GEOTECHNICAL INVESTIGATION:

Alterations and Additions and New Pool at **38 The Drive, Freshwater**

1. Proposed Development

1.1 Demolish the existing garage and construct a new garage with secondary dwelling over in the same location be excavating to a maximum depth of ~11.2m.

1.2 Extend the S side of the house by excavating to a maximum depth of ~4.0m.

1.3 Extend the downhill side of the house.

1.4 Install a new pool on the uphill side of the property by excavating to a maximum depth of ~1.8m.

1.5 Various other internal and external alterations.

1.6 Details of the proposed development are shown on 39 drawings prepared by Sketch Arc, project number 2046, drawings numbered DA4 to DA42, dated 19/5/22.

2. Site Description

2.1 The site was inspected on the 11th February, 2021.

2.2 This residential property is on the high side of the road and has an E aspect. It is located on the gentle to steeply graded upper reaches of a hillslope. From the road frontage to the uphill side of the house, the natural surface rises at steep angles of ~30°. The slope continues at angles of <5° to the upper common boundary.

2.3 At the road frontage, a concrete driveway runs to a garage on the downhill side of the property (Photo 1). The garage will be demolished as part of the proposed works. Competent Medium Strength Sandstone outcrops on both sides of the garage

(Photo 2). The steep slope between the garage and the downhill side of the house is naturally terraced with sandstone rock faces and has a dense covering of vegetation (Photo 3). Some portions of the rock faces are undercut to a maximum of ~2.0m (Photo 4). Each undercut joint block has a thick cantilever arm in relation to its overhang length and display no signs of cracking as viewed from below. Thus, they are considered stable. An inclined lift runs up the N boundary from the garage to the uphill side of the house (Photo 5). The lift has been cut directly into the outcropping sandstone (Photo 6). The cut faces display no significant geological defects and are considered stable. Near the top of the lift, another rock face with a ~2.0m undercut was observed (Photo 7). Similarly, the undercut joint block has a thick cantilever arm in relation to its overhang length and display no signs of cracking as viewed from above or below. Thus, it is considered stable. The part two-storey brick house is supported on brick walls and piers (Photo 8). The supporting walls display no significant signs of movement and the supporting piers stand vertical. Most of the supporting walls and piers were observed to be supported directly onto outcropping Medium Strength Sandstone. A concrete-paved fill extends off the uphill side of the house. The fill is supported by a stable ~1.5m high brick retaining wall (Photo 9). A gently sloping lawn extends into the SW corner of the property (Photo 10). Sandstone bedrock outcrops through this lawn and below the lawn at additional stable rock faces (Photo 11).

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

As sandstone bedrock was observed to be outcropping and stepping up the entire property, no subsurface investigation was carried out. See the attached site plan for key locations where bedrock was observed to be outcropping.

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. The rock is exposed across the majority of the property and in the locations of the proposed works. The exposed sandstone across the site is estimated to be Medium Strength and a similar strength rock is expected to underly the entire site. 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. It is expected that normal sheet wash will move onto the site from above the property during heavy down pours.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed above or beside the property. The steeply graded slope that rises across the downhill side of the property and continues below at reduced angles 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**). Building materials and equipment on the steep slope are a potential hazard (**Hazard Four**).

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two
TYPE	The steep slope that rises across the property and continues below at reduced angles 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' (12%)	'Medium' (15%)
RISK TO PROPERTY	'Low' (2×10^{-5})	'Moderate' (2×10^{-4})
RISK TO LIFE	9.1×10^{-7}/annum	5.3×10^{-7}/annum
COMMENTS	This level of risk is 'ACCEPTABLE' provided the recommendations in **Section 16** are carried out.	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.	Building materials and equipment rolling down the steep slope and impacting on the slope below and existing house during the construction process.
LIKELIHOOD	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (35%)	'Minor' (5%)
RISK TO PROPERTY	'Moderate' (2×10^{-4})	'Moderate' (5×10^{-5})
RISK TO LIFE	8.6×10^{-3}/annum	8.3×10^{-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 The Drive. 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 ~11.2m is required to construct the proposed garage. Another excavation to a maximum depth of ~4.0m is required to construct the proposed extension to the S side of the house. A third excavation to a maximum depth of ~1.8m is required to install the proposed pool. Each excavation is expected to be taken almost entirely through Medium Strength Sandstone.

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 building damage. The majority of the proposed excavations are expected to be through Medium Strength Sandstone.

Excavations through Medium Strength Sandstone or better should be carried out to minimise the potential to cause vibration damage to the subject house, neighbouring houses, and rock face. The supporting walls of the subject house will be immediately beside the proposed excavation to extend the S side of the house, The N neighbouring house will be as close as ~5.0m, the S neighbouring house will be as close as ~1.4m, and the W neighbouring house

will be as close as ~1.6m from the edges of the proposed excavations. Close controls by the contractor over rock excavation are recommended so excessive vibrations are not generated.

It is recommended a dilapidation report be carried out on the S neighbouring property prior to the commencement of any excavation.

Excavation methods are to be used that limit peak particle velocity to 5mm/sec at the supporting walls of the subject house and common 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 5mm/sec at the supporting walls of the subject house and 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 subject and neighbouring houses.

13. Excavation Support Requirements

The excavation for the extension to the S side of the house will come close to flush with the S supporting wall of the subject house (Photo 7). However, apart from a thin layer of soil over the rock, the excavations will be taken almost entirely through Medium Strength Sandstone and any nearby structures are already supported on the rock. As such, no structures or boundaries will be within the zone of influence of the excavations.

Due to the steep slope across the downhill side of the property, the builders are to carry out the works following standard safety practices on steep slopes to prevent any building materials or equipment from rolling down the slope in an uncontrolled manner. This may involve the use of a crash barrier/fence at the base of the slope and above the S neighbouring property.

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. The materials and labour to construct the retaining walls/pool structure 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 for the extension to the S side of the house, the geotechnical consultant is to inspect the excavation as it approaches a distance of 1.0m from the S supporting wall of the house to confirm the suitability of the cut to go flush with the footings.

Additionally, during the excavation process for all cuts, the geotechnical consultant is to inspect the cut faces in 1.5m intervals as they are lowered or after encountering a softer section of rock, while the machine is on site to ensure the ground materials are as expected and no wedges or other geological defects are present that could require additional support. Should any weak sections of rock or potentially destabilising jointing be exposed by the excavation, works are to stop until temporary or permanent support such as rock anchors, bolts, mesh and sprayed concrete, or similar support designed by the structural engineer is installed in consultation with the geotechnical consultant.

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
Sandy Soil	20	0.40	0.55
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 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 supported directly off Medium Strength Sandstone are suitable footings for the proposed garage and extensions to the house. This ground material is expected to be exposed across the entire base of the excavations.

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

As the area around the pool will periodically become saturated with pool use, to prevent excessive settlement it is recommended the proposed pavilion be supported on piers and any paving be laid on a concrete slab supported on 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 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. Site Maintenance/Remedial Works

Where slopes approach or exceed 30° (such as on the downhill side of the property), it is prudent for the owners to occasionally inspect the slope (say annually or after heavy rainfall events, whichever occurs first). Should any of the following be observed: movement or

cracking in retaining walls, cracking in any structures, cracking or movement in the slope surface, tilting or movement in established trees, leaking pipes, or newly observed flowing water, or changes in the erosional process or drainage regime, then a geotechnical consultant should be engaged to assess the slope. We can carry out these inspections upon request. The risk assessment in **Section 8** is subject to this site maintenance being carried out.

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.

- During the excavation process for the extension to the S side of the house, the geotechnical consultant is to inspect the excavation as it approaches a distance of 1.0m from the S supporting wall of the house to confirm the suitability of the cut to go flush with the footings.
- During the excavation process the geotechnical consultant is to inspect the cut face in 1.5m intervals as it is lowered, while the machine is on site 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 and contractors are still onsite and before steel reinforcing is placed or concrete is poured.

White Geotechnical Group Pty Ltd.

Ben White M.Sc. Geol.,
AusIMM., CP GEOL.
No. 222757
Engineering Geologist.

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

Photo 11

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.

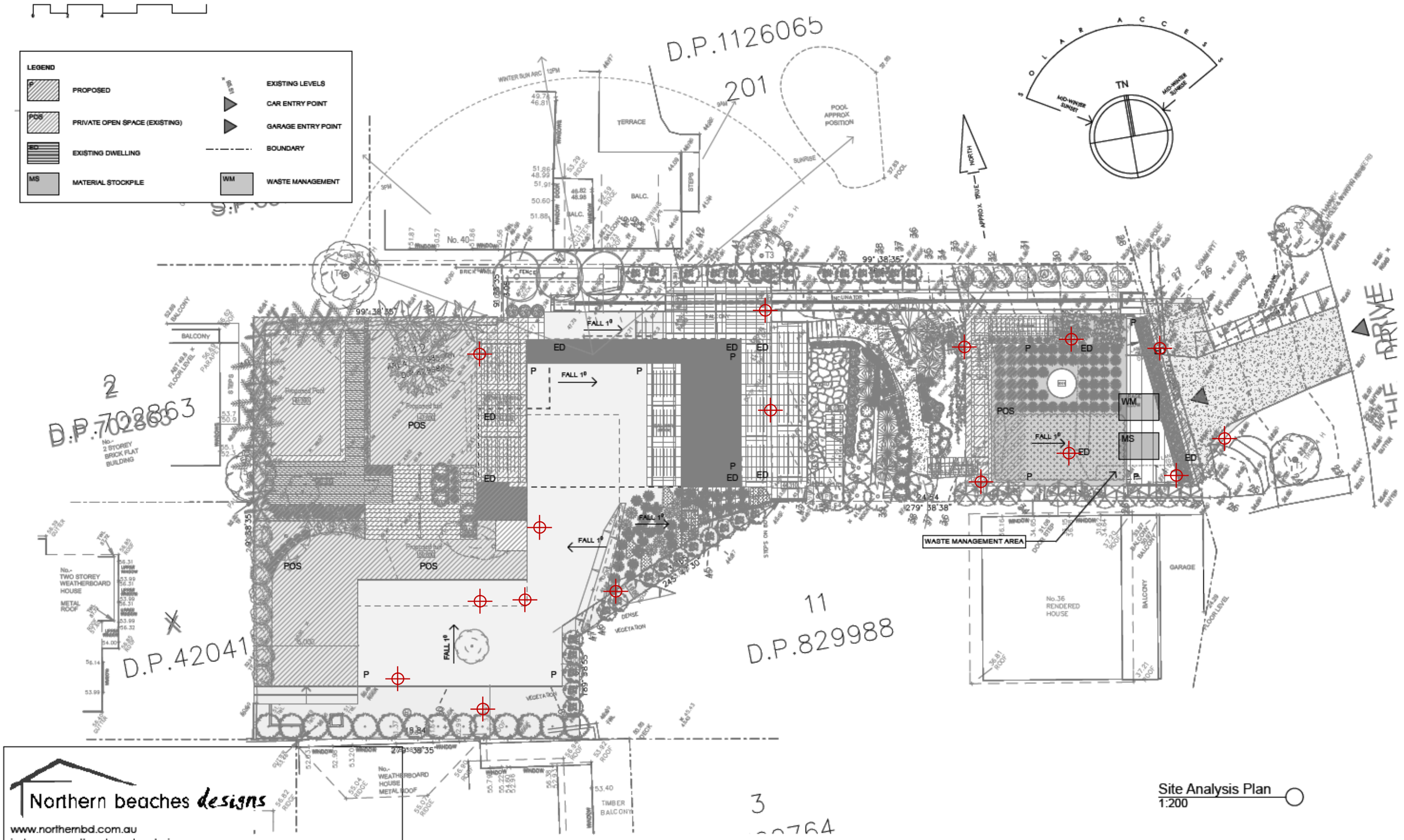
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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 locations where bedrock was observed to be outcropping



Site Analysis Plan
1:200

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TN

DO NOT SCALE DRAWINGS. CHECK ALL DIMENSIONS ON SITE. FIGURED DIMENSIONS TAKE PRECEDENCE.
The builder shall check and verify all dimensions and verify all errors and omissions to the Architect. Do not scale the drawings. Drawings shall not be used for construction purposes until issued by the Architect for construction.

REV	DATE	DESCRIPTION

sketchArc
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PROJECT: 38 The Drive, Freshwater, 2096, NSW
Alterations & Additions
LOT 12 in DP 829988 - 985.7m2

CLIENT: Private

- Proposed Work
- Demolition
- Existing

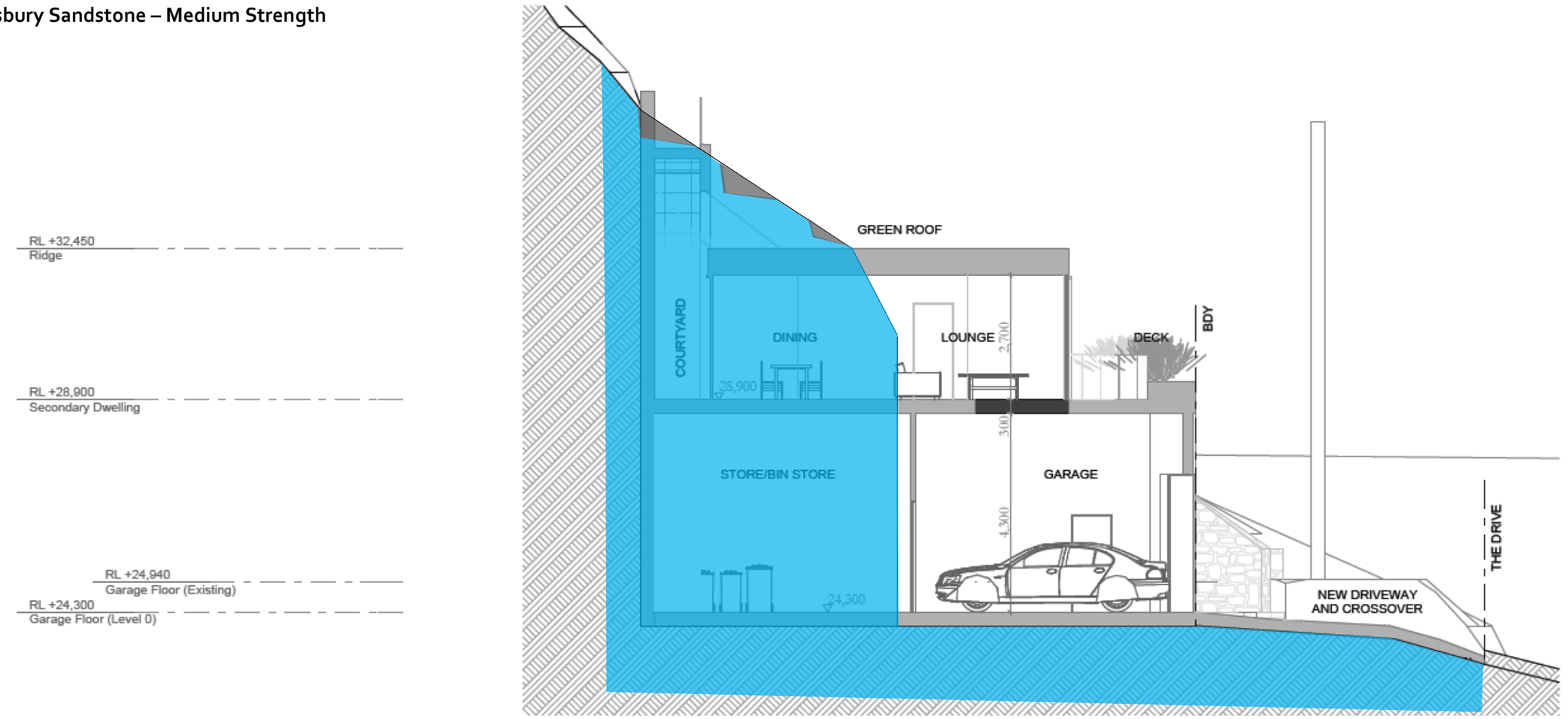
STATUS: DA		
DATE: 190522	SCALE: 1:200@A3	PROJECT NUMBER: 2046
STAGE: DA	DRAWN/DESIGNED: PB / MP	ISSUE:
DRAWING NO: DA4		

0 2 4

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials

Topsoil

Hawkesbury Sandstone – Medium Strength



Section C-C
1:100

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DO NOT SCALE DRAWINGS. CHECK ALL DIMENSIONS ON SITE. FIGURED DIMENSIONS TAKE PRECEDENCE.
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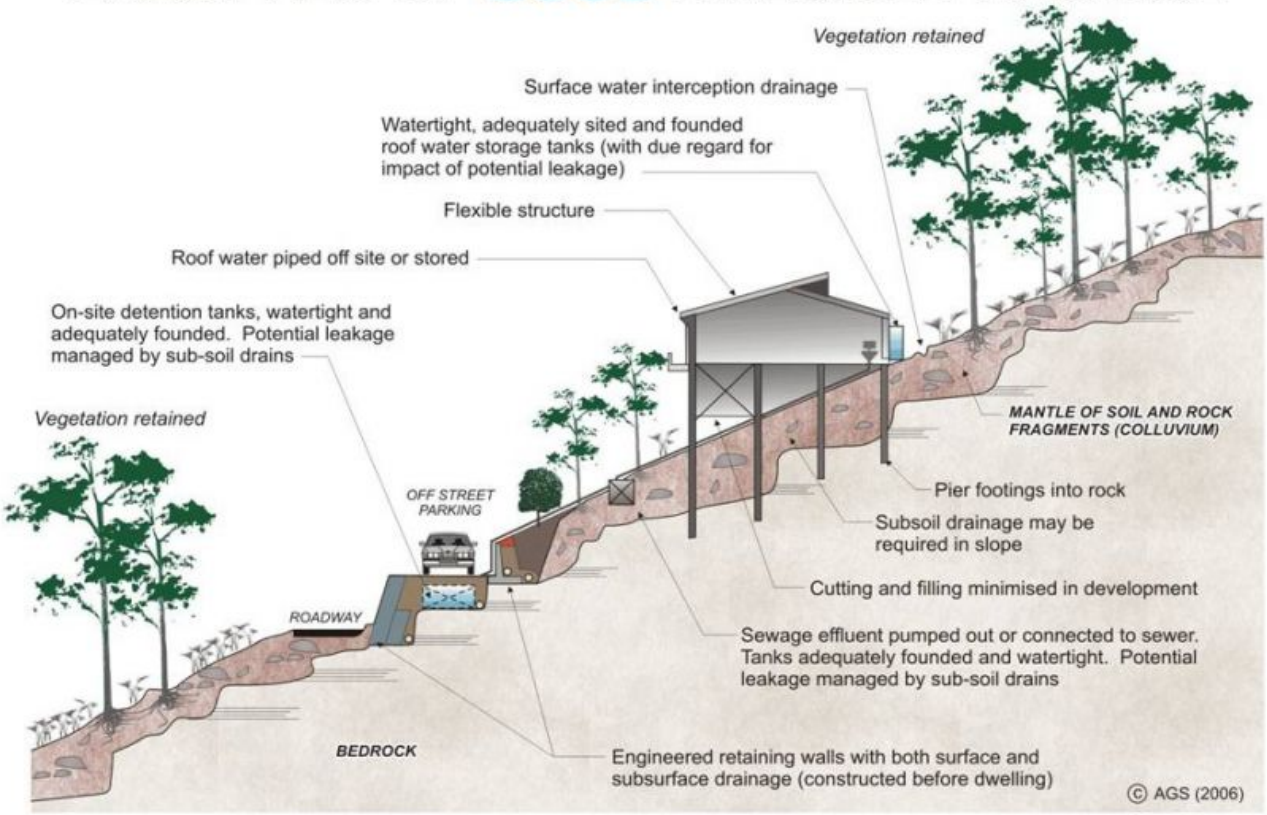
- Proposed Work
- Demolition
- Existing

STATUS: DA		
DATE: 190522	SCALE: 1:100@A3	PROJECT NUMBER: 2046
STAGE: DA	DRAWN/DESIGNED: PB / MP	ISSUE:
DRAWING NO: DA28		

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE