GEOTECHNICAL INVESTIGATION:

Alterations and Additions at **83-85 Bower St, Manly**

1. Proposed Development

1.1 Demolish part of the existing house, leaving most of the walls and floors on the E side of the house intact. Rebuild the house by excavating to a maximum depth of ~1.0m.

1.2 Add a new first floor addition to the house.

1.3 Construct a new carport on the SW side of the existing garage at the Montpelier Place entrance. Minor alterations to both of the existing garages.

1.4 Construct a pool storage room with terrace above on the N side of the house by excavating to a maximum depth of ~2.2m.

1.5 Install a new pool and spa by excavating to a maximum depth of ~0.7m. The existing pool shell will remain and will be used as a detention tank water reuse tank. A concrete lid will be installed on the old pool shell.

1.6 Install a water feature on the W side of the house.

1.7 Landscape new lawn/garden areas on the N and W sides of the proposed pool by filling to a maximum depth of ~2.0m.

1.8 Details of the proposed development are shown on 16 drawings prepared by Evans and Green, drawings numbered S4.55.03 to S4.55.07, S4.55.20a, S4.55.20b, S4.55.21, S4.55.22, S4.55.24, S4.55.25, S4.55.30 to S4.55.32, S4.55.51 and S4.55.52, Revision A, dated March 2021.

2. Site Description

2.1 The site was inspected on the 24th of January, 2020.

2.2 This residential property is on the high side of the road and has a N aspect. It is located on the gentle to moderately graded middle reaches of a hillslope. The natural slope rises from the N boundary of the property to the downhill side of the existing house at an angle of ~11°. The slope eases to an angle of ~5° from the downhill side of the house to the S boundary. The slope below the property increases in grade and the slope above the property continues at similar shallow angles.

2.3 At the Bower St Road Reserve is a rendered brick garage that is cut into the slope. Overall it appears stable but has some seepage issues and cracking in the floor slab (Photos 1 & 2). Sandstone stack rock retaining walls line the slope either side of the garage. Stable sandstone bedrock outcrops to the W of the garage. At the Eastern side of the road frontage sandstone steps provide access to the property. A garden bed at a landing along the stairs is formed with a sandstone block wall. The wall is supported on exposed sandstone bedrock (Photo 3). Seepage was moving over the rock at the time of the inspection. A well-constructed ~1.5m sandstone block retaining wall is located along downhill boundary of the property downhill of the proposed OSD tank (Photo 4).

A stone path and steps lead up to the existing house (Photo 5). Sandstone is outcropping near the stone path (Photo 6). The existing two storey rendered brick, sandstone block wall and timber clad house is supported on brick piers, brick walls and sandstone block walls (Photos 7 to 9). The supporting piers and walls stand vertical and show no significant signs of movement (Photo 10). A timber deck is located at the NW corner of the existing house and along part of the W side of the existing house (Photo 11). At the SW corner of the property is a gently sloping lawn (photo 12). S of the deck is the existing pool and cabana (Photo 13). A stable sandstone retaining wall supports the slope S of the pool and a stack rock retaining wall terraces the slope to the W of the pool. A shared concrete parking area, with a rendered brick and timber clad garage is located at the Montpelier Place vehicle entrance (Photo 14).

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. Four 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. 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. The results are as follows:

AUGER HOLE 1 (~RL22.3) **–** AH1 (photo 15)

Depth (m)	**Material Encountered**
0.0 to 0.3	**SANDY SOIL**, brown, fine to medium grained, moist.
0.3 to 0.5	**SANDY SOIL**, grey, fine to medium grained, moist.

Refusal @ 0.5m in Sandy Soil. 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** (~RL24.8)	**DCP 2** (~RL22.3)	**DCP 3** (~RL19.6)	**DCP 4** (~RL23.2)
0.0 to 0.3	9	2F	9	5
0.3 to 0.6	#	#	#	#
	Refusal @ 0.6m	Refusal @ 0.6m	Refusal @ 0.5m	Refusal @ 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 – Refusal @ 0.6m, DCP bouncing, white dust on moist tip.
DCP2 – Refusal @ 0.6m, DCP bouncing, white dust on moist tip.
DCP3 – Refusal @ 0.5m, DCP bouncing, white dust on moist tip.
DCP4 – Refusal @ 0.6m, DCP bouncing, nothing on moist tip.

5. Geological Observations/Interpretation

The surface features of the block are controlled by the 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 soil that fills the bench step formation. In the test locations, the depth to rock ranged between 0.5m to 0.6m below the current surface of the proposed works. The sandstone underlying the property is estimated to be medium strength or better. 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 in the rock.

Due to the slope and elevation of the block, the water table in the location 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 moderately graded slope that falls across the property and continues below is a potential hazard (**Hazard One**). The proposed excavation for the pool storage room is a potential hazard until retaining structures are in place (**Hazard Two**). The vibrations from the proposed excavations are a potential hazard (**Hazard Three**). The proposed landscaping fill is a potential hazard until retaining walls are in place (**Hazard Four**).

Geotechnical Hazards and Risk Analysis - Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two
TYPE	The moderately graded slope that falls across the property and continues below is a potential hazard.	The proposed excavations collapsing onto the worksite during the excavation process.
LIKELIHOOD	'Unlikely' (10^{-4})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (12%)	'Minor' (5%)
RISK TO PROPERTY	'Low' (2×10^{-5})	'Low' (2×10^{-5})
RISK TO LIFE	8.3×10^{-7}/annum	8.3×10^{-7}/annum
COMMENTS	This level of risk is 'ACCEPTABLE'.	This level of risk to life and property is 'ACCEPTABLE', provided the recommendations in **Section 13** are to be followed.

(See Aust. Geomech. Jnl. Mar 2007 Vol. 42 No 1, for full explanation of terms)

RISK ANALYSIS SUMMARY CONTINUES ON NEXT PAGE

HAZARDS	Hazard Three	Hazard Four
TYPE	The vibrations produced during the proposed excavations impacting on the subject house and neighbouring properties.	The proposed landscaping fill failing and impacting on the workers below before the retaining walls are in place.
LIKELIHOOD	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (15%)	'Medium' (25%)
RISK TO PROPERTY	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	5.3×10^{-7}/annum	5.3×10^{-6}/annum
COMMENTS	This level of risk to property is 'UNACCEPTABLE'. To move risk to 'ACCEPTABLE' levels the recommendations in **Sections 11 & 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 14** 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 Bower Street. Stormwater from the proposed 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 ~1.0m is required to construct the proposed new ground floor of the house. Another excavation to a maximum depth of ~2.2m is required to construct the pool storage room. A third excavation to a maximum depth of ~0.7m is required to construct the new pool. The excavations are interpreted to be through sandy soil to depths of up to 0.6m before encountering Medium Strength Sandstone. It is envisaged that excavations through sandy soil can be carried out with a machine and bucket and excavations through rock will require grinding or rock sawing and breaking.

12. Vibrations

Possible vibrations generated during excavations through soil will be below the threshold limit for building damage.

Excavations through Medium Strength Rock or better should be carried out to minimise the potential to cause vibration damage to the subject house and neighbouring property to the E. Allowing for backwall-drainage, the excavation for the house (at the deepest portion) is set back ~5.0m from the E side of the existing house (that will remain). Allowing for backwall-drainage, the excavation for the pool storage room is set back ~7.0m from the E neighbouring house. The excavation for the pool is set back ~9.7m from the E side of the subject house. 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 subject house and E property boundary. 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 E property boundary 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 house and neighbouring properties.

13. Excavation Support Requirements

An excavation to a maximum depth of ~1.0m is required to construct the proposed new ground floor of the house. Another excavation to a maximum depth of ~2.2m is required to construct the pool storage room. A third excavation to a maximum depth of ~0.7m is required to construct the new pool.

The excavations are set back sufficiently from the surrounding structures and boundaries.

The shallow soil portion of the proposed excavations will stand at near-vertical angles for a very short period of time until the retaining walls are installed, provided the cut batters are kept from becoming saturated. Medium Strength Sandstone or better 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 face in 1.5m intervals as it is lowered to ensure ground materials are as expected and that additional support is not required.

Upslope runoff is to be diverted from the cut faces by sandbag mounds or other diversion works. All 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 materials and labour to construct the retaining walls/pool structure are to be organised so on completion of the excavation 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 retaining walls/pool structure are not constructed within a few days of the excavation being completed temporary shoring will be required.

All excavation spoil is to be removed from site or be supported by engineered retaining walls.

14. Fill

Fill will be placed on the N and W sides of the proposed new pool to form level lawn/garden areas. No fills are to be laid until the retaining walls are in place.

The fills will reach a maximum depth of ~2.0m. Fills for landscaping purposes are to be laid in a loose thickness not exceeding 0.3m before being moderately compacted. Tracking the machine over the loose fill in 1 to 2 passes should be sufficient. Filling within ~1.5m behind retaining walls should be compacted with light weight equipment such as a hand operated plate compacter or similar so as to not damage the wall. No structures are to be supported on landscaped fill.

15. 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	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 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 full hydrostatic pressures are to be accounted for in the retaining structure design.

16. Foundations

The uphill sides of the ground floor, pool storage room and pool are expected to be seated in Medium Strength Sandstone. This is a suitable bearing material. Where the pool storage room, pool and house are not cut into rock, they are to be supported on spread footings or shallow piers taken to rock to maintain a uniform bearing material across the structure. A maximum allowable bearing pressure of 1000 KPa can be assumed for footings on Medium Strength Sandstone.

The foundations of the existing house are currently unknown. Footings should be founded on the same footing material across the structure. Where the footing material does change across the structure construction joints or similar are to be installed to prevent differential settlement, where the structure cannot tolerate such movement.

Spread footings taken to a minimum depth of ~0.4m below the current surface to the underlying Sandy Soil are suitable footings for the proposed new carport. A maximum allowable bearing pressure of 100kPa can be assumed for footings on Sandy Soil.

The footing walls in sandy soil are to be shored with timber to prevent collapse. The base of the footing excavations should be compacted as the excavation will loosen the upper sands. This can be carried out with a hand-held plate compactor. Water may be used to assist in compaction in sand but footing materials should be kept damp but not saturated. As a guide to the level of compaction required a density index of >85% is to be achieved.

Alternatively for the best quality footings, spread footings or shallow piers supported on Medium Strength Sandstone are suitable footings for the proposed carport.

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 professional 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.

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

- During the excavation process, the geotechnical consultant is to inspect the excavation in 1.5m intervals as it is lowered to ensure ground materials are as expected and that additional support is not required.

- 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

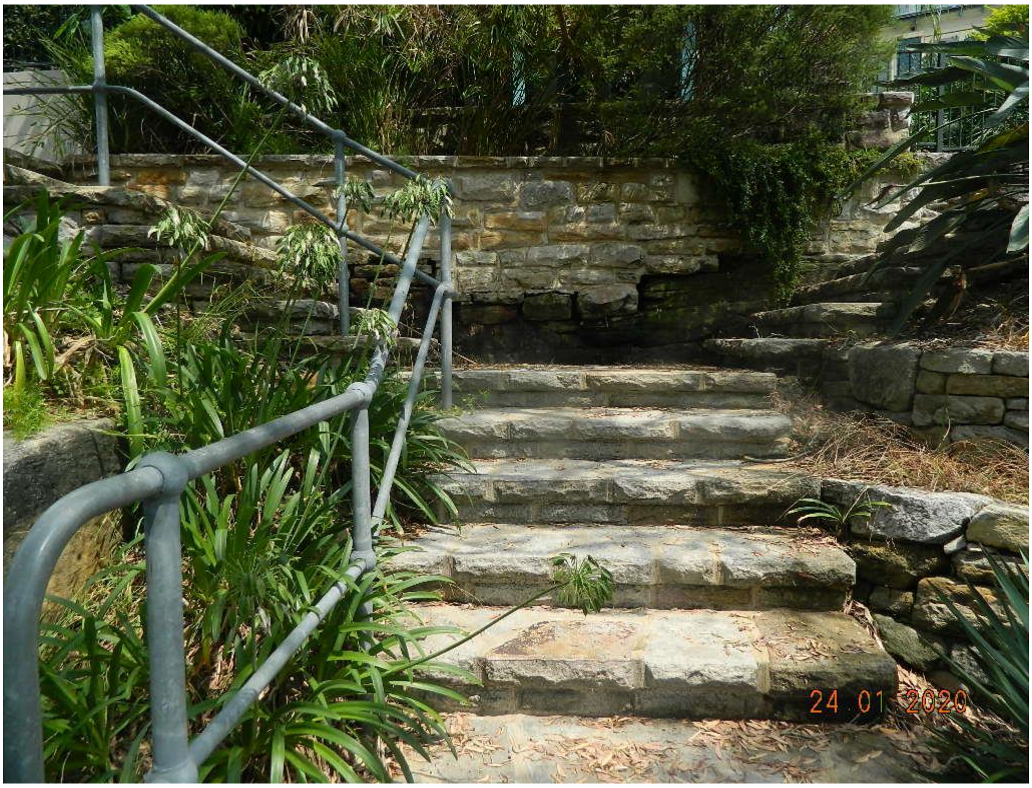


Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

Photo 11

Photo 12

Photo 13

Photo 14

Photo 15: AH1 – Downhole is from 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.

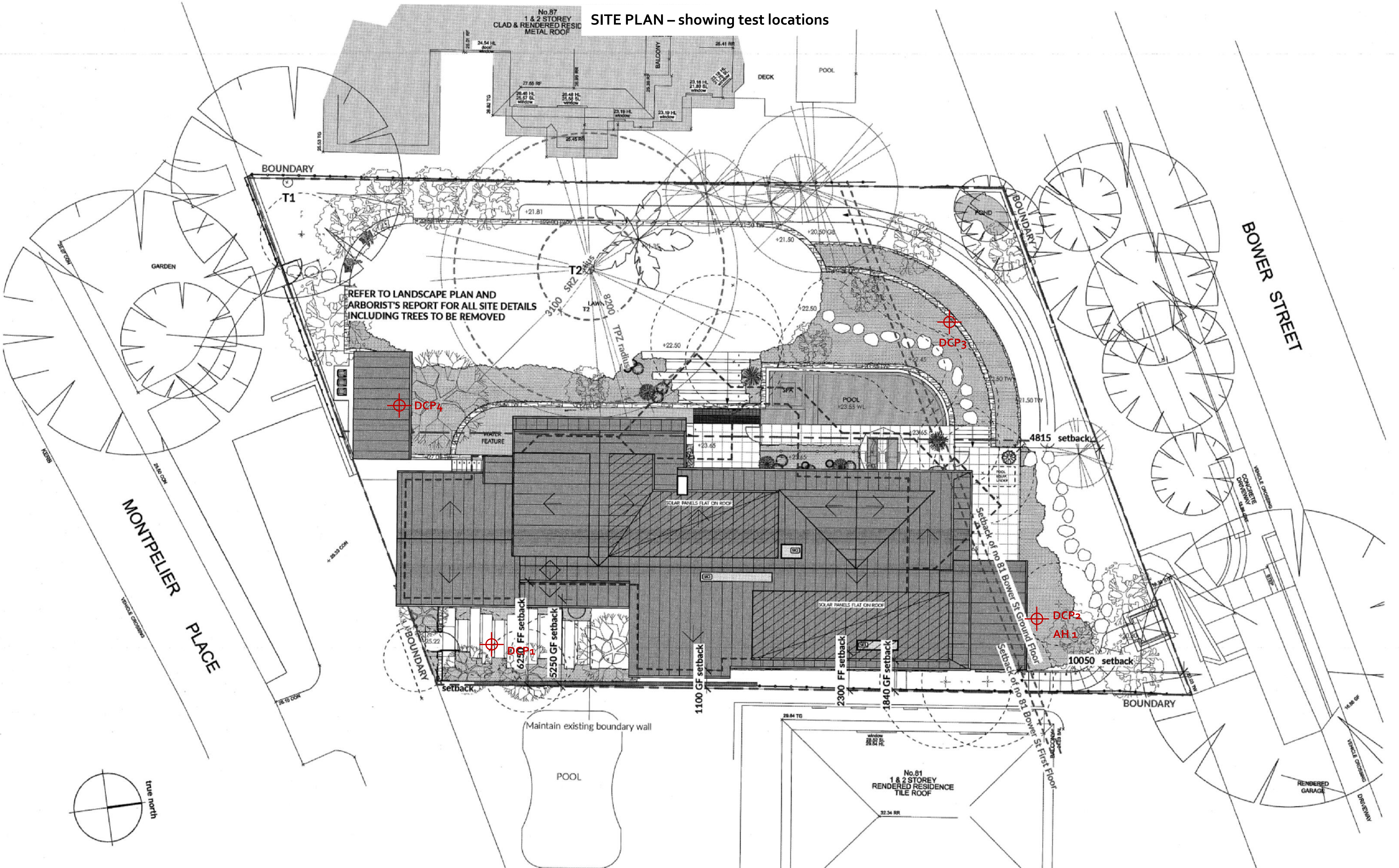
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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.

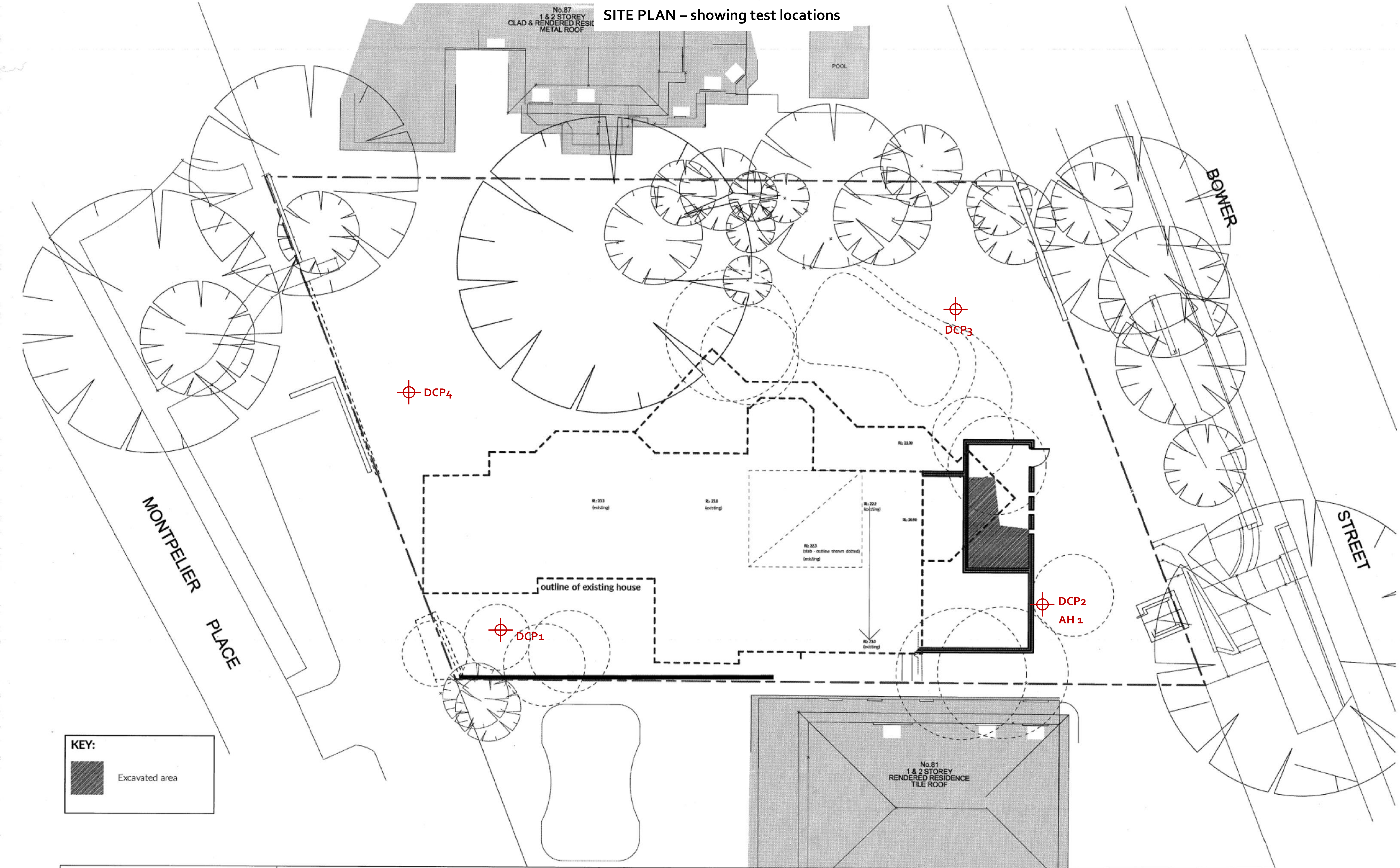
- It is common for the design and construction process to be adapted as it progresses (sometimes to suit the previous experience of the contractors involved). If alternative design and construction processes are required to those described in this report, contact White Geotechnical Group. We are familiar with a variety of techniques to reduce risk and can advise if your proposed methods are suitable for the site conditions.

SITE PLAN – showing test locations



EVANS AND GREEN 43 McKell St Birchgrove ph: 0425 249 804	**NOTES** Measurements in mm unless otherwise noted. Use Figured dimensions. Do not scale drawings. This drawing is for Council Approval only, not for construction.	**CLIENTS:** Ray + Julie Balcomb **PROPERTY:** 83-85 Bower Street MANLY, LOT 76 + 77 DP 8075	**SCALE:** 1:200	**REVISION:** A **DATE:** March 2021	**DRAWING:** SITE PLAN **DRAWING No:** **S4.55.03**

SITE PLAN – showing test locations



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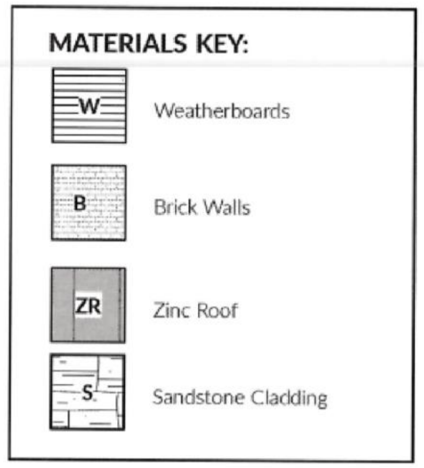
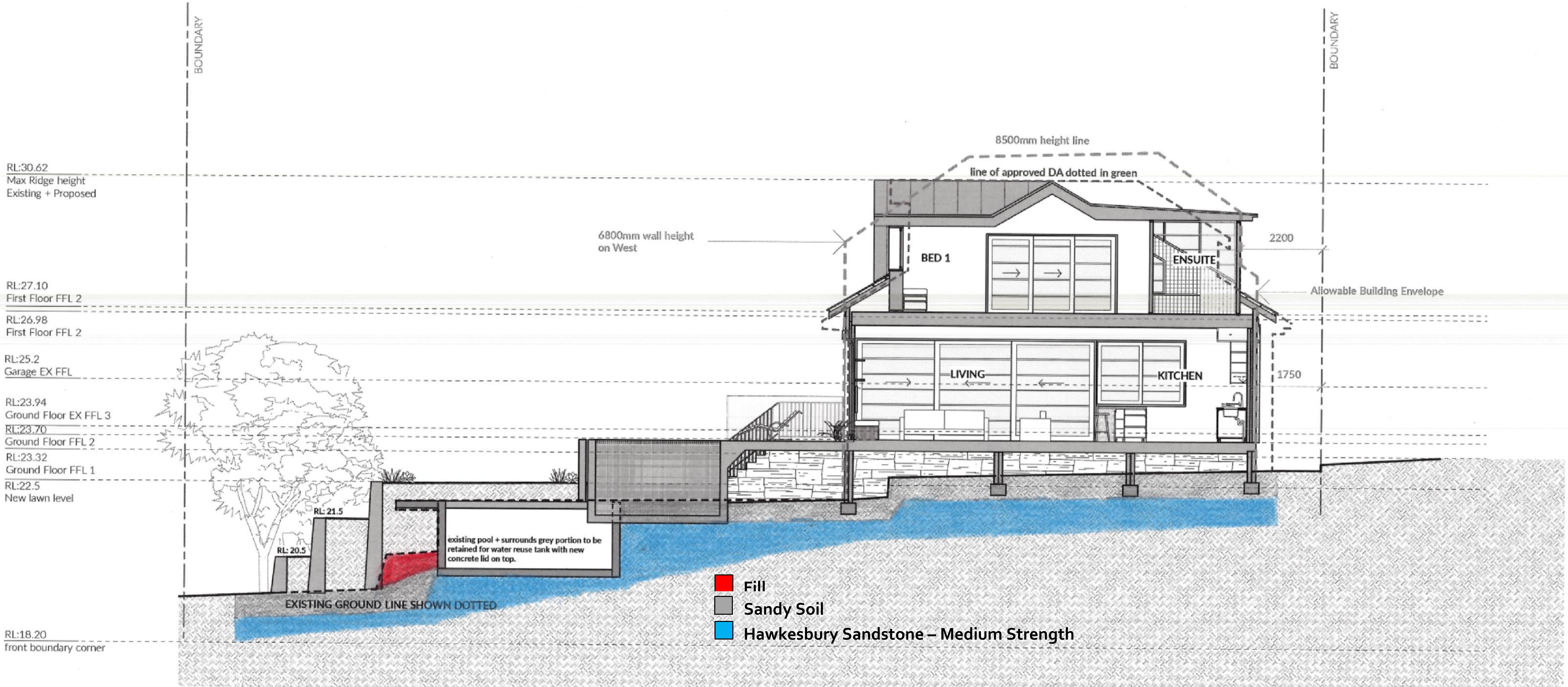
TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials

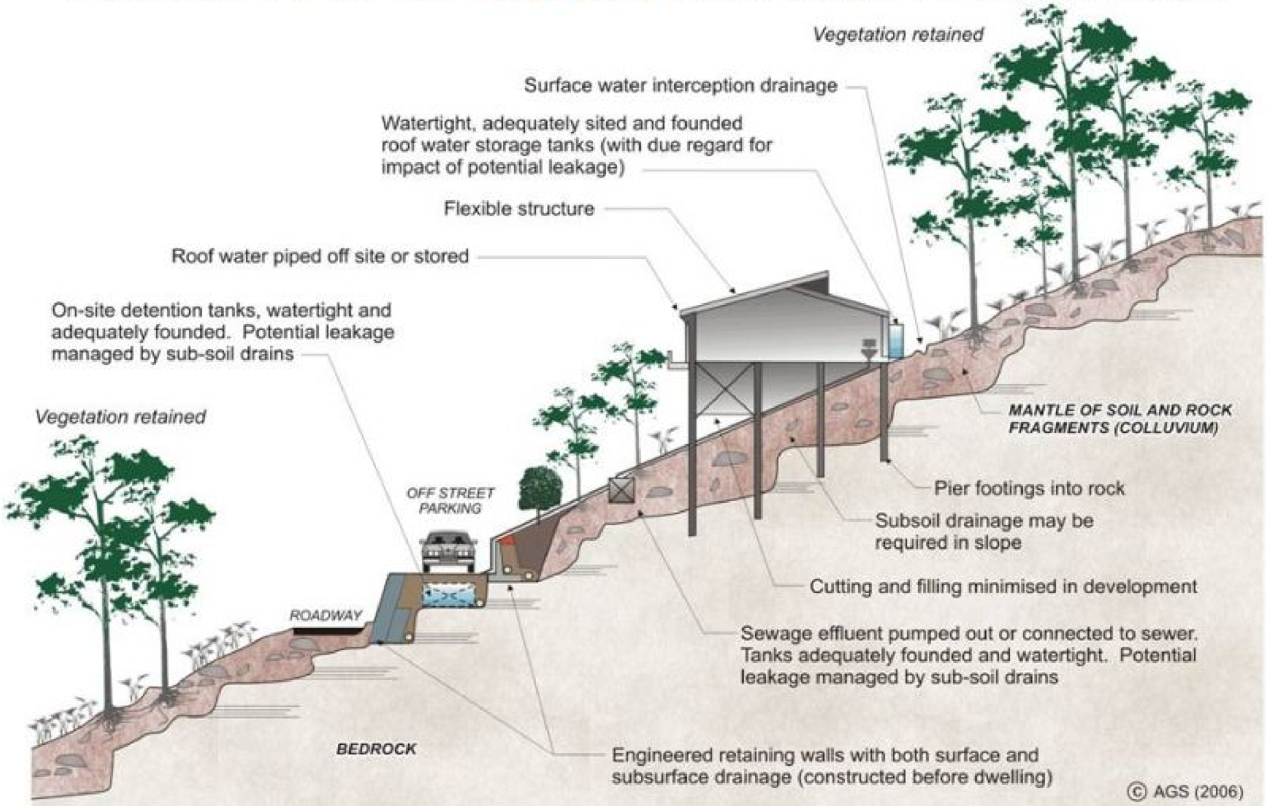
s4.55 STAGE BASIX	**Certificate A394178 83-85 Bower St Manly NSW**	
RainWater tank	Minimum of 3510 Litres- connected to 200sqm of roof.	
Swimming Pool &Spa	Pool Located outdoors & maximum volume of 53kL. Spa max vol 6kL	
Hot Water & Alt. Energy	Electric Storage Hot Water with Minimum 2.6kw photovoltaic system.	
Insulation/Construction	Concrete Slab on Ground.	R 1.0 insulation
	Suspended floor above enclosed subfloor	R1.3 incl construction
	Floor above ex. Dwelling & wall between garage & dwelling	Nil
	Ext Wall- brick veneer & framed	R1.7 incl construction
	Ext Wall- cavity brick	0.5 or 1.17 incl construction
	Flat ceiling/pitched roof, framed. Roof foil backed blanket min 75mm	Ceiling R1.45up, colour medium solar Absorptance. 0.475-0.7
	Raked ceiling/pitched skillion roof, framed. Roof foil backed blanket min 75mm	Ceiling R1.74up, , colour medium solar Absorptance. 0.475-0.7
	Flat ceiling/flat roof, framed. Roof foil backed blanket min 75mm,	Ceiling R1.58up, colour medium solar Absorptance. 0.475-0.7
Glazing- windows	Windows 1-11 & 15-27, 28,29, 30-35. All single glazed Standard Aluminium Framed.	U-Value 7.63, SHGC 0.75
	Windows 12-14, All single glazed toned Standard Aluminium Framed.	U-Value 7.63, SHGC 0.522-0.638
	Windows 6-11,17-27, Al Single low Tsol low-e	U-Value 5.6, SHGC 0.369-0.451
	Windows 12-16, Alum thermal break double	U-Value 3.5, SHGC 0.576-0.704
Skylights	All double glazed, timber framed	Low-E/argon gap/clear.





EVANS AND GREEN 43 McKell St Birchgrove ph: 0425 249 804	**NOTES** Measurements in mm unless otherwise noted. Use Figured dimensions. Do not scale off drawings. This drawing is for Council Approval only, not for construction.	**CLIENTS:** Ray + Julie Balcomb **PROPERTY:** 83-85 Bower Street MANLY, LOT 76 + 77 DP 8075	**SCALE:** 1:100	**REVISION:** A **DATE:** March 2021	**DRAWING:** SECTION BB **DRAWING No:** **S4.55.31**

EXAMPLES OF GOOD HILLSIDE PRACTICE



EXAMPLES OF POOR HILLSIDE PRACTICE