# GEOTECHNICAL INVESTIGATION:

New Duplex at **6 Neild Avenue, Balgowlah**

## 1. Proposed Development

**1.1** Demolish the existing house and garage and construct a new part-two storey duplex with basement by excavating to a maximum depth of ~1.5m.

**1.2** Details of the proposed development are shown on 8 architectural drawings prepared by Sean Smyth Design, Job Number 2020/110, drawings numbered SK00 to SK07, revision B, all dated 14/11/2020

## 2. Site Description

**2.1** The site was inspected on the 1st February, 2023.

**2.2** This residential property is on the low side of the road and has an E aspect. The block is located on the gently graded reaches of a hillslope. The natural slope falls across the property at an average angle of ~5°. The slope above and below the property continues at similar angles.

**2.3** At the road frontage, a brick and concrete driveway runs down the slope past the N side of the house to a brick garage on the downhill side of the property (Photos 1 & 2). The part three-storey brick house is supported on sandstone block and brick walls, and brick piers (Photo 3). The supporting walls show no significant signs of movement and the visible brick piers appear to stand vertical. A cut has been made for the basement level of the house. The cut has been taken through competent Medium Strength Sandstone bedrock and displays no signs of geological defects (Photos 4, 5 & 6). A fill has been placed on the SE corner of the property for a level area (Photo 7). The fill is supported by a stable brick wall ~0.5m high. All the existing structures on the property will be demolished as part of the proposed works.

## 3. Geology

The Sydney 1:100 000 Geological sheet indicates the site is underlain by Hawkesbury Sandstone. It is described as a medium to coarse grained quartz sandstone with very minor shale and laminite lenses.

## 4. Subsurface Investigation

One hand Auger Hole (AH) was put down to identify the soil materials. Eight Dynamic Cone Penetrometer (DCP) tests were put down to determine the relative density of the overlying soil and the depth to weathered rock. The locations of the tests are shown on the site plan attached. It should be noted that a level of caution should be applied when interpreting DCP test results. The test will not pass through hard buried objects so in some instances it can be difficult to determine whether refusal has occurred on an obstruction in the profile or on the natural rock surface. This is not expected to be an issue for the testing on this site. However, excavation and foundation budgets should always allow for the possibility that the interpreted ground conditions in this report vary from those encountered during excavations. See the appended "Important information about your report" for a more comprehensive explanation. The results are as follows:

**AUGER HOLE 1** (~RL33.1) **–** AH1 (Photo 8)

| Depth (m) | Material Encountered |
|---|---|
| 0.0 to 0.2 | **FILL**, disturbed clayey sand, dark brown & yellow, medium dense, damp, medium grained with fine trace organic matter. |
| 0.2 to 0.5 | **CLAYEY SAND**, dark brown, loose, damp, medium grained. |
| 0.5 to 0.7 | **CLAYEY SAND**, grey-brown, medium dense, wet, medium grained. |

Refusal @ 0.7m. Auger grinding on the rock surface. No water table encountered.

**DCP TEST RESULTS ON NEXT PAGE**

| DCP TEST RESULTS – Dynamic Cone Penetrometer | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Equipment: 9kg hammer, 510mm drop, conical tip. | | | | | | | Standard: AS1289.6.3.2 - 1997 | |
| **Depth(m) Blows/0.3m** | **DCP 1** (~RL33.0) | **DCP 2** (~RL32.6) | **DCP 3** (~RL32.9) | **DCP 4** (~RL33.1) | **DCP 5** (~RL33.9) | **DCP 6** (~RL34.8) | **DCP 7** (~RL34.8) | **DCP 8** (~RL35.1) |
| 0.0 to 0.3 | Rock exposed at surface | Rock exposed at surface | 4 | 4 | 1F | 3 | 3 | 2 |
| 0.3 to 0.6 | | | 3F | 3F | 1 | 4 | 5 | 2 |
| 0.6 to 0.9 | | | 2 | 8 | 8 | 8 | 6 | 4 |
| 0.9 to 1.2 | | | 10 | # | # | 9 | 3 | 8 |
| 1.2 to 1.5 | | | # | | | 11 | 6 | # |
| 1.5 to 1.8 | | | | | | 31 | 8 | |
| 1.8 to 2.1 | | | | | | 30 | 14 | |
| 2.1 to 2.4 | | | | | | # | 25 | |
| 2.4 to 2.7 | | | | | | | # | |
| | | | Refusal on Rock @ 1.3m | Refusal on Rock @ 0.7m | Refusal on Rock @ 0.8m | End of Test @ 2.0m | Refusal on Rock @ 2.4m | Refusal on Rock @ 1.2m |

#refusal/end of test. F = DCP fell after being struck showing little resistance through all or part of the interval.

***DCP Notes:***

DCP1 – Medium Strength Sandstone exposed at surface.
DCP2 – Medium Strength Sandstone exposed at surface.
DCP3 – Refusal on rock @ 1.3m, DCP bouncing off rock surface, brown clayey sand on wet tip.
DCP4 – Refusal on rock @ 0.7m, DCP bouncing off rock surface, wet muddy tip.
DCP5 – Refusal on rock @ 0.8m, DCP bouncing off rock surface, brown sand on damp tip.
DCP6 – End of test @ 2.0m, DCP still very slowly going down, red clay on wet tip. Brown clay streak up rod.
DCP7 – Refusal on rock @ 2.4m, DCP bouncing off rock surface, wet muddy tip. Brown clay streak up rod.
DCP8 – Refusal on rock @ 1.2m, DCP bouncing off rock surface, brown clayey sand on wet tip.

## 5. Geological Observations/Interpretation

The surface features of the block are controlled by the outcropping and underlying sandstone bedrock that steps down the property forming sub-horizontal benches between the steps. Where the grade is steeper, the steps are larger and the benches narrower. Where the slope eases, the opposite is true. Where the rock is not exposed, it is overlain by sandy soils and clayey sands which fill the bench step formation. In the test locations, where the rock is not exposed, it was encountered at depths of between 0.8m to 1.3m below the current surface. DCP6 ended after a high blow count and DCP7 encountered rock at 2.4m. We interpret these test results were due to variable weather of the rock profile with possible association with jointing. Clay was streaking up the rods for DCP6 & 7 upon extraction indicating that possible jointing is clay filled. The outcropping sandstone on the property is estimated to be Medium Strength or better and similar strength rock is expected to underlie the entire site as all the DCP tests bounced at refusal. See Type Section attached for a diagrammatical representation of the expected ground materials.

## 6. Groundwater

Normal ground water seepage is expected to move over the buried surface of the rock and through the cracks. Due to the slope and elevation of the block, the water table is expected to be many metres below the base of the proposed excavation.

## 7. Surface Water

No evidence of significant surface flows were observed on the property during the inspection. Normal sheet wash from the slope above will be intercepted by the street drainage system for Nield Avenue above.

## 8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed beside the property. The gently graded slope that falls across the property and continues above and below at similar angles is a potential hazard (**Hazard One**), The vibrations from the proposed excavation are a potential hazard (**Hazard**

**Two**). The excavation is a potential hazard until retaining walls are in place (**Hazard Three**). The proposed excavation undercutting the footings for the N neighbouring house and the S common boundary wall is a potential hazard (**Hazard Four**).

**Risk Analysis Summary**

| HAZARDS | Hazard One | Hazard Two |
|---|---|---|
| **TYPE** | The gentle slope that falls across the property and continues above and below failing and impacting on the proposed works. | The vibrations produced during the proposed excavation impacting on the surrounding structures. |
| **LIKELIHOOD** | 'Unlikely' ($10^{-4}$) | 'Possible' ($10^{-3}$) |
| **CONSEQUENCES TO PROPERTY** | 'Minor' (5%) | 'Medium' (15%) |
| **RISK TO PROPERTY** | 'Low' ($5 \times 10^{-6}$) | 'Moderate' ($2 \times 10^{-4}$) |
| **RISK TO LIFE** | $8.3 \times 10^{-7}$/annum | $8.3 \times 10^{-7}$/annum |
| **COMMENTS** | This level of risk is 'ACCEPTABLE'. | This level of risk to property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels, the recommendations in **Section 12** are to be followed. |

**RISK ANALYSIS SUMMARY CONTINUES ON NEXT PAGE**

| HAZARDS | Hazard Three | Hazard Four |
|---|---|---|
| **TYPE** | The excavation collapsing onto the work site before retaining walls are in place. | The proposed excavation undercutting the footings of the N neighbouring house and the S common boundary wall causing failure. |
| **LIKELIHOOD** | 'Possible' ($10^{-3}$) | 'Possible' ($10^{-3}$) |
| **CONSEQUENCES TO PROPERTY** | 'Medium' (15%) | 'Medium' (35%) |
| **RISK TO PROPERTY** | 'Moderate' ($2 \times 10^{-4}$) | 'Moderate' ($2 \times 10^{-4}$) |
| **RISK TO LIFE** | $2.3 \times 10^{-5}$/annum | $5.0 \times 10^{-5}$/annum |
| **COMMENTS** | This level of risk to life and property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels, the recommendations in **Section 13 and 14** are to be followed. | This level of risk to life and property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels, the recommendations in **Section 13** are to be followed. |

(See Aust. Geomech. Jnl. Mar 2007 Vol. 42 No 1, for full explanation of terms)

## 9. Suitability of the Proposed Development for the Site

The proposed development is suitable for the site. No geotechnical hazards will be created by the completion of the proposed development provided it is carried out in accordance with the requirements of this report and good engineering and building practice.

## 10. Stormwater

The fall is away from the street. The stormwater engineer is to refer to council stormwater policy for suitable options for stormwater disposal.

## 11. Excavations

An excavation to a maximum depth of ~1.5m is required for the proposed duplex.

The excavation is expected to be through soil and clayey sand with Medium Strength Sandstone expected at depths of between of 0.7m and 1.3m below the current surface where it is not exposed in the area of the proposed excavation.

It is envisaged that excavations through shallow soil and clayey sand can be carried out with an excavator and toothed bucket and excavations through rock will require grinding or rock sawing and breaking.

## 12. Vibrations

Possible vibrations generated during excavations through soil and clayey sand will be below the threshold limit for building damage. It is expected that the majority of the excavation will be through Medium Strength Sandstone or better.

Excavations through rock should be carried out to minimise the potential to cause vibration damage to the neighbouring houses to the N and S. Allowing for ~0.5m of back wall drainage, the setbacks are as follows:

- ~1.5m from the N neighbouring house.
- ~3.5m from the S neighbouring house.

To reduce the likelihood of spurious building damage claims, dilapidation reporting carried out on the N and S neighbouring properties is recommended prior to the excavation works commencing.

Close controls by the contractor over rock excavation are recommended so excessive vibrations are not generated.

Excavation methods are to be used that limit peak particle velocity to 5 mm/sec at the N and S neighbouring house walls. Vibration monitoring will be required to verify this is achieved. The vibration monitoring equipment must include a light/alarm so the operator knows if vibration limits have been exceeded. It also must log and record vibrations throughout the excavation works.

In Medium Strength Rock or better techniques to minimise vibration transmission will be required. These include:

- Rock sawing the excavation perimeter to at least 1.0m deep prior to any rock breaking with hammers, keeping the saw cuts below the rock to be broken throughout the excavation process.
- Limiting rock hammer size.
- Rock hammering in short bursts so vibrations do not amplify.
- Rock breaking with the hammer angled away from the nearby sensitive structures.
- Creating additional saw breaks in the rock where vibration limits are exceeded.
- Use of rock grinders (milling head).

Should excavation induced vibrations exceed vibration limits after the recommendations above have been implemented, excavation works are to cease immediately and our office is to be contacted.

It is worth noting that vibrations that are below thresholds for building damage may be felt by the occupants of the subject house and neighbouring houses.

## 13. Excavation Support Requirements

The excavation will reach a maximum depth of ~1.5m. Allowing for 0.5m of back wall drainage, the setbacks are as follows:

- ~1.5m from the S common boundary masonry wall.
- ~1.5m from the N neighbouring house and N common boundary.

As such, the N neighbouring house and N and S common boundaries are expected to be within the zone of influence of the proposed excavation. In this instance, the zone of influence is the area above a theoretical 30° line from the base of the excavation or top of Medium Strength Rock, whichever is encountered first, towards the surrounding structures and boundaries.

Where the N neighbouring house and the S common boundary wall falls within the zone of influence of the excavation, exploration pits along the walls will need to be put down by the

builder to determine the foundation depth and material. These are to be inspected by the geotechnical consultant.

If the foundations are confirmed to be supported on rock or extend below the zone of influence of the proposed excavation, the excavation may commence. If they are not, the supporting walls will need to be underpinned to rock or to below the zone of influence of the cut prior to the excavation commencing. See the site plan attached for the minimum extent of the required exploration pits/underpinning.

The owners of the N neighbouring property will need to provide their permission for the underpinning works. If permission cannot be granted, our office is to be contacted to provide an alternative means of support.

Underpinning is to follow the underpinning sequence 'hit one miss two'. Under no circumstances is the bulk excavation to be taken to the edges of the walls and then underpinned. Underpins are to be constructed from drives that should be proportioned according to footing type and size. Allowances are to be made for drainage through the underpinning to prevent a build-up of hydrostatic pressure. Underpins that are not designed as retaining walls are to be supported by retaining walls. The void between the retaining walls and the underpinning is to be filled with free-draining material such as gravel.

The soil and clayey sand portions of the remaining excavation faces are to be battered temporarily at 1.0 Vertical to 1.7 Horizontal (30°) until the retaining walls are in place. Medium Strength Sandstone or better is expected to stand at vertical angles unsupported subject to approval by the geotechnical consultant.

During the excavation process, the geotechnical consultant is to inspect the cuts at 1.2m to ensure the ground materials are as expected and no wedges or other geological defects are present that could require additional support. Should additional ground-support be required, this will likely involve the use of mesh, sprayed concrete, and rock bolts.

Upslope runoff is to be diverted from the cut faces by sandbag mounds or other diversion works. Unsupported cut batters through soil and clay are to be covered to prevent access of water in wet weather and loss of moisture in dry weather. The covers are to be tied down with metal pegs or other suitable fixtures so they cannot blow off in a storm. The materials and labour to construct the retaining walls are to be organised so on completion of the excavations they can be constructed as soon as possible. The excavations are to be carried out during a dry period. No excavations are to commence if heavy or prolonged rainfall is forecast.

Upon completion of the excavation, it is recommended all cut faces be supported with retaining walls to prevent any potential future movement of joint blocks in the cut face that can occur over time, when unfavourable jointing is obscured behind the excavation face. Additionally, retaining walls will help control seepage and to prevent minor erosion and sediment movement. Excavation spoil may be used for landscaping on site.

All excavation spoil is to be removed from site following the current Environmental Protection Agency (EPA) waste classification guidelines.

## 14. Retaining Structures

For cantilever or singly-propped retaining structures, it is suggested the design be based on a triangular pressure distribution of lateral pressures using the parameters shown in Table 1.

**Table 1 – Likely Earth Pressures for Retaining Structures**

| Unit | Earth Pressure Coefficients | | |
|---|---|---|---|
| | Unit weight (kN/m$^3$) | 'Active' $K_a$ | 'At Rest' $K_0$ |
| Soil and Clayey Sand | 20 | 0.40 | 0.55 |
| Medium Strength Sandstone | 24 | 0.00 | 0.01 |

For rock classes refer to Pells et al "Design Loadings for Foundations on Shale and Sandstone in the Sydney Region". Australian Geomechanics Journal 1978.

It is to be noted that the earth pressures in Table 1 assume a level surface above the structure, do not account for any surcharge loads, and assume retaining structures are fully drained. Rock strength and relevant earth pressure coefficients are to be confirmed on site by the geotechnical consultant.

All retaining structures are to have sufficient back-wall drainage and be backfilled immediately behind the structure with free-draining material (such as gravel). This material is to be wrapped in a non-woven Geotextile fabric (i.e., Bidim A34 or similar), to prevent the drainage from becoming clogged with silt and clay. If no back-wall drainage is installed in retaining structures, the likely hydrostatic pressures are to be accounted for in the structural design.

## 15. Foundations

The proposed duplex is expected to be partially seated in Medium Strength Sandstone. This is a suitable foundation material. This ground material is expected to be exposed across the uphill side of the excavation. Where it is not exposed, and where the footprint of the duplex does not fall over the excavation, shallow piers taken to rock will be required to maintain a uniform foundation material across the structure. The piers for the duplex are expected to encounter Medium Strength Sandstone at depths of between 0.7m to 1.3m below the current surface.

A maximum allowable bearing pressure of 1000kPa can be assumed for footings on Medium Strength Sandstone.

Naturally occurring vertical cracks (known as joints) commonly occur in sandstone. These are generally filled with soil and are the natural seepage paths through the rock. They can extend to depths of several metres and are usually relatively narrow but can range between 0.1 to 0.8m wide. If a footing falls over a joint in the rock, the construction process is simplified if, with the approval of the structural engineer, the joint can be spanned or, alternatively, the footing can be repositioned so it does not fall over the joint.

***NOTE***: If the contractor is unsure of the footing material required, it is more cost effective to get the geotechnical consultant on site at the start of the footing excavation to advise on footing depth and material. This mostly prevents unnecessary over-excavation in clay like shaly rock but can be valuable in all types of geology.

## 16. Inspections

The client and builder are to familiarise themselves with the following required inspections as well as council geotechnical policy. We cannot provide geotechnical certification for the owner or the regulating authorities if the following inspections have not been carried out during the construction process.

- The exploration pits to determine the foundation material along the N neighbouring house and the S boundary wall are to be inspected by the geotechnical consultant to determine if underpinning is necessary. This is to occur before the bulk excavation for the basement commences.
- During the excavation process, the geotechnical consultant is to inspect the cut faces as they are lowered to 1.2m to ensure ground materials are as expected and that there are no wedges or other defects present in the rock that may require additional support.
- All footings are to be inspected and approved by the geotechnical consultant while the excavation equipment and contractors are still onsite and before steel reinforcing is placed or concrete is poured.

White Geotechnical Group Pty Ltd.

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*Photo 1*


*Photo 2*


*Photo 3*


*Photo 4*


*Photo 5*


*Photo 6*


*Photo 7*


*Photo 8 (AH1 - Downhole from Left to Right)*

## Important Information about Your Report

It should be noted that Geotechnical Reports are documents that build a picture of the subsurface conditions from the observation of surface features and testing carried out at specific points on the site. The spacing and location of the test points can be limited by the location of existing structures on the site or by budget and time constraints of the client. Additionally, the test themselves, although chosen for their suitability for the particular project, have their own limiting factors. The testing gives accurate information at the location of the test, within the confines of the test's capability. A geological interpretation or model is developed by joining these test points using all available data and drawing on previous experience of the geotechnical consultant. Even the most experienced practitioners cannot determine every possible feature or change that may lie below the earth. All of the subsurface features can only be known when they are revealed by excavation. As such, a Geotechnical report can be considered an interpretive document. It is based on factual data but also on opinion and judgement that comes with a level of uncertainty. This information is provided to help explain the nature and limitations of your report.

With this in mind, the following points are to be noted:

- If upon the commencement of the works the subsurface ground or ground water conditions prove different from those described in this report, it is advisable to contact White Geotechnical Group immediately, as problems relating to the ground works phase of construction are far easier and less costly to overcome if they are addressed early.

- If this report is used by other professionals during the design or construction process, any questions should be directed to White Geotechnical Group as only we understand the full methodology behind the report's conclusions.

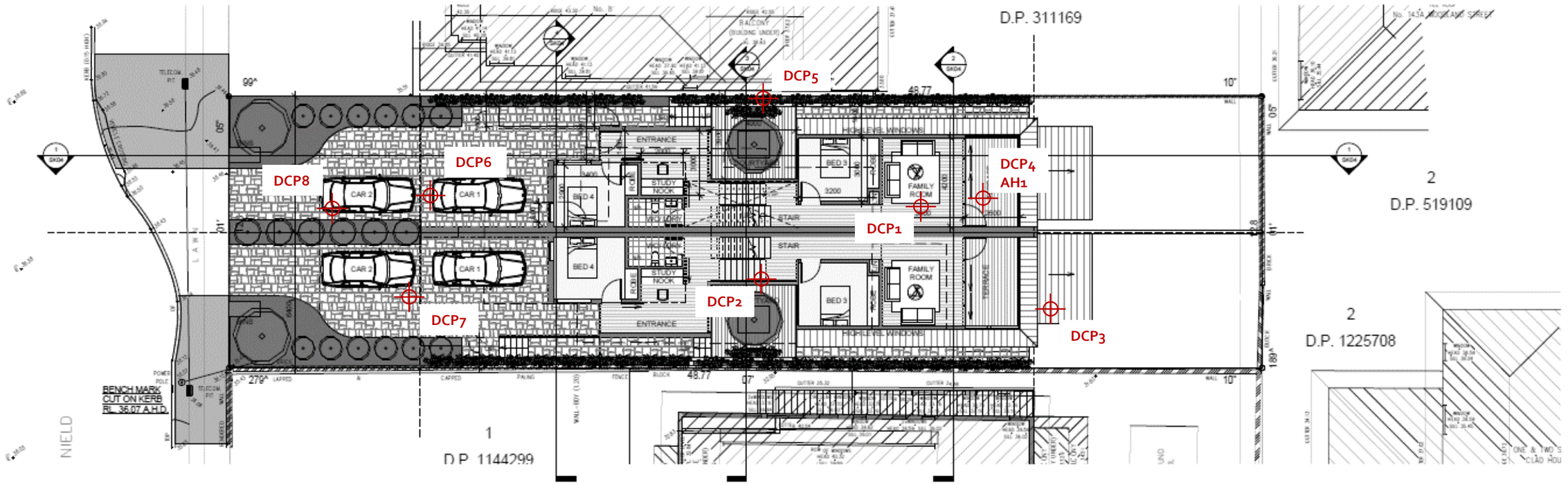
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- This report should not be applied to any other project other than that outlined in section 1.0.

- This report is to be read in full and should not have sections removed or included in other documents as this can result in misinterpretation of the data by others.

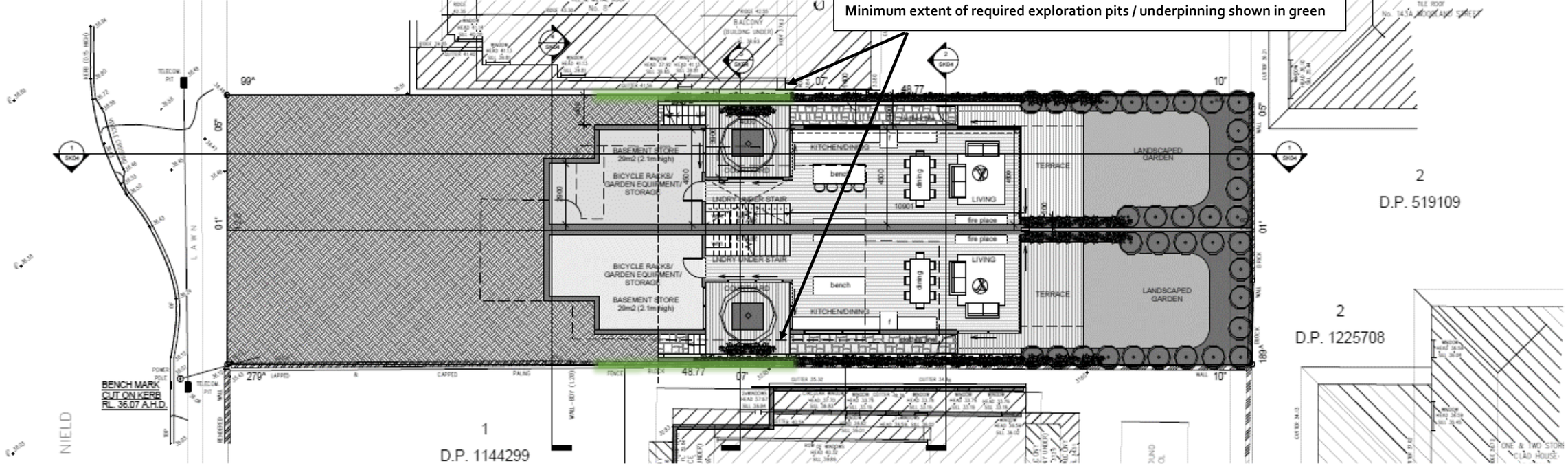
- It is common for the design and construction process to be adapted as it progresses (sometimes to suit the previous experience of the contractors involved). If alternative design and construction processes are required to those described in this report, contact White Geotechnical Group. We are familiar with a variety of techniques to reduce risk and can advise if your proposed methods are suitable for the site conditions.

# SITE PLAN – showing test locations




2 UPPER GROUND & FIRST FLOOR
1 : 100

Minimum extent of required exploration pits / underpinning shown in green




1 LOWER GROUND FLOOR
1 : 100

| | | |
|---|---|---|
| ISSUED FOR COMMENT | B | 14/11/2020 |
| ISSUED FOR COMMENT | A | 14/11/2020 |
| Amendment / Issue | No. | Date |

All dimensions are in millimetres unless stated otherwise. All drawings are to be read in conjunction with the relevant consultant documents. All dimension and levels are to be checked and verified on site prior to the commencement of work. Also drawings or fabrication of any components. Drawings are not to be scaled, use only figured dimensions. This drawing is the exclusive property of Sean Smyth Design Pty Ltd and must not be retained, copied or used without permission. This document has been prepared for and on behalf of the clients listed on the drawing.

PROPRIETOR: P&T

PROJECT TITLE: NEW DUAL OCCUPANCY AT 6 NIELD AVENUE

SHEET TITLE: BASEMENT & LOWER GROUND / UPPER GROUND AND LOWER FIRST FLOOR PLANS

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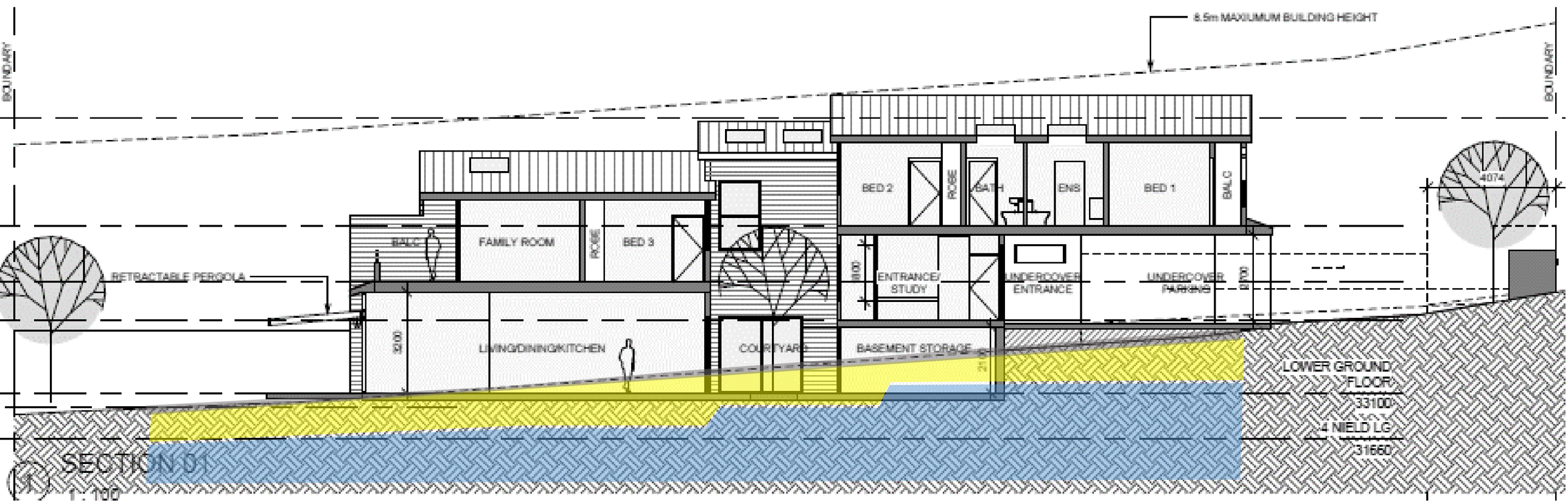
| | | | |
|---|---|---|---|
| SCALE: | 1 : 100 | DATE: | 14 NOV 2020 |
| DRAWN: | Author | CHECKED: | |
| PROJECT NO: | 2020/110 | REV: | B |
| DRAWING NO: | SK01 | | |

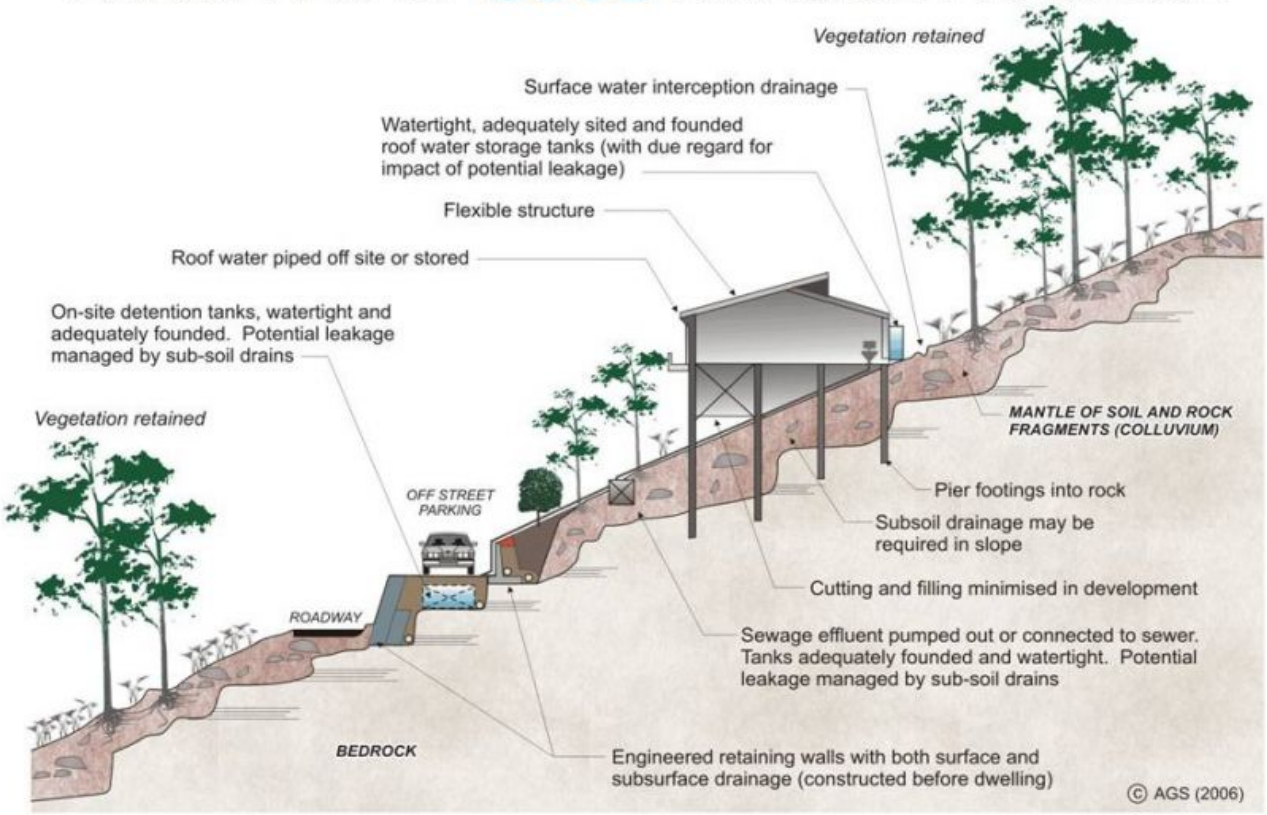
**TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials**




**Expected Ground Materials**

- Fill
- Topsoil
- Clayey Sand
- Hawkesbury Sandstone – Medium Strength

# EXAMPLES OF **GOOD** HILLSIDE PRACTICE




# EXAMPLES OF **POOR** HILLSIDE PRACTICE