



REPORT

Geotechnical Site Investigation Report, St Leonards South

18-32 Holdsworth Avenue & 21-41 Canberra Avenue

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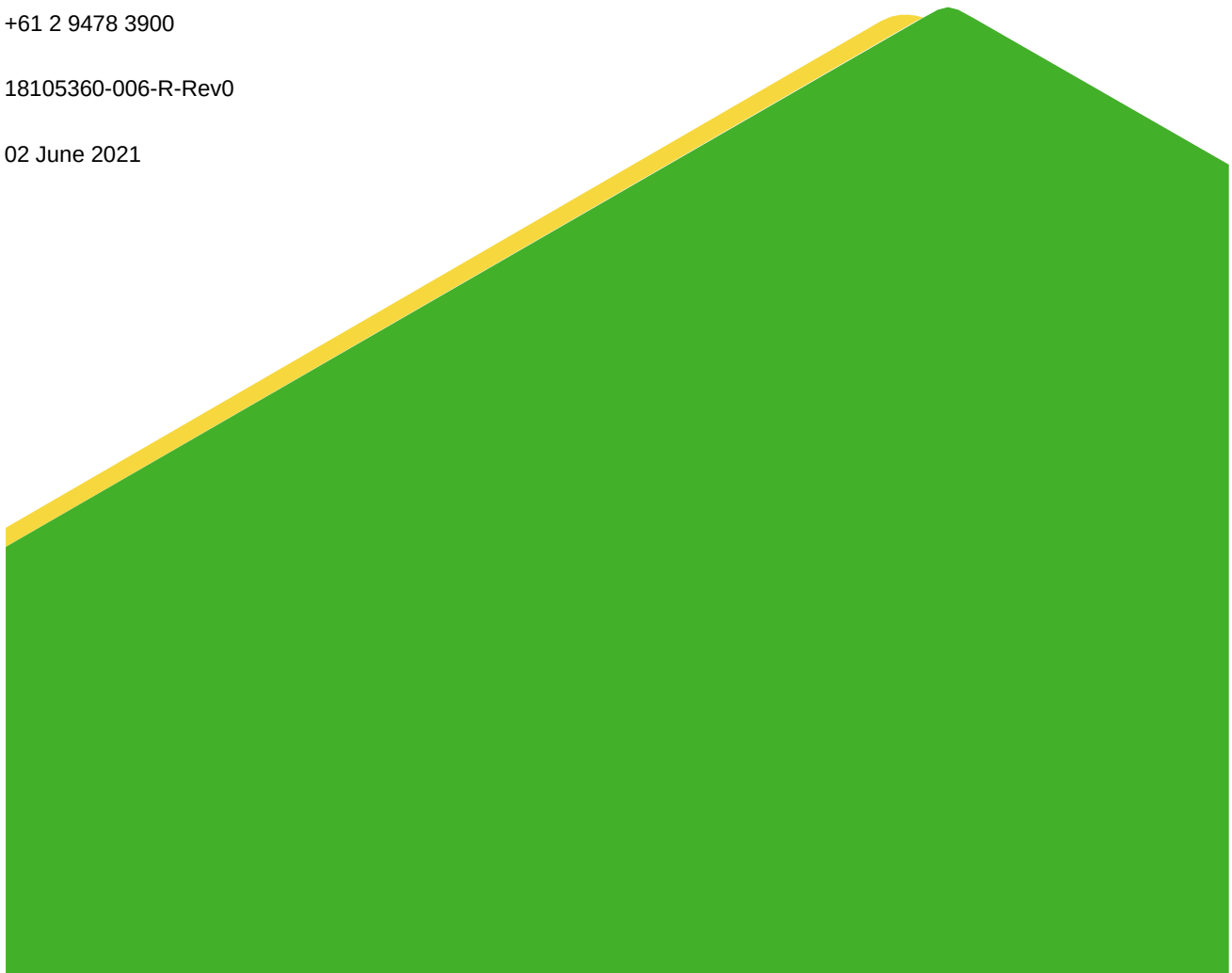


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1.0 INTRODUCTION

Top Spring Australia Property and Development Services (Top Spring) engaged Golder Associates Pty Ltd (Golder) to undertake geotechnical investigations at 18-32 Holdsworth Avenue and 21-41 Canberra Avenue, St Leonards NSW associated with the St Leonards South development site in 2018.

The development site is separated into stages:

- Stage 1: 26-32 Holdsworth Avenue and 27-41 Canberra Avenue which will include three residential towers with basement levels; and
- Stage 2: 18-24 Holdsworth Avenue and 21-25 Canberra Avenue which will include two residential towers with basement levels

Initially, two separate reports were issued according to the Stages listed above. However, this current revision consolidates the reports, such that the findings and recommendation for both Stages are included in this single report.

Prior to the Golder site investigations in 2017, a preliminary site investigation was carried out by Asset Geotechnical (Ref. 3792-R1-Rev1, dated 25 August 2016) for an alternative development across parts of the site. The previous investigations comprised drilling of two boreholes and three hand auger holes. The findings from the Asset Geotechnical investigations were provided to us by Top Spring and have been considered in development of this Golder report.

1.1 Project Understanding

Stage 1 forms the southern portion of the broader site, comprising 26-32 Holdsworth Avenue and 27-41 Canberra Avenue.

We understand the concept development across Stage 1 comprises three residential towers (namely Buildings 9, 10 and 11) reaching up to ten levels above ground and up to four basement levels, with assumed bulk excavation levels (BEL) ranging from RL 47.110 to RL 48.200, (approximated from the FFL levels shown in “Key Plans Level 01” prepared by Bates Smart, attached in Appendix A). As the site extends across a south-east dipping hillside, we estimate that the maximum excavation depths required are between 0 m and 2 m across the southern portions of Stage 1 increasing to about 14 m towards the north-west corner.

Stage 2 forms the northern portion of the St Leonards site, as shown in Appendix A.

We understand that the concept development for Stage 2 includes two multi-storey towers (namely Buildings 7 and 8) with up to ten levels above ground and two basement levels. These buildings have a bulk excavation levels (BEL) ranging between RL 53.000 and RL 56.700. As the site extends across a south-east dipping hillside, we estimate that the basement excavation depths may vary between about 17 m (towards the north-west corner of Stage 2) and 5 m (towards the south-east corner).

Table 1 summarises approximate excavation depths required to achieve the BEL for the proposed buildings across Stages 1 and 2. These depths were estimated using the architectural drawings prepared by Bates Smart and by assuming a 200 mm base slab below the FFL levels provided.

Table 1: Approximate excavation and fill depths to achieve BEL

Building	Maximum Bulk Excavation Level (RL)	Approximate Maximum Excavation Depths (m)
BDG07	53.000	8 m
BDG08	56.700	9 m
BDG09	48.200	12 m
BDG10	48.200	14 m
BDG11	47.110	¹ 11 m

¹Some minor fill may be required across the southern portions of Stage 1

The objectives of the site investigation were to:

- Assess the existing site surface features, terrain, surface drainage and vegetation;
- Assess the subsurface conditions at the site, including the description and classification of soil and rock encountered, depth to rock and depth to groundwater, if encountered;
- Provide high level geotechnical recommendations including:
 - Recommendations for foundation options of the proposed structure(s);
 - Recommendations for basement retention options;
 - Preliminary geotechnical parameters for design of footings and retention systems; and
 - Recommendations for possible ground performance during construction for traffic and excavation conditions.

Preliminary waste classification was also conducted to assist with the management of materials generated during the excavation works. This is reported in a separate Golder report (Report Ref: 18105360-007-R-Rev0).

2.0 SCOPE AND METHODOLOGY

The fieldwork for the investigation was carried out between the period from 17 August to 10 September 2018 and was undertaken in general accordance with the proposal scope, comprising the following:

- Dial Before You Dig (DBYD) review and service clearance by an accredited service locator at all borehole locations;
- Positioning of borehole locations relative to existing site features and record coordinates of the boreholes from a hand-held GPS unit;
- Hand auger drilling through existing fill with soil sampling as part of Waste Classification Testing;
- Drilling of nine boreholes (BH1 to BH9) to depths ranging between 12.06m and 13.63m below ground level (by means of auger drilling and NMLC rock coring). Given the difficult terrain across the site, the boreholes were drilled with a combination of a track-mounted drill rig and a hand-portable drill rig;
- Installation of three groundwater monitoring standpipes (BH2, BH4 and BH7);
- Field testing including Standard Penetrometer Testing (SPT), Dynamic Cone Penetration (DCP) Testing and Point Load Testing;
- Collection of soil and rock samples for geotechnical laboratory testing and soil samples for Waste Classification Testing; and
- Laboratory analysis of samples.

A site plan showing the location of borehole locations is presented in Appendix A. Factual data including Borehole Logs, explanatory notes and abbreviations is contained in Appendix B.

3.0 SITE DESCRIPTION AND GEOLOGY

The site is currently occupied by low density residential housing, which will be demolished to make way for the development. A site walk-over of the proposed area was undertaken by a Golder Geotechnical Engineer who observed the following:

- The current residential houses are located on a south-eastern sloping hillside, which continues to a valley floor, close to the eastern boundary of the site. The topography across the south-eastern sloping hillside has a change in elevation of approximately 20 m across Stage 1 and 10 – 15 m across Stage 2;
- There are steep driveways/staircases and exposed rock outcrops along Canberra Avenue;
- No ponding of water was observed, it should be noted that no rainfall occurred on or in the days prior to conducting the site walkover;
- There are a number of retaining walls and sandstone outcrops along Canberra Avenue, suggesting the likely presence of some past filling.

Photographs across the proposed Stage 1 site are shown below in Figure 1.



Figure 1: Stage 1 Site photographs (southern portions and 27 Holdsworth Avenue (right))

Photographs across Stage 2 are shown below in Figure 2.



Figure 2: Stage 2 Site photographs (various locations along Canberra Avenue)

3.1 Regional Geology

The 1:100,000 scale Sydney Geological Map (Sheet 9130) indicates that the proposed site is underlain by Hawkesbury Sandstone. Ashfield Shale may be present towards the northern reaches of the site.

The materials observed during the geotechnical investigation of St Leonards South are consistent with the information presented in the geological map. Further details are discussed in Section 4.1.

4.0 SITE INVESTIGATION RESULTS

Borehole locations were positioned with the aim to be relatively evenly distributed across the site. Five boreholes were drilled within the extents of Stage 1 and four boreholes were drilled in Stage 2. Additionally, the investigation locations carried out by Asset Geotechnical are shown in Appendix A.

One groundwater monitoring well was installed in borehole BH7 within Stage 1 and two groundwater monitoring wells were installed in boreholes BH2 and BH4 within Stage 2. Due to access constraints, the well in BH7 is located within the footprint of the proposed basement and is likely to be destroyed during construction.

The locations of all boreholes were recorded on site using a hand-held GPS (accurate to approximately +/- 5 m). The surface elevations of the test locations were estimated using the contoured survey plans provided to us. A summary of the borehole locations and approximated existing ground surface levels is presented in Table 2.

Table 2: Borehole location summary

Borehole ID	Stage	Easting (m)	Northing (m)	Surface RL (m AHD)	Monitoring Well Installed?
BH1	1	332764	6255503	50.5	No
BH2	2	332787	6255598	64.1	Yes
BH3	2	332792	6255642	67.4	No
BH4	2	332867	6255636	58.0	Yes
BH5	1	332865	6255587	55.9	No
BH6	1	332844	6255543	49.5	No
BH7	1	332806	6255490	47.6	Yes
BH8	2	332820	6255645	64.5	No
BH9	1	332812	6255580	60.6	No

Note:

- 1) Coordinates are relative to GDA94/ MGA zone 56.

The locations of the Asset Geotechnical boreholes shown in Appendix A are approximated from existing site features.

4.1 Description of Subsurface Conditions

The subsurface conditions encountered during the investigation are summarised in Table 3. During borehole drilling across Stage 1, auger refusal was noted at approx. depths between 0.6 m and 2.2 m, which may be indicative of variable fill and soil depths or variable conditions through the weathered rock profile. Similarly, auger refusal for the Stage 2 boreholes occurred at depths between 0.4 m and 2.2 m.

Based on the BELs presented above, the deepest basement levels across the site are anticipated to be founded within:

- BDG7 – Medium to high strength sandstone;
- BDG8 – Medium to high strength sandstone;
- BDG9 - Residual soil to low strength sandstone towards the south-eastern portions and medium to high strength sandstone elsewhere;
- BDG10 – Medium to high strength sandstone;
- BDG11 - Fill and residual soils plus low/medium strength sandstone towards the southern and south-eastern portions and medium to high strength sandstone elsewhere.

Due to the transition between residual soil and weathered sandstone being gradational, it is anticipated that the sandstone rock head level across the site is variable. The upper profile of the competent sandstone (i.e. medium strength and better) is likely to be stepped, with an overall grade similar to the hillside terrain.

Indicative geological sections showing proposed basement levels across the site and the approximate extent of the excavation are included in Appendix A. Detailed descriptions of the subsurface conditions are presented in the borehole logs in Appendix B.

Table 3: Summary of subsurface conditions at borehole locations

Unit	General Description	Typical Depth Encountered (m)	Typical Thickness (m)
Concrete/Brick	With fine to coarse dark grey gravels	0	0 to 0.2
¹Fill	Mixed soils comprising sands, clays and silts, typically fine to coarse grained sand and gravel, medium plasticity clays and some sandstone cobbles.	0.1 to 0.2, but up to 0.5 where topsoil present	0 to 0.5, but up to 1m in BH5
Residual Soil	Sandy clay (/clayey sand) and clay, typically medium to high plasticity of very stiff to hard consistency. Sands are generally fine to medium grained.	0.2 to 0.5, but up to 0.8 in BH2	0 to 1.1
Weathered Sandstone	Extremely low to low strength sandstone, red to orange brown, with some clay seams typically up to 100 mm thick. A clay layer 0.9 m thick was observed in BH2.	0.4 to 2.2	0.4 to 2.0, but up to 5m in BH3
Competent Sandstone	Medium to high strength sandstone, pale grey, fine to coarse grained, generally with siltstone laminations and occasional extremely low	1.3 to 4.3, but up to 6.1m in BH3	To end of borehole

Unit	General Description	Typical Depth Encountered (m)	Typical Thickness (m)
	strength zones to 300 mm thick. BH5 encountered a 2 m thick zone of medium strength siltstone with interbeds of fine grained sandstone.		

¹Topsoils (0.2 to 0.5m thick) are generally present where ground surface is not paved.

4.2 Groundwater Observations

Groundwater monitoring wells were installed in three boreholes (BH2, BH4 & BH7), with screens installed between depths of 3.00m and 8.65m, all positioned within the sandstone. A Golder geotechnical engineer conducted groundwater monitoring of the three standpipes on 3 September 2018 with the findings summarised in Table 4 below. Table 4 also includes a groundwater level from a standpipe that was installed by Asset Geotechnical (i.e. BH1), although it is unclear if this well was developed prior to recording the groundwater level.

Table 4: Summary of groundwater monitoring results (3 September 2018)*

Borehole	Screen Range (mAHD)	Material	Depth to Groundwater (mbgl)	RL of Groundwater (m AHD)
BH2	59.95 to 56.95	Weathered and Competent Sandstone	3.2	60.9
BH4	51.65 to 48.65	Competent Sandstone	5.2	52.8
BH7	44.60 to 41.60	Competent Sandstone	1.7	45.9
¹ BH1	40.9 to 37.9	Competent Sandstone	0.5	45.3

¹ BH1 from the Asset Geotechnical report

Heavy rainfall occurred during the day when the groundwater levels were monitored in the Golder boreholes, which may have resulted in a temporary rise in the groundwater level.

4.3 Field and Laboratory Testing Results

4.3.1 Rock Strength Testing

Point load testing was carried out at approximately 1 m depth intervals within the recovered rock core with axial and diametrical $IS_{(50)}$ values ranging between 0.2 MPa to 2.1 MPa and 0.1 MPa to 2.4 MPa respectively. Unconfined Compressive Testing (UCS) was carried out on selected test specimens with the results presented in Table 5. The full results of the Point Load and UCS testing are provided in Appendix C.

Assuming that $UCS = 17 \times IS_{(50)}$, the average interpreted UCS strength of the competent sandstone, based on point load testing, is 22.8 MPa.

Table 5: Summary of rock testing results

BH ID	Sample Depth (mbgl)	Sample RL (m AHD)	Borehole Sample Description	UCS Result (MPa)
BH1	2.77 to 2.96	47.73 to 47.54	High strength sandstone	27
BH3	3.76 to 3.97	63.64 to 63.43	Low strength sandstone	4.2
BH5	10.51 to 10.77	45.39 to 45.13	Medium strength siltstone	9.3
BH6	1.73 to 2.00	47.77 to 47.50	Medium strength sandstone	15
BH9	9.10 to 9.29	51.50 to 51.31	Medium strength sandstone	17

4.3.2 Soil and Groundwater Quality Testing

Samples of residual soil and groundwater were sent to a NATA accredited laboratory to test their potential aggressive nature to buried steel and concrete elements. The results of the tests are summarised in Table 6 and laboratory test certificates provided in Appendix B.

Table 6: Soil and groundwater durability test results

Borehole	Type	Sample depth (m)	pH	Sulphate (ppm)	Chloride (ppm)	Electrical Conductivity (µS/cm)
BH4	Groundwater	N/A	6.3	38	171	751
BH7	Groundwater	N/A	6.1	30	280	996
BH2	Residual Soil	1.9 to 2.0	4.9	16.5	4.0	-
BH6	Residual Soil	0.85 to 1.3	4.7	22.2	4.0	-

5.0 DISCUSSIONS AND RECOMMENDATIONS

The proposed development across Stage 1 comprises three above ground buildings of up to ten storeys with up to four basement levels. Stage 2 consists of two buildings of up to ten storeys and featuring two basement levels. The development footprint is bordered by existing residential houses or neighbourhood streets, with buried and overhead services present in places.

Based on the proposed development and the expected ground conditions across the site, the primary geotechnical considerations for this preliminary stage of the project include:

- Type of foundations to support the proposed multi-storey and associated low level buildings/structures;
- Types and extent of permanent retention to support the proposed basement excavations;
- Long-term groundwater management;
- Site subgrade conditions for at-grade structures and pavements;
- Temporary works to allow the development to be constructed, including temporary retention, site ground conditions during construction, construction vibration effects, groundwater inflow management during construction.

The following sections of the report address each of these identified geotechnical considerations for the project and provide geotechnical advice and parameters to allow the concept design to be developed.

5.1 Geotechnical Design Parameters

Preliminary geotechnical parameters have been developed, suitable for a concept design development, based on the assessment of available field and laboratory test data from both the historical and the 2018 Golder investigations. Where limited data was available, design parameters have been developed based on local experience with similar material.

The preliminary geotechnical parameters are provided in Table 7. For the purposes of this report, no parameters are provided for the fill subsurface unit, as it is expected that it will be removed during construction and removed from site or stockpiled for later use in non-sensitive movement areas across the site.

Table 7: Preliminary geotechnical parameters for concept design

Unit	Bulk Density (kN/m ³)	Effective cohesion, c' (kPa)	Effective Friction Angle, ϕ' (°)	Undrained shear strength, s_u (kPa)	Drained Young's Modulus, E' (MPa)	Poisson Ratio, ν
Residual Soil	20	5	28	100	40	0.3
Weathered Sandstone	22	50	35	N/A	300	0.25
Competent Sandstone	24	100	42	N/A	1,500	0.2

Note: Young's Modulus values presented here for soil are considered appropriate for the purposes of carrying out analysis of shallow footings and retaining structures for drained loading (long term conditions). Alternative stiffness values or non-linear models may be required for alternative cases or where smaller strain levels prevail, such as for assessment of pile settlements, dynamic response or ground deformations adjacent to an excavation.

The modulus values shown for rock are for the rock mass

The soil parameters shown in Table 7 were developed based on the results of field and laboratory testing, our experiences with similar materials and established published correlations.

The shear strength parameters for rock shown in Table 7 were assessed using RocLab¹, in which equivalent rock mass Mohr-Coulomb parameters (i.e. c' and Φ') have been assessed using the Hoek-Brown failure criterion. This method provides guidance for equivalent shear strength parameters for the entire rock mass, with consideration to the strength of the intact rock and the impact of defects of the rock mass. Therefore, it does not consider the potential for isolated rock block fallout due to failure along specific defect planes. Treatment of rock faces through competent rock mass which have the potential for rock block fallout should be considered separately with the use of kinematic analysis.

5.2 Bulk Excavation

Bulk excavations are required for the proposed basement levels across the St Leonards South site. Due to the south-eastern dipping hillside across which the development is proposed, bulk excavation for Stage 1 is expected to extend to about 14 m depth at the north-western corner of the site and be close to at-grade or on small fill at the south-eastern corner of the site. For Stage 2, this is expected to vary between 9 m depth at the north-western corner and 8 m at the south-eastern corner of the site.

Prior to commencing any excavation works on the site, we recommend a dilapidation survey be carried out of adjacent buildings and infrastructures, such as houses, pavements and services. This assessment process would include documenting any existing damage or defects present.

5.2.1 Excavation Conditions

The proposed bulk excavation across the site will likely encounter fill, residual soil and weathered sandstone of very low to low strength through the upper 2 m to 5 m depth. The weathered sandstone may contain zones of higher strength ironstone. Beneath this, medium to high strength sandstone is likely to be encountered.

Excavation of the competent sandstone was assessed using the graphical method proposed by Pettifer and Fookes (1994). The method utilises an empirical chart which correlates point load index strength and average defect spacing to an excavation condition. Based on the point load index test results, inferred logged strengths and logged average defect spacings, the approximate excavation resistances were estimated as shown in Figure 3.

To facilitate excavation of the fill, residual clays and weathered sandstone (extremely low to low strength rock), a conventional hydraulic excavator with a bucket is likely to be suitable. Excavation of competent sandstone (medium or high strength sandstone) or ironstone bands will likely require dozers with rippers for bulk excavation, and rock hammering, grinders and rock sawing for detailed trimming and to reduce vibrations and over-break.

Note that during the site investigation, sandstone with widely spaced joints was encountered, so ripping alone may be uneconomical in which case large hydraulic breakers may be required instead of or in conjunction with ripping.

Prior to excavation works, we recommend the borehole logs, photographs, rock core samples and findings detailed in this report to be reviewed by excavation contractors to ensure they are fully aware of the subsurface conditions and excavation conditions likely to be encountered.

¹ Rocscience Inc, Rock mass strength analysis using the Hoek-Brown failure criterion, Version 1.033, 2007

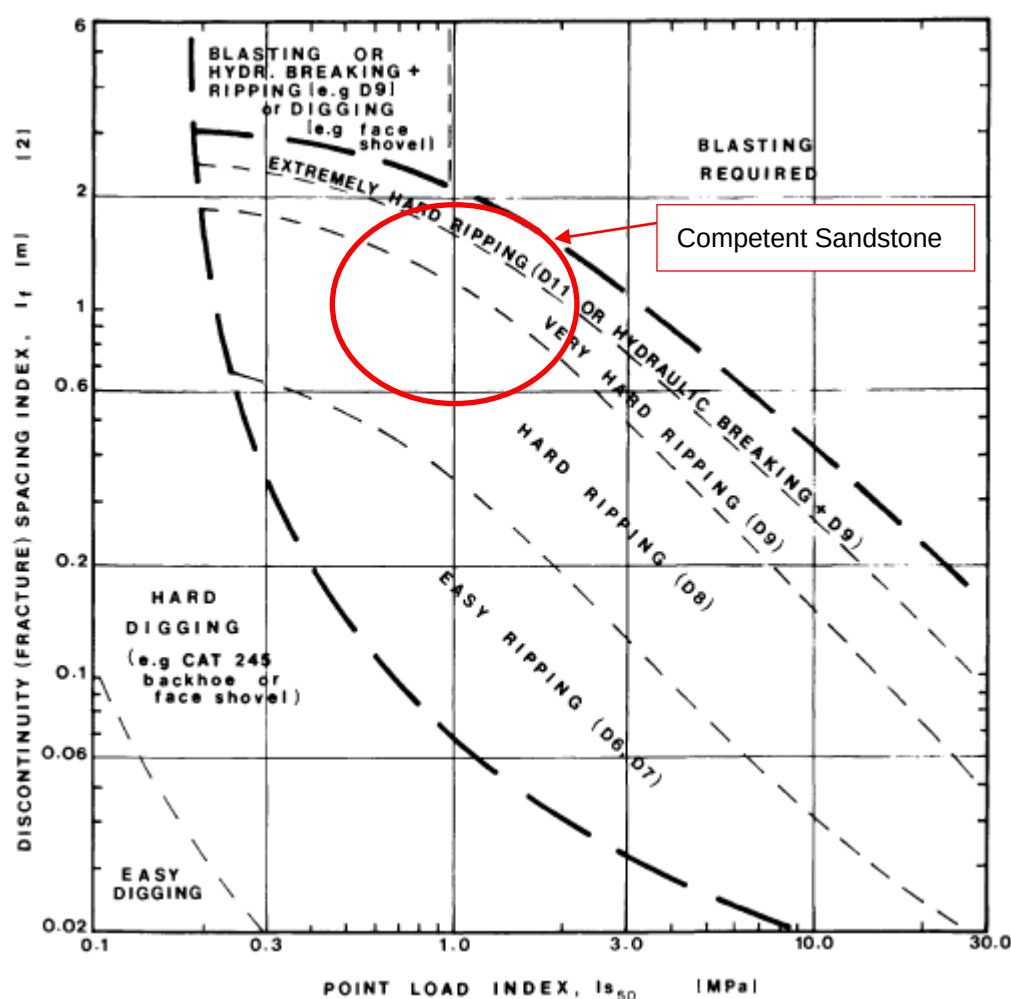


Figure 3: Estimated excavatability (based on Graphical Method proposed by Pettifer and Fookes (1994))

5.2.2 Excavation Support

5.2.2.1 Unsupported Cuts

Table 8 presents recommended cut batters for unsupported slopes. Based on our understanding of the site, we anticipate that open cuts will not be able to be used for the main bulk excavation, but they may be used for shallower permanent or temporary slopes, including service installation and initial excavation works.

Table 8: Cut batter recommendations

Unit	Temporary Cuts	Permanent Cuts
Fill	2H:1V	2.5H:1V
Residual Soil	1.5H:1V	2H:1V
Weathered Sandstone	1H:1V	1.5H:1V

Notes:

- Excavations in soil are above the groundwater table;
- The ground surface at the crest of the excavation is horizontal;
- No surcharge loads are applied within a distance equal to the depth of the excavation from the crest of the excavation;

- All cuts are protected from erosion.

Large rainfall events may affect the stability of excavations and cause softening of soil slopes. Appropriate drains should be installed to divert water from the face of batters.

Dependant on the angle of the design cut batter slope, various slope treatments may be required to support the batters. Selection of slope treatments and batter support should be assessed following confirmation of the design of the cut slopes, however may include erosion protection and/or bolting and shotcrete facing. Steeper slopes than those recommended in Table 8 may be achievable with the use of additional batter support.

5.2.2.2 Retaining Structures

An anchored (tie-back) bored soldier pile wall with shotcrete panels is likely to be an appropriate vertical retention system for the residual soil and weathered sandstone, assuming that a drained basement is selected. Typically soldier piles are spaced at three to four pile diameters, although this spacing can be adjusted to produce a retention system with a stiffer response if movement sensitive structures or services are located close to the proposed excavation.

Strip drains can be placed behind shotcrete panels. Excavation should proceed in stages, to a maximum 2 m height when in soil and extremely low to low strength rock or 3 m in medium strength or better rock. The ground conditions between piles should be inspected by an experienced geotechnical engineer or engineering geologist prior to installation of drainage or application of shotcrete, to confirm that the design assumptions are achieved.

We recommend that the piles are terminated a minimum of 1 m into the medium or high strength sandstone for a drained basement option. Where feasible, the permanent design case would allow for the internal floor props to resist the horizontal earth pressures that were temporarily resisted by the anchors. If the internal slabs are unable to permanently prop the walls (i.e. due to the site levels), anchors will need to be designed to be permanent.

Alternatively, if site access constraints allow, it may be feasible to use conventional L-Shaped or gravity retention systems to support the relatively shallow soil and weather sandstone profile in places. This approach would need to carefully consider the ground profile depth at any particular location relative to the geometric constraints required to construct these types of wall.

It is anticipated that medium to high strength sandstone may be left unsupported with spot rock bolting (or anchors for larger wedges) in areas with potential wedge failures. Using this methodology it would be necessary for a geotechnical engineer/ engineering geologist to carry out face mapping of the basement during excavation to identify potential rock wedges that could slip into the excavation. An allowance should be made for rock bolting or anchoring of these potential rock wedges. Additionally, zones of siltstone within the competent sandstone profile will need to be protected to prevent them from deteriorating when exposed to wetting and drying cycles. An allowance should be made for shotcrete surfacing across zones of siltstone.

We recommend that the contents of this report (including borehole logs and lab testing results) be provided to piling contractors to allow them to make an assessment of appropriate equipment for the project.

Design of shoring should include allowance for loading applied at the top of the excavation (e.g. construction plant, traffic, sloped ground, existing structure foundations).

Hydrostatic water pressure must also be considered in retaining wall designs except for when an effective drainage system is installed behind the retaining structure. Drainage could include strip drains behind the shotcrete panels, with the bases of drains extending out from the base of the shoring wall to allow discharge into a perimeter toe drain. Design may need to consider appropriate ultimate limit state conditions. For instance, if a water main bursts close to a retention system, the strip drain drainage system may not have

sufficient discharge capacity to prevent water levels on the wall rising. In such a case, a raised hydrostatic design case may be appropriate.

Table 9 presents suggested preliminary design parameters for initial design of retaining structures.

Table 9: Preliminary design parameters for retaining structures

Unit	Unit Weight (kN/m ³)	Earth Pressure Coefficients			² Ultimate Passive Resistance (kPa)
		K _a 'Active'	¹ K ₀ 'At Rest'	K _p Passive	
Residual Clay	20	0.3	1.2	2.8	N/A
Weathered Sandstone	22	0.2	1.2	5	600 kPa
Competent Sandstone	24	N/A	N/A	N/A	2000 kPa

Notes:

1) K₀ values are appropriate for rigid wall design; lower values may apply on consideration of wall movements and development of partial or full active pressures. To use K_a values, design tools should be used that allow for modelling of staged excavation processes and stress relaxation of the ground, including the use unloading modulus values for the rock.

2) Value used in design needs to consider an appropriate factor of safety to limit wall movement during excavation staging.

5.2.2.3 Ground Anchors

The advice provided in this section is suitable for rock anchors with bond lengths between 3 m and 10 m, designed based on AS5100.3 and AS4678. Permanent pre-stressed ground anchors may be installed inclined below the horizontal to provide lateral restraint of the retaining structure and retained ground. The full extent of the anchor bond lengths should be within the rock mass and "behind" a 45° line from the base of the soldier pile to the ground surface behind the excavated face.

Care should be taken to avoid adversely impacting adjacent structures, buried services or other receptors during installation. Permission will be required from adjacent property owners where anchors are to be installed across the property boundary.

The greater of one or 1% of installed anchors should be subjected to a suitability test. Other anchors should be subjected to an acceptance load test in accordance with Appendix A of AS5100.3.

A geotechnical engineer should observe the installation, grouting and proof loading for anchors to confirm that the encountered conditions are consistent with design expectations. It should be noted that achieved bond stresses are heavily dependent on the method of installation and chosen anchor contractor.

Table 10: Suggested bond stresses for preliminary anchor design

Unit	Ultimate Bond Stresses (kPa)
Residual soil	N/A
Weathered Sandstone	300
Competent Sandstone	1,600

5.2.2.4 *Ground Movement Due to Stress Relief*

Based on experience of basement excavations in the Sydney region, deep excavations in sandstone can experience horizontal movements due to rock stress relief effects. Typically, the removal of material within the excavation will cause horizontal movements along the weak planes within the rock, such as bedding planes or joints.

Based on previous experience of similar excavations, movements in the order of 1 mm per metre depth of rock excavation can occur. These movements would need to be assessed to understand their impacts on the retention system and their contribution to ground movement around the excavation.

We expect that lateral displacements due to stress relief may be reduced from those levels indicated below due to the hillside relief that may have already occurred. However, the extent of this reduction would need to be considered carefully during subsequent stages of design.

5.2.3 *Groundwater Conditions*

Based on the groundwater monitoring results, the bulk excavation level for the site could be up to approximately 12m below the groundwater level, based on the assumption of a 2 m groundwater depth.

Groundwater level measurements suggest groundwater flows primarily from the north west to the valley floor, which is located along the eastern boundary of the site. Groundwater monitoring carried out in close proximity to the south-eastern boundary indicates a relatively high level, expected to be about 0.5 m to 1 m below existing ground surface levels.

Based on observations during drilling of the boreholes, it's possible groundwater seepages may eventuate on excavation surfaces, whilst steeply dipping joints exist within the excavation footprint may also draw groundwater into the excavation. On this basis, groundwater seepage and possible discrete inflows along defects within the sandstone rock mass should be expected during excavation.

It is anticipated that groundwater seepages and inflows may be controlled using drains around the excavation perimeter connected to a sump. The quantity of groundwater is likely to depend on the nature and connectivity of the discontinuities and the amount of available water in the discontinuity network.

The groundwater level discussed above is based on one site visit during September 2018 and therefore does not take into account seasonal variations. Additional monitoring of groundwater levels in the existing wells at the site could be completed to assess to better appreciate groundwater levels at the site, in particular the amount of variation in response to rainfall and climatic influences.

The excavation of the building basements will likely draw down the groundwater level in the area surrounding the basement excavations. The impact of this drawdown on adjacent buildings/buried structures will need to be addressed during subsequent stages of design development.

It is recommended that rising or falling head permeability testing is carried out within the sandstone to gain an understanding for site water management requirements, including likely groundwater inflows and sump and pump sizing.

In view of the ground conditions, drained basements may be a viable option for this development. This would require permanent subfloor drainage to be provided with appropriate pumping capacity to remove water from the building basement in the long-term, although some ongoing maintenance may be required should groundwater quality be problematic. Should results of the rising or falling head permeability tests suggest groundwater inflows to the planned basement be significant, then a pump test may also be required to allow further assessment of the possible long-term drainage and pumping requirements.

It should be noted that the groundwater inflow into the basement during the excavation and the lifetime of the structure will need to be disposed of. Groundwater may need treatment prior to disposal into the stormwater system and will require council approval. Further investigation into likely groundwater inflows and volumes should be carried out and will likely take the form of additional field and laboratory testing.

5.3 Foundation Options

We anticipate that foundations for the buildings across both Stage 1 and 2 will predominantly comprise pad footings founded on the competent sandstone. However, due to the variable levels across the site some footings may have to be deepened or short piles used to found within the competent sandstone towards the southern and south-eastern margins of Stage 1. Ancillary structures may be able to be founded on the residual soil or weathered sandstone. Shallow spread footings used to support any particular building should be founded within a similar soil or rock unit.

For high level spread footings, there may be cases where defects, nearby excavations or slopes may control their behaviour. Therefore, it may be necessary to locally modify design parameters or otherwise limit permissible loading of the spread footings in such cases.

All footings and piles should be inspected by a geotechnical engineer or engineering geologist prior to pouring concrete or installing steel reinforcement.

Preliminary design parameters for foundation design are presented in Table 11.

Table 11: Preliminary allowable foundation design parameters

Unit	Allowable End Bearing Pressure (kPa) ⁽¹⁾	Ultimate End Bearing Pressure (MPa)	Ultimate Shaft Adhesion (kPa) ⁽²⁾
Residual Soil	150	N/A	60
Weathered Sandstone	1,000	3	250
Competent Sandstone	8,000	60	1,500

Notes:

1) Assumes the footing is embedded at least 0.5 m into the founding material. Anticipated settlement at the allowable end bearing pressure are expected to be in the order of <1% of minimum footing dimension.

2) Socket assumed to be clean with roughly category R2 or better. The socket should be cleaned and roughened by suitable tools orientated perpendicular to the pile shaft. The majority of the load will be carried by end bearing for shorter sockets.

5.3.1 Site Classification

Selection of high-level, shallow spread footings will need to consider the risk of adverse movements due to the ground conditions, both within and between proposed structures. The Australian Standard AS2870-2011: Residential Slabs and Footings (2011) provides guidance for site classification to assist designers with high-level footing design.

Given the presence of uncontrolled fill across much of the site, it should be classified as 'Class P', unless all footings are founded beneath the fill on the natural residual soil.

No laboratory soil classification tests have been carried out on the residual soils, but given their occasional clayey nature, a preliminary classification of 'Class S' could be considered. Lightly loaded structures supported on shallow footings on this Class S site could expect characteristic soil movements (y_s) in the order of 0 to 20 mm.

However, the level of site reactivity experienced by structures will be dependent on the prevailing weather conditions at the time of construction. For example, if construction occurs during drought, the structures may experience the full range of swell following prolonged periods of rainfall. Careful consideration should also be given to site drainage, and the proximity of trees and shrubs in the vicinity of the shallow footings. No allowance for trees or shrubs has been included in the y_s value provided above.

5.3.2 Concrete Durability

The chemical test results presented in Section 4.3.2 were compared to the exposure classifications used for concrete and steel piles presented in table 6.4.2(c) and Table 6.5.2(c) of AS 2159-2009, "Piling – Design and Installation". The resulting exposure classifications are presented in Table 12 and Table 13.

In general, exposure classifications for the residual soils, which are expected to be above groundwater are mildly aggressive to concrete and non-aggressive to steel. Below the groundwater table, the soils have an exposure classification of mild for both concrete and steel piles.

The mild exposure classification for concrete piles is based on acidic pH values.

Table 12: AS2159 (2009) Exposure classification for concrete piles

Exposure Conditions				Exposure Classification	
Sulphates (Expressed as SO ₄)		pH	Chlorides in Groundwater (ppm)	Soil Conditions A ⁽¹⁾	Soil Conditions B ⁽²⁾
In Soil (ppm)	In Groundwater (ppm)				
<5 000	<1 000	>5.5	<6 000	Mild	Non-aggressive
5 000-10 000	1 000-3 000	4.5-5.5	6 000-12 000	Moderate	Mild
10 000-20 000	3 000-10 000	4-4.5	12 000-30 000	Severe	Moderate
>20 000	>10 000	<4	>30 000	Very severe	Severe

Notes: ⁽¹⁾Soil conditions A - high permeability soils (e.g. sands and gravels) which are in groundwater.

⁽²⁾Soil conditions B - low permeability soils (e.g. silts and clays) or all soils above groundwater.

Table 13: AS2159 (2009) Exposure classification for steel piles

Exposure Conditions				Exposure Classification	
pH	Chlorides (Cl)		Resistivity (ohm.cm)	Soil Conditions A ⁽¹⁾	Soil Conditions B ⁽²⁾
	In Soil (ppm)	In Groundwater (ppm)			
>5	<5 000	<1 000	>5 000	Non-aggressive	Non-aggressive
4-5	5 000-20 000	1 000-10 000	2 000-5 000	Mild	Non-aggressive

Exposure Conditions				Exposure Classification	
3-4	20 000-50 000	10 000-20 000	1 000-2 000	Moderate	Mild
<3	>50 000	>20 000	<1 000	Severe	Moderate

Notes: ⁽¹⁾Soil conditions A - high permeability soils (e.g. sands and gravels) which are in groundwater.

⁽²⁾Soil conditions B - low permeability soils (e.g. silts and clays) or all soils above groundwater.

5.3.3 Earthquake Site Soil Sub-Class

The methods of assessing the earthquake risk classification are outlined in the Australian Standard AS1170.4 (2007) *Structural Design Actions, Part 4: Earthquake Actions in Australia*. The standard uses a number of factors in assessing an earthquake design category for a particular structure at a given site.

The hazard factor (z) depends on the geographic location of the proposed structure. For the St Leonards site, AS1170.4 indicates a hazard factor of 0.08.

The governing condition for the site subsoil class is the thickness and consistency of the subsurface materials beneath the building footings. Based on observed ground conditions and regional geologic conditions, we recommend that a site Subsoil Class of 'B_e Rock' is appropriate for the site, in accordance with Section 4.2 of AS1170.4 (2007).

5.4 Site Trafficability and Working Platforms

It may be necessary to construct temporary access roads and crane and piling rig working platforms to meet bearing capacity requirements and to prevent degradation of exposed subgrade soils. Recycled crushed concrete or ripped sandstone fill may be possible sources of fill for temporary access road construction. Preventing deterioration of exposed natural subgrade surfaces will be particularly important on the south-eastern side of the site where the existing ground level is close to the proposed basement level.

A geotechnical bearing capacity assessment of the subgrade materials should be undertaken prior to large plant trafficking the site.

5.5 Vibration

The excavation works are likely to be associated with noise and vibration which may impact sensitive receptors in the area such as adjacent structures, utilities and land owners. Excessive vibration may also inflict damage upon nearby structures.

The amount of acceptable vibration will be dependent on several aspects such as the type of building structure, current structure condition and vibrating frequencies of the excavating plant and natural frequencies of the affected structures. Table J4.4.2.1 of Australian Standard AS 2187.2 – 2006 (Blasting Standard) provides guidance on maximum Peak Particle Velocities (PPV) for the prevention of cosmetic damage to structures, which is summarised below:

- Reinforced or framed structure – Industrial and heavy commercial buildings
 - 50 mm/s at 4 Hz and above.
- Unreinforced or light framed structure – Residential or light commercial type buildings
 - 15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz;
 - 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above.

Risks associated with excessive vibration can be managed and assessed by completing the following:

- Identify vibration sensitive structures and assess the proximity to the excavation works;
- Carry out condition surveys on existing structures prior to commencing the excavation and following the completion of excavations;
- Prepare a vibration management plan with recommended limits on PPV;
- Install monitoring instruments and systems to assess vibrations associated with excavation works.

In addition to considering potential damage to existing site structures and services, the potential impact on nearby residents or workers should be considered. Even relatively low vibration levels can cause annoyance to the occupants of a nearby property. In view of this, the above values may need to be reduced if there are occupied buildings close to the proposed excavation area.

A site based trial of vibration from construction equipment could be completed to assess levels of vibration at various offsets using different types of equipment.

The DBYD information and on-site utility survey during the investigation show the presence of utilities within the site as well as surrounding the area. Utility providers of those nearby should be contacted for utility specific vibration and deformation requirements.

6.0 IMPORTANT INFORMATION

Your attention is drawn to the document titled - “Important Information Relating to this Report”, which is included in Appendix E of this report. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder Associates has under the contract between it and its client.

Signature Page

Golder Associates Pty Ltd



Callum Fisher
Geotechnical Engineer



Bernie Francis
Principal Geotechnical Engineer

CF/BF/cl

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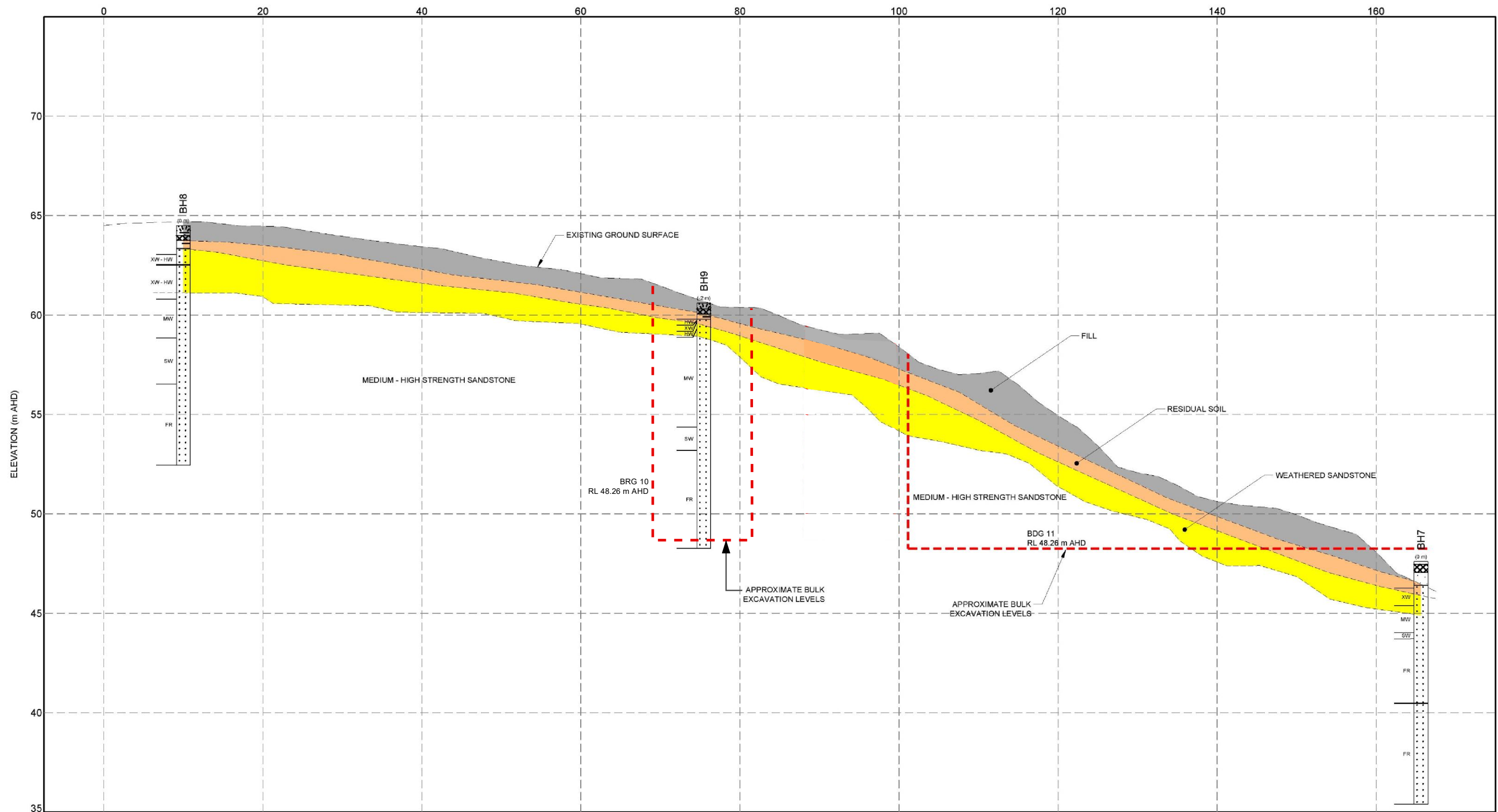
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APPENDIX A

Site Plan and Sections

18105360	CONTROL	REV.	FIGURE
18105360	006-R	A	F0003

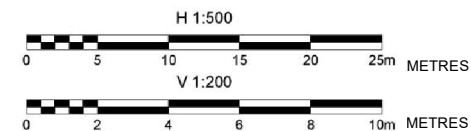
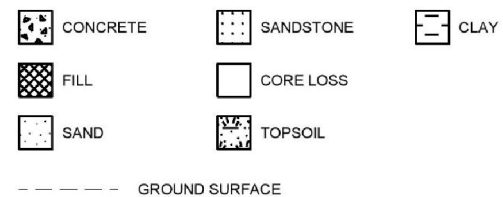
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POST LEGEND



MATERIAL GRAPHIC



CLIENT
SILVER POND INVESTMENTS PTY LTD ATF SILVER POND
UNIT TRUST
CONSULTANT



DD-MM-YYYY	04/06/2021
DESIGNED	SL
PREPARED	JC / RP
REVIEWED	CF
APPROVED	CF

NOTE(S)
1. COORDINATE SYSTEM: MGA94 ZONE 56
2. HEIGHT DATUM: AHD

PROJECT
ST LEONARDS DEVELOPMENT

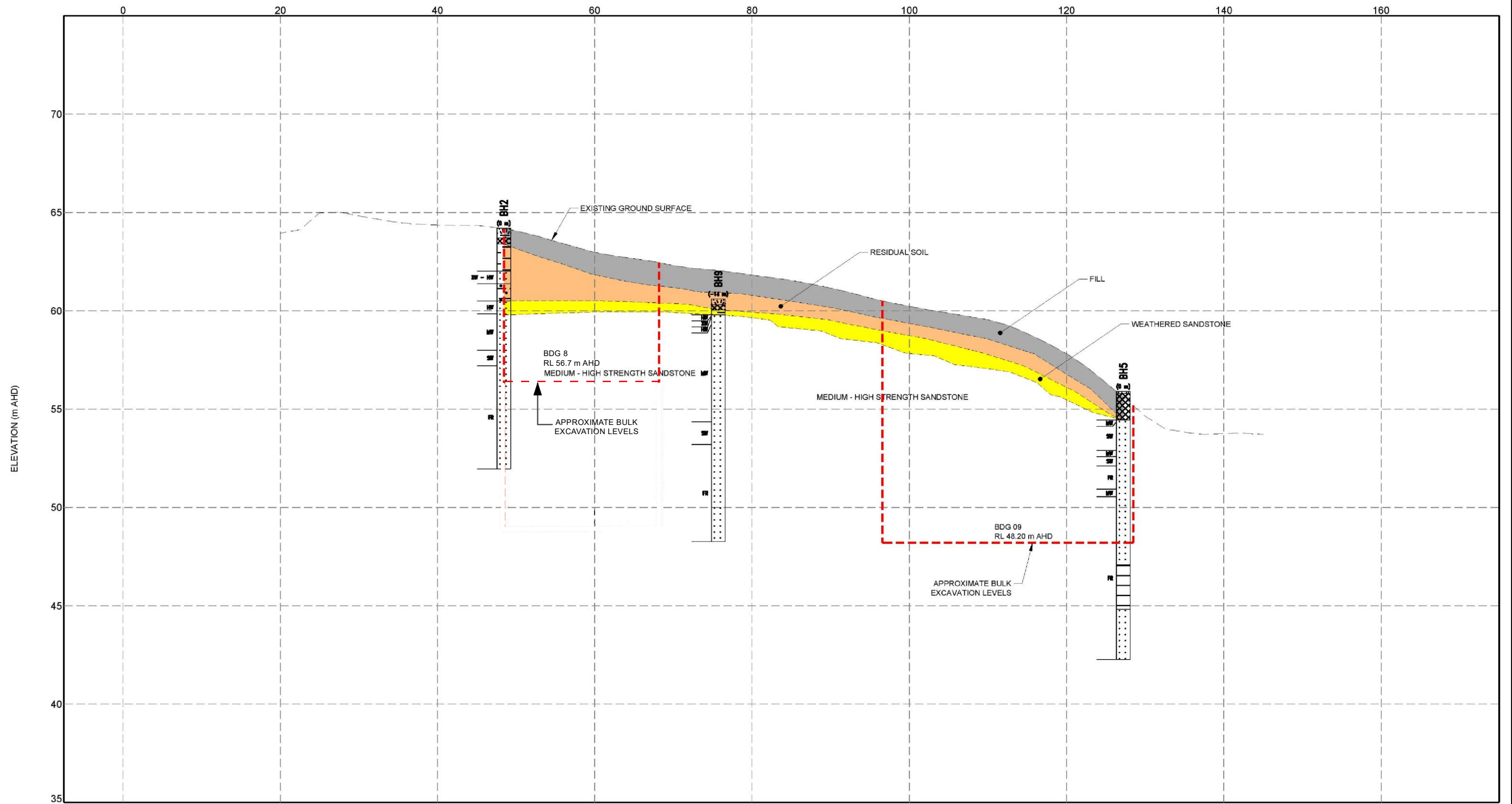
TITLE
SUBSURFACE SECTION - A-A'
STAGE 1 AND 2

PROJECT NO.	CONTROL	REV.	FIGURE
18105360	006-R	A	0004

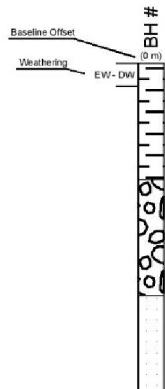
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25mm

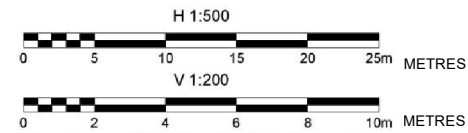
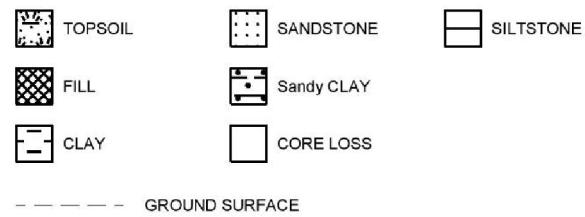
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POST LEGEND



MATERIAL GRAPHIC



CLIENT
SILVER POND INVESTMENTS PTY LTD ATF SILVER POND
UNIT TRUST
CONSULTANT



DD-MM-YYYY 04/06/2021
DESIGNED SL
PREPARED JC / RP
REVIEWED CF
APPROVED CF

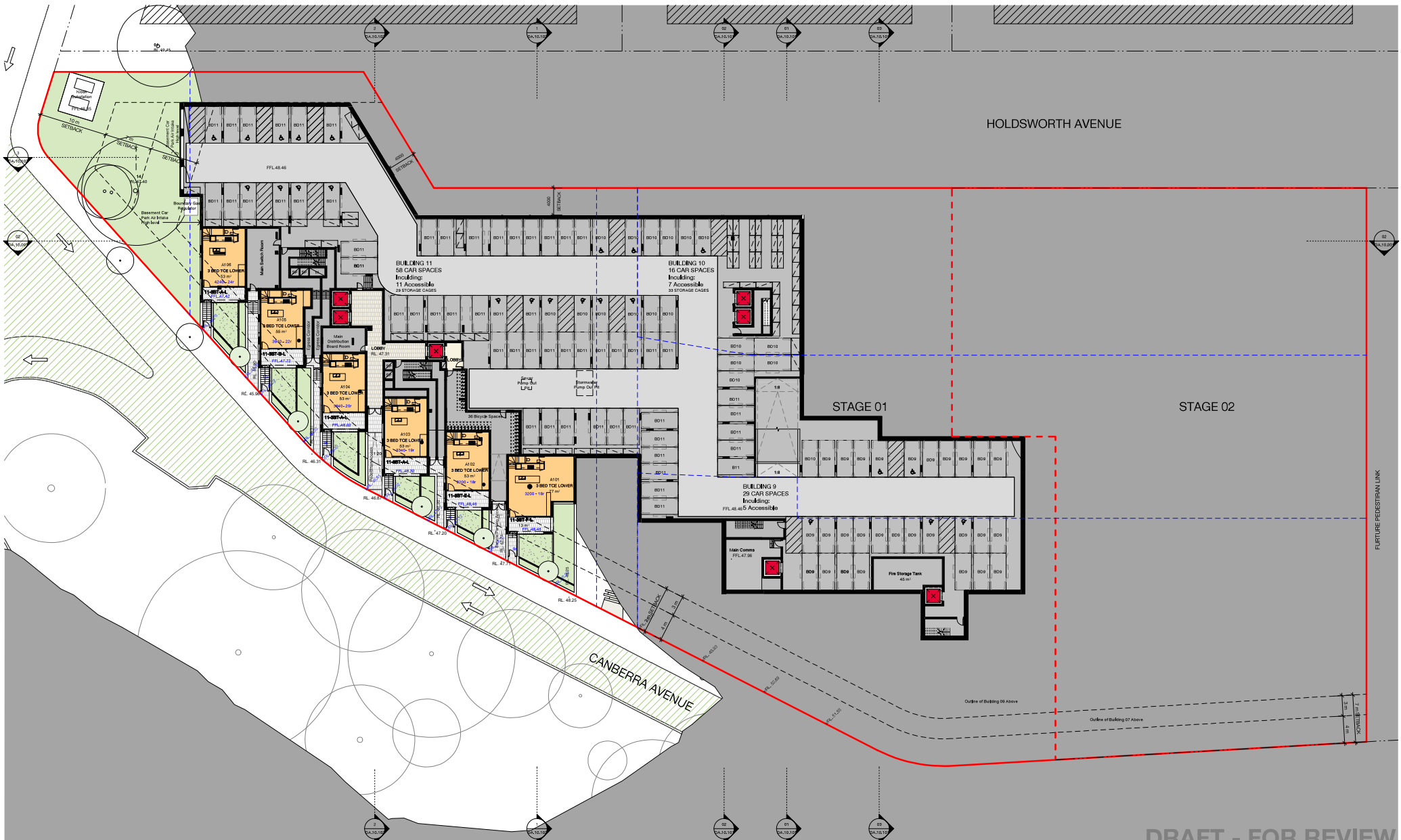
NOTE(S)
1. COORDINATE SYSTEM: MGA94 ZONE 56
2. HEIGHT DATUM: AHD

PROJECT
ST LEONARDS DEVELOPMENT

TITLE
SUBSURFACE SECTION - B-B'
STAGE 1 AND 2

PROJECT NO. 18105360 CONTROL 006-R REV. A FIGURE 0005

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3 25mm



LEGEND	
	BOUNDARY OF THIS DA
	STAGE BOUNDARY
	ADJACENT LOT BOUNDARY
	LEP ENVELOPE + DCP PEDESTRIAN LINK ZONE
	DCP SET BACKS
	FUTURE ROAD CLOSURE
	ADJACENT DCP MASSING

SIGNIFICANT TREES LEGEND:	
	ROOT ZONE
	TREE PROTECTION ZONE
	TREE CANOPY
	TREE TO BE REMOVED
	EXISTING (NON-SIGNIFICANT) TREE

Revision	Date	Description	Initial	Checked
6	18.02.21	DRAFT 1	MM	HC
5	07.02.21	DRAFT 2	MM	HC
4	15.02.21	FOR INFORMATION	MM	HC
3	13.02.21	DCP	MM	HC
2	01.02.21	DRAFT - FOR INFORMATION	MM	HC
1	18.02.21	ISSUED FOR CONSTRUCTION	MM	HC

Project Manager
POS GROUP

Architect
BATES SMART

Planning Consultant
MEOWIE

Landscaping Consultant
ARCADIA

DCP Specialist Engineer
MEINHARDT BONACCI

Structural Engineer
IGS SERVICES

Professional Engineer
CORE ENGINEERING

BM+G

6

TOPSPRING

27 - 41 CANBERRA AVE
26 - 32 HOLDSWORTH AVE
ST LEONARDS SOUTH

Key Plans
Level 01

Check all dimensions and details for compliance with the requirements of any code, the purchase or change of any material, or the construction of any structure, and the interpretation of this drawing and the location of any components.
Do not scale dimensions or use the drawing as a guide. Any discrepancy shall be referred to the architect for clarification.
All drawings must be reproduced or distributed without prior permission in writing by the architect.

Scale	1:250 @ A1
Drawn	M/Mc
Project no.	S12199
Status	DEVELOPMENT APPLICATION
Plot Date	19/05/2021 5:37:39 PM
BM	
Drawing no.	DA.02.001
Revision	6

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Bates Smart

BATESSMART

APPENDIX B

Borehole Logs and Explanatory Notes



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH1

SHEET: 1 OF 3

CLIENT: Property Development Solutions Group

COORDS: 332764.0 m E 6255503.0 m N MGA94 56

DRILL RIG: Jackro

PROJECT: St Leonards Development

SURFACE RL: 50.50 m DATUM: mAHD

CONTRACTOR: Nealings Drilling Pty Ltd

LOCATION: 41 Canberra Avenue

INCLINATION: -90°

LOGGED: SL DATE: 27/8/18

JOB NO: 18105360

HOLE DEPTH: 12.24 m

CHECKED: BF DATE: 17/9/18

Drilling					Sampling		Field Material Description									
METHOD		PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION			MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	L	Groundwater not encountered	0	0.20	50.30	DS 0.08 m R = 0A Jar 0.08 m QCA102 Jar 0.08 m QCB102 Jar 0.08 m PID = 0.2 ppm R = 0A Jar 0.10 m PID = 0.1 ppm DS 0.50 m R = 0A Jar 0.50 m PID = 0.1 ppm		SC / CL	Brick pavers			D	MD		FILL POSSIBLE FILL RESIDUAL SOIL 0.6m: DCP - 18, 30/40mm HB	
	M			Silty SAND fine to medium grained, sub-angular, brown, with fine to medium grained, sub-angular gravel												
	H			Clayey SAND fine to medium grained, sub-angular, orange brown and grey, low plasticity clay Clayey SAND /Sandy CLAY fine to medium grained, orange brown, low plasticity clay For Continuation Refer to Sheet 2												
			1													
			2													
			3													
			4													
			5													
			6													
			7													
			8													
			9													

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F01a
RL3



SHEET: 2 OF 3

DRILL RIG: Jackro

CONTRACTOR: Nealings Drilling Pty Ltd

LOGGED: SL DATE: 27/8/18

CHECKED: BF DATE: 17/9/18

CLIENT: Property Development Solutions Group

COORDS: 332764.0 m E 6255503.0 m N MGA94 56

PROJECT: St Leonards Development

SURFACE RL: 50.50 m DATUM: mAHD

LOCATION: 41 Canberra Avenue

INCLINATION: -90°

JOB NO: 18105360

HOLE DEPTH: 12.24 m

NMLC

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a
RL3



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH1

SHEET: 3 OF 3

CLIENT: Property Development Solutions Group
PROJECT: St Leonards Development
LOCATION: 41 Canberra Avenue
JOB NO: 18105360

COORDS: 332764.0 m E 6255503.0 m N MGA94 56
SURFACE RL: 50.50 m DATUM: mAHD
INCLINATION: -90°
HOLE DEPTH: 12.24 m

DRILL RIG: Jackro
CONTRACTOR: Nealings Drilling Pty Ltd
LOGGED: SL DATE: 27/8/18
CHECKED: BF DATE: 17/9/18

Drilling						Field Material Description						Defect Information			
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)			
NMLC	100% RETURN		100 (100)	10			SANDSTONE grey, irregular bedding dipping at 0 to 20 degrees	FR		PLI(D)=1.50 PLI(A)=1.46	10.00 m: HB				
											10.64 m: B, 10°, Pl, Ro, clay Ve 10.75 m: DB				
				11						PLI(D)=1.40 PLI(A)=1.83	11.00 m: HB				
			100 (100)								11.45 m: HB				
				12						PLI(D)=1.61 PLI(A)=1.46	11.79 m: HB				
				12.24	38.26		END OF BOREHOLE @ 12.24 m TARGET DEPTH GROUNDWATER NOT OBSERVED GROUTED				12.00 m: HB 12.03 m: HB				
				13											
				14											
				15											
				16											
				17											
				18											
				19											
				20											

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a
RL3



CLIENT PDS
JOB No. 18105360



JOB St Leonards Development **DEPTH** 0.58 - 12.24 m **DATE**
BOREHOLE BH1 **CORE TYPE** NMLC 27/08/2018



Project No.: 18105360

Date: 27-08-18

St Leonards Development

CORE PHOTOGRAPHS

BOREHOLE BH1





GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH2

SHEET: 1 OF 3

CLIENT: Property Development Solutions Group
PROJECT: St Leonards Development
LOCATION: 24 Holdsworth Avenue
JOB NO: 18105360

COORDS: 332787.0 m E 6255598.0 m N MGA94 56
SURFACE RL: 64.20 m DATUM: mAHD
INCLINATION: -90°
HOLE DEPTH: 12.24 m

DRILL RIG: Komatsu 05
CONTRACTOR: Nealings Drilling Pty Ltd
LOGGED: SL DATE: 20/8/18
CHECKED: BF DATE: 17/9/18

Drilling				Sampling		Field Material Description													
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm						
													0	5	10	15	20	25	
HA	L	Groundwater not encountered	0	64.20	DS 0.00 m				Silty SAND			FILL							
	M		0.40	Jar 0.00 m		fine to medium grained, sub-angular, dark brown, with roots													
	0.50		QCA100		orange brown, increasing clay content														
	63.70		Jar 0.00 m																
ADT	H	Groundwater not encountered	0.80	63.40	QCB100				CLAY			RESIDUAL SOIL							
			0.80	Jar 0.00 m		low to medium plasticity, black and orange brown, with silt, trace fine grained sand, with charcoal and glass fragments													
	1		63.40	PID = 0.3 ppm		CLAY													
				DS 0.30-0.30 m		high plasticity, yellow brown													
		Groundwater not encountered	1		Rec = /0 mm			CH		M	VSt								
				DS 0.50 m															
				Jar 0.50 m															
				R = 0A															
		Groundwater not encountered	2	1.90	PID = 0.1 ppm														
				62.30	DS 0.70-0.80 m														
					Rec = /100 mm														
					DS 0.80-0.90 m														
		Groundwater not encountered	2		Rec = /100 mm			CI	CLAY		H								
					Jar 0.80 m				medium plasticity, pale brown and grey, trace silt										
					R = 0A														
					PID = 0.1 ppm														
		Groundwater not encountered	3		DS 1.90-2.00 m				For Continuation Refer to Sheet 2										
					Rec = /100 mm														
					SPT 2.00-2.10 m														
					8/100mm HB N=R														
		Groundwater not encountered	4																
		Groundwater not encountered	5																
		Groundwater not encountered	6																
		Groundwater not encountered	7																
		Groundwater not encountered	8																
		Groundwater not encountered	9																
		Groundwater not encountered	10																

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F01h
RL3



SHEET: 2 OF 3

DRILL RIG: Komatsu 05
CONTRACTOR: Nealings Drilling Pty Ltd
LOGGED: SL DATE: 20/8/18
CHECKED: BF DATE: 17/9/18

[illegible]

GAP gINT FN. F02a
RL3



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH2

SHEET: 3 OF 3

CLIENT: Property Development Solutions Group
PROJECT: St Leonards Development
LOCATION: 24 Holdsworth Avenue
JOB NO: 18105360

COORDS: 332787.0 m E 6255598.0 m N MGA94 56
SURFACE RL: 64.20 m DATUM: mAHD
INCLINATION: -90°
HOLE DEPTH: 12.24 m

DRILL RIG: Komatsu 05
CONTRACTOR: Nealings Drilling Pty Ltd
LOGGED: SL DATE: 20/8/18
CHECKED: BF DATE: 17/9/18

Drilling						Field Material Description						Defect Information			
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)		DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)		
NMLC	100% RETURN	100 (100)	100 (100)	10			SANDSTONE fine to medium grained, grey, indistinct bedding, with less than 1% carbonaceous flecks and laminations	FR		PLI(D)=1.34 PLI(A)=1.40		10.00 m: HB 10.15 m: B, 10°, Pl, Ro, Clay Ct, 3 mm			
				11	11.05 53.15		distinct cross bedding dipping at approximately 5 to 20 degrees, with less than 1% carbonaceous flecks of up to 5mm and laminations			PLI(D)=0.86 PLI(A)=1.02		10.86 m: DB 11.00 m: HB 11.24 m: B, 5-20°, Pl, Ro, Cn			
				12	11.81 52.39		indistinct bedding, with carbonaceous flecks of up to 2mm			PLI(D)=1.46 PLI(A)=1.45		12.00 m: DB			
					12.24 51.96		END OF BOREHOLE @ 12.24 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 3.21 m DEPTH STANDPIPE INSTALLED								
				13											
				14											
				15											
				16											
				17											
				18											
				19											
				20											

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a
RL3



GOLDER PRELIMINARY REPORT OF STANDPIPE INSTALLATION: BH2

SHEET: 1 OF 1

CLIENT: Property Development Solutions Group

COORDS: 332787.0 m E 6255598.0 m N MGA94 56

DRILL RIG: Komatsu 05

PROJECT: St Leonards Development

SURFACE RL: 64.20 m DATUM: mAHD

CONTRACTOR: Nealings Drilling Pty Ltd

LOCATION: 24 Holdsworth Avenue

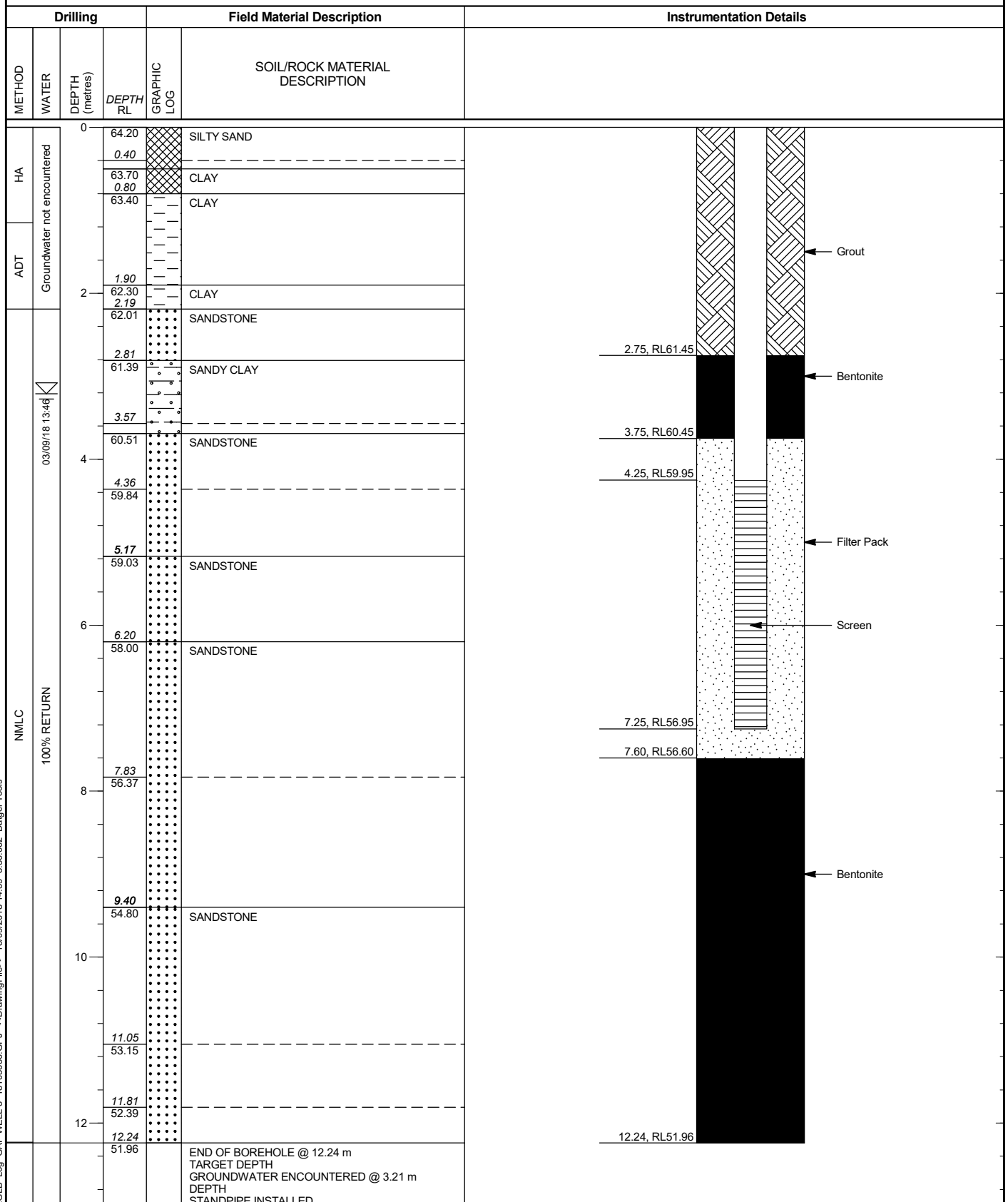
INCLINATION: -90°

LOGGED: SL DATE: 20/8/18

JOB NO: 18105360

HOLE DEPTH: 12.24 m

CHECKED: BF DATE: 17/9/18



This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F17
RL1



CLIENT PDS
JOB No. 18105360



JOB St Leonards Development **DEPTH** 2.19 - 12.24 m **DATE**
BOREHOLE BH2 **CORE TYPE** NMLC 20/08/2018



Project No.: 18105360

Date: 20-08-18

St Leonards Development

CORE PHOTOGRAPHS

BOREHOLE BH2





GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH3

SHEET: 1 OF 3

CLIENT: Property Development Solutions Group
PROJECT: St Leonards Development
LOCATION: 18 Holdsworth Avenue
JOB NO: 18105360

COORDS: 332792.0 m E 6255642.0 m N MGA94 56
SURFACE RL: 67.40 m DATUM: mAHD
INCLINATION: -90°
HOLE DEPTH: 12.26 m

DRILL RIG: Jackro
CONTRACTOR: Nealings Drillings
LOGGED: SL DATE: 31/8/18
CHECKED: BF DATE: 17/9/18

Drilling				Sampling		Field Material Description																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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HA	L	Groundwater not encountered	0	67.40	DS 0.00 m R = 0A Jar 0.00 m PID = 0.1 ppm			CL-CH	Silty SAND fine to medium grained, sub-angular, dark brown, with roots CLAY medium to high plasticity, orange red, with roots becoming grey and red grey medium to high plasticity, grey and red, with bands of ironstone gravel	D	VSt - H	TOPSOIL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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ADT	H		1	67.00								DS 0.50 m R = 0A Jar 0.50 m PID = 0.1 ppm							H																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
			66.70	DS 0.80 m R = 0A Jar 0.95 m PID = 0.1 ppm																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						

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GAP gINT FN. F01h
RL3



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH3

SHEET: 2 OF 3

CLIENT: Property Development Solutions Group

COORDS: 332792.0 m E 6255642.0 m N MGA94 56

DRILL RIG: Jackro

PROJECT: St Leonards Development

SURFACE RL: 67.40 m DATUM: mAHD

CONTRACTOR: Nealings Drillings

LOCATION: 18 Holdsworth Avenue

INCLINATION: -90°

LOGGED: SL DATE: 31/8/18

JOB NO: 18105360

HOLE DEPTH: 12.26 m

CHECKED: BF DATE: 17/9/18

Drilling					Field Material Description							Defect Information			
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)		DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)		
				0											
				1											
				1.35			Continuation of Sheet 1								
				66.05			SANDSTONE fine to medium grained, red, indistinct bedding, with bands of grey clay and ironstone gravels up to 170mm thick	XW							
				2								1.95 m: DB 2.00 m: HB			
				2.23											
				65.17			SANDSTONE fine to medium grained, red, orange and grey, indistinct bedding, with some bands of hard ironstone, iron-stained	XW - HW				2.74 m: DB			
				3								3.00 m: HB			
				3.23								3.17 m: DB			
				64.17			SANDSTONE fine to medium grained, red and grey, irregular to indistinct bedding dipping at approximately 0 to 15 degrees, iron-stained	HW				3.31 m: B, 0°, Pl, Ro, fe clay Ve			
				64.08											
				3.64			3.32-3.40m: medium plasticity, grey clay band								
				63.76			3.64-3.74m: medium plasticity, grey clay band								
				4								4.00 m: HB			
				4.64											
				62.76			red, indistinct bedding,					4.32 m: B, 0°, Pl, Ro, fe clay Ve 4.39 m: B, 5°, Pl, Ro, clay Ct, 2 mm 4.49-4.55 m: J, 90°, Pl, Ro, iron Sn, discontinuous, intact 4.56 m: B, 0°, Pl, Ro, iron Sn, intact 4.57 m: J, 80-90°, Ir, Ro, iron Sn, intact 4.64 m: J, 40-50°, Ir, Ro, iron Sn 4.67 m: DB 4.72 m: B, 0-5°, Ir, Ro, iron Sn 4.85 m: B, 0-5°, Ir, Ro, iron Sn 4.95 m: B, 0-5°, Ir, Ro, iron Sn 5.00 m: HB 5.08 m: DB			
				5											
				5.62											
				5.78			SILTSTONE fine to medium grained, dark grey, irregular bedding dipping at approximately 0 to 10 degrees								
				61.62											
				6.07			CORE LOSS (290MM)					6.00 m: HB			
				61.33											
				6.41			SANDSTONE fine to medium grained, grey, indistinct to irregular bedding dipping at approximately 0 to 10 degrees					6.27 m: DB 6.33 m: B, 0-10°, Cv, Ro, Cn 6.41 m: EWS, 5°, Pl, Ro, Siltstone - low strength 6.64 m: B, 5°, Pl, Ro, Cn			
				60.94											
				7			SILTSTONE grey and dark grey, indistinct bedding dipping at approximately 0 to 5 degrees					6.96 m: B, 0-5°, Cv, Ro, Cn 7.00 m: HB 7.09 m: DB			
				7.40			SANDSTONE fine to medium grained, grey, irregular bedding dipping at approximately 0 to 10 degrees					7.30 m: J, 15-35°, Un, Ro, iron Ve, healed 7.33 m: J, 10-25°, Un, Ro, iron Ve, healed 7.57 m: B, 5°, Pl, Ro, iron Sn 7.66 m: B, 10°, Pl, Ro, Cn			
				7.52											
				59.88			INTERLAMINATED SILTSTONE (50%) AND SANDSTONE (50%) grey and dark grey, regular bedding dipping at approximately 5 degrees								
				8											
				8.16			SANDSTONE fine to medium grained, grey, irregular bedding dipping at approximately 0 to 10 degrees, with <5% carbonaceous laminations, some iron-staining					7.95 m: B, 5°, Pl, Ro, Cn, possible drill break 8.00 m: HB 8.08 m: B, 5°, Pl, Ro, iron Sn 8.10 m: J, 25°, Pl, Ro, fe clay Ct, 4 mm 8.15 m: DB 8.16 m: Bx3, 0-5°, Pl, Ro, Cn, possible drill break			
				59.24											
				9			SANDSTONE fine to medium grained, grey and orange, regular bedding dipping at approximately 10 degrees					9.00 m: HB			
				9.38											
				58.02			SANDSTONE fine to medium grained, grey, irregular bedding dipping at approximately 0 to 20 degrees, with <1% carbonaceous laminations and flecks up to 2mm thick	FR				9.36 m: DB			
				10											

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GAP gINT FN. F02a
RL3



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH3

SHEET: 3 OF 3

CLIENT: Property Development Solutions Group

COORDS: 332792.0 m E 6255642.0 m N MGA94 56

DRILL RIG: Jackro

PROJECT: St Leonards Development

SURFACE RL: 67.40 m DATUM: mAHD

CONTRACTOR: Nealings Drillings

LOCATION: 18 Holdsworth Avenue

INCLINATION: -90°

LOGGED: SL DATE: 31/8/18

JOB NO: 18105360

HOLE DEPTH: 12.26 m

CHECKED: BF DATE: 17/9/18

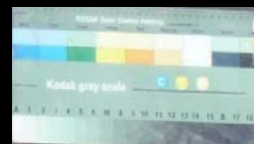
Drilling						Field Material Description						Defect Information			
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)		DEFECT DESCRIPTION & Additional Observations		AVERAGE DEFECT SPACING (mm)	
NMLC	80% RETURN	100	100 (100)	10	50.03		SANDSTONE fine to medium grained, grey, irregular bedding dipping at approximately 0 to 20 degrees, with <1% carbonaceous laminations and flecks up to 2mm thick reduction in cross bedding	FR		PLI(D)=1.15 PLI(A)=1.23		9.96 m: HB 9.98 m: HB 10.00 m: HB			
				11											
				12											
				12.26	55.14		END OF BOREHOLE @ 12.26 m TARGET DEPTH GROUNDWATER NOT OBSERVED GROUTED			PLI(D)=1.24 PLI(A)=1.74		12.00 m: HB			
				13											
				14											
				15											
				16											
				17											
				18											
				19											
				20											

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GAP gINT FN. F02a
RL3



CLIENT PDS
JOB No. 18105360



JOB St Leonards Development **DEPTH** 1.35 - 12.24 m **DATE**
BOREHOLE BH3 **CORE TYPE** NMLC 3/09/2018



Project No.: 18105360

Date: 03-09-18

St Leonards Development

CORE PHOTOGRAPHS

BOREHOLE BH3





GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH4

SHEET: 1 OF 3

CLIENT: Property Development Solutions Group

COORDS: 332867.0 m E 6255636.0 m N MGA94 56

DRILL RIG: Komatsu 05

PROJECT: St Leonards Development

SURFACE RL: 57.30 m DATUM: mAHD

CONTRACTOR: Nealings Drilling Pty Ltd

LOCATION: 21 Canberra Avenue

INCLINATION: -90°

LOGGED: SL DATE: 21/8/18

JOB NO: 18105360

HOLE DEPTH: 12.32 m

CHECKED: BF DATE: 17/9/18

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
DTC	H	Groundwater not encountered	0	57.21	BH4_0.09 Jar 0.09 m R = 0A PID = 0.1 ppm	✓	•••••	1-2-3-4	CONCRETE SANDSTONE fine to medium grained, red and yellow, indistinct bedding, inferred very low strength, extremely weathered For Continuation Refer to Sheet 2				WEATHERED ROCK
			1										
			2										
			3										
			4										
			5										
			6										
			7										
			8										
			9										

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GAP gINT FN. F01a
RL3



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH4

SHEET: 2 OF 3

CLIENT: Property Development Solutions Group

COORDS: 332867.0 m E 6255636.0 m N MGA94 56

DRILL RIG: Komatsu 05

PROJECT: St Leonards Development

SURFACE RL: 57.30 m DATUM: mAHD

CONTRACTOR: Nealings Drilling Pty Ltd

LOCATION: 21 Canberra Avenue

INCLINATION: -90°

LOGGED: SL DATE: 21/8/18

JOB NO: 18105360

HOLE DEPTH: 12.32 m

CHECKED: BF DATE: 17/9/18

Drilling					Field Material Description					Defect Information				
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)		
				0			Continuation of Sheet 1							
			100 (100)	0.38	56.92		SANDSTONE fine to medium grained, yellow brown, indistinct bedding dipping at approximately 0 to 5 degrees, with roots and clay seams	XW						
				1							0.98 m: DB 1.00 m: HB 1.08 m: EWS, 5°, Pl, Ro, clay Ct, 4 mm 1.32 m: HB 1.40 m: HB			
				1.26	56.04		red							
				1.50	55.80		grey							
				1.74	55.56		SANDSTONE fine to medium grained, orange, indistinct bedding dipping at approximately 10 to 20 degrees, iron-stained	MW						
			65 (60)				1.74m: 40mm bed of yellow, fine to medium grained sandstone				1.77 m: HB 1.85 m: DB 2.00 m: HB			
				2										
				3			SANDSTONE fine to medium grained, grey, irregular, indistinct bedding dipping at 0 to 15 degrees, with seams of iron-stained rock up to 15mm thick				3.00 m: HB 3.00-3.04 m: EWS, 5°, Pl, Ro, clay Ct, 40 mm 3.00 m: HB 3.00-3.04 m: EWS, 5°, Pl, Ro, clay Ct, 40 mm 3.10 m: B, 0-5°, Ir, Ro, clay Ct, 2 mm 3.39 m: DB 3.43 m: B, 5°, Cv, Ro, iron Sn 3.57 m: B, 0°, Pl, Ro, iron Ve 3.65 m: B, 0°, Pl, Ro, iron Sn 3.82 m: HB 4.00 m: HB 4.14 m: HB			
				3.00	54.30									
				3.52	53.78		distinct bedding dipping at approximately 0 to 20 degrees, with <5% carbonaceous laminations up to 2mm thick	SW						
			100 (95)											
				4							4.51 m: B, 5°, Pl, Ro, carbonacoue Ve 4.88 m: DB 5.00 m: HB			
				5										
			100 (90)											
				5.43	51.72		SILTSTONE dark grey, indistinct bedding, siltstone lamination up to 15mm thick				5.43 m: EWSx2, 0-15°, Ir, Ro, clay Ct, 15 mm 5.45 m: DB 5.58 m: B, 5°, Pl, Sl, Cn			
				6			SANDSTONE fine to medium grained, grey, irregular bedding dipping at approximately 0 to 10 degrees, with <5% carbonaceous laminations up to 3mm thick				5.84 m: B, 0°, Pl, Ro, carbonaceous Ve 5.86 m: J, 30°, Pl, Ro, iron Sn 5.98 m: HB 6.00 m: HB 6.29 m: HB 6.38 m: B, 0°, Pl, Ro, carbonaceous Ve 6.58 m: DB			
			100 (95)											
				7			indistinct bedding dipping at approximately 0 to 15 degrees				6.98 m: HB 7.00 m: HB 7.04-7.07 m: EWS, 5-10°, Ir, Ro, clay Ct, 30 mm			
				7.35	49.95		7.03m: siltstone lamination of up to 3mm thick							
			100 (100)				7.35-7.43m: yellow, iron-stained, medium grained sandstone	SW FR			7.38 m: SS, 0-15°, Cv, Ro, iron Sn			
				8							8.00 m: HB 8.04 m: HB 8.09 m: DB 8.28 m: B, 15°, Pl, Ro, Ve, appears stained by brown mineral (hard, rough) 8.43 m: J, 30°, Cv, Ro, iron Sn 8.48 m: J, 5-30°, Un, Ro, iron Sn 8.54 m: J, 35°, Pl, Ro, iron Sn 8.57 m: J, 25°, Ir, Ro, iron Ve, discontinuous 8.60-8.75 m: J, 85°, Pl, Ro, iron Sn 8.65 m: B, 10°, Pl, Ro, iron Sn 8.76 m: SS, 0-10°, Pl, Ro, gravel 8.80 m: J, 20-30°, Un, Ro, Cn			
				8.27	49.03		8.27-8.67m: yellow, iron-stained, jointed sandstone	SW						
			100 (90)											
				9										
				9.83	47.47		bedding becoming indistinct, with <1% siltstone flecks	FR			9.70 m: B, 5°, Pl, Ro, Cn			
			100 (100)											
				10										

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GAP gINT FN. F02a
RL3



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH4

SHEET: 3 OF 3

CLIENT: Property Development Solutions Group

COORDS: 332867.0 m E 6255636.0 m N MGA94 56

DRILL RIG: Komatsu 05

PROJECT: St Leonards Development

SURFACE RL: 57.30 m DATUM: mAHD

CONTRACTOR: Nealings Drilling Pty Ltd

LOCATION: 21 Canberra Avenue

INCLINATION: -90°

LOGGED: SL DATE: 21/8/18

JOB NO: 18105360

HOLE DEPTH: 12.32 m

CHECKED: BF DATE: 17/9/18

Drilling					Field Material Description					Defect Information				
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations			AVERAGE DEFECT SPACING (mm)
NMLC	0% RETURN		100	100 (100)	10		up to 2mm SANDSTONE fine to medium grained, grey, irregular bedding dipping at approximately 0 to 10 degrees, with <5% carbonaceous laminations up to 3mm thick	FR		PLI(D)=2.26 PLI(A)=1.69	10.00 m: HB			
					11					PLI(D)=2.04 PLI(A)=2.11	11.00 m: HB 11.09 m: DB			
			100	100 (100)	12					PLI(D)=1.32 PLI(A)=0.80	11.87 m: EWS, 5°, PI, Ro, clay Ct, 3 mm 12.00 m: HB 12.09 m: DB			
					12.32 44.98		END OF BOREHOLE @ 12.32 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 5.36 m DEPTH STANDPIPE INSTALLED							
					13									
					14									
					15									
					16									
					17									
					18									
					19									
					20									

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GAP gINT FN. F02a
RL3



GOLDER PRELIMINARY REPORT OF STANDPIPE INSTALLATION: BH4

SHEET: 1 OF 1

CLIENT: Property Development Solutions Group

COORDS: 332867.0 m E 6255636.0 m N MGA94 56

DRILL RIG: Komatsu 05

PROJECT: St Leonards Development

SURFACE RL: 57.30 m DATUM: mAHD

CONTRACTOR: Neallings Drilling Pty Ltd

LOCATION: 21 Canberra Avenue

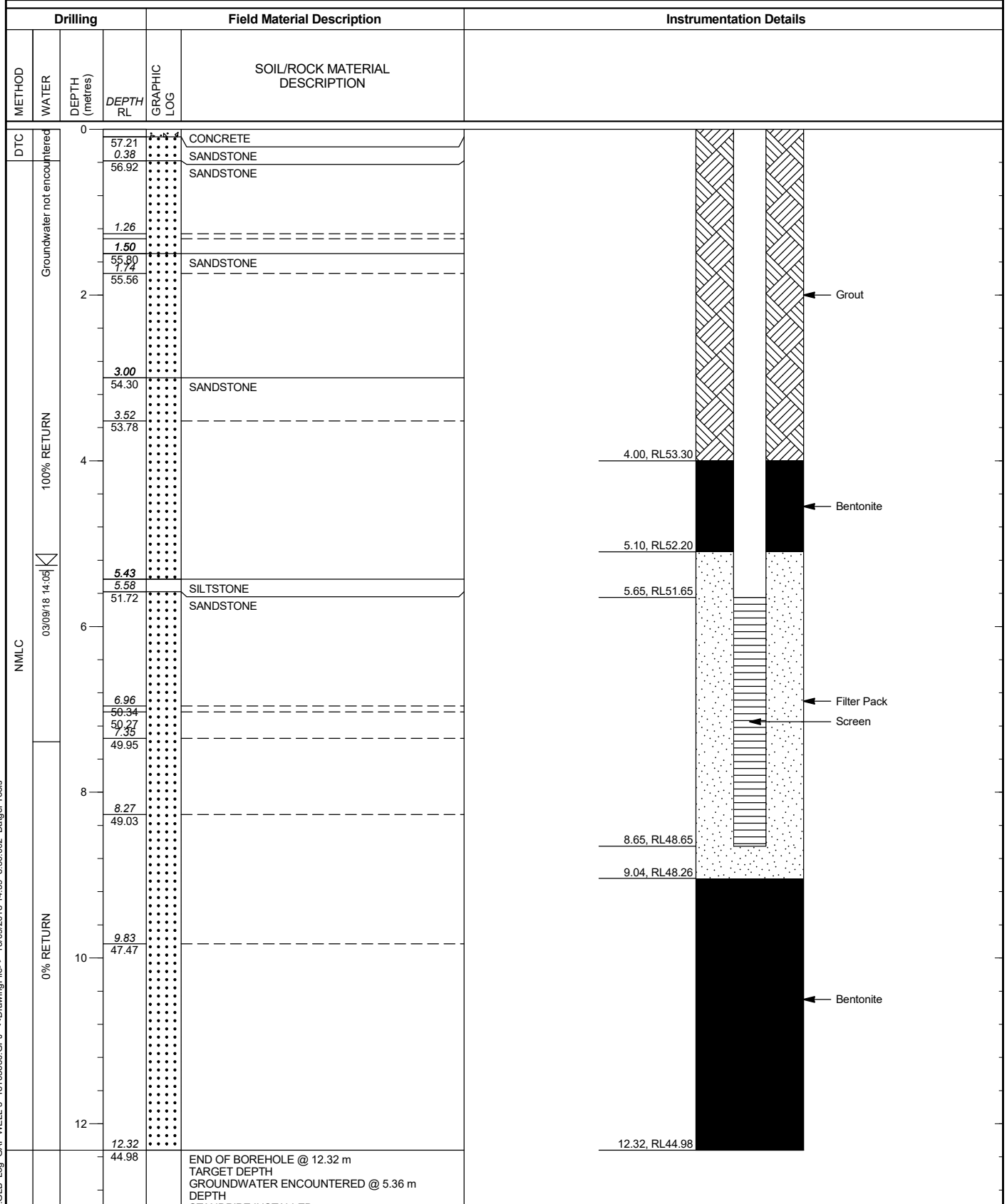
INCLINATION: -90°

LOGGED: SL DATE: 21/8/18

JOB NO: 18105360

HOLE DEPTH: 12.32 m

CHECKED: BF DATE: 17/9/18

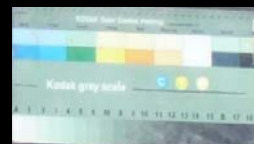


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GAP gINT FN. F17
RL1



CLIENT PDS
JOB No. 18105360



JOB St Leonards Development **DEPTH** 0.38 - 12.32 m **DATE**
BOREHOLE BH4 **CORE TYPE** NMLC 22/08/2018



Project No.: 18105360

Date: 22-08-18

St Leonards Development

CORE PHOTOGRAPHS

BOREHOLE BH4





CHECKED: BF DATE: 17/9/18

JOB NO: 18105360

HOLE DEPTH: 13.63 m

GAP gINT FN. F01h
RI 3



SHEET: 2 OF 3

DRILL RIG: Jackro
CONTRACTOR: Nealings Drilling
LOGGED: SL DATE: 4/9/18
CHECKED: BF DATE: 17/9/18

[illegible]GAP gINT FN. F02a
RI 3



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH5

SHEET: 3 OF 3

CLIENT: Property Development Solutions Group

COORDS: 332865.0 m E 6255587.0 m N MGA94 56

DRILL RIG: Jackro

PROJECT: St Leonards Development

SURFACE RL: 55.90 m DATUM: mAHD

CONTRACTOR: Nealings Drilling

LOCATION: 27 Canberra Avenue

INCLINATION: -90°

LOGGED: SL DATE: 4/9/18

JOB NO: 18105360

HOLE DEPTH: 13.63 m

CHECKED: BF DATE: 17/9/18

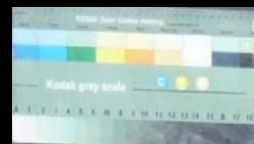
Drilling					Field Material Description					Defect Information				
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)		
NMLC	100% RETURN	100 (100)	100 (100)	10			SILTSTONE dark grey, regular to indistinct bedding dipping at approximately 0 to 5 degrees	FR		PLI(D)=0.54 PLI(A)=0.54				
				10.67	45.23		increasing sandstone laminations							
				11	11.07		SANDSTONE fine to medium grained, grey, indistinct bedding dipping at approximately 0 to 5 degrees, with <1% carbonaceous flecks up to 2mm			PLI(D)=0.59 PLI(A)=0.55	10.78 m: DB 10.88 m: HB 10.93 m: B, 0-5°, St, Sm-Ro, Cn 10.95-11.04 m: EWS, 0°, Pl, Sm, clay Ve 11.07 m: B, 5°, Pl, Sm-Ro, Cn			
				11	44.83						11.54 m: HB			
				12						PLI(D)=1.68 PLI(A)=1.19	12.00 m: HB 12.14 m: DB			
				12.75	43.15		irregular bedding dipping at approximately 0 to 15 degrees, with <5% carbonaceous flecks up to 2mm							
				13	13.22		indistinct bedding, with <5% carbonaceous flecks up to 3mm			PLI(D)=0.79 PLI(A)=0.96	13.00 m: HB 13.17 m: B, 5°, Pl, Ro, Cn			
				13	42.68									
				13.63										
				14			END OF BOREHOLE @ 13.63 m TARGET DEPTH GROUNDWATER NOT OBSERVED GROUTED							
				15										
				16										
				17										
				18										
				19										
				20										

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GAP gINT FN. F02a
RL3



CLIENT PDS
JOB No. 18105360



JOB St Leonards Development **DEPTH** 1.06 - 13.63 m **DATE**
BOREHOLE BH5 **CORE TYPE** NMLC 5/09/2018



Project No.: 18105360

Date: 05-09-18

St Leonards Development

CORE PHOTOGRAPHS

BOREHOLE BH5





GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH6

SHEET: 1 OF 3

CLIENT: Property Development Solutions Group
PROJECT: St Leonards Development
LOCATION: 31 Canberra Avenue
JOB NO: 18105360

COORDS: 332844.0 m E 6255543.0 m N MGA94 56
SURFACE RL: 49.50 m DATUM: mAHD
INCLINATION: -90°
HOLE DEPTH: 12.22 m

DRILL RIG: Komatsu 05
CONTRACTOR: Nealings Drilling Pty Ltd
LOGGED: SL DATE: 22/8/18
CHECKED: BF DATE: 17/9/18

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA		Groundwater not encountered	0	0.18	SPT 0.85-1.30 m 2, 3, 13 N=16			CI-CH	BRICK DRIVEWAY	D	VSt-H	FILL 0.02m layer of fine to medium grained sand between two brick layers
			49.23						SAND			
			0.50						fine to medium grained, sub-angular, brown, with silt			
			49.00						Sandy CLAY			
ADT	H		1	0.85					low to medium plasticity, yellow brown, fine to medium grained, sub-angular sand			RESIDUAL SOIL
			48.65						CLAY			
			1.05						medium to high plasticity, yellow brown and red, trace fine to medium grained, sub-angular sand, with ironstone gravel			
			48.45						SANDSTONE			
									fine to medium grained, orange red, soil like properties, iron-stained, extremely weathered grey			WEATHERED ROCK
									For Continuation Refer to Sheet 2			

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GAP gINT FN. F01a
RL3



SHEET: 2 OF 3

DRILL RIG: Komatsu 05

CONTRACTOR: Nealings Drilling Pty Ltd

LOGGED: SL DATE: 22/8/18

CHECKED: BF DATE: 17/9/18

CLIENT: Property Development Solutions Group

COORDS: 332844.0 m E 6255543.0 m N MGA94 56

PROJECT: St Leonards Development

SURFACE RL: 49.50 m DATUM: mAHD

LOCATION: 31 Canberra Avenue

INCLINATION: -90°

JOB NO: 18105360

HOLE DEPTH: 12.22 m

NMLC	100% RETURN
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GAP gINT FN. F02a
RL3



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH6

SHEET: 3 OF 3

CLIENT: Property Development Solutions Group

COORDS: 332844.0 m E 6255543.0 m N MGA94 56

DRILL RIG: Komatsu 05

PROJECT: St Leonards Development

SURFACE RL: 49.50 m DATUM: mAHD

CONTRACTOR: Nealings Drilling Pty Ltd

LOCATION: 31 Canberra Avenue

INCLINATION: -90°

LOGGED: SL DATE: 22/8/18

JOB NO: 18105360

HOLE DEPTH: 12.22 m

CHECKED: BF DATE: 17/9/18

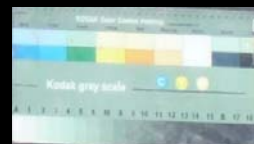
Drilling						Field Material Description						Defect Information			
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)			
NMLC	100% RETURN		100 (100)	10			SANDSTONE fine to medium grained, grey, indistinct bedding dipping at 0 to 25 degrees	FR		PLI(D)=1.42 PLI(A)=1.63					
				11						PLI(D)=1.42 PLI(A)=1.30					
			100 (100)	12						PLI(D)=1.16 PLI(A)=0.86					
				12.22 37.28			END OF BOREHOLE @ 12.22 m TARGET DEPTH GROUNDWATER NOT OBSERVED GROUTED								
				13											
				14											
				15											
				16											
				17											
				18											
				19											
				20											

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GAP gINT FN. F02a
RL3



CLIENT PDS
JOB No. 18105360



JOB St Leonards Development **DEPTH** 1.31 - 12.22 m **DATE**
BOREHOLE BH6 **CORE TYPE** NMLC 22/08/2018



Project No.: 18105360

Date: 22-08-18

St Leonards Development

CORE PHOTOGRAPHS

BOREHOLE BH6





GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH7

SHEET: 1 OF 3

CLIENT: Property Development Solutions Group
PROJECT: St Leonards Development
LOCATION: 35 Canberra Avenue
JOB NO: 18105360

COORDS: 332806.0 m E 6255490.0 m N MGA94 56
SURFACE RL: 47.60 m DATUM: mAHD
INCLINATION: -90°
HOLE DEPTH: 12.21 m

DRILL RIG: Komatsu 05
CONTRACTOR: Nealings Drilling
LOGGED: SL DATE: 23/8/18
CHECKED: BF DATE: 17/9/18

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	H	Groundwater not encountered	0	0.13	DS 0.15 m BH7 0.15m Jar 0.15 m R = 0A QCA101 Jar 0.15 m QCB101 Jar 0.15 m PID = 0.1 ppm DS 0.50 m Jar 0.50 m R = 1B PID = 0.2 ppm Jar 0.60 m DS 0.90 m Jar 0.90 m PID = 0.1 ppm SPT 0.95-1.35 m 15, 13, 8/100mm HB N=R				CONCRETE			FILL
	M		47.45	Crushed gravel and sandstone								
	H		47.25	Silty SAND								
			0.55	fine to medium grained, sub-angular, brown								
ADT	H	47.05	R = 0A	SC / CL				trace low plasticity clay, slight sewer odour, some green and red staining	M	MD	RESIDUAL SOIL	
		0.85	Jar 0.15 m									
		46.75	QCB101									
		1	Jar 0.15 m									
			1.20	DS 0.50 m				increasing in clay content			WEATHERED ROCK	
									SANDSTONE			
									fine to medium grained, grey			
									For Continuation Refer to Sheet 2			

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GAP gINT FN. F01a
RL3



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH7

SHEET: 2 OF 3

CLIENT: Property Development Solutions Group

COORDS: 332806.0 m E 6255490.0 m N MGA94 56

DRILL RIG: Komatsu 05

PROJECT: St Leonards Development

SURFACE RL: 47.60 m DATUM: mAHD

CONTRACTOR: Nealings Drilling

LOCATION: 35 Canberra Avenue

INCLINATION: -90°

LOGGED: SL DATE: 23/8/18

JOB NO: 18105360

HOLE DEPTH: 12.21 m

CHECKED: BF DATE: 17/9/18

Drilling					Field Material Description						Defect Information										
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa					LABORATORY STRENGTH (MPa)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)					
									0.8	1.0	1.5	2.0	2.5			10	30	100	300	1000	3000
					0																
					1																
					1.33		Continuation of Sheet 1														
					46.27		SANDSTONE	XW													
					1.65		fine to medium grained, grey, with some quartz gravel														
					45.95		SANDSTONE														
					2		fine to medium grained, grey, with roots														
					2.22																
					45.38		SANDSTONE	MW						PLI(D)=1.62 PLI(A)=0.47		1.85 m: DB 2.00 m: HB 2.13 m: HB					
					3		fine to medium grained, red, indistinct bedding, iron rich									2.45 m: DB 2.48-2.62 m: J, 50-70°, Ir, Ro, iron Ve, healed					
					4									PLI(D)=1.68 PLI(A)=1.00		2.90-3.06 m: J, 55-75°, Ir, Ro, iron Sn 3.00 m: HB					
					5											3.18 m: DB					
					6																
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GAP gINT FN. F02a
RL3



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH7

SHEET: 3 OF 3

CLIENT: Property Development Solutions Group

COORDS: 332806.0 m E 6255490.0 m N MGA94 56

DRILL RIG: Komatsu 05

PROJECT: St Leonards Development

SURFACE RL: 47.60 m DATUM: mAHD

CONTRACTOR: Nealings Drilling

LOCATION: 35 Canberra Avenue

INCLINATION: -90°

LOGGED: SL DATE: 23/8/18

JOB NO: 18105360

HOLE DEPTH: 12.21 m

CHECKED: BF DATE: 17/9/18

Drilling						Field Material Description						Defect Information			
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)		DEFECT DESCRIPTION & Additional Observations		AVERAGE DEFECT SPACING (mm)	
NMLC	100% RETURN		100	100 (100)	10		SANDSTONE fine to medium grained, grey, irregular cross bedding dipping at approximately 5 to 25 degrees, with less than 1% carbonaceous laminations	FR		PLI(D)=1.82 PLI(A)=1.55		10.00 m: HB			
					11							10.05 m: B, 10°, Pl, Ro, clay Ve 10.06-10.08 m: EWS, Pl, Ro, 20 mm			
			100	100 (100)	12							10.60 m: HB 10.67 m: DB			
					12.21 35.39		END OF BOREHOLE @ 12.21 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 1.73 m DEPTH STANDPIPE INSTALLED			PLI(D)=1.61 PLI(A)=1.83		11.00 m: HB			
					13										
					14										
					15										
					16										
					17										
					18										
					19										
					20										

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GAP gINT FN. F02a
RL3



GOLDER PRELIMINARY REPORT OF STANDPIPE INSTALLATION: BH7

SHEET: 1 OF 1

CLIENT: Property Development Solutions Group

COORDS: 332806.0 m E 6255490.0 m N MGA94 56

DRILL RIG: Komatsu 05

PROJECT: St Leonards Development

SURFACE RL: 47.60 m DATUM: mAHD

CONTRACTOR: Nealings Drilling

LOCATION: 35 Canberra Avenue

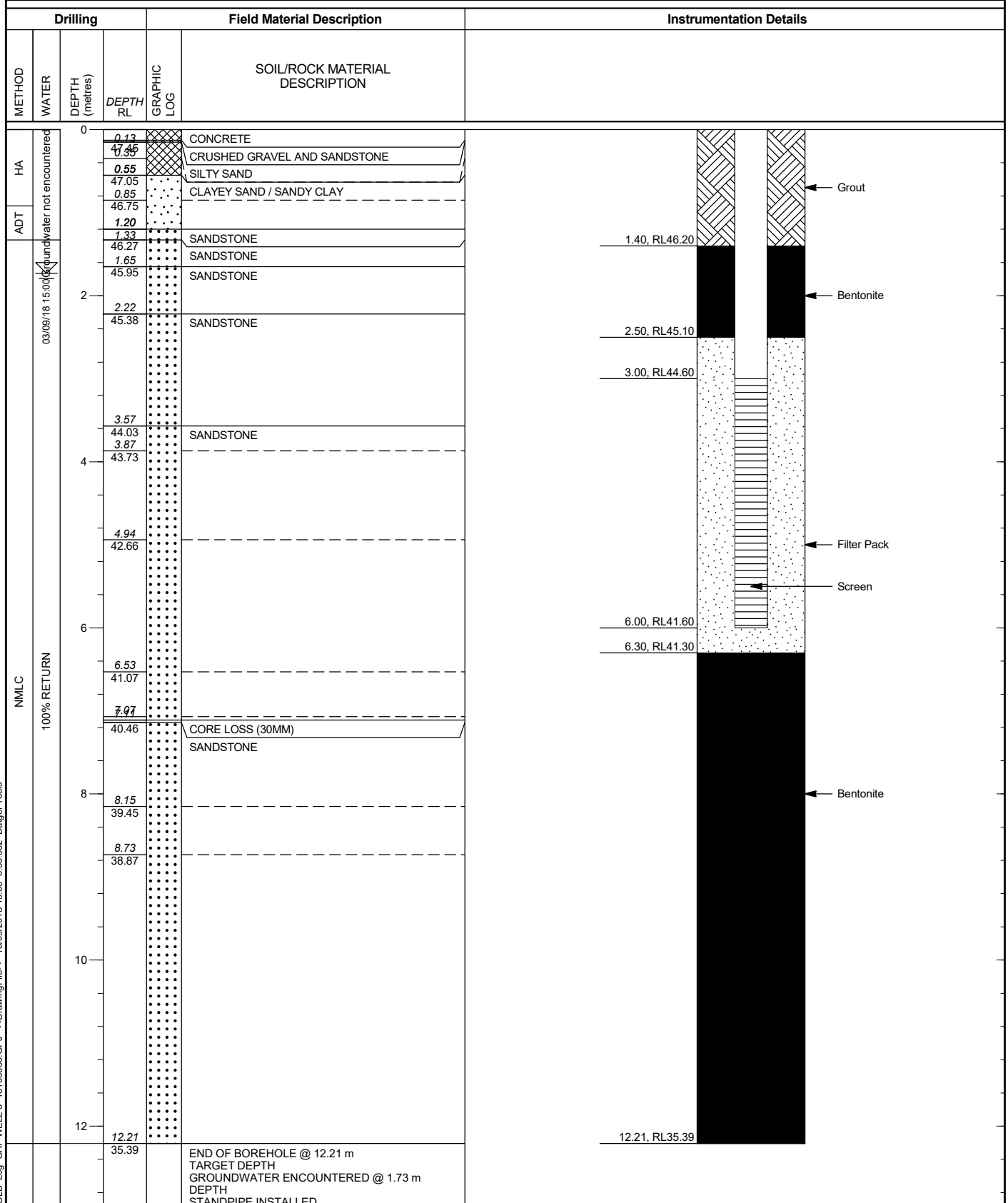
INCLINATION: -90°

LOGGED: SL DATE: 23/8/18

JOB NO: 18105360

HOLE DEPTH: 12.21 m

CHECKED: BF DATE: 17/9/18



This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F17
RL1



CLIENT PDS
JOB No. 18105360



JOB St Leonards Development **DEPTH** 1.33 - 12.21 m **DATE**
BOREHOLE BH7 **CORE TYPE** NMLC 24/08/2018



Project No.: 18105360

Date: 24-08-18

St Leonards Development

CORE PHOTOGRAPHS

BOREHOLE BH7





SHEET: 1 OF 3

COORDS: 332820.0 m E 6255645.0 m N MGA94 56

DRILL RIG: Jackro

SURFACE RL: 64.50 m DATUM: mAHD

CONTRACTOR: Nealings Drilling

INCLINATION: -90°

LOGGED: SL DATE: 30/8/18

HOLE DEPTH: 12.06 m

CHECKED: BF DATE: 17/9/18

[illegible]

GAP gINT FN. F01h
RL3



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH8

SHEET: 2 OF 3

CLIENT: Property Development Solutions Group

COORDS: 332820.0 m E 6255645.0 m N MGA94 56

DRILL RIG: Jackro

PROJECT: St Leonards Development

SURFACE RL: 64.50 m DATUM: mAHD

CONTRACTOR: Nealings Drilling

LOCATION: 18 Holdsworth Avenue

INCLINATION: -90°

LOGGED: SL DATE: 30/8/18

JOB NO: 18105360

HOLE DEPTH: 12.06 m

CHECKED: BF DATE: 17/9/18

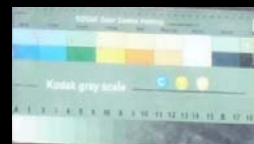
Drilling					Field Material Description							Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)		DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)
				0									
				1									
				1.45			Continuation of Sheet 1						
				63.05			SANDSTONE	XW					
				1.96			fine to medium grained, orange and red, indistinct bedding, with bands of grey, low to medium plasticity clay up to 80mm, iron-stained	HW					
				2			CORE LOSS (40MM)	XW					
				62.50			SANDSTONE	HW					
				2			fine to medium grained, orange and red, indistinct bedding dipping at approximately 0 to 15 degrees, with bands of grey, low to medium plasticity clay up to 140mm, iron-stained						
				3									
				3.71									
				60.79			SANDSTONE	MW					
				4			medium to coarse grained, orange and grey, irregular bedding dipping at approximately 0 to 25 degrees						
				4.05			4.05-4.10m: heavily iron-stained						
				60.45									
				4.51									
				59.99			regular distinct bedding dipping at approximately 0 to 25 degrees						
				5									
				5.65									
				58.85			SANDSTONE	SW					
				58.84			fine to medium grained, grey, irregular to indistinct bedding dipping at approximately 0 to 25 degrees, slightly iron-stained						
				6			5.66-5.68m: siltstone laminations up to 20mm and siltstone flecks up to 10mm long						
				7									
				7.65									
				56.85			discontinuous carbonaceous laminations						
				7.97									
				56.53			SANDSTONE	FR					
				8			fine to medium grained, grey, indistinct to irregular bedding dipping at approximately 0 to 20 degrees						
				9									
				9.59									
				54.91			irregular bedding dipping at 0 to 20 degrees						
				10									

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GAP gINT FN. F02a
RL3



CLIENT PDS
JOB No. 18105360



JOB St Leonards Development **DEPTH** 1.45 - 12.06 m **DATE**
BOREHOLE BH8 **CORE TYPE** NMLC 31/08/2018



Project No.: 18105360

Date: 31-08-18

St Leonards Development

CORE PHOTOGRAPHS

BOREHOLE BH8





GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH9

SHEET: 1 OF 3

CLIENT: Property Development Solutions Group
PROJECT: St Leonards Development
LOCATION: 26 Holdsworth Avenue
JOB NO: 18105360

COORDS: 332812.0 m E 6255580.0 m N MGA94 56
SURFACE RL: 60.60 m DATUM: mAHD
INCLINATION: -90°
HOLE DEPTH: 12.34 m

DRILL RIG: Jackro

CONTRACTOR: Nealings Drilling

LOGGED: SL DATE: 28/8/18

CHECKED: BF DATE: 17/9/18

Drilling				Sampling		Field Material Description												
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm					
													0	5	10	15	20	25
ADIT	HA	Groundwater not encountered	0	60.60	DS 0.10 m R = 0A Jar 0.10 m PID = 0.3 ppm DS 0.50 m R = 0A Jar 0.50 m PID = 2.7 ppm DS 0.65 m R = 0A Jar 0.65 m PID = 1.5 ppm				Silty SAND fine to medium grained, sub-angular, dark brown, with roots CLAY medium to high plasticity, orange brown and grey, with fine to medium grained, sub-angular sand CLAY medium plasticity, grey with ironstone gravel For Continuation Refer to Sheet 2			FILL						
	L																	
	M																	
	H																	
								CI		M	H	RESIDUAL SOIL						

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GAP gINT FN. F01h
RL3



SHEET: 2 OF 3

DRILL RIG: Jackro

CONTRACTOR: Nealings Drilling

LOGGED: SL DATE: 28/8/18

CHECKED: BF DATE: 17/9/18

CLIENT: Property Development Solutions Group

COORDS: 332812.0 m E 6255580.0 m N MGA94 56

PROJECT: St Leonards Development

SURFACE RL: 60.60 m DATUM: mAHD

LOCATION: 26 Holdsworth Avenue

INCLINATION: -90°

JOB NO: 18105360

HOLE DEPTH: 12.34 m

JMLC

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a
RL3



GOLDER

PRELIMINARY REPORT OF BOREHOLE: BH9

SHEET: 3 OF 3

CLIENT: Property Development Solutions Group

COORDS: 332812.0 m E 6255580.0 m N MGA94 56

DRILL RIG: Jackro

PROJECT: St Leonards Development

SURFACE RL: 60.60 m DATUM: mAHD

CONTRACTOR: Nealings Drilling

LOCATION: 26 Holdsworth Avenue

INCLINATION: -90°

LOGGED: SL DATE: 28/8/18

JOB NO: 18105360

HOLE DEPTH: 12.34 m

CHECKED: BF DATE: 17/9/18

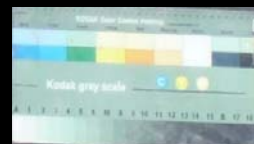
Drilling						Field Material Description						Defect Information			
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH UCS MPa	LABORATORY STRENGTH (MPa)		DEFECT DESCRIPTION & Additional Observations		AVERAGE DEFECT SPACING (mm)	
NMLC	100% RETURN	100 (100)	100 (100)	10	10.16		SANDSTONE fine grained, grey, indistinct bedding dipping at approximately 0 to 5 degrees, with <1% carbonaceous laminations SANDSTONE medium grained, grey, irregular bedding dipping at 5 to 15 degrees, with <1% carbonaceous laminations indistinct bedding dipping at 0 to 5 degrees, some carbonaceous flecks up to 5mm and siltstone clasts up to 10mm wide	FR		PLI(D)=0.45 PLI(A)=1.71		9.93 m: HB 10.00 m: HB 10.59 m: B, 10-15°, Ir, Ro, siltstone clast 10.74 m: B, 10-15°, Ir, Ro, siltstone clast 10.79 m: DB 11.00 m: HB 11.01 m: HB 12.00 m: HB			
					50.44										
					10.75										
					49.85										
				11						PLI(D)=1.14 PLI(A)=1.52					
				12						PLI(D)=1.19 PLI(A)=1.29					
					12.34		END OF BOREHOLE @ 12.34 m TARGET DEPTH GROUNDWATER NOT OBSERVED GROUTED								
					48.26										
				13											
				14											
				15											
				16											
				17											
				18											
				19											
				20											

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a
RL3



CLIENT PDS
JOB No. 18105360



JOB St Leonards Development **DEPTH** 0.80 - 12.34 m **DATE**
BOREHOLE BH9 **CORE TYPE** NMLC 29/08/2018



Project No.: 18105360

Date: 29-08-18

St Leonards Development

CORE PHOTOGRAPHS

BOREHOLE BH9





SYMBOLS

	FILL		CLAY (CL, CI or CH)
	GRAVEL (GW, GP, GM or GC)		ORGANIC SOILS (OL, OH or Pt)
	SAND (SW, SP, SM or SC)		COBBLES or BOULDERS
	SILT (ML or MH)		

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay.

CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and Rock is classified and described in Reports of Boreholes and Test Pits using the preferred method given in AS1726-2017. The material properties are assessed in the field by visual/tactile methods.

Particle Size			Plasticity Properties	
Soil Group	Sub Division	Particle Size		
BOULDERS		> 200 mm		
COBBLES		63 to 200 mm		
GRAVEL	Coarse	19 to 63 mm		
	Medium	6.7 to 19 mm		
	Fine	2.36 to 6.7 mm		
SAND	Coarse	0.6 to 2.36 mm		
	Medium	0.21 to 0.6 mm		
	Fine	0.075 to 0.21 mm		
SILT		0.002 to 0.075 mm		
CLAY		< 0.002 mm		

MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sand and gravels tend to cohere.

Moisture condition for fine grained soils is described relative to the plastic limit or liquid limit as specified in AS1726-2017.

CONSISTENCY AND DENSITY

Fine Grained Soils			Coarse Grained Soils			
Symbol	Term	Undrained Shear Strength	Symbol	Term	Density Index (%)	SPN "N" *
VS	Very Soft	0 to 12 kPa	VL	Very Loose	Less than 15	0 to 4
S	Soft	12 to 25 kPa	L	Loose	15 to 35	4 to 10
F	Firm	25 to 50 kPa	MD	Medium Dense	35 to 65	10 to 30
St	Stiff	50 to 100 kPa	D	Dense	65 to 85	30 to 50
VSt	Very Stiff	100 to 200 kPa	VD	Very Dense	Above 85	Above 50
H	Hard	Above 200 kPa				
Fr	Friable	-				

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.

* SPT correlations are not stated in AS1726-2017, and may be subject to corrections for overburden pressure and equipment type.

CEMENTATION

Weakly Cemented	The soil may be easily disaggregated by hand in air or water.
Moderately Cemented	Effort is required to disaggregate the soil by hand in air or water.



DRILLING/EXCAVATION METHOD

ADH	Hollow auger drilling	EX	Excavator	PQ3	Diamond core - 83 mm
ADT	Auger drilling with tc-bit	HA	Hand auger	PT	Push tube sampling
ADV	Auger drilling with v-bit	HAND	Excavated by hand methods	RAB	Rotary air blast
AIRCORE	Aircore	HMLC	Diamond core - 63 mm	RC	Reverse circulation
AT	Air track	HQ3	Diamond core - 61 mm	RT	Rock roller
BH	Backhoe bucket	JET	Jetting	SONIC	Sonic drilling
CT	Cable tool rig	MZ	Mazier tube sampling	SPT	Standard penetration testing
DTC	Diatube coring	NDD	Non-destructive digging	U	Undisturbed tube sampling
EE	Existing excavation	NMLC	Diamond core - 52 mm	WB	Washbore drilling
EPT	Extruded push tube	NQ3	Diamond core - 45 mm		

PENETRATION/EXCAVATION RESISTANCE

L	Low resistance. Rapid penetration possible with little effort from the equipment used.
M	Medium resistance. Excavation/possible at an acceptable rate with moderate effort from the equipment used.
H	High resistance to penetration/excavation. Further penetration is possible at a slow rate and requires significant effort from the equipment.
R	Refusal or Practical Refusal. No further progress possible without the risk of damage or unacceptable wear to the digging implement or machine.
These assessments are subjective and are dependent on many factors including the equipment power, weight, condition of excavation or drilling tools, and the experience of the operator.	

WATER

	Water level at date shown		Partial water loss
	Water inflow		Complete water loss
GROUNDWATER NOT OBSERVED	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.		
GROUNDWATER NOT ENCOUNTERED	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.		

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following 150mm seating
30/80 mm	Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
DS	Disturbed sample
BDS	Bulk disturbed sample
G	Gas Sample
W	Water Sample
FP	Field permeability test over section noted
FV	Field vane shear test expressed as uncorrected shear strength (sv = peak value, sr = residual value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket penetrometer test expressed as instrument reading in kPa
U63	Thin walled tube sample - number indicates nominal sample diameter in millimetres
WPT	Water pressure test
DCP	Dynamic cone penetration test
CPT	Cone penetration test
CPTu	Cone penetration test with pore pressure (u) measurement

RANKING OF VISUALLY OBSERVABLE CONTAMINATION AND ODOUR (for specific soil contamination assessment projects)

R = 0	No visible evidence of contamination	R = A	No non-natural odours identified
R = 1	Slight evidence of visible contamination	R = B	Slight non-natural odours identified
R = 2	Visible contamination	R = C	Moderate non-natural odours identified
R = 3	Significant visible contamination	R = D	Strong non-natural odours identified

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)	RQD = Rock Quality Designation (%)	SCR = Solid Core Recovery (%)	F = Fracture Frequency
$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100$	$= \frac{\sum \text{Axial lengths of core} > 100 \text{ mm}}{\text{Length of core run}} \times 100$	$= \frac{\sum \text{Length of cylindrical core recovered}}{\text{Length of core run}} \times 100$	$= \frac{\text{No. of defects}}{\text{Length of zone (m)}}$



GOLDER

TERMS FOR ROCK MATERIAL STRENGTH & WEATHERING AND ABBREVIATIONS FOR DEFECT DESCRIPTIONS

STRENGTH

Symbol	Term	UCS (MPa)	Field Guide
VL	Very Low	0.6 to 2	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm can be broken by finger pressure.
L	Low	2 to 6	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	6 to 20	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	20 to 60	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	60 to 200	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>200	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Material with strength less than 'Very Low' shall be described using soil characteristics. The presence of an original rock structure, fabric or texture should be noted, if relevant.

ROCK MATERIAL WEATHERING

ROCK MATERIAL WEATHERING			Field Guide
Symbol	Term		
RS	Residual Soil		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
XW	Extremely Weathered		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.
DW	HW	Highly Weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
	MW	Moderately Weathered	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable, but shows little or no change of strength from fresh rock.
SW	Slightly Weathered		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
FR	Fresh		Rock shows no sign of decomposition of individual minerals or colour changes.

ABBREVIATIONS FOR DEFECT TYPES AND DESCRIPTIONS

Defect Type	Coating or Infilling	Roughness
P Parting	Cn Clean	VRo Very Rough
X Foliation	Sn Stain	Ro Rough
L Cleavage	Ve Veneer	Sm Smooth
C Contact	Ct Coating	Po Polished
J Joint	In Infill	Sl Slickensided
SSu Sheared Surface	Planarity Pl Planar Cv Curved Un Undulating St Stepped Ir Irregular	Vertical Boreholes – The dip (inclination from horizontal) of the defect is given. Inclined Boreholes – The inclination is measured as the acute angle between the core axis and the vertical direction.
SS Sheared Seam		
SZ Sheared Zone		
CS Crushed Seam		
IS Infilled Seam		
EWS Extremely Weathered Seam		
V Vein		

APPENDIX C

Point Load Testing Results

Summary of Point Load Testing Results

Borehole	Depth (mbgl)	RL (m AHD)	Point Load Strength Index $Is_{(50)}$ (MPa)	
			Axial	Diametrical
BH1	0.94	49.56	0.39	0.49
	1.95	48.55	1.73	0.32
	2.96	47.54	1.04	1.06
	3.93	46.57	0.56	0.91
	4.95	45.55	1.53	1.04
	5.96	44.54	1.72	2.24
	6.96	43.54	2.14	2.16
	7.96	42.54	1.54	2.35
	8.96	41.54	1.13	1.74
	9.96	40.54	1.46	1.50
	10.95	39.55	1.83	1.40
	11.90	38.60	1.46	1.61
BH2	4.45	59.75	1.35	1.29
	5.39	58.81	2.35	0.57
	6.55	57.65	1.56	1.82
	7.52	56.68	2.00	1.58
	8.07	56.13	1.34	1.20
	9.12	55.08	1.13	1.05
	10.05	54.15	1.40	1.34
	11.05	53.15	1.02	0.86
	12.05	52.15	1.45	1.46
BH3	3.27	64.13	0.50	0.36
	4.21	63.19	0.18	0.09
	5.24	62.16	0.19	0.17
	6.23	61.17	0.97	0.87
	7.20	60.20	1.31	0.66
	8.22	59.18	1.96	1.47
	9.10	58.30	1.40	1.25
	10.05	57.35	1.23	1.15
	11.05	56.35	1.31	1.58
	12.05	55.35	1.74	1.24
BH4	1.13	56.17	0.42	0.48
	2.05	55.25	0.75	0.63
	3.23	54.07	0.39	0.65
	4.05	53.25	1.04	0.92
	5.05	52.25	0.92	0.71
	6.05	51.25	1.49	1.39
	7.11	50.19	0.78	0.76
	8.13	49.17	1.20	0.94
	9.09	48.21	1.92	1.80
	10.04	47.26	1.69	2.26
	11.13	46.17	2.11	2.04
	12.04	45.26	0.80	1.32

BH5	1.57	54.33	0.63	0.39
	2.05	53.85	0.55	0.51
	3.10	52.80	0.60	0.56
	4.05	51.85	0.95	0.37
	5.10	50.80	0.22	0.17
	6.05	49.85	0.35	0.48
	7.05	48.85	0.82	0.83
	8.05	47.85	0.98	0.62
	9.15	46.75	1.98	0.63
	10.09	45.81	0.54	0.54
	11.11	44.79	0.55	0.59
	12.05	43.85	1.19	1.68
	13.05	42.85	0.96	0.79
BH6	1.43	48.07	2.08	1.19
	2.05	47.45	0.51	0.30
	3.15	46.35	1.39	1.42
	4.05	45.45	1.59	1.72
	5.06	44.44	1.99	1.82
	6.05	43.45	1.76	1.74
	7.05	42.45	2.00	1.69
	8.07	41.43	1.82	1.73
	9.22	40.28	0.99	1.09
	10.05	39.45	1.63	1.42
	11.04	38.46	1.30	1.42
	12.05	37.45	0.86	1.16
BH7	2.25	45.35	0.47	1.62
	3.14	44.46	1.00	1.68
	4.05	43.55	2.37	1.76
	5.05	42.55	2.10	1.73
	6.10	41.50	2.33	2.22
	7.05	40.55	1.76	1.67
	8.06	39.54	1.33	1.89
	9.05	38.55	1.90	2.37
	10.16	37.44	1.55	1.82
	11.05	36.55	1.67	1.56
	12.05	35.55	1.83	1.61
BH8	2.05	62.45	0.27	0.27
	3.06	61.44	0.91	0.46
	4.05	60.45	0.89	0.78
	5.05	59.45	1.76	1.42
	6.05	58.45	1.09	1.02
	7.15	57.35	0.67	0.47
	8.05	56.45	1.37	1.11
	9.05	55.45	1.51	1.40
	10.05	54.45	1.21	1.23
	11.05	53.45	1.10	0.99

BH9	1.10	59.50	1.57	1.09
	2.05	58.55	1.53	1.16
	3.05	57.55	1.32	0.83
	4.05	56.55	1.57	1.08
	5.05	55.55	1.22	0.96
	6.06	54.54	1.02	0.91
	7.08	53.52	1.01	0.63
	8.09	52.51	1.38	1.15
	9.05	51.55	0.82	0.92
	10.06	50.54	1.71	0.45
	11.06	49.54	1.52	1.14
	12.05	48.55	1.29	1.19

APPENDIX D

Laboratory Test Certificates

SOIL CHEMICAL PROPERTIES REPORT

Client	Golder Associates	Source	BH2 1.9m-2mm
Address	124 Pacific Highway St Leonards NSW 2065	Sample Description	Silty CLAY
Project	St Leonards Development (18105360/3000/001)	Report No.	B50431-SCP
Job No	S18381	Lab No.	B50431 (S42637)

Test Procedure:	☐	AS1289 4.2.1	Soil Chemical Tests - Determination of a sulfate content of a natural soil and the sulfate content of the groundwater - Normal Method
	☐	AS1289 4.3.1	Soil Chemical Tests - Determination of the pH value of a soil - Electrometric method
	☐	AS 1289 4.4.1	Soil Chemical Tests - Determination of the electrical resistivity of a soil - Method for sands and granular material
	☐	AS 1012.20	Chloride and sulphate
	☐	RMS T123	pH value of a soil (electrometric method)
	☐	RMS T185	Resistivity of sands and granular road construction materials
	☐	RMS T200	Chloride content of roadbase
	☐	RMS T1010	Quantitative determination of chlorides in soil
	☐	RMS T1011	Quantitative determination of sulphates in soil
	☐	BS1377(1990 pt.3)	Water soluble sulphate content
	☒	APHA 4500 H+B	pH
	☒	APHA 4500 SO4 2-B	Sulphate
	☒	APHA 4500 Cl-B	Chloride
	☐	APHA 2510 & 2520-B	Electrical Conductivity
	☐	TAI B117	Sulphides Present (This service Not Covered by NATA Accreditation)

Sampling:	Sampled by Client	Date Sampled:	unknown
Preparation:	Prepared in accordance with the test method		

Sulphides Present	-
Sulphur Peroxide (% w/w)	-
Sulphate content (ppm)	16.5
Sulphate content (% w/w)	-
Chloride ion content (ppm)	4.0
Chloride ion content (% w/w)	-
pH	4.9
Electrical Conductivity (uS/cm)	-
Mean Resistivity Ω .m	-
(Resistivity) Density ratio (R_D)	-
(Resistivity) Density index (I_D)	-



The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025 - Testing. This document shall not be reproduced, except in full.

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

John Boyle

John Boyle

20/09/2018

Date:

**MACQUARIE
GEOTECH**

Macquarie Geotechnical
3 Watt Drive
Bathurst NSW 2795

SOIL CHEMICAL PROPERTIES REPORT

Client	Golder Associates	Source	BH6 0.85m-1.3mm
Address	124 Pacific Highway St Leonards NSW 2065	Sample Description	Sandy CLAY with silt
Project	St Leonards Development (18105360/3000/001)	Report No.	B50432-SCP
Job No	S18381	Lab No.	B50432 (S42638)

Test Procedure:	☐	AS1289 4.2.1	Soil Chemical Tests - Determination of a sulfate content of a natural soil and the sulfate content of the groundwater - Normal Method
	☐	AS1289 4.3.1	Soil Chemical Tests - Determination of the pH value of a soil - Electrometric method
	☐	AS 1289 4.4.1	Soil Chemical Tests - Determination of the electrical resistivity of a soil - Method for sands and granular material
	☐	AS 1012.20	Chloride and sulphate
	☐	RMS T123	pH value of a soil (electrometric method)
	☐	RMS T185	Resistivity of sands and granular road construction materials
	☐	RMS T200	Chloride content of roadbase
	☐	RMS T1010	Quantitative determination of chlorides in soil
	☐	RMS T1011	Quantitative determination of sulphates in soil
	☐	BS1377(1990 pt.3)	Water soluble sulphate content
	☒	APHA 4500 H+B	pH
	☒	APHA 4500 SO4 2-B	Sulphate
	☒	APHA 4500 Cl-B	Chloride
	☐	APHA 2510 & 2520-B	Electrical Conductivity
	☐	TAI B117	Sulphides Present (This service Not Covered by NATA Accreditation)

Sampling:	Sampled by Client	Date Sampled:	unknown
Preparation:	Prepared in accordance with the test method		

Sulphides Present	-
Sulphur Peroxide (% w/w)	-
Sulphate content (ppm)	22.2
Sulphate content (% w/w)	-
Chloride ion content (ppm)	4.0
Chloride ion content (% w/w)	-
pH	4.7
Electrical Conductivity (uS/cm)	-
Mean Resistivity Ω .m	-
(Resistivity) Density ratio (R_D)	-
(Resistivity) Density index (I_D)	-



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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

John Boyle

John Boyle

20/09/2018

Date:

**MACQUARIE
GEOTECH**

Macquarie Geotechnical
3 Watt Drive
Bathurst NSW 2795

Uniaxial Compressive Strength			
Client:	Golder Associates	Sample Source:	BH1 2.77-2.96m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Sandstone
Project:	St Leonards Development (18105360/3000/001)	Report No.:	S42632-UCS
Job No.:	S18381	Lab No.:	S42632
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	Sample Curing:	-
Sampling Method:	Sampled by Client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition
 			
Uniaxial Compressive Strength 27 MPa			
Date Tested:	15/09/2018	Moisture Content:	6.6 %
Specimen Height:	140.6 mm	Duration of Test:	621 seconds
Average Specimen Diameter:	51.7 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type: Single shear plane			
Other Pertinent Observations:			
 The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025 - Testing. This document shall not be reproduced, except in full. NATA Accredited Laboratory Number: 14874 Authorised Signatory:  Jacob Lloyd Date: 19/09/2018			
		Macquarie Geotechnical U7/8 10 Bradford Street Alexandria NSW 2015	

Uniaxial Compressive Strength			
Client:	Golder Associates	Sample Source:	BH3 3.76-3.97m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Sandstone
Project:	St Leonards Development (18105360/3000/001)	Report No.:	S42633-UCS
Job No.:	S18381	Lab No.:	S42633
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	Sample Curing:	-
Sampling Method:	Sampled by Client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition
 			
Uniaxial Compressive Strength 4.2 MPa			
Date Tested:	15/09/2018	Moisture Content:	8.2 %
Specimen Height:	112.0 mm	Duration of Test:	631 seconds
Average Specimen Diameter:	51.0 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type:	Single shear plane		
Other Pertinent Observations:			
Deviation from Standard:	Test specimen length to diameter ratio falls outside of standard limitations of 2.5-3.0.		
 The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025 - Testing. This document shall not be reproduced, except in full.		Authorised Signatory:  Jacob Lloyd	
NATA Accredited Laboratory Number: 14874		Date: 19/09/2018	
		Macquarie Geotechnical U7/8 10 Bradford Street Alexandria NSW 2015	

Uniaxial Compressive Strength			
Client:	Golder Associates	Sample Source:	BH5 10.51-10.77m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Sandstone
Project:	St Leonards Development (18105360/3000/001)	Report No.:	S42634-UCS
Job No.:	S18381	Lab No.:	S42634
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	Sample Curing:	-
Sampling Method:	Sampled by Client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition
 			
Uniaxial Compressive Strength 9.3 MPa			
Date Tested:	15/09/2018	Moisture Content:	3.9 %
Specimen Height:	142.4 mm	Duration of Test:	602 seconds
Average Specimen Diameter:	51.4 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type: Tensile dominated			
Other Pertinent Observations:			
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Uniaxial Compressive Strength			
Client:	Golder Associates	Sample Source:	BH6 1.73-2m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Sandstone
Project:	St Leonards Development (18105360/3000/001)	Report No.:	S42635-UCS
Job No.:	S18381	Lab No.:	S42635
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	Sample Curing:	-
Sampling Method:	Sampled by Client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition
 			
Uniaxial Compressive Strength 15 MPa			
Date Tested:	15/09/2018	Moisture Content:	6.9 %
Specimen Height:	142.6 mm	Duration of Test:	646 seconds
Average Specimen Diameter:	51.8 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type:	Multiple shear plane		
Other Pertinent Observations:			
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NATA Accredited Laboratory Number: 14874		Jacob Lloyd Date: 19/09/2018	
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Uniaxial Compressive Strength			
Client:	Golder Associates	Sample Source:	BH9 9.1-9.29m
Address:	124 Pacific Highway St Leonards NSW 2065	Sample Description:	Sandstone
Project:	St Leonards Development (18105360/3000/001)	Report No.:	S42636-UCS
Job No.:	S18381	Lab No.:	S42636
Test Procedure:	AS 4133.4.2.2 Determination of uniaxial compressive strength-Rock strength less than 50 MPa		
Testing Machine:	Matest 2000 kN Compression Machine	Sample Curing:	-
Sampling Method:	Sampled by Client	Date Sampled:	Unknown
Storage History:	Sealed	Storage Environment:	Sealed at as received moisture condition
 			
Uniaxial Compressive Strength 17 MPa			
Date Tested:	15/09/2018	Moisture Content:	6.5 %
Specimen Height:	141.6 mm	Duration of Test:	625 seconds
Average Specimen Diameter:	51.7 mm	Rate of Displacement:	< 0.1 mm/min
Failure Type: Single shear plane			
Other Pertinent Observations:			
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APPENDIX E

Limitations

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

This Report constitutes or is part of services ("Services") provided by Golder to its client ("Client") under and subject to a contract between Golder and its Client ("Contract"). The contents of this page are not intended to and do not alter Golder's obligations (including any limits on those obligations) to its Client under the Contract.

This Report is provided for use solely by Golder's Client and persons acting on the Client's behalf, such as its professional advisers. Golder is responsible only to its Client for this Report. Golder has no responsibility to any other person who relies or makes decisions based upon this Report or who makes any other use of this Report. Golder accepts no responsibility for any loss or damage suffered by any person other than its Client as a result of any reliance upon any part of this Report, decisions made based upon this Report or any other use of it.

This Report has been prepared in the context of the circumstances and purposes referred to in, or derived from, the Contract and Golder accepts no responsibility for use of the Report, in whole or in part, in any other context or circumstance or for any other purpose.

The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

At any location relevant to the Services conditions may exist which were not detected by Golder, in particular due to the specific scope of the investigation Golder has been engaged to undertake. Conditions can only be verified at the exact location of any tests undertaken. Variations in conditions may occur between tested locations and there may be conditions which have not been revealed by the investigation and which have not therefore been taken into account in this Report.

Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification



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