GEOTECHNICAL INVESTIGATION:

Alterations and Additions at **50 Condover Street, North Balgowlah**

1. Proposed Development

1.1 Demolish the existing driveway and carport and construct a new extension to the downhill side of the house by excavating to a maximum depth of ~2.6m.

1.2 Construct a new deck on the N side of the house.

1.3 Construct a new first floor addition.

1.4 Various other internal and external alterations.

1.5 Details of the proposed development are shown on 9 drawings prepared by Duffy Regan Design, Job number 639/19, drawings numbered DA-01 to 09, dated September 2019.

2. Site Description

2.1 The site was inspected on the 23rd September, 2019 and previously on the 28th August, 2019.

2.2 This residential property has dual access. It is on the uphill side of Condover Street and on the downhill side of Kimo Street. The property has a NE aspect. It is located on the moderately graded lower middle reaches of a hillslope. The natural surface falls across the property at an average angle of ~16°. The slope above the property continues at similar angles. The slope below eases to the toe of the slope.

2.3 At the road frontage, a brick-paved driveway runs up the slope to a carport on the downhill side of the property (Photo 1). The driveway and carport will both be demolished as part of the proposed works. Competent Medium Strength Sandstone outcrops at the road frontage and on the downhill side of the carport. The single-

storey brick house is supported on brick walls and brick piers (Photo 2). No significant signs of movement were observed in the supporting brick walls and the supporting brick piers stand vertical. Some of the supporting walls and piers were observed to be supported directly off outcropping sandstone. A ~1.0m cut for the uphill side of the house is currently partially unsupported (Photo 3). The existing rough stack rock retaining wall is in the process of remediation and upgrade by the owner of the property. We were informed by the owner that they intend to complete the remediation works as soon as possible. Medium Strength Sandstone bedrock outcrops and steps up the slope above the cut (Photo 4). The outcropping rock is slightly undercut but has been underpinned in the past by the owner using concrete block and brick blade walls and piers mortared with non-shrink grout (Photo 5). A gentle to moderately sloping lawn rises above the outcrop to the road frontage with Kimo Street. Sandstone bedrock outcrops through this lawn in places (Photo 6).

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

Seven 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:

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** (~RL45.4)	**DCP 2** (~RL43.5)	**DCP 3** (~RL42.6)	**DCP 4** (~RL41.3)	**DCP 5** (~RL41.8)	**DCP 6** (~RL42.9)	**DCP 7** (~RL45.3)
0.0 to 0.3	Rock Exposed at Surface	4	3	4	Rock Exposed at Surface	11	4
0.3 to 0.6		12	3	28		#	8
0.6 to 0.9		30	5	16			9
0.9 to 1.2		#	25	#			13
1.2 to 1.5			#				14
1.5 to 1.8							#
		End of Test @ 0.7m	Refusal on Rock @ 1.1m	Refusal on Rock @ 1.0m		Refusal on Rock @ 0.3m	Refusal on Rock @ 1.4m

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

DCP Notes:

DCP1 – Rock exposed at the surface.
DCP2 – End of test @ 0.7m, DCP still very slowly going down, orange sandstone fragments on wet muddy tip.
DCP3 – Refusal on rock @ 1.1m, DCP bouncing off rock surface, white and maroon sandstone on dry tip.
DCP4 – Refusal on rock @ 1.0m, DCP bouncing off rock surface, white impact dust on damp tip.
DCP5 – Rock exposed at the surface.
DCP6 – Refusal on rock @ 0.3m, DCP bouncing off rock surface, orange and maroon sandstone on dry tip.
DCP7 – Refusal on rock @ 1.4m, DCP bouncing off rock surface, orange sandstone fragments on dry tip.

5. Geological Observations/Interpretation

The surface features of the block are controlled by the outcropping and 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 sandy soils and sandy clays that fill the bench step formation. In the test locations where rock was not exposed, the depth to rock ranged between 0.3 to 1.4m below the current surface, being slightly deeper due to the stepped nature of the underlying bedrock. 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. It is interpreted that a thin layer of Very Low Strength Sandstone overlies the buried rock as some of the tests ended after a high blow count. See the 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 excavations.

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 Kimo Street above.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed below or beside the property. The moderately graded slope that falls across the property and continues above is a potential hazard (**Hazard One**). The vibrations from the proposed excavations 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**). The proposed excavation undercutting the footings for the house is a potential hazard (**Hazard Four**).

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two
TYPE	The moderate slope that falls across the property and continues above failing and impacting on the property.	The vibrations produced during the proposed excavation impacting on the surrounding structures.
LIKELIHOOD	'Unlikely' (10^{-4})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (20%)	'Medium' (15%)
RISK TO PROPERTY	'Low' (2×10^{-5})	'Moderate' (2×10^{-4})
RISK TO LIFE	8.3×10^{-7}/annum	5.3×10^{-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.

HAZARDS	Hazard Three	Hazard Four
TYPE	A loose boulder, wedge, or similar geological defect toppling onto the work site during the excavation process.	The proposed excavation undercutting the footings of the house causing failure (Photo 10).
LIKELIHOOD	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (20%)	'Medium' (35%)
RISK TO PROPERTY	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	2.3×10^{-5}/annum	5.3×10^{-5}/annum
COMMENTS	This level of risk to life and property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels, the recommendations in **Section 13** 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 Condover Street. 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

A stepped excavation is required to construct the proposed extension to the downhill side of the house. The step for the garage level is to be a maximum depth of ~1.4m and the step for the under-house storage is to be a maximum depth of ~1.7m with a distance of ~2.9m between the steps. The excavation is expected to be through sandy soils and firm to stiff sandy clays with Medium Strength Sandstone expected at a maximum depth of ~1.4m below the surface.

It is envisaged that excavations through 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 sandy soils and sandy clays will be below the threshold limit for building damage.

It is expected most 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 subject house and neighbouring houses to the SE and NW. The edges of the excavation will be immediately beside the downhill supporting wall of the subject house, ~4.0m from the SE neighbouring house, and ~7.0m from the NW neighbouring house. 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 10mm/sec at the supporting walls of the subject house and property 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 10mm/sec at the property 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 house and neighbouring properties.

13. Excavation Support Requirements

The proposed excavation will come close to flush with the downhill supporting wall of the subject house (Photo 10) and will come to within ~1.2m of the SE common boundary. The SE neighbouring house is sufficiently set back from the excavation to not be impacted upon. Thus, only the subject house and SE common boundary will be within the zone of influence of the excavation. The zone of influence, in this instance, is the area above a theoretical 30° line extending from the top of Medium Strength Sandstone towards the surrounding structures and boundaries. Before any excavation through rock commences, the following is to be carried out:

- The NW side and portions of the SE side of the excavation through soil and clay are to be battered.
- The downhill supporting wall of the subject house is to be underpinned to rock if it is not already supported on Medium Strength Sandstone.
- The soil on the SE side of the excavation is to be temporarily or permanently supported before excavations through rock commence.

Given the depth to rock, we think it likely the house is supported on rock. However, to be sure, exploration pits along the wall 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 determined to be supported at an adequate depth or on rock, the excavation may commence. If they are not, the wall 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 edge of the wall 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.

The cut through soil and clay can be battered on the NW side of the excavation at 1.0 Vertical to 1.7 Horizontal (30°) and along the SE side where the depth to rock is less than 0.8m. Where the depth to rock is greater than 0.8m along the SE side, the soil and clay portions of the cut are to be temporarily or permanently supported systematically as the excavation through the soil/clay is progressed. The temporary or permanent support is to be approved by the structural engineer in consultation with the geotechnical consultant. The shoring/retaining walls for the soil/clay portion of the cut are to be in place before any excavation through rock commences. Excavations through 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. Unsupported cut batters through soil 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. The materials and labour to construct the retaining walls are to be organised so on completion of the excavation it can be constructed as soon as possible. The excavation is 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 excavation as it is 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 excavation, 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 ON NEXT PAGE

Table 1 – Likely Earth Pressures for Retaining Walls

Unit	Earth Pressure Coefficients		
	Unit weight (kN/m^3)	'Active' K_a	'At Rest' K_0
Fill, 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

A concrete slab and shallow piers supported directly off Medium Strength Sandstone are suitable footings for the proposed extension. This ground material is expected to be exposed across the majority of the base of the excavation. Where sandstone is not exposed, it is expected at shallow depths.

The proposed deck on the NW side of the house is to be supported on piers taken to the underlying Medium Strength Sandstone. This material is expected at shallow depths.

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 inspection as well as council geotechnical policy. We cannot provide geotechnical certification for the owners or the regulating authorities if the following inspection has 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 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 is still onsite and before steel reinforcing is placed or concrete is poured.

White Geotechnical Group Pty Ltd.

Ben White M.Sc. Geol.,
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Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

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.

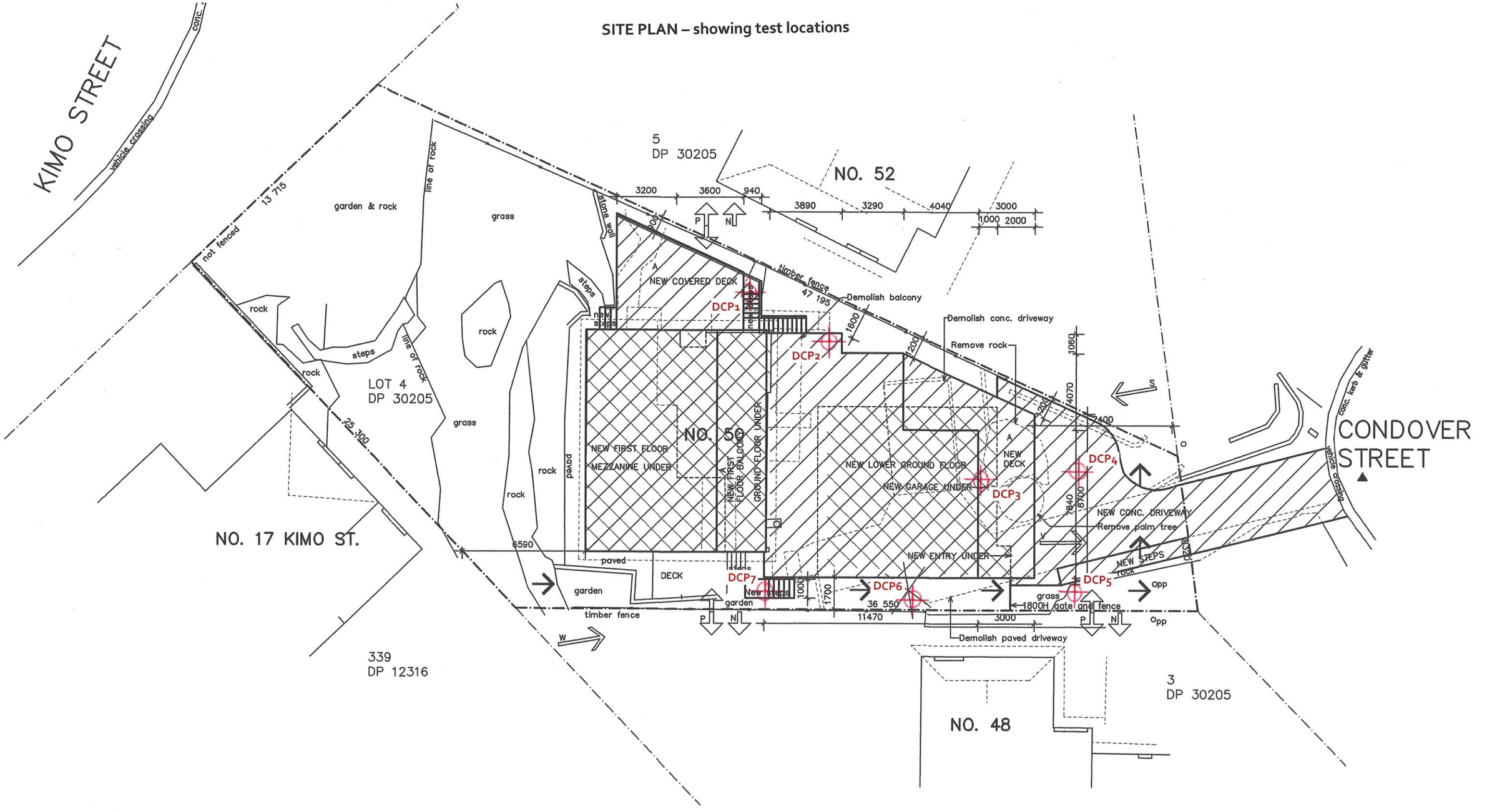
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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



KEY

- S — PREVAILING WINDS (SUMMER)
- W — PREVAILING WINDS (WINTER)
- P — PRIVACY CONSIDERATIONS
- N — NOISE CONSIDERATIONS
- V — VIEWS TO RESERVE
- A — BALCONY, DECK, PATIO
- FALLS FOR DRAINAGE
- BOUNDARY
- CAR ENTRY POINT
- INDICATES GROUND FLOOR
- INDICATES FIRST FLOOR

SITE AREA: 847.2 sq.m.
EXISTING STORAGE: 19.6 sq.m.
EXISTING GROUND FLOOR: 103.3 sq.m.
EXISTING STUDY: 7.8 sq.m.
EXISTING DECK: 12.7 sq.m.
EXISTING CARPORT: 20.4 sq.m.
NEW FIRST FLOOR: 86.9 sq.m.
NEW FIRST FLOOR BALCONY: 24.9 sq.m.
NEW LOWER GROUND FLOOR: 122.9 sq.m.
NEW GROUND FLOOR COVERED DECK: 34.5 sq.m.
NEW LOWER GROUND FLOOR DECK: 40.9 sq.m.
NEW GARAGE, ENTRY & CORRIDOR: 88.4 sq.m.

Project: ALTERATIONS & ADDITIONS — Job. No. 639/19

for: C. Rose
at: 50 Condover Street, North Balgowlah

Title: **SITE PLAN**

Scale: 1:200 @ A3
Date: SEPT 2019
Drawn: D.R.

Revision:

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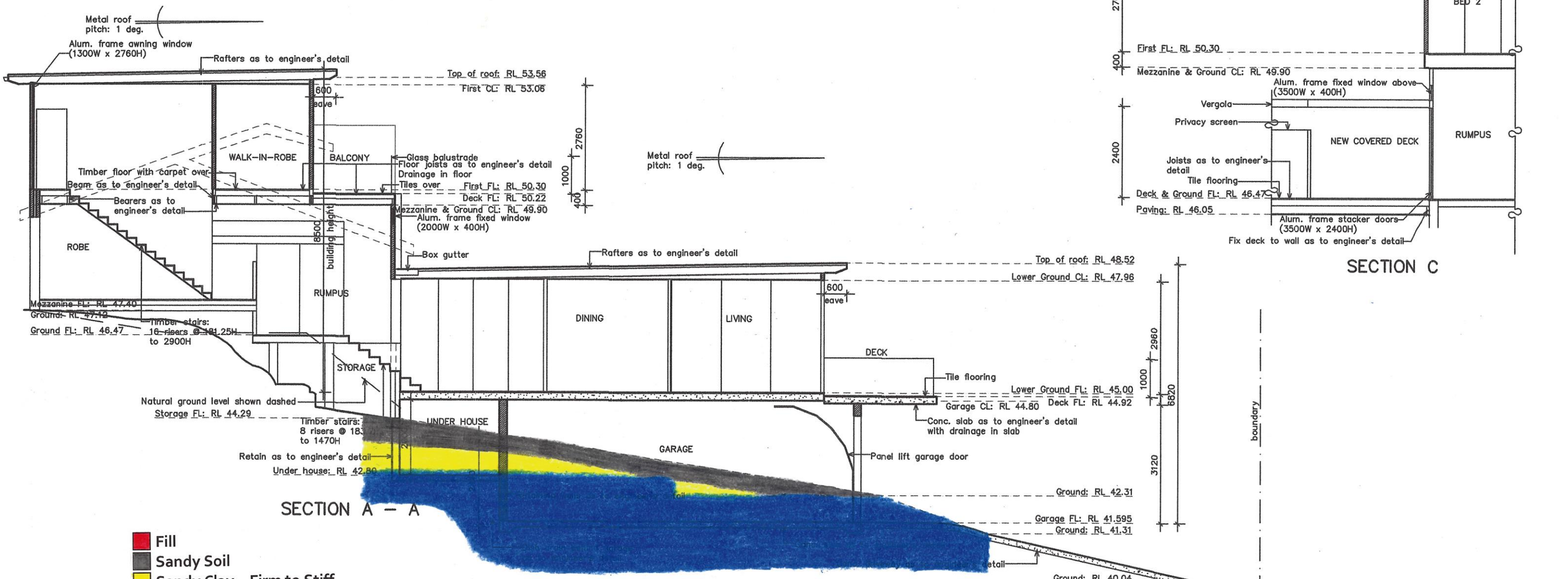
Drawing No. DA–01

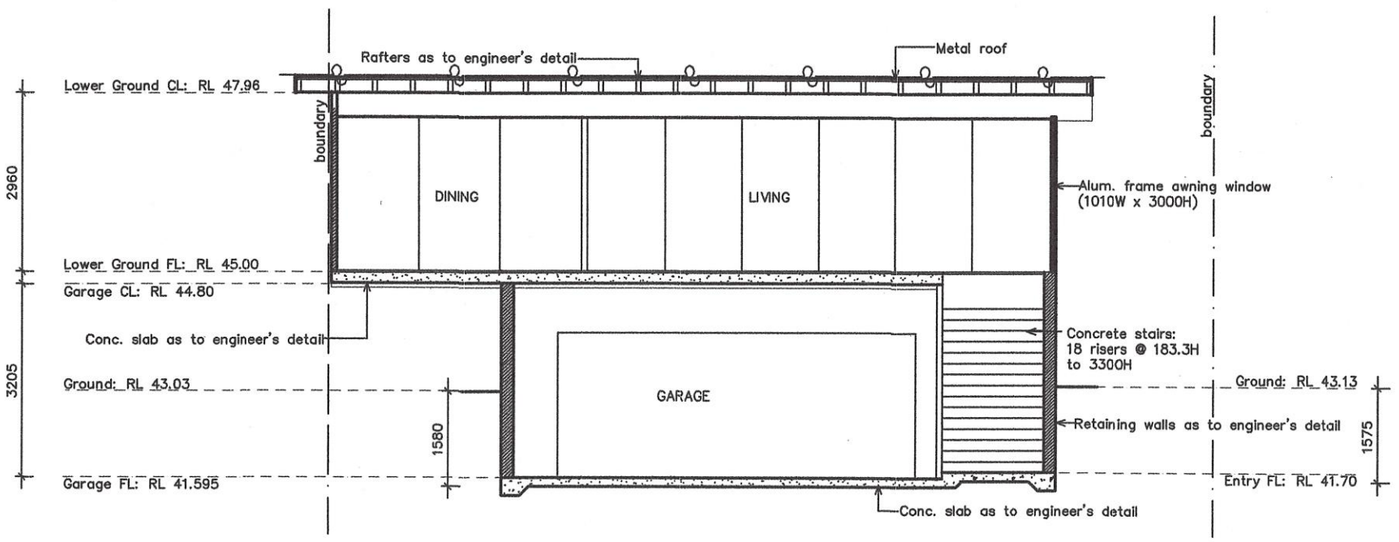
TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



SECTION A – A

SECTION C

- Fill
- Sandy Soil
- Sandy Clay – Firm to Stiff
- Hawkesbury Sandstone – Medium Strength



SECTION B – B

NOTES:
This drawing is the copyright of Duffy Regan Design and may not be altered, reproduced or transmitted without permission of Duffy Regan Design.
All levels and dimensions are to be checked on site prior to commencement of any work.
All new and altered works to relevant BCA and AS/NZ standards.
NOT FOR CONSTRUCTION

Project: ALTERATIONS & ADDITIONS — Job. No. 639/19

for: C. Rose
at: 50 Condover Street, North Balgowlah

Title: **SECTIONS**

Scale: 1:100 @ A3
Date: SEPT 2019
Drawn: D.R.
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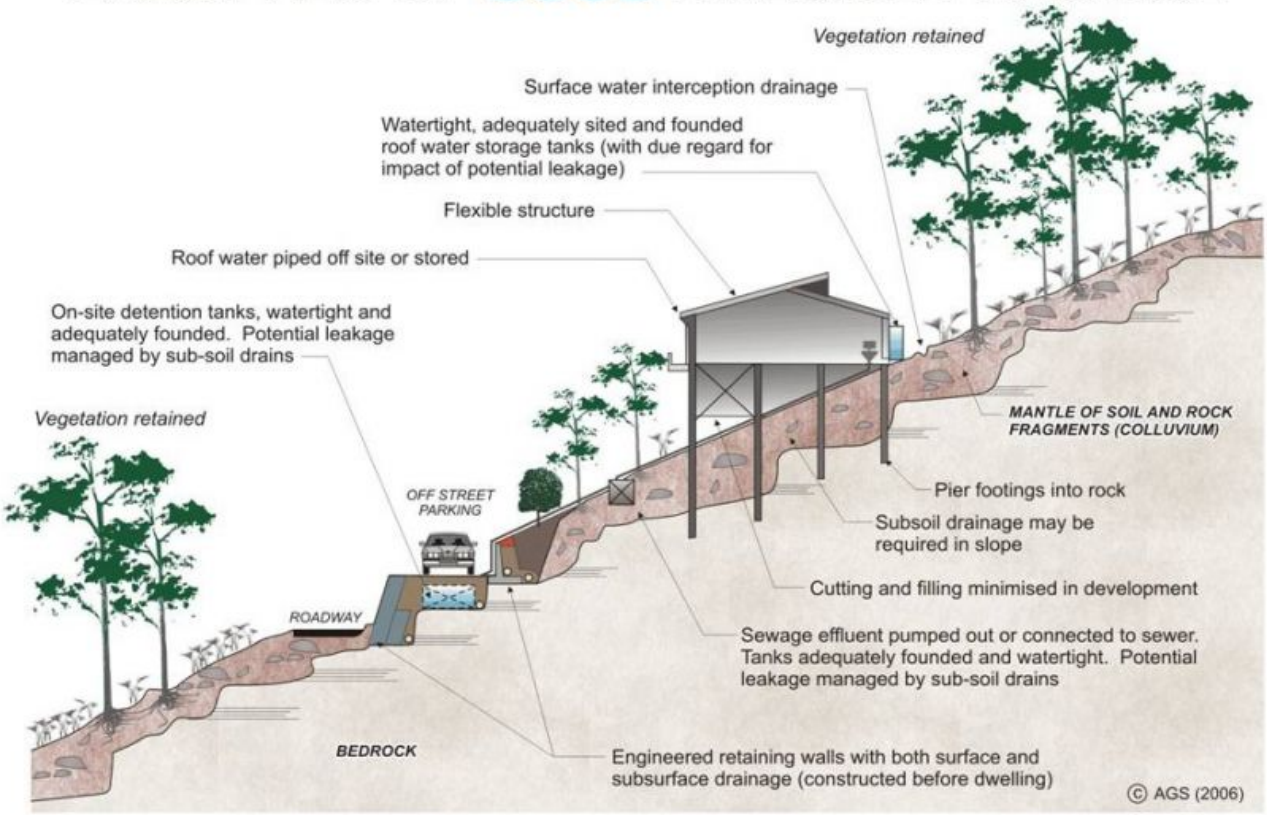
Drawing No. DA–08

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE