GEOTECHNICAL INVESTIGATION:

Alterations & Additions at **18 Francis Street, Fairlight**

1. Proposed Development

1.1 Extend the house upslope by excavating to a maximum depth of ~2.0m into the slope.

1.2 Various other internal and external modifications.

1.3 Details of the proposed development are shown on 10 drawings prepared by Watershed Design, issue B, job numbered 18013, drawings numbered MD01, DA01 to 09, dated 12th December 2018.

2. Site Description

2.1 The site was inspected on the 27th November, 2018.

2.2 This residential property is on the high side of the road and has a W aspect. The block is located on the gentle to moderately graded upper reaches of a hillslope. From the road frontage to the uphill side of the house, the slope rises at <5° and continues at ~10° to the uphill boundary. The slope below the property continues at gradually increasing angles. The land surface above the block decreases in grade.

2.3 Between the road frontage and the house is a gently sloping garden area (Photo 1 & 2). The old single-storey timber framed weatherboard clad and plasterboard house is supported on sandstone block piers (Photo 3). The supporting piers stand vertical (Photo 4). A cut has been made into the slope for a paved patio that extends off the uphill side of the house (Photo 5). A stable ~0.6m rendered brick retaining wall supports the cut for the patio area. The wall will be demolished as part of the proposed works. A moderately sloping lawn area extends from the retaining wall. A covered deck is located in the NE corner of the property (Photo 6). Competent

Medium Strength Sandstone bedrock outcrops in the SE corner of the property (Photo 7). A stable ~0.5m rendered brick retaining wall close to the uphill boundary retains a fill for a garden bed at the upper boundary (Photo 8). No significant signs of movement were observed on the property. No geotechnical hazards that could impact on the subject property were observed on the neighbouring properties as seen from the subject property and the road.

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 laminate lenses.

4. Subsurface Investigation

One Hand Auger Hole (AH) was put down to identify the soil materials. Three Dynamic Cone Penetrometer (DCP) tests were put down to determine the relative density of the overlying soil and the depth to bedrock. The location 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 is not expected to be an issue for the testing on this site and the results are as follows:

AUGER HOLE 1 (~RL 48.7) **–** AH1 (Photo 9)

Depth (m)	**Material Encountered**
0.0 to 0.5	**SANDY SOIL,** light brown, loose, fine to medium grained, black rock fragments, sandstone rock fragments, organic matter, dry.

Refusal @ 0.5m on hard surface. 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** (~RL48.7)	**DCP 2** (~RL49.18)	**DCP 3** (~RL47.9)
0.0 to 0.3	8	8	12
0.3 to 0.6	17	12	#
0.6 to 0.9	39	50	
0.9 to 1.2	#	#	
	End of Test @ 0.9m	End of Test @ 0.9m	Refusal @ 0.1m

#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 @ 0.9m, DCP still very slowly going down/bouncing, white impact dust on dry tip.
DCP2 – End of Test @ 0.9m, DCP still very slowly going down/bouncing, white impact dust on dry tip.
DCP3 – Refusal @ 0.1m, DCP bouncing off hard surface, clean dry tip.

5. Geological Observations/Interpretation

The surface features of the block are controlled by the outcropping and underlying sandstone bedrock that steps up the property forming sub horizontal benches between the steps. Where the grade is steeper the steps are larger and the benches narrower. Where the slope eases the opposite is true. The rock is overlain by natural sandy soils and sandy clays that cover the bench step formation. In the test locations rock was encountered at depths of between ~0.1 to ~0.9m below the current surface. The outcropping sandstone on the property is estimated to be medium strength or better and similar strength rock is expected to underlie the entire site. 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. Due to the slope and elevation of the block, the water table is expected to be many metres below the base of the proposed excavation.

7. Surface Water

No evidence of surface flows were observed on the property during the inspection. Normal sheet wash from the slope above will move onto the property during heavy downpours.

8. Geotechnical Hazards and Risk Analysis

No geotechnical hazards were observed above, below or beside the property. The vibrations produced during the proposed excavation impacting the surrounding structures is a potential hazard (**Hazard One**). The proposed excavation is a potential hazard until retaining structures are in place (**Hazard Two**). The proposed excavation undercutting the S neighbouring house footings is a potential hazard (**Hazard Three**).

SEE OVER THE PAGE FOR RISK ANALYSIS SUMMARY

Risk Analysis Summary

HAZARDS	Hazard Three	Hazard Two	Hazard One
TYPE	The vibrations produced during the proposed excavation damaging the subject house and neighbouring houses to the N and S.	The proposed excavation collapsing onto the work site before retaining structures are in place.	The proposed excavation undercutting the S neighbouring house footings causing failure.
LIKELIHOOD	'Possible' (10^{-3})	'Possible' (10^{-3})	'Possible' (10^{-3})
CONSEQUENCES TO PROPERTY	'Medium' (20%)	'Medium' (12%)	'Medium' (15%)
RISK TO PROPERTY	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})	'Moderate' (2×10^{-4})
RISK TO LIFE	6.2×10^{-7}/annum	2.3×10^{-6}/annum	5.2×10^{-7}/annum
COMMENTS	This level of risk to property is '**UNACCEPTABLE'**. To move the risk levels 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 levels to acceptable levels the recommendations in **Section 13** are to be followed.	This level of risk to property is '**UNACCEPTABLE'**. To move the risk levels to acceptable levels the recommendations in **Section 13** are to be followed.

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

9. Suitability of the Proposed Development for the Site

The proposed development is suitable for the site. No geotechnical hazards will be created by the completion of the proposed development provided it is carried out in accordance with the requirements of this report and good engineering and building practice.

10. Stormwater

The fall is to Francis Street below. Roof water from the proposed addition is to be piped to Francis Street 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 extend the existing house upslope. Where rock is not exposed the excavation is expected to be through a sandy soil over firm to stiff sandy clays with Medium Strength Sandstone expected at average depths of ~0.9m below the current ground surface. It is envisaged that excavations through sandy soil and clay can be carried out by a bucket only and excavations through rock will require grinding or rock sawing and breaking.

12. Vibrations

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

If excavations through rock are required, they are to be carried out to minimise the potential to cause vibration damage to the subject house and neighbouring houses to the N and S. The subject house will ~6.0m, the neighbouring house to the N will be ~2.7m and the S neighbouring house will come flush with the edges of the proposed 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 edge perimeters of the excavation. 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 excavation perimeters 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.

13. Excavation Support Requirements

The S side of the excavation for the proposed addition will come flush with a portion of the S neighbouring house wall. The DCP tests indicate that rock is quite shallow in this location and we think it is likely the wall is supported on rock. However to be sure, exploration pits are to be dug by the builder beside the wall to determine the foundation depth and material. Upon completion, the pits are to be inspected by the geotechnical professional to confirm their depth. No additional support is required if these structures are supported on Medium Strength Sandstone. If any of the footings are not supported on rock they are to be underpinned to competent rock, before the bulk excavation can commence. This will require the approval of the S property owner. If approval is not granted a piled wall can be installed along the S boundary prior to the commencement of the bulk excavation. The remaining sides of the excavation are set back at safe distances from any boundaries or structures.

If underpinning is required, it is to follow the underpinning sequence 'hit one miss two'. Under no circumstances is the bulk excavation to be taken to the edge of the footing and then underpinned. The underpins are to be carried out in drives pushed forward from beyond the zone of influence following the underpinning sequence. Under pins should not exceed 0.6m in width. Allowances are to be made for drainage through the underpinning to prevent a build-up of hydrostatic pressure. Underpins that are not designed as retaining walls are to be supported by retaining walls. The void between the retaining walls and the underpinning is to be filled with free draining material such as gravel.

Where room permits the soil and clay portions of the unsupported excavation faces are to be battered temporarily at 1.0 Vertical to 2.0 Horizontal (26°) until the retaining walls are in

place, provided the cut batters are kept from becoming saturated. Excavations through Medium Strength Sandstone or better will stand at vertical angles unsupported subject to approval by the geotechnical consultant.

The cut batters 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. Upslope runoff is to be diverted from the cut faces by sandbag mounds or other diversion works. The materials and labour to construct the retaining walls 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.

The geotechnical consultant is to inspect the excavation as it is lowered to a depth of 1.5m, while the machine is on site to ensure ground materials are as expected and that no additional support is required.

All excavation spoil is to be removed from site.

14. Retaining Walls

For cantilever or singly propped retaining walls 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 Walls

Unit	Earth Pressure Coefficients		
	Unit weight (kN/m^3)	'Active' K_a	'At Rest' K_0
Sandy Soil and Silty Sands	20	0.4	0.55
Weathered Rock up to Low Strength	24	0.30	0.35
Medium Strength Sandstone	24	0.0	0.1

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 wall, do not account for any surcharge loads and assume retaining walls are fully drained. So in this instance, slope surcharge loads will need to be accounted for in the design. Rock strength and relevant earth pressure coefficients are to be confirmed on site by the geotechnical consultant.

All retaining walls are to have sufficient back-wall drainage and be backfilled immediately behind the wall 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 retaining wall design.

15. Foundations

A concrete slab supported directly off Medium Strength Sandstone is a suitable footing for the proposed house addition. This ground material is expected to be exposed across most of the base of the new addition. Where it is not exposed, shallow piers will be required to maintain a uniform bearing material. A maximum allowable bearing pressure of 800kPa can be assumed for footings on Medium Strength Sandstone.

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.

16. 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.

- The geotechnical consultant is to inspect any exploration pits that may be required to expose the foundation materials of the S neighbouring house footings.

- The geotechnical consultant is to inspect the excavation as it is lowered to a depth of 1.5m, while the machine is on site to ensure ground materials are as expected and that no additional support is required.

- All footings are to be inspected and approved by the geotechnical professional 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 – The base of the auger is at the bottom of the picture

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 tests 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 professional. 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.

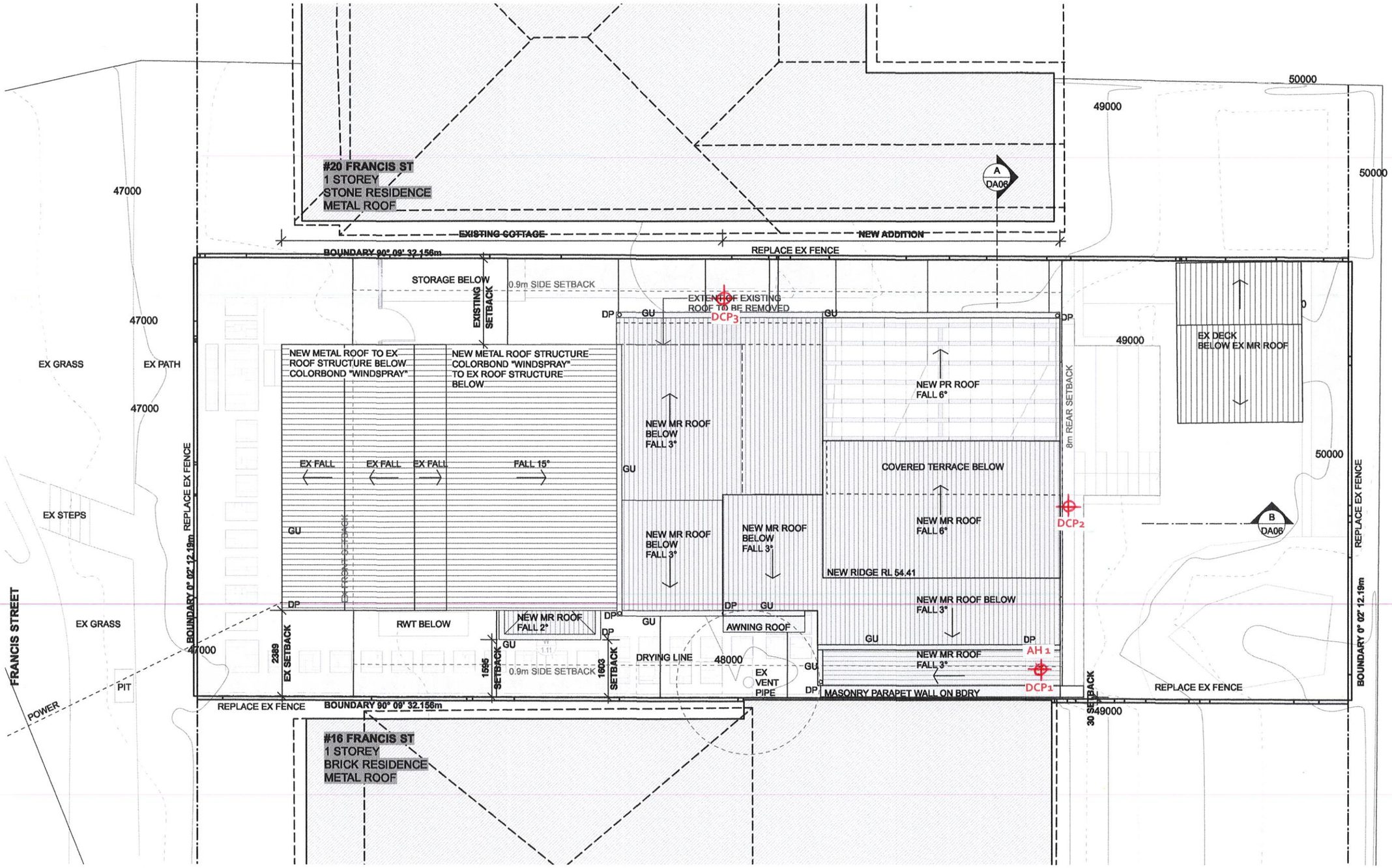
- The report addresses issues relating to your specific design and site. If the proposed project design changes, aspects of the report may no longer apply. Contact White Geotechnical if this occurs.

- 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



NOTES

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REVISIONS

no	amendment	date
A	PRELIMINARY ISSUE	13.11.18
B	UPDATED ISSUE	16.11.18
C	PRELIMINARY DA ISSUE	12.12.18

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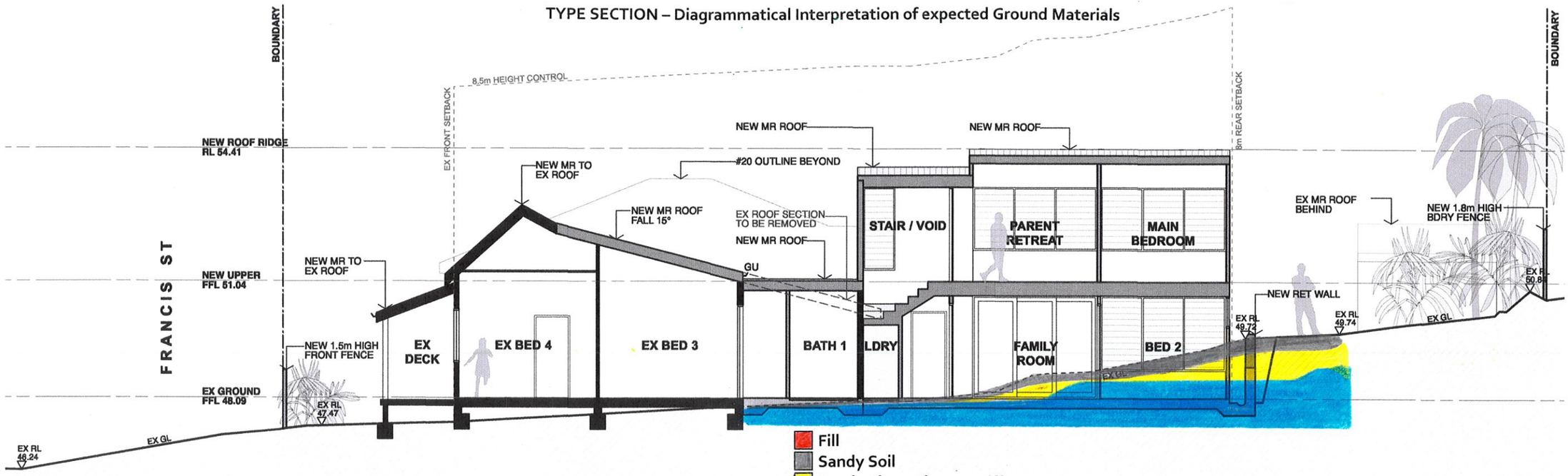
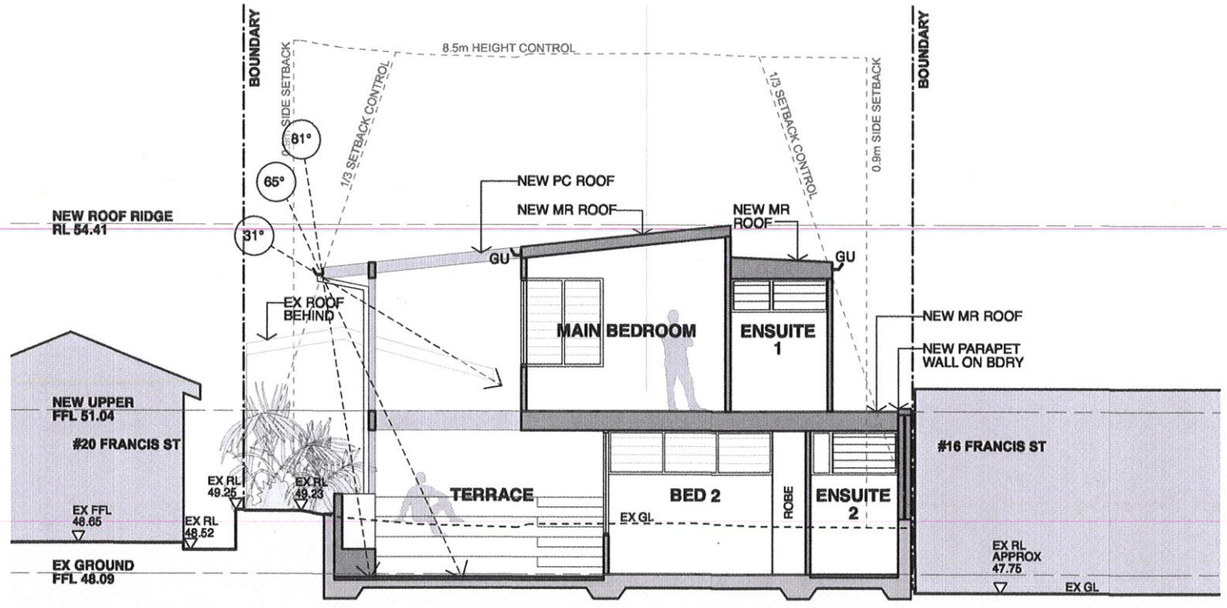
true north

CLIENT	Tineke & Jake Condon	ADDRESS	18 Francis Street, Fairlight	JOB NO	18013	DRAWING NO	DA02
				DRAWN	NT		
PROJECT	Alterations & Additions	TITLE	**Proposed Site & Roof Plan**	CHECKED	MK	ISSUE	B
				SCALE	1:100 @ A3		

TYPE SECTION – Diagrammatical Interpretation of expected Ground Materials



SECTION A-A



SECTION B-B

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REVISIONS

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A	PRELIMINARY ISSUE	13.11.18
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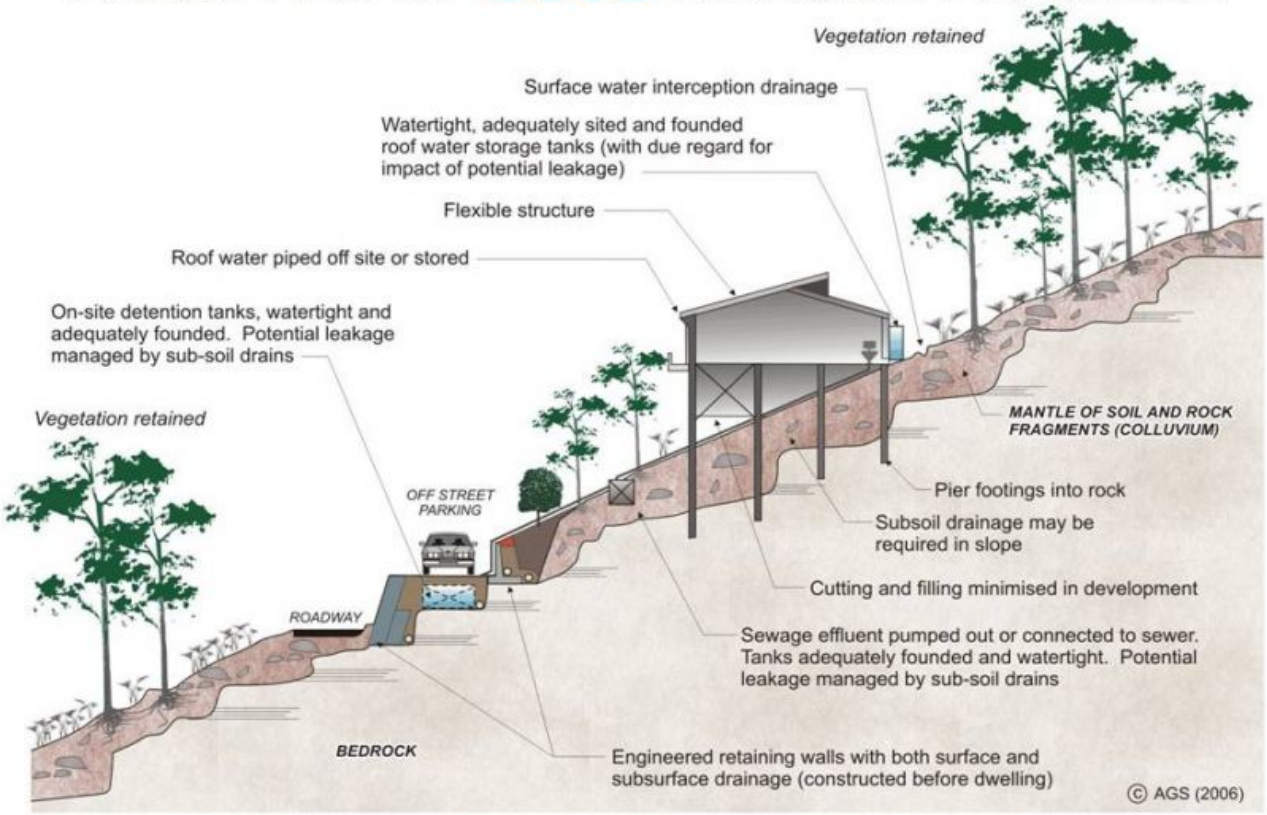
CLIENT	Tineke & Jake Condon	ADDRESS	18 Francis Street, Fairlight	JOB NO	18013	DRAWING NO	DA06
PROJECT	Alterations & Additions	TITLE	**Proposed Sections A-A & B-B**	DRAWN	NT		
				CHECKED	MK	ISSUE	B
				SCALE	1:100 @ A3		

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE