GEOTECHNICAL INVESTIGATION:

Alterations and Additions at **150 Queenscliff Road, Queenscliff**

1. Proposed Development

1.1 Demolish the existing garage on the downhill side of the property and construct a new garage with secondary dwelling over in the same location by excavating to a maximum depth of ~6.9m.

1.2 Construct a new carport on the uphill side of the property.

1.3 Enclose the existing terrace on the uphill side of the house.

1.4 Construct new balconies on the downhill side of the house.

1.5 Demolish the existing roof and construct a new roof.

1.6 Various other minor internal and external alterations.

1.7 Details of the proposed development are shown on 15 drawings prepared by Scope Architects, Project number 02201, drawings numbered A05 and A09 are unrevised and drawings numbered A01 to A04, A06 to A08, and A10 to A15 are Revision 1, all drawings dated 5/7/22.

2. Site Description

2.1 The site was inspected on the 6th June, 2022.

2.2 This residential property has dual access. It is on the uphill side of Aitken Avenue and on the downhill side of Queenscliff Road. The property has a S aspect. The block is located on the steeply graded lower reaches and toe of a hillslope. The slope falls across the site at an average angle of ~23°. The slope above the property continues at decreasing angles. The slope below the property falls at near-level angles across the road before encountering Manly Lagoon.

2.3 The fill for Queenscliff Road is supported by a formed concrete retaining wall reaching ~2.0m high (Photo 1). The wall approximates the road frontage and displays some vertical cracking but no deflection and is currently considered stable. Between the road frontage and the house is a gentle to moderately sloping lawn and garden area (Photo 2). An excavation has been made in the slope for the lower ground floor of the house. The cut is supported by a stable ~1.8m high mortared sandstone block retaining wall (Photo 3). The W end of this wall was observed to be supported directly onto outcropping Medium Strength Sandstone (Photo 4). The part two-storey brick house is supported on brick walls and brick piers (Photo 5). The supporting walls display no significant signs of movement and the supporting piers stand vertical. The E side of the house was observed to be supported directly onto outcropping Medium Strength Sandstone (Photo 6). A steep garden slope falls from the downhill side of the house to the lower road frontage with Aitken Avenue (Photo 7). Medium Strength Sandstone outcrops through this slope in places (Photo 8). A fill at the lower portion of this slope is supported by a stable mortared stack rock retaining wall ~1.8m high (Photo 9). A garage has been cut into the slope at the road frontage to Aitken Avenue (Photo 10). The garage 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

Eight Dynamic Cone Penetrometer (DCP) tests were put down to determine the relative density of the overlying soil and the depth to bedrock. 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:

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** (~RL3.2)	**DCP 2** (~RL5.6)	**DCP 3** (~RL7.2)	**DCP 4** (~RL9.7)	**DCP 5** (~RL10.1)	**DCP 6** (~RL13.6)	**DCP 7** (~RL16.0)	**DCP 8** (~RL16.2)
0.0 to 0.3	1	Rock Exposed at Surface	Rock Exposed at Surface	2	Rock Immediately Below Surface	Rock Exposed at Surface	3	F
0.3 to 0.6	2F			11			4	4
0.6 to 0.9	1			6			6	3
0.9 to 1.2	3			#			#	6
1.2 to 1.5	7							#
1.5 to 1.8	13							
1.8 to 2.1	#							
	Refusal on Rock @ 1.7m			Refusal on Rock @ 0.8m			Refusal on Rock @ 0.7m	Refusal on Rock @ 1.0m

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

DCP Notes:

DCP1 – Refusal on rock @ 1.7m, DCP bouncing off rock surface, wet muddy tip.
DCP2 – Medium Strength Sandstone exposed at surface.
DCP3 – Medium Strength Sandstone exposed at surface.
DCP4 – Refusal on rock @ 0.8m, DCP bouncing off rock surface, wet muddy tip.
DCP5 – Medium Strength Sandstone immediately below surface (<0.1m).
DCP6 – Medium Strength Sandstone exposed at surface.

DCP7 – Refusal on rock @ 0.7m, DCP bouncing off rock surface, white impact dust on wet muddy tip.
DCP8 – Refusal on rock @ 1.0m, DCP bouncing off rock surface, wet muddy 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 natural sandy soils and firm to stiff sandy clays that fill the bench step formation. In the test locations, where it was not exposed, rock was typically encountered at depths of between 0.7 to 1.0m below the current surface. DCP1 was located at the toe of the slope. As such, the rock in this location was encountered deeper than the other tests. The exposed sandstone across the site is estimated to be Medium Strength and a similar strength rock is expected to underly the entire site. 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 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 Queenscliff Road above.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed below or beside the property. The steeply graded land surface that falls across the property and continues above is a potential hazard (**Hazard One**). The vibrations from the proposed excavation are a potential hazard (**Hazard Two**). A loose boulder, wedge, or similar geological defect toppling onto the work site during the excavation process is a potential hazard (**Hazard Three**).

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two	Hazard Three
TYPE	The steep slope that falls across the property and continues above failing and impacting on the proposed works.	The vibrations produced during the proposed excavation impacting on the supporting walls of the subject and neighbouring houses.	A loose boulder, wedge, or similar geological defect toppling onto the work site during the excavation process.
LIKELIHOOD	'Unlikely' (10^{-4})	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (15%)	'Medium' (15%)	'Medium' (20%)
RISK TO PROPERTY	'Low' (2×10^{-5})	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	5.5×10^{-7}/annum	5.3×10^{-7}/annum	9.6×10^{-5}/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.	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 to Aitken Avenue. Roof water from the development is to be piped to the street drainage system through any tanks that may be required by the regulating authorities.

11. Excavations

An excavation to a maximum depth of ~6.9m is required to construct the proposed garage with studio over. The excavation is expected to be through sandy soils over firm to stiff sandy clays. Where Medium Strength Sandstone is not exposed at the surface, it is expected to be encountered at a maximum depth of ~0.8m below the current surface.

It is envisaged that excavations through sandy soil and clays can be carried out with a toothed bucket and excavations through rock will require grinding or rock sawing and breaking.

12. Vibrations

Possible vibrations generated during excavations through sandy soils and clays will be below the threshold limit for building damage.

Excavations through Medium Strength Rock or better should be carried out to minimise the potential to cause vibration damage to the subject house and neighbouring house to the W. Allowing for backwall-drainage, the excavation will be set back ~2.3m from the supporting walls of the subject house and ~1.3m from the supporting walls of the W neighbouring house.

Dilapidation reporting carried out on the W neighbouring property is recommended prior to the excavation works commencing.

Excavation methods are to be used that limit peak particle velocity to 8mm/sec at the property boundaries. 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.

13. Excavation Support Requirements

Due to the shallow depth to Medium Strength Sandstone, no structures or boundaries will be within the zone of influence of the excavation. In this instance, the zone of influence is the area above a theoretical 30° line through soil, and a 45° line through clay from the top of Medium Strength Sandstone towards the surrounding structures and boundaries.

The soil and clay portions of the cut are to be temporarily or permanently supported before the excavation through rock commences. Medium Strength Sandstone or better will stand at vertical angles unsupported subject to approval by the geotechnical consultant.

Upslope runoff is to be diverted from the cut faces by sandbag mounds or other diversion works. 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.

During the excavation process, the geotechnical consultant is to inspect the excavations as they are lowered in 1.5m intervals 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.

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

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

14. Retaining Walls

For cantilever or singly-propped retaining walls, 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 Walls

Unit	Earth Pressure Coefficients		
	Unit weight (kN/m^3)	**'Active' K_a**	**'At Rest' K_0**
Sandy Soil and Residual Clay	20	0.4	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 wall, do not account for any surcharge loads, and assume retaining walls are fully drained. Rock strength and relevant earth pressure coefficients are to be confirmed on site by the geotechnical consultant.

All retaining walls are to have sufficient back-wall drainage and be backfilled immediately behind the wall 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 walls, the likely hydrostatic pressures are to be accounted for in the structural design.

15. Foundations

Concrete slabs supported directly off Medium Strength Sandstone are suitable footings for the proposed garage. This material is expected to be exposed across the majority of the base of the excavation. Where it is not exposed, and where the footprint of the proposed studio does not fall over the excavation, piers will be required to maintain a uniform bearing material.

The proposed carport on the uphill side of the property and proposed decks on the downhill side of the house are to be supported on piers taken to the underlying Medium Strength Sandstone. This material is expected at variable depths of between 0.7 to 1.0m below the current surface where it is not exposed.

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 pad 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.

- During the excavation process, the geotechnical consultant is to inspect the cut faces as they are lowered in 1.5m intervals 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

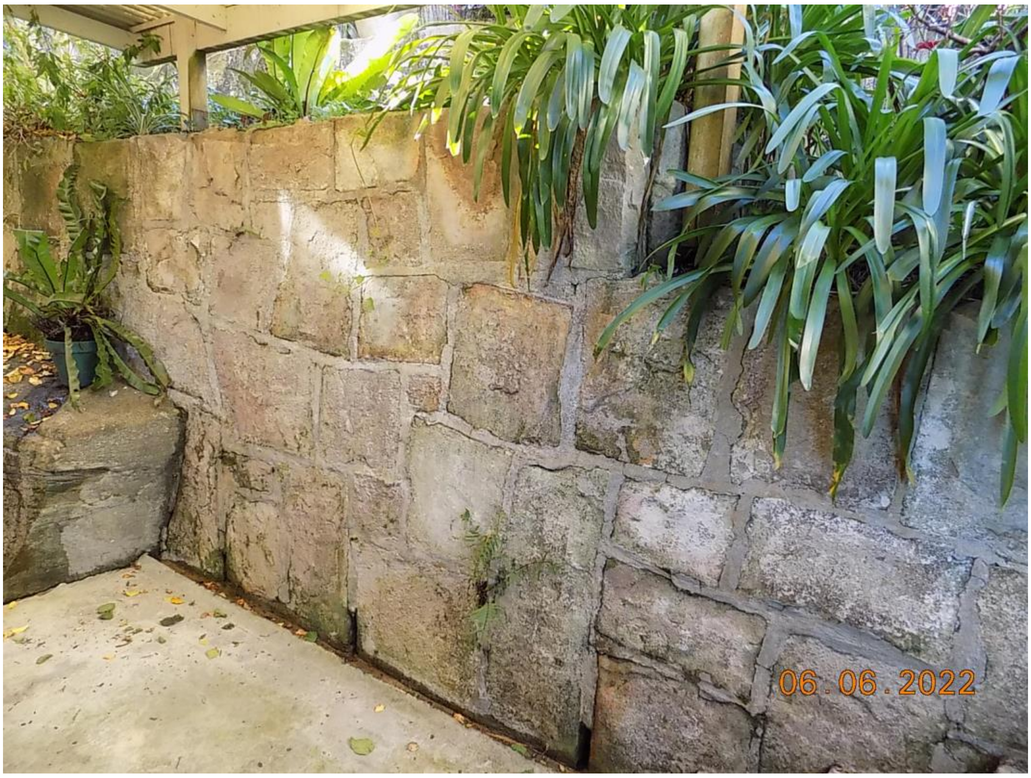


Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

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.

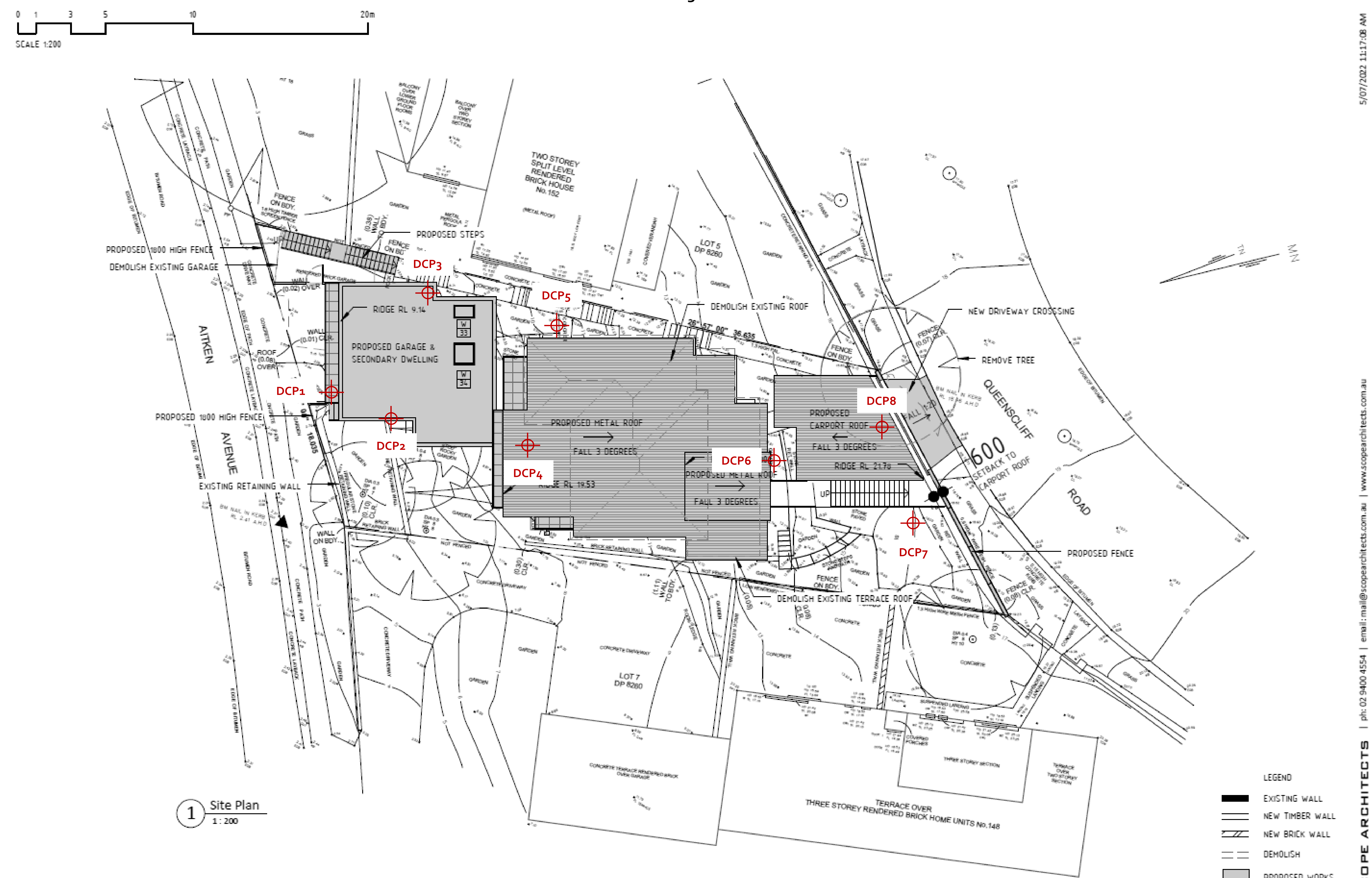
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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



1 Site Plan
1 : 200

No	Revision Description	Date
1	Development Application	05.07.2022

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CLIENT: CHRISTINA & ANTONY CLARKE

PROJECT: Alterations & Additions
150 QUEENSCLIFF RD QUEENSCLIFF 2096
LOT: 6 DP: 8260

DRAWING TITLE: SITE PLAN

TRUE NORTH	DRAWN	PROJECT NO.	DRAWING NO	REV NO
	XK	02201	A01	1
	SIZE: A3	SCALE: As indicated		

5/07/2022 11:17:08 AM

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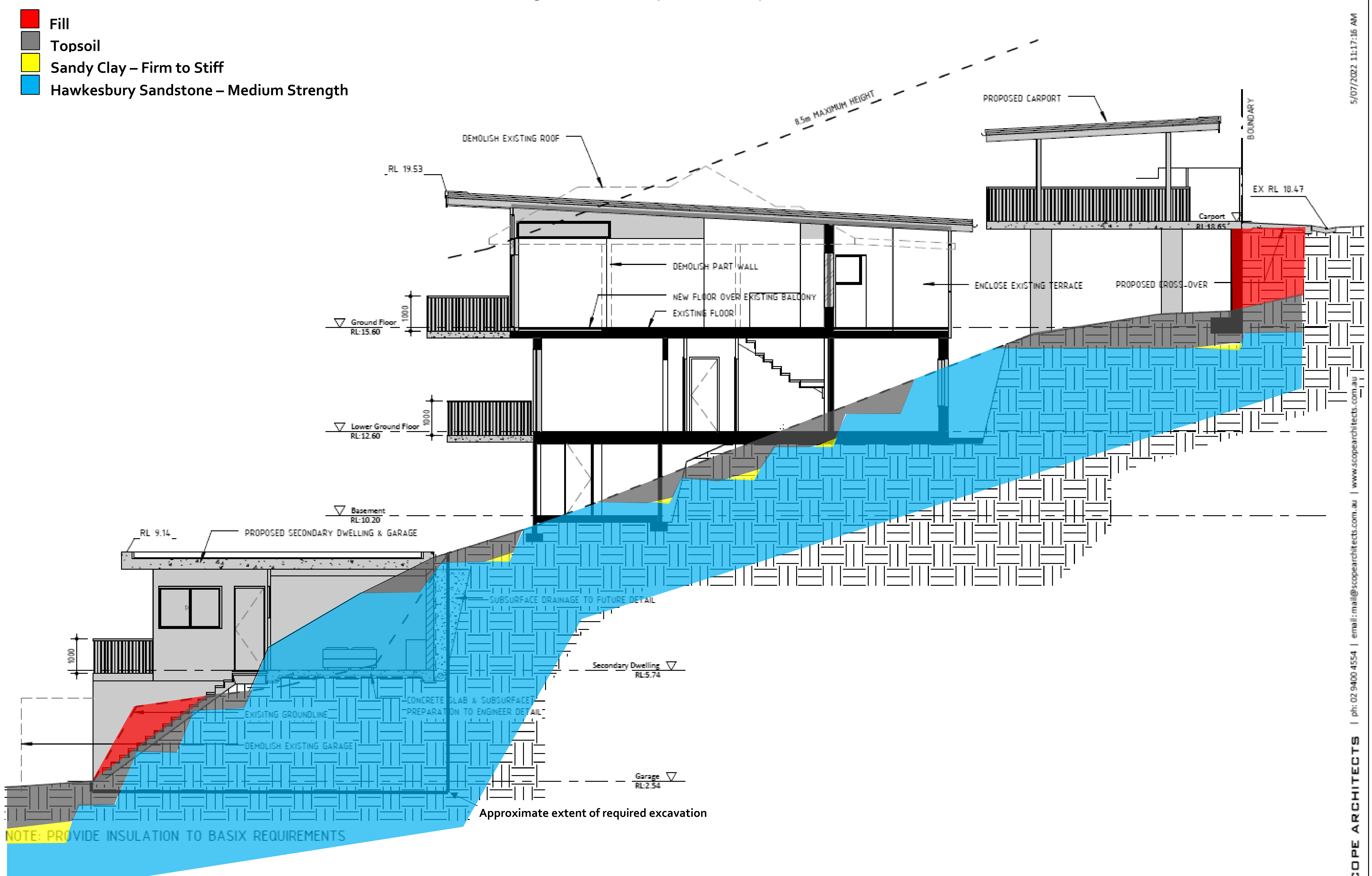
TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



No	Revision Description	Date
1	Development Application	05.07.2022

5/07/2022 11:17:16 AM

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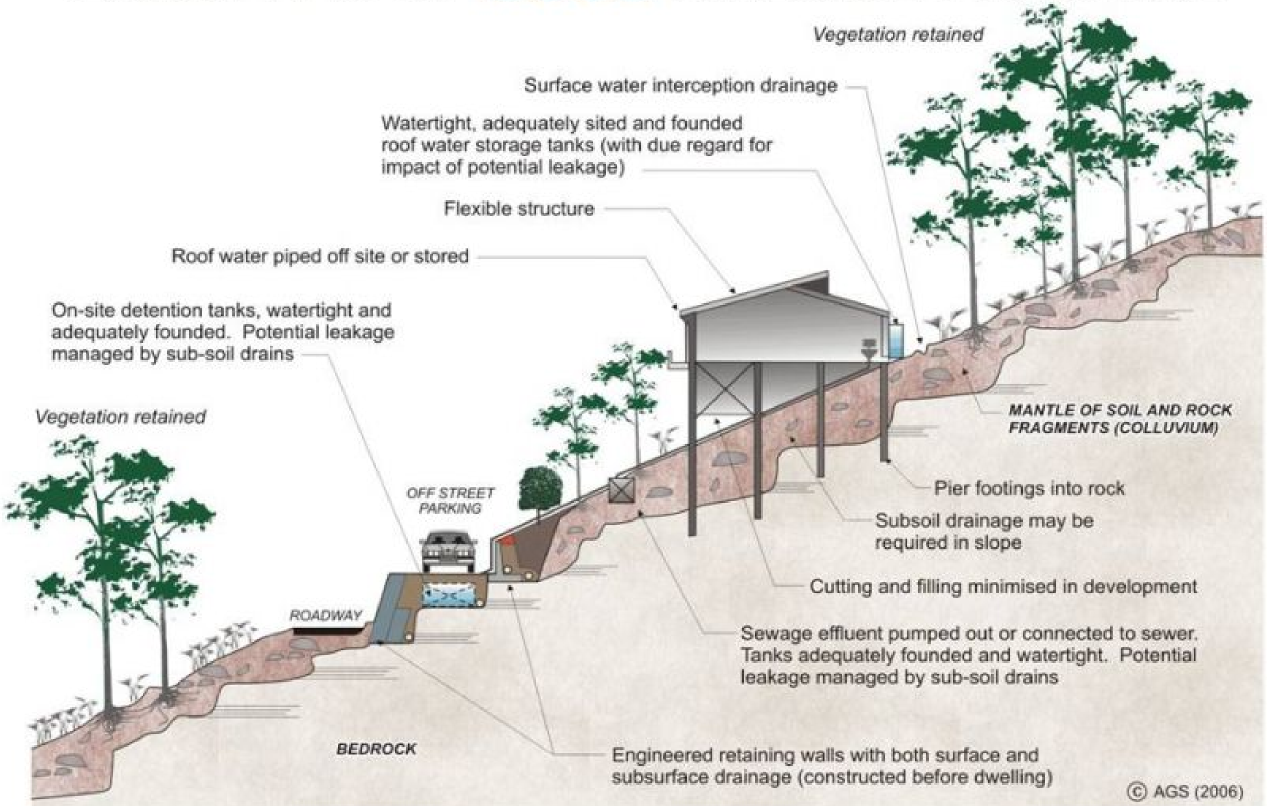
CLIENT	CHRISTINA & ANTONY CLARKE
PROJECT	Alterations & Additions 150 QUEENSCLIFF RD QUEENSCLIFF 2096 LOT: 6 DP: 8260
DRAWING TITLE	SECTIONS
TRUE NORTH	
DRAWN	XK
PROJECT NO.	02201
SIZE	A3
SCALE	1 : 100
DRAWING NO	A11
REV NO	1

EXAMPLES OF GOOD HILLSIDE PRACTICE



EXAMPLES OF POOR HILLSIDE PRACTICE