GEOTECHNICAL INVESTIGATION:

New Garage and Deck at **82 Binburra Avenue, Avalon**

1. Proposed Development

1.1 Construct a garage on the downhill side of the property by excavating to a maximum depth of ~5.7m.

1.2 Construct a deck off the downhill side of the house.

1.3 Various other minor external additions and alterations.

1.4 Details of the proposed development are shown on 2 drawings prepared by Shim Design, project number 0422, drawings numbered 1/2 and 2/2, dated April 2022.

2. Site Description

2.1 The site was inspected on the 14th April, 2022.

2.2 This residential property is on the high side of the road and has a W aspect. It is located on the steeply graded upper reaches of a hillslope. The natural slope rises across the property at an average angle of ~21° before increasing in grade to angles approaching 30° above the house. The slope above the property continues at steep angles to the crest of the slope, and the slope below the property eases to moderate to steep angles.

2.3 At the road frontage, a concrete driveway runs up the slope to a garage underneath the downhill side of the house (Photo 1). The cut for the driveway is supported by a stack rock retaining wall reaching up to 1.6m high. This retaining wall is covered in dense vegetation and could not be adequately assessed. It is to be demolished as part of the proposed works. The part two-storey timber clad and rendered brick house is supported on rendered brick walls (Photo 2). Internal access

was not available at the time of inspection. The external rendered brick walls show no signs of significant movement. A level platform for the uphill side of house has been created by a ~2.2m unsupported cut batter (Photos 3 & 4). The cut has been partially taken through Extremely Low Strength Rock. Part of this batter has failed. See **Section 16** for recommendations regarding this cut batter. A stable ~2.0m high concrete crib wall supports the cut for the house along the S common boundary (Photo 5). A densely vegetated, steeply sloping bushland area extends immediately above this batter to the upper common boundary (Photo 6). A large band of outcropping Sandstone sits some ~15m upslope of the house (Photo 7). This sandstone band could not be assessed due to access difficulties.

3. Geology

The Sydney 1:100 000 Geological sheet indicates the site is underlain by Hawkesbury Sandstone with the contact point of the Narrabeen Ground of Rocks downslope of the property. Given the ground test results, the Newport Formation of the Narrabeen Group is expected to underlie the proposed works. This is described as interbedded laminite, shale and quartz to lithic quartz sandstone.

4. Subsurface Investigation

One hand Auger Hole (AH) was put down to identify soil materials. Seven Dynamic Cone Penetrometer (DCP) tests were put down to determine the relative density of the overlying soil and the depth to weathered rock. 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:

AUGER HOLE 1 (~RL58.8) **–** AH1 (Photo 8)

Depth (m)	**Material Encountered**
0.0 to 0.2	**FILL**, dark brown clayey soil and orange sand, medium grained, fine trace of organic matter, dry.
0.2 to 0.4	**FILL**, mottled orange, yellow, sandy clay, fine to medium grained, fine trace of organic matter, dry.
0.4 to 0.8	**CLAY**, brown and orange, sandy, fine to medium grained, dry.

End of test @ 0.8m. No water table 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** (~RL58.9)	**DCP 2** (~RL59.7)	**DCP 3** (~RL56.6)	**DCP 4** (~RL57.1)
0.0 to 0.3	5	3	3	1
0.3 to 0.6	5	5	5	3
0.6 to 0.9	7	3	8	4
0.9 to 1.2	8	7	5	7
1.2 to 1.5	8	8	12	8
1.5 to 1.8	15	12	18	12
1.8 to 2.1	23	18	#	17
2.1 to 2.4	32	27		34
2.4 to 2.7	#	36		#
2.7 to 3.0		#		
	End of Test @ 2.4m	End of Test @ 2.7m	Refusal on Rock @ 1.8m	End of Test @ 2.4m

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 5** (~RL59.5)	**DCP 6** (~RL60.0)	**DCP 7** (~RL60.8)
0.0 to 0.3	11	13	5
0.3 to 0.6	6	11	3
0.6 to 0.9	15	10	#
0.9 to 1.2	21	14	
1.2 to 1.5	32	16	
1.5 to 1.8	#	34	
1.8 to 2.1		#	
	End of Test @ 1.4m	End of Test @ 1.7m	Refusal on Rock @ 0.6m

#refusal/end of test. F=DCP fell after being struck showing little resistance through all or part of the interval.

DCP Notes:

DCP1 – End of test @ 2.4m, DCP still going down slowly, orange clay on dry tip.
DCP2 – End of test @ 2.7m, DCP still going down slowly, orange clay on dry tip.
DCP3 – Refusal on rock @ 1.8m, DCP thudding, orange and brown shale on dry tip.
DCP4 – End of test @ 2.4m, DCP still going down slowly, orange clay on dry tip.
DCP5 – End of test @ 1.4m, DCP still very slowly going down, clean dry tip.
DCP6 – End of test @ 1.7m, DCP still very slowly going down, clean dry tip.
DCP7 – Refusal on rock @ 0.6m, DCP bouncing off rock surface, clean dry tip.

5. Geological Observations/Interpretation

The slope materials are colluvial at the near surface and residual at depth. In the test locations, the ground materials consist of fill and shallow soils over clays. The clay merges into the underlying weathered rock at depths of between ~1.2m to ~2.1m below the current surface. The weathered zone is interpreted to be Extremely Low Strength Shale. We point out around the contact of two rock types (sandstone & shale) the rock can be variable and associated with higher groundwater seepage. If there are bands of sandstone underlying the

house, this will have implications for the proposed excavations. These are addressed in **Section 13:** "Excavation Support Requirements". 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. As above, ground water seepage may be slightly elevated around the contact of the Hawkesbury Sandstone and Narrabeen Group.

7. Surface Water

Significant surface water was observed running down the cut batter and exposed Extremely Low Strength Rock above the house as well as through the steep soil slope adjacent to the driveway. It is expected that normal sheet wash such as these will move onto the site from above the property during heavy down pours. This will move down the slope at a relatively high velocity due to the steep slope.

Should the owners be aware or, if at a later time, become aware that overland flows enter the property during prolonged heavy rainfall, our office is to be contacted so appropriate drainage can be designed and installed. It is a condition of the risk assessment in **Section 8** that this be done.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed beside the property. The steeply graded slope that rises across the property and continues above and below is a potential hazard (**Hazard One**). The proposed excavations are a potential hazard until retaining walls are in place (**Hazard Two**). The proposed excavation undercutting the footings for the subject and neighbouring houses is a potential hazard (**Hazard Three**). The existing unsupported ~2.0 to

~3.0m cut batter above the house is a potential hazard (**Hazard Four**). The sandstone beds exposed on the upper half of the property are a potential hazard (**Hazard Five**).

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two	Hazard Three
TYPE	The steep slope that rises across the property and continues above and below failing and impacting on the proposed works.	The excavation for the garage (Up to a maximum depth of ~5.7m) collapsing onto the work site before retaining walls are in place.	The proposed excavation undercutting the footings of the subject and neighbouring houses causing failure.
LIKELIHOOD	'Unlikely' (10^{-4})	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (15%)	'Medium' (15%)	'Medium' (35%)
RISK TO PROPERTY	'Low' (2×10^{-5})	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	9.1×10^{-7}/annum	8.3×10^{-6}/annum	5.3×10^{-5}/annum
COMMENTS	This level of risk is 'ACCEPTABLE', provided the recommendations in **Section 7 & 16** are followed.	This level of risk to life and property is 'UNNACEPTABLE'. To move risk to 'ACCEPTABLE' levels, the recommendations in **Section 13 and 14** 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.

RISK ANALYSIS CONTINUED ON NEXT PAGE

HAZARDS	Hazard Four	Hazard Four
TYPE	The exposed ~2.0 to ~3.0m high cut batter (Photos 3, 4, and 5) failing and damaging the house.	The sandstone beds exposed on the upper half of the property toppling, and rolling downhill and colliding with the house and proposed development (Photo 7).
LIKELIHOOD	'Possible' (10^{-3})	'Rare' (10^{-5})
CONSEQUENCES TO PROPERTY	'Medium' (15%)	'Major' (60%)
RISK TO PROPERTY	'Moderate' (2×10^{-4})	'Low' (6×10^{-5})
RISK TO LIFE	8.3×10^{-6}/annum	8.3×10^{-8}/annum
COMMENTS	This level of risk to life and property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels, the recommendations in **Section 16** are to be followed.	This level of risk is 'ACCEPTABLE', provided the recommendations in **Section 16** are 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 Binburra Avenue. 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.

Any roof water from the existing development that is not already adequately piped to the street 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 ~5.7m will be required to construct the proposed garage.

The excavation is expected to be through fill and shallow soil over clay with Extremely Low Strength Shale expected at depths of between ~1.8m and ~2.1m in the area of the proposed works. It is envisaged that excavations through fill, soil, clay, and Extremely Low Strength Shale can be carried out with an excavator and bucket.

12. Vibrations

No excessive vibrations will be generated by excavation through soil, clay, and Extremely Low Strength Shale. Any vibrations generated by a domestic machine and bucket up to 16 ton carrying out excavation works will be below the threshold limit for infrastructure or building damage.

13. Excavation Support Advice

The excavations for the proposed garage will reach a maximum depth of ~5.7m. Allowing for 0.5m of back wall drainage, the setbacks are as follows:

- Flush with the utility pole that runs up the N side of the property.
- ~0.5m from the N common boundary.
- ~0.5m from the subject house.
- ~4.5m from the N neighbouring house.

As such, the utility pole, N common boundary and the N neighbouring and subject house will lie within the zone of influence of the proposed excavation. In this instance, the zone of influence is the area above a theoretical 45° line from the base of the excavation towards the surrounding structures and boundaries. This line reduces to 30° through the fill and soil.

Due to the depth of the excavation and its proximity to the common boundaries, we recommend heavy ground support be installed along all sides of the excavation prior to the commencement of the excavation to ensure the safety of any workers below the cut and integrity of the neighbouring properties. See the site plan attached for the minimum required extent of the shoring shown in blue.

A spaced piled retaining wall is a suitable method of support. Pier spacing for the wall is typically ~2.0m but can vary between 1.6 to 2.4m depending on the design. To drill the pier holes for the wall, a mini piling rig or similar that can excavate through Medium to High Strength Rock is recommended as the ground testing did not extend to the likely required depth of the piles. If a machine of this type is not available, we recommend carrying out core drilling before the construction commences to confirm the strength of the rock and to ensure the excavation equipment is capable of reaching the required depths. As the excavation is lowered in 1.5m lifts, infill sprayed concrete panels or similar are added between the piers to form the spaced wall. Drainage is installed behind the panels. The piers can be temporarily supported by embedment below the base of the excavation, or by a combination of embedment and temporary propping. Upon completion of the excavation, the piled walls are to be tied into the concrete floor and ceiling slabs of the garage to provide permanent bracing.

The geotechnical consultant is to inspect the drilling process of the entire first pile and the ground materials at the base of all pier holes/excavations for ground support purposes.

Upslope runoff is to be diverted from the cut faces by sandbag mounds or other diversion works. The excavation is to be carried out during a dry period. No excavations are to commence if heavy or prolonged rainfall is forecast.

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

14. Retaining Walls

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	Passive Pressure 'Ultimate'
Soil and Residual Clays	20	0.40	0.55	N/A
Extremely Low Strength Shale	22	0.25	0.35	Kp 2.5 ultimate

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. Rock strength and relevant earth pressure coefficients are to be confirmed on site by the geotechnical consultant.

It should be noted that passive pressure is an ultimate value and should have an appropriate safety factor applied. No passive resistance should be assumed for the top 0.4m to account for any disturbance from the excavation.

All retaining walls 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 walls, the likely hydrostatic pressures are to be accounted for in the structural design.

15. Foundations

The garage can be supported on a thickened edge/ raft slab with piers taken to Extremely Low Strength Shale where necessary. This ground material is expected to be exposed across the uphill side of the excavation. Where it is not exposed, and where this material drops away with the slope, piers will be required to maintain a uniform bearing material across the structure.

Due to the steep grade of the slope, it is recommended that the proposed deck be supported on piers taken to and embedded at least ~0.6m into the underlying Extremely Low Strength Shale. This ground material is expected at depths of between 1.8m to 2.1m below the current surface in the area of the proposed works. As such, the required depths of the piered foundations for the deck are expected to be between 2.4m and 2.7m below the current surface measured from the downhill side of the pier hole. See Type Section appended.

A maximum allowable bearing pressure of 600kPa can be assumed for footings on Extremely Low Strength Shale. It should be noted that this material is a soft rock and a rock auger will cut through it so the builders should not be looking for refusal to end the footings.

As the bearing capacity of clay and shale reduces when it is wet, we recommend the footings be dug, inspected, and poured in quick succession (ideally the same day if possible). If the footings get wet, they will have to be drained and the soft layer of wet clay or shale on the footing surface will have to be removed before concrete is poured.

If a rapid turnaround from footing excavation to the concrete pour is not possible, a sealing layer of concrete may be added to the footing surface after it has been cleaned.

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

A) There is a large cut face that is currently unsupported above the house (Photos 3,4, and 5). Although it is not part of our scope of works, we recommend this unsupported cut face be supported with a retaining wall designed by the structural engineer as soon as possible to ensure the integrity of slope and to prevent further erosion.

B) On steep slopes such as on this site, 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. Geotechnical Review

The structural plans are to be checked and certified by the geotechnical engineer as being in accordance with the geotechnical recommendations. On completion, a Form 2B will be issued. This form is required for the Construction Certificate to proceed.

18. 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 and Occupation Certificate if the following inspections have not been carried out during the construction process.

- The geotechnical consultant is to inspect the ground materials while the first pier for the ground support is being dug to assess the ground strength and to ensure it is in line with our expectations.

All finished pier holes for piled wall/excavations for ground support are to be inspected and measured before concrete is placed.

- 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

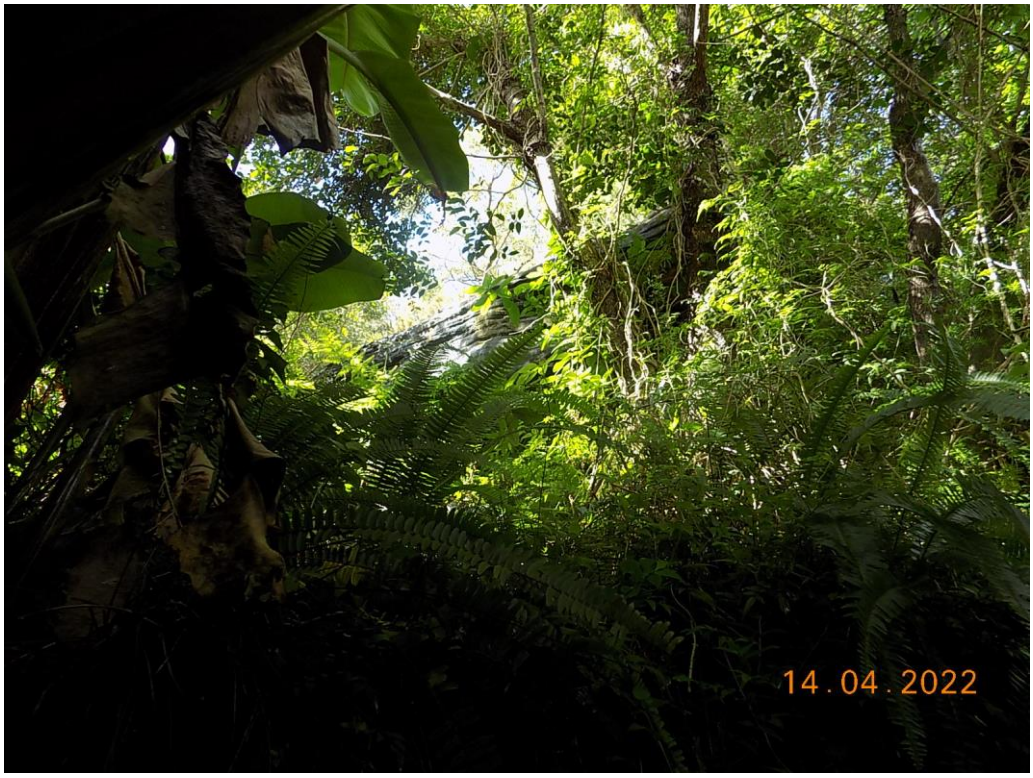

Photo 7

Photo 8 (Top to bottom)

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.