GEOTECHNICAL INVESTIGATION:

New House and Pool at **23 Acacia Street, Collaroy Plateau**

1. Proposed Development

1.1 Demolish the existing house and construct a new house by excavating to a maximum depth of ~2.3m into the slope.

1.2 install a pool in the NE corner of the property by excavating to a maximum depth of ~1.9m into the slope.

1.3 Details of the proposed development are shown on 7 drawings prepared by Gartner Trovato Architects, project numbered 1904, drawings numbered DA.01 to DA.07, dated 21/02/19.

2. Site Description

2.1 The site was inspected on the 4th March, 2019.

2.2 This residential property is on the corner of Acacia Street and Essilia Street. It is on the uphill side of Essilia Street and the downhill side of Acacia Street. The property has a W aspect. The block is located on the gently graded upper reaches of a hillslope. From the road frontage of Essilia Street to the uphill boundary, the slope rises at an average angle of ~5°. The slope above the property eases as the crest of the slope is approached. The land surface below the property continues at gentle angles.

2.3 At the road frontage of Essilia Street, a concrete driveway runs to a single garage under the downhill side of the house (Photo 1). The majority of the part two storey brick house will be demolished as part of the proposed works (Photo 3). A gently sloping lawn area extends from the uphill boundary to the property frontages on either side of the house (Photos 4 & 5). 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. It is described as a medium to coarse grained quartz sandstone with very minor shale and laminate lenses.

4. Subsurface Investigation

One Hand Auger Hole (AH) was put down to identify the ground materials. 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:

AUGER HOLE 1 (~RL96.5) **–** AH1 (Photo 9)

Depth (m)	**Material Encountered**
0.0 to 0.2	**TOPSOIL**, sandy soil, dark brown, loose, fine to medium grained, organic matter, dry.
0.2 to 0.4	**SILTY SAND**, brownish yellow, loose, fine to medium grained, dry.
0.4 to 0.8	**SILTY SAND**, yellow, loose, fine to medium grained, weathered sandstone, rock fragments, dry.

End of hole @ 0.8m in silty sand, auger refusing on hard 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 (~RL96.9)	DCP 2 (~RL96.8)	DCP 3 (~RL95.9)	DCP 4 (~RL96.0)	DCP 5 (~RL96.5)	DCP 6 (~RL97.3)	DCP 7 (~RL97.2)
0.0 to 0.3	9	4	7	4	2F	11	6
0.3 to 0.6	26	9	44	17	2F	22	11
0.6 to 0.9	21	17	47	9	14	39	8
0.9 to 1.2	16	#	#	25	32	25	29
1.2 to 1.5	#			#	11	#	#
1.5 to 1.8					#		
	Refusal on Rock @ 1.2m	Refusal on Rock @ 0.9m	End of Test @ 0.9m	Refusal on Rock @ 1.1m	Refusal on Rock @ 1.3m	Refusal on Rock @ 1.1m	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 @ 1.2m, DCP bouncing off rock surface, white impact dust on dry tip.
DCP2 – Refusal on rock @ 0.9m, DCP bouncing off rock surface, white impact dust on dry tip.
DCP3 – End of test @ 0.9m, DCP still very slowly going down, white impact dust on dry tip.
DCP4 – Refusal on rock @ 1.1m, DCP bouncing off rock surface, white impact dust on dry tip.
DCP5 – Refusal on rock @ 1.3m, DCP bouncing off rock surface, white impact dust on dry tip
DCP6 – Refusal on rock @ 1.1m, DCP bouncing off rock surface, white impact dust on dry tip
DCP7 – Refusal on rock @ 1.1m, 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. The rock is overlain by sandy soils over silty sands that fill the bench step formation. In the test locations, the depth to rock ranged between ~0.9 to ~1.3m below the current surface. No fill was encountered or observed during the ground testing on the property. 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 excavations.

7. Surface Water

No evidence of surface flows were observed on the property during the inspection. Normal sheet wash from the slope above will move onto the property during heavy downpours.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed above, below, or beside the property. The vibrations produced by the proposed excavations are a potential hazard (**Hazard One**). The proposed excavations undercutting the E common boundary is a potential hazard (**Hazard Two**). The proposed excavations undercutting the remaining footings of the existing house are a potential hazard (**Hazard Three**).

SEE THE RISK ANALYSIS SUMMARY OVER THE PAGE

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two	Hazard Three
TYPE	The vibrations from the proposed excavations impacting the existing house walls and neighbouring house to the E.	The proposed excavations undercutting the E common boundary impacting on the E neighbouring property (Photos 8).	The proposed excavation for the house footings of the subject house causing failure of the supporting house walls. (Photo 4).
LIKELIHOOD	'Possible' (10^{-3})	'Likely' (10^{-2})	'Likely' (10^{-2})
CONSEQUENCES TO PROPERTY	'Medium' (15%)	'Medium' (25%)	'Medium' (20%)
RISK TO PROPERTY	'Moderate' (2×10^{-4})	'High' (2×10^{-4})	'High' (2×10^{-4})
RISK TO LIFE	2.5×10^{-7}/annum	5.3×10^{-7}/annum	4.7×10^{-7}/annum
COMMENTS	This level of risk to property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels the recommendations in **Section 12** are followed.	This level of risk to 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 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 the Essilia 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

An excavation to a maximum depth of ~2.3m is required to install the lower ground floor level. Another excavation to ~1.9m will be required to install the pool. Both excavations are expected to be through a shallow sandy soil over silty sand and firm to stiff clay with Medium Strength Sandstone expected at an average depth of ~1.0m below the current ground surface. It is envisaged that excavations through sandy soil and silty sands can be carried out with an excavator and bucket and excavations through rock will require grinding or rock sawing and breaking.

12. Vibrations

Possible vibrations generated during excavations through sandy soil, silty sand 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 rock should be carried out to minimise the potential to cause vibration damage to the remaining supporting house walls on the subject property and the neighbouring houses to the E. The supporting brick walls and piers of the subject house will be located immediately beside the proposed excavation and the supporting walls of the neighbouring house to the E will be as close as ~4.7m. 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 brick walls and piers of the house or at the excavation perimeters, whichever is closer. Vibration monitoring will be required to verify this is achieved.

If a milling head is used to grind the rock or hand tools are used such a jack hammers or similar, 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 supporting brick walls and piers of the house or excavation perimeter using this method provided the saw cuts are kept well below the rock to be broken.

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

13. Excavation Support Requirements

The proposed excavation for the lower ground floor will be located immediately beside the supporting brick walls of the subject house and come as close as ~0.5m from the E common boundary. No other structures or boundaries will lie within the zone of influence of the lower ground floor excavation.

We think it likely the footings of the subject house are supported on sand. This is to be confirmed with small pits dug by the builder beside the structures to expose the footing material. Upon completion, the pits are to be inspected by the geotechnical consultant to confirm the footing material. If these structures are founded on Medium Strength Sandstone no additional support is required. If any of the structures are not founded on Medium Strength Sandstone and are within the zone of influence of the excavation they are to be underpinned to Medium Strength Sandstone. In this instance the zone of influence is the area above a theoretical 30^{o} line through sand and soil from the top of Medium Strength Sandstone towards the surrounding structures or boundaries.

If underpinning is required, it is to follow an underpinning sequence as specified by the structural engineer. In no circumstances is the bulk excavation to be taken to the edge of the house wall or footing and then underpinned. The underpins are to be carried out in drives pushed forward from beyond the zone of influence following the underpinning sequence. Under pins should not exceed 0.6m in width. 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.

Approximately 6.0m of the E common boundary will be set back ~0.5m from the E edge of the excavation allowing for back wall drainage, and will be within the zone of influence of the excavation. Prior to any excavation commencing, the portion of the timber fence along this boundary within the zone of influence of the excavation is to be propped.

Excavations for the house through soil and sand are to be battered temporarily at 1.0 Vertical: 1.7 Horizontal (30°) until permanent retaining walls are in place. Where room is limited along the E side of the excavation, the cut batters may be steepened accordingly provided any boundary fences are propped where necessary. Where batters need to be steepened beyond 30° the geotechnical consultant is to be onsite as the excavation begins to ensure the ground materials are as expected and no additional shoring is required. Excavations through Medium Strength Sandstone will stand at vertical angles unsupported, subject to approval by the geotechnical consultant.

During the excavation process, the geotechnical consultant is to inspect the cut in 1.5m intervals as it is 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 this 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.

Excavations through sandy soil and silty sands for the pool will stand at near vertical angles for short periods of time until the pool structure is installed provided they are prevented from becoming saturated. The geotechnical consultant is to be onsite as the excavation begins to ensure the ground materials are as expected and no additional support is required along the E boundary. Excavations through Medium Strength Sandstone will stand at vertical angles unsupported subject to approval by the geotechnical professional.

Unsupported cut batters through soil, sand, 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 structures 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.

Excavation spoil is to be removed from site.

14. Retaining Structures

For cantilever or singly propped retaining structures it is suggested the design be based on a triangular 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
Sandy Soil and Silty Sand	20	0.40	0.55
Medium Strength Sandstone	22	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 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 retaining structure design.

15. Foundations

A concrete slab and pads supported directly off Medium Strength Sandstone is a suitable footing for the proposed lower ground floor level. This ground material is expected to be exposed across most of the base of the lower ground floor excavation. Where it is not exposed on the downhill edge, shallow piers will be required to maintain a uniform bearing material.

Medium Strength Sandstone is expected to be exposed across the base of the excavation for the pool, this is a suitable bearing material. As the area around the pool will become saturated during pool use, it is recommended any paving around the pool be supported on a slab supported off rock. This will reduce the risk of settlement around the pool that can result from ongoing saturation of the soil.

A maximum allowable bearing pressure of 800kPa 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.

SEE OVER THE PAGE FOR REQUIRED INSPECTIONS

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.

- The geotechnical consultant is to be onsite as the excavation begins for the house and pool to ensure the ground materials are as expected and no additional support is required.

- 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.

- 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

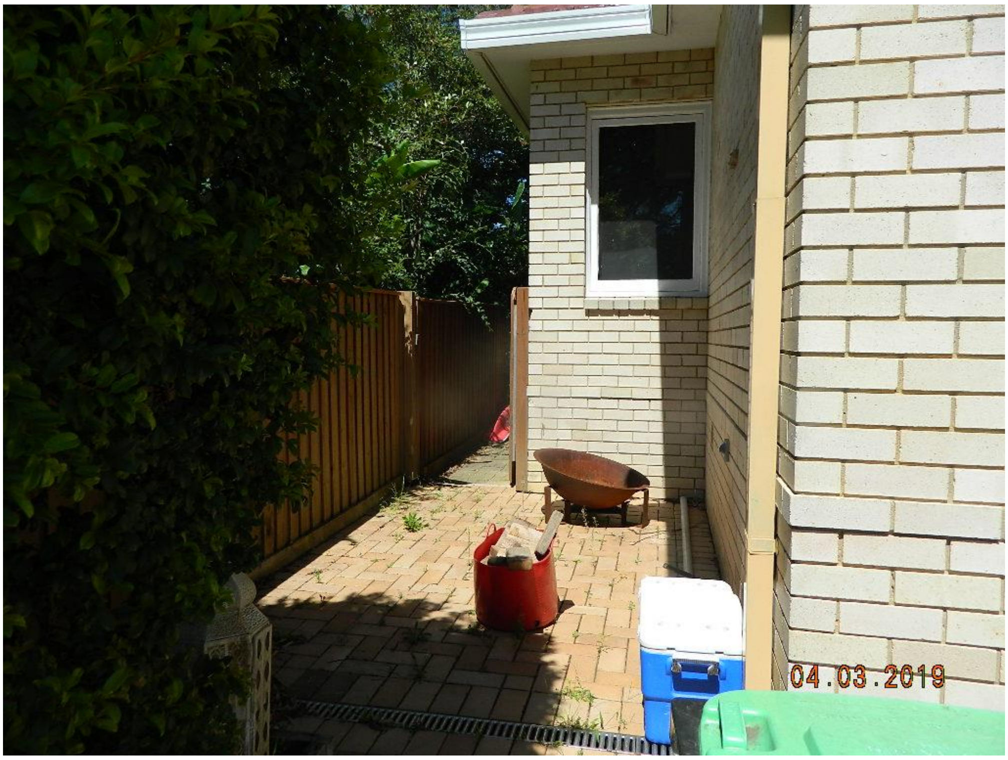


Photo 8

Photo 9: 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.

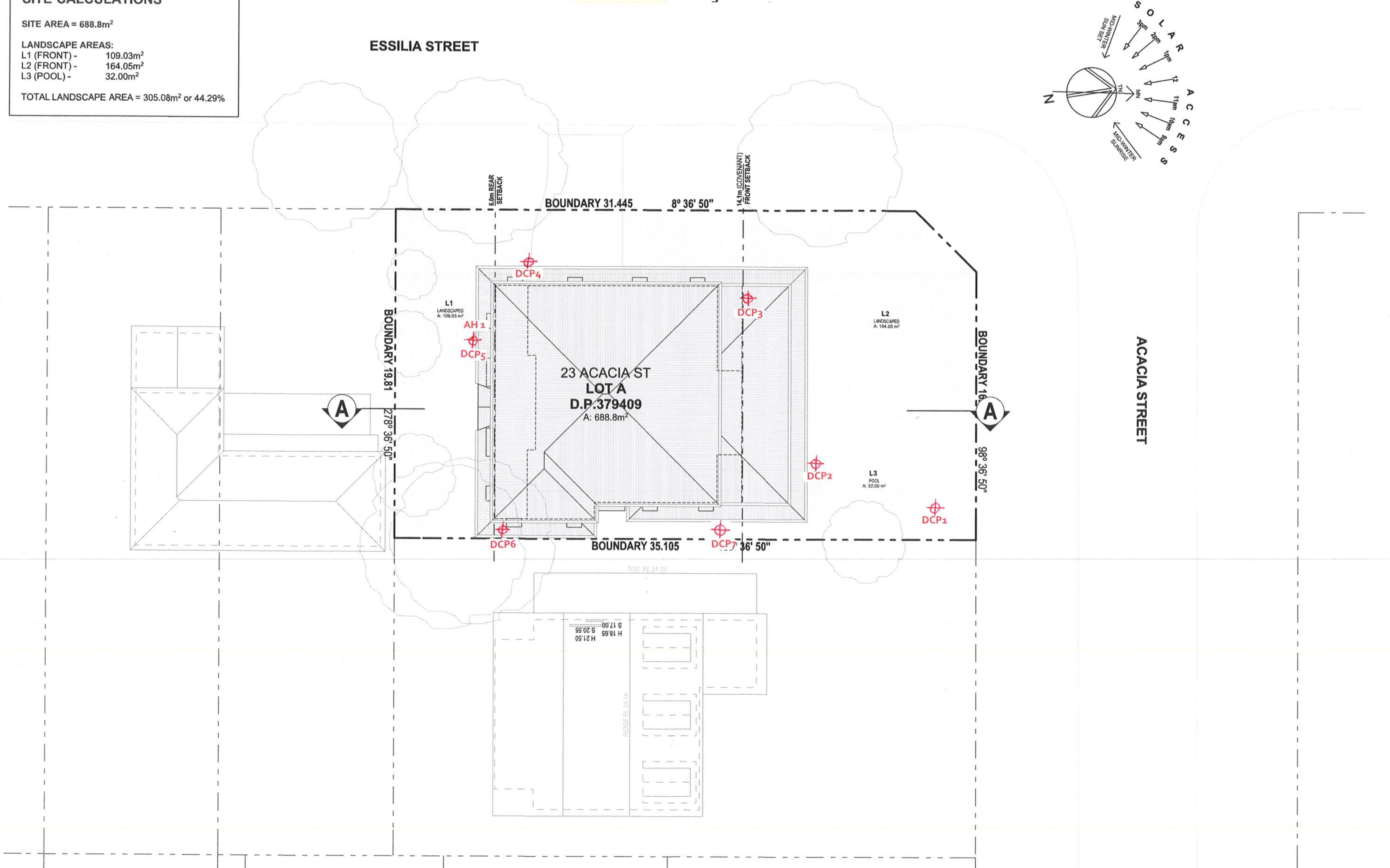
SITE PLAN – showing test locations

SITE CALCULATIONS

SITE AREA = 688.8m²

LANDSCAPE AREAS:
L1 (FRONT) - 109.03m²
L2 (FRONT) - 164.05m²
L3 (POOL) - 32.00m²

TOTAL LANDSCAPE AREA = 305.08m² or 44.29%



GARTNERTROVATO ARCHITECTS	DATE	REV	DESCRIPTION
	21/02/2019	A	SKETCH DESIGN

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PROJECT
PROPOSED NEW RESIDENCE
DEVELOPMENT APPLICATION
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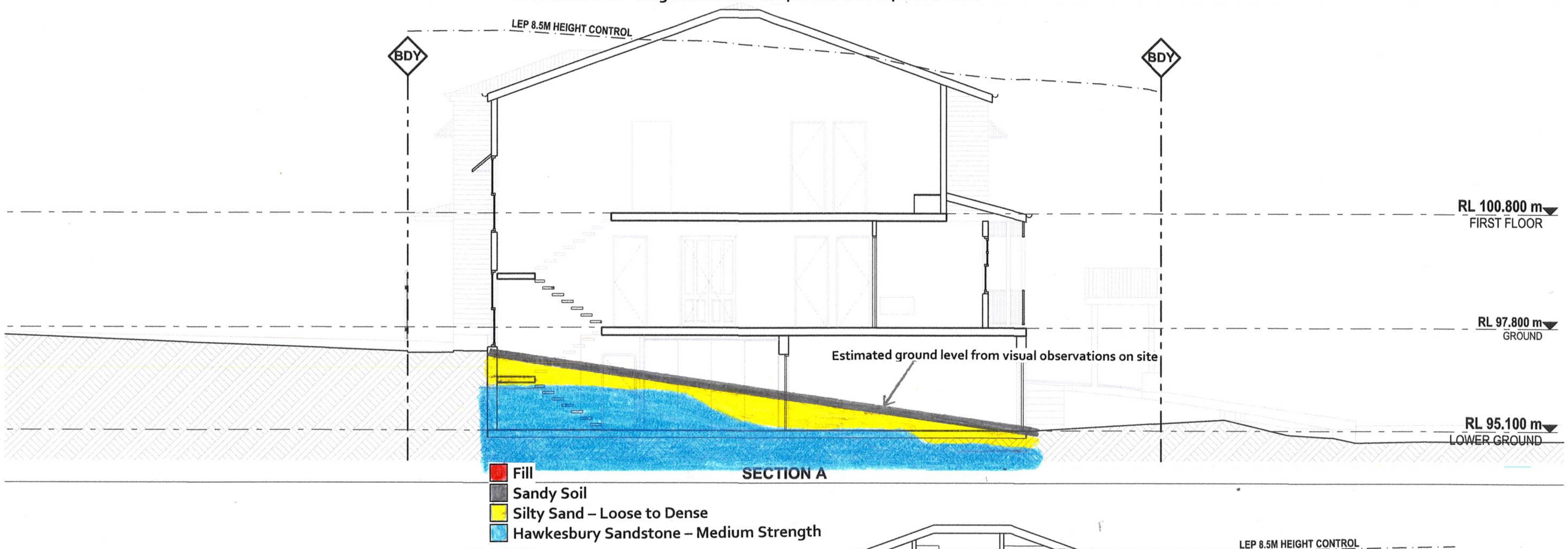
FOR NICHOLSON

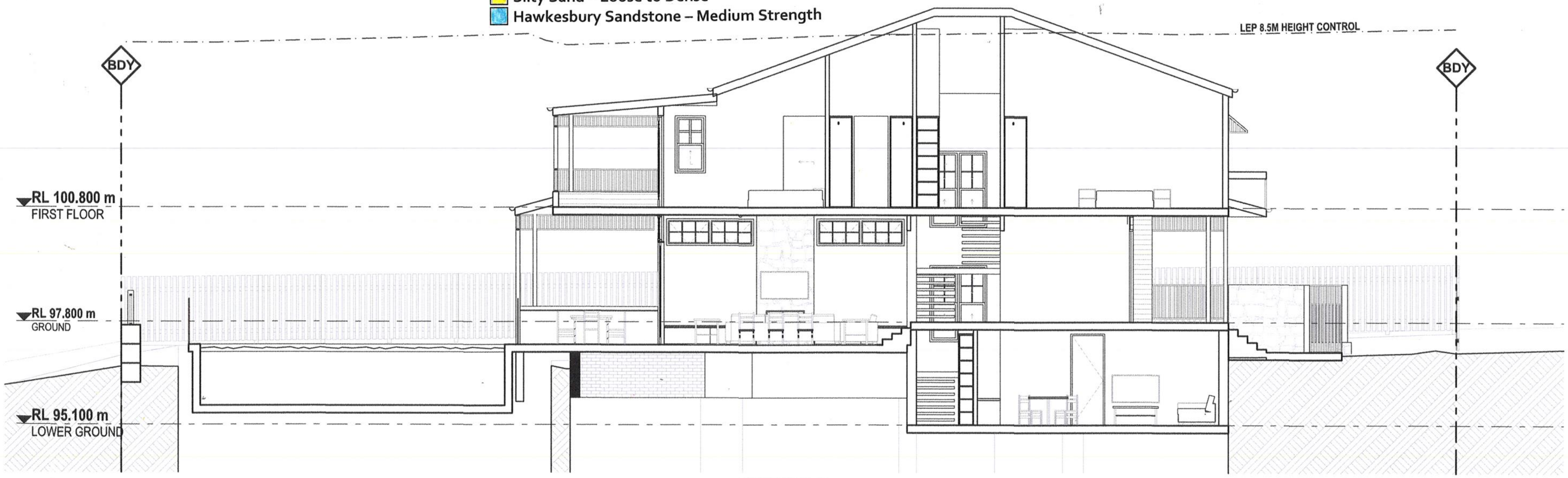
DRAWING TITLE
SITE PLAN / SITE ANALYSIS

SCALE	DRAWN BY	PLOT DATE
1:200 @ A3	LT/AB	21/02/2019
PROJECT NO.	**DRAWING NO.**	**REVISION**
1904	DA.01	A

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



SECTION A



SECTION B

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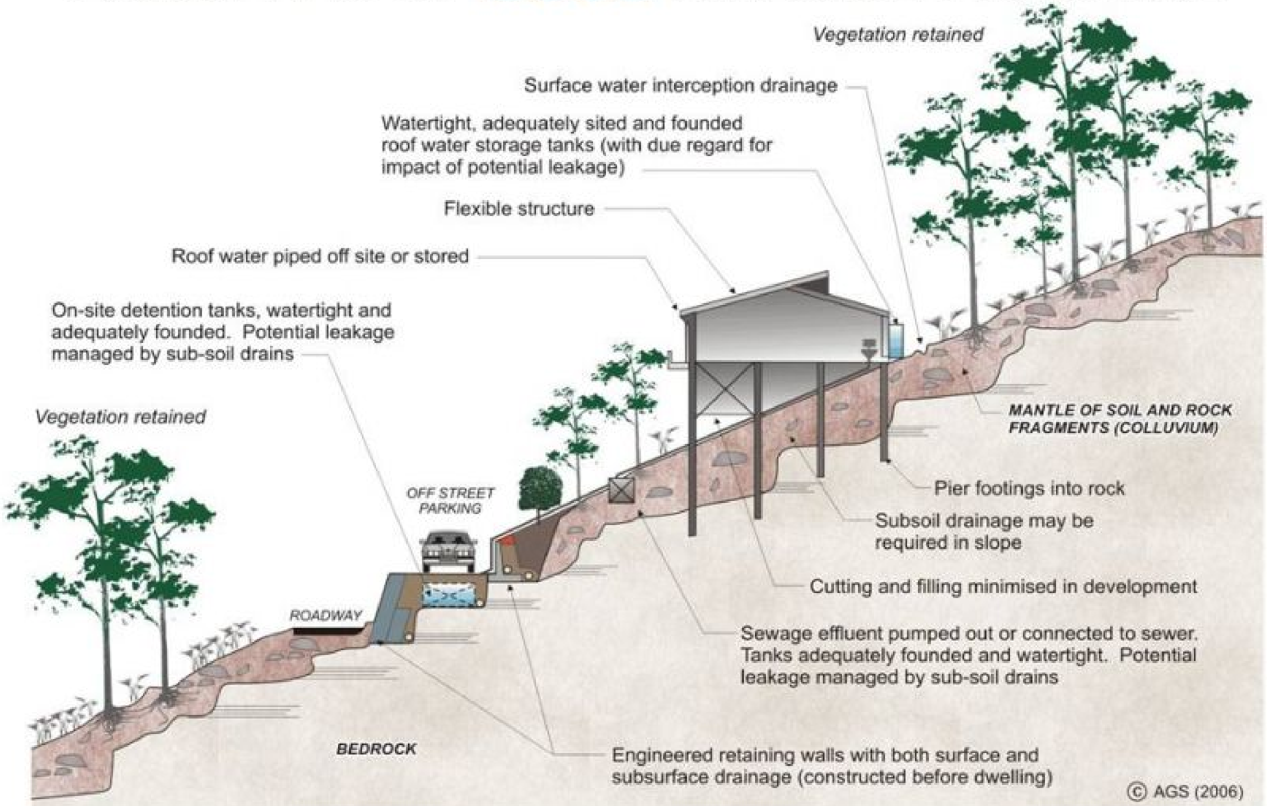
DATE	REV	DESCRIPTION
25/02/2019	A	SKETCH DESIGN

PROJECT
PROPOSED NEW RESIDENCE
DEVELOPMENT APPLICATION
23 ACACIA ST, COLLAROY PLATEAU NSW
LOT A, DP 379409
FOR NICHOLSON

DRAWING TITLE: SECTION

SCALE	DRAWN BY	PLOT DATE
1:100 @ A3	LT/AB	25/02/2019
PROJECT NO.	**DRAWING NO.**	**REVISION**
1904	DA.07	A

EXAMPLES OF GOOD HILLSIDE PRACTICE



EXAMPLES OF POOR HILLSIDE PRACTICE