GEOTECHNICAL INVESTIGATION:

New pool and Retaining Walls at 2/86 Anzac Avenue, Collaroy
aka: 58B Suffolk Avenue, Collaroy

1. Proposed Development

1.1 Construct a new pool and pool area by a stepped excavation to a maximum depth of 3.0m.

1.2 Details of the proposed development are shown on 4 drawings prepared by Right Angle Design and Drafting, job number RADD19054, drawings numbered P1-P4 and dated 9/19.

2. Site Description

2.1 The site was inspected on the 24th October, 2019.

2.2 This residential property is on the low side of Suffolk Ave and has a N aspect. The block is located on the upper reaches of a hill slope. The steep slope falls across the site at an average angle of 21°. The slope above the property eases to moderate angles as the crest of the hillslope is reached. The slope below the property continues at steep angles for a short distance before easing to moderate angles.

2.3 A concrete Right of Carriageway (ROW) extends downslope from Suffolk Ave to the property (Photo 1). Below the ROW a carport and timber stair case extend to the house (Photo 2). Next to the staircase is a landscaped slope that has been terraced with rough stack rock retaining walls (Photo 3). The up most stack rock retaining wall that lines the fill batter for the ROW has partially collapsed over a width of ~ 2.0m. The failed portion shows the fill consists of sandstone gravel and boulders (Photo 4). It is covered with a tarp (Photo 5). See **Section 16** for recommended remedial works that require immediate action. The plans show new retaining walls will be constructed as part of the proposed development for the pool below. The cut for the house is

supported by a 1.0m concrete retaining wall (Photo 6). The one and two storey rendered house extends downslope where it ends at a party wall dividing the house and where the block below begins. There are no visible signs of movement and the house is considered stable.

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. Three DCP (Dynamic Cone Penetrometer) 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 expected to be an issue for the testing on this site as the fill for the ROW consists of soil and sandstone boulders. The results are as follows:

AUGER HOLE 1 (~RL54.3) **–** AH1 (Photo 6)

Depth (m)	**Material Encountered**
0.0 to 0.5	**SANDY SOIL**, dark brown, medium grained with gravel.

Refusal @ 0.5m 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	**DCP 1** (~RL54.3)	**DCP 2** (~RL54.3)	**DCP 3** (~RL57.0)
0.0 to 0.3	11	5	4
0.3 to 0.6	12	10	3
0.6 to 0.9	22	#	7
0.9 to 1.2	#		#
	Refusal on Rock @ 0.8m	Refusal on Rock @ 0.5m	Refusal on Rock @ 0.7m

#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 @ 0.8m, DCP bouncing off rock surface, orange fragments on dry tip.
DCP2 – Refusal on rock @ 0.5m, DCP bouncing off rock surface, orange fragments on dry tip.
DCP3 – Refusal on rock @ 0.7m, DCP bouncing off rock surface, clean dry 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. At the top of the site the slope below the ROW consists of a surface covering of rocky fill, detached sandstone joint blocks and bedrock. Our ground testing equipment has difficult penetrating this material and thus difficulty in defining where bedrock begins. For this reason caution should be applied when looking at the Auger Log and the DCP results in terms of depth to bedrock. We think it is relatively shallow but expect it to be variable and this should be accounted for in the design, construction and budget. The outcropping sandstone across 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 groundwater is expected to move over the buried surface of the rock underlying the site. 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 significant surface flows were observed on the property during the inspection. We note it was dry at the time of the inspection and had not rained fore weeks prior.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed above or beside the property. The vibrations from the proposed excavations are a potential hazard (**Hazard One**). The proposed excavation is a potential hazard until retaining walls are in place (**Hazard Two**). The partially collapsed fill batter is a potential hazard until new retaining structures are in place (**Hazard Three**).

See Risk Analysis Summary next page

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two	Hazard Three
TYPE	The vibrations produced during the proposed excavations impacting on the surrounding structures.	The proposed excavation collapsing onto the work site before the retaining walls are in place.	The fill batter for the ROW falling before new walls are in place (Photo 4).
LIKELIHOOD	'Possible' (10^{-3})	'Possible' (10^{-3})	'Likely' (10^{-2})
CONSEQUENCES TO PROPERTY	'Medium' (15%)	'Medium' (12%)	'Medium' (20%)
RISK TO PROPERTY	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})	'Moderate' (6×10^{-4})
RISK TO LIFE	5.3×10^{-7}/annum	8.3×10^{-6}/annum	5.3×10^{-5}/annum
COMMENTS	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.	This level of risk to life and property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels, the recommendations in **Section 16 & 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 technically difficult but provided sufficient vigilance and thought is put into the design and construction the project is considered 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

No significant stormwater runoff will be generated by the proposed development.

11. Excavations

A stepped excavation to a total depth of ~3.0m is required for the pool. The upper step is ~ 1.2m deep with a bench ~ 1.0m wide then the excavation for the pool reaches a maximum depth of 1.8m. This work is immediately above a rough stack rock wall that lines the fill batter for the ROW above of which a section ~ 2.0m wide has recently failed. Rock is expected at relatively shallow but also variable depths below the proposed works. It is envisaged that excavations through soil 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 soils will be below the threshold limit for infrastructure or building damage.

It is expected that a portion of the excavations for the proposed pool 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. The fill batter for the ROW is immediately above the proposed works and the subject house will be within ~1.5m from the edges of the excavation for the pool. 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 stack rock wall lining the fill for the ROW above. 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 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 neighbouring properties.

13. Excavation Support Requirements

The only way to determine the depth to rock with any certainty in this location is for the builder to put down a series of exploration pits before any excavation work commences. We recommend 3 pits along the line of the proposed upper boundary retaining wall and 2 pits at either end of the footprint of the proposed pool. The Geotechnical consultant is to inspect the pits once they are dug to confirm the presence of bedrock. The following advice is somewhat preliminary and will may have to be refined depending on the depth to rock found in the exploration pits.

The upper retaining wall will need to be installed first. It will need to be founded on rock so the proposed excavation for the pool below does not undercut its foundations. Care will need to be taken with the foundation design of this wall so they do not undercut the fill batter for the ROW immediately above.

Once the upper retaining wall is in place and backfilled the excavation for the pool below can commence.

The soil portions of the upper step, that provides a level platform around the pool, are to be battered at not more than 1.0 vertical to 1.7 horizontal (30^{o}). Excavations through Medium Strength Sandstone or better will stand at vertical angles unsupported subject to approval by the geotechnical consultant.

Excavations for the pool shell through soil and clay are expected to stand at near vertical angles for the short period of time until the pool shell is in place provided they are prevented from becoming saturated.

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 and the pool 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.

If the cut batters for the pool remain unsupported for more than a few days before the commencement of pool construction they are to be temporarily supported with typical pool shoring such as braced sheet metal or similar until the pool structure is in place

During the excavation process, the geotechnical consultant is to inspect the excavation as it is lowered in ~1.2m intervals 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.

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

14. Retaining Walls

Currently a stack rock retaining wall lining the fill batter for the ROW has partially collapsed. See recommended remedial works in **Section 16**.

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	20	0.40	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 structure, do not account for any surcharge loads and assume retaining walls are fully drained. We note that the proposed retaining wall along the upper boundary will be backfilled to support the fill batter for the ROW so the wall needs to be designed for the surcharge load of the fill batter above plus the vehicle loads on the ROW. 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

The proposed upper boundary retaining wall needs to be supported on rock so the proposed excavations below do not undercut the wall. See **Section 13**. The proposed pool excavation is expected to be seated in rock. If rock is not be exposed across the entire pool excavation base, piers to rock will be a required. 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. Remedial Works

It is recommended the failed portion of the fill batter for the ROW be temporarily supported with a sandbag retaining wall to be installed immediately. The wall is to be not less than 0.8m wide at the base. The back of the wall is to be flush against the remaining face of the failed material. The face of the sandbag wall is to be tapered back at ~ 20° from vertical from the downhill toe edge. It is recommended the sandbags be filled with 10% cement so once they are in place they set hard. This way they can remain in place permanently noting the proposed retaining wall below will be built and the backfill will cover/ partially cover the sandbag wall.

Until these works are complete the fill batter should be monitored by the owners on a daily basis. If further movement is noted in the fill batter the driveway is to be barricaded off so cars cannot access the ROW. Our office is to be informed immediately.

17. 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 owners or the regulating authorities if the following inspections have not been carried out during the construction process.

- All exploration pits are to be inspected by the geotechnical consultant so the depth to rock can be confirmed and the excavation advice can be refined on the findings.

- During the excavation process, the geotechnical consultant is to inspect the cut faces as they are lowered in 1.2m 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.

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AusIMM., CP GEOL.
No. 222757
Engineering Geologist.

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7 – AH1

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.

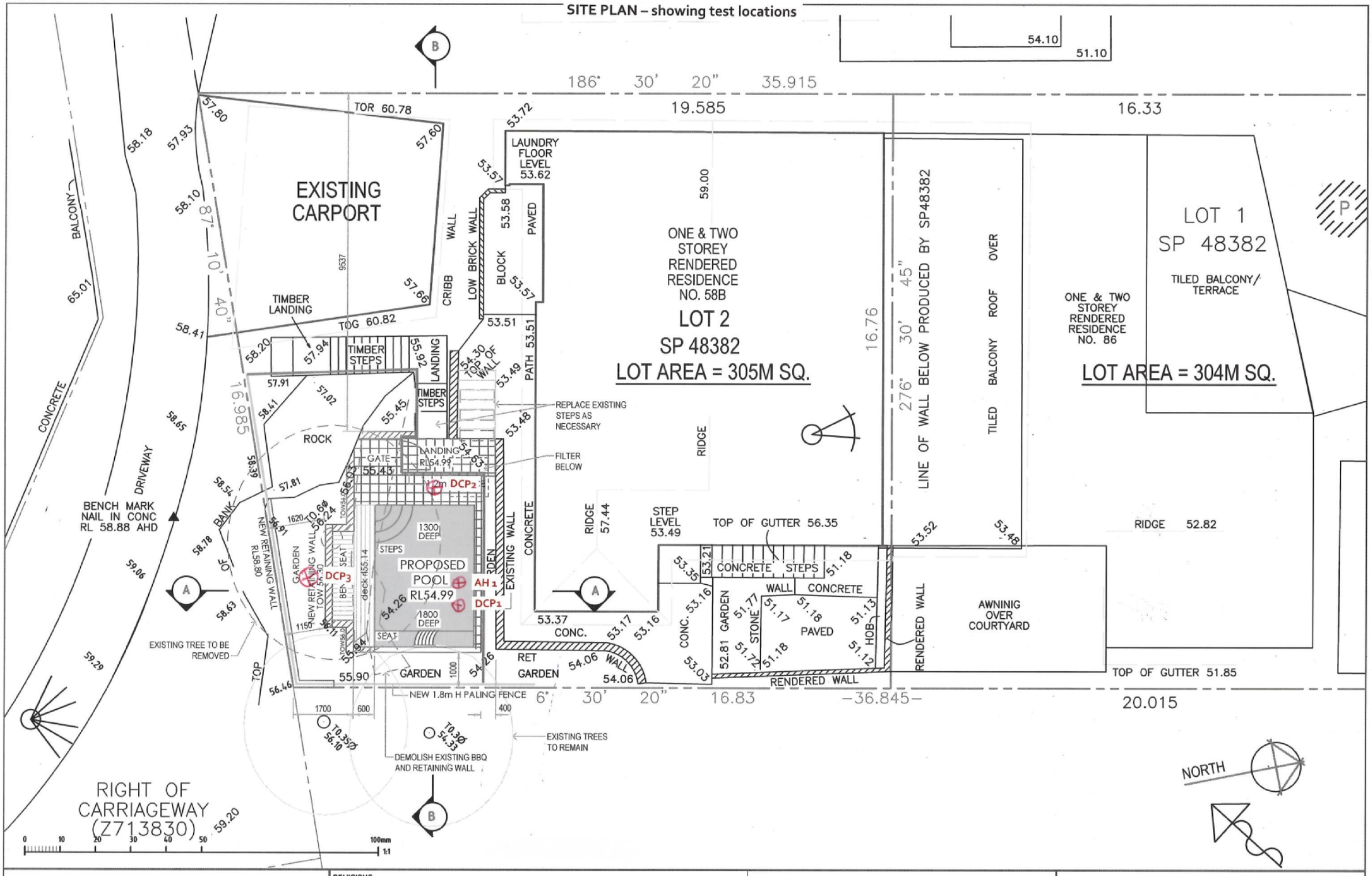
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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



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PROPOSED POOL & ASSOCIATED WORKS
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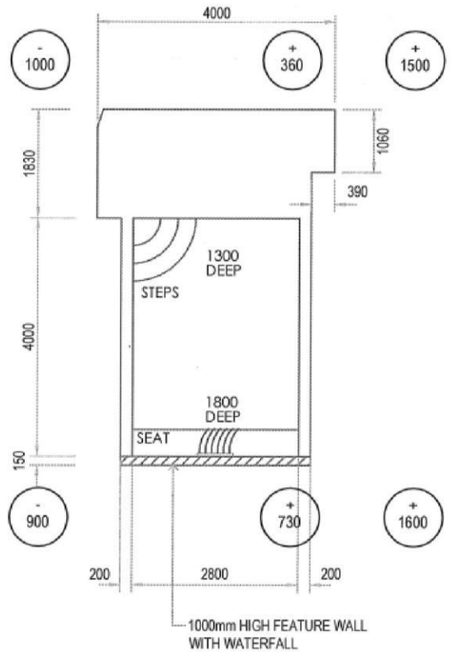
LOT 2 SP48382
No. 2/86 ANZAC AVENUE
COLLAROY 2097

DWG NAME
PLAN AT REAR YARD

DATE	SCALE AT A3	JOB NUMBER	DWG NUMBER
SEPT 19	1:100	RADD19054	P2

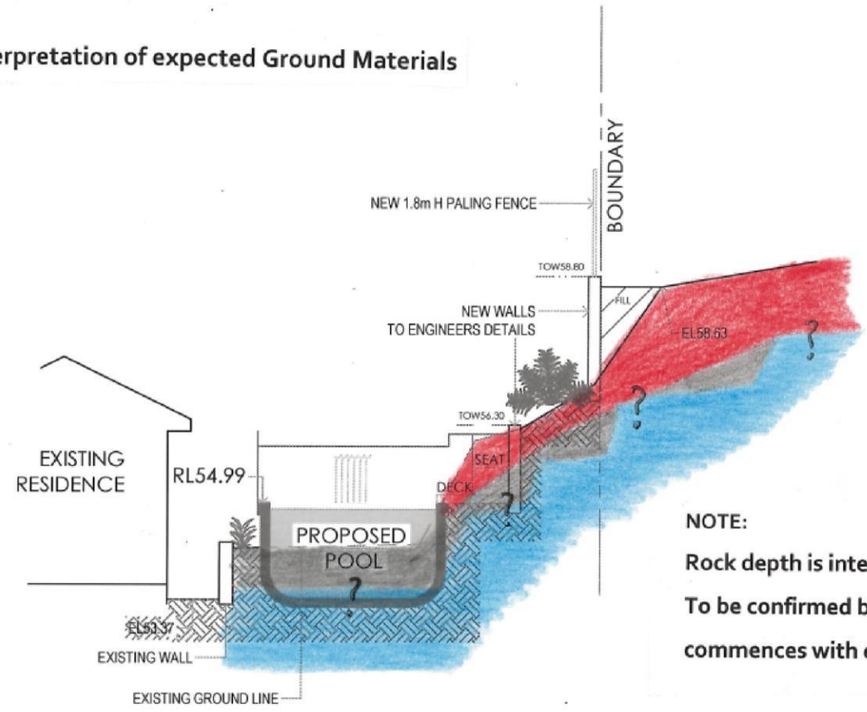
TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



POOL PLAN

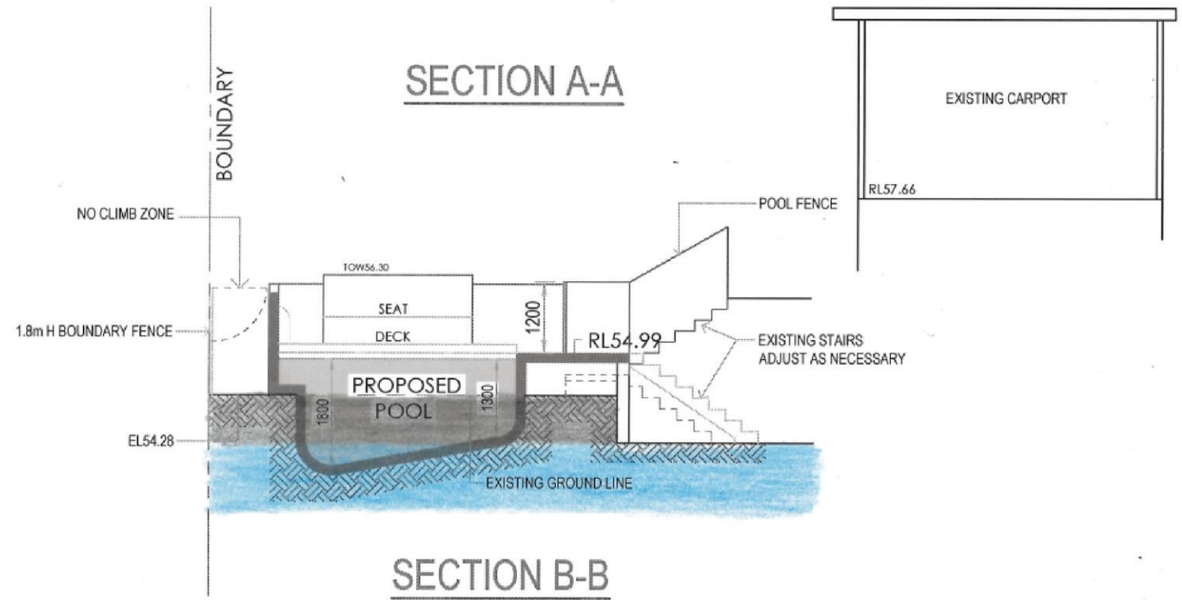
+100 DENOTES TOP OF POOL RELATIVE TO NATURAL GROUND LEVEL

- Fill
- Sandy Soil
- Sandy Clay
- Hawkesbury Sandstone – Medium Strength



SECTION A-A

NOTE:
Rock depth is interpreted only.
To be confirmed before constructed commences with exploration pits.



SECTION B-B

0 10 20 30 40 50 100mm 1:1

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PROPOSED POOL & ASSOCIATED WORKS
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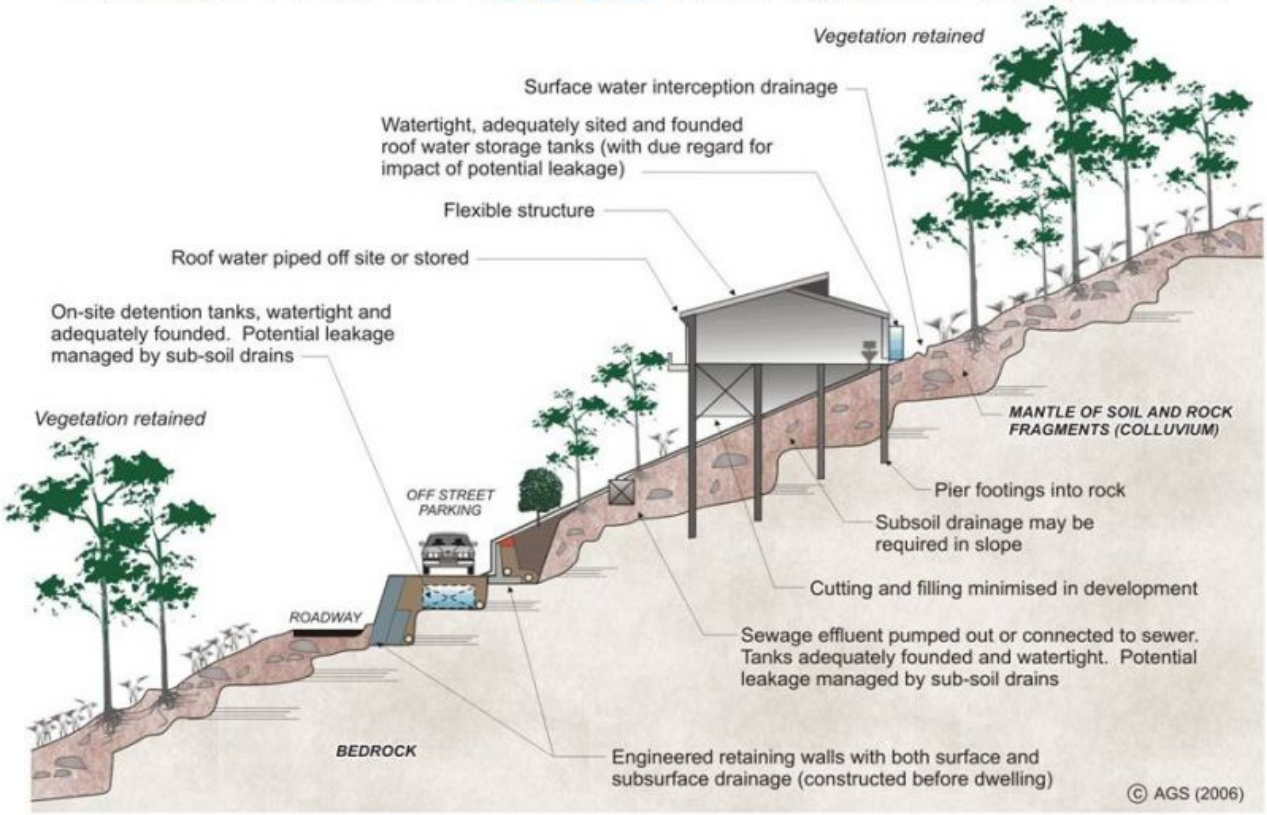
LOT 2 SP48382
No. 2/86 ANZAC AVENUE
COLLAROY 2097

DWG NAME
POOL PLAN AND SECTIONS

DATE	SCALE AT A3	JOB NUMBER	DWG NUMBER
SEPT 19	1:100	RADD19054	P3

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE