GEOTECHNICAL INVESTIGATION:

New House, Pool, and Rainwater Tank at **13 Morgan Road, Belrose**

1. Proposed Development

1.1 Demolish the existing house and construct a new part three-storey house by excavating to a maximum depth of ~3.0m.

1.2 Construct a new pool on the downhill side of the proposed house.

1.3 Install a new 200kL rainwater tank in the S corner of the property by excavating to a maximum depth of ~6.0m.

1.4 Various other minor alterations.

1.5 Details of the proposed development are shown on 8 drawings prepared by Preston Peterson, Project number AUST01, drawings numbered A02, A06, and A08 are Revision A, and drawings numbered A01, A03 to A05, and A07 are Revision B, all drawings are dated 10/3/22.

1.6 Details of the proposed rainwater tank are shown on 8 stormwater plans by NB Consulting Engineers, Job number 210575, Issue C, drawings numbered D02.2 to D02.4 are dated 17/2/22, and drawings numbered D01, D02, D02.1, D03, and D04 are dated 24/2/22.

2. Site Description

2.1 The site was inspected on the 24th February, 2022, and previously on the 6th May, 2021.

2.2 This large rural/residential property is on the high side of the road. The property encompasses the crest and both flanks of a NW to SE-trending ridgeline. The slope rises from the road frontage to the crest of the ridge at an average angle of ~13°.

The slope falls to the NE from the ridge at an average angle of <5°. The slope above and below the property continues at increasing angles.

2.3 At the road frontage, a concrete driveway runs up the slope to a parking area adjacent to a stable horse stable building and large equestrian arena with a large stable awning over (Photos 1 to 4). Another stable building has been constructed at the NW end of the equestrian arena (Photo 5). The concrete driveway continues up the slope and ends above where the house has since been demolished (Photo 6). Competent Medium Strength Sandstone outcrops between the concrete parking area and where the house was located prior to its demolition (Photo 7). An excavation has been made in the outcropping rock to level the site. The cut has been taken entirely through the sandstone bedrock and displays no significant geological defects. As such, the rock is considered stable. The demolition of the house revealed an existing excavation through the rock (Photo 8). These cut faces also display no significant signs of movement and are considered stable. The area surrounding the equestrian arena, outbuildings, and driveways mostly consists of gentle to moderately sloping paddocks (Photos 9 & 10). No signs of slope instability were observed in these paddocks.

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

Eight 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 attached. 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. However, excavation and foundation budgets should always allow for the possibility that the interpreted ground conditions in this report vary from those encountered during excavations. See the appended "Important information about your report" for a more comprehensive explanation. 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 (~RL134.0)	DCP 2 (~RL138.2)	DCP 3 (~RL137.4)	DCP 4 (~RL135.8)	DCP 5 (~RL133.5)	DCP 6 (~RL133.9)	DCP 7 (~RL129.7)	DCP 8 (~RL130.9)
0.0 to 0.3	4	9	2	Rock Exposed at Surface	21	16	17	7
0.3 to 0.6	8	#	13		17	40	30	19
0.6 to 0.9	#		35		19	24	25	34
0.9 to 1.2			#		#	#	20	16
1.2 to 1.5							#	#
	Refusal on Rock @ 0.5m	Refusal on Rock @ 0.2m	Refusal on Rock @ 0.9m		Refusal on Rock @ 0.9m	Refusal on Rock @ 0.8m	Refusal on Rock @ 1.1m	Refusal on Rock @ 1.0m

#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 @ 0.5m, DCP bouncing off rock surface, wet muddy tip.
DCP2 – Refusal on rock @ 0.2m, DCP bouncing off rock surface, orange sandstone fragments on wet tip.
DCP3 – Refusal on rock @ 0.9m, DCP bouncing off rock surface, brown sand on wet tip.
DCP4 – Rock exposed at surface.
DCP5 – Refusal on rock @ 0.9m, DCP bouncing off rock surface, wet muddy tip.
DCP6 – Refusal on rock @ 0.8m, DCP bouncing off rock surface, wet muddy tip.
DCP7 – Refusal on rock @ 1.1m, DCP bouncing off rock surface, white sandstone fragments on wet muddy tip.
DCP8 – Refusal on rock @ 1.0m, DCP bouncing off rock surface, wet muddy 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. The rock is overlain by sandy soils over sandy clays that fill the bench step formation. In the location of the testing where rock was not exposed, the depth to rock ranged between 0.2 to 1.1m below the current surface, being slightly deeper due to the stepped nature of the underlying bedrock. The sandstone outcropping on the property is estimated to be medium strength and similar strength rock is expected to underlie the entire site. 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 Sunset Lane above.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed beside the property. The gentle to moderately graded slope that rises across the property and continues above and below 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**).

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two	Hazard Three
TYPE	The gentle to moderate slope that rises across the site and continues above and below failing and impacting on the proposed works.	The vibrations produced during the proposed excavations impacting on the supporting walls of the neighbouring houses.	A loose boulder, wedge, or similar geological defect toppling onto the work site during the excavation process.
LIKELIHOOD	'Unlikely' (10^{-4})	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (12%)	'Medium' (15%)	'Medium' (30%)
RISK TO PROPERTY	'Low' (2×10^{-5})	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	5.5×10^{-7}/annum	5.3×10^{-7}/annum	9.3×10^{-4}/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.	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 Morgan Road. However, the road edges are not guttered below the subject property. As such, the stormwater engineer is to refer to council stormwater policy for suitable options.

11. Excavations

The builders on site at the time of our inspection (24/2/22) informed us that the demolition of the house revealed an as-dug excavation that was undertaken by the previous owner for the purpose of installing a basement garage that never went ahead. The current owners decided to make use of the existing excavation and, as such, the excavation for the proposed basement level of the house and pool were mostly completed at the time of the inspection but were left unsupported. These excavations were taken through a thin topsoil over Medium Strength Sandstone. The cut batters were stable at the time of the inspection.

An excavation to a maximum depth of ~6.0m is required to install the proposed rainwater tank. The excavation is expected to be through a thin fill and sandy soil over sandy clays with Medium Strength Sandstone expected to be encountered at a maximum depth of ~1.1m below the current surface.

It is envisaged that excavations through fill, sandy soil, and clays can be carried out with a bucket and excavations through rock will require grinding or rock sawing and breaking.

12. Vibrations

The proposed excavation is set back sufficiently from any surrounding structures or boundaries so that vibrations from the excavation will not exceed tolerable limits for building or infrastructure damage.

13. Excavation Support Requirements

No structures or boundaries will be within the zone of influence of any excavations. In this instance, the zone of influence is the area above a theoretical 30° line through fill and soil,

and a 45° line through clay from the top of Medium Strength Sandstone towards the surrounding structures and boundaries.

The fill, soil, and clay portions of the cut batters are to be battered temporarily at 1.0 Vertical to 2.0 Horizontal (30°) until the retaining walls are in place. We note due to the depth of the excavation for the rainwater tank, the fill, soil, and clay is to be scraped back from the footprint of this excavation at least 0.5m and then battered. 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 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. The materials and labour to construct the retaining walls/rainwater tank 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 excavations as they are 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 excavations, 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 Structures

For cantilever or singly-propped retaining structures, 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 Structures

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 structure, 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 structural design.

15. Foundations

Concrete slabs and shallow piers supported directly off Medium Strength Sandstone are suitable footings for the proposed house. This material is expected to be exposed across most of the base of the excavations. Where it is not exposed, and where the footprint of the proposed house does not fall over the excavation, piers will be required to maintain a uniform bearing material.

The proposed rainwater tank is expected to be seated on the Medium Strength Sandstone. This is a suitable foundation material.

The proposed pool is expected to be partially seated in Medium Strength Sandstone. Where sandstone is not exposed at the base of the excavation, the pool is to be supported on shallow piers taken to the underlying Medium Strength Sandstone.

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 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.

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, 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 and contractors are still onsite and before steel reinforcing is placed or concrete is poured.

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Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

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.

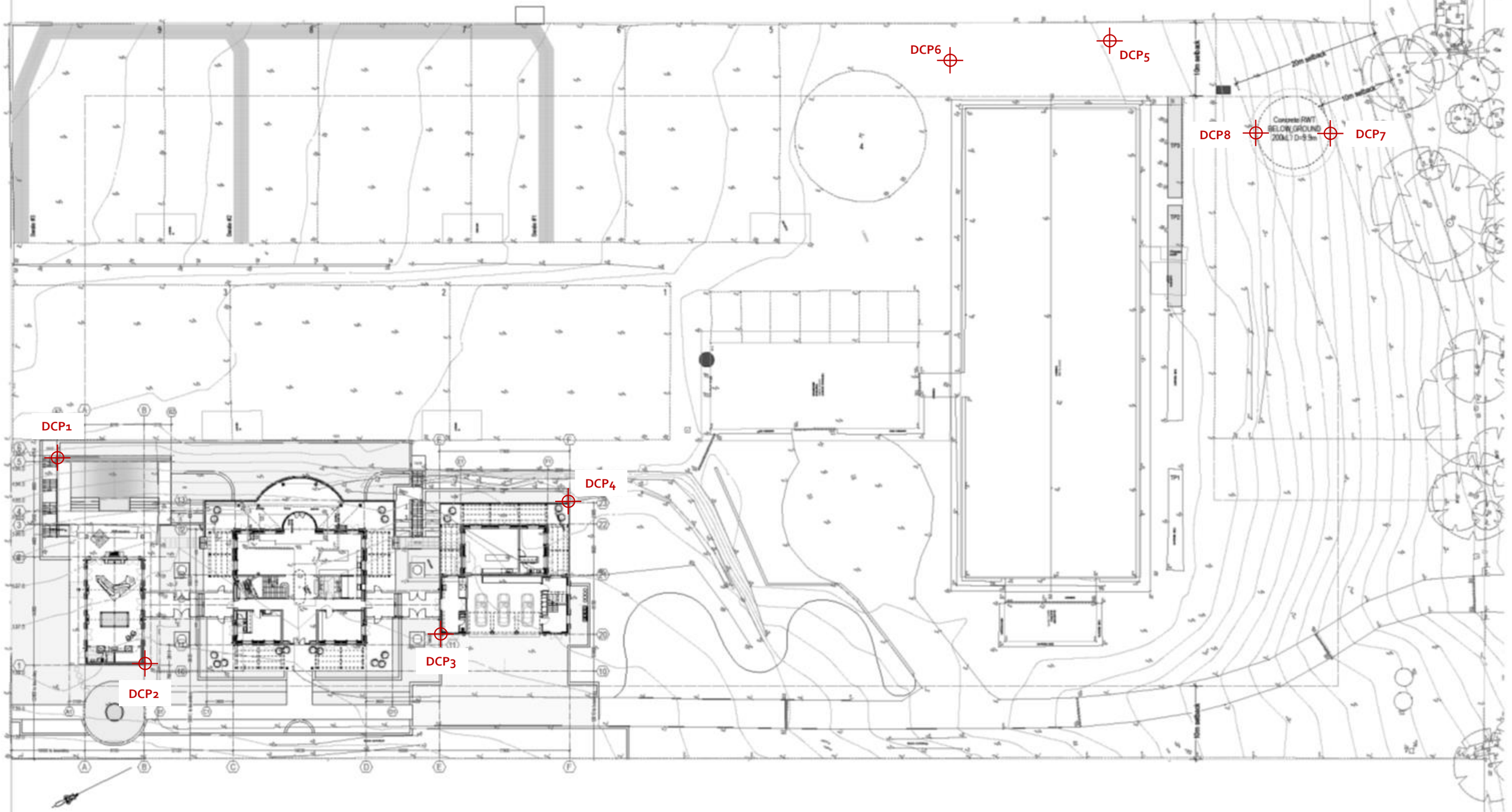
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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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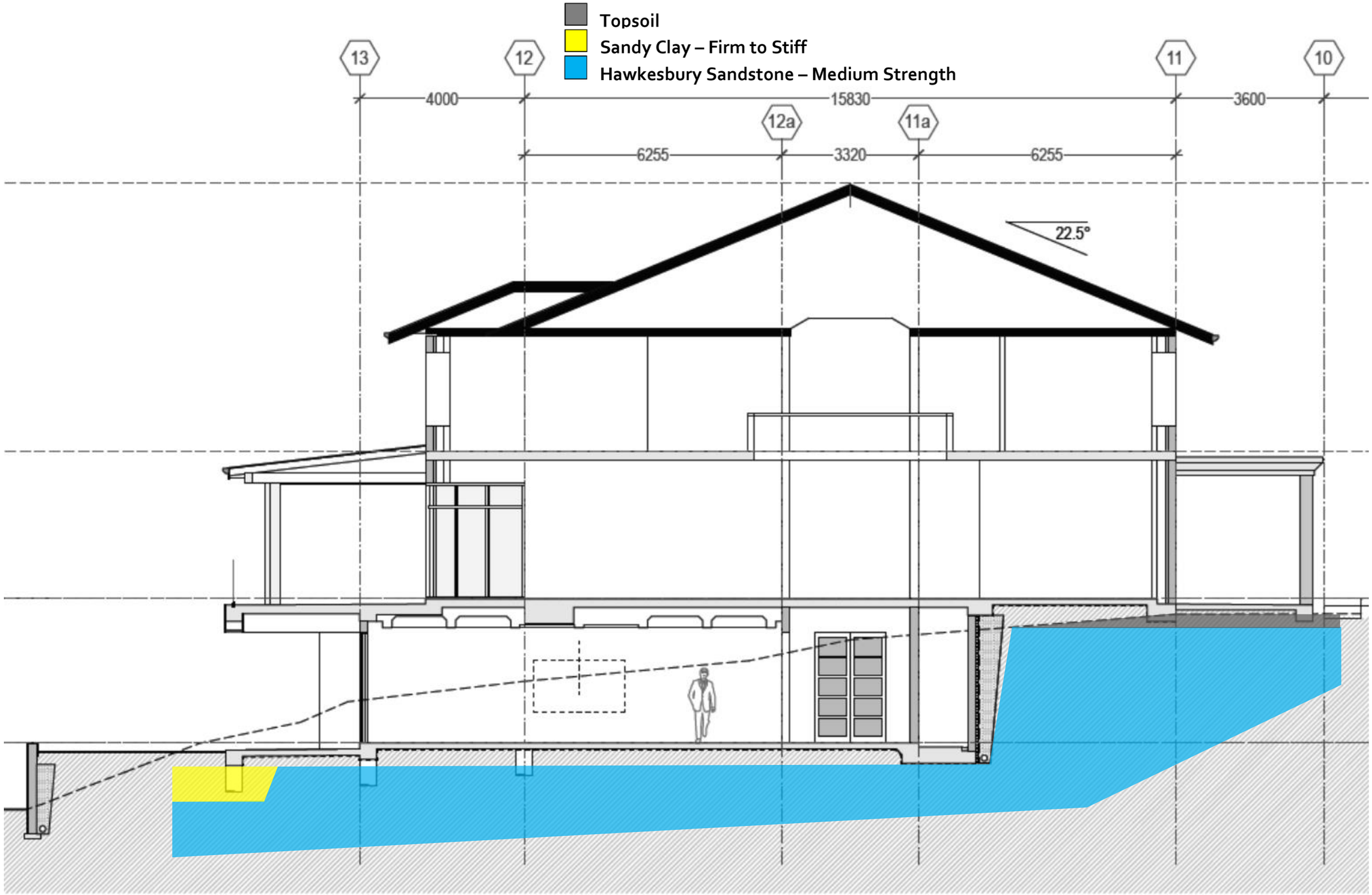
Drawing Notes

Revision Control

B	10/3/22	S4.55 Application
A	10/3/22	CC Application

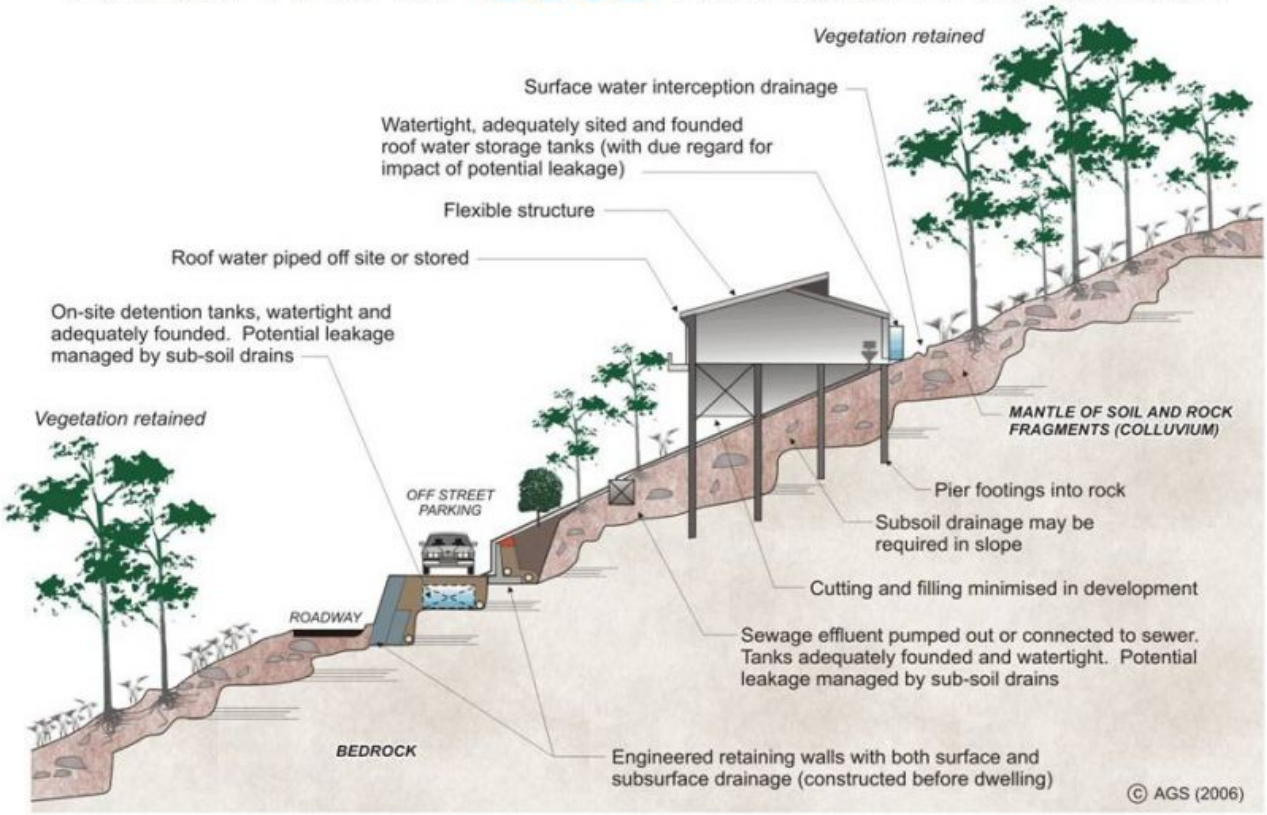
Client: Jenny and David Austin		Drawing: Site Plan	
Project: Taronnah		Scale: 1:250 @ A1	Drawing Number: A01
Project Address: 13 Morgan Road Belrose 2085		Rev Date: 10/3/2022	
Project Code: AUST01	Drawn by: JDP	Checked by: JLP	Revision: B

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



1 Section A-A

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE