GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER

FORM NO. 1 – To be submitted with Development Application

Development Application for ______________________________

Name of Applicant

Address of site **120 Prince Alfred Parade, Newport**

The following checklist covers the minimum requirements to be addressed in a Geotechnical Risk ***Declaration made by geotechnical engineer or engineering geologist or coastal engineer (where applicable) as part of a geotechnical report***

I, Ben White *on behalf of* White Geotechnical Group Pty Ltd

(Insert Name) (Trading or Company Name)

on this the 12/11/21 certify that I am a geotechnical engineer or engineering geologist or coastal engineer as defined by the Geotechnical Risk Management Policy for Pittwater - 2009 and I am authorised by the above organisation/company to issue this document and to certify that the organisation/company has a current professional indemnity policy of at least $10million.

I:

Please mark appropriate box

☒ have prepared the detailed Geotechnical Report referenced below in accordance with the Australia Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009

☒ am willing to technically verify that the detailed Geotechnical Report referenced below has been prepared in accordance with the Australian Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009

☐ have examined the site and the proposed development in detail and have carried out a risk assessment in accordance with Section 6.0 of the Geotechnical Risk Management Policy for Pittwater - 2009. I confirm that the results of the risk assessment for the proposed development are in compliance with the Geotechnical Risk Management Policy for Pittwater - 2009 and further detailed geotechnical reporting is not required for the subject site.

☐ have examined the site and the proposed development/alteration in detail and I am of the opinion that the Development Application only involves Minor Development/Alteration that does not require a Geotechnical Report or Risk Assessment and hence my Report is in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009 requirements.

☐ have examined the site and the proposed development/alteration is separate from and is not affected by a Geotechnical Hazard and does not require a Geotechnical Report or Risk Assessment and hence my Report is in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009 requirements.

☐ have provided the coastal process and coastal forces analysis for inclusion in the Geotechnical Report

Geotechnical Report Details:

Report Title: Geotechnical Report **120 Prince Alfred Parade, Newport**

Report Date: 12/11/21

Author: BEN WHITE

Author's Company/Organisation: **WHITE GEOTECHNICAL GROUP PTY LTD**

Documentation which relate to or are relied upon in report preparation:

Australian Geomechanics Society Landslide Risk Management March 2007.
White Geotechnical Group company archives.

I am aware that the above Geotechnical Report, prepared for the abovementioned site is to be submitted in support of a Development Application for this site and will be relied on by Pittwater Council as the basis for ensuring that the Geotechnical Risk Management aspects of the proposed development have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature

Name Ben White

Chartered Professional Status MScGEOLAusIMM CP GEOL

Membership No. 222757

Company White Geotechnical Group Pty Ltd

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER
FORM NO. 1(a) - Checklist of Requirements for Geotechnical Risk Management Report for Development Application

Development Application for ______________________________
Name of Applicant

Address of site **120 Prince Alfred Parade, Newport**

The following checklist covers the minimum requirements to be addressed in a Geotechnical Risk Management Geotechnical Report. This checklist is to accompany the Geotechnical Report and its certification (Form No. 1).

Geotechnical Report Details:

Report Title: Geotechnical Report **120 Prince Alfred Parade, Newport**

Report Date: 12/11/21

Author: BEN WHITE

Author's Company/Organisation: WHITE GEOTECHNICAL GROUP PTY LTD

Please mark appropriate box

☒ Comprehensive site mapping conducted **21/10/21**
(date)

☒ Mapping details presented on contoured site plan with geomorphic mapping to a minimum scale of 1:200 (as appropriate)

☒ Subsurface investigation required
- ☐ No Justification ______________________
- ☒ Yes Date conducted **21/10/21**

☒ Geotechnical model developed and reported as an inferred subsurface type-section

☒ Geotechnical hazards identified
- ☒ Above the site
- ☒ On the site
- ☐ Below the site
- ☐ Beside the site

☒ Geotechnical hazards described and reported

☒ Risk assessment conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
- ☒ Consequence analysis
- ☒ Frequency analysis

☒ Risk calculation

☒ Risk assessment for property conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009

☒ Risk assessment for loss of life conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009

☒ Assessed risks have been compared to "Acceptable Risk Management" criteria as defined in the Geotechnical Risk Management Policy for Pittwater - 2009

☒ Opinion has been provided that the design can achieve the "Acceptable Risk Management" criteria provided that the specified conditions are achieved.

☒ Design Life Adopted:
- ☒ 100 years
- ☐ Other ______________________
  specify

☒ Geotechnical Conditions to be applied to all four phases as described in the Geotechnical Risk Management Policy for Pittwater - 2009 have been specified

☒ Additional action to remove risk where reasonable and practical have been identified and included in the report.

☐ Risk assessment within Bushfire Asset Protection Zone.

I am aware that Pittwater Council will rely on the Geotechnical Report, to which this checklist applies, as the basis for ensuring that the geotechnical risk management aspects of the proposal have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated, and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature

Name Ben White

Chartered Professional Status MScGEOLAusIMM CP GEOL

Membership No. 222757

Company White Geotechnical Group Pty Ltd

GEOTECHNICAL INVESTIGATION:

Subdivision and New Houses at **120 Prince Alfred Parade, Newport**

1. Proposed Development

1.1 Subdivide the property.

1.2 Construct a part three storey house with garage for 120A Prince Alfred Pde and a two storey house with garage for 120B Prince Alfred Pde. These works require an excavation to a maximum depth of ~4.5m.

1.3 Construct a new suspended driveway for 120A Prince Alfred Pde. Construct a new driveway for 120B and suspended walkway.

1.4 Construct new lower terraces and install new pools for both properties requiring excavations to maximum depths of ~1.7m for 120A and ~1.4m for 120B.

1.5 Details of the proposed development are shown on 9 drawings prepared by Corben Architects, job number NEWP, drawings numbered SK01 to SK09, dated 26/10/21.

2. Site Description

2.1 The site was inspected on the 21st October, 2021.

2.2 This waterfront residential property is on the low side of the road and has a NE aspect. It is located on the gentle to moderately graded lower reaches and toe of a hillslope that falls to Old Mangrove Bay. The natural slope falls at an average angle of ~14° from the uphill property boundary before quickly easing to near level angles at the uphill side of the house. The slope above the property gradually increases in grade.

2.3 At the road frontage, a concrete driveway runs down the slope to a rendered masonry and timber clad garage and studio (Photo 1). A concrete crib and concrete retaining wall up to ~2.0m high supports the fill batter for the road (Photo 2). The wall is partially obscured by vegetation, but from what can be seen of the wall it appears to be stable. Low brick retaining walls terrace the slope downhill of the road (Photo 3). The walls display significant cracking, bulging and tilting downslope, but will be demolished as part of the proposed works. A level lawn area is located on the downhill side of the terraced area (Photo 4). The single storey weatherboard clad house is supported by brick walls and brick piers (Photos 4 & 5). The supporting walls and piers stand vertical and show no significant signs of movement (Photo 6). A level lawn area extends off the downhill side of the house (Photos 5 & 7). A low sandstone block seawall supports the fill for the lawn. A fibre cement and weatherboard clad boatshed is located at the waterfront NE of the house (Photo 8). The adjoining neighbouring properties were observed to be in good order as seen from the street and subject property.

3. Geology

The Sydney 1:100 000 Geological sheet indicates the site is underlain by the Newport Formation of the Narrabeen Group. This is described as interbedded laminite, shale, and quartz to lithic quartz sandstone. But deep sediments underlie the lower half of the property.

4. Subsurface Investigation

Four Auger holes were put down to identify the 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. 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 may have occurred for DCP1 & 5. Due to the possibility that the actual ground conditions vary from our interpretation there should be allowances in the excavation and foundation budget to account for this. We refer to the appended “Important Information about Your Report” to further clarify. The results are as follows:

AUGER HOLE 1 (~RL2.8) **–** AH1 (Photo 9)

Depth (m)	Material Encountered
0.0 to 0.8	**TOPSOIL**, sandy soil, dark brown, damp, fine to course grained.
0.8 to 1.0	**CLAYEY SAND**, light brown, damp.
1.0 to 1.4	**CLAY**, brown, orange, grey and red, mottled, firm to stiff.

Refusal @ 1.4m in firm to stiff clay. No watertable encountered.

AUGER HOLE 2 (~RL6.1) **–** AH1 (Photo 10)

Depth (m)	Material Encountered
0.0 to 0.3	**TOPSOIL**, sandy soil, dark brown, damp, fine to medium grained.
0.3 to 0.4	**CLAY**, orange/brown, firm to stiff, moist.

End of Hole @ 0.4m in firm to stiff clay. No watertable encountered.

AUGER HOLE 3 (~RL2.0) **–** AH1 (Photo 11)

Depth (m)	Material Encountered
0.0 to 0.9	**FILL**, sandy soil, dark brown, dry, fine to medium grained.
0.9 to 1.1	**FILL**, sandy clay, orange, stiff, moist.

Refusal @ 1.1m in fill. No watertable encountered.

AUGER HOLE 4 (~RL1.8) **–** AH1 (Photo 12)

Depth (m)	**Material Encountered**
0.0 to 0.4	**FILL**, sandy soil, dark brown, dry to moist, fine to medium grained.
0.4 to 0.8	**FILL**, sand, light yellow/brown, dry to moist, fine to medium grained.
0.8 to 1.3	**SANDY SOIL**, with some clay, dark brown/grey, damp, fine to medium grained.
1.3 to 1.9	**SANDY SOIL**, with some clay, dark brown/grey, wet to very wet, fine to medium grained.

End of hole @ 1.9m in very wet sandy soil. Watertable encountered @ ~1.5m.

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** (~RL2.9)	**DCP 2** (~RL2.9)	**DCP 3** (~RL6.1)	**DCP 4** (~RL2.8)	**DCP 5** (~RL2.3)	**DCP 6** (~RL2.0)	**DCP 7** (~RL1.8)
0.0 to 0.3	7	6	6	4	10	11	6
0.3 to 0.6	13	9	17	4	20	5	7
0.6 to 0.9	18	5	20	15	21	9	5
0.9 to 1.2	#	18	37	10	#	16	5
1.2 to 1.5		9	28	22		14	5
1.5 to 1.8		14	28	22		11	17
1.8 to 2.1		17	34	30		16	13
2.1 to 2.4		28	#	#		28	7
2.4 to 2.7		#				10	12
2.7 to 3.0						#	26
3.0 to 3.3							26
3.3 to 3.6							39
3.6 to 3.9							#
	Refusal @ 0.9m	Refusal on rock @ 2.4m	Refusal on rock @ 2.1m	End of Test @ 1.9m	Refusal @ 0.9m	Refusal on rock @ 2.5m	End of Test @ 3.6m

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

DCP Notes:

DCP1 – Refusal @ 0.9m, DCP bouncing, brown soil on dry tip.
DCP2 – Refusal on rock @ 2.4m, DCP bouncing off rock surface, brown soil on damp tip.
DCP3 – Refusal on rock @ 2.1m, DCP bouncing off rock surface, orange shale fragments on dry tip.
DCP4 – End of test @ 1.9m, DCP still going down, orange shale fragments and dark brown soil on damp tip.
DCP5 – Refusal @ 0.9m, DCP bouncing, orange clay on dry tip.
DCP6 – Refusal on rock @ 2.5m, DCP bouncing off rock surface, orange red shale fragments and brown soil on wet tip.
DCP7 – End of test @ 3.6m, DCP still very slowly going down, dark brown/grey sandy soil on muddy wet tip.

5. Geological Observations/Interpretation

The geology across the site is variable as the site is located on the toe and lower reaches of a hillslope.

The ground materials across the uphill portion of the property consist of a sandy topsoil and clayey sand over firm to stiff clays, with Extremely Low Strength Shale at depths from between ~1.2 to ~2.5m below the current surface. The shale becomes progressively deeper from the SW to the NE side of the property.

The ground materials at the downhill side of the property consist of fill to depths from depths of between ~0.8m to ~1.1m over sediments. The sediments consist of sand of variable density that ranges from Loose to Medium Dense before encountering Dense sand at a depth of ~3.6m. It is interpreted that the shale profile was not encountered so it is envisaged that the sediments, although they grade into the shale upslope, could exceed depths of 3.6m on the downhill side of the proposed works.

See the Type Section attached for a diagrammatical representation of the expected ground materials.

6. Groundwater

Normal ground water seepage is expected to move over the buried surface of the rock and through the cracks in the rock.

The watertable was encountered at a depth of ~1.5m (~RL0.3) below the current surface at the location of AH4. The base of the proposed pools are at ~RL0.5. The sandy soil above the watertable (~0.2m above the watertable) was noted as wet indicating seepage will be moving through the sandy soil at the base of the proposed excavations. This has implications for the stability of the excavation as the seepage will likely cause undercutting and collapse of the cut batters. See '**Section 13** Excavation Support Requirements'.

If the houses are to be supported on shale the foundations will be taken below the watertable on the downhill side. See '**Section 15** Foundations'.

It should be noted the watertable fluctuates slightly with the tide and climatic changes.

7. Surface Water

No evidence of 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 Prince Alfred Parade above.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed below or beside the property. The moderate slope that falls across the property and continues above is a potential hazard (**Hazard One**). The proposed excavation for the houses is a potential hazard until retaining structures are in place (**Hazard Two**). The proposed excavations for the pools are a potential hazard until retaining structures are in place (**Hazard Three**). The additional surcharge loads from the proposed suspended driveway and walkway structures are a potential hazard to the existing retaining wall (Photo 2) (**Hazard Four**).

Geotechnical Hazards and Risk Analysis - Risk Analysis Summary

HAZARDS	Hazard One	Hazard Two
TYPE	The moderate slope that falls across the property and continues above failing and impacting on the property.	The proposed excavation for the houses collapsing onto the work site, impacting the neighbouring properties and road reserve, and undercutting the W neighbouring terrace before retaining structures are in place.
LIKELIHOOD	‘Unlikely’ (10^{-4})	‘Possible’ (10^{-3})
CONSEQUENCES TO PROPERTY	‘Medium’ (12%)	‘Medium’ (25%)
RISK TO PROPERTY	‘Low’ (2×10^{-5})	‘Moderate’ (2×10^{-4})
RISK TO LIFE	8.3×10^{-7}/annum	4.1×10^{-5}/annum
COMMENTS	This level of risk is ‘ACCEPTABLE’.	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)

RISK ANALYSIS SUMMARY CONTINUES ON NEXT PAGE

Geotechnical Hazards and Risk Analysis - Risk Analysis Summary

HAZARDS	Hazard Three	Hazard Four
TYPE	The proposed excavations for the pools collapsing onto the work site, impacting the neighbouring properties and undercutting the W neighbouring concrete pathway before retaining structures are in place.	The additional surcharge loads from the proposed suspended driveway and walkway structures transferring onto the existing retaining wall causing movement or failure (Photo 2).
LIKELIHOOD	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (20%)	'Medium' (30%)
RISK TO PROPERTY	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	3.7×10^{-6}/annum	5.6×10^{-6}/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 the risk to 'ACCEPTABLE' levels the recommendations in **Section 15** 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 Old Mangrove Bay. All stormwater from the proposed development is to be piped to Old Mangrove Bay through any tanks that may be required by the regulating authorities.

11. Excavations

An excavation to a maximum depth of ~4.5m is required to construct the proposed new houses. The excavation is expected to be through fill, topsoil, clayey sand and firm to stiff clays, with Extremely Low Strength Shale expected at depths from between ~1.2m to ~2.4m below the current surface.

Excavations to maximum depths of ~1.7m and ~1.4m are required for the proposed new pools. The excavations are expected to be through fill and sandy soil.

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

Possible vibrations generated during excavations through fill, soil, clay and Extremely Low Strength Shale will be below the threshold limit for building damage.

13. Excavation Support Requirements

Bulk Excavation for Houses

An excavation to a maximum depth of ~4.5m is required to construct the proposed new houses. Allowing for backwall drainage, the excavation is set back ~0.3m from the road reserve, ~1.5m from the W common boundary and ~1.9m from the W neighbouring terrace. The road reserve, W common boundary and W neighbouring terrace will be within the zone of influence of the excavation. In this instance, the zone of influence is the area above a theoretical 30° line through fill/soil/sand and a theoretical 45° line through clay/shale from the base of the excavation towards the surrounding structures and boundaries.

Due to the depths of the excavation and the proximity to the nearby property boundaries and structures, all sides of the excavations will require ground support installed prior to the commencement of the excavation. See the Ground Level Plan attached for the minimum extent of the required ground support shown in blue.

A spaced pile retaining wall is one of the suitable methods of support. Pier spacing is typically ~2.0m but can vary between 1.6 to 2.4m depending on the design. As the excavation is lowered in 1.5m lifts infill sprayed concrete panels or similar are added between the piers to form the wall. Drainage is installed behind the panels. To drill the pier holes for the walls, a pilling rig that can excavate through Medium to High Strength Rock will be required. The piers can be temporarily supported by embedment below the base of the excavation or with a combination of embedment and propping. For permanent bracing, the walls can be tied into a slab built under the proposed lawn area, braced with buttresses, or anchored. Where anchors need to be drilled into and below the adjoining property, the permission of the owners is required (in this case permission will need to be granted by the appropriate authority responsible for the road reserve).

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 installed for ground support purposes.

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

Bulk Excavations for Pools

Excavations to maximum depths of ~1.7m and ~1.4m are required for the proposed new pools at 120A and 120B respectively. The setbacks are as follows:

- The 120A pool excavation is set back ~1.3m from the W common boundary and W neighbouring concrete pathway. The above boundary and structure will be within the zone of influence of the excavation.
- The 120B pool excavation is set back ~1.5m from Florence Park and ~1.3m from the existing timber deck beside the boatshed, although the deck is suspended above ground lower than the existing ground surface at the location of the pool, reducing

the zone of influence. Florence Park will be within the zone of influence of the excavation.

In this instance, the zone of influence is the area above a theoretical 30° line through fill/soil from the base of the excavation towards the surrounding structures and boundaries.

The watertable was encountered in AH4 at ~RL0.5 (~0.2m below the bases of the proposed excavations). It should be noted that the watertable fluctuates with the tide and climatic changes and therefore has implications for the excavation stability.

The cut batters are to be temporarily supported until the pool structures are in place. The ground support is to be designed and approved by a structural engineer. Seepage is expected through the profile from a depth of ~1.3m and is likely the water will cause undercutting and slumping through the batter. An example of suitable ground support is a sandbag retaining wall that is installed as the excavation is progressed and remains in place while the pool is formed and concreted. The sandbags allow water flow but prevent sediment movement and subsequent batter collapse. It should be noted that this is one of many possible shoring solutions.

The watertable is expected to be encountered at the base of the excavations only. A sump and pump may be required during construction to keep the base of the excavations dry. As the watertable will likely only be encountered by ~0.2m, any draw down effects from pumping are expected to be negligible.

Advice Applying to All Excavations

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**	**Passive**
Fill, Sandy Soil, Clayey Sand	20	0.40	0.55	N/A
Residual Clays	20	0.35	0.45	Kp = 2.0 ultimate
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 structures are fully drained. No passive resistance should be assumed for the top 0.4m to account for any disturbance from the excavation. Passive pressures are 'ultimate' so should have a suitable safety factor applied. Rock strength and relevant earth pressure coefficients are to be confirmed on site by the geotechnical consultant.

A multi-propped or anchored shoring system can be designed using a rectangular lateral earth pressure distribution using a pressure of 4H kPa for soil/clay and 3H kPa for Extremely Low Strength Shale, where H is the depth of the excavation in metres. Where small movements are not tolerable, the wall can be designed using a pressure of 6H kPa for soil/clay and 4H kPa for Extremely Low Strength Shale

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

The proposed driveway at 120B can be supported off the natural surface after any organic matter has been stripped. A maximum allowable bearing pressure of 100kPa can be assumed for soil of the natural surface.

The proposed suspended driveway at 120A and suspended walkway at 120B are to be supported on piers embedded into Extremely Low Strength Shale and taken to beyond the zone of influence of the existing concrete crib/concrete retaining wall supporting the fill for the road reserve (Photo 2). Provided the footings are taken to and embedded into this ground material at the required depths, no additional loads will be transferred onto the existing retaining wall. A maximum allowable bearing pressure of 600kPa can be assumed for footings on Extremely Low Strength Shale.

The SW portions of the proposed houses are expected to be seated in Extremely Low Strength Shale. Where the houses are not cut into the shale it is recommended screw piles be utilised as the watertable is expected to be encountered above the shale across a significant portion of the houses. The screw piles can be embedded in shale or sediment (at the SE side of the property where the sediment is deepest), noting that slight ground movements can occur in shale in accordance with 'Class S' ground movement.

Note that we do not certify screw pile foundations. Screw pile design varies between contractors and we are not privy to the details of individual design or how the screw pile contractor converts torque to bearing pressure. As such, the screw pile contractor is totally responsible for ensuring the screw piles can support the loads on the piles and that these are within acceptable settlement limits.

The proposed pools are expected to be seated in Loose to Medium Dense sandy soil. Although the underlying ground material at the bases of the pools has an adequate bearing pressure to support the pools we recommend screw piles be installed to prevent possible 'pop-out' that can occur when the pool is empty and floats on the water table and subsequently pops out of the ground. The Structural Engineer is to calculate the required pressure for the screw piles to resist buoyancy.

If another method of "hold down" is used and the pool can be supported on the sediment at the base of the excavation, it should be compacted as the excavation will loosen the upper sands. This can be carried out with a hand-held plate compactor. As a guide to the level of compaction required, a density index of >65% is to be achieved, correlating to a dense sand. The geotechnical consultant is to inspect and test the compacted base of the pool excavation to ensure the required density has been achieved.

If the cost of these measures to prevent 'pop out' are considered too much and the owners wish to support the pool on the base of the excavation only, we point out the pool will always need to be kept full of water to prevent the possibility of it floating on the water table during wet periods. We recommend the pool be anchored. If it is not and the pool does pop out of the ground, we accept no liability whatsoever.

As the areas around the pools will become saturated during pool use, it is recommended the proposed paving be supported on raft slabs. The rafts are to be taken to a depth of 0.4m below the current surface into the Medium Dense fill. This will reduce the risk of settlement around the pool that can result from ongoing saturation of the soil. A maximum allowable bearing pressure of 100kPa can be assumed for footings supported on Medium Dense fill. Alternatively the terraces can be supported on screw piles.

The raft slab footing walls are to be shored with timber to prevent collapse. The base of the footing excavations in fill should be compacted as the excavation will loosen the upper fill. This can be carried out with a hand-held plate compactor. Water may be used to assist in compaction in sandy soil 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.

16. 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.

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.

- The geotechnical consultant is to inspect the ground materials while the first pile for the pile wall is being dug to assess the ground strength and to ensure it is in line with our expectations. All finished pier holes are to be inspected and measured before concrete is placed.

- Any conventional foundations other than screw piles 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

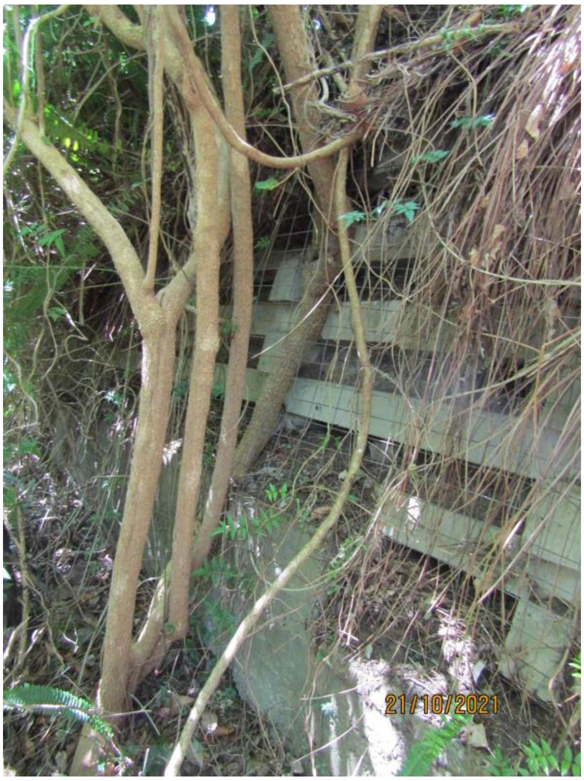


Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9: AH1 – Downhole is from top to bottom.

Photo 10: AH2 – Downhole is from left to right.

Photo 11: AH3 – Downhole is from left to right.

Photo 12: AH4 – Downhole is from bottom to top.

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.

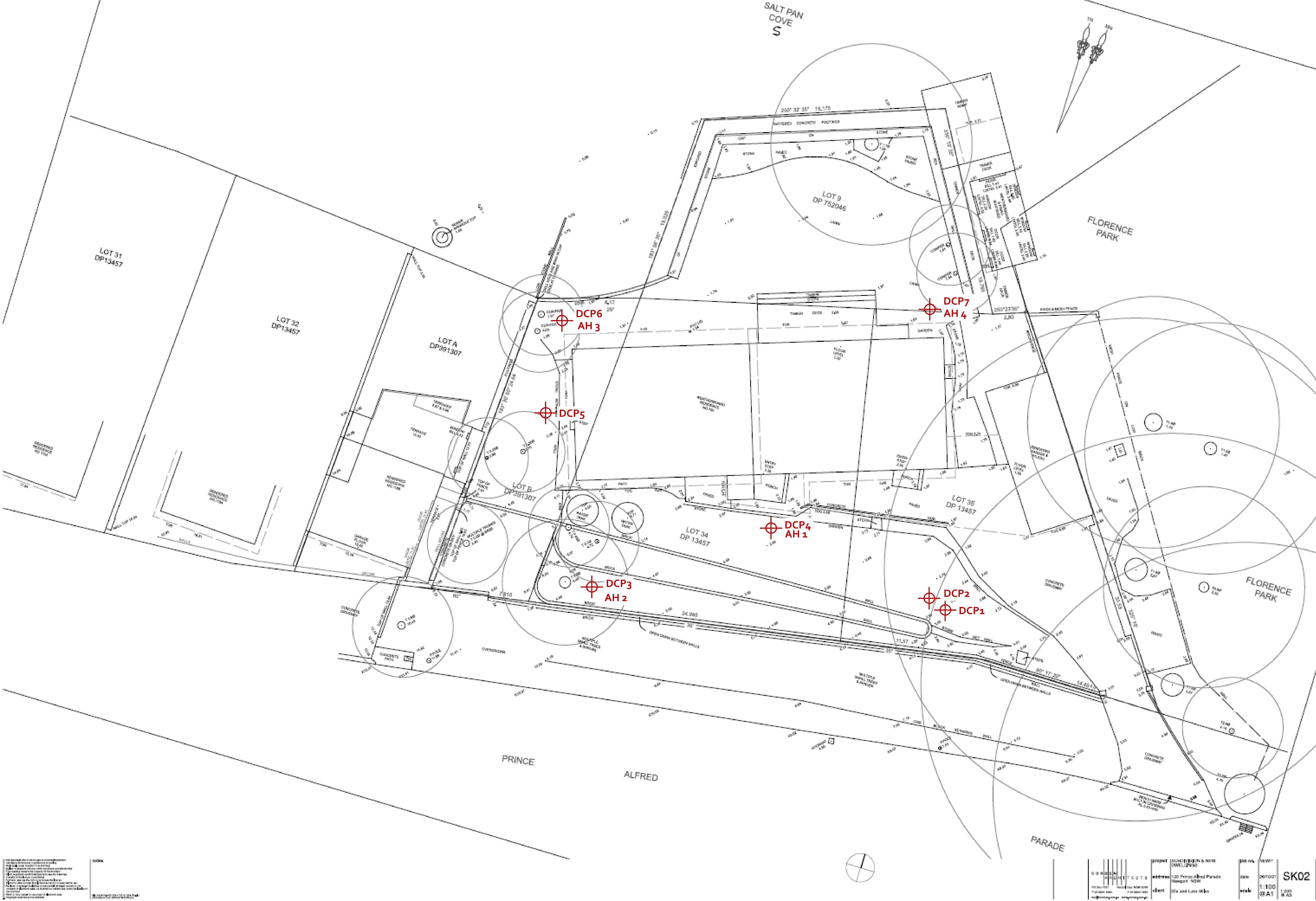
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- This report should not be applied to any other project other than that outlined in section 1.0.

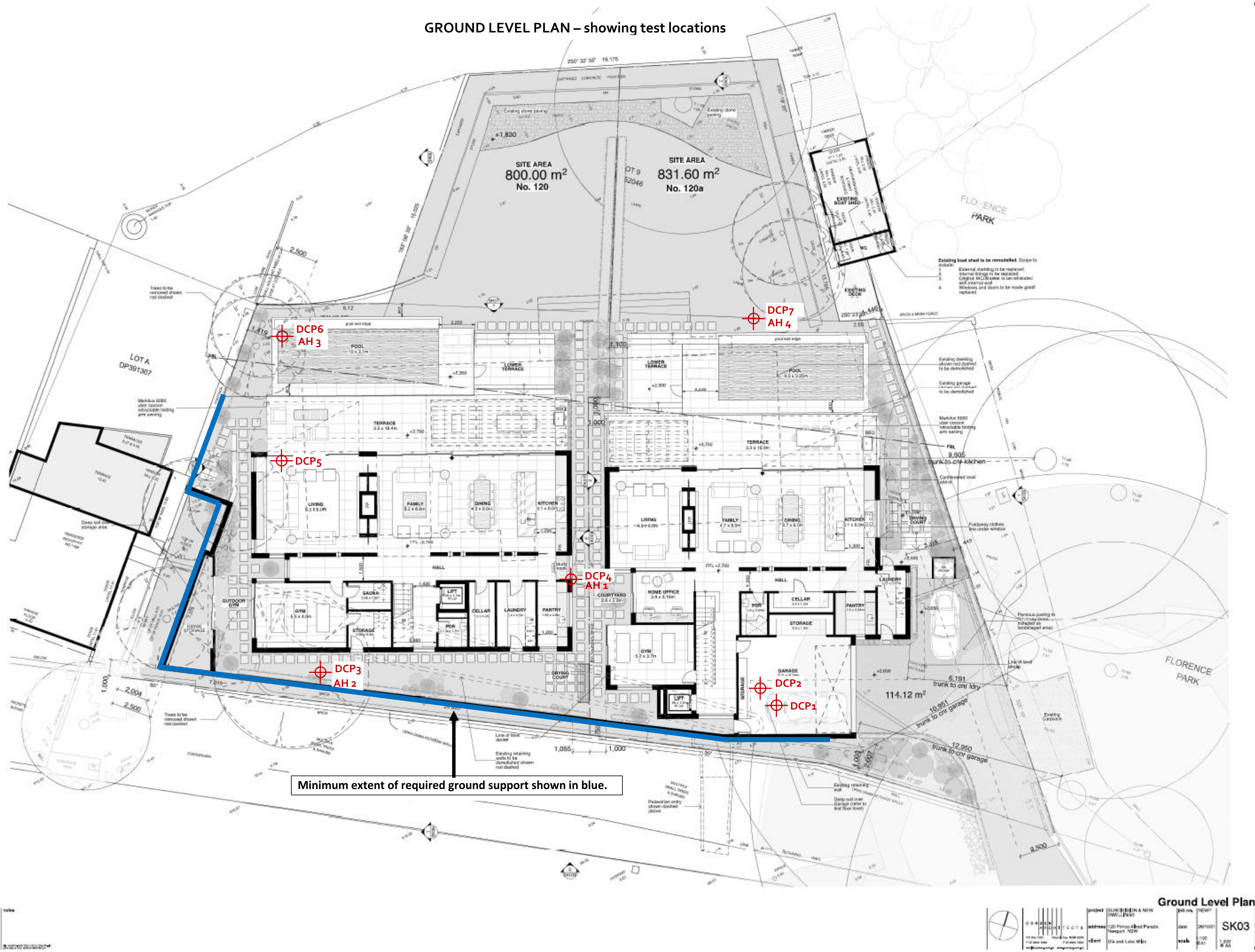
- This report is to be read in full and should not have sections removed or included in other documents as this can result in misinterpretation of the data by others.

- 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.

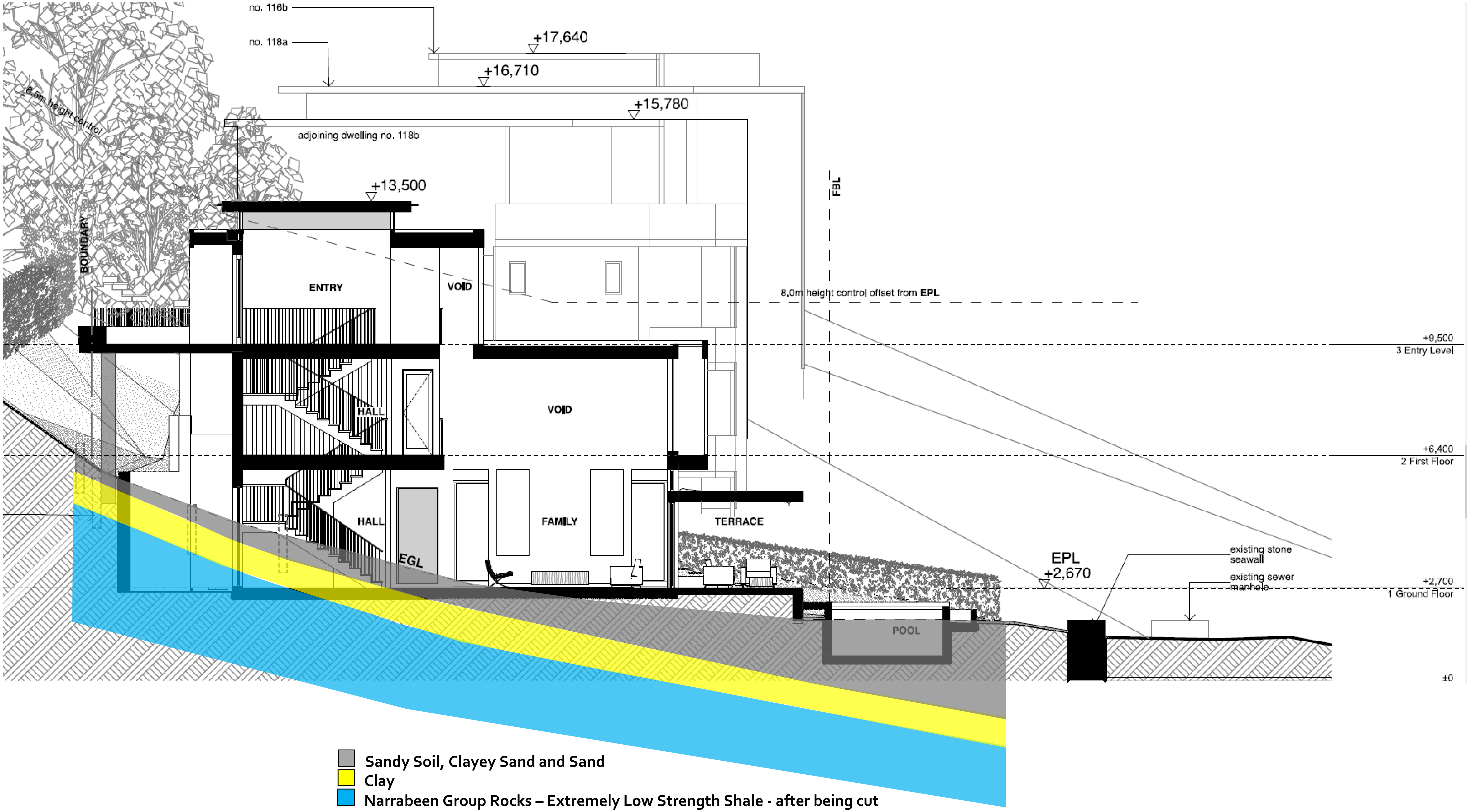
SURVEY – showing test locations



GROUND LEVEL PLAN – showing test locations

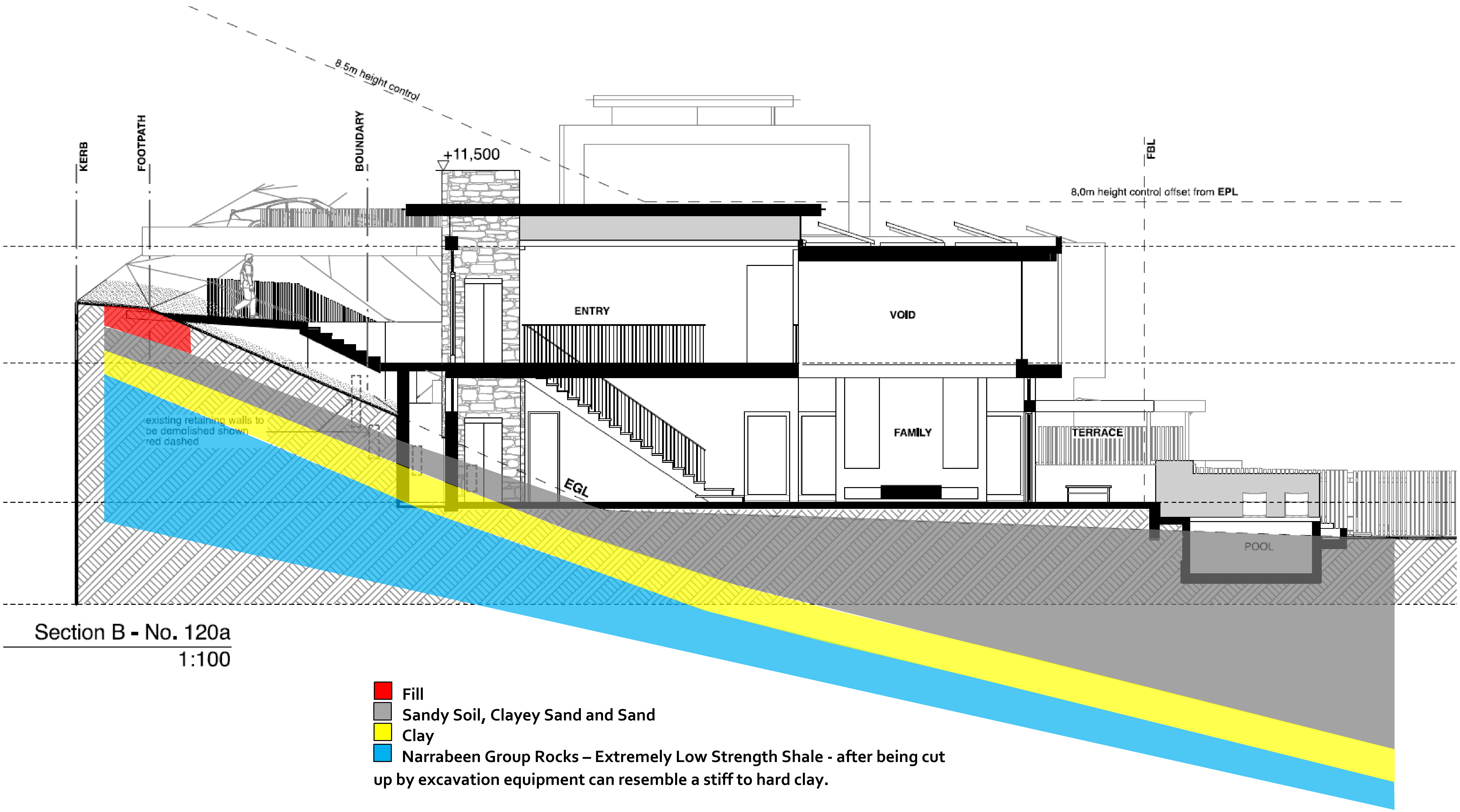


TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



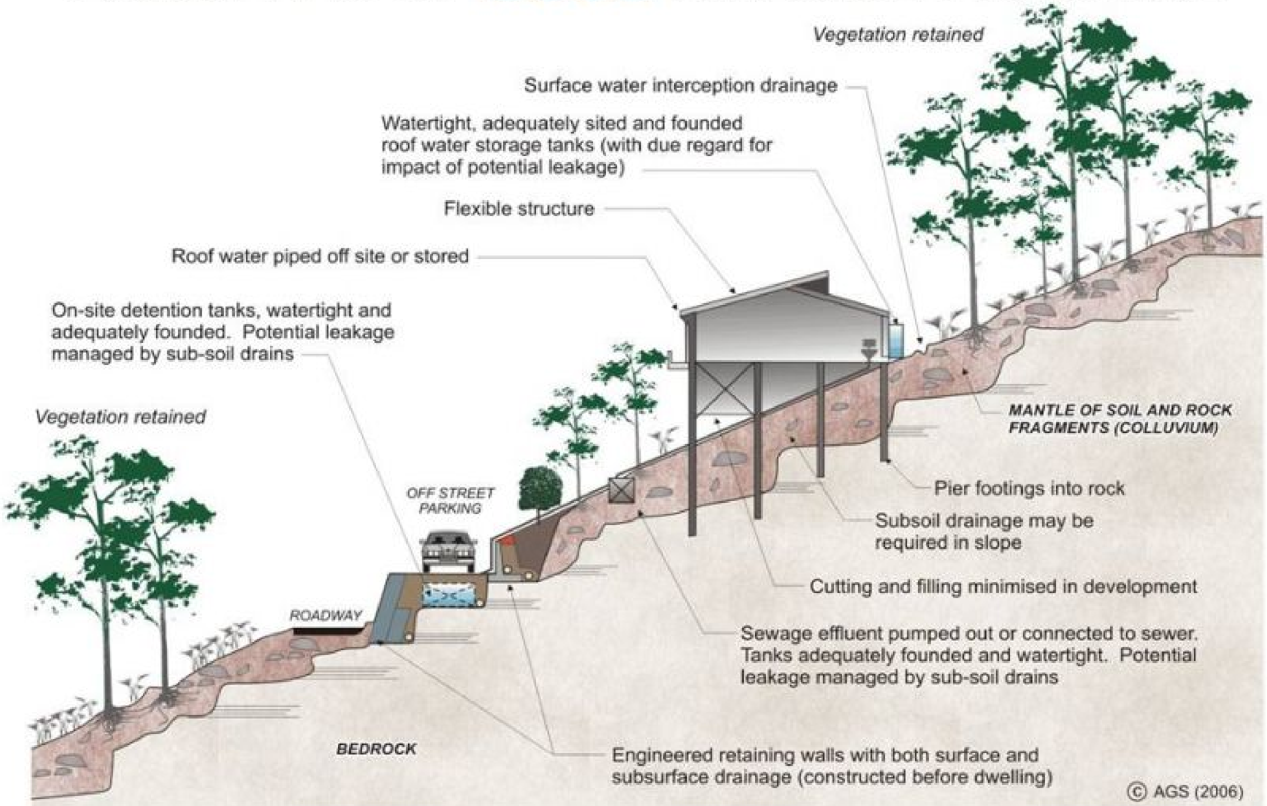
Sandy Soil, Clayey Sand and Sand
Clay
Narrabeen Group Rocks – Extremely Low Strength Shale - after being cut up by excavation equipment can resemble a stiff to hard clay.

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



Fill
Sandy Soil, Clayey Sand and Sand
Clay
Narrabeen Group Rocks – Extremely Low Strength Shale - after being cut up by excavation equipment can resemble a stiff to hard clay.

EXAMPLES OF GOOD HILLSIDE PRACTICE



EXAMPLES OF POOR HILLSIDE PRACTICE