GEOTECHNICAL INVESTIGATION:

For Alterations and Additions at **21 Wattle Avenue, Fairlight**

1. Proposed Development

1.1 Extend the existing garage at the road frontage by excavating to a maximum depth of ~3.3m.

1.2 Construct a new storage room under the house by excavating to a maximum depth of ~2.1m.

1.3 Construct a new first floor addition.

1.4 Various other internal and external modifications.

1.5 Details of the proposed development are shown on 11 drawings prepared by Sketch Arc, Project number 1712, drawings numbered DA3 to 13, dated 17/7/2018.

2. Site Description

2.1 The site was inspected on the 9th August, 2018.

2.2 This residential property is on the high side of the road and has a N aspect. The block is located on the gentle to moderately graded middle reaches of a hillslope. The slope rises gently across the property at an average angle of ~7°. The slope above and below the property continues at similar angles.

2.3 A garage has been cut into the slope at the road frontage (Photo 1). The internal brick walls of the garage display no signs of movement that could be related to slope instability. The single-storey sandstone block and brick house is supported on sandstone block and brick walls and brick piers (Photos 2 & 3). The supporting walls display no significant signs of movement and the supporting brick piers stand vertical (Photo 4). An excavation has been in the slope to create a level platform for the uphill side of the house. The cut is supported by a ~1.2m high retaining wall that has been dressed in timber cladding (Photo 5). Another cut has been made in the slope for a level lawn area above the house. This cut is supported by another ~1.2m high retaining wall that has been dressed in timber cladding (Photo 6). The construction material and condition of these retaining walls was unable to be determined due to the timber dressing.

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 auger hole was put down to identify the soil materials. Four 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. 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 and the results are as follows:

AUGER HOLE 1 (~RL21.4) **–** AH1 (Photo 7)

Depth (m)	**Material Encountered**
0.0 to 0.9	**FILL**, disturbed sand, dark brown and white, medium to coarse grained with fine trace organic matter and rock fragments.

End of hole @ 0.9m, auger grinding on rock surface. No watertable encountered.

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** (~RL21.4)	**DCP 2** (~RL20.4)	**DCP 3** (~RL20.6)	**DCP 4** (~RL21.4)
0.0 to 0.3	7	7	3	9
0.3 to 0.6	22	#	1	5
0.6 to 0.9	5		#	16
0.9 to 1.2	#			#
	Refusal on Rock @ 0.8m	Refusal on Rock @ 0.3m	Refusal on Rock @ 0.4m	Refusal on Rock @ 0.8m

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

DCP Notes:

DCP1 – Cored through concrete with core drill, slab ~0.2m thick. Refusal on rock @ 0.8m, DCP bouncing off rock surface, grey sand on wet tip.
DCP2 – Refusal on rock @ 0.3m, DCP bouncing off rock surface, white and orange sandstone fragments on dry tip.
DCP3 – Refusal on rock @ 0.4m, DCP bouncing off rock surface, white impact dust on dry tip.
DCP4 – Refusal on rock @ 0.8m, DCP bouncing off rock surface, white impact dust on dry tip.

5. Geological Observations/Interpretation

The surface features of the block are controlled by the underlying sandstone bedrock that steps up 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 manmade filling over sandy soils and sandy clays that fill the bench step formation. In the test locations, the depth to rock ranged between 0.3 to 0.9m below the current surface, being slightly deeper where filling has been placed across the site and due to the stepped nature of the underlying bedrock. It is interpreted from ground tests that the fill across the property reaches a maximum depth of ~0.9m. As the DCP was bouncing off the rock surface at the end of every test, the sandstone underlying the property is estimated to be medium strength or better and similar strength rock is expected to underlie 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 many metres below the base of the proposed excavation.

7. Surface Water

No evidence of surface flows were observed on the property during the inspection. It is expected that normal sheet wash will move onto the site from above the property during heavy down pours.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed above, below, or beside the property. A loose boulder, wedge, or similar geological defect toppling onto the work site during the excavation process is a potential hazard (**Hazard One**). The proposed excavations undercutting the footings for the house is a potential hazard (**Hazard Two**). The vibrations from the proposed excavations are a potential hazard (**Hazard Three**).

RISK ANALYSIS SUMMARY ON THE NEXT PAGE

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two	Hazard Three
TYPE	A loose boulder, wedge, or similar geological defect toppling onto the work site during the excavation process.	The proposed excavations undercutting the footings of the house causing failure (Photos 3 & 4).	The vibrations produced during the proposed excavations impacting on the surrounding structures and boundaries.
LIKELIHOOD	'Possible' (10^{-3})	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (20%)	'Medium' (35%)	'Medium' (15%)
RISK TO PROPERTY	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	6.3×10^{-5}/annum	5.3×10^{-5}/annum	5.3×10^{-7}/annum
COMMENTS	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.	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.	This level of risk to property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels the recommendations in **Section 12** 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 the street. Roof water from the proposed 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 ~3.3m is required to construct the proposed extension to the garage at the road frontage. Another excavation to a maximum depth of ~2.1m is required to construct the proposed storage room under the house. The excavations are expected to be through a manmade fill over sandy soil and firm to stiff sandy clay with Medium Strength Sandstone expected at a maximum depth of ~0.9m below the current surface. It is envisaged that excavations through fill, sandy soil, and sandy clays can be carried out with a bucket and excavations through rock will require grinding or rock sawing and breaking.

12. Vibrations

Possible vibrations generated during excavations through fill, sandy soil, and sandy clays will be below the threshold limit for building damage. The majority of the excavations are expected to be through Medium Strength Sandstone.

Excavations through Medium Strength Sandstone should be carried out to minimise the potential to cause vibration damage to the subject house and neighbouring properties to the E and W. The supporting walls and brick piers of the subject house will be immediately beside the proposed excavations, the neighbouring property to the E will be as close as 2.2m, and the neighbouring property to the W will be as close as 6.0m from the edges of the proposed excavation for the storage room. 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 5mm/sec at the supporting walls of the subject house and common boundaries. Vibration monitoring will be required to verify this is achieved.

If a milling head is used to grind the rock, vibration monitoring will not be required. Alternatively, if rock sawing is carried out around the perimeter of the excavation boundaries in not less than 1.0m lifts, a rock hammer up to 300kg could be used to break the rock without vibration monitoring. Peak particle velocity will be less than 5mm/sec at the common boundaries using this method provided the saw cuts are kept well below the rock to broken.

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

13. Excavation Support Requirements

The proposed excavation for the storage room will be taken within the foundation space of the house (Photo 4) and the proposed excavation for the garage extension will be taken close to flush with the downhill supporting wall of the house (Photo 3). Thus, the supporting walls and piers of the house will be within the zone of influence of both excavations. They will need to be underpinned if they are not already supported on competent rock.

Where the supporting sandstone block and brick walls and brick piers of the house are within the zone of influence of the proposed excavations, if the walls/foundations are not supported on competent rock, they will need to be underpinned to competent rock or to the base of the excavation, whichever is encountered first, before any excavation commences. The zone of influence, in this instance, is the area above a theoretical 30° line extending from the top of Medium Strength Sandstone or from the base of the proposed excavation, whichever is encountered first, towards the surrounding footings.

Given the depth to rock, we think it likely the house is supported on rock, however, to be sure, exploration pits along the walls/beside the footings will need to be put down by the builder to determine the foundation material. These are to be inspected by the geotechnical consultant.

If the foundations are found to be supported on competent rock, the excavation may commence. If they are not on rock, the walls/piers will need to be underpinned prior to the excavation commencing.

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 or piers and then underpinned. Underpins are to be constructed from drives that should not exceed 0.8m in width along strip footings. 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.

Where underpinning is not required, the soil portions of the excavations are to be battered at 30°. The clay portions of the cuts will stand at near-vertical angles for short periods of time until the retaining walls are installed, provided the cut batters are kept dry. Excavations through Medium Strength Sandstone or better will stand at vertical angles unsupported subject to approval by the geotechnical consultant.

Unsupported cut batters through fill, 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 can’t blow off in a storm. 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 cuts in 1.5m intervals as they are lowered to ensure the ground materials are as expected and no wedges or other geological defects are present that could require additional support.

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 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 provided it is battered permanently at 1.0 Vertical to 2.0 Horizontal (26°) or be supported by engineered retaining walls.

14. Retaining Walls

Retaining walls supporting fill, sandy soil, and firm to stiff sandy clays can be designed for a lateral earth pressure coefficient K_a of 0.35 and assume a bulk density of 20kN/m^3. Cuts through Low to Medium Strength Sandstone or better will exert no earth pressure subject to the inspection of the cut face by the geotechnical consultant to ensure no wedges or other defects are present.

Any surcharge loads that may act on the proposed retaining walls are to be accounted for in the design.

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 retaining wall design.

15. Foundations

Concrete slabs supported directly off Medium Strength Sandstone are suitable footings for the proposed garage extension and storage room. This ground material is expected across the base of both excavations. A maximum allowable bearing pressure of 1.2MPa 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 geotechnical consultant is to inspect any exploration pits that may be required to expose the foundation materials of the house.

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

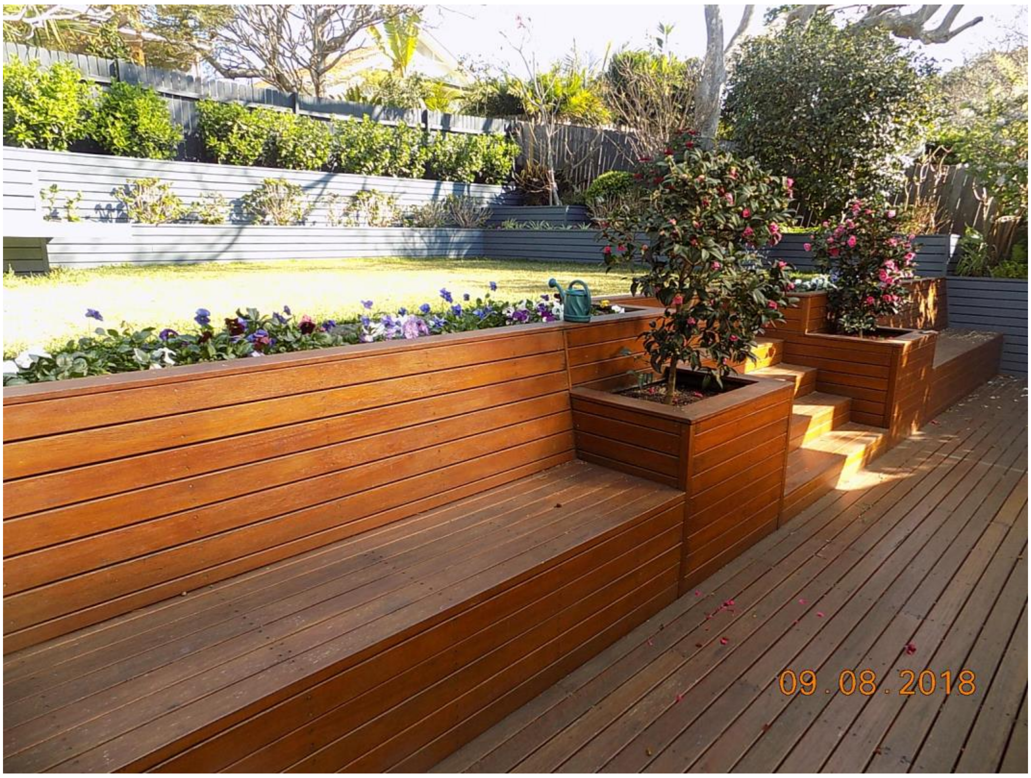


Photo 5

Photo 6

Photo 7: AH1 – Downhole is from top to bottom.

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.

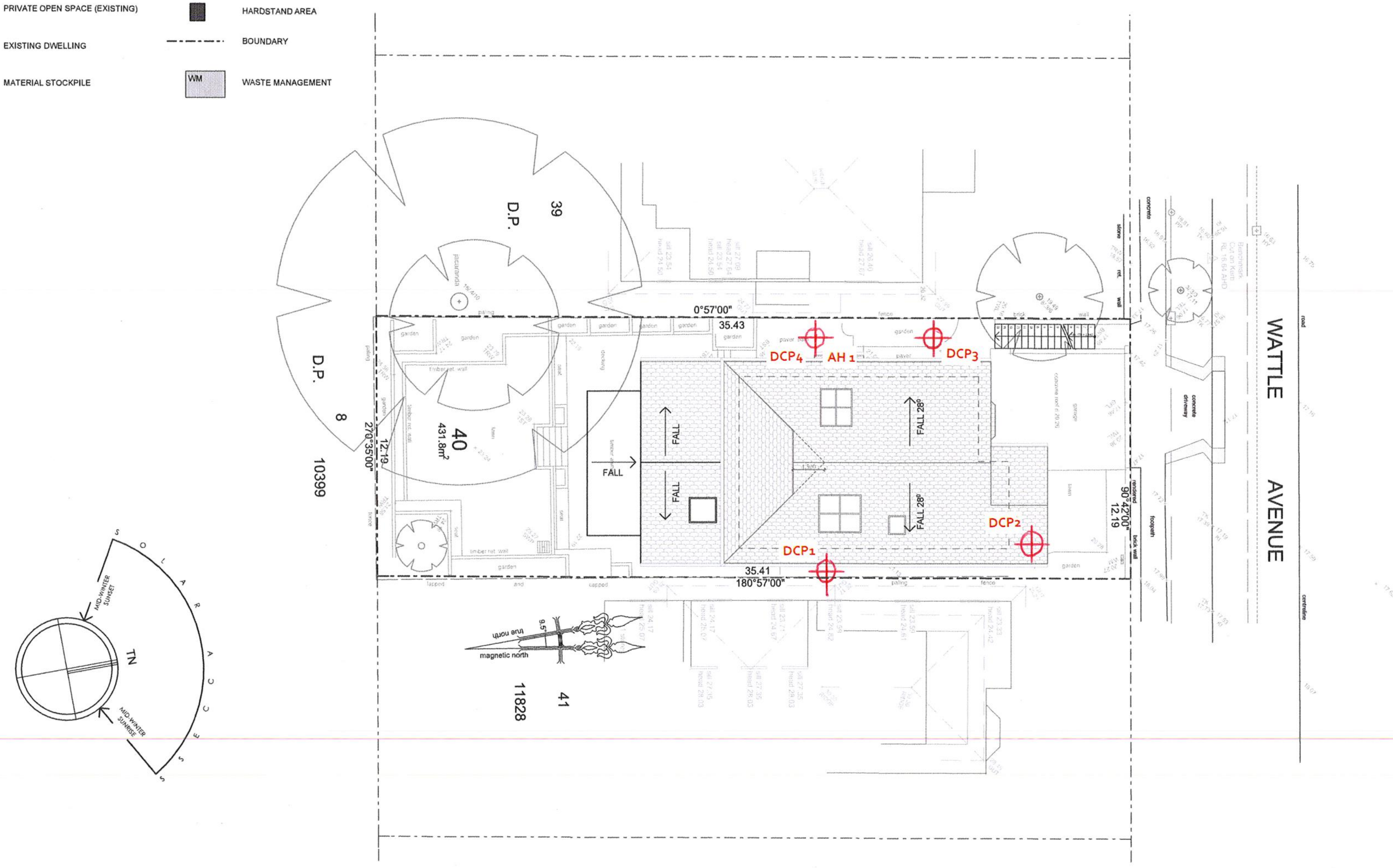
- This report is to be read in full and should not have sections removed or included in other documents as this can result in misinterpretation of the data by others.

- 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

LEGEND

P	PROPOSED		EXISTING LEVELS
POS	PRIVATE OPEN SPACE (EXISTING)		CAR ENTRY POINT
ED	EXISTING DWELLING		HARDSTAND AREA
MS	MATERIAL STOCKPILE		BOUNDARY
		WM	WASTE MANAGEMENT



Site Analysis Plan
1:200

sketchArc

DO NOT SCALE DRAWINGS. CHECK ALL DIMENSIONS ON SITE. FIGURED DIMENSIONS TAKE PRECEDENCE. The builder shall check and verify all dimensions and verify all errors and omissions to the Architect. Do not scale the drawings. Drawings shall not be used for construction purposes until issued by the Architect for construction.

REV	DATE	DESCRIPTION

sketchArc
Po Box 377 Manly 1655
m : 0422 521 871
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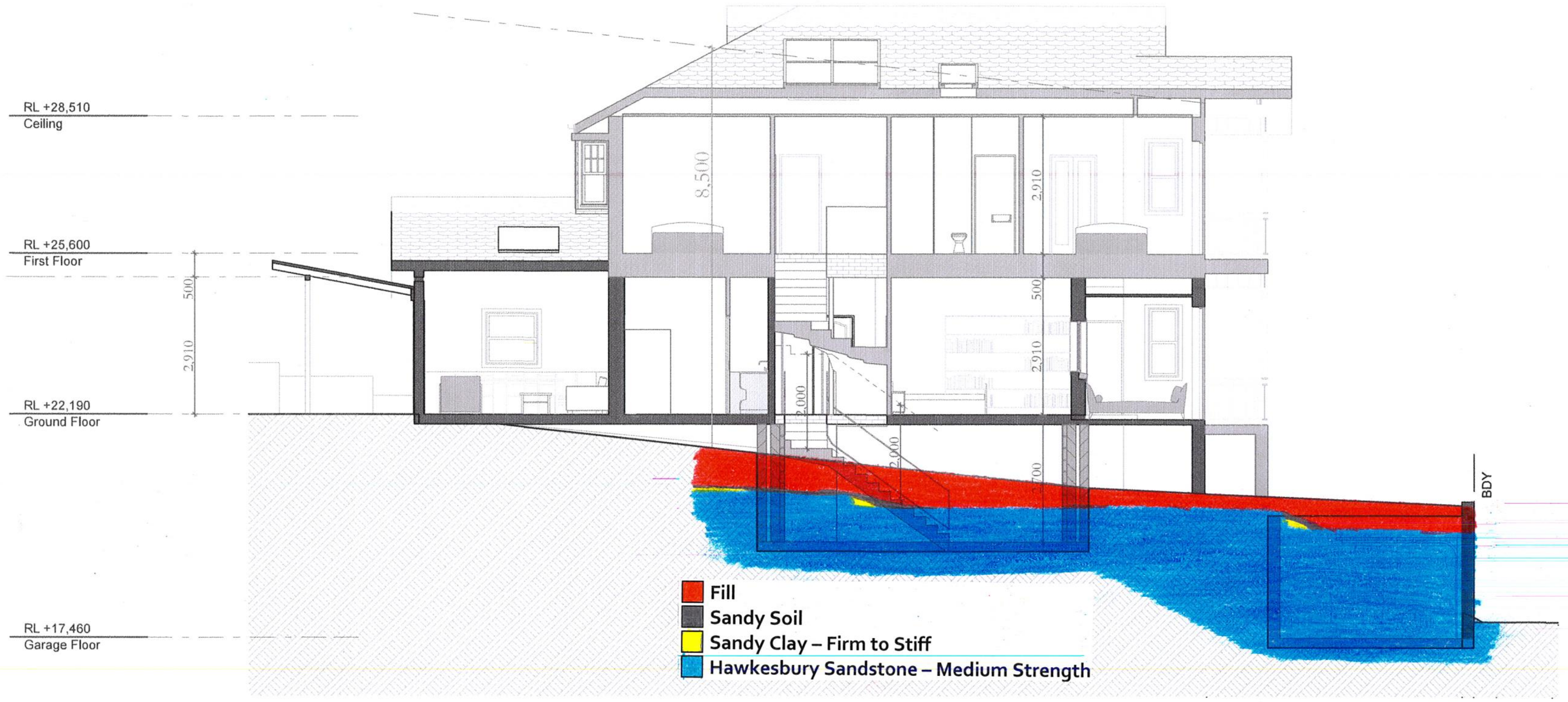
PROJECT: 21 Wattle Avenue, Fairlight, 2094, NSW
Alterations & Additions
LOT 40 in DP 11828 - 431.8m2

CLIENT: Private

- Proposed Work
- Demolition
- Existing

STATUS: Design 3A		
DATE: 170718	SCALE: 1:200@A3	PROJECT NUMBER: 1712
STAGE: Design 3A	DRAWN/DESIGNED: PB / MP	ISSUE:
DRAWING NO: DA3		

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



Section D-D
1:100

0 2 4

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CLIENT: Private

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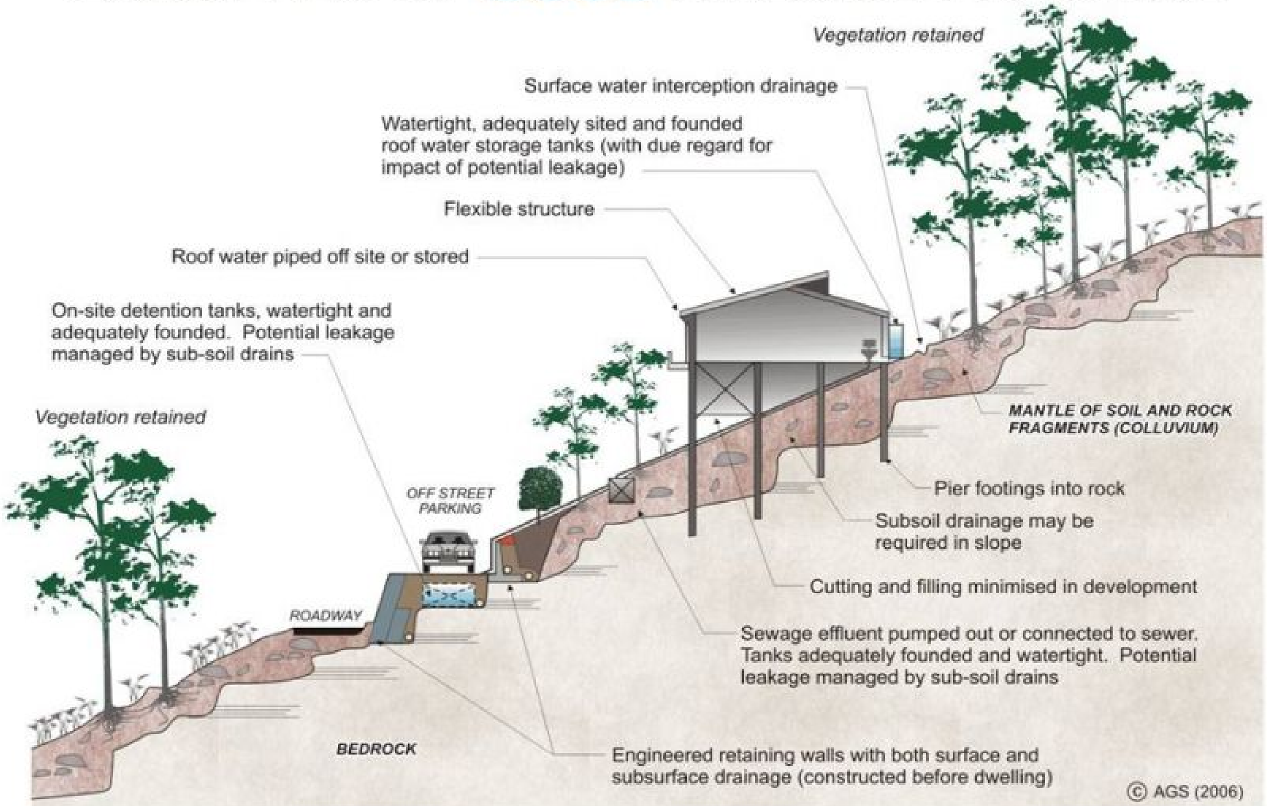
- Demolition
- Existing

STATUS: Design 3A		
DATE: 170718	SCALE: 1:100@A3	PROJECT NUMBER: 1712
STAGE: Design 3A	DRAWN/DESIGNED: PB / MP	ISSUE:
DRAWING NO: DA13		

EXAMPLES OF GOOD HILLSIDE PRACTICE



EXAMPLES OF POOR HILLSIDE PRACTICE