GEOTECHNICAL INVESTIGATION:

New Residence at **2 Lincoln Avenue, Collaroy**

1. Proposed Development

1.1 Demolish the existing house and construct a new house by excavating to a maximum depth of ~2.7m into the slope.

1.2 Details of the proposed development are shown on 11 drawings prepared by Sally Gardner Design and Draft, job number 19-0125, drawings numbered A1 to A10 and S2, drawings dated 2nd April, 2019.

2. Site Description

2.1 The site was inspected on the 5th April, 2019.

2.2 This residential property is on the high side of the road and has a S aspect. It is located on the gently graded upper reaches and crest of a hillslope. The natural slope rises at an average angle of ~6° across the property. The slope below the property continues at gentle angles that gradually increase. The slope above the property eases as the crest of the slope is approached.

2.3 At the road frontage a concrete driveway runs up the slope to a garage under the house (Photo 1). A gently sloping lawn rises from the road frontage to the downhill side of the house (Photo 2). The single storey brick house will be demolished as part of the proposed works (Photo 3). Another gently sloping lawn rises from the uphill side of the house to the uphill boundary (Photo 4). No significant signs of movement were observed on the property. No geotechnical hazards that could impact on the subject property were observed on the neighbouring properties as seen from the subject property and the road.

3. Geology

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

4. Subsurface Investigation

One Hand Auger Holes (AH) was put down to identify the soil materials. Six 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 to 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. With the testing on this site this is not expected to be an issue and the results are as follows.

AUGER HOLE 1 (~RL 65.7) **–** AH1 (Photo 6)

Depth (m)	Material Encountered
0.0 to 0.1	**TOPSOIL,** loamy soil, brown, loose, roots, organic matter, fine grained, damp.
0.1 to 0.4	**SANDY SOIL,** light brown, loose, rock fragments, roots, fine to medium grained, dry.
0.4 to 0.6	**CLAY,** reddish brown, stiff, fine grained, rock fragments, dry.
0.6 to 1.0	**CLAY,** reddish brown with white mottling, stiff, rock fragments, fine grained, dry.
1.0 to 1.6	**CLAY,** reddish brown with orange mottling, stiff, rock fragments, fine trace charcoal, fine grained, dry.
1.6 to 1.7	**CLAY,** brownish yellow with orange mottling, firm to stiff, fine grained, rock fragments, red mottling, dry.

Refusal @ 1.7m, grinding on rock. 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	**DCP1** (~RL64.5)	**DCP2** (~RL64.5)	**DCP3** (~RL65.0)	**DCP4** (~RL66.0)	**DCP5** (~RL65.7)	**DCP6** (~RL65.0)
0.0 to 0.3	7	4	8	4	3	5
0.3 to 0.6	10	9	12	13	11	6
0.6 to 0.9	13	23	16	13	12	13
0.9 to 1.2	15	22	13	20	13	16
1.2 to 1.5	#	#	10	15	23	#
1.5 to 1.8			#	#	17	
1.8 to 2.1					#	
	Refusal on Rock @ 1.0m	Refusal on Rock @ 1.2m	Refusal on Rock @ 1.3m	Refusal on Rock @ 1.4m	Refusal on Rock @ 1.7m	Refusal on Rock @ 1.1m

#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 @ 1.0m, DCP bouncing off rock surface, orange and red clay on dry tip.
DCP2 – Refusal on rock @ 1.2m, DCP bouncing off rock surface, orange clay on wet tip.
DCP3 – Refusal on rock @ 1.3m, DCP bouncing off rock surface, white impact dust on dry tip.
DCP4 – Refusal on rock @ 1.4m, DCP bouncing off rock surface, orange clay on dry tip.
DCP5 – Refusal on rock @ 1.7m, DCP bouncing off rock surface, orange clay on dry tip.
DCP6 – Refusal on rock @ 1.1m, DCP bouncing off rock surface, orange clay 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. In the test locations, the ground materials consist of a loamy and sandy soil over firm to stiff clays with rock fragments throughout the profile. In the test locations, rock was encountered at an average depth of ~1.3m below the current ground surface. 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. Due to the location of the block on the upper reaches/crest of a slope, surface water movement will be minimal.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed above, below or beside the property. The vibrations from the proposed excavations are a potential hazard to the neighbouring houses and pool (**Hazard One**). The proposed garage level excavation is a potential hazard until retaining walls are in place (**Hazard Two**).

SEE OVER THE PAGE FOR RISK ANALYSIS SUMMARY

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two
TYPE	The vibrations produced during the proposed excavations impacting on the neighbouring houses and pool to the E (Photo 5).	The proposed garage level excavation for the house collapsing onto the work site before retaining walls are in place.
LIKELIHOOD	'Possible' (10^{-3})	'Possible' (10^{-2})
CONSEQUENCES TO PROPERTY	'Minor' (9%)	'Medium' (20%)
RISK TO PROPERTY	'Moderate' (5×10^{-5})	'Moderate' (2×10^{-4})
RISK TO LIFE	2.1×10^{-7}/annum	6.7×10^{-4}/annum
COMMENTS	'This level of risk to property is '**UNACCEPTABL**E'. 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

There is fall to the street below. All stormwater or drainage runoff 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 ~2.7m is required to install the garage level of the proposed house. The excavation is expected to be through a sandy and loamy soil over firm to stiff clays with Medium Strength Sandstone expected at an average depth of ~1.3m below the current ground surface. Excavations through soil and clays can be carried out with an excavator and bucket. Excavations through Medium Strength Sandstone or better will require grinding or rock sawing and breaking.

12. Vibrations

Possible vibrations generated during excavations through soil and clay will be below the threshold limit for building damage.

Excavations through Medium Strength Sandstone or better should be carried out to minimise the potential to cause vibration damage to the neighbouring pool to the E and neighbouring houses to the E and W (Photo 5). The neighbouring pool will be as close ~6.6m from the edge of the excavation and the E and W neighbouring houses ~9.0m. 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 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 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 neighbouring house.

13. Excavation Support Requirements

The soil portion of the proposed excavation is to be battered at 1.0 Horizontal to 1.7 Vertical (30°) until the retaining walls are installed. Excavations through clay will stand unsupported for short periods of time until the retaining walls are in place provided the cut batters are prevented from becoming saturated. Excavations through Medium Strength Sandstone will stand at near vertical angles unsupported until retaining walls are in place.

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 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 structure is 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 for the proposed garage level, the geotechnical consultant is to inspect the cut face as it is lowered in 1.5m intervals, while the machine is onsite to ensure the ground materials are as expected, and no wedges or other geological defects are present that could require additional support.

Excavation spoil is to be removed from site.

14. Retaining Walls

For cantilever retaining walls it is suggested the design be based on a triangular distribution of lateral pressures using the parameters shown in Table 1.

SEE OVER THE PAGE FOR 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	20	0.40	0.55
Residual Clays	20	0.35	0.45
Medium Strength Sandstone	24	0.00	0.10

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 retaining wall design.

15. Foundations

Medium Strength Sandstone is expected to be exposed across most of the base of the excavation for the garage. A concrete slab supported on the underlying Medium Strength Sandstone is a suitable bearing material. Where it is not exposed, such as that across the downhill portion of the excavation, shallow piers will be required to maintain a uniform bearing material.

A maximum allowable pressure of 800kPa can be assumed for footings on Medium Strength Sandstone.

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 for the proposed garage the geotechnical consultant is to inspect the cut face in 1.5m intervals, while the machine is onsite, as it is lowered to ensure ground materials are as expected and that there are no wedges or other defects present in the rock.

- 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

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Photo 5

Photo 6: Auger Hole 1: Base of hole at base of image

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 tests 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 professional. 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.

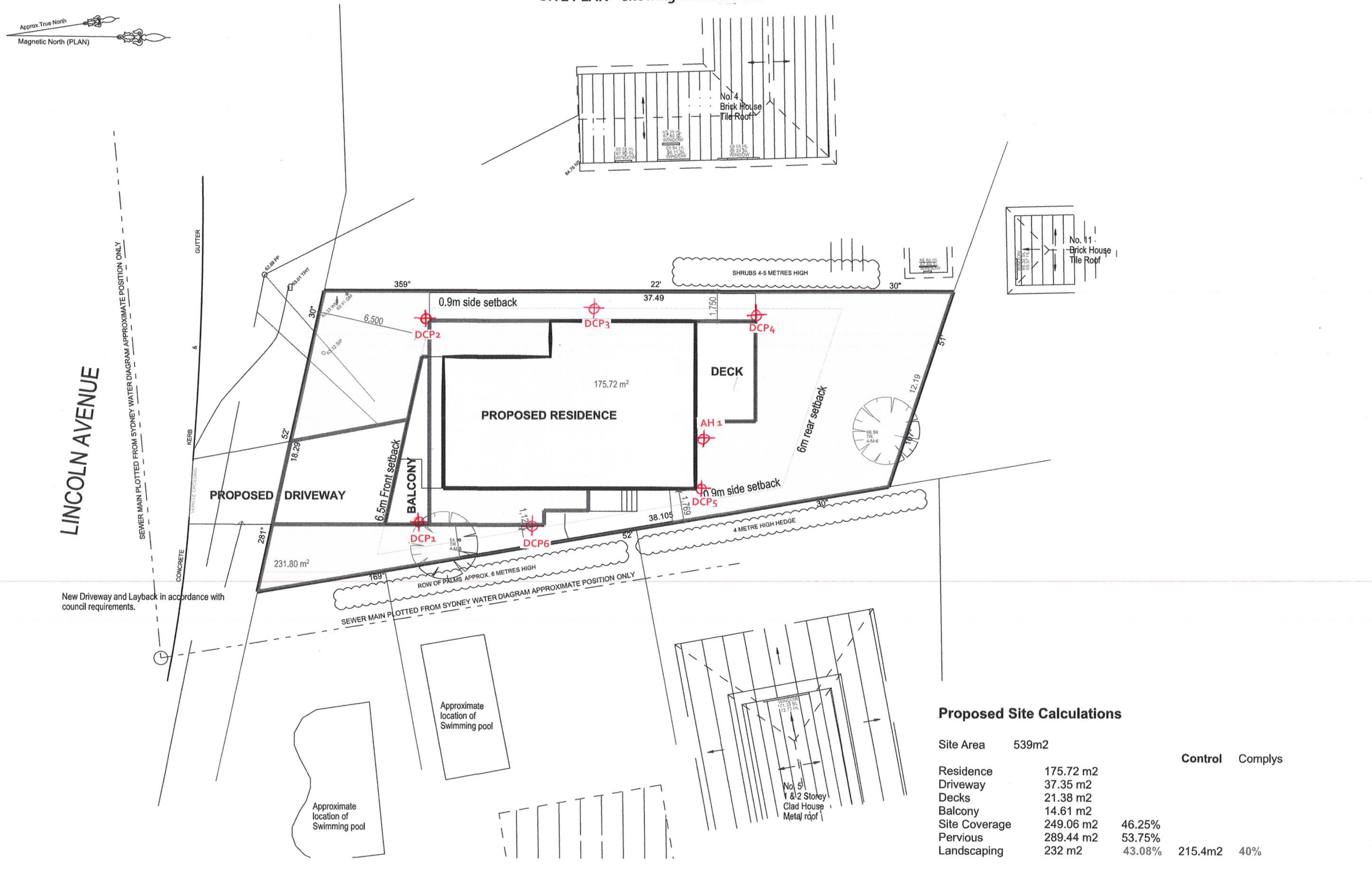
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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

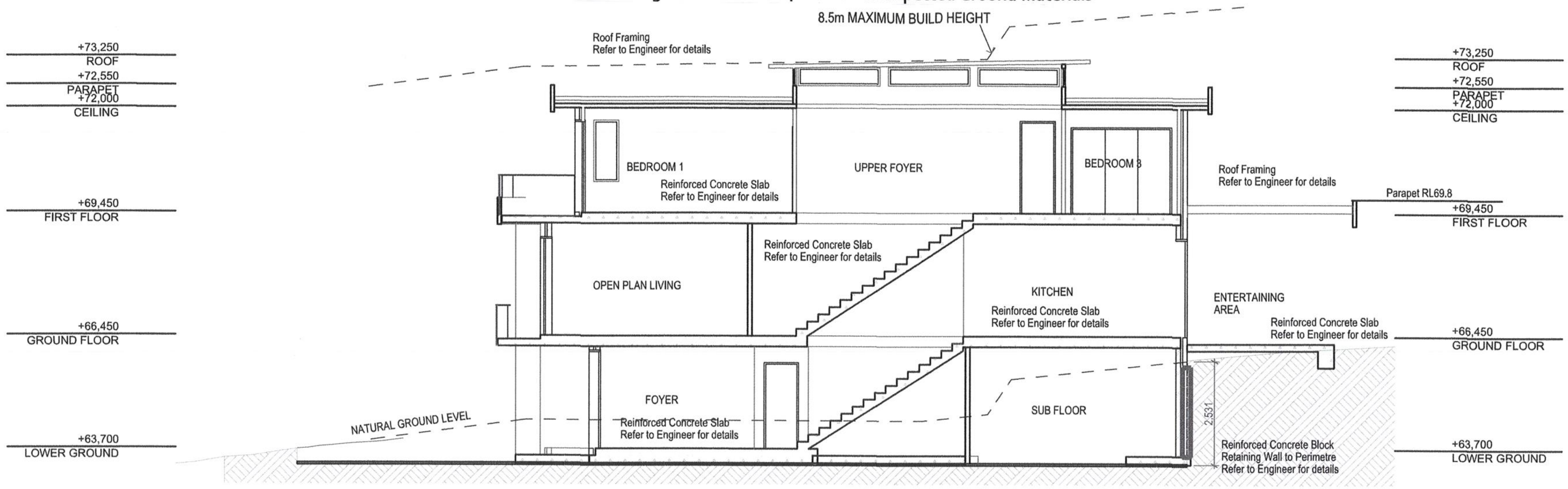


Proposed Site Calculations

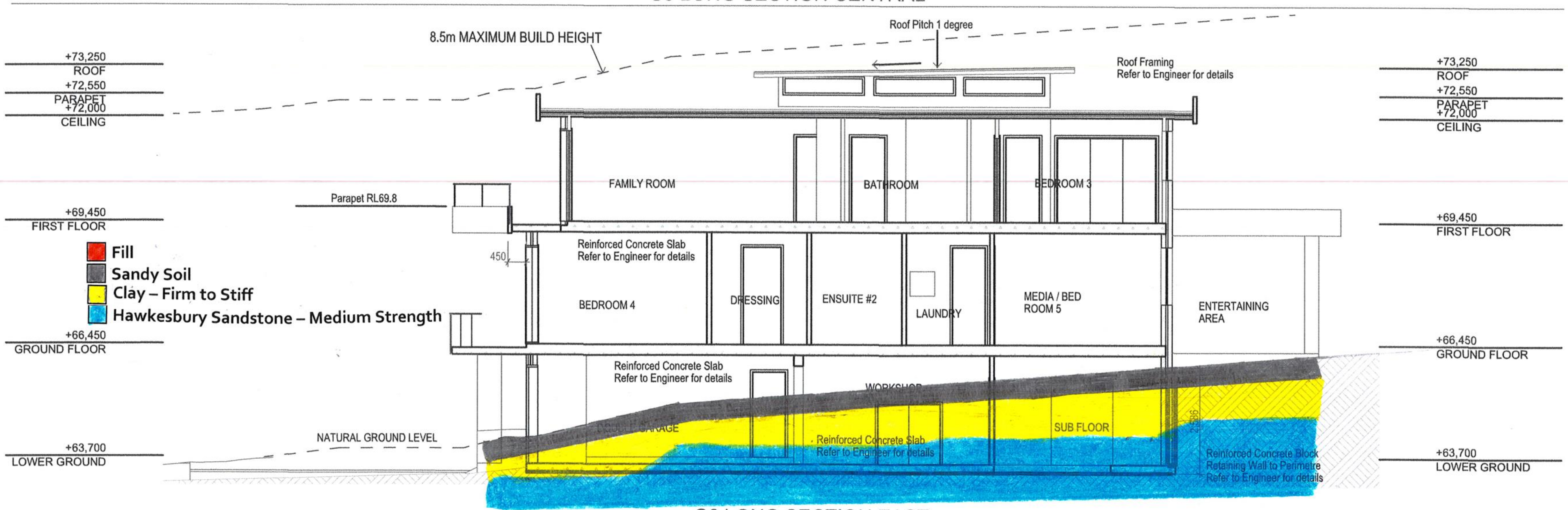
Site Area	539m2			
			Control	Complys
Residence	175.72 m2			
Driveway	37.35 m2			
Decks	21.38 m2			
Balcony	14.61 m2			
Site Coverage	249.06 m2	46.25%		
Pervious	289.44 m2	53.75%		
Landscaping	232 m2	43.08%	215.4m2	40%

bdaa ACCREDITED BUILDING DESIGNER · SALLY GARDNER DESIGN AND DRAFT · SDS	Client: Alana and Lucian MIHALASCU	NEW RESIDENCE 2 LINCOLN AVENUE COLLAROY NSW 2097	True North	Scale 1:200	Job Number 19-0125		
		Drawing Title: SITE PLAN AND CALCULATIONS		Date Tuesday, 2 April 2019	Drawn S.G.	Drawing No. S2	

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



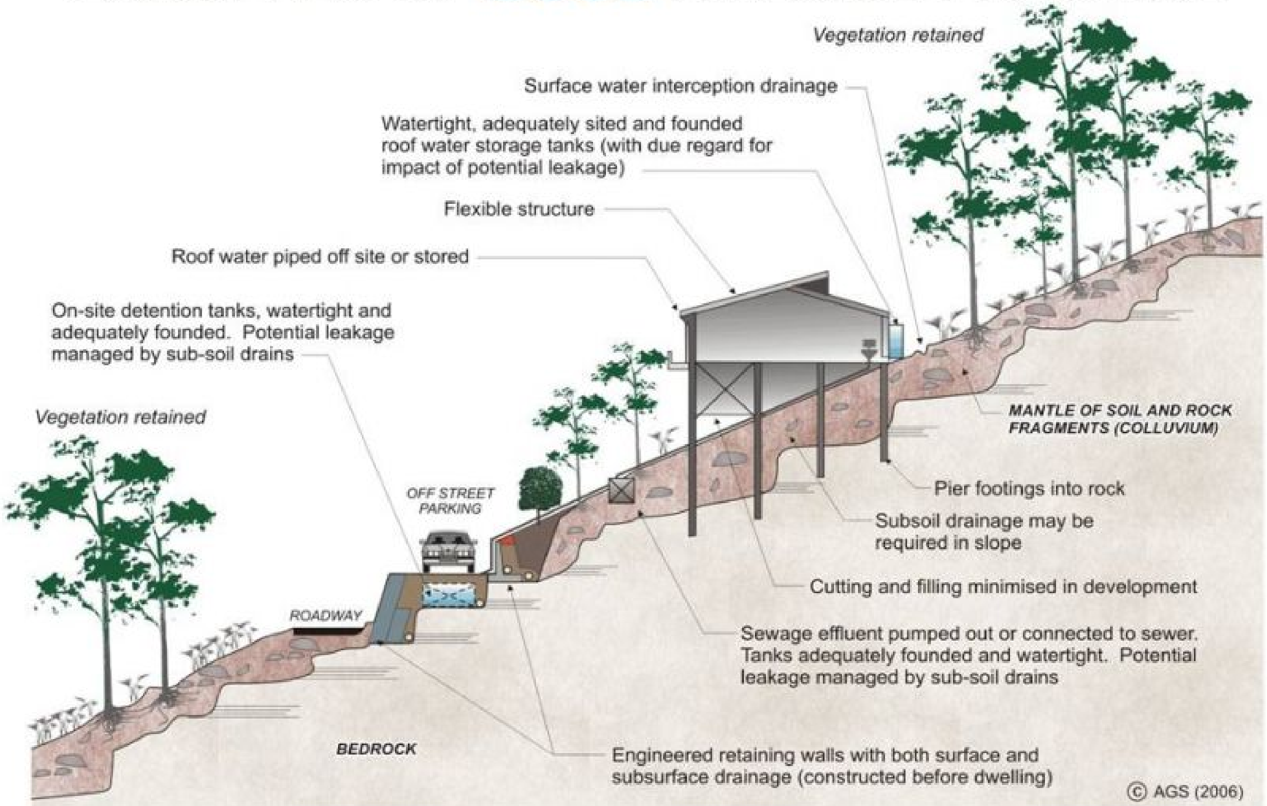
S5 LONG SECTION CENTRAL



S6 LONG SECTION EAST

bdaa ACCREDITED BUILDING DESIGNER	SALLY GARDNER DESIGN AND DRAFT PLANS DRAWN FOR APPROVAL	SDS SustainAbility Design Specialist	Client: Alana and Lucian MIHALASCU	NEW RESIDENCE 2 LINCOLN AVENUE COLLAROY NSW 2097	Scale 1:100	Job Number 19-0125
				Drawing Title: LONG SECTION SHEET 3	Date Tuesday, 2 April 2019	Drawn S.G. / Drawing No. A10

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE