GEOTECHNICAL INVESTIGATION:

New Garage, Pool, and Tennis Court at **6 Guwara Road, Duffys Forest**

1. Proposed Development

1.1 Construct a new six-car garage on the downhill side of the property.

1.2 Construct a new tennis court on the downhill side of the property by excavating to a maximum depth of ~2.0m and filling to a maximum height of ~0.6m.

1.3 Construct a new pool on the downhill side of the house by excavating to a maximum depth of ~1.9m.

1.4 Construct a new pavilion on the uphill side of the property.

1.5 Various other minor internal and external alterations.

1.6 Details of the proposed development are shown on 13 drawings prepared by Cadence and Co Design, drawings numbered A00 to A12, Issue A, dated 22/6/21.

2. Site Description

2.1 The site was inspected on the 10th March, 2021, and previously on the 14th September, 2015.

2.2 This large rural/residential property is on the low side of the road and has a NW aspect. The block is located on the gentle to moderately graded upper reaches of a hillslope. The slope falls across the site from the road frontage at gentle angles that gradually increase to moderate angles. The slope above the property eases to the crest of the slope. The slope below the property continues to increases in grade.

2.3 At the road frontage, a bitumen driveway runs to a parking area on the uphill side of the house and to a garage attached to the S side of the house (Photo 1). The

two-storey rendered masonry house is supported on masonry walls (Photo 2). No significant signs of movement were observed in the supporting walls. A large gently sloping lawn-covered fill extends off the N and W sides of the house (Photo 3). The fill is battered to stable angles and merges into the natural slope (Photo 4). A fire trail cuts through the property below the fill batter (Photo 5). The fill for the fire trail is also battered to stable angles and merges into the natural slope (Photo 6). Beyond the fire trail is undeveloped bush (Photo 7). Competent Medium Strength Sandstone was observed to be outcropping through the bush (Photo 8). The bush continues to and beyond the lower boundary.

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 Dynamic Cone Penetrometer (DCP) 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** (~RL173.4)	**DCP 2** (~RL172.2)	**DCP 3** (~RL170.4)	**DCP 4** (~RL173.4)	**DCP 5** (~RL173.5)	**DCP 6** (~RL175.0)	**DCP 7** (~RL174.0)	**DCP 8** (~RL175.1)
0.0 to 0.3	6	8	Rock exposed at surface	2	4F	9	5	10
0.3 to 0.6	12	15		4	1	7	11	30
0.6 to 0.9	11	17		5	5	#	13	12
0.9 to 1.2	8	12		7	8		15	#
1.2 to 1.5	25	12		5	5		#	
1.5 to 1.8	#	5		#	#			
1.8 to 2.1		#						
	Refusal on Rock @ 1.4m	Refusal on Rock @ 1.7m		Refusal on Rock @ 1.4m	Refusal on Rock @ 1.4m	Refusal on Rock @ 0.4m	Refusal on Rock @ 1.0m	Refusal on Rock @ 0.8m

#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 @ 1.4m, DCP bouncing off rock surface, maroon impact dust on dry tip.

DCP2 – Refusal on rock @ 1.7m, DCP bouncing off rock surface, maroon sandstone on dry tip.

DCP3 – Rock exposed at surface.

DCP4 – Refusal on rock @ 1.4m, DCP bouncing off rock surface, white impact dust on damp tip.

DCP5 – Refusal on rock @ 1.4m, DCP bouncing off rock surface, brown and orange sandstone on dry tip.

DCP6 – Refusal on rock @ 0.4m, DCP bouncing off rock surface, white sandstone fragments on dry tip.

DCP7 – Refusal on rock @ 1.0m, DCP bouncing off rock surface, light brown impact dust on dry tip.

DCP8 – Refusal on rock @ 0.8m, DCP bouncing off rock surface, white impact dust on dry tip.

5. Geological Observations/Interpretation

The surface features of the block are controlled by the outcropping and underlying sandstone bedrock that steps down the property forming sub-horizontal benches between the steps. Where the grade is steeper, the steps are larger, and the benches narrower. Where the slope eases, the opposite is true. Where the rock is not exposed, it is overlain by natural sandy soils and firm to stiff sandy clays that fill the bench step formation. Filling has been placed across the uphill side of the property for a large lawn area to a maximum estimated depth of ~2.0m. In the test locations, where it was not exposed, rock was encountered at depths of between 0.4 to 1.7m below the current surface. 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 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 Guwara Road above.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed above or beside the property. The gentle to moderately graded slope that falls across the property and continues below is a potential hazard (**Hazard One**). The vibrations from the proposed excavations are a potential hazard

(**Hazard Two**). The proposed excavations are a potential hazard until retaining structures are in place (**Hazard Three**).

Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two	Hazard Three
TYPE	The gentle to moderate slope that falls across the site and continues below failing and impacting on the proposed works.	The vibrations produced during the proposed excavations impacting on the supporting walls of the subject house.	The proposed excavations collapsing onto the work site before retaining structures are in place.
LIKELIHOOD	'Unlikely' (10^{-4})	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (12%)	'Medium' (15%)	'Medium' (15%)
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	5.3×10^{-5}/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 the 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 away from the street. As a bushland reserve is immediately below the property, it is recommended stormwater runoff from the proposed works be piped to a spreader pipe clear of the downhill side of the house, through any tanks that may be required by the regulating authorities.

11. Excavations

An excavation to a maximum depth of ~2.0m is required to construct the tennis court. Another excavation to a maximum depth of ~1.9m is required to install the proposed pool. The excavations are expected to be through a maximum of ~1.4m of fill over a thin sandy soil and sandy clays with Medium Strength Sandstone expected at depths of between 0.4 to 1.4m.

It is envisaged that excavations through fill, sandy soil, and sandy clays 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 fill, sandy soil, and sandy clays will be below the threshold limit for building damage. The majority of the proposed excavations are expected to encounter 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. The supporting walls of the subject house will be as close as ~9.0m from the edges of the proposed pool excavation. 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 supporting walls of the subject house. 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 600kg 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 using this method provided the saw cuts are kept well below the rock to broken.

It is worth noting that vibrations that are below thresholds for building damage may be felt by the occupants of the neighbouring houses.

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 and soil portions of the cut batters for the tennis court are to be battered temporarily at 1.0 Vertical to 2.0 Horizontal (30°) until the retaining walls are in place. Excavations through natural clay will stand unsupported for a short period of time until the retaining walls are in place, provided they are kept from becoming saturated.

The sides of the cut for the pool will stand at near-vertical angles for short periods of time until the pool structure is installed provided the cut batters are kept from becoming saturated. If the cut batters through fill, soil, and clay remain unsupported for more than a few days, they are to be supported with typical pool shoring, such as sacrificial form ply, until the pool structure is in place.

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/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 tennis court, 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.

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

14. Fill

Filling will be placed on the downhill side of the property to create a level platform for the proposed tennis court. We are of the understanding that the fill will be used as formwork for the overlying slab only and that no foundations will be supported on the fill.

The fill will reach a maximum depth of ~0.6m. The surface is to be prepared before any fills are laid by removing any organic matter and topsoil. Fills 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. Immediately behind the retaining walls (say to 1.5m), the fills are to be compacted with light weight equipment such as a hand-held plate compactor so as not to damage the retaining walls. Where light weight equipment is used, fills are to be laid in a loose thickness not exceeding 0.2m before being compacted.

15. 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	0.40	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.

16. Foundations

A concrete slab and piers supported directly off Medium Strength Sandstone are suitable footings for the proposed tennis court. This material is expected to be exposed across a portion of the base of the excavation. Where it is not exposed, and where the slope drops away on the downhill side, piers will be required to maintain a uniform bearing 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.

Due to the presence of fill, the proposed garage and pavilion are to be supported off piers taken to Medium Strength Sandstone. This material is expected at depths of between 0.8 to 1.7m below the current surface.

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.

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

- During the excavation process for the tennis court, 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 is still onsite and before steel reinforcing is placed or concrete is poured.

White Geotechnical Group Pty Ltd.

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No. 222757
Engineering Geologist

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

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.

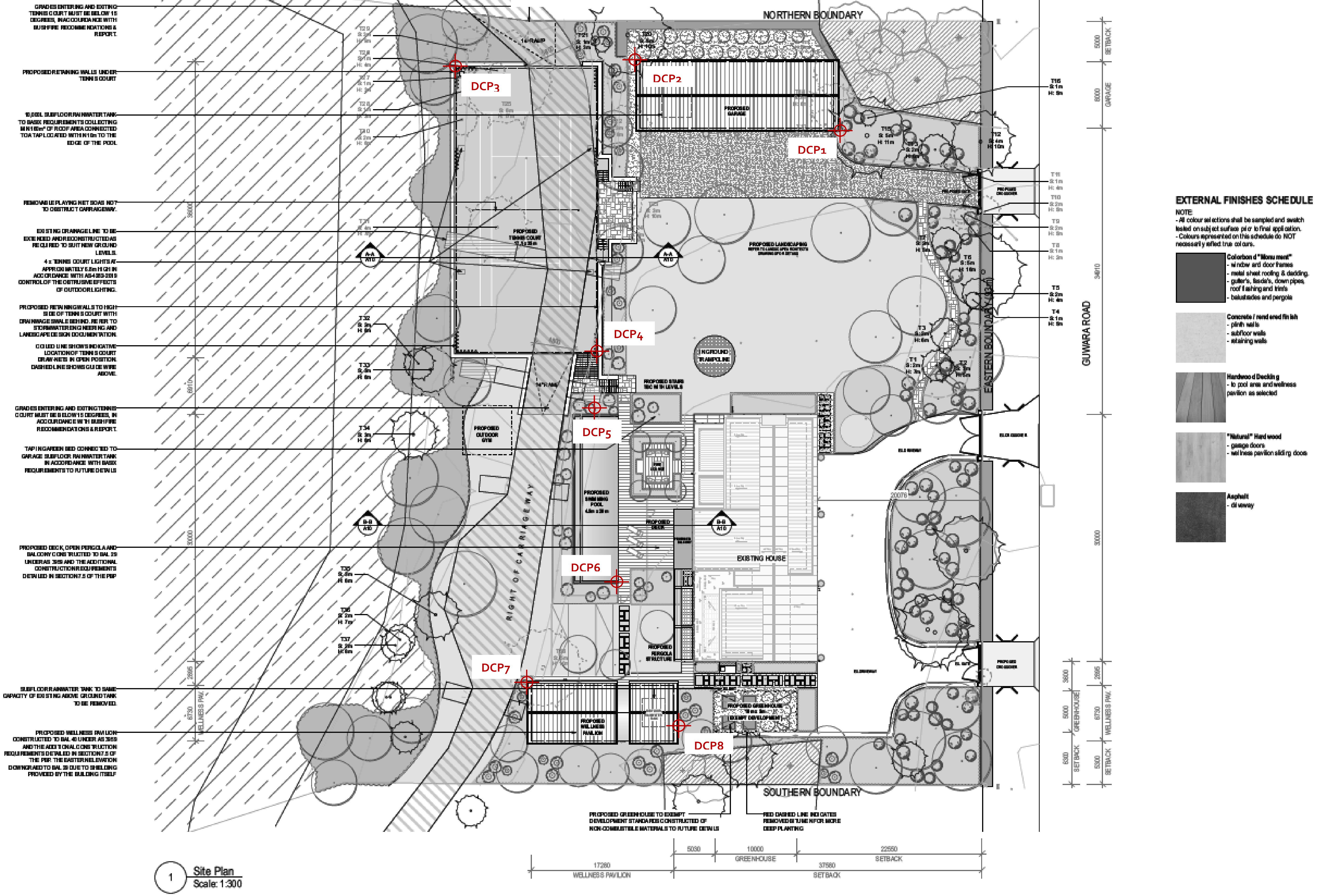
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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



18500
4015
24825
17430
SETBACK
NORTHERN BOUNDARY
SOUTHERN BOUNDARY
EASTERN BOUNDARY (143m)
GUWARA ROAD
DCP1
DCP2
DCP3
DCP4
DCP5
DCP6
DCP7
DCP8
GRADES ENTERING AND EXITING TENNIS COURT MUST BE BELOW 15 DEGREES, IN ACCOURDANCE WITH BUSHFIRE RECOMMENDATIONS & REPORT.
PROPOSED RETAINING WALLS UNDER TENNIS COURT
10,000L SUBFLOOR RAINWATER TANK TO BASIX REQUIREMENTS COLLECTING MIN 160m² OF ROOF AREA CONNECTED TO A TAP LOCATED WITHIN 10m TO THE EDGE OF THE POOL.
REMOVABLE PLAYING NET SO AS NOT TO OBSTRUCT CARRIAGEWAY.
EXISTING DRAINAGE LINE TO BE EXTENDED AND RECONSTRUCTED AS REQUIRED TO SUIT NEW GROUND LEVELS.
4 x TENNIS COURT LIGHTS AT APPROXIMATELY 6.8m HIGH IN ACCORDANCE WITH AS4282-2019 CONTROL OF THE OBTRUSIVE EFFECTS OF OUTDOOR LIGHTING.
PROPOSED RETAINING WALLS TO HIGH SIDE OF TENNIS COURT WITH DRAINAGE SWALE BEHIND. REFER TO STORMWATER ENGINEERING AND LANDSCAPE DESIGN DOCUMENTATION.
COILED LINE SHOWS INDICATIVE LOCATION OF TENNIS COURT DRAW-NETS IN OPEN POSITION. DASHED LINE SHOWS GUIDE WIRE ABOVE.
GRADES ENTERING AND EXITING TENNIS COURT MUST BE BELOW 15 DEGREES, IN ACCORDANCE WITH BUSHFIRE RECOMMENDATIONS & REPORT.
TAP IN GARDEN BED CONNECTED TO GARAGE SUBFLOOR RAINWATER TANK IN ACCORDANCE WITH BASIX REQUIREMENTS TO FUTURE DETAILS
PROPOSED DECK, OPEN PERGOLA AND BALCONY CONSTRUCTED TO BAL 29 UNDER AS 3959 AND THE ADDITIONAL CONSTRUCTION REQUIREMENTS DETAILED IN SECTION 7.5 OF THE PBP
SUBFLOOR RAINWATER TANK TO SAME CAPACITY OF EXISTING ABOVE GROUND TANK TO BE REMOVED.
PROPOSED WELLNESS PAVILION CONSTRUCTED TO BAL 40 UNDER AS 3959 AND THE ADDITIONAL CONSTRUCTION REQUIREMENTS DETAILED IN SECTION 7.5 OF THE PBP. THE EASTERN ELEVATION DOWNGRADED TO BAL 29 DUE TO SHIELDING PROVIDED BY THE BUILDING ITSELF
PROPOSED GREENHOUSE TO EXEMPT DEVELOPMENT STANDARDS CONSTRUCTED OF NON-COMBUSTIBLE MATERIALS TO FUTURE DETAILS
RED DASHED LINE INDICATES REMOVED BITUMEN FOR MORE DEEP PLANTING
PROPOSED GARAGE
PROPOSED TENNIS COURT
PROPOSED LANDSCAPING
INGROUND TRAMPOLINE
PROPOSED STAIRS
PROPOSED OUTDOOR GYM
PROPOSED SWIMMING POOL
PROPOSED DECK
EXISTING HOUSE
PROPOSED PERGOLA STRUCTURE
PROPOSED WELLNESS PAVILION
PROPOSED GREENHOUSE EXEMPT DEVELOPMENT
RIGHT OF CARRIAGEWAY
1:4 RAMP
A-A A10
B-B A10
5030
10000
GREENHOUSE
22550
SETBACK
17280
WELLNESS PAVILION
37580
SETBACK
1 Site Plan Scale: 1:300
EXTERNAL FINISHES SCHEDULE
NOTE:
- All colour selections shall be sampled and swatch tested on subject surface prior to final application.
- Colours represented on this schedule do NOT necessarily reflect true colours.
Colorbond "Monument"
- window and door frames
- metal sheet roofing & cladding
- gutter's, fascia's, down pipes, roof flashing and trims
- balustrades and pergola
Concrete / rendered finish
- plinth walls
- subfloor walls
- retaining walls
Hardwood Decking
- to pool area and wellness pavilion as selected
"Natural" Hardwood
- garage doors
- wellness pavilion sliding doors
Asphalt
- driveway

Revision	Date	For
A	22/6/21	Issued for development application

Drawing Title: Site Plan

Project: 6 Guwara Road, Duffys Forest LOT 3, DP 1196894

Drawn:	Chkd:	Scale @ A2:	Drawing Number:	Issue:
NG	DV	1:300	A02	A

CADENCE & CO DESIGN
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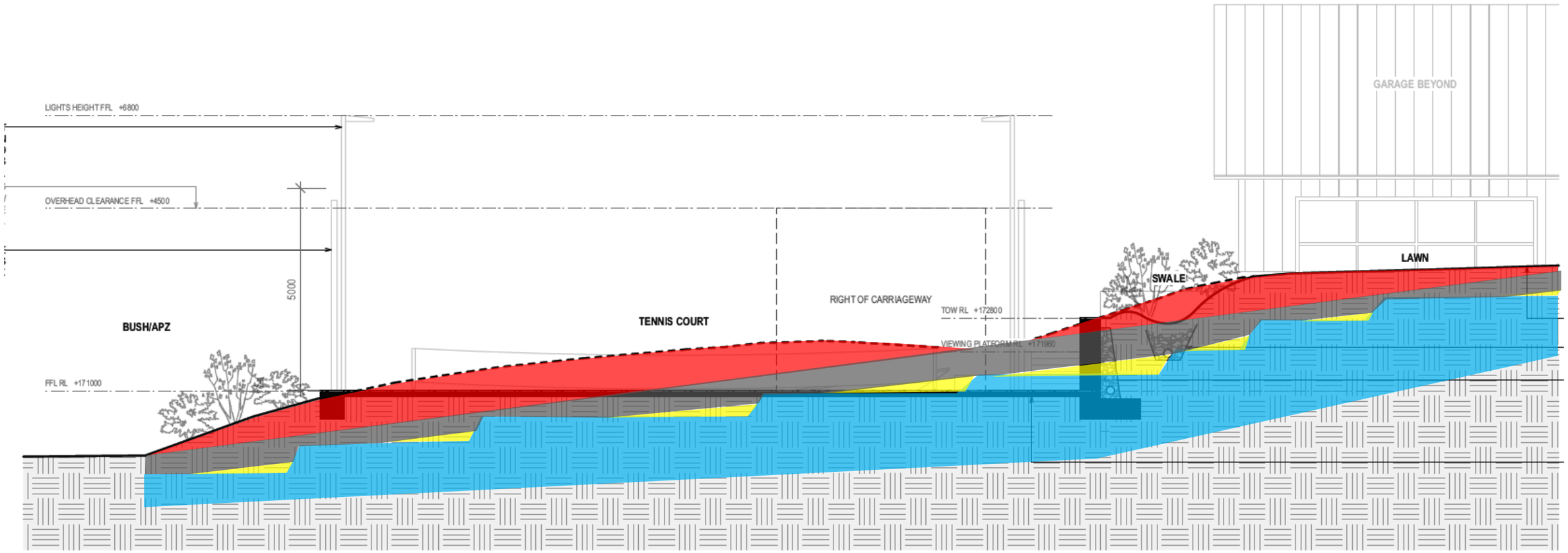
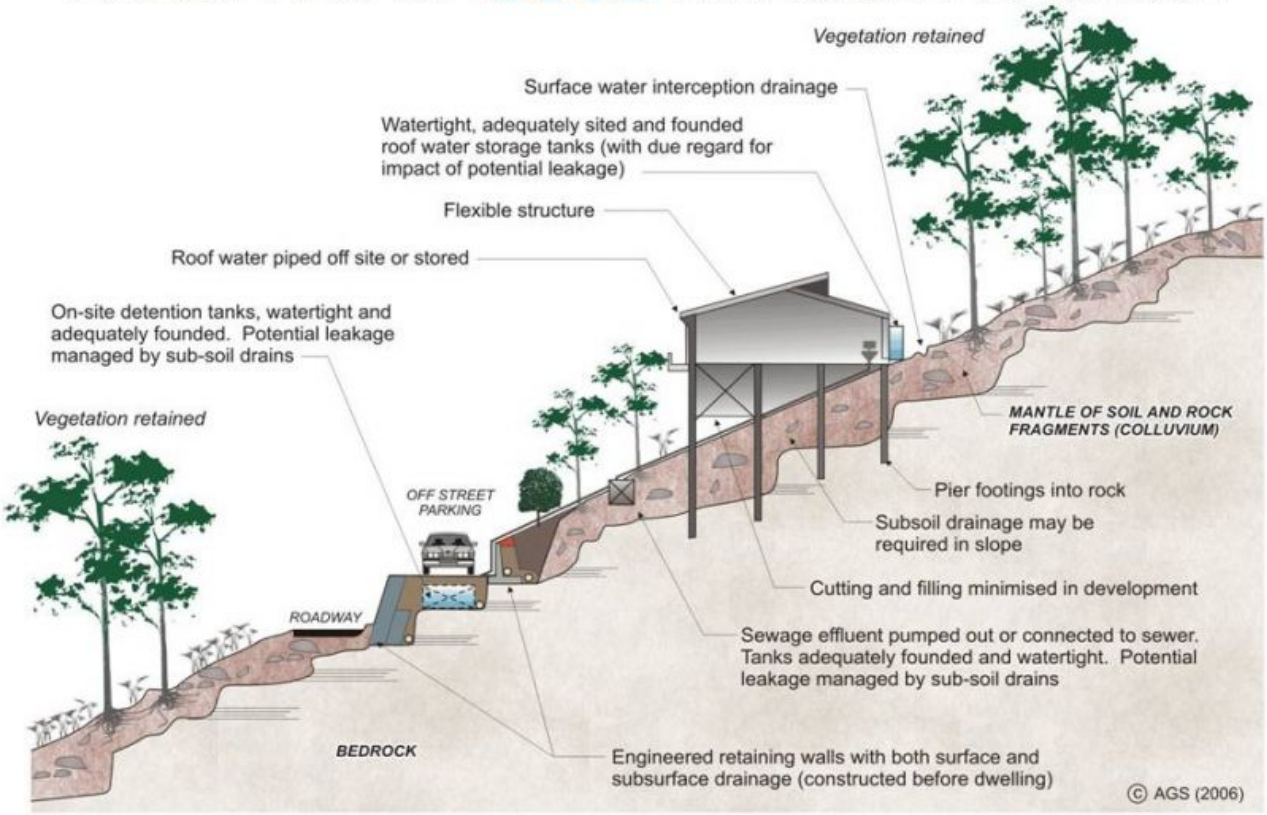
TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials

- Fill
- Topsoil
- Sandy Clay – Firm to Stiff
- Hawkesbury Sandstone – Medium Strength



A-A Tennis Court Section
Scale: 1:100

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE