available for excavation activities. Therefore, any earthworks contractor should satisfy themselves regarding excavatability of the material. As a minimum, the Contractor shall be provided with this report, they shall review the logs and point load test results and undertake a site inspection to visually assess the site conditions. We note that the logs record the depth of TC auger refusal.

7.6 Vibrations

Use of earthmoving and particularly rock breaking equipment can result in ground vibrations that can in turn damage neighbouring structures and assets.

It is the responsibility of the earthworks contractor to develop methodologies that do not result in damage to neighbouring structures and assets.

The methodology should include appropriate sizing of rock breaking equipment, use of saw cutting if required, dilapidation surveys of neighbouring structures, development of vibration limits at the site boundaries and monitoring procedures to minimise the risk of damage to neighbouring dwellings and assets.

The Contractor shall also consider the effect of potential work induced vibrations on equipment typically present within health infrastructure which are highly sensitive to vibrations Even when the operation and trafficking of a given plant or equipment is deemed unlikely to affect structures and assets, their impact on sensitive medical equipment, as well as their impact on hospital staff and patients, should be assessed.

7.7 Articulation

Particular attention shall be given to detailing the foundations and superstructure where a new building connects to an existing structure. It is likely that differential settlements due to loading and shrink swell movements will occur between existing and new structures and allowances shall be included in the design to cater for such movements.

It is our experience articulation between new and old structures will need to be provided to accommodate the potential for differential movements between the separate structures.

7.8 Permanent and Temporary Batters

The batter slope angles shown in Table 10 are recommended for the design of batters up to 3 m height and above the groundwater, subject to the following recommendations:

- All batters shall be protected from erosion
- Permanent batters shall be drained
- Temporary batters shall not be left unsupported for more than 2 months without further advice, and inspection by a geotechnical engineer should be undertaken following significant rain events
- No buildings, loads or services should be located within 1 batter height of the crest.

If the conditions above cannot be met, further advice should be sought.

Table 10 - Batter Slope Angles

Unit	Temporary	Permanent
ENGINEERED FILL / NATURAL SOIL	1.5H: 1V	2.5H: 1V
BEDROCK (subject to inspection)	Vertical	1H:1V

The batters should be inspected by an experienced geotechnical engineer or engineering geologist during excavation to confirm the batter advice provided and assess the need for localised support.

Batters in the BEDROCK unit shall be inspected at regular intervals (less than 1.5 m) during excavation. The purpose of the inspection is to identify the presence of adversely oriented defects that may impact the stability of the batters. Where such features are observed, additional support in the form of rock bolts or anchors may be required.

Proper and suitable safe work method statements and OHS documents need to be developed for works to be undertaken in the vicinity of the crest and toe of batters.

7.9 Excavation and retention advice

Temporary or permanent cuts steeper than the recommended permanent batter slopes in Table 10 will need to be supported by some form of retaining structure.

The design of these structures should be based on the following geotechnical properties:

- Effective soil strength parameters for the soil units of:
  - c' = 0 kPa and phi' = 30^{o}
- Surcharge loads behind the retention
- Water pressure (depending on the type of structure)
- A lateral pressure of 10 kPa for vertical cuts in the BEDROCK unit. This is to allow for blocks and rock wedges formed due to adverse defects that may exist within the unit.

Note that design of retention systems may be based on either Ka or Ko earth pressures. Design using active earth pressures provides the minimum lateral earth pressure that must be supported to avoid failure and requires a wall that can rotate or translate to allow the pressures to reduce to these values (vertical and lateral movements up to 2% of height may occur, typical movements will be much less).

Where the design is based on Ko pressures, construction should be carefully controlled to avoid unwanted effects. It should be noted that designing for Ko pressures do not, of themselves, ensure that movement does not occur. Movements are controlled by the construction method, especially sequence.

Both surface and sub-surface drainage needs to be designed and constructed properly to prevent pore water pressures from building up behind the retaining walls or appropriate water pressures must be included in the design.

Where excavations are proposed adjacent to neighbouring properties the effects of excavation induced ground movements on neighbouring properties shall be considered and appropriate retention systems designed to limit the movement to prevent damage to neighbouring properties.

The designers and builders of the retention system shall include consideration of ground deformation resulting from installation of the support and during temporary stages of the support installation. Where anchors or rock bolts are proposed to extend below neighbouring properties permits from other owners will need to be negotiated.

We recommend that once details of the proposed development are defined, further advice regarding the effects of the proposed excavation on neighbouring structures is sought from a suitably qualified geotechnical engineer.

7.10 Slabs

The design of slabs on ground can be based on:

- The subsurface conditions as described in Section 5.3,
- The site classification described in Section 7.3 and
- A subgrade with a long - term Young's Modulus of 10 MPa.

We note that the environmental effects (e.g., drying or wetting up of the finished surface) affecting the land prior to development should be taken into account by the various designers of the proposed development.

7.11 Pavements

Three (3) CBR tests were undertaken on samples of fill. The results (refer Table 1) indicated a CBR of between 17% and 35%.

A CBR of 10% can be adopted for subgrade and fill formed in bulk earthworks placed in accordance with a PSM Specification.

Subgrade CBR for pavement design depends on the material at the finished subgrade levels.

We recommend that specific CBR testing be undertaken at subgrade level when pavement layouts are finalised. CBR testing shall be undertaken for any new imported material within the pavement subgrade (e.g., within 1 m below pavement).

Pavement shall be designed and constructed in accordance with the Council's requirements.

7.12 Earthquake Site Classification

We have reviewed AS1170.4-2007[6] to determine the Hazard Design Factor (Z) and Site Sub-Soil Class for the Site. For earthquake provisions, we recommend the following for the proposed development:

- Site Sub-Soil Class = B_e (Rock)
- Hazard Design Factor (Z) = 0.03 (for Broken Hill).

7.13 Mine Subsidence

Consultation of the Mine Subsidence Advisory website indicates that the Site is not located within a Mine Subsidence District. On this basis we understand that the Site is not affected by mine Subsidence.

7.14 Site Suitability for Stormwater Infiltration Systems

Infiltration systems are systems designed to detain and retain stormwater to provide an opportunity for infiltration of stored water to the surrounding soils. The aim is to reduce stormwater volumes by retaining and infiltrating the water into the soil and the local groundwater.

Design guidelines for such systems indicate that these are not suitable where the ground conditions comprise clays overlying shallow bedrock. The presence of a water table near the surface also reduces the suitability of a site for this system.

On the above basis, we consider that the Site is unsuitable for an infiltration system as:

- The ground conditions comprise clay overlying shallow bedrock.
- A perched water table has been observed within 2 m of the existing ground surface.

[6] Standards Australia (2007) Structural design actions – Part 4: Earthquake actions in Australia, AS 1170.4-2007, Standards Australia, NSW.

8. General

Should there be any queries, do not hesitate to contact the undersigned.

Yours Sincerely

HARLEY ZHENG
GEOTECHNICAL ENGINEER

DAVID PICCOLO
PRINCIPAL

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Perth

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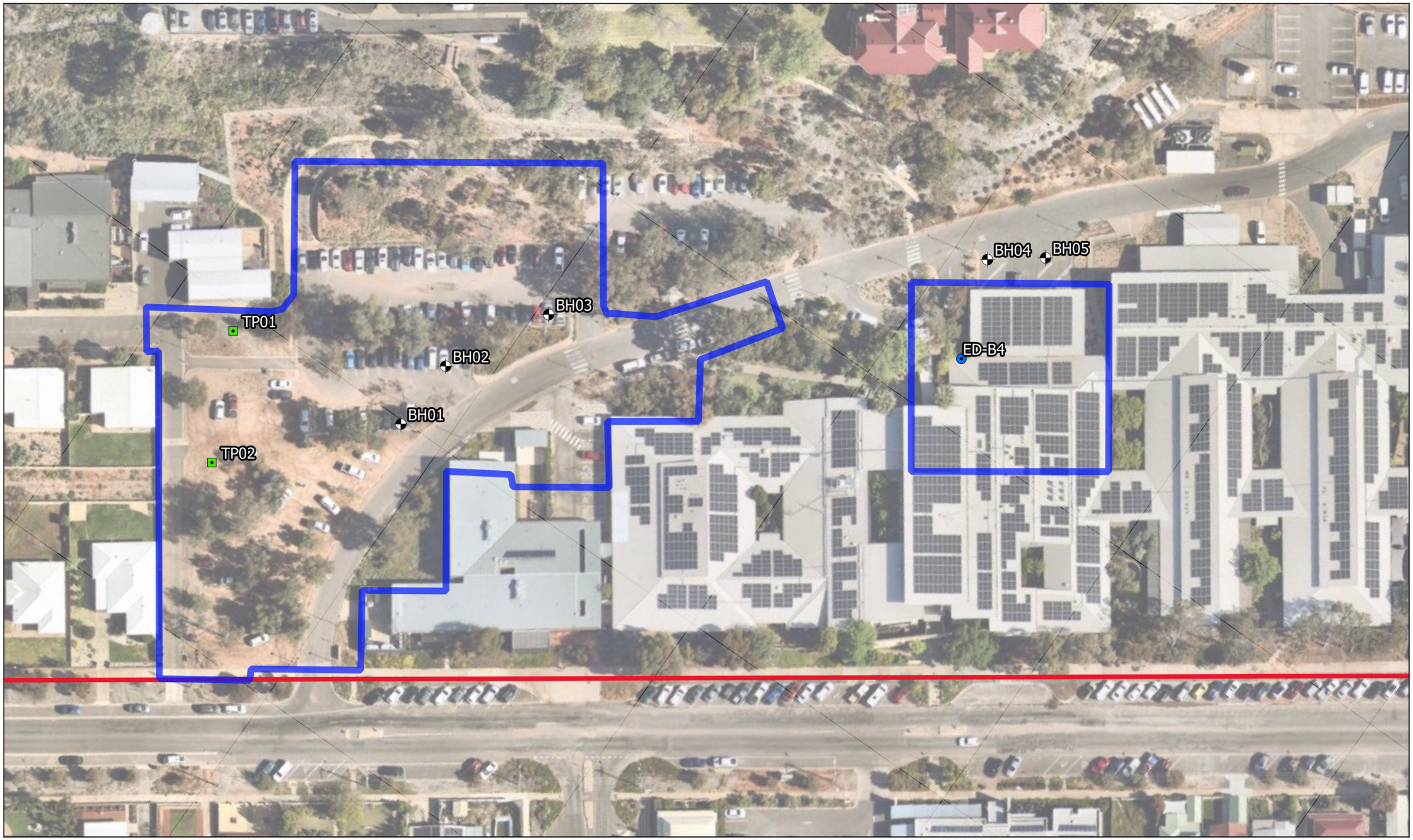
West Perth WA 6005
+61 8 9462 8400



Legend

- Approximate extent of hospital Lot
- Approximate extent of proposed development area
- Boreholes
- Test Pits
- Hand augered hole (JBS&G)

Scale 1:800

0 15 30 m

Map Projection:
Horizontal Datum:
Grid: EPSG:7854

P S M

Created By:	Revision:
PSM	A
Date: 05 Oct 2023	Paper Size: A3

JBS&G
Broken Hill Hospital Redevelopment
176 Thomas St, Broken Hill

Locality Plan

PSM4951-004R | Figure 1

C:\Users\Harley.Zheng\Pells Sullivan Meyninh\GIS - ArcGIS\PSM4951\02_WorkSpace\01_MXDs\PSM4951.qgz Layout: PSM4951-004R REV1 locality plan

Photo 1 - General photo of MHU area, looking west

Photo 2 - General photo of MHU area, looking east

JBS&G

Broken Hill Hospital Upgrade

176 Thomas St, Broken Hill

SELECTED PHOTOS (1 OF 5)

PSM4951-004L	FIGURE 2

Photo 3 - General photo of ED area, looking west

Photo 4 - General photo of ED area, looking north

JBS&G

Broken Hill Hospital Upgrade

176 Thomas St, Broken Hill

SELECTED PHOTOS (2 OF 5)

PSM4951-004L	FIGURE 3

Photo 5 - General photo from fieldwork, showing drill rig set up at BH02

Photo 6 - General photo from fieldwork, showing a slab of pavement

JBS&G

Broken Hill Hospital Upgrade

176 Thomas St, Broken Hill

SELECTED PHOTOS (3 OF 5)

PSM4951-004L	FIGURE 4

Photo 7 - General photo from fieldwork, showing typical roadbase material encountered on site

Photo 8 - General photo from fieldwork, showing typical gravelly sand FILL encountered on site

JBS&G

Broken Hill Hospital Upgrade

176 Thomas St, Broken Hill

SELECTED PHOTOS (4 OF 5)

PSM4951-004L	FIGURE 5

Photo 9 - General photo from fieldwork, showing typical gravelly CLAY soil encountered on site

Photo 10 - General photo from fieldwork, showing well installed at BH05

JBS&G

Broken Hill Hospital Upgrade

176 Thomas St, Broken Hill

SELECTED PHOTOS (5 OF 5)

PSM4951-004L	FIGURE 6

Appendix A
Engineering Borehole Logs

Borehole ID

BH01

Engineering Log - Non Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	02/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	02/02/2023
Hole Location:	Proposed MHU Area	Logged By:	HZ
Hole Position:	542900 m E 6465200 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Hole Diameter:	115 mm	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information								Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Plasticity, behaviour or particle characteristics of primary component, colour, secondary components, additional observations	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure, Zoning, Origin, Additional Observations
DT		N							GW	SEALED PAVEMENT: 60 mm				0.00: PAVEMENT 0.06: ROADBASE
AD/V		N	Not Encountered	SPT 0.50-0.95 m 3, 5, 6 N = 11		308.0	1		GW	Sandy GRAVEL: to 30 mm, well graded, sub-angular to angular, grey; sand fine to coarse.	M	VD		
									CI	CLAY with gravel with sand: medium plasticity, red; gravel subangular, up to 15 mm; sand fine to coarse.	M	St to VSt		0.30: Inferred NATURAL
				SPT 1.50-1.95 m 9, 15, 13 N = 28						GNEISS: brown-yellow/pale orange, highly weathered, very low to low strength	D			1.90: Increase in strength
						307.0	2			Continued on cored borehole sheet				
						306.0	3							
						305.0	4							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger screwing
CT - Continuous push tube 1.5m long 76mm diameter

Penetration
No resistance
Refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	02/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	02/02/2023
Hole Location:	Proposed MHU Area	Logged By:	HZ
Hole Position:	542900 m E 6465200 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Barrel Type and Length:	HQ3 3 m	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information							***Rock Substance***				***Rock Mass Defects***	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL L M H VH EH 0.1 0.3 1 3 10	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
					308.0	1						
					307.0	2		Continued from non-cored borehole sheet				
HQ3	Not Encountered	59						GNEISS: medium to coarse grained, grey/pale grey, layered, with some pegmatite veins.				CZ, 0°, RF, =20 mm JT, 30°, CN, CU, RF JT, 40°, CN, PR, RF SM, 80°, CL, =50 mm JT, 80°, CN, PR, RF JT, 45°, CN, UN, RF
					306.0	3						
		92			305.0	4						JT, 45°, FE, PR, RF JT, 45°, FE, UN, RF JT, 45°, FE, UN, RF JT, 45°, FE, UN, RF CZ, 45°, RF, =20 mm FL, 0°, CN, IR, RF FL, 10°, FE, IR, RF

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube
WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	02/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	02/02/2023
Hole Location:	Proposed MHU Area	Logged By:	HZ
Hole Position:	542900 m E 6465200 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Barrel Type and Length:	HQ3 3 m	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information							***Rock Substance***						***Rock Mass Defects***	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
HQ3	Not Encountered	92			303.0	6		GNEISS: medium to coarse grained, grey/pale grey, layered, with some pegmatite veins.*(continued)*				CZ, 0°, RF, =10 mm FL, 0°, CN, IR, RF FL, 0°, FE, IR, RF JT, 45°, FE, ST, RF JT, 80°, FE, PR, RF
		95			302.0	7						JT, 60°, FE, PR, RF JT, 60°, FE, PR, RF JT, 60°, CN, PR, RF
					301.0	8						CZ, 5°, CL, =50 mm FL, 0°, CN, IR, RF FL, 0°, CN, IR, RF JT, 70°, FE, PR, RF JT, 45°, FE, PR, RF
					300.0	9		QUARTZITE: fine to medium grained, dark grey-blue, crystalline, massive, compact.				JT, 45°, CN, ST, RF FL, 0°, CN, IR, RF
		95										FL, 15°, FE, PR, RF FL, 0°, CN, PR, RF

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube
WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	02/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	02/02/2023
Hole Location:	Proposed MHU Area	Logged By:	HZ
Hole Position:	542900 m E 6465200 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Barrel Type and Length:	HQ3 3 m	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information							***Rock Substance***						***Rock Mass Defects***	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
HQ3	Not Encountered	95			298.0	11		QUARTZITE: fine to medium grained, dark grey-blue, crystalline, massive, compact. *(continued)*				JT, 70°, FE, PR, RF FL, 0°, CN, PR, RF CZ, 0°, RF, =40 mm FL, 0°, CN, PR, RF
		95			297.0	12		Hole Terminated at 12.00 m Target depth				JT, 45°, Fe & Clay, ST, RF FL, 10°, Fe & Clay, PR, RF FL, 10°, CN, PR, RF
					296.0	13						
					295.0	14						

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube
WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

PointID : BH01 Depth Range: 0.00 - 4.00 m

PointID : BH01 Depth Range: 4.00 - 8.00 m

PSM	TITLE: JBS&G Broken Hill Hospital Upgrade 176 Thomas St Core Photo - BH01	DRAWN: HZ	DATE: 02/02/2023
		CHECKED: DP	DATE: 10/02/2023
		SCALE: Not To Scale	A4
		PROJECT No: PSM4951	FIGURE No: 1/2

PointID : BH01 Depth Range: 8.00 - 12.00 m

TITLE: JBS&G Broken Hill Hospital Upgrade 176 Thomas St Core Photo - BH01	DRAWN: HZ	DATE: 02/02/2023	
	CHECKED: DP	DATE: 10/02/2023	
	SCALE: Not To Scale		A4
	PROJECT No: PSM4951	FIGURE No: 2/2	

Borehole ID

BH02

Engineering Log - Non Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	03/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	03/02/2023
Hole Location:	Proposed MHU Area	Logged By:	HZ
Hole Position:	542905 m E 6465220 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Hole Diameter:	115 mm	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information							Soil Description					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m) / Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Plasticity, behaviour or particle characteristics of primary component, colour, secondary components, additional observations	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure, Zoning, Origin, Additional Observations
AD/T		N	Not Encountered			309.0 / 0		GW	SEALED PAVEMENT: 60 mm	M	VD		0.00: PAVEMENT 0.06: ROADBASE 0.16: FILL
AD/T		N							Sandy Silty GRAVEL: to 30 mm, well graded, sub-angular to angular, dark brown-grey; sand / fine to coarse.	M	MD		
AD/T		N		SPT 0.50-0.87 m 4, 13, 12 (refusal) N >25					Gravelly SAND: well graded, brown; gravel subangular, up to 60 mm.				0.50: Inferred NATURAL
									Gravelly CLAY with sand: medium plasticity, red; gravel angular, up to 30 mm; sand medium to coarse.	M	VSt		
						308.0 / 1			GNEISS: pale gre/pale yellow/pale orange, extremely weathered, very low strength	D			
									Continued on cored borehole sheet				
						307.0 / 2							
						306.0 / 3							
						305.0 / 4							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger screwing
CT - Continuous push tube 1.5m long 76mm diameter

Penetration
No resistance
Refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	03/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	03/02/2023
Hole Location:	Proposed MHU Area	Logged By:	HZ
Hole Position:	542905 m E 6465220 m N MGA2020 Zone 54	Checked By:	DP
Drill Model and Mounting:	Comacchio Geo 305	Inclination: -90°	RL Surface: 309.00 m
Barrel Type and Length:	HQ3 3 m	Bearing:	Datum: AHD Operator: MacGeo

Drilling Information | ***Rock Substance*** | ***Rock Mass Defects***

Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description: ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering (XW HW MW SW FR)	Strength Is(50) ● Axial ○ Diametral (VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (<20 60 200 600 1000)	Defect Descriptions / Comments: Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
					308.0	1		Continued from non-cored borehole sheet				
HQ3	Not Encountered	31						GNEISS: medium to coarse grained, grey/dark grey/orange-brown, layered.				JT, 60°, Fe & Clay, UN, RF
					307.0	2						JT, 35°, FE, UN, RF SM, 60°, CL, =10 mm
		100			306.0	3						JT, 60°, CN, PR, RF
		84			305.0	4						SM, 0°, CL, =50 mm JT, 60°, CN, PR, RF JT, 60°, CN, PR, RF

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube
WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	03/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	03/02/2023
Hole Location:	Proposed MHU Area	Logged By:	HZ
Hole Position:	542905 m E 6465220 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m	
Barrel Type and Length:	HQ3 3 m	Bearing:		Datum:	AHD	Operator: MacGeo

Drilling Information							***Rock Substance***			***Rock Mass Defects***	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
HQ3	Not Encountered	84			303.0	6		GNEISS: medium to coarse grained, grey/dark grey/orange-brown, layered.*(continued)*				SM, 60°, CL, =15 mm FL, 0°, Fe & Clay, IR, RF SZ, 30°, RF, =300 mm JT, 60°, FE, PR, RF JT, 70°, FE, CU, RF JT, 60°, FE, CU, RF JT, 60°, FE, PR, RF JT, 60°, FE, UN, RF
		94			302.0	7		QUARTZITE: fine to medium grained, dark grey/grey, crystalline, massive, compact.				FL, 10°, FE, PR, RF JT, 75°, FE, UN, RF
		100			301.0	8						JT, 60°, FE, CU, RF JT, 80°, FE, CU, RF JT, 70°, FE, ST, RF FL, 0°, FE, IR, RF JT, 60°, FE, PR, RF
		91			300.0	9		GNEISS: medium to coarse grained, grey/dark grey/orange-brown, layered.				JT, 45°, UN, RF

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	03/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	03/02/2023
Hole Location:	Proposed MHU Area	Logged By:	HZ
Hole Position:	542905 m E 6465220 m N MGA2020 Zone 54	Checked By:	DP
Drill Model and Mounting:	Comacchio Geo 305	Inclination: -90°	RL Surface: 309.00 m
Barrel Type and Length:	HQ3 3 m	Bearing:	Datum: AHD Operator: MacGeo

Drilling Information							Rock Substance				Rock Mass Defects	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
HQ3	Not Encountered	91			298.0	11		GNEISS: medium to coarse grained, grey/dark grey/orange-brown, layered.*(continued)*				JT, 80°, CU, RF FL, 0°, PR, RF FL, 0°, PR, RF FL, 0°, PR, RF FL, 0°, PR, RF JT, 45°, PR, RF CZ, 0°, CL, =70 mm SM, 0°, CL, =15 mm
												FL, 5°, PR, RF
												JT, 20°, CU, RF
					297.0	12		Hole Terminated at 12.00 m Target depth				
					296.0	13						
					295.0	14						

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube
WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

PointID : BH02 Depth Range: 0.00 - 4.00 m

PointID : BH02 Depth Range: 4.00 - 8.00 m

PSM	TITLE: JBS&G Broken Hill Hospital Upgrade 176 Thomas St Core Photo - BH02	DRAWN: HZ	DATE: 03/02/2023
		CHECKED: DP	DATE: 10/02/2023
		SCALE: Not To Scale	A4
		PROJECT No: PSM4951	FIGURE No: 1/2

PointID : BH02 Depth Range: 8.00 - 12.00 m

P S M	TITLE: JBS&G Broken Hill Hospital Upgrade 176 Thomas St Core Photo - BH02	DRAWN: HZ	DATE: 03/02/2023
		CHECKED: DP	DATE: 10/02/2023
		SCALE: Not To Scale	A4
		PROJECT No: PSM4951	FIGURE No: 2/2

Engineering Log - Non Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	01/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	01/02/2023
Hole Location:	Proposed MHU Area	Logged By:	HZ
Hole Position:	542920 m E 6465240 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Hole Diameter:	115 mm	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information							***Soil Description***					***Observations***
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m) / Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Plasticity, behaviour or particle characteristics of primary component, colour, secondary components, additional observations	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure, Zoning, Origin, Additional Observations
DT AD/V		N N	Not Encountered	SPT 0.50-0.65 m 15, refusal				GW SM-SC	SEALED PAVEMENT: 60 mm GRAVEL: to 30 mm, well graded, angular, grey. Silty SAND with clay: fine to medium grained, brown-red; clay medium plasticity.	M M	VD D		0.00: PAVEMENT 0.06: ROADBASE 0.20: FILL
						308.0 / 1 307.0 / 2 306.0 / 3 305.0 / 4			GNEISS: brown-yellow/pale orange, highly weathered, low strength Continued on cored borehole sheet	D			

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger screwing
CT - Continuous push tube 1.5m long 76mm diameter

Penetration
No resistance
Refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	01/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	01/02/2023
Hole Location:	Proposed MHU Area	Logged By:	HZ
Hole Position:	542920 m E 6465240 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Barrel Type and Length:	HQ3 3 m	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information | ***Rock Substance*** | ***Rock Mass Defects***

Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
								Continued from non-cored borehole sheet				
HQ3	Not Encountered	79			308.0	1		GNEISS: medium to coarse grained, grey/dark grey/pale yellow, layered, significant amounts of healed sub-vertical fractures.	MW	H		JT, 80°, Fe & Clay, PR, RF FL, 0°, FE, PR, RF FL, 0°, FE, PR, RF
					307.0	2		QUARTZITE: fine grained, pale grey/pale blue/dark grey, crystalline, massive, compact, significant amounts of healed sub-vertical fractures.		VH		JT, 80°, Fe & Clay, PR, RF JT, 55°, RF, PR, RF
					306.0	3						JT, 85°, FE, ST, RF CZ, 70°, RF, =60 mm
		92						GNEISS: medium to coarse grained, grey/dark grey/pale green, layered.				
					305.0	4		QUARTZITE: fine to medium grained, dark grey/pale green, crystalline, massive.				FL, 0°, FE, PR, RF FL, 0°, Fe & Clay, PR, RF JT, 80°, FE, UN, RF

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	01/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	01/02/2023
Hole Location:	Proposed MHU Area	Logged By:	HZ
Hole Position:	542920 m E 6465240 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting: Comacchio Geo 305 Inclination: -90° RL Surface: 309.00 m
Barrel Type and Length: HQ3 3 m Bearing: Datum: AHD Operator: MacGeo

Drilling Information							Rock Substance				Rock Mass Defects	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
HQ3	Not Encountered	92			303.0	6		QUARTZITE: fine to medium grained, dark grey/pale green, crystalline, massive.*(continued)*				FL, 5°, Z, PR, RF JT, 50°, FE, ST, RF JT, 50°, RF, ST, RF JT, 65°, FE, PR, RF SM, 70°, CL, =15 mm JT, 70°, FE, ST, RF JT, 70°, CN, PR, RF JT, 90°, CN, CU, RF
		99			302.0	7						JT, 60°, FE, UN, RF JT, 60°, CL, PR, RF JT, 70°, Fe & Clay, PR, S JT, 60°, Fe & Clay, ST, RF SM, 65°, CL, =5 mm JT, 70°, Fe & Clay, PR, S
					301.0	8						JT, 45°, FE, PR, RF JT, 60°, CN, PR, RF
		94			300.0	9		GNEISS: medium to coarse grained, grey/dark grey/pale orange, layered.				SM, 70°, Fe & Clay, =10 mm CZ, 70°, RF, =20 mm JT, 80°, FE, PR, RF

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube
WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Borehole ID

BH03

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	01/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	01/02/2023
Hole Location:	Proposed MHU Area	Logged By:	HZ
Hole Position:	542920 m E 6465240 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Barrel Type and Length:	HQ3 3 m	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information							***Rock Substance***										***Rock Mass Defects***	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
HQ3	Not Encountered	94			298.0	11		GNEISS: medium to coarse grained, grey/dark grey/pale orange, layered.*(continued)*				JT, 70°, FE, PR, RF JT, 75°, Fe & Clay, ST, RF JT, 75°, FE, PR, RF JT, 75°, Z, PR, RF
					297.0	12		Hole Terminated at 12.00 m Target depth				
					296.0	13						
					295.0	14						

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube
WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

PointID : BH03 Depth Range: 0.00 - 4.00 m

PointID : BH03 Depth Range: 4.00 - 8.00 m

P S M	TITLE: JBS&G Broken Hill Hospital Upgrade 176 Thomas St Core Photo - BH03	DRAWN: HZ	DATE: 01/02/2023
		CHECKED: DP	DATE: 10/02/2023
		SCALE: Not To Scale	A4
		PROJECT No: PSM4951	FIGURE No: 1/2

PointID : BH03 Depth Range: 8.00 - 12.00 m

	TITLE: JBS&G Broken Hill Hospital Upgrade 176 Thomas St Core Photo - BH03	DRAWN: HZ	DATE: 01/02/2023
		CHECKED: DP	DATE: 10/02/2023
		SCALE: Not To Scale	A4
		PROJECT No: PSM4951	FIGURE No: 2/2

Borehole ID

BH04

Engineering Log - Non Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	04/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	04/02/2023
Hole Location:	Proposed ED Area	Logged By:	HZ
Hole Position:	542990 m E 6465310 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Hole Diameter:	115 mm	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information								*Soil Description*					*Observations*
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Plasticity, behaviour or particle characteristics of primary component, colour, secondary components, additional observations	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure, Zoning, Origin, Additional Observations
DT AD/T		N N	Not Encountered						GW	SEALED PAVEMENT: 60 mm	M	VD		0.00: PAVEMENT 0.06: ROADBASE
									SW	Sandy GRAVEL: to 30 mm, well graded, angular, pale grey-brown; sand medium to coarse.	M	D		0.20: FILL
										Gravelly SAND: fine to coarse grained, well graded, brown/grey-brown; gravel angular, up to 30 mm.	D			
										GNEISS: grey/orange/pale orange, extremely weathered, very low strength				0.80: TC-bit refusal
						308.0	1			Continued on cored borehole sheet				
						307.0	2							
						306.0	3							
						305.0	4							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger screwing
CT - Continuous push tube 1.5m long 76mm diameter

Penetration
No resistance
Refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	04/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	04/02/2023
Hole Location:	Proposed ED Area	Logged By:	HZ
Hole Position:	542990 m E 6465310 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Barrel Type and Length:	HQ3 3 m	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information							***Rock Substance***				***Rock Mass Defects***	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL L M H VH EH 0.1 0.3 1 3 10	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
								Continued from non-cored borehole sheet				
HQ3	Not Encountered	22			308.0	1		GNEISS: medium grained, orange/pale orange/grey/pale grey, layered, extremely fractured rockmass, heavy iron staining.				JT, 80°, Fe & Clay, PR, RF SM, 60°, RF & CL, =40 mm SM, 70°, RF & CL, =10 mm JT, 70°, FE, PR, RF SM, 70°, RF & CL, =10 mm JT, 70°, CL & S, PR, RF CZ, 0°, RF & S, =100 mm CZ, 0°, RF & CL, =30 mm JT, 80°, RF & CL, UN, RF FL, 10°, FE, UN, RF CZ, 5°, RF & CL, =80 mm JT, 70°, FE, CU, RF
					307.0	2						
		39			306.0	3						
		77			305.0	4		GNEISS: medium to coarse grained, orange/pale orange/brown/grey/pale grey, layered.				SM, 45°, RF & CL, =40 mm JT, 70°, FE, IR, RF SM, 60°, S & CL, =10 mm JT, 60°, FE, CU, RF

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube
WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	04/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	04/02/2023
Hole Location:	Proposed ED Area	Logged By:	HZ
Hole Position:	542990 m E 6465310 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Barrel Type and Length:	HQ3 3 m	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information							***Rock Substance***				***Rock Mass Defects***	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
HQ3	Not Encountered	77			303.0	6		GNEISS: medium to coarse grained, orange/pale orange/brown/grey/pale grey, layered.*(continued)*				JT, 80°, FE, UN, RF JT, 70°, FE, CU, RF JT, 80°, FE, UN, RF JT, 60°, FE, UN, RF SM, 80°, CL, =4 mm SM, 80°, CL, =15 mm JT, 70°, FE, PR, RF SM, 70°, RF & CL, =50 mm
		17			302.0	7						JT, 80°, FE, PR, RF JT, 35°, FE, PR, RF JT, 80°, FE, PR, RF JT, 80°, FE, PR, RF JT, 35°, FE, UN, RF JT, 35°, FE, PR, RF FL, 5°, FE, PR, RF
					301.0	8						JT, 85°, FE, CU, RF JT, 70°, FE, UN, RF JT, 85°, Fe & Clay, CU, RF JT, 85°, FE, CU, RF
		94			300.0	9						JT, 85°, FE, UN, RF JT, 70°, FE, CU, RF JT, 80°, FE, UN, RF FL, 20°, Fe & Clay, IR, RF
		93										JT, 70°, FE, UN, RF JT, 70°, FE, PR, RF JT, 85°, FE, UN, RF JT, 75°, FE, CU, RF

Method

AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube

WPT - Water pressure test

Water

Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss

Core recovered (hatching indicates material)
No core recovery

Weathering

XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength

VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type

FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating

CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness

SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape

PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	04/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	04/02/2023
Hole Location:	Proposed ED Area	Logged By:	HZ
Hole Position:	542990 m E 6465310 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Barrel Type and Length:	HQ3 3 m	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information							***Rock Substance***				***Rock Mass Defects***	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL L M H VH EH 0.1 0.3 1 3 10	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
HQ3	Not Encountered	93			298.0	11		GNEISS: medium to coarse grained, orange/pale orange/brown/grey/pale grey, layered.*(continued)*				JT, 75°, FE, CU, RF JT, 75°, FE, PR, RF JT, 75°, FE, PR, RF CZ, 60°, RF & CL, =60 mm JT, 85°, Fe & Clay, UN, RF JT, 80°, FE, UN, RF FL, 45°, CN, IR, RF SM, 45°, Fe & Clay, =10 mm JT, 70°, FE, PR, RF SM, 70°, Fe & Clay, =10 mm CZ, 30°, RF & CL, =40 mm JT, 70°, FE, CU, RF
					297.0	12		Hole Terminated at 12.00 m Target depth				
					296.0	13						
					295.0	14						

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube
WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

PointID : BH04 Depth Range: 0.00 - 4.00 m

PointID : BH04 Depth Range: 4.00 - 8.00 m

PSM	TITLE: JBS&G Broken Hill Hospital Upgrade 176 Thomas St Core Photo - BH04	DRAWN: HZ	DATE: 04/02/2023
		CHECKED: DP	DATE: 10/02/2023
		SCALE: Not To Scale	A4
		PROJECT No: PSM4951	FIGURE No: 1/2

PointID : BH04 Depth Range: 8.00 - 12.00 m

TITLE: JBS&G Broken Hill Hospital Upgrade 176 Thomas St Core Photo - BH04	DRAWN: HZ	DATE: 04/02/2023	
	CHECKED: DP	DATE: 10/02/2023	
	SCALE: Not To Scale		A4
	PROJECT No: PSM4951	FIGURE No: 2/2	

Borehole ID

BH05

Engineering Log - Non Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	04/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	04/02/2023
Hole Location:	Proposed ED Area	Logged By:	HZ
Hole Position:	543000 m E 6465315 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Hole Diameter:	115 mm	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information							***Soil Description***					***Observations***
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m) / Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Plasticity, behaviour or particle characteristics of primary component, colour, secondary components, additional observations	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure, Zoning, Origin, Additional Observations
DT AD/T		N N	Not Encountered	SPT 0.50-0.59 m 15 (refusal)		308.0 / 1		GW	SEALED PAVEMENT: 60 mm Sandy GRAVEL: to 30 mm, well graded, angular, grey-brown; sand fine to coarse. GNEISS: grey/pale brown, extremely weathered, very low strength	M D to M	D		0.00: PAVEMENT 0.06: ROADBASE 1.00: TC-bit refusal
						307.0 / 2			Continued on cored borehole sheet				
						306.0 / 3							
						305.0 / 4							

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger screwing
CT - Continuous push tube 1.5m long 76mm diameter

Penetration
No resistance
Refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very soft
S - Soft
F - Firm
St - Stiff
VSt - Very stiff
H - Hard
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense
Ce - Cemented
C - Compact

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	04/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	04/02/2023
Hole Location:	Proposed ED Area	Logged By:	HZ
Hole Position:	543000 m E 6465315 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting: Comacchio Geo 305 Inclination: -90° RL Surface: 309.00 m
Barrel Type and Length: HQ3 3 m Bearing: Datum: AHD Operator: MacGeo

Drilling Information							Rock Substance						Rock Mass Defects	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
					308.0	1		Continued from non-cored borehole sheet				
HQ3	Not Encountered	9			307.0	2		GNEISS: medium grained, pale grey-brown/pale orange, layered, extremely fractured rockmass.				JT, 80°, Fe & Clay, PR, RF JT, 80°, Fe & Clay, PR, RF JT, 80°, Fe & Clay, UN, RF JT, 80°, Fe & Clay, PR, RF
					306.0	3						JT, 90°, Fe & Clay, CU, RF JT, 90°, Fe & Clay, CU, RF SM, 80°, CL, =3 mm JT, 70°, FE, CU, RF SM, 50°, RF & CL, IR, RF JT, 80°, Fe & Clay, PR, RF
		21			305.0	4						SM, 45°, CL, =5 mm JT, 80°, FE, PR, RF SM, 60°, RF & CL, =150 mm
		0										

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube
WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	04/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	04/02/2023
Hole Location:	Proposed ED Area	Logged By:	HZ
Hole Position:	543000 m E 6465315 m N MGA2020 Zone 54	Checked By:	DP
Drill Model and Mounting:	Comacchio Geo 305	Inclination: -90°	RL Surface: 309.00 m
Barrel Type and Length:	HQ3 3 m	Bearing:	Datum: AHD Operator: MacGeo

Drilling Information							Rock Substance				Rock Mass Defects	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
HQ3	Not Encountered	0			303.0	6		GNEISS: medium grained, pale grey-brown/pale orange, layered, extremely fractured rockmass.*(continued)*				SM, 60°, CL, =20 mm JT, 90°, Fe & Clay, UN, RF JT, 80°, Fe & Clay, ST, RF JT, 50°, FE, UN, RF JT, 80°, FE, PR, RF FL, 10°, FE, IR, RF JT, 45°, FE, PR, RF
		90			302.0	7		QUARTZITE: fine to medium grained, dark grey/pale green/pale orange, crystalline, massive.				CZ, 20°, RF, =30 mm JT, 40°, FE, PR, RF FL, 0°, FE, IR, RF JT, 70°, FE, UN, RF FL, 0°, FE, IR, RF CZ, 0°, RF, =20 mm FL, 15°, FE, IR, RF FL, 30°, FE, IR, RF
					301.0	8		GNEISS: medium to coarse grained, grey/dark grey/pale brown/pale orange, layered.				JT, 80°, FE, UN, RF SM, 30°, CL, =15 mm
		87			300.0	9						JT, 80°, FE, UN, RF JT, 85°, FE, UN, RF JT, 80°, FE, UN, RF

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
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Partial Loss
Complete Loss

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Strength
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VH - Very High
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Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
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Infilling/Coating
CN - Clean
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QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
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Shape
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Logged in accordance with AS 1726:2017 Geotechnical site investigations

Engineering Log - Cored Borehole

Project No.: PSM4951

Client:	JBS&G	Commenced:	04/02/2023
Project Name:	Broken Hill Hospital Upgrade	Completed:	04/02/2023
Hole Location:	Proposed ED Area	Logged By:	HZ
Hole Position:	543000 m E 6465315 m N MGA2020 Zone 54	Checked By:	DP

Drill Model and Mounting:	Comacchio Geo 305	Inclination:	-90°	RL Surface:	309.00 m		
Barrel Type and Length:	HQ3 3 m	Bearing:		Datum:	AHD	Operator:	MacGeo

Drilling Information							***Rock Substance***				***Rock Mass Defects***	
Method	Water	RQD (%)	Samples and Field Tests	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK NAME: particle/grain characteristics, colour, fabric/texture, inclusions or minor components, moisture, mineral composition, alteration	Weathering XW HW MW SW FR	Strength Is(50) ● - Axial ○ - Diametral VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
HQ3	Not Encountered	87			298.0	11		GNEISS: medium to coarse grained, grey/dark grey/pale brown/pale orange, layered.*(continued)*				SM, 70°, Fe & Clay, =15 mm JT, 45°, FE, PR, RF JT, 85°, FE, CU, RF JT, 30°, RF & FE, PR, RF JT, 60°, Fe & Clay, PR, RF JT, 85°, FE, CU, RF JT, 80°, FE, PR, RF JT, 45°, FE, UN, RF JT, 15°, FE, PR, RF JT, 45°, RF & FE, UN, RF
					297.0	12		Hole Terminated at 12.00 m Target depth				
					296.0	13						
					295.0	14						

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
HQ3- Wireline core (63.5 mm)
PQ3- Wireline core (85.0 mm)
SPT- Standard penetration test
PT - Push tube
WPT - Water pressure test

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
XW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
FR - Fresh

Strength
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
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JT - Joint
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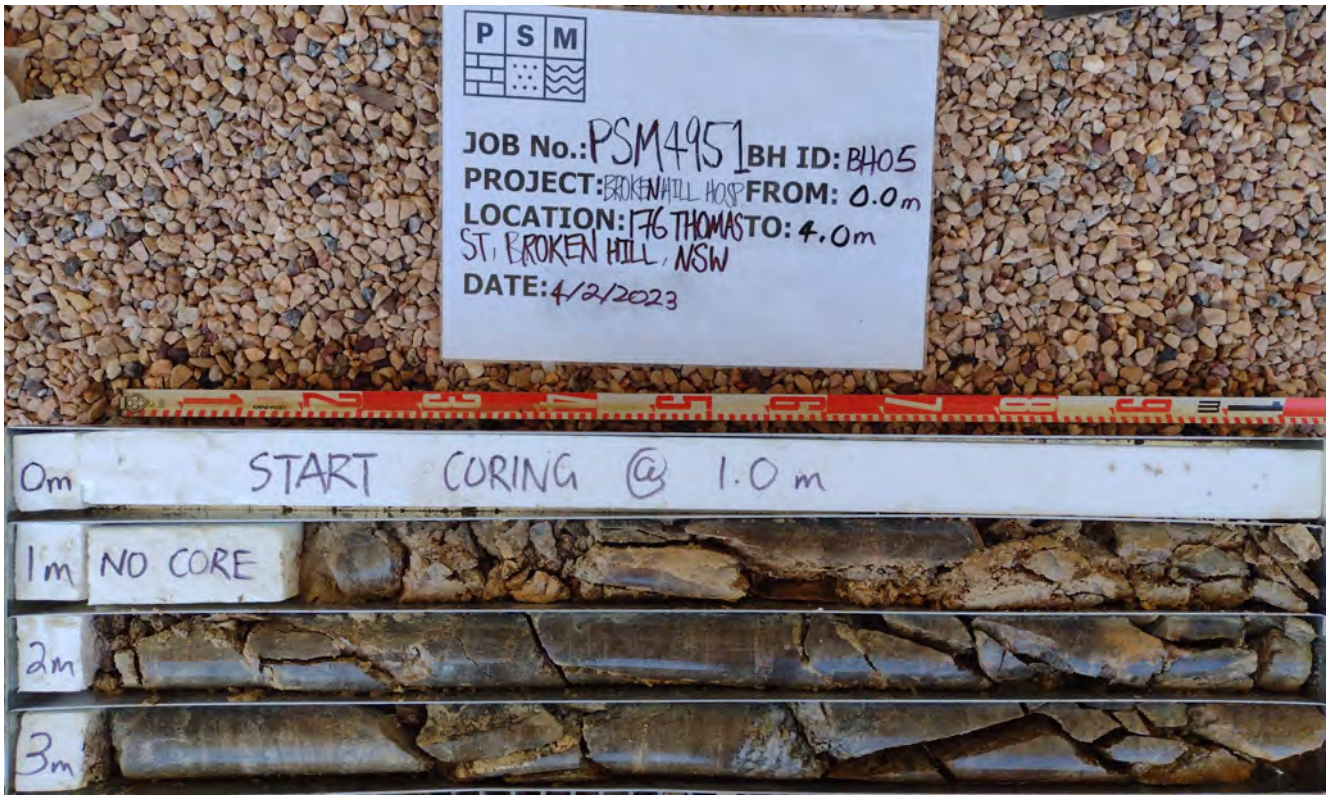
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Logged in accordance with AS 1726:2017 Geotechnical site investigations



PointID : BH05 Depth Range: 0.00 - 4.00 m

PointID : BH05 Depth Range: 4.00 - 8.00 m

P S M	TITLE: JBS&G Broken Hill Hospital Upgrade 176 Thomas St Core Photo - BH05	DRAWN: HZ	DATE: 04/02/2023
		CHECKED: DP	DATE: 10/02/2023
		SCALE: Not To Scale	A4
		PROJECT No: PSM4951	FIGURE No: 1/2

PointID : BH05 Depth Range: 8.00 - 12.00 m

	TITLE: JBS&G Broken Hill Hospital Upgrade 176 Thomas St Core Photo - BH05	DRAWN: HZ	DATE: 04/02/2023
		CHECKED: DP	DATE: 10/02/2023
		SCALE: Not To Scale	A4
		PROJECT No: PSM4951	FIGURE No: 2/2

Appendix B
Point Load Index Test Results

Pells Sullivan Meynink

POINT LOAD STRENGTH INDEX TEST RESULTS

Job No. ***PSM4951*** **Sheet 1 of 3**

Project ***Broken Hill Hospital Upgrade***

Test Method	*AS 4133.4.1-2007 Methods of testing rocks for engineering purposes - Determination of point load strength index*	Sampling Technique	*HQ*	Sampling Date	*2/2/2023 & 3/2/2023*
		Storage History		Testing Date	*2/2/2023 & 3/2/2023*
Test Machine	*GSA 6510-0702*	Moisture Condition	*Natural*	Tested By	*HZ*
Calibration Date	*27/10/2022*	Loading Rate	*< 30 seconds*		

Rock Type	Location	Depth	Diametral Tests					Axial Tests						AS 1726:2017 Strength Class
			D	L	P	$I_{s(50)}$	Failure Mode	W	D	P	I_s	$I_{s(50)}$	Failure Mode	
		(m)	(mm)	(mm)	(kN)	(MPa)		(mm)	(mm)	(kN)	(MPa)	(MPa)		
Gneiss	***BH01***	***2.35***	*60*	*40*	*9.0*	***2.7***	*Parallel to foliation*	*60*	*40*	*9.6*	*3.1*	***3.3***	*Through substance*	***H / VH***
Gneiss	***BH01***	***3.65***	*60*	*40*	*7.3*	***2.2***	*Parallel to foliation*	*60*	*55*	*7.7*	*1.8*	***2.1***	*Parallel to foliation*	***H***
Gneiss	***BH01***	***4.25***	*60*	*40*	*10.4*	***3.1***	*Parallel to foliation*							***VH***
Gneiss	***BH01***	***5.67***	*60*	*35*	*1.7*	***0.5***	*Parallel to foliation*	*60*	*37*	*4.5*	*1.6*	***1.6***	*Through substance*	***M / H***
Gneiss	***BH01***	***6.60***	*60*	*41*	*12.5*	***3.8***	*Through substance*	*60*	*40*	*8.0*	*2.6*	***2.7***	*Through substance*	***H / VH***
Gneiss	***BH01***	***7.50***	*60*	*40*	*12.9*	***3.9***	*Through substance*	*60*	*30*	*6.7*	*2.9*	***2.9***	*Through substance*	***H / VH***
Gneiss	***BH01***	***8.05***	*60*	*38*	*2.6*	***0.8***	*Through substance*	*60*	*40*	*3.4*	*1.1*	***1.2***	*Through substance*	***M / H***
Quartzite	***BH01***	***9.20***	*60*	*40*	*15.1*	***4.6***	*Through substance*	*60*	*39*	*23.9*	*8.0*	***8.3***	*Through substance*	***VH***
Quartzite	***BH01***	***10.50***	*60*	*40*	*> 17.7*	***> 5.3***	*Bad break*							***≥ VH***
Quartzite	***BH01***	***11.80***	*60*	*35*	*6.6*	***2.0***	*Through substance*	*60*	*40*	*6.3*	*2.1*	***2.2***	*Through substance*	***H***
						0								
						0								
Gneiss	***BH02***	***1.68***	*60*	*40*	*1.2*	***0 0.4***	*Parallel to foliation*	*60*	*40*	*> 1.2*	*> 0.4*	***> 0.4***	*Bad break*	***M***
Gneiss	***BH02***	***2.27***	*60*	*45*	*2.3*	***0 0.7***	*Through substance*	*60*	*45*	*0.3*	*0.1*	***0.1***	*Through substance*	***VL / M***
Gneiss	***BH02***	***3.46***	*60*	*35*	*> 24.6*	***> 7.4***	*Bad break*							***≥ VH***
Gneiss	***BH02***	***4.70***	*60*	*35*	*13.0*	***0 3.9***	*Through substance*	*60*	*35*	*5.9*	*2.2*	***2.2***	*Through substance*	***H / VH***
Gneiss	***BH02***	***5.89***	*60*	*60*	*> 2.9*	***> 0.9***	*Bad break*							***≥ M***
Gneiss	***BH02***	***6.48***	*60*	*35*	*0.9*	***0 0.3***	*Parallel to foliation*	*60*	*35*	*2.7*	*1.0*	***1.0***	*Through substance*	***L / H***
Quartzite	***BH02***	***7.64***	*60*	*40*	*> 21.5*	***> 6.5***	*Bad break*							***≥ VH***
Quartzite	***BH02***	***8.33***	*60*	*150*	*> 22.7*	***> 6.8***	*Bad break*							***≥ VH***
Gneiss	***BH02***	***9.52***	*60*	*41*	*10.5*	***0 3.2***	*Parallel to foliation*	*60*	*36*	*16.9*	*6.1*	***6.3***	*Through substance*	***VH***
Gneiss	***BH02***	***10.49***	*60*	*45*	*7.2*	***0 2.2***	*Through substance*	*60*	*45*	*> 8.7*	*> 2.5*	***> 2.7***	*Bad break*	***H***
Gneiss	***BH02***	***11.54***	*60*	*36*	*6.8*	***0 2.1***	*Parallel to foliation*	*60*	*35*	*9.4*	*3.5*	***3.6***	*Through substance*	***H / VH***
						0								
						0								

By: ***HZ*** **Checked:** ***DP*** **Date:** ***10/2/2023***

Pells Sullivan Meynink

POINT LOAD STRENGTH INDEX TEST RESULTS

Job No. ***PSM4951*** **Sheet 2 of 3**

Project ***Broken Hill Hospital Upgrade***

Test Method	*AS 4133.4.1-2007 Methods of testing rocks for engineering purposes - Determination of point load strength index*	Sampling Technique	*HQ*	Sampling Date	*1/2/2023 & 4/2/2023*
		Storage History		Testing Date	*1/2/2023 & 4/2/2023*
Test Machine	*GSA 6510-0702*	Moisture Condition	*Natural*	Tested By	*HZ*
Calibration Date	*27/10/2022*	Loading Rate	*< 30 seconds*		

Rock Type	Location	Depth	Diametral Tests					Axial Tests						AS 1726:2017 Strength Class
			D	L	P	$I_{s(50)}$	Failure Mode	W	D	P	I_s	$I_{s(50)}$	Failure Mode	
		(m)	(mm)	(mm)	(kN)	(MPa)		(mm)	(mm)	(kN)	(MPa)	(MPa)		
Gneiss	***BH03***	***0.96***	*60*	*60*	*> 6.9*	***> 2.1***	*Bad break*	*60*	*60*	*> 1.9*	*> 0.4*	***> 0.5***	*Along defect*	***≥ H***
Gneiss	***BH03***	***1.30***	*60*	*50*	*> 3.0*	***> 0.9***	*Along defect*							***≥ M***
Quartzite	***BH03***	***2.05***	*60*	*40*	*> 15.2*	***> 4.6***	*Along defect*							***≥ VH***
Quartzite	***BH03***	***3.30***	*60*	*40*	*> 23.8*	***> 7.2***	*Bad break*							***≥ VH***
Gneiss	***BH03***	***3.95***	*60*	*50*	*> 10.1*	***> 3.1***	*Bad break*							***≥ VH***
Quartzite	***BH03***	***4.40***	*60*	*40*	*> 5.6*	***> 1.7***	*Along defect*							***≥ H***
Quartzite	***BH03***	***5.15***	*60*	*40*	*> 3.6*	***> 1.1***	*Bad break*							***≥ H***
Quartzite	***BH03***	***6.45***	*60*	*35*	*10.8*	***3.2***	*Through substance*	*60*	*35*	*> 1.4*	*> 0.5*	***> 0.5***	*Along defect*	***VH***
Quartzite	***BH03***	***7.95***	*60*	*70*	*> 6.7*	***> 2.0***	*Bad break*							***≥ H***
Quartzite	***BH03***	***8.50***	*60*	*35*	*7.3*	***2.2***	*Through substance*	*60*	*35*	*2.4*	*0.9*	***0.9***	*Along defect*	***M / H***
Gneiss	***BH03***	***9.70***	*60*	*80*	*> 4.5*	***> 1.4***	*Bad break*							***≥ H***
Gneiss	***BH03***	***10.60***	*60*	*35*	*8.6*	***2.6***	*Through substance*							***H***
Gneiss	***BH03***	***11.80***	*60*	*50*	*> 14.3*	***> 4.3***	*Bad break*							***≥ VH***
Gneiss	***BH04***	***2.25***	*60*	*62*	*> 11.3*	***> 3.4***	*Bad break*							***≥ VH***
Gneiss	***BH04***	***3.40***	*60*	*40*	*> 7.1*	***> 2.1***	*Along defect*							***≥ H***
Gneiss	***BH04***	***4.05***	*60*	*45*	*> 5.9*	***> 1.8***	*Bad break*							***≥ H***
Gneiss	***BH04***	***5.33***	*60*	*50*	*> 4.3*	***> 1.3***	*Bad break*							***≥ H***
Gneiss	***BH04***	***6.46***	*60*	*50*	*> 1.5*	***> 0.5***	*Bad break*							***≥ M***
Gneiss	***BH04***	***8.38***	*60*	*50*	*> 1.1*	***> 0.3***	*Bad break*							***≥ M***
Gneiss	***BH04***	***9.73***	*60*	*220*	*> 8.7*	***> 2.6***	*Bad break*							***≥ H***
Gneiss	***BH04***	***10.95***	*60*	*60*	*> 2.5*	***> 0.7***	*Along defect*							***≥ M***
Gneiss	***BH04***	***11.94***	*60*	*42*	*4.8*	***1.5***	*Parallel to foliation*							***H***

By: ***HZ*** **Checked:** ***DP*** **Date:** ***10/2/2023***

Pells Sullivan Meynink

POINT LOAD STRENGTH INDEX TEST RESULTS

Job No. ***PSM4951*** **Sheet 3 of 3**

Project ***Broken Hill Hospital Upgrade***

Test Method	*AS 4133.4.1-2007 Methods of testing rocks for engineering purposes - Determination of point load strength index*	Sampling Technique	*HQ*	Sampling Date	*4/2/2023*
		Storage History		Testing Date	*4/02/2023*
Test Machine	*GSA 6510-0702*	Moisture Condition	*Natural*	Tested By	*HZ*
Calibration Date	*27/10/2022*	Loading Rate	*< 30 seconds*		

Rock Type	Location	Depth	Diametral Tests					Axial Tests						AS 1726:2017 Strength Class
			D	L	P	$I_{s(50)}$	Failure Mode	W	D	P	I_s	$I_{s(50)}$	Failure Mode	
		(m)	(mm)	(mm)	(kN)	(MPa)		(mm)	(mm)	(kN)	(MPa)	(MPa)		
Gneiss	***BH05***	***3.47***	*60*	*60*	*> 1.5*	***> 0.4***	*Along defect*							***≥ M***
Gneiss	***BH05***	***4.54***	*60*	*60*	*> 0.6*	***> 0.2***	*Along defect*							***≥ L***
Gneiss	***BH05***	***5.20***	*60*	*50*	*> 0.5*	***> 0.2***	*Bad break*							***≥ L***
Gneiss	***BH05***	***6.51***	*60*	*70*	*> 4.5*	***> 1.3***	*Along defect*							***≥ H***
Quartzite	***BH05***	***7.55***	*60*	*50*	*> 15.0*	***> 4.5***	*Bad break*							***≥ VH***
Gneiss	***BH05***	***8.70***	*60*	*50*	*12.8*	***3.9***	*Through substance*	*60*	*42*	*5.8*	*1.8*	***1.9***	*Through substance*	***H / VH***
Gneiss	***BH05***	***9.65***	*60*	*50*	*> 1.5*	***> 0.4***	*Along defect*							***≥ M***
Gneiss	***BH05***	***10.20***	*60*	*60*	*> 2.8*	***> 0.9***	*Along defect*							***≥ M***
Gneiss	***BH05***	***11.80***	*60*	*50*	*> 5.6*	***> 1.7***	*Along defect*							***≥ H***

By: ***HZ*** **Checked:** ***DP*** **Date:** ***10/2/2023***

Appendix C
Piezometer Construction Records

PSM
Engineering Consultants
Rock - Soil - Water

JOB no.: PSM4951

PROJECT: Broken Hill Hospital

PIEZOMETER CONSTRUCTION RECORD

HOLE NUMBER: BH01
PIEZOMETER: 1
COLLAR EASTING: 542900 m
COLLAR NORTHING: 6465200 m
COLLAR RL(m): 309 m
DATUM: MGA2020 Zone 54

DRILLING CONTRACTOR: MacGeo
RIG: Comacchio Geo 305
DEPTH OF HOLE (m): 12 m
BOREHOLE INCLINATION: -90
PIEZO INSTALLATION DATE: 2/02/2023
SUPERVISED BY: HZ

Tick boxes

Steel protective well cover [X]
PVC cap [X]
Concrete colar [X]

Back fill type:
Cement bentonite [ ]
Soil [ ]
None [X]

Seal:
Bentonite pellets [X]
Other [ ]

Gravel type:
2-5mm gravel [X]
Other [ ]

Perforation type:
Drill holes [ ]
Hack saw cuts [ ]
40um machine slots [X]

Complete dimensions if appropriate

Height of stickup (m)	0
Diameter of PVC (mm)	50
Depth to top of seal	0
Depth to top of gravel pack	2
Depth to top of screen	3
Depth to base of screen	12
Depth to base of piezo	12
Depth to base of gravel	12

COMMENTS:

PSM
Engineering Consultants
Rock - Soil - Water

JOB no.: PSM4951

PROJECT: Broken Hill Hospital

PIEZOMETER CONSTRUCTION RECORD

HOLE NUMBER: BH03
PIEZOMETER: 2
COLLAR EASTING: 542920 m
COLLAR NORTHING: 6465240 m
COLLAR RL(m): 309 m
DATUM: MGA2020 Zone 54

DRILLING CONTRACTOR: MacGeo
RIG: Comacchio Geo 305
DEPTH OF HOLE (m): 12 m
BOREHOLE INCLINATION: -90
PIEZO INSTALLATION DATE: 1/02/2023
SUPERVISED BY: HZ

Tick boxes

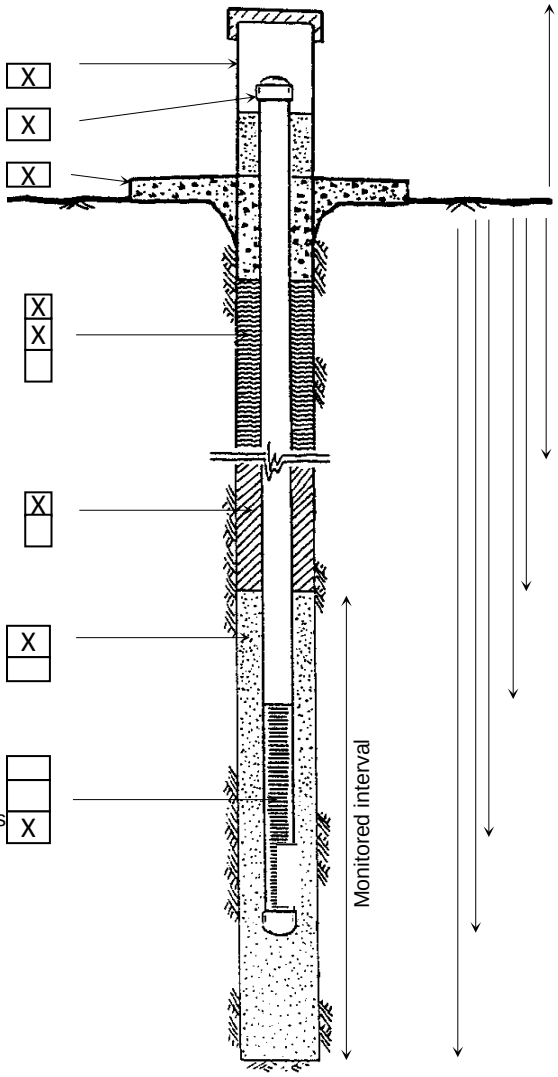
Steel protective well cover [X]
PVC cap [X]
Concrete colar [X]

Back fill type:
Cement bentonite [X]
Soil [X]
None [ ]

Seal:
Bentonite pellets [X]
Other [ ]

Gravel type:
2-5mm gravel [X]
Other [ ]

Perforation type:
Drill holes [ ]
Hack saw cuts [ ]
40um machine slots [X]



Complete dimensions if appropriate

Height of stickup (m)	0
Diameter of PVC (mm)	50
Depth to top of seal	7
Depth to top of gravel pack	8
Depth to top of screen	9
Depth to base of screen	12
Depth to base of piezo	12
Depth to base of gravel	12

COMMENTS:

PSM
Engineering Consultants
Rock - Soil - Water

JOB no.: PSM4951

PROJECT: Broken Hill Hospital

PIEZOMETER CONSTRUCTION RECORD

HOLE NUMBER: BH05
PIEZOMETER: 3
COLLAR EASTING: 543000 m
COLLAR NORTHING: 6465315 m
COLLAR RL(m): 309 m
DATUM: MGA2020 Zone 54

DRILLING CONTRACTOR: MacGeo
RIG: Comacchio Geo 305
DEPTH OF HOLE (m): 12 m
BOREHOLE INCLINATION: -90
PIEZO INSTALLATION DATE: 4/02/2023
SUPERVISED BY: HZ

Tick boxes

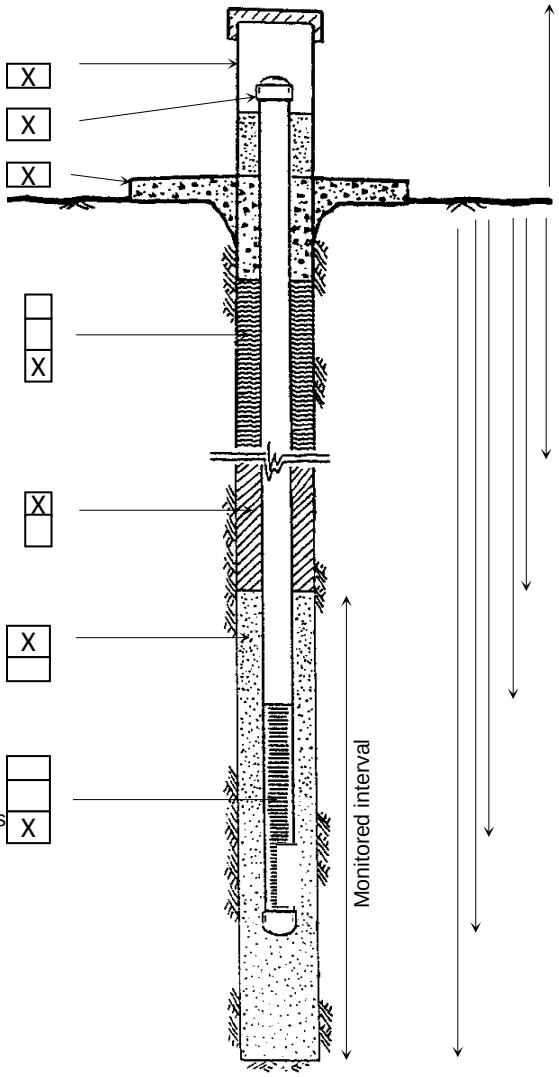
Steel protective well cover [X]
PVC cap [X]
Concrete colar [X]

Back fill type:
Cement bentonite [ ]
Soil [ ]
None [X]

Seal:
Bentonite pellets [X]
Other [ ]

Gravel type:
2-5mm gravel [X]
Other [ ]

Perforation type:
Drill holes [ ]
Hack saw cuts [ ]
40um machine slots [X]



Complete dimensions if appropriate

Height of stickup (m)	0
Diameter of PVC (mm)	50
Depth to top of seal	0
Depth to top of gravel pack	2
Depth to top of screen	6
Depth to base of screen	12
Depth to base of piezo	12
Depth to base of gravel	12

COMMENTS:

Appendix D
CBR Test Results

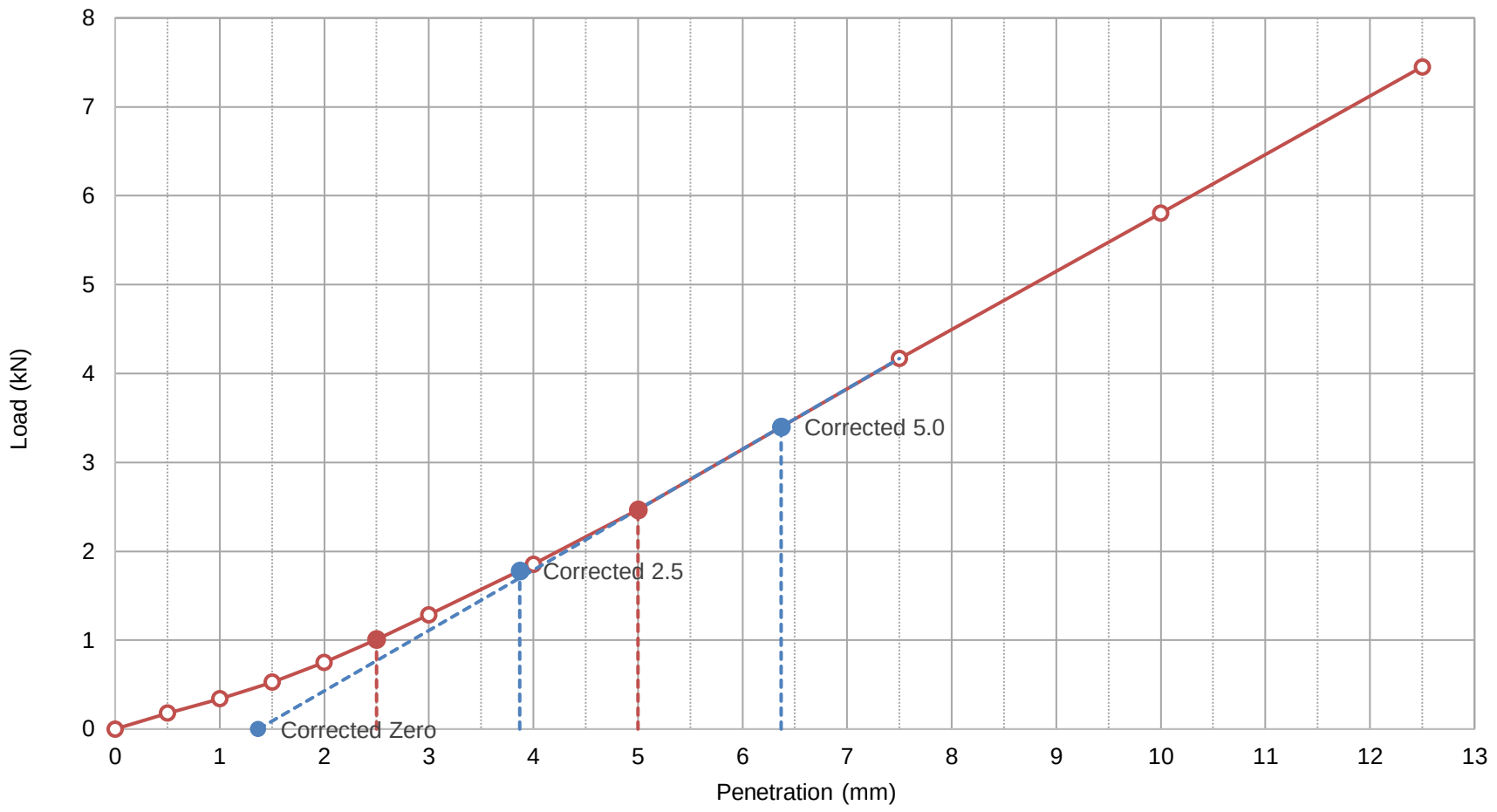
CALIFORNIA BEARING RATIO REPORT

Client	PSM	**Source**	Sample 1 0.0-0.5m
Address	g3, 56 Delhi Rd, North Ryde, NSW, 2113	**Sample Description**	Clayey Gravelly SAND
Project	Broken Hill Hospital Upgrade (PSM4951	**Report No.**	S83998-CBR
Job No.	S23043-1	**Sample No.**	S83998

Test Procedure	☑ AS 1289.6.1.1	☐ RMS T117	California Bearing Ratio
	☑ AS 1289.5.1.1	☐ RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
	☐ AS 1289.5.2.1	☐ RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
	☑ AS 1289.2.1.1	☐ RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** Unknown

Preparation Prepared in accordance with the test method **Date Tested** 13/03/2023



Preparation & Specification	
Retained on 19.0mm Sieve (%)	3
Method of Establishing Plasticity Level	Technician Assessment
Sample Curing Time (hrs)	48 hrs
Compaction Hammer Used	Standard
Surcharge Mass Applied (kg)	4.5
Period of Soaking (Days)	4
Maximum Dry Density - MDD (t/m³)	2.09
Optimum Moisture Content - OMC (%)	10.1

Density & Moisture	Achieved	Target
Lab Moisture Ratio - LMR (%)	98.5	100.0
Lab Density Ratio - LDR (%)	98.5	98.0
Dry Density - At Compaction (t/m³)	2.05	2.04
Dry Density - After Soaking (t/m³)	2.05	
Specimen Swell (%)	0.0	
Moisture Content - At Compaction (%)	9.9	
Moisture Content - Top 30mm (%)	10.7	
Moisture Content - Remainder (%)	10.6	

Material CBR Value (%): 17 at a penetration of 5.0 mm

Notes

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Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd Date: 14/03/2023

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

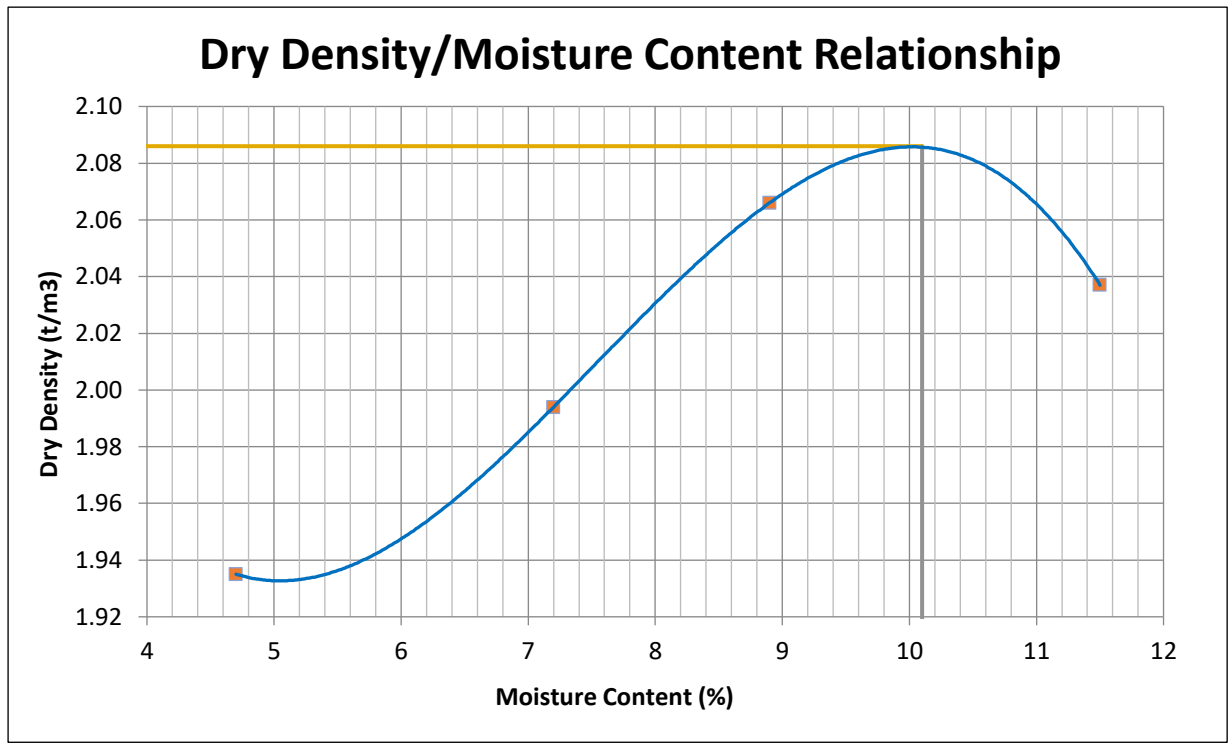
Client	PSM	**Source**	Sample 1 0.0-0.5m
Address	g3, 56 Delhi Rd, North Ryde, NSW, 2113	**Sample Description**	Clayey Gravelly SAND
Project	Broken Hill Hospital Upgrade (PSM4951	**Report No**	S83998-MDD
Job No	S23043-1	**Sample No**	S83998

Test Procedure

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Preparation	Prepared in accordance with the test method	**Date Tested**	6/03/2023



Maximum Dry Density (t/m^3)	2.086
Optimum Moisture Content (%)	10.1
Oversize Retained on 19mm sieve (%)	3.0
Oversize Retained on 37.5mm sieve (%)	0.0
Curing Time	94 hrs
Liquid Limit Determination	Technician Assessment

Notes

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Chris Lloyd

14/03/2023

Date:

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Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

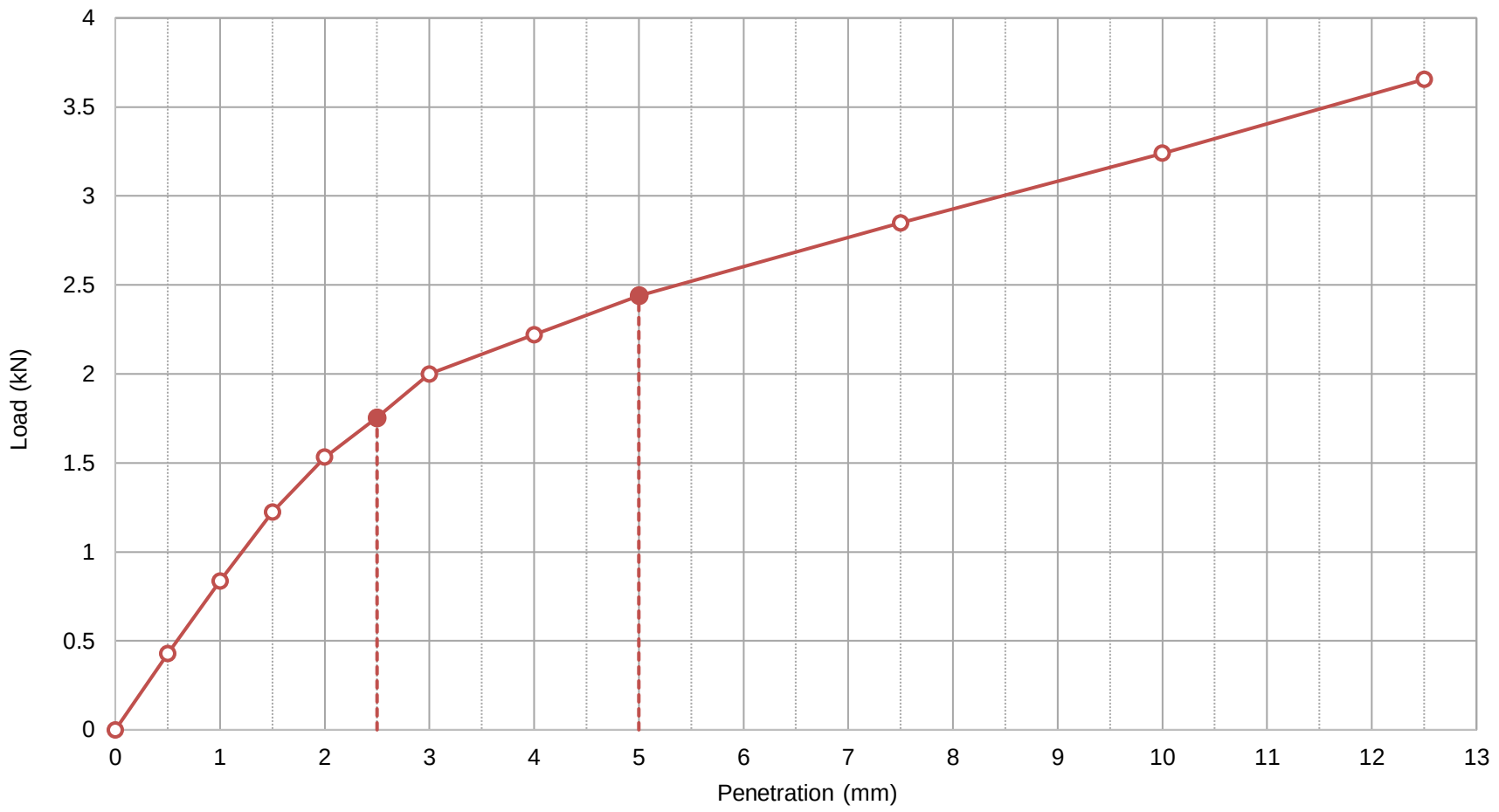
CALIFORNIA BEARING RATIO REPORT

Client	PSM	**Source**	Sample 2 0.0-0.5m
Address	g3, 56 Delhi Rd, North Ryde, NSW, 2113	**Sample Description**	Silty Sandy CLAY, trace of Gravel
Project	Broken Hill Hospital Upgrade (PSM4951	**Report No.**	S83999-CBR
Job No.	S23043-1	**Sample No.**	S83999

Test Procedure	☑ AS 1289.6.1.1	☐ RMS T117	California Bearing Ratio
	☑ AS 1289.5.1.1	☐ RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
	☐ AS 1289.5.2.1	☐ RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
	☑ AS 1289.2.1.1	☐ RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** Unknown

Preparation Prepared in accordance with the test method **Date Tested** 13/03/2023



Preparation & Specification		Density & Moisture	Achieved	Target
Retained on 19.0mm Sieve (%)	1	Lab Moisture Ratio - LMR (%)	100.5	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	98.0	98.0
Sample Curing Time (hrs)	48 hrs	Dry Density - At Compaction (t/m³)	1.79	1.79
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.79	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	0.2	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	15.7	
Maximum Dry Density - MDD (t/m³)	1.83	Moisture Content - Top 30mm (%)	17.4	
Optimum Moisture Content - OMC (%)	15.6	Moisture Content - Remainder (%)	17.0	

Material CBR Value (%): 13 at a penetration of 2.5 mm

Notes

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14/03/2023

Chris Lloyd Date:

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

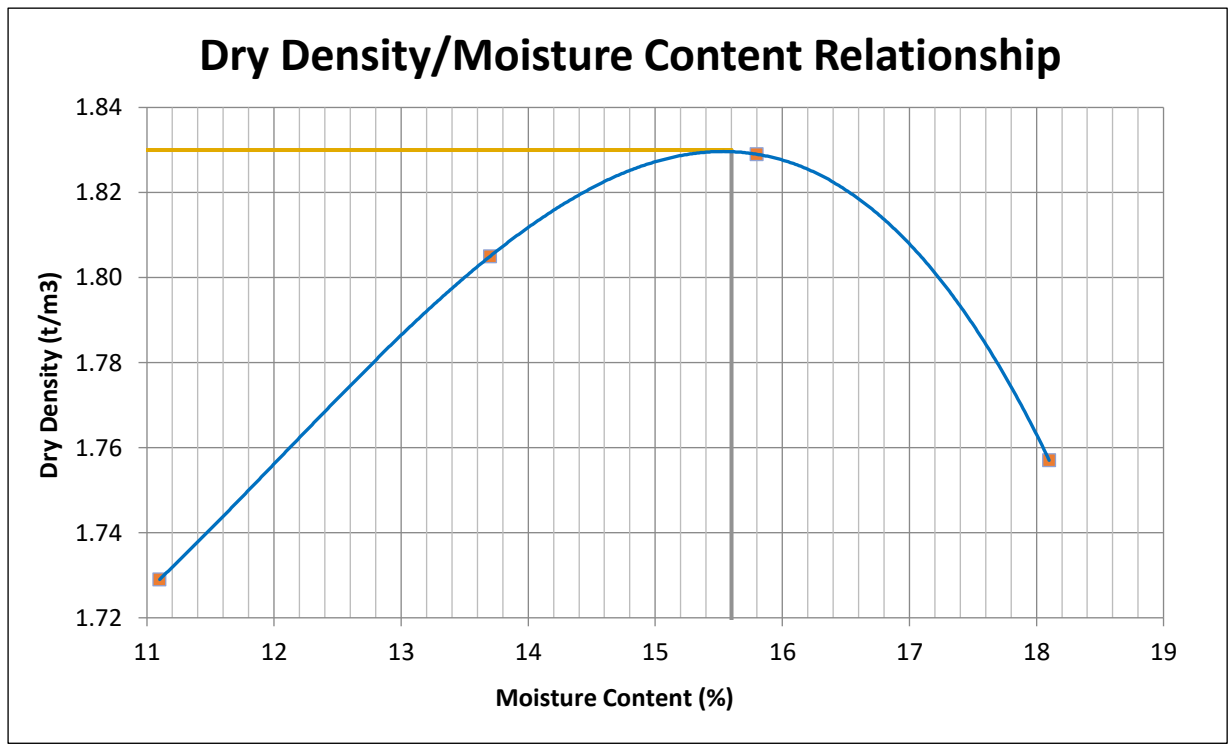
Client	PSM	**Source**	Sample 2 0.0-0.5m
Address	g3, 56 Delhi Rd, North Ryde, NSW, 2113	**Sample Description**	Silty Sandy CLAY, trace of Gravel
Project	Broken Hill Hospital Upgrade (PSM4951	**Report No**	S83999-MDD
Job No	S23043-1	**Sample No**	S83999

Test Procedure

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Preparation	Prepared in accordance with the test method	**Date Tested**	6/03/2023



Maximum Dry Density (t/m^3)	1.830
Optimum Moisture Content (%)	15.6
Oversize Retained on 19mm sieve (%)	1.0
Oversize Retained on 37.5mm sieve (%)	0.0
Curing Time	94 hrs
Liquid Limit Determination	Technician Assessment

Notes

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Chris Lloyd

14/03/2023

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

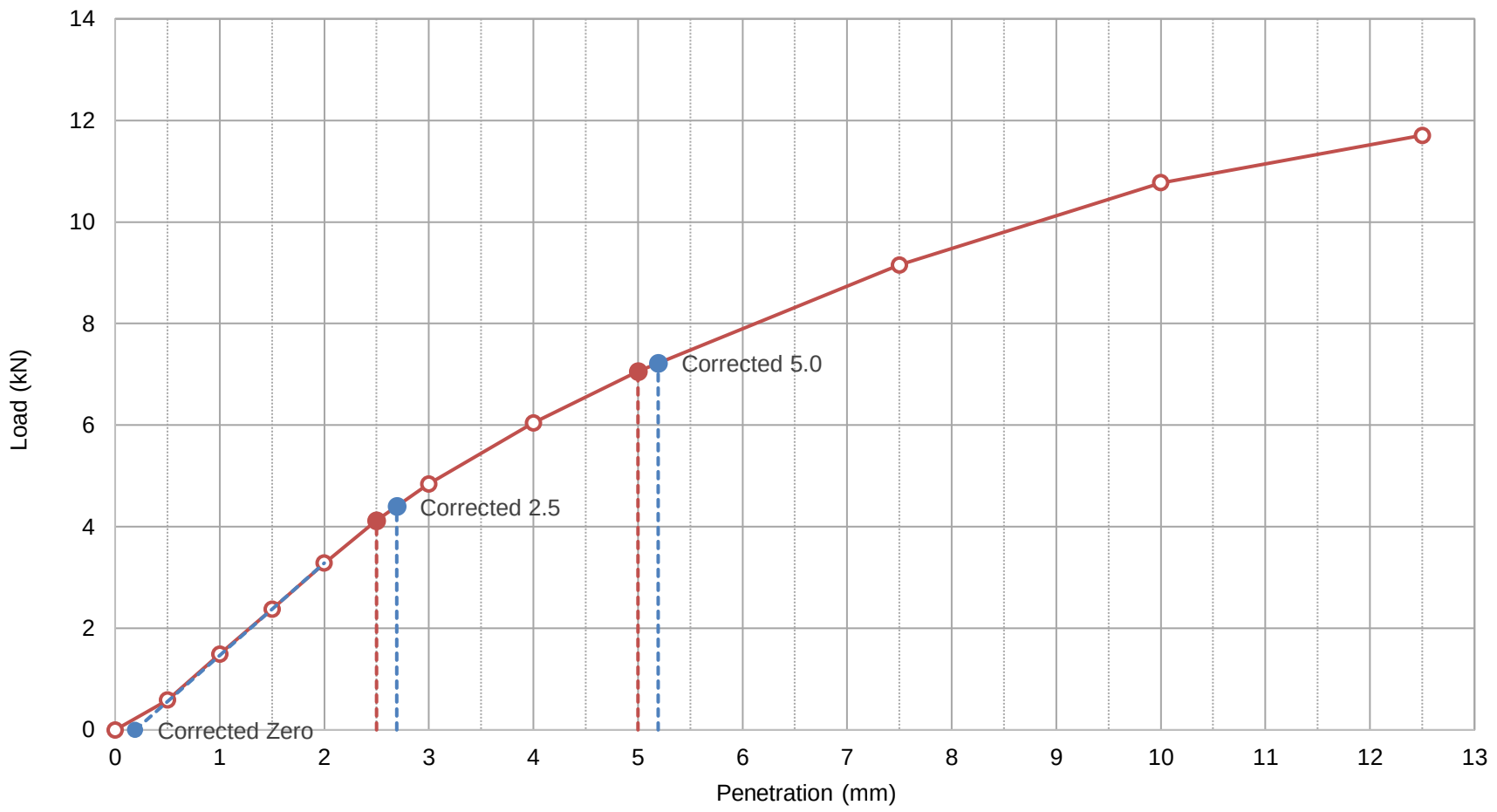
CALIFORNIA BEARING RATIO REPORT

Client	PSM	**Source**	Sample 3 (BH03) 0.20-0.80m
Address	g3, 56 Delhi Rd, North Ryde, NSW, 2113	**Sample Description**	Silty SAND with Gravel
Project	Broken Hill Hospital Upgrade (PSM4951	**Report No.**	S84000-CBR
Job No.	S23043-1	**Sample No.**	S84000

Test Procedure	☑ AS 1289.6.1.1	☐ RMS T117	California Bearing Ratio
	☑ AS 1289.5.1.1	☐ RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
	☐ AS 1289.5.2.1	☐ RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
	☑ AS 1289.2.1.1	☐ RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** Unknown

Preparation Prepared in accordance with the test method **Date Tested** 13/03/2023



Preparation & Specification	
Retained on 19.0mm Sieve (%)	1
Method of Establishing Plasticity Level	Technician Assessment
Sample Curing Time (hrs)	49 hrs
Compaction Hammer Used	Standard
Surcharge Mass Applied (kg)	4.5
Period of Soaking (Days)	4
Maximum Dry Density - MDD (t/m³)	2.16
Optimum Moisture Content - OMC (%)	8.1

Density & Moisture	Achieved	Target
Lab Moisture Ratio - LMR (%)	99.5	100.0
Lab Density Ratio - LDR (%)	98.0	98.0
Dry Density - At Compaction (t/m³)	2.11	2.11
Dry Density - After Soaking (t/m³)	2.11	
Specimen Swell (%)	0.1	
Moisture Content - At Compaction (%)	8.1	
Moisture Content - Top 30mm (%)	9.7	
Moisture Content - Remainder (%)	9.6	

Material CBR Value (%): 35 at a penetration of 2.5 mm

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

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Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd Date: 14/03/2023

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

Client	PSM	**Source**	Sample 3 (BH03) 0.20-0.80m
Address	g3, 56 Delhi Rd, North Ryde, NSW, 2113	**Sample Description**	Silty SAND with Gravel
Project	Broken Hill Hospital Upgrade (PSM4951	**Report No**	S84000-MDD
Job No	S23043-1	**Sample No**	S84000

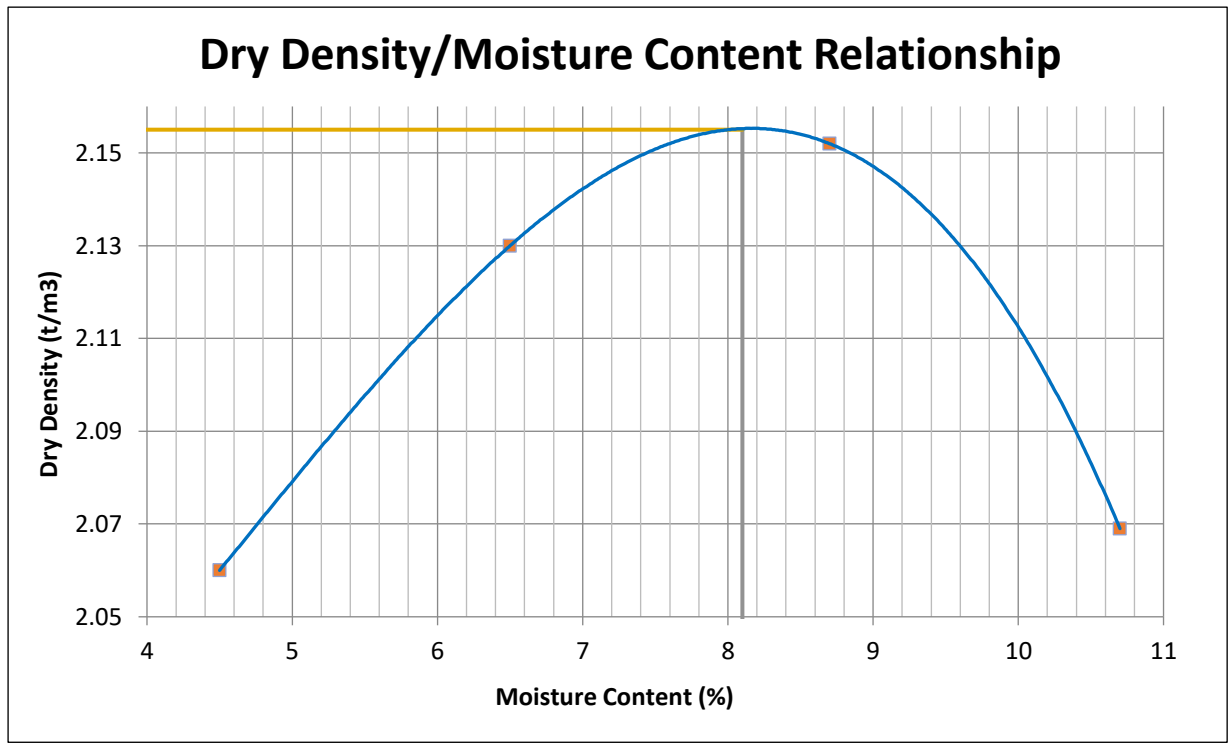
Test Procedure

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** Unknown

Preparation Prepared in accordance with the test method **Date Tested** 6/03/2023



Maximum Dry Density (t/m^3)	2.155
Optimum Moisture Content (%)	8.1
Oversize Retained on 19mm sieve (%)	1.0
Oversize Retained on 37.5mm sieve (%)	0.0
Curing Time	68 hrs
Liquid Limit Determination	Technician Assessment

Notes

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
This document shall not be reproduced, except in full.
Results relate only to the samples tested.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

14/03/2023

Date:

Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

Appendix E
Atterberg Limit Test Results

SOIL CLASSIFICATION REPORT

Client	PSM	**Source**	Sample 1 0.0-0.5m
Address	g3, 56 Delhi Rd, North Ryde, NSW, 2113	**Sample Description**	Clayey Gravelly SAND
Project	Broken Hill Hospital Upgrade (PSM4951	**Report No.**	S83998-PI
Job No.	S23043-1	**Lab No.**	S83998

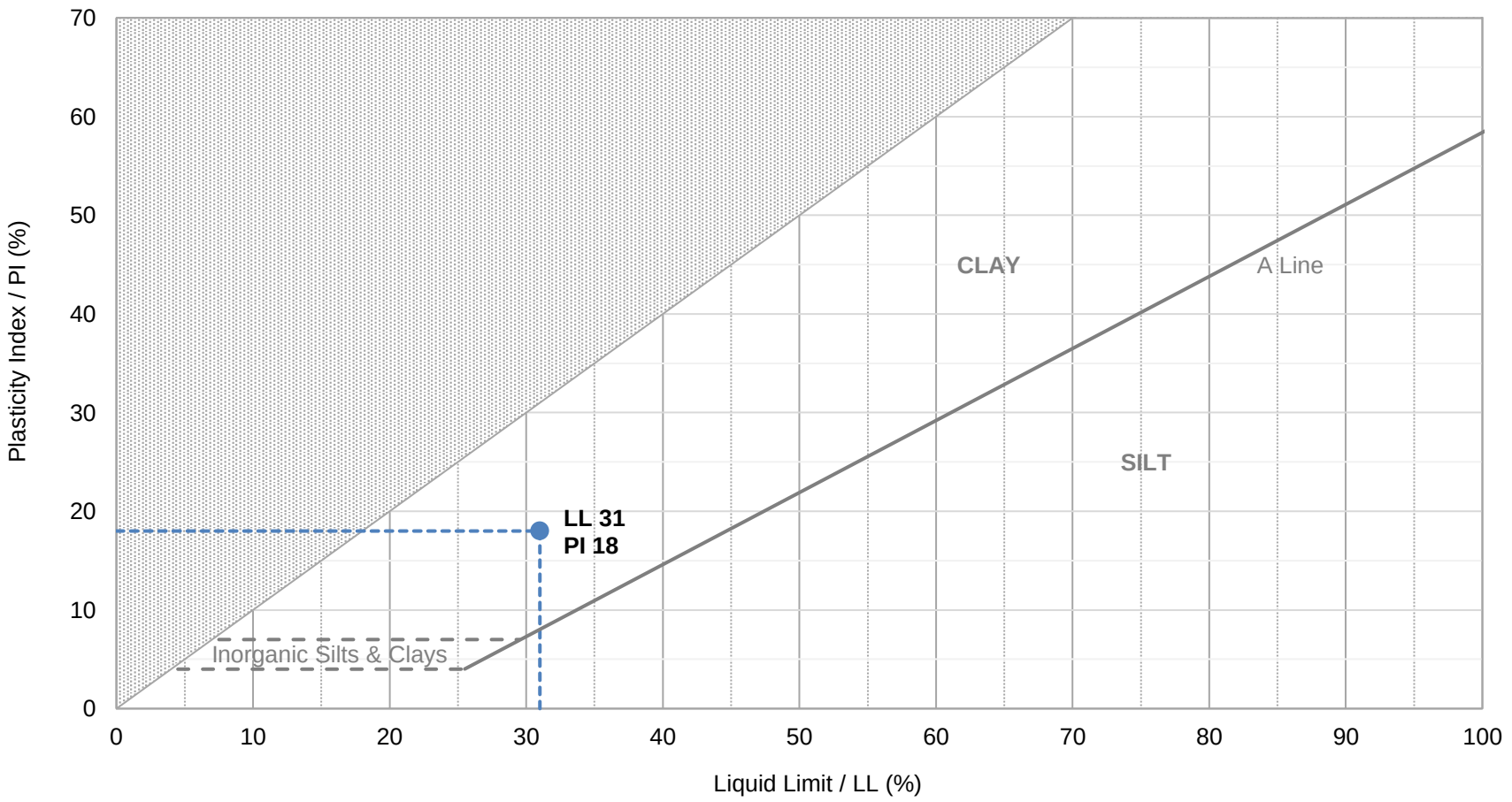
Test Procedure

- ☑ AS1289 3.1.1 Liquid Limit - Four point Casagrande method
- ☐ AS1289 3.1.2 Liquid Limit - One point Casagrande method
- ☑ AS1289 3.2.1 Plastic Limit - Standard method
- ☑ AS1289 3.3.1 Calculation of the Plasticity Index
- ☐ AS1289 3.4.1 Linear Shrinkage - Standard method

Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Preparation	Prepared in accordance with the test method	**Date Tested**	7/03/2023

Plasticity Chart for Classification of Fine-Grained Soils

AS 1726:2017 Clause 6.1.6 (Figure 5)



Preparation

Method of Preparation	**Dry Sieved**
History of the Sample	**Air Dried**

Results

Liquid Limit / LL (%)	**31**
Plastic Limit (%)	**13**
Plasticity Index / PI (%)	**18**

Notes

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

8/03/2023

Date:

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Macquarie Geotechnical
14 Carter St
Lidcombe NSW 2141

SOIL CLASSIFICATION REPORT

Client	PSM	**Source**	Sample 2 0.0-0.5m
Address	g3, 56 Delhi Rd, North Ryde, NSW, 2113	**Sample Description**	Silty Sandy CLAY, trace of Gravel
Project	Broken Hill Hospital Upgrade (PSM4951	**Report No.**	S83999-PI
Job No.	S23043-1	**Lab No.**	S83999

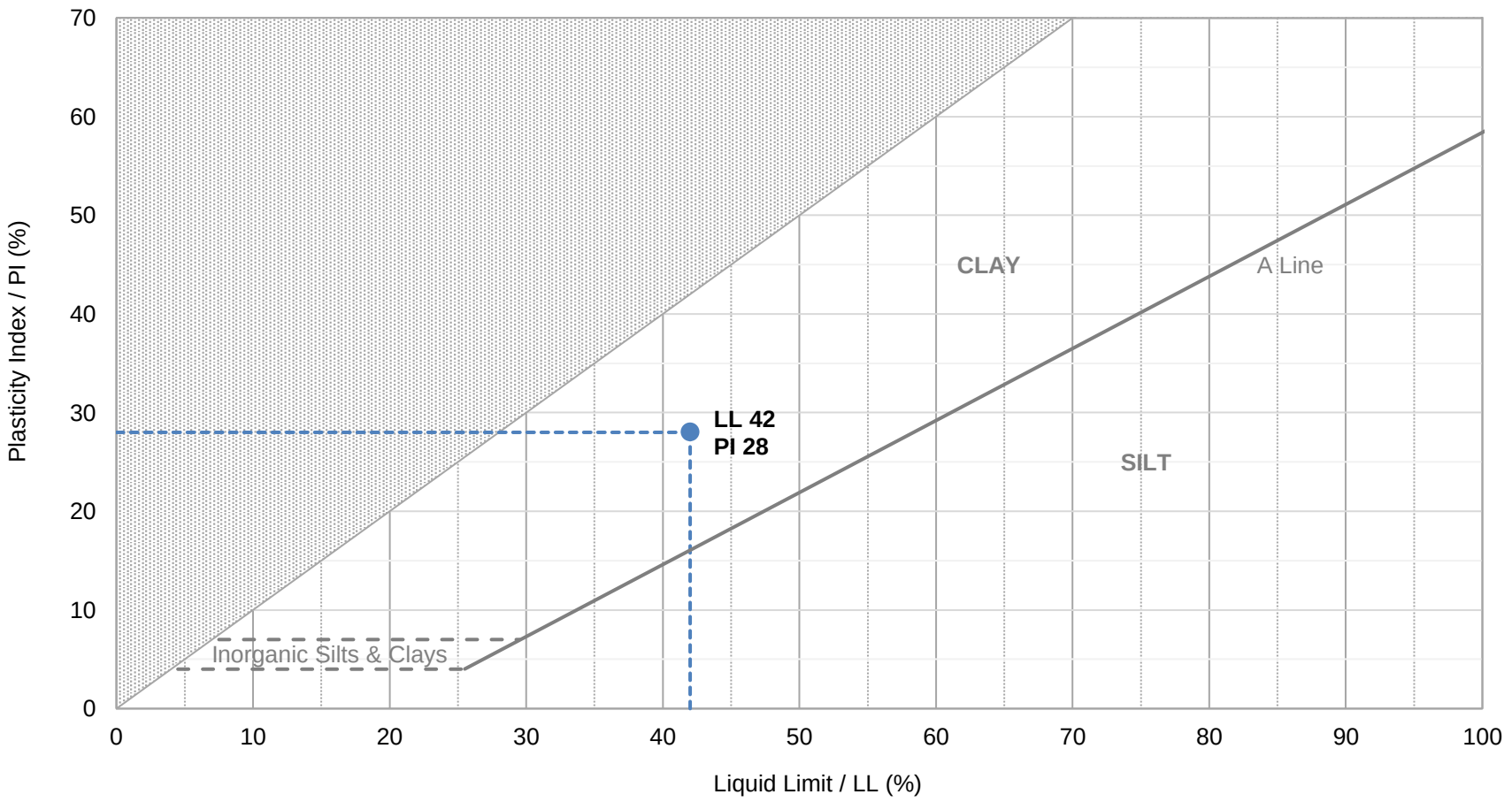
Test Procedure

- ☑ AS1289 3.1.1 Liquid Limit - Four point Casagrande method
- ☐ AS1289 3.1.2 Liquid Limit - One point Casagrande method
- ☑ AS1289 3.2.1 Plastic Limit - Standard method
- ☑ AS1289 3.3.1 Calculation of the Plasticity Index
- ☐ AS1289 3.4.1 Linear Shrinkage - Standard method

Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Preparation	Prepared in accordance with the test method	**Date Tested**	7/03/2023

Plasticity Chart for Classification of Fine-Grained Soils

AS 1726:2017 Clause 6.1.6 (Figure 5)



Preparation

Method of Preparation	**Dry Sieved**
History of the Sample	**Air Dried**

Results

Liquid Limit / LL (%)	**42**
Plastic Limit (%)	**14**
Plasticity Index / PI (%)	**28**

Notes

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Authorised Signatory:

Chris Lloyd

8/03/2023

Date:

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Lidcombe NSW 2141

SOIL CLASSIFICATION REPORT

Client	PSM	**Source**	Sample 3 (BH03) 0.20-0.80m
Address	g3, 56 Delhi Rd, North Ryde, NSW, 2113	**Sample Description**	Silty SAND with Gravel
Project	Broken Hill Hospital Upgrade (PSM4951	**Report No.**	S84000-PI
Job No.	S23043-1	**Lab No.**	S84000

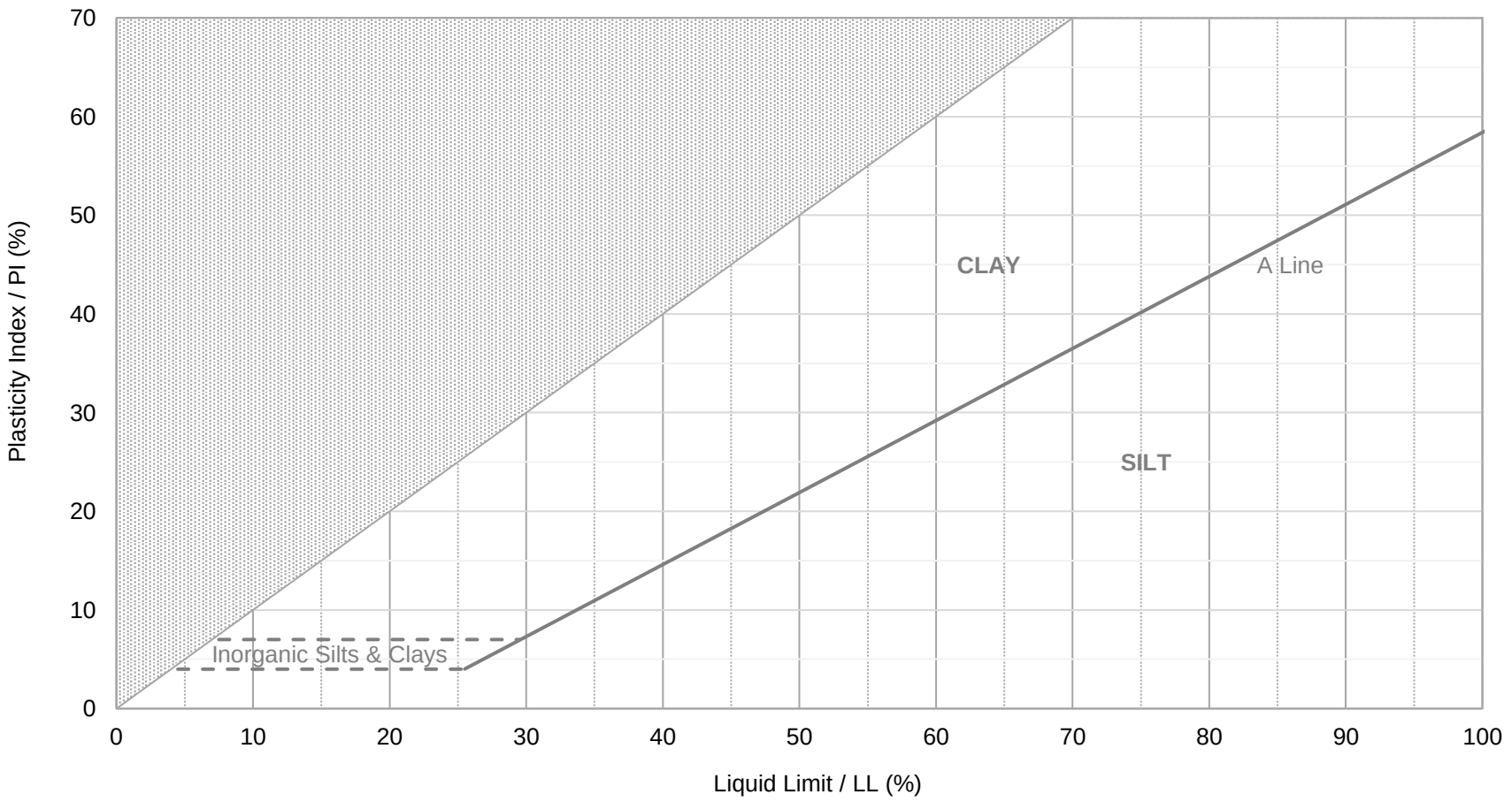
Test Procedure

- ☑ AS1289 3.1.1 Liquid Limit - Four point Casagrande method
- ☐ AS1289 3.1.2 Liquid Limit - One point Casagrande method
- ☑ AS1289 3.2.1 Plastic Limit - Standard method
- ☑ AS1289 3.3.1 Calculation of the Plasticity Index
- ☐ AS1289 3.4.1 Linear Shrinkage - Standard method

Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	Unknown
Preparation	Prepared in accordance with the test method	**Date Tested**	7/03/2023

Plasticity Chart for Classification of Fine-Grained Soils

AS 1726:2017 Clause 6.1.6 (Figure 5)



Preparation

Method of Preparation	**Dry Sieved**
History of the Sample	**Air Dried**

Results

Liquid Limit / LL (%)	**Unobtainable**
Plastic Limit (%)	**Unobtainable**
Plasticity Index / PI (%)	**Non-Plastic**

Notes

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Authorised Signatory:

Chris Lloyd

7/03/2023

Date:

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14 Carter St
Lidcombe NSW 2141

Appendix F
Particle Size Distribution Test Results

Particle Size Distribution Report

Client	PSM	**Source**	Sample 1 0.0-0.5m
Address	g3, 56 Delhi Rd, North Ryde, NSW, 2113	**Sample Description**	Clayey Gravelly SAND
Project	Broken Hill Hospital Upgrade (PSM4951	**Report No**	S83998-PSD
Job No	S23043-1	**Lab No**	S83998

Test Procedure AS 1289.3.6.1 - Particle size distribution of a soil

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** Unknown

Preparation Prepared in accordance with the test method **Date Tested** 7/03/2023

Sieve Aperture: (mm)	% Passing	Specification (..) Envelope	Sieve Aperture: (mm)	% Passing	Specification (..) Envelope
200	100		4.75	79	
75	100		2.36	69	
63	100		1.18	60	
37.5	100		0.600	52	
26.5	99		0.425	47	
19	97		0.300	43	
13.2	93		0.212	38	
9.5	90		0.150	33	
6.7	85		0.075	26	

Notes

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NATA Accredited Laboratory Number: 14874

Authorised Signatory: Date:

8/03/2023

Chris Lloyd

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14 Carter St
Lidcombe NSW 2141

Particle Size Distribution Report

Client	PSM	**Source**	Sample 2 0.0-0.5m
Address	g3, 56 Delhi Rd, North Ryde, NSW, 2113	**Sample Description**	Silty Sandy CLAY, trace of Gravel
Project	Broken Hill Hospital Upgrade (PSM4951	**Report No**	S83999-PSD
Job No	S23043-1	**Lab No**	S83999

Test Procedure AS 1289.3.6.1 - Particle size distribution of a soil

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** Unknown

Preparation Prepared in accordance with the test method **Date Tested** 7/03/2023

Sieve Aperture: (mm)	% Passing	Specification (..) Envelope	Sieve Aperture: (mm)	% Passing	Specification (..) Envelope
200	100		4.75	93	
75	100		2.36	88	
63	100		1.18	82	
37.5	100		0.600	76	
26.5	100		0.425	71	
19	99		0.300	66	
13.2	97		0.212	60	
9.5	96		0.150	54	
6.7	95		0.075	46	

Notes

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NATA Accredited Laboratory Number: 14874

Authorised Signatory: Date:

8/03/2023

Chris Lloyd

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14 Carter St
Lidcombe NSW 2141

Particle Size Distribution Report

Client	PSM	**Source**	Sample 3 (BH03) 0.20-0.80m
Address	g3, 56 Delhi Rd, North Ryde, NSW, 2113	**Sample Description**	Silty SAND with Gravel
Project	Broken Hill Hospital Upgrade (PSM4951	**Report No**	S84000-PSD
Job No	S23043-1	**Lab No**	S84000

Test Procedure AS 1289.3.6.1 - Particle size distribution of a soil

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** Unknown

Preparation Prepared in accordance with the test method **Date Tested** 7/03/2023

Sieve Aperture: (mm)	% Passing	Specification (..) Envelope	Sieve Aperture: (mm)	% Passing	Specification (..) Envelope
200	100		4.75	86	
75	100		2.36	77	
63	100		1.18	71	
37.5	100		0.600	65	
26.5	100		0.425	62	
19	99		0.300	57	
13.2	95		0.212	49	
9.5	91		0.150	42	
6.7	88		0.075	33	

Notes

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NATA Accredited Laboratory Number: 14874

Authorised Signatory: Date:

7/03/2023

Chris Lloyd

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Lidcombe NSW 2141

Appendix G
Salinity and Aggressivity Test Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2303962**	Page	: 1 of 3
Client	: **PELLS SULLIVAN MEYNINK T/A PSM Admin PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: HARLEY ZHENG	Contact	: Customer Services ES
Address	: G3, 56 DELHI ROAD NORTH RYDE NSW, AUSTRALIA 2113	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: PSM4951	Date Samples Received	: 08-Feb-2023 11:20
Order number	: ----	Date Analysis Commenced	: 08-Feb-2023
C-O-C number	: ----	Issue Date	: 13-Feb-2023 15:45
Sampler	: ----		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 3		
No. of samples analysed	: 3		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Dian Dao	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity ($H^+ + Al^{3+}$).

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	BH01	BH03	ED-B4	----	----
			Sampling date / time	02-Feb-2023 00:00	01-Feb-2023 00:00	04-Feb-2023 00:00	----	----
Compound	CAS Number	LOR	Unit	ES2303962-001	ES2303962-002	ES2303962-003	--------	--------
				Result	Result	Result	----	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	8.9	9.1	9.1	----	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	1190	434	137	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	11.9	8.8	7.5	----	----
EA080: Resistivity								
Resistivity at 25°C	----	1	ohm cm	840	2300	7300	----	----
ED006: Exchangeable Cations on Alkaline Soils								
Exchangeable Calcium	----	0.2	meq/100g	5.1	2.1	3.9	----	----
Exchangeable Magnesium	----	0.2	meq/100g	4.0	0.9	0.9	----	----
Exchangeable Potassium	----	0.2	meq/100g	1.0	0.2	0.2	----	----
Exchangeable Sodium	----	0.2	meq/100g	5.2	0.7	<0.2	----	----
Cation Exchange Capacity	----	0.2	meq/100g	15.2	4.0	5.0	----	----
Exchangeable Sodium Percent	----	0.2	%	34.3	17.6	<0.2	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	1080	330	60	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	1240	260	50	----	----