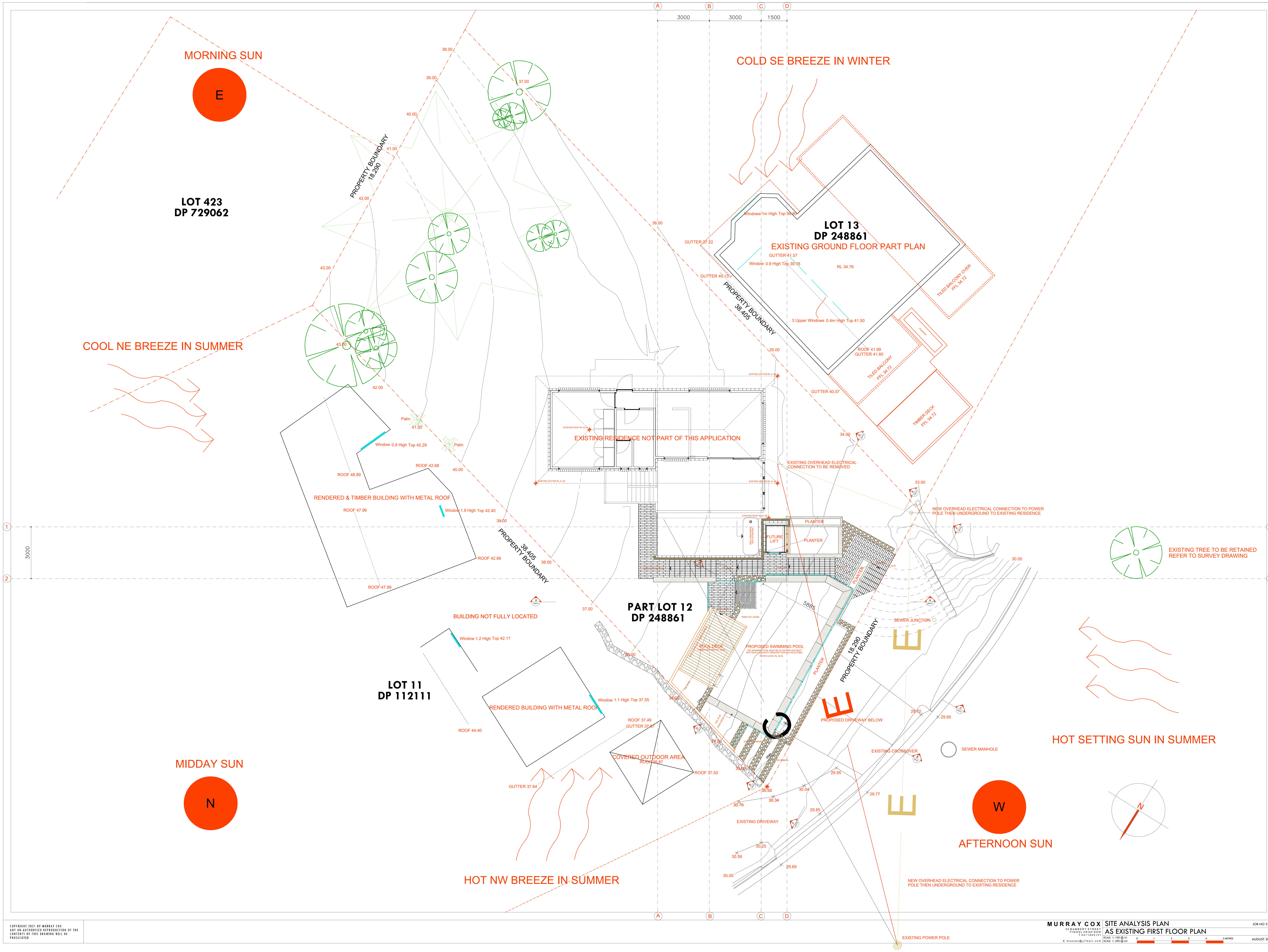


ISSUE	
31/03/2021	DEVELOPMENT APPLICATION ISSUE
05/08/2021	SECTION 34 ISSUE
25/08/2021	SECTION 34 MEDIATION ISSUE

NOTES

B	25/08/2021 S34 MEDIATION AMENDMENTS
A	05/08/2021 AMENDMENTS TO ADDRESS COUNCIL RFI's

REVISIONS

MURRAY COX
30 BAMBERY STREET
FINGAL HEAD NSW
T 0411640101
E muzzac@y7mail.com

SITE ANALYSIS PLAN
AS EXISTING FIRST FLOOR PLAN

JOB NO 2101

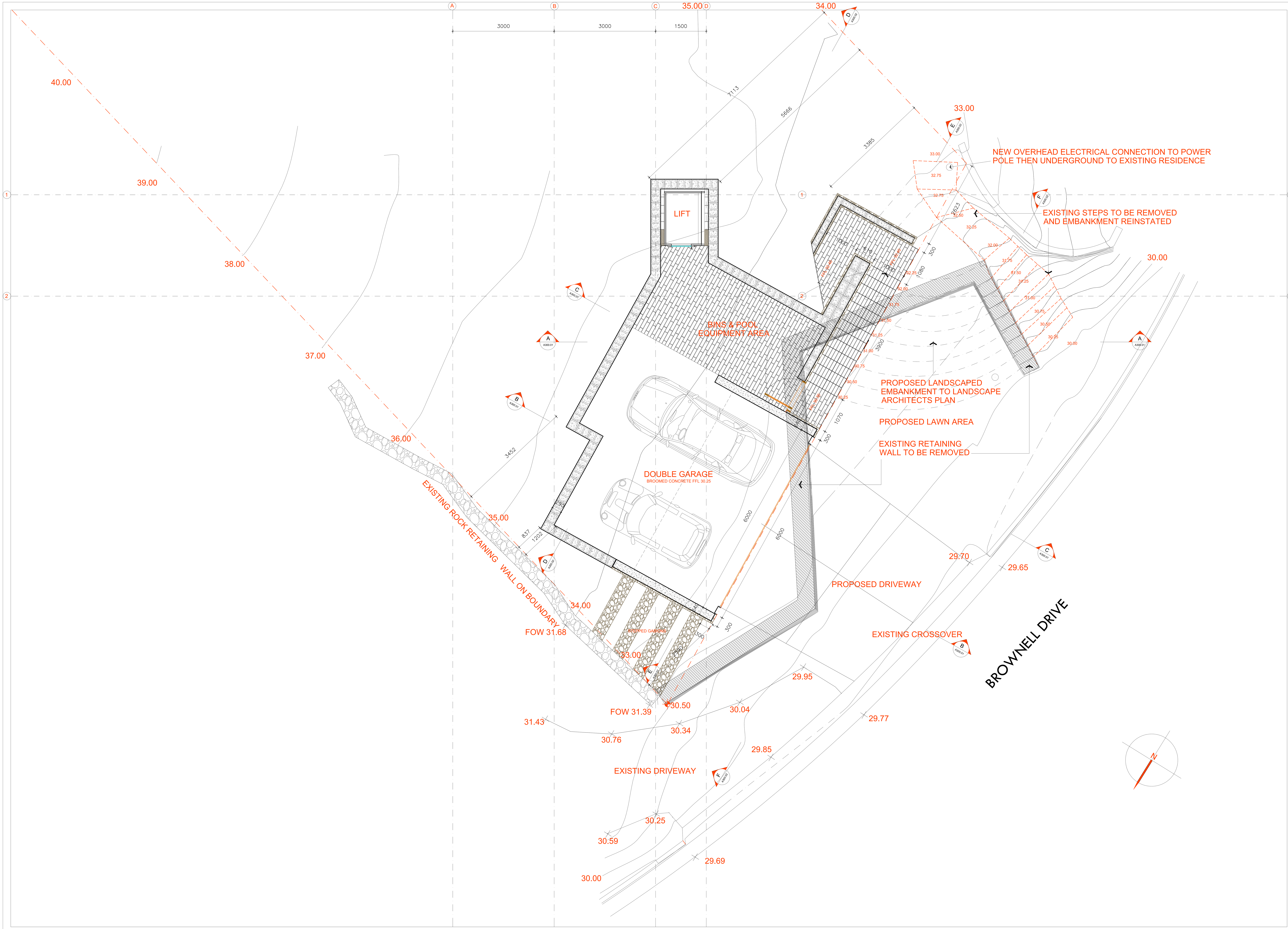
SCALE 1: 100 @ A1
SCALE 1: 200 @ A3
0 1 2 3 4 5 METRES

AUGUST 2021

A000.01

REV B

PROPOSED RESIDENCE: PART LOT 12 DP 248861 # 51 BROWNELL DRIVE WATEGOS NSW



ISSUE	
31/03/2021	DEVELOPMENT APPLICATION ISSUE
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REVISIONS

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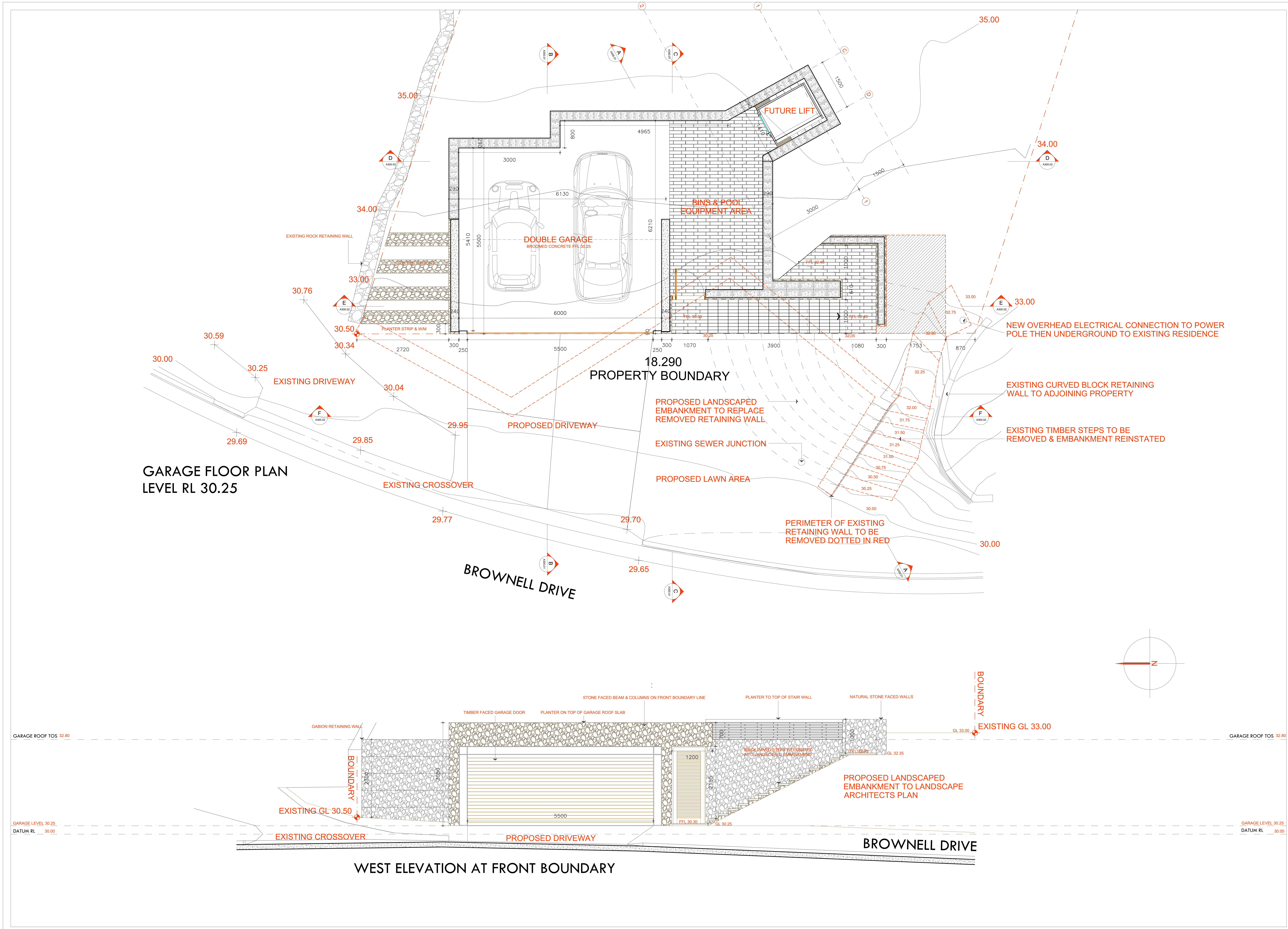
PROPOSED GARAGE & BIN AREA PLAN
STAIR ACCESS TO EXISTING RESIDENCE

SCALE 1:50
@ A1 SHEET
0.0 0.5 1.0 1.5 2.0 2.5 3.0

JOB NO 2101
AUGUST 2021

A100.01
REV
B

PROPOSED RESIDENCE: PART LOT 12 DP 248861 #51 BROWNELL DRIVE WATEGOS NSW



ISSUE	
31/03/2021	DEVELOPMENT APPLICATION ISSUE
05/08/2021	SECTION 34 ISSUE
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REVISIONS

MURRAY COX
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GARAGE PLAN & WEST ELEVATION
AT FRONT BOUNDARY

JOB NO 2101

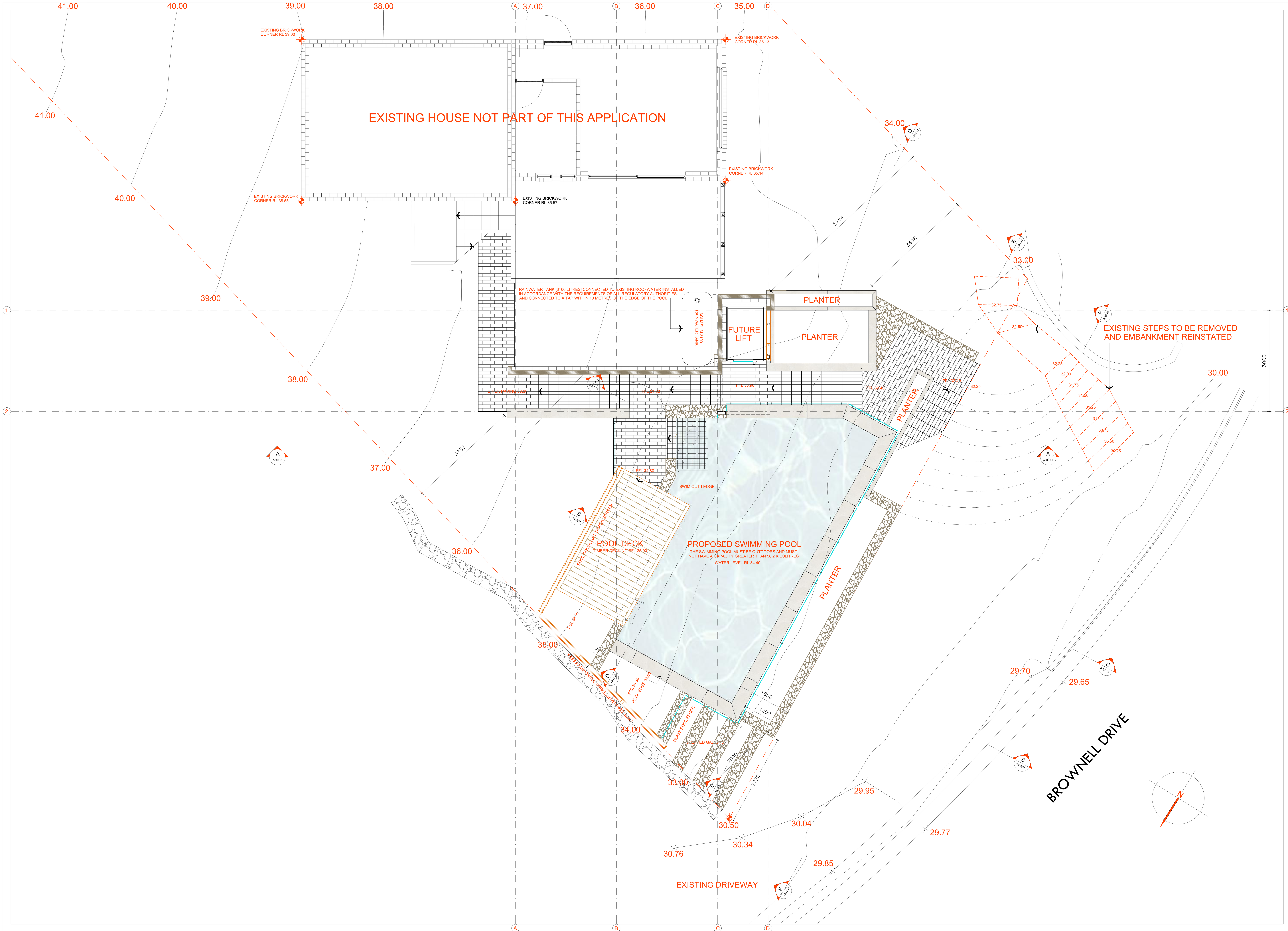
SCALE 1:50 @ A1 SHEET

AUGUST 2021

A100.01a

REV B

PROPOSED RESIDENCE: PART LOT 12 DP 248861 # 51 BROWNELL DRIVE WATEGOS NSW



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05/08/2021	SECTION 34 ISSUE
25/08/2021	SECTION 34 MEDIATION ISSUE

N O T E S

B	25/08/2021 S34 MEDIATION AMENDMENTS
A	05/08/2021 AMENDMENTS TO ADDRESS COUNCIL RFI's

R E V I S I O N S

MURRAY COX
30 BAMBERY STREET
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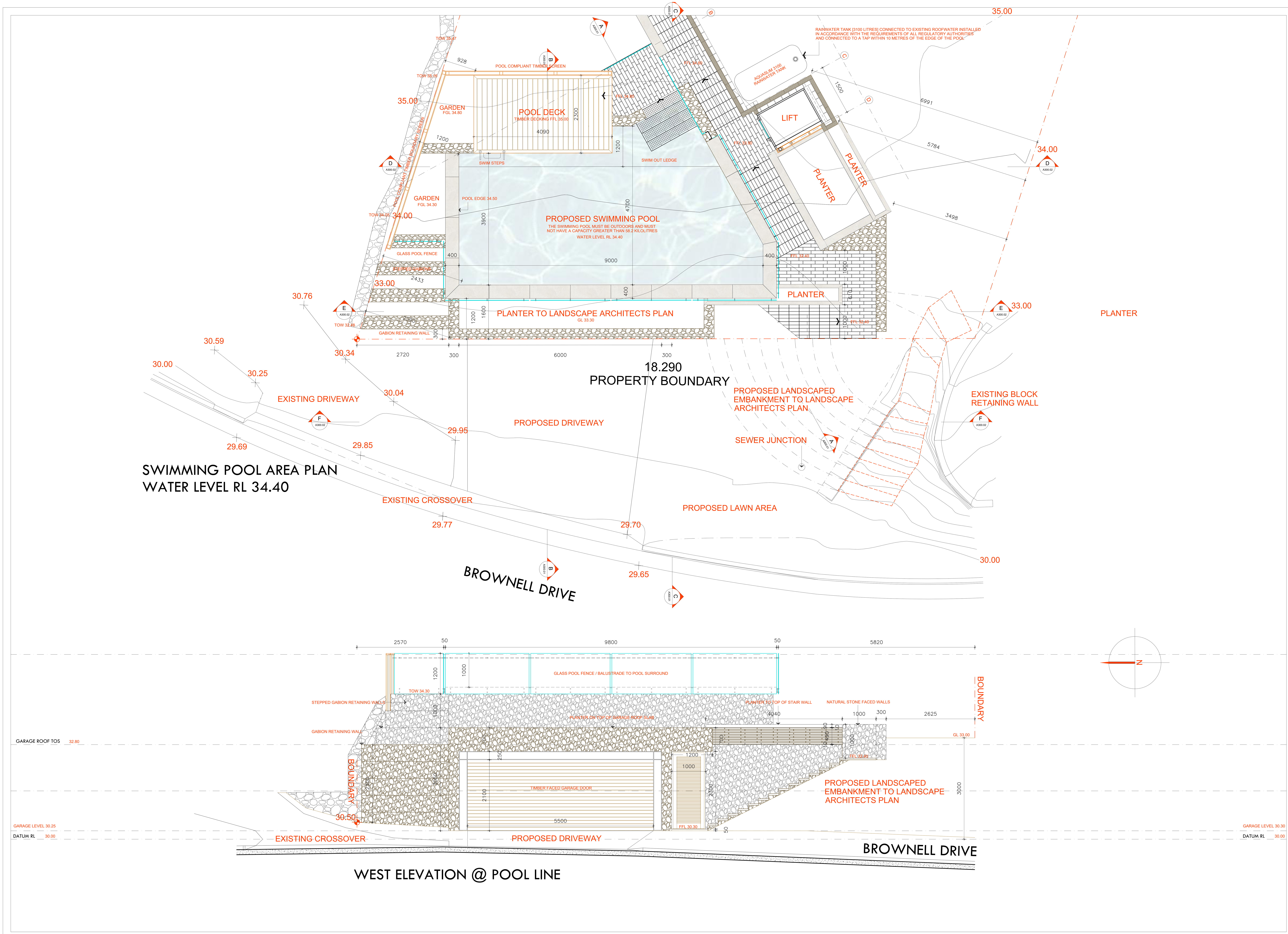
E muzzac@y7mail.com

PROPOSED LIFT ACCESS & SWIMMING POOL
JOB NO 2101
AS EXISTING GROUND FLOOR PLAN
SCALE 1:50 @ A1 SHEET
0.0 0.5 1.0 1.5 2.0 2.5 3.0
AUGUST 2021

A100.02

REV B

PROPOSED RESIDENCE: PART LOT 12 DP 248861 # 51 BROWNELL DRIVE WATEGOS NSW



ISSUE	
31/03/2021	DEVELOPMENT APPLICATION ISSUE
05/08/2021	SECTION 34 ISSUE
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REVISIONS

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SWIMMING POOL & LIFT PLAN
& WEST ELEVATION @ POOL LINE

JOB NO 2101

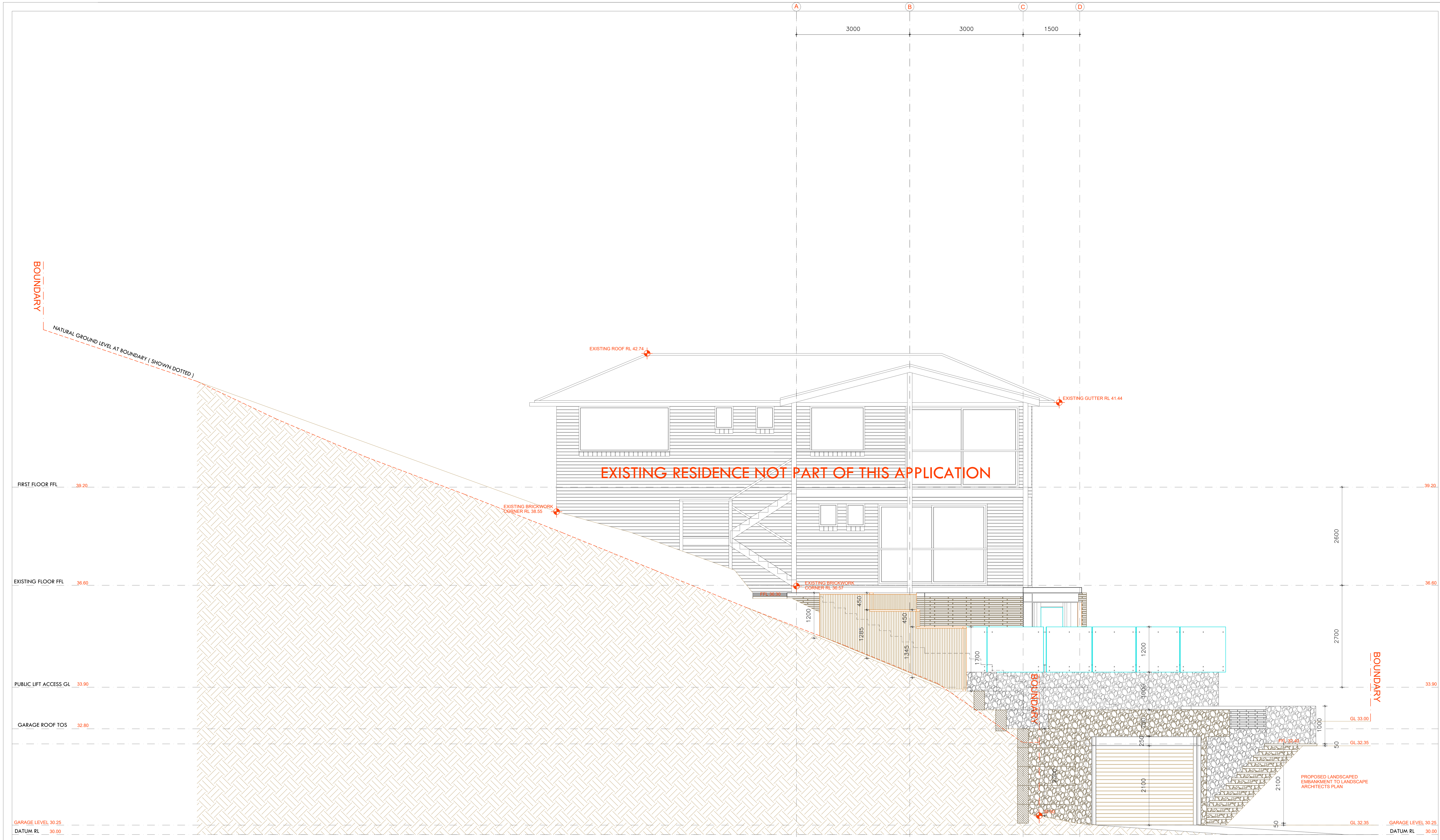
SCALE 1:50 @ A1 SHEET

AUGUST 2021

A100.02a

REV B

PROPOSED RESIDENCE: PART LOT 12 DP 248861 # 51 BROWNELL DRIVE WATEGOS NSW



GARAGE POOL & EXISTING RESIDENCE NORTH WEST ELEVATION

ISSUE	
31/03/2021	DEVELOPMENT APPLICATION ISSUE
05/08/2021	SECTION 34 ISSUE
25/08/2021	SECTION 34 MEDIATION ISSUE

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REVISIONS

MURRAY COX
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FINGAL HEAD NSW
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E muzzac@y7mail.com

GARAGE & POOL NORTH WEST ELEVATION
AS EXISTING RESIDENCE NORTH WEST ELEVATION

JOB NO 2101

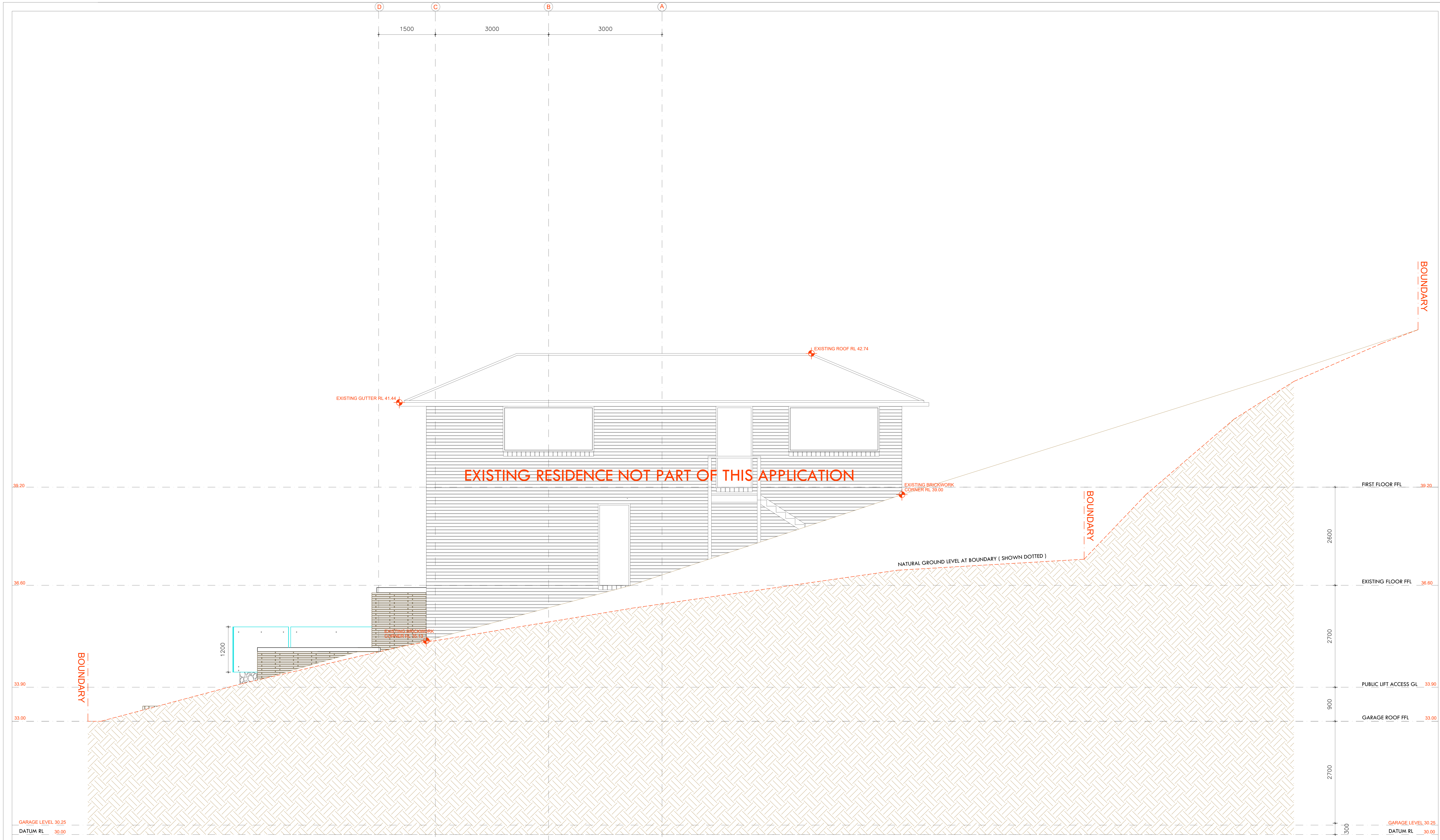
SCALE 1:50 @ A1 SHEET — 0.0 0.5 1.0 1.5 2.0 2.5 3.0 METRES

AUGUST 2021

A200.01

REV B

PROPOSED RESIDENCE: PART LOT 12 DP 248861 # 51 BROWNELL DRIVE WATEGOS NSW



GARAGE POOL & EXISTING RESIDENCE SOUTH EAST ELEVATION

ISSUE	
31/03/2021	DEVELOPMENT APPLICATION ISSUE
05/08/2021	SECTION 34 ISSUE
25/08/2021	SECTION 34 MEDIATION ISSUE

NOTES

B	25/08/2021 S34 MEDIATION AMENDMENTS
A	05/08/2021 AMENDMENTS TO ADDRESS COUNCIL RFI's

REVISIONS

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FINGAL HEAD NSW
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E muzzac@y7mail.com

GARAGE & POOL SOUTH EAST ELEVATION
AS EXISTING RESIDENCE SOUTH EAST ELEVATION

JOB NO 2101

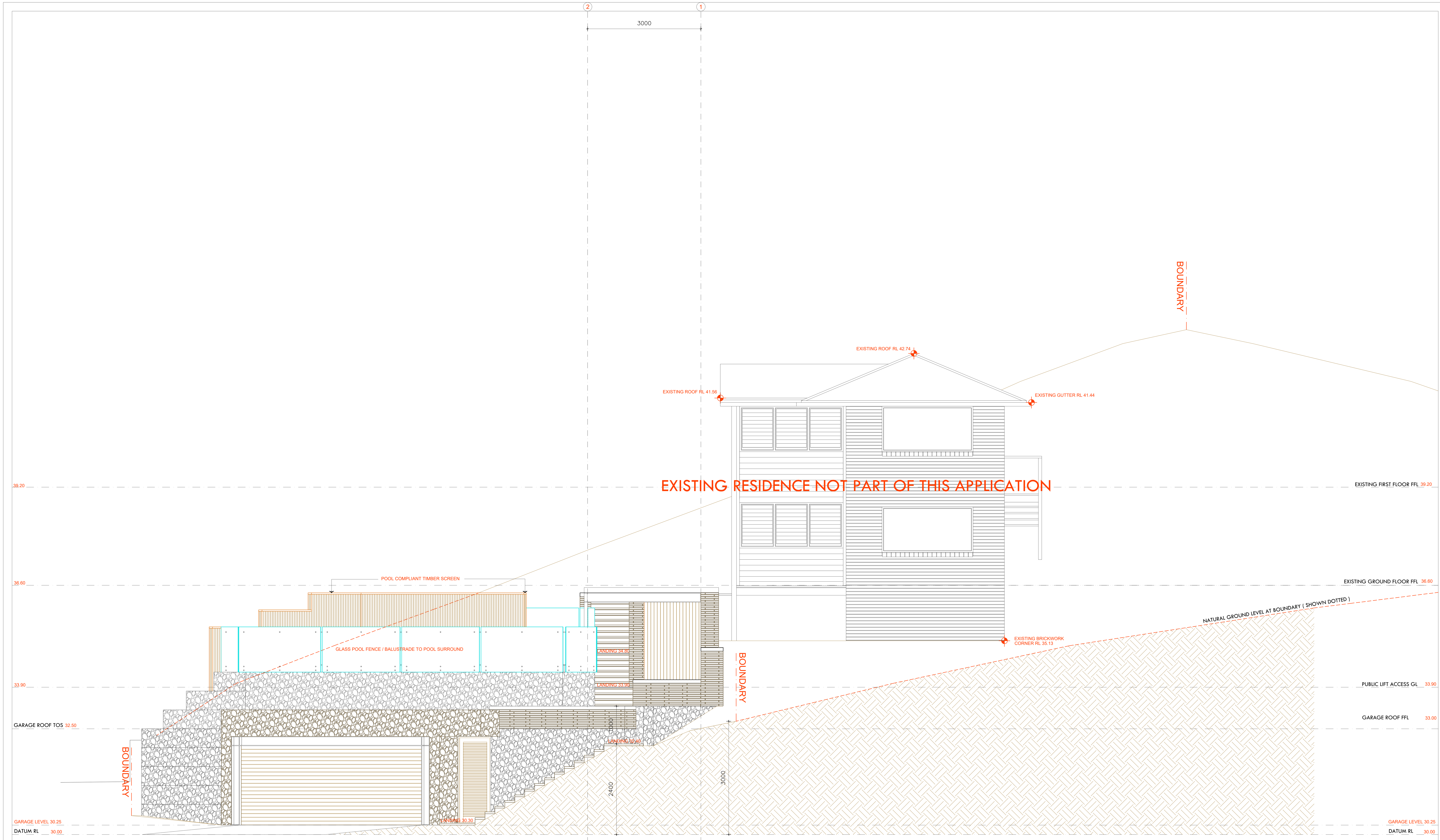
SCALE 1:50 @ A1 SHEET 0.0 0.5 1.0 1.5 2.0 2.5 3.0 METRES

AUGUST 2021

A200.02

REV B

PROPOSED RESIDENCE: PART LOT 12 DP 248861 # 51 BROWNELL DRIVE WATEGOS NSW



GARAGE POOL & EXISTING RESIDENCE SOUTH WEST ELEVATION

I S S U E

31/03/2021	DEVELOPMENT APPLICATION ISSUE
05/08/2021	SECTION 34 ISSUE
25/08/2021	SECTION 34 MEDIATION ISSUE

N O T E S

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R E V I S I O N S

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30 BAMBERY STREET
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E muzzac@y7mail.com

GARAGE & POOL SOUTH WEST ELEVATION
AS EXISTING RESIDENCE SOUTH WEST ELEVATION

JOB NO 2101

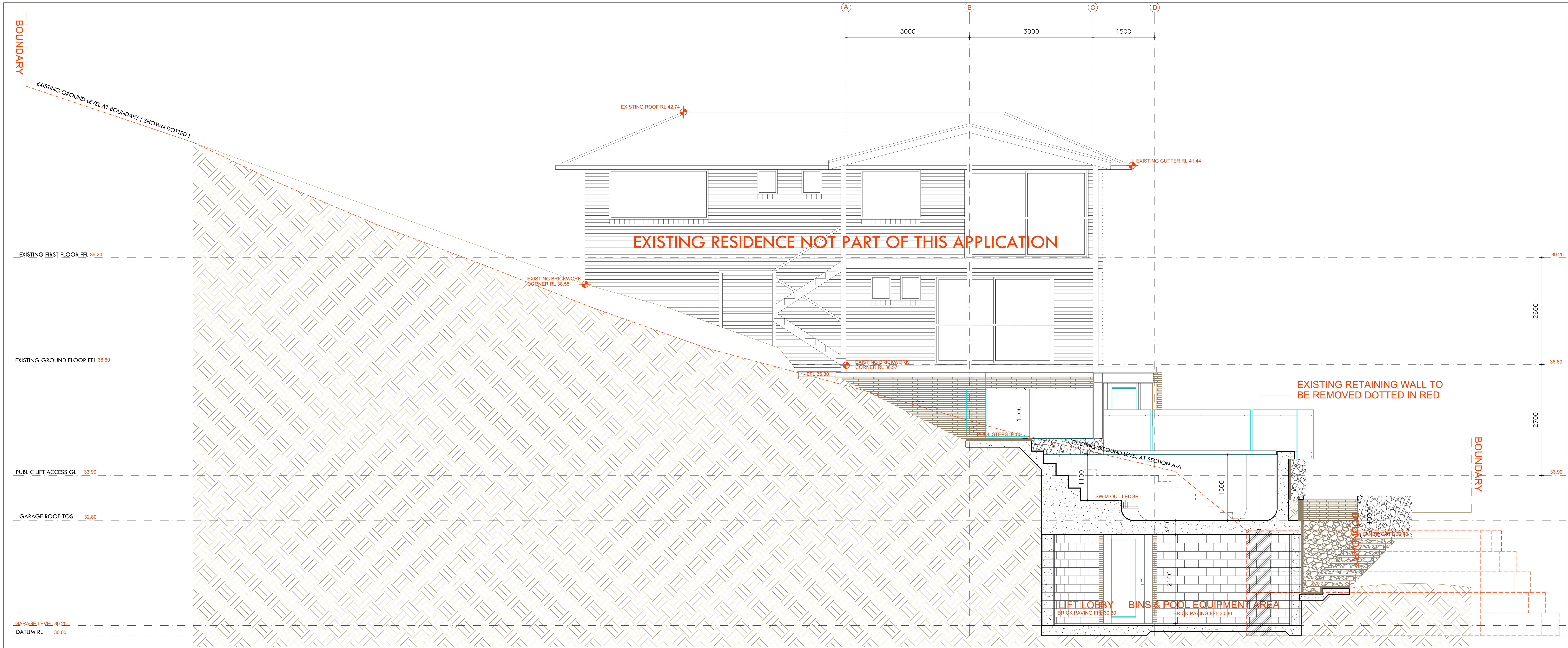
SCALE 1:50 @ A1 SHEET 0.0 0.5 1.0 1.5 2.0 2.5 3.0 METRES

AUGUST 2021

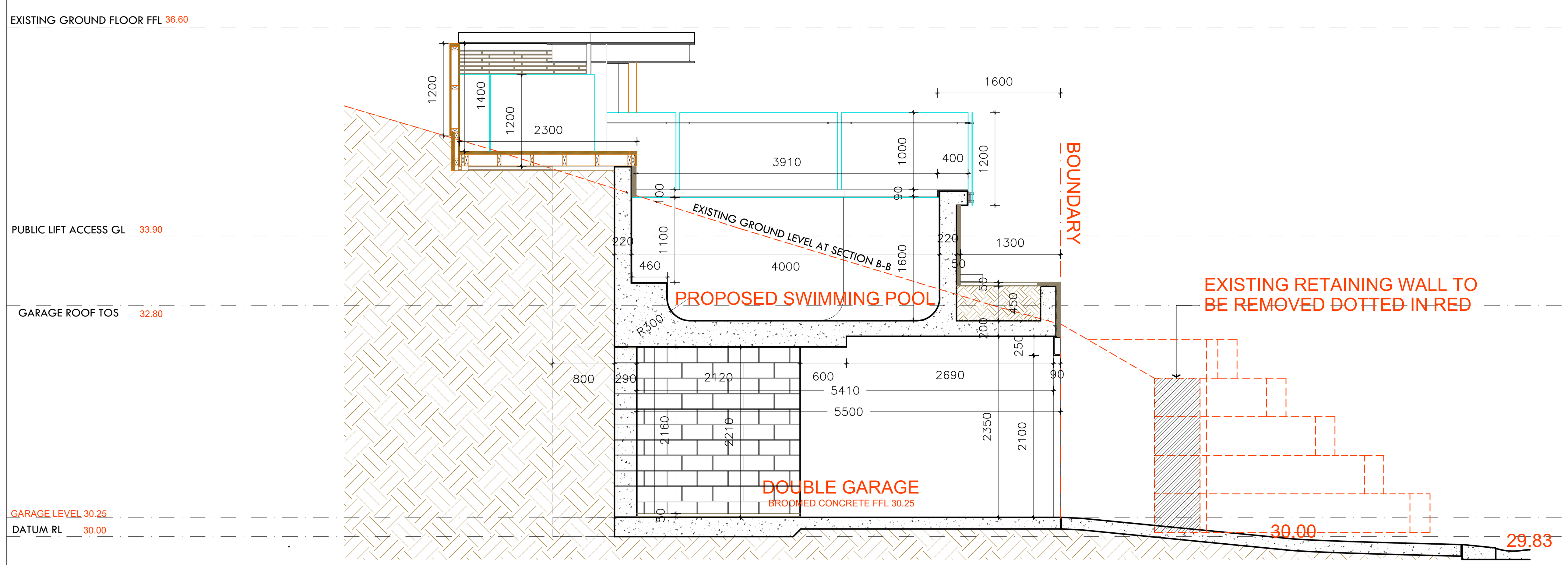
A200.03

REV B

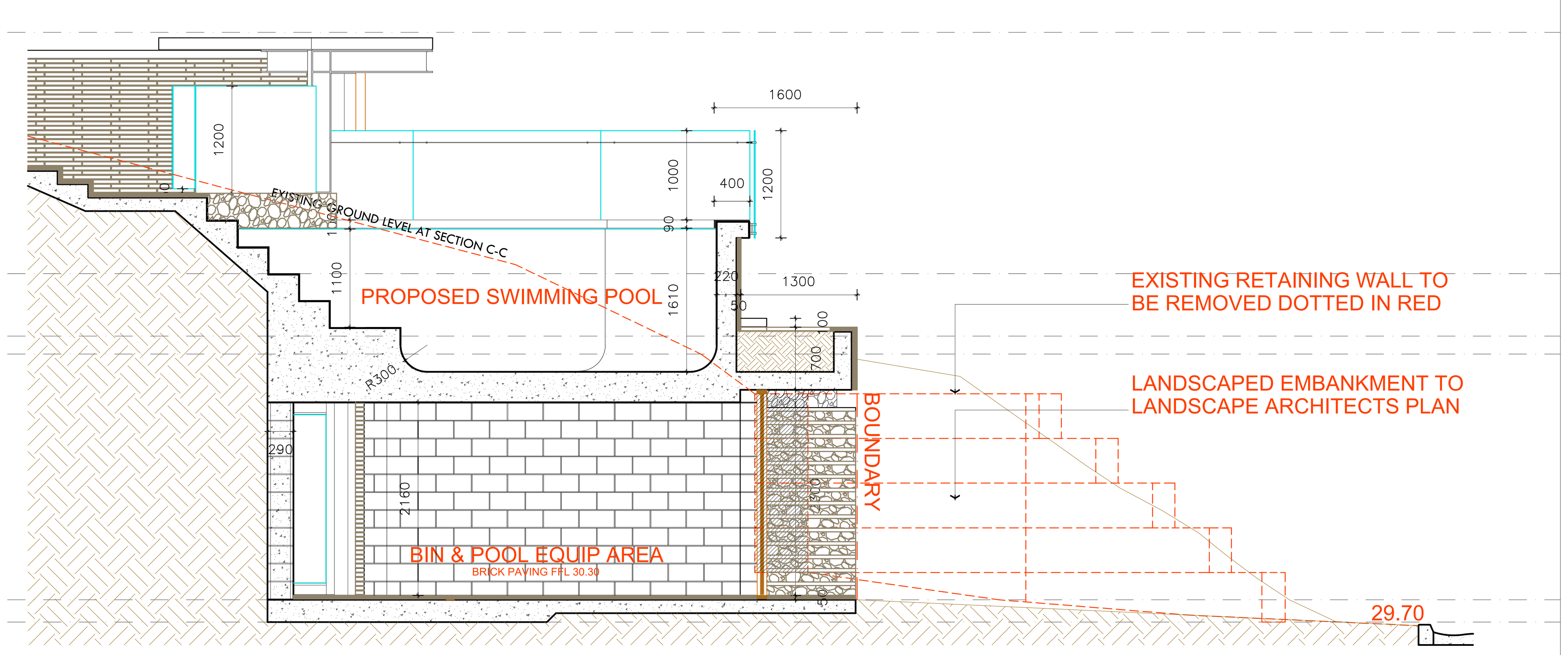
PROPOSED RESIDENCE: PART LOT 12 DP 248861 # 51 BROWNELL DRIVE WATEGOS NSW



SECTIONAL ELEVATION A-A (THROUGH BIN ROOM LIFT LOBBY & SWIMMING POOL)



SECTION B-B (THROUGH GARAGE & SWIMMING POOL)



SECTION C-C (THROUGH BIN AREA & SWIMMING POOL)

I S S U E	
31/03/2021	DEVELOPMENT APPLICATION ISSUE
05/08/2021	SECTION 34 ISSUE
25/08/2021	SECTION 34 MEDIATION ISSUE

N O T E S

B	25/08/2021 S34 MEDIATION AMENDMENTS
A	05/08/2021 AMENDMENTS TO ADDRESS COUNCIL RFI's

R E V I S I O N S

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FINGAL HEAD NSW
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E muzzac@y7mail.com

SECTIONAL ELEVATION A-A
SECTION B-B & C-C

JOB NO 2101

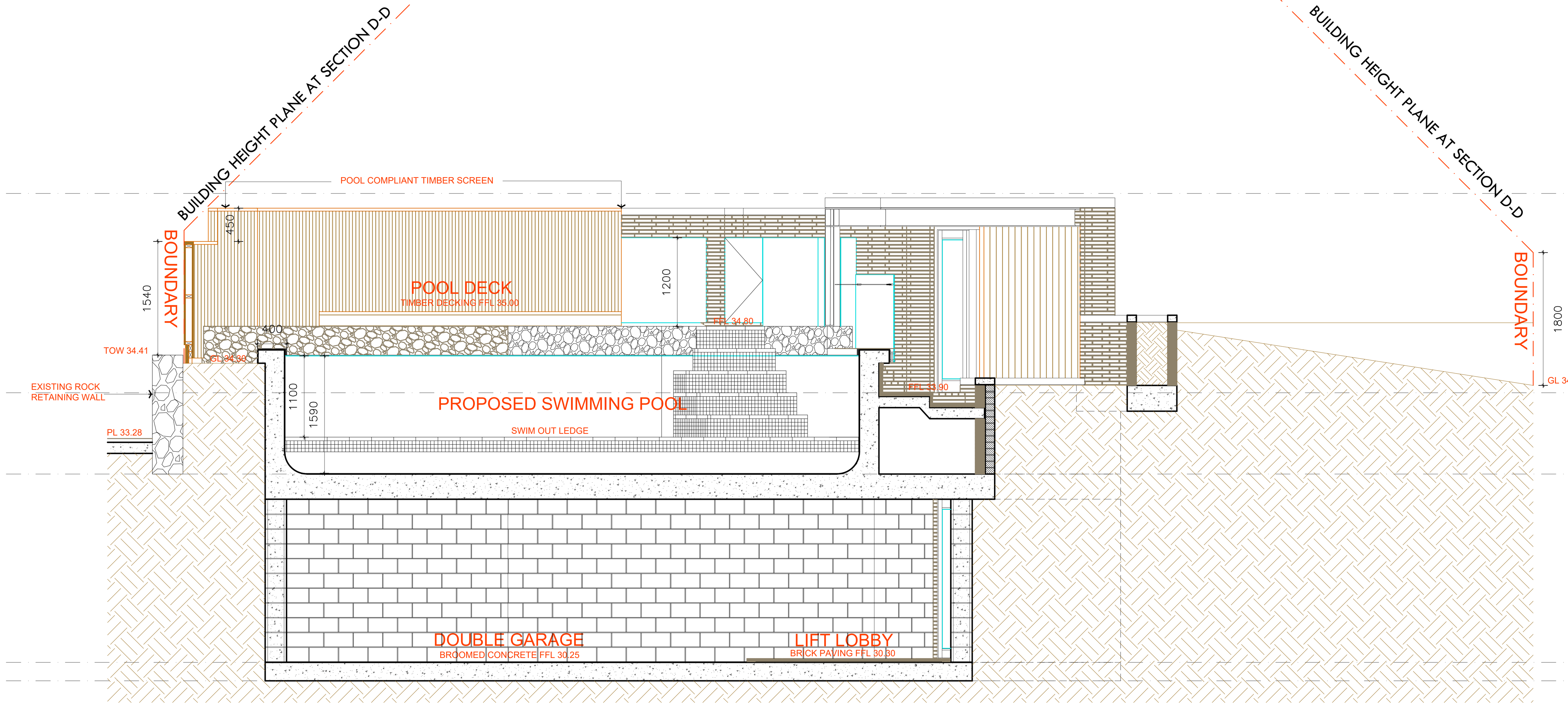
SCALE 1:50 @ A1 SHEET — 0.0 0.5 1.0 1.5 2.0 2.5 3.0 METRES

AUGUST 2021

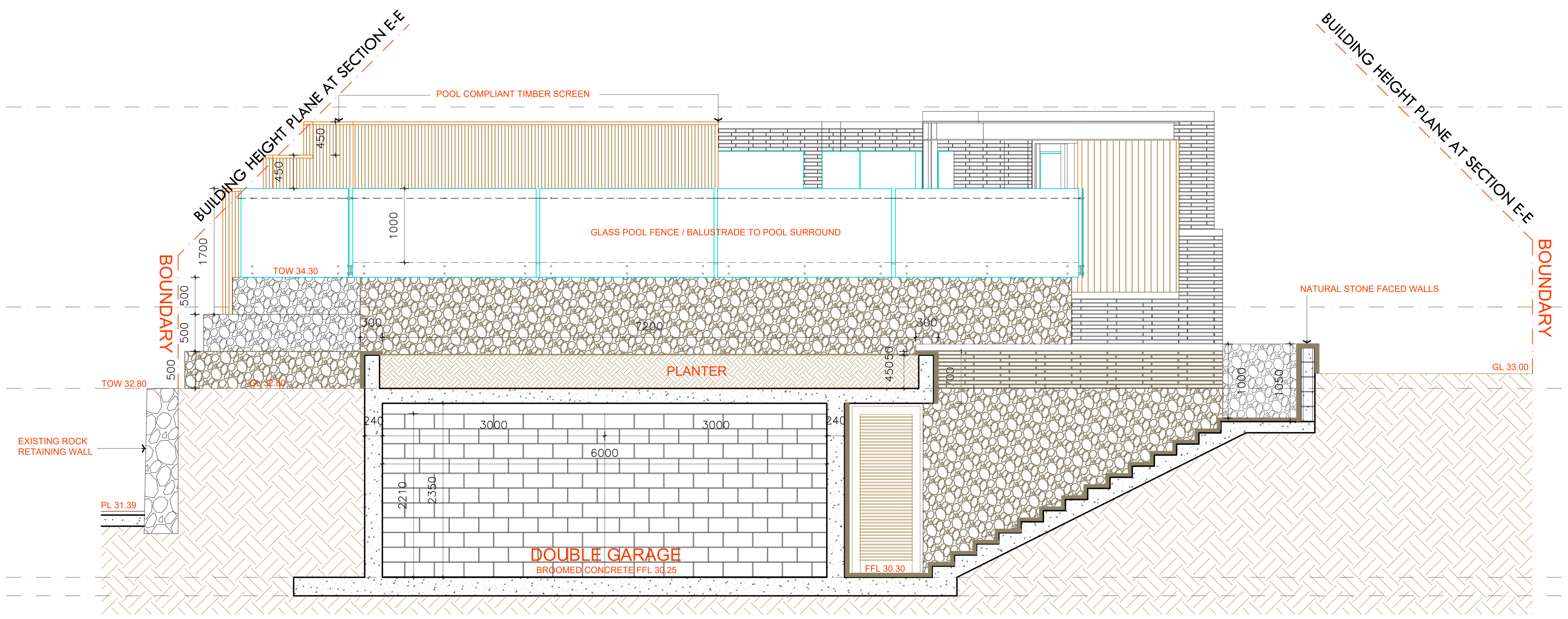
A300.01

REV B

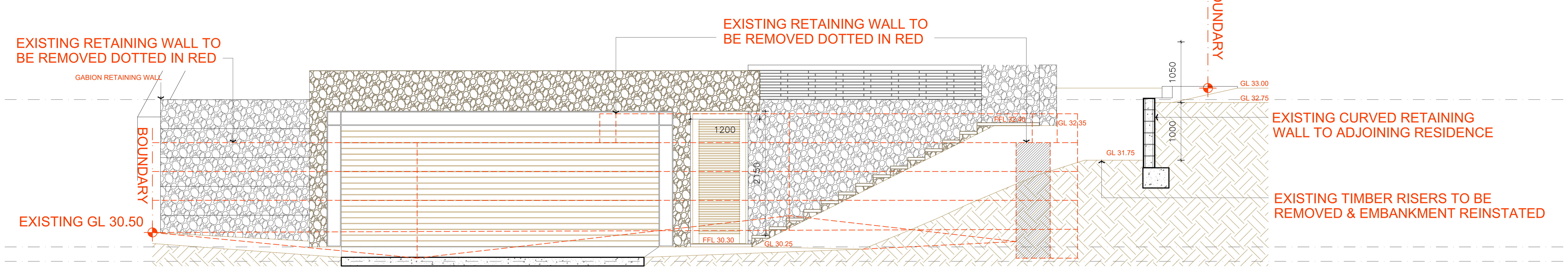
PROPOSED RESIDENCE: PART LOT 12 DP 248861 # 51 BROWNELL DRIVE WATEGOS NSW



LONG SECTION D-D (THROUGH GARAGE LIFT LOBBY & SWIMMING POOL)



LONG SECTION E-E (THROUGH GARAGE PLANTER & STAIRS)



SECTIONAL ELEVATION F-F (THROUGH LANDSCAPED EMBANKMENT)

ISSUE

NOTES

REVISIONS

MURRAY COX

SECTION D-D E-E & F-F
THROUGH GARAGE POOL & EMBANKMENT

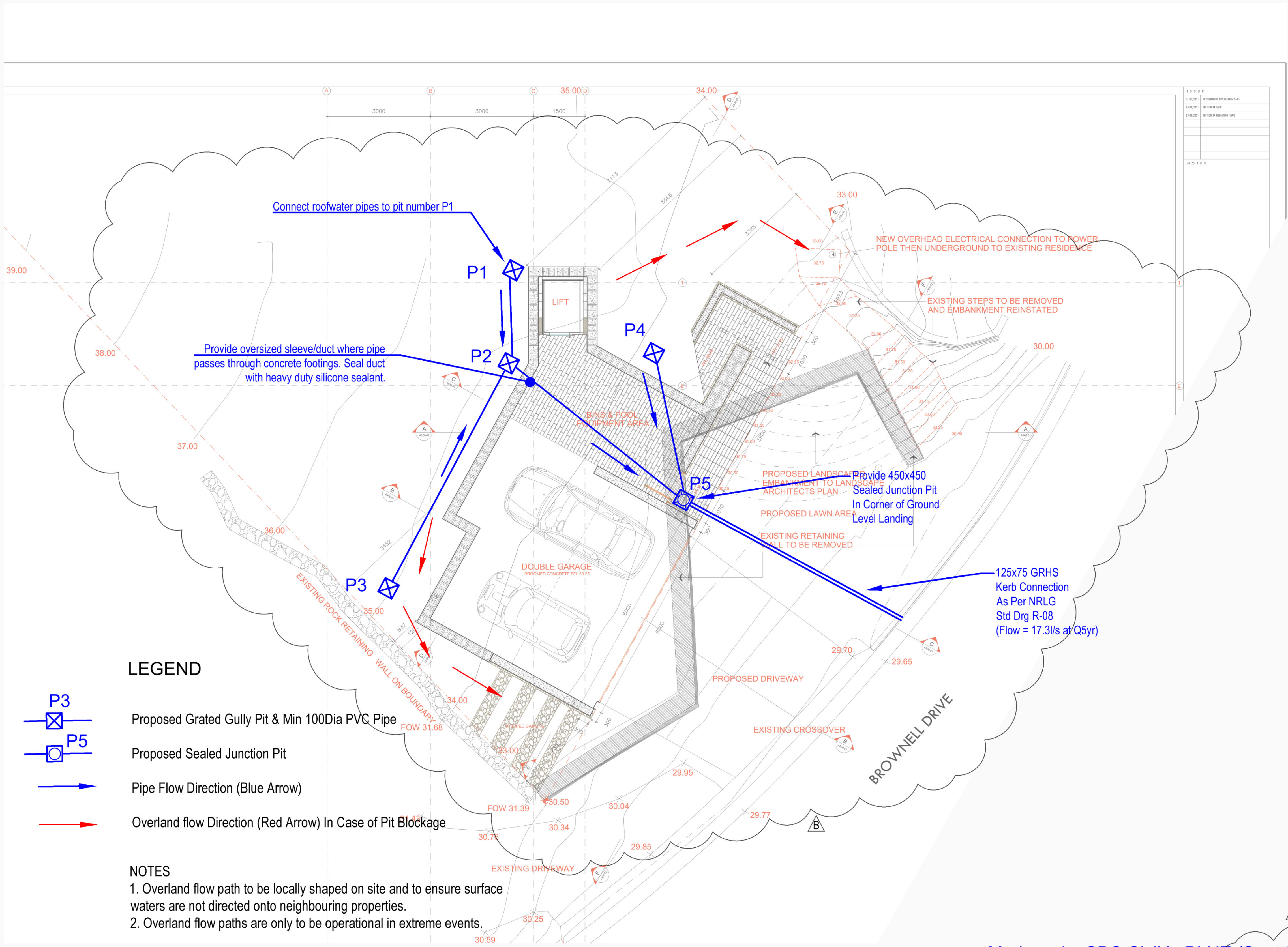
JOB NO 2101

AUGUST 2021

A300.02

REV B

PROPOSED RESIDENCE: PART LOT 12 DP 248861 # 51 BROWNELL DRIVE WATEGOS NSW



LEGEND

P3	Proposed Grated Gully Pit & Min 100Dia PVC Pipe
P5	Proposed Sealed Junction Pit
	Pipe Flow Direction (Blue Arrow)
	Overland flow Direction (Red Arrow) In Case of Pit Blockage

NOTES
1. Overland flow path to be locally shaped on site and to ensure surface waters are not directed onto neighbouring properties.
2. Overland flow paths are only to be operational in extreme events.

Markups by SDS Civil in BLUE (Sept 2021)
(Architectural Drawing by Murray Cox - Drg No A100.01B)

SDS Civil Ref: JN2074 Survey Datum: AHD / MGA Survey Source: Heath McPhail Surveying

SDS Civil Enterprises
A.B.N. 56 656 467 255
461 Hinterland Way, Knockrow NSW
m 0438 725 414 e peterw@sdscivil.com.au

IMPORTANT NOTES
1. Verify and locate all dimensions and levels PRIOR to performing any works.
2. Ensure DBYD enquiries are made to locate current service information.
3. Pothole or service locator of any underground services before performing works.
4. Drawing may not be modified or used by others without approval of SDS Civil Enterprises.

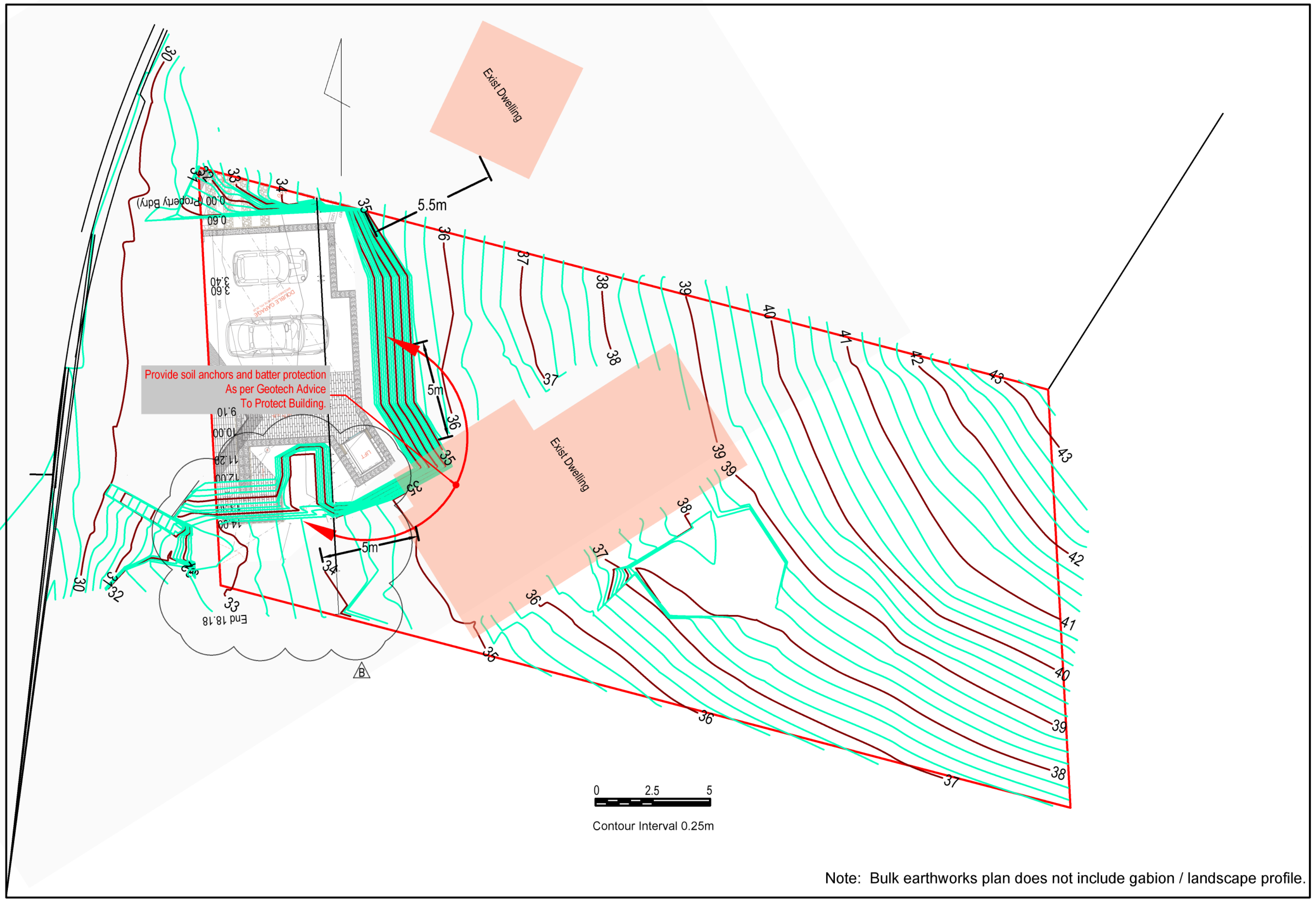
Rev	Date	Amendment
A	20/8/2021	Pit P5 located to stair landing, Underlay Plan Updated
B	3/9/2021	Underlay Plan Updated to A100.01 Rev B
C		
D		

SCALE 0 1.25 2.5

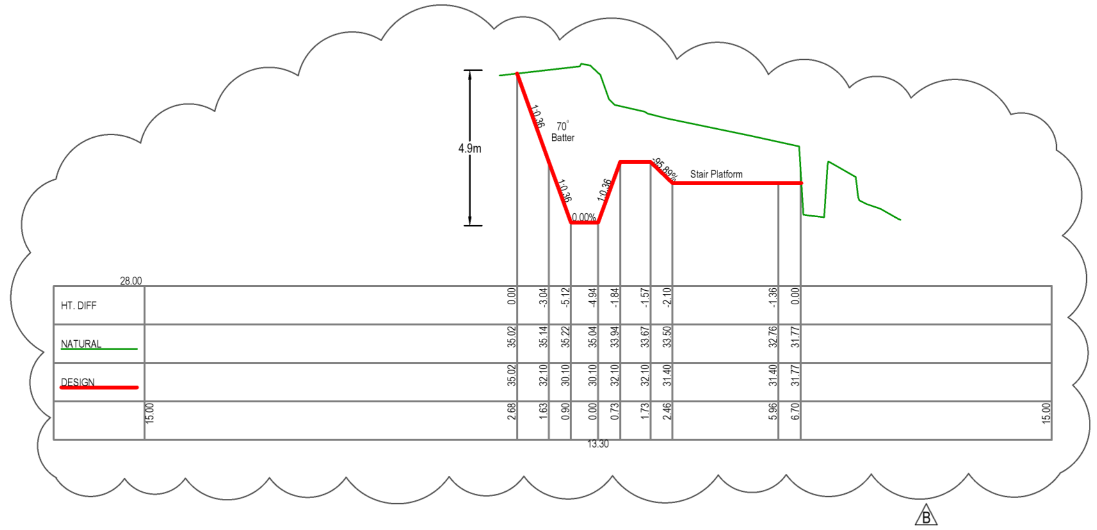
Mr P Williams B.Eng (Civil)

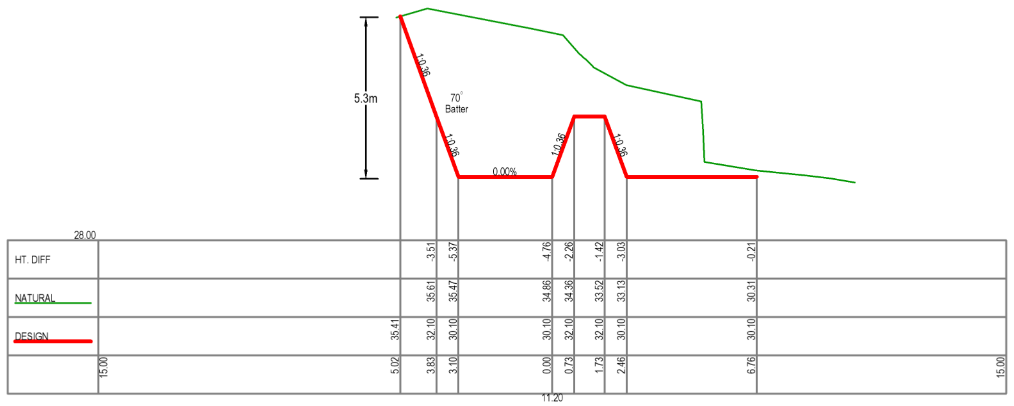
PROJECT	Garage and Retaining Wall	ADDRESS	51 Brownell Drive, Byron Bay	DATE	August 2021
CLIENT	Mr R Mateer	LAND	Lot 12 DP 248861	DRAWING PURPOSE	Development Application
DRAWING DETAILS	SWMP - Proposed Drainage Plan			DRAWING NUMBER	SDS C2

REV B

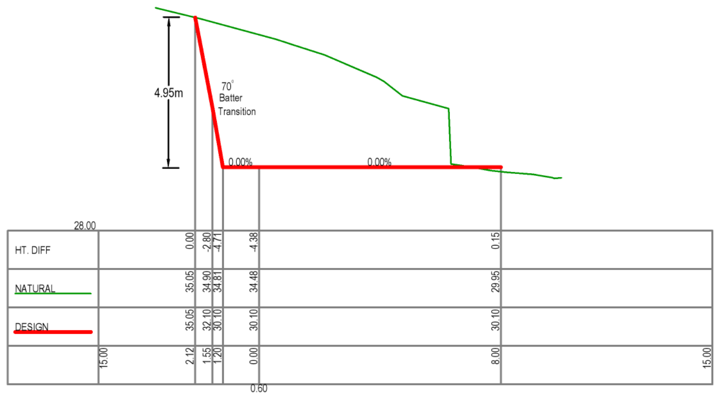


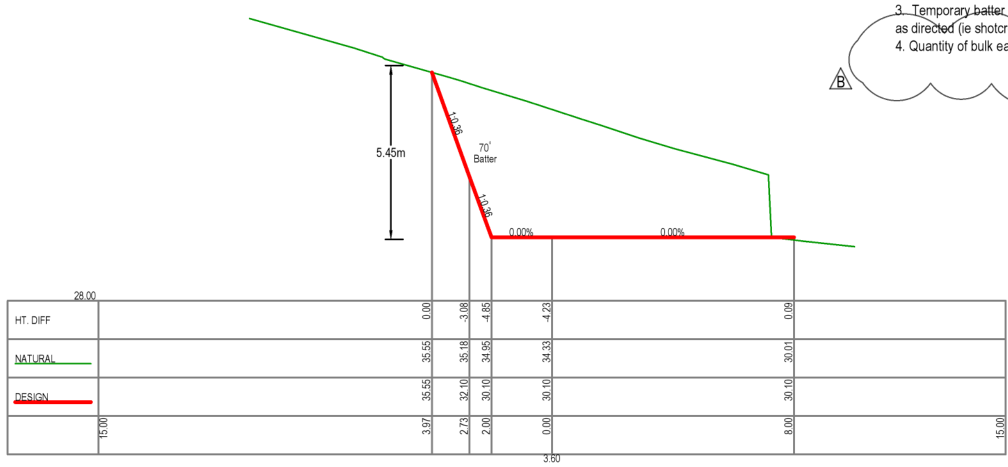
Construction Bulk Earthworks Plan

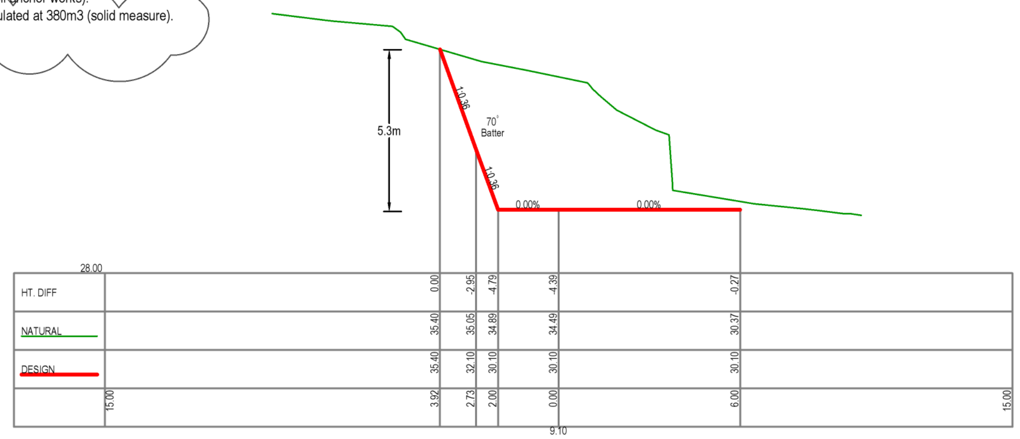




General Notes.
1. Earthworks excavation to be in accordance with geotechnical supervision.
2. Stabilisation of existing dwelling footings within 5m of excavation to be achieved via either underpinning footings OR retaining exposed batters with soil anchors or similar. Final method to be determined prior to receipt of construction certificate.
3. Temporary batter to be inspected by geotechnical engineer and any localised stabilisation works undertaken as directed (ie shotcrete and / or soil anchor works).
4. Quantity of bulk earthworks calculated at 380m3 (solid measure).







SDS Civil Ref: JN2074 Survey Datum: AHD / MGA Survey Source: Heath McPhail Surveying

SDS Civil Enterprises
A.B.N. 56 656 467 255
461 Hinterland Way, Knockrow NSW
m 0438 725 414 e peterw@sdscivil.com.au

IMPORTANT NOTES
1. Verify and locate all dimensions and levels PRIOR to performing any works.
2. Ensure DBYD enquiries are made to locate current service information.
3. Pothole or service locator of any underground services before performing works.
4. Drawing may not be modified or used by others without approval of SDS Civil Enterprises.

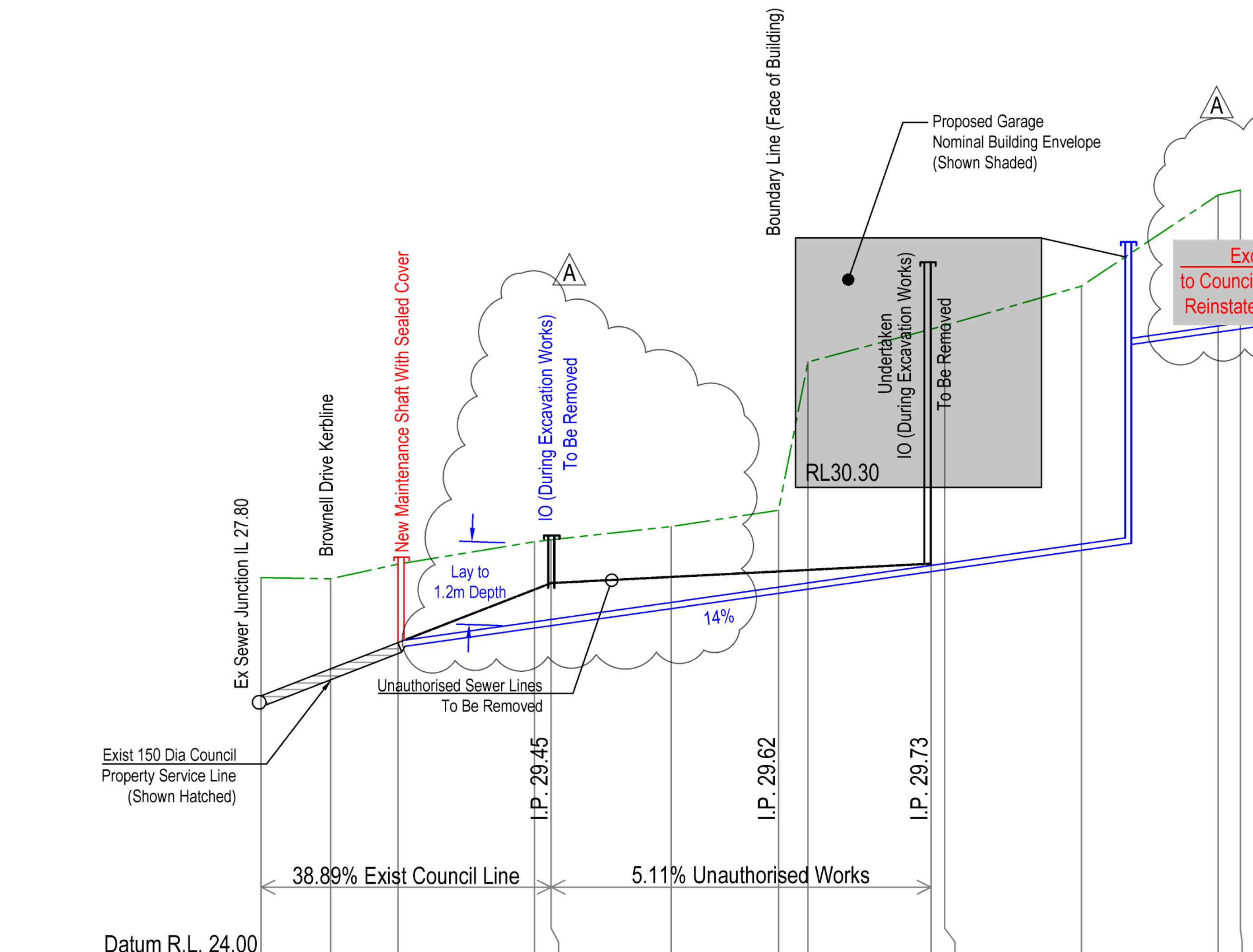
Rev	Date	Amendment
A	Aug 2021	Temporary batter flattened from 80 to 70 degrees
B	Sept 2021	Southern Earthworks Reduced
C		
D		

SCALE
Refer Dimensions

Mr P Williams B.Eng (Civil)

PROJECT	Garage and Retaining Wall	ADDRESS	51 Brownell Drive, Byron Bay	DATE	Sept 2021
CLIENT	Mr R Mateer	LAND	Lot 12 DP 248861	DRAWING PURPOSE	Development Application
DRAWING DETAILS	Bulk Earthworks Construction Batters & Sections			DRAWING NUMBER	SDS C3

REV B



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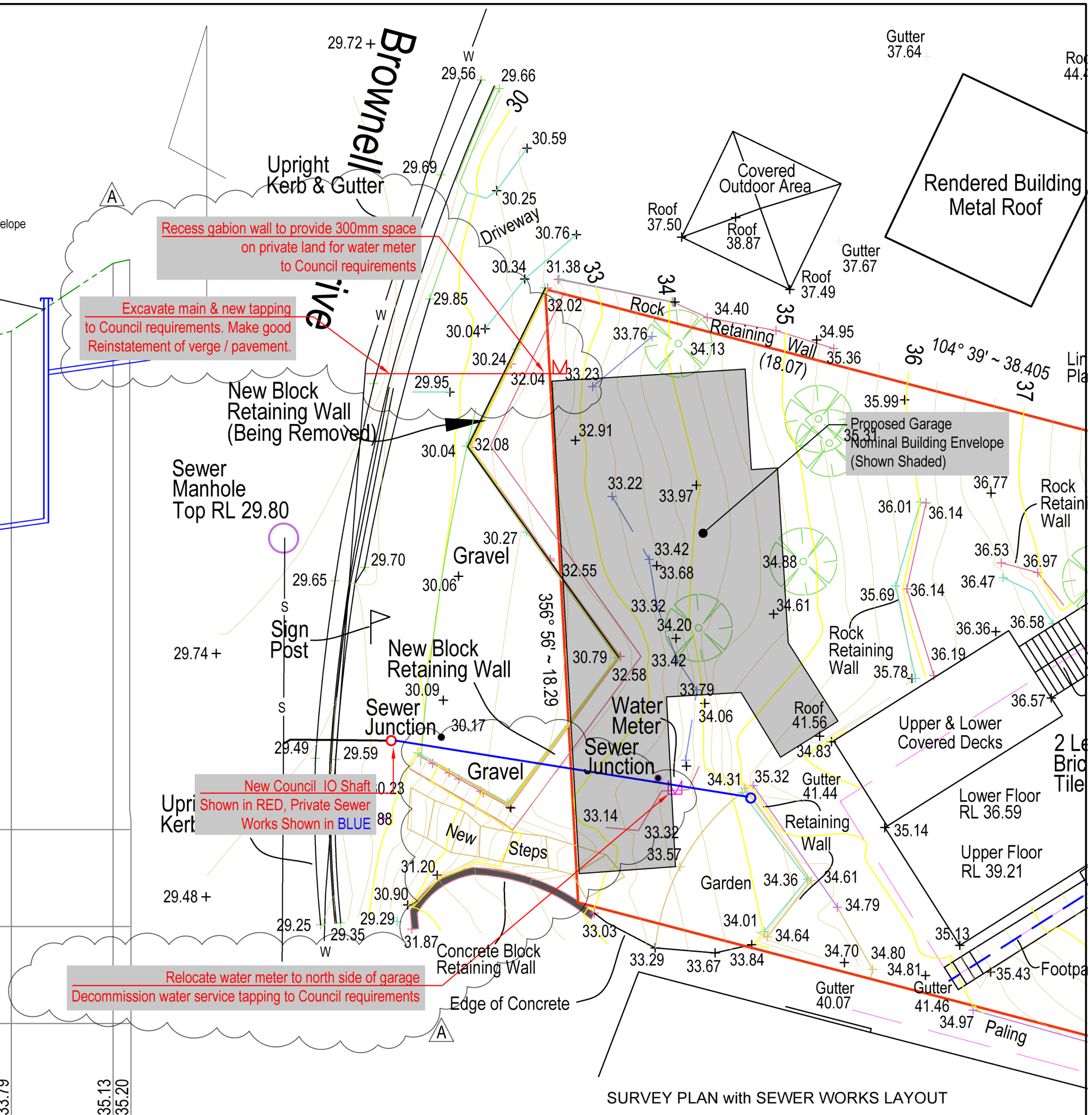
Depth	-1.73	-1.32	-1.25	-0.70	-0.63	-0.74	-0.90	-3.04					
Exist Invert Level	27.80	28.19	28.58	29.36	29.45	29.54	29.62	29.64	29.73				
NATURAL	29.53	29.51	29.73	30.05	30.08	30.28	30.52	32.68		33.22	33.79	35.13	35.20

Scale Horizontal 1:100 Vertical 1:100



SURVEY PLAN with SEWER WORKS LAYOUT

NOTES
1. All new works to accord with the requirements of Byron shire Council and WSA-Sewerage Code of Australia specifications.
2. Inspections required of all Council works.
3. Council proposed asset works shown in RED and private works shown in BLUE.
4. All Council sewer assets to be minimum 150mm dia.
5. Where private sewer line passes under retaining walls, bridging protection works to be insatlled in accordance with Std Drg 281.

SDS Civil Ref: JN2074 Survey Datum: AHD / MGA Survey Source: Heath McPhail Surveying

SDS Civil Enterprises
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461 Hinterland Way, Knockrow NSW
m 0438 725 414 e peterw@sdscivil.com.au

IMPORTANT NOTES
1. Verify and locate all dimensions and levels PRIOR to perfoming any works.
2. Ensure DBYD enquiries are made to locate current service information.
3. Protection or service locator of any underground services before performing works.
4. Drawing may not be modified or used by others without approval of SDS Civil Enterprises.

Rev	Date	Amendment
A	18/8/21	Water meter to north, single Council IO sewer shown
B		
C		
D		

SCALE 1:100 at A3
Mr P Williams B.Eng (Civil)

PROJECT	Garage and Retaining Wall	ADDRESS	51 Brownell Drive, Byron Bay	DATE	August 2021
CLIENT	Mr R Mateer	LAND	Lot 12 DP 248861	DRAWING PURPOSE	Development Application
DRAWING DETAILS	Sewer Servicing Works			DRAWING NUMBER	SDS C5

REV A

Pacific Geotech
Consulting Geotechnical Engineers

GEOTECHNICAL REPORT: Geotechnical Investigation and Slope Stability Assessment for Proposed Alterations and Additions

51 Brownell Drive

Wategos

Rianon Mateer

July 2021

PG-5091

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E: info@pacgeo.com.au
A: 3 Jowett Street, Coomera QLD 4209
Postal: PO Box 499, Paradise Point QLD 4216

www.pacgeo.com.au ABN: 62 615 248 952

Ref: PG-5091, 2021-07-09, GR VER 1
Author: Leigh Bexley

9th July, 2021

Rianon Mateer
Email: rmateer@hotmail.com

Dear Sir,

GEOTECHNICAL INVESTIGATION AND SLOPE STABILITY ASSESSMENT FOR PROPOSED ALTERATIONS AND ADDITIONS
51 BROWNELL DRIVE, WATEGOS

Enclosed is a copy of our report for the above project dated July 2021. An electronic copy of the report has been issued.

Should you have any queries regarding this report, please do not hesitate to contact Leigh Bexley or Peter Elkington at this office.

Yours faithfully,

P. ELKINGTON (RPEQ 7226)

For and on behalf of
PACIFIC GEOTECH PTY LTD

P: (07) 5636 4680 F: (07) 5636 0286 E: info@pacgeo.com.au
3 Jowett Street, Coomera, Qld, 4209 | PO Box 499, Paradise Point, Qld, 4216
www.pacgeo.com.au
ABN: 62 615 248 952

TABLE OF CONTENTS

Appendices

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation and slope stability assessment for proposed alterations and additions to the existing residence at 51 Brownell Drive, Wategos.

From the information supplied by the Client, it is understood that the proposed development is to comprise the construction of a new garage and swimming pool at the above site. It is also proposed that extensions to the existing house including a new deck area will be proposed in the future. Cut up to 3m have previously been carried out adjacent to Brownell drive, however it is proposed that additional cuts up to approximately 3m to 4m will also be carried out with minor filling to create a level building platform.

Due to the presence of sloping terrain as well as the existing earthworks, a stability assessment of the development area is required.

The slope stability assessment was confined to an evaluation of the Lot with respect to the building envelope, identifying any major geotechnical constraints or issues which would impact on the proposed development. It identifies the constraints associated with the proposed development as well as providing recommendations to minimise the risk of future slope instability. A Landslide Risk Rating has also been assigned to the building envelope for the proposed development and recommendations to maintain or improve stability have been provided.

The slope stability assessment methodology has been carried out in accordance with Appendix C of Australian Geomechanics Society (AGS) "Practice Note Guidelines for Landslide Risk Management ", March, 2007. This approach for risk assessment is qualitative or semi-quantitative, suiting sites where historic instability data are not available and combines the likelihood of an instability event with the consequences to property to derive an assessment of risk. The process is inherently subjective.

A geotechnical investigation for the proposed alterations and additions including a site classification in accordance with AS.2870 "Residential Slabs and Footings" has also been provided.

This report contains the results of the Geotechnical Investigation and Slope Stability Assessment and provides advice and recommendations relating to the following:

- Subsurface conditions in accordance with AS 1726, including strength properties of encountered materials.
- Site classification in accordance with AS.2870, including predicted ground movement (y_s).
- Footing recommendations for the proposed development, including allowable bearing pressures for high level footings and ultimate bearing pressures for deep footings as well as shaft adhesion for piles.

- Retaining wall design parameters.
- Slope stability assessment which assesses the suitability of proposed alterations and additions for development. A Landslide Risk Rating has also been assigned to the building envelope for the proposed development. Recommendations have also been provided to maintain or improve stability.
- Geotechnical issues or constraints for development.
- Drainage recommendations.
- Earthworks considerations including stripping depths, site preparation, filling recommendations, suitability of excavated material for reuse as structural fill and suggested compaction standards for structural fill.
- Batter slope recommendations.
- Site trafficability of subsoil material.
- General recommendations for development at the site.
- The feasibility of the proposed development based on existing geotechnical conditions of the site.

Plans of the proposed development are shown below.

PROPOSED DEVELOPMENT

2.0 METHODOLOGY

A desk study of the Moreton 1:500,000 Geological Map as well as aerial photographs, contour plans and design drawings were initially carried out to identify the site geology, sloping terrain and areas of potential instability at the site.

Following the desk study, a walkover survey of the site was performed by a Principal Engineering Geologist from Pacific Geotech. This involved mapping and measuring features of significance to slope stability such as slope angles and direction, erosion features, surface and subsurface drainage, wet zones, vegetation density, cut and fill areas and the presence of any irregular surface features such as curved trees, slips, slumps, debris slides or any associated features.

To assess the subsurface conditions at the site, one (1) borehole (BH01) was drilled in the only accessible area at the site using a Compac 018 drilling rig fitted with 100mm solid flight augers and extended to a depth of 1.5m. Due to limited access for the drilling rig, Dynamic Cone Penetrometer (DCP) tests were carried out in areas where no access was available for the drilling rig to estimate depths to bedrock. DCP tests were carried out adjacent to borehole BH01 as well as at the additional locations (DCP02 to DCP04). The boreholes and DCP tests were used to assess the subsurface profiles and to assist with the slope stability assessment.

The soil classification descriptions and field tests were carried out in general accordance with Australian Standards.

AS 1726	Geotechnical Site Investigations
AS 1289	Methods of Testing Soils for Engineering Purposes

Site photographs are shown in the site description below. The logs of the boreholes including the DCP test results are presented in Appendix B. The Guidelines for Hillside Construction are presented in Appendix C. A Site Plan showing the building footprint and location of the boreholes is attached in Appendix D to this report.

3.0 SITE DESCRIPTION

The Lot is located at 51 Brownell Drive, Wategos. Excavations have previously been carried out into the slope to form a flat carparking area immediately downslope of the existing residence and adjacent to Brownell Drive. The excavations range up to approximately 3m in depth and are currently retained by a sandstone block retaining wall. The base of the carparking area comprises gravel material at the surface.

Behind the crest of the existing retaining wall, the ground surface forms natural mild sloping terrain of approximately 15° in slope gradient which extends back approximately 6m to 8m to the existing residence as well as around the northern side. It is proposed that the existing cuts into the slope for the carparking area will be extended back towards the existing residence as well as the area to the north as part of the works for the garage, swimming pool and building extensions.

Access to the existing residence is via a staircase which extends along the side of the sandstone block retaining wall and to a grassed area between the crest of the wall and the existing residence.

The Lot has been cleared of vegetation and supports grass within the natural sloping terrain with numerous plants and garden beds evident around the perimeter of the Lot.

Drainage at the site is assessed to be fair.

Refer following aerial and site photographs for typical site conditions.

AERIAL IMAGE

SITE PHOTOGRAPHS

Plate 1 – Looking at excavation into the slope which is retained by sandstone block retaining wall from Brownell Drive. Excavations to extend back into the slope as part of the proposed development.

Plate 2 – Excavation prior to being retained by sandstone block retaining wall. Excavation exposes natural clay soil in upper section and weathered rock in the base.

Plate 3 – Natural sloping terrain behind retaining wall where garage and swimming pool and building extensions are to be located.

Plate 4 – Natural sloping terrain immediately behind existing sandstone block retaining wall.

Plate 5 – Sandstone block retaining wall downslope of existing residence.

4.0 GEOTECHNICAL MODEL

4.1 Regional Geology

The regional geology at the area forms part of the Neranleigh Fernvale Beds which are undifferentiated but are thought to have been formed in the Silurian to Devonian Geological Time Period. These Neranleigh Fernvale Beds comprise greywacke, argillite, quartzite, chert, shale, sandstone and greenstone (Moreton 1:500 000 Geological Map).

4.2 Local Subsurface Geology

Based on the results of borehole drilling, the subsurface conditions encountered at the site typically comprise natural very stiff, silty clay overlying shallow weathered siltstone rock. In the retained area adjacent to Brownell Drive, some gravel fill material as well as clay fill material ranging up to approximately 0.5m in thickness has been placed at the surface as part of the earthworks for the carparking area.

Based on the results of DCP testing behind the crest of the existing retaining wall where no access was available for the drilling rig, it appears that weathered rock would be encountered at a depth typically ranging between 1.5m and 2.0m below the existing natural ground surface.

Table 1 presents a summary of the encountered subsurface profile. Detailed borehole record sheets are appended to this report.

TABLE 1 - SUBSURFACE PROFILE SUMMARY

BH No.	Fill	Natural Clay	XW/HW Siltstone Bedrock	BH (DCP) TD
		Very Stiff/Hard	VLS/LS	
BH01	0.0-0.5	0.5-0.9	0.9-TD	1.5
#DCP02	N/A	N/A	2.4(3)	(2.4)
#DCP03	N/A	N/A	1.5(3)	(1.5)
#DCP04	N/A	N/A	1.9(3)	(1.9)

Notes:
1. All depths in metres below ground level at time of investigation.
2. N/A - Not Applicable; TD - Termination Depth; VLS - Very Low Strength; LS – Low Strength.
3. #Inferred from DCP testing

Groundwater or subsurface seepage was not encountered in the boreholes at the time of drilling. Seepage could be expected through the fill soils and along the fill/natural soil and natural soil/rock interface following periods of rainfall.

5.0 SLOPE STABILITY ASSESSMENT

There is no evidence of existing or recent past slope instability involving large scale movements of significant quantities of soil or rock in a short duration event such as a slip or landslide within the proposed development area. There is, however evidence of instability involving movements of the surficial soil in the form of creep movement at the surface of the natural soil. A retaining wall has also been constructed to retain the steep excavation adjacent to Brownell Drive.

Slow movement or creep of the surficial soil is presently occurring in the natural sloping terrain at the site upslope of the existing retaining wall. The creep movement appears to typically involve movement within the upper approximately 0.3m of soil at the surface and is evident by the presence of minor back slants on trees. This minor creep movement of the surficial soil is not expected to impact on the proposed development providing the recommendations outlined in this report are followed.

A sandstone block retaining wall ranging up to approximately 3m in height and retaining a steep excavation adjacent to Brownell Drive has been constructed at the site. It is proposed that this excavation is to extend back into the natural sloping terrain at the site as part of the proposed development. Consideration must be given to stabilising this temporary excavation during the works and prior to permanent retention as the unsupported excavation may undermine the stability of the existing residence. Recommendations to stabilise the excavation for the short term are provided in this report.

The likelihood of slope movement in the form of deep seated failures through the rock mass is considered to be low, due to the shallow depths to bedrock and the estimated friction angle of the rock being higher than the angle of the slope.

With the exception of the creep movement at the surface, the site displays no evidence of major instability which would impact on the proposed development. However, due to the sloping nature of the site, the minor creep movement evident at the surface and the potential for stability issues associated with additional excavations into the slope, precautions must be taken during development in relation to earthworks, foundations and drainage to reduce the potential for instability and erosion. This includes implementing and maintaining properly designed and constructed drainage structures upslope and around the proposed development areas, adequately retaining any excavations at the site and extending the footings into the weathered rock.

5.1 Landslide Hazard Risk Rating

The slope stability assessment methodology adopted for this assessment is in accordance with the Australian Geomechanics Society (AGS) "Practice Note Guidelines For Landslide Risk Management" March 2007. These guidelines have been applied to the building envelope location in its existing condition.

On this basis, it can be expected that some areas of the building envelope may contain higher Levels of Risk to Property than the overall assigned rating for that building envelope. The subsurface conditions at the site have been obtained from borehole drilling at the site and onsite observations.

The building envelope has been assigned a Landslide Risk Rating based on:-

- Ground surface slope angle and shape
- Geology
- Typical depth of soil cover
- Presence of erosion features, uncontrolled fill, steep cuts, drainage features or surface irregularities
- Seepage and drainage conditions as assessed during the walkover survey carried out for this study

The results of the AGS slope stability assessment is presented in Table 2 below.

TABLE 2 – LANDSLIDE HAZARD RISK RATING

Building Envelope	Likelihood	Consequences to Property	Assessed Hazard Risk Rating	Required Works to Reduce Risk Rating to Low
51 Brownell Drive	Unlikely	Medium	Low	Sections 6.0 to 11.0 as reported herein

The risk to property can be assessed as "Low" under present conditions for the building envelope but also based on the designs of the proposed development being incorporated which includes the adequate retention of all additional or future excavations into the slope which may undermine the stability of the existing residence. This level of risk is usually acceptable to regulators but requires on going maintenance to maintain the risk to "Low".

If the recommendations outlined in Sections 6.0 to 11.0 below are followed, the risk level to property can be maintained to a level of "Low".

5.2 *Implications of Hazard Classifications*

The risk level implications of the Risk to Property are presented in the AGS publication "Practice Note Guidelines for Landslide Risk Management" March 2007 and reproduced in Table 3.

TABLE 3 – RISK LEVEL IMPLICATIONS (AGS PUBLICATION)

Hazard Rating	Implications
VH (Very High Hazard)	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low.
H (High Hazard)	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low.
M (Moderate Hazard)	May be tolerated in certain circumstances but requires investigation, planning and implementation of treatment options to reduce risk to Low.
L (Low Hazard)	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, on going maintenance is required.
VL (Very Low Hazard)	Acceptable. Managed by normal slope maintenance procedures.

6.0 RECOMMENDATIONS TO MAINTAIN LANDSLIDE RISK RATING TO LOW

The Level of Risk to Property for the development within the building envelope is assessed to be "Low" for the long term. However, there are several development constraints including the presence of creep movement and the proposed excavations into the slope. The following risk maintenance strategies are required to maintain the Level of Risk to Property to a "Low" level of risk.

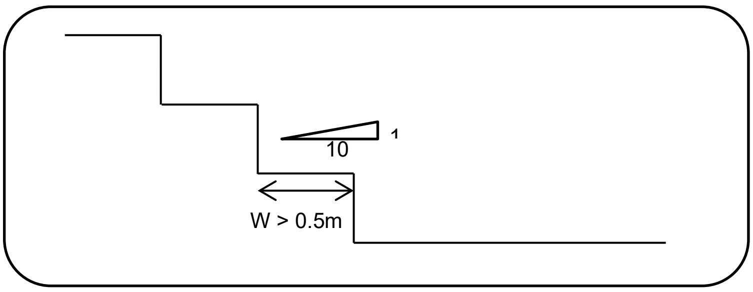
- All foundations must extend below all existing or new fill material and natural soils which may be susceptible to creep movement and found into the weathered siltstone bedrock. Where cuts have been or are to be carried out to form a flat pad for the proposed development, high level footings can be adopted.
- All excavations into the slope must not undermine the stability of the existing residence or any other structures. This may require the footings for the existing residence or structures to be extended to found at least 200mm below a line drawn up at 45 degrees from the base of any excavation. Alternatively, the excavation must be temporarily retained by a system of shotcrete and anchors or other adequate temporary retention system, taking into account the loads which are to be imposed by the existing residence or any other structures.
- All vertical cuts into the slope must be adequately retained or reprofiled to the batter angles stated in Section 7.0 below and 1m wide benches installed at every 2.5m height interval.
- Upslope surficial water flows should be intercepted and directed away from the building pad, cut and fill batters and retaining walls limiting the ingress of water into the fill platforms.
- All building pad runoff and roof water should be discharged into the stormwater systems via a system of pipe conduits to minimise water infiltration into the slopes and fill platforms. Alternatively, roof water can be discharged into roof water tanks for storage.
- Storage tanks must be located to the side or downslope of the dwelling.
- The recommendations outlined in this report must be followed which includes recommendations for drainage, site preparation prior to filling, filling, safe cut and fill batters slope angles and general recommendations for residential development.

7.0 EARTHWORKS RECOMMENDATIONS

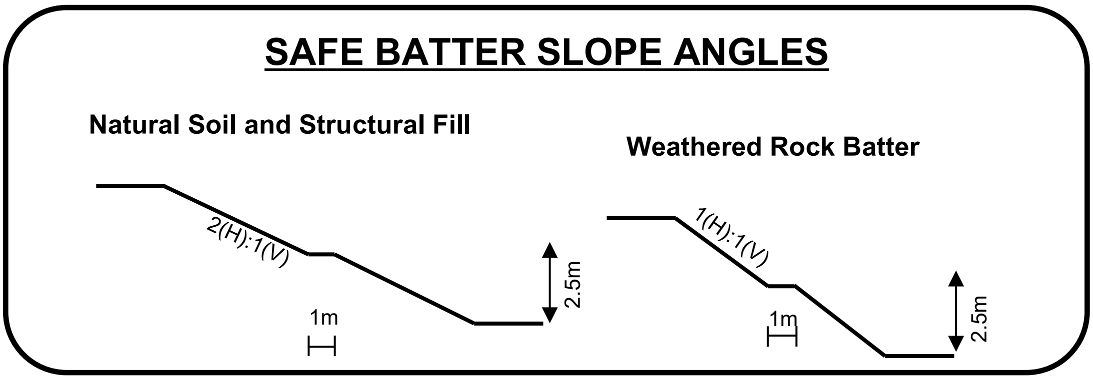
Earthworks have previously been carried out and comprise cuts ranging up to 3m which have been retained by a sandstone block retaining wall. Additional earthworks are expected comprising further cuts into the slope for the proposed garage and swimming pool. All cuts and filling should be suitably retained with structurally designed retaining walls or battered to appropriate angles provided below. All proposed retaining walls should be assessed by Pacific Geotech as part of the design process.

It is recommended that the following site preparation and earthworks procedures be carried out as part of the earthworks procedures during development.

- All earthworks operations should be carried out under appropriate supervision and in general accordance with AS 3798-2007 "Guidelines on Earthworks for Commercial and Residential Developments".
- No filling or residential development should take place within any surface irregularities such as slips, washouts, hummocky terrain, seepage zones, uncontrolled fill or erosion features without detailed assessment by Pacific Geotech. Surface irregularities must be removed prior to development and appropriate drainage provisions must be implemented as described in above.
- If filling is to be carried out all trees, grass, topsoil, uncontrolled fill, soils containing deleterious matter and surface irregularities (as described above) are to be removed from the existing ground surface.
- Following stripping, the stripped surface should be proof rolled under Pacific Geotech's supervision, to identify areas of weak surficial soils and to compact the upper level material.
- The majority of the soils on site will be suitable for re-use as structural fill, provided material is free of organic matter and deleterious material. It is likely that the soils will require moisture conditioning to bring them to optimum moisture content. If the clays are overly moist, difficulty in achieving compaction of the materials will be encountered and moisture conditioning will be required. It should be noted that reuse of the natural clay soils as structural fill material will most likely result in a highly reactive site classification.
- Imported fill should be of fair to good quality with a minimum Soaked CBR value of 10%, a maximum Iss=1.0% and a maximum particle size of 75mm.
- All filling should be undertaken in layer thicknesses of approximately 250mm (or as appropriate for the compaction equipment being used). Fill should be compacted to at least 95% Standard Maximum Dry Density and be "Controlled Fill" in accordance with A.S. 2870 (Clause 6.4.2 (a)) – "Residential Slabs and Footings" and A.S. 3798.
- Where the ground surface slopes, the foundation is benched prior to filling (as shown below) and the fill supported by engineered retaining walls or battered to a slope angle of no steeper than 2(H):1(V).



- Natural soil batters should be battered to an angle of no steeper than 2(H):1(V) or 26° whilst cut batters in weathered rock should be no steeper than 1(H):1(V) and incorporating a 1.0m wide flat bench at every 2.5m height interval (unless otherwise assessed by Pacific Geotech).



- Fill slopes should be over-filled and trimmed back to ensure fill compaction of the batter is achieved.
- Batters are to be stabilised using techniques such as vegetation and mulching or similar to minimise erosion. Properly maintained vegetation should reduce the occurrence of surface erosion by impingent rainfall.
- Trafficability across the site at the time of the investigation was assessed to be fair. If significant rainfall events occur during the earthworks operation, difficulties could be experienced in trafficking the exposed surface. Site trafficability may be improved by constructing haulage tracks into and on the site or placing rock along high traffic areas.
- Excavations into the slope must not undermine the stability of the upslope or adjacent structures. Ie. all footings from adjacent buildings or structures must be founded at least 200mm below a line drawn up at 45 degrees from the base of any excavation.
- Depressions formed by the removal of vegetation or other features should have all disturbed soil removed to expose competent natural soil and be backfilled with compacted and suitably moisture conditioned select fill material.

8.0 POTENTIAL GROUND SURFACE MOVEMENTS

Due to the presence of uncontrolled fill which has been placed on moderate sloping terrain, the site must necessarily be classified as a Class' P' site in accordance with *AS2870-2011 Residential Slabs and Footings – Construction.*

Where cuts have been carried out to expose the weathered siltstone rock at the surface, these areas of the site can be classified as Class 'S' in accordance with *AS2870*-2011 with ground surface movements of less than 20mm expected.

It is recommended that the readers satisfy themselves that the use of AS 2870-2011 is applicable for the proposed design and the above site classification re-confirmed following the completion of the bulk earthworks operation.

9.0 BUILDING FOUNDATIONS

Cuts ranging up to approximately 3m in depth have previously been carried out at the site to form a flat pad for the existing carpark but will further be extended into the slope as part of the proposed development. It is therefore recommended that in the cut areas of the site, the proposed new residence be founded on high level footings founding into the weathered siltstone rock. In areas where fill material or natural soil is encountered at the surface, a deep footing system should be adopted also founding into the weathered siltstone rock.

9.1 High Level Foundations

It is recommended that in the cut areas of the site which have been carried out to form a flat pad which exposes weathered siltstone rock at the surface, a high level footing system be adopted. In areas where fill material or natural soil is encountered at the surface or the ground surface slopes at 10° or more, a deepened foundation system be adopted for the support of the proposed building.

An allowable bearing capacity of 400kPa in the weathered siltstone rock would be available, subject to inspection at the time of excavation.

It is recommended that footing inspections be undertaken by Pacific Geotech, following excavation, to confirm the specified founding strata has been reached.

Where footings are located adjacent to excavations such as underground service trenches, it is recommended that the footings be deepened to found at least 200mm below a line drawn up at 45 degrees from the base of the trench.

If footings cannot be poured on the same day as the excavations, a concrete blinding layer of at least 50mm thickness is recommended.

9.2 Deep Foundations

In areas where fill material or natural soil is encountered at the surface, a deep footing system should be adopted. This could comprise bored piles founding in the weathered siltstone rock.

The deep foundation system should be designed in accordance with the recommendations of AS 2159-2009 'Piling - Design and Installation'.

The ultimate geotechnical strength ($R_{d,ug}$) of piles can be calculated using the unfactored, ultimate shaft adhesion and end bearing values given in Table 4. The $R_{d,ug}$ values given in Table 4 will need to be multiplied by a suitable geotechnical strength reduction factor (ϕ_g) to obtain the design geotechnical strength ($R_{d,g}$) of piles. In accordance with AS2159-2009, the $\varnothing_g$ value must be determined by the designer, but based on the anticipated site, design and installation risk factors, a $\varnothing_g$ value of 0.48 is recommended. Higher values may be applicable with suitable supervision.

If working stress methods are used in the pile design, the $R_{d,ug}$ values given in Table 4 will need to be divided by a factor of safety of 2.5 to calculate the maximum single pile working load.

Bored piles can be designed using the ultimate geotechnical pressures presented in Table 4 below.

TABLE 4 – ULTIMATE DESIGN PARAMETERS FOR BORED OR GROUT INJECTED PILES

Material		**Ultimate Geotechnical Shaft Adhesion (kPa)**	**Ultimate Geotechnical End Bearing Pressure (kPa) (3)**	
			$L \leq 4D$ (2)	$L \geq 4D$ (2)
Fill		NC(1)	NR(1)	NR(1)
Natural Clay Soils	Very Stiff	35	NR(1)	NR(1)
	Hard	50	NR(1)	NR(1)
XW/HW Bedrock	VLS/LS	90	1800	2700

Notes:

(1) NC – Not considered; NR – Not recommended.
(2) L – Total pier length; D – Pile diameter.
(3) Very Low Strength; LS – Low Strength.

Construction Considerations

If bored piers are adopted, the bases of the bored pile holes must be thoroughly cleaned of all loose soil and rock debris using a proper cleaning tool. The practice of adding water and spinning the auger is generally not acceptable. If there is any doubt as to the effectiveness of the base cleaning, the base resistance must be ignored.

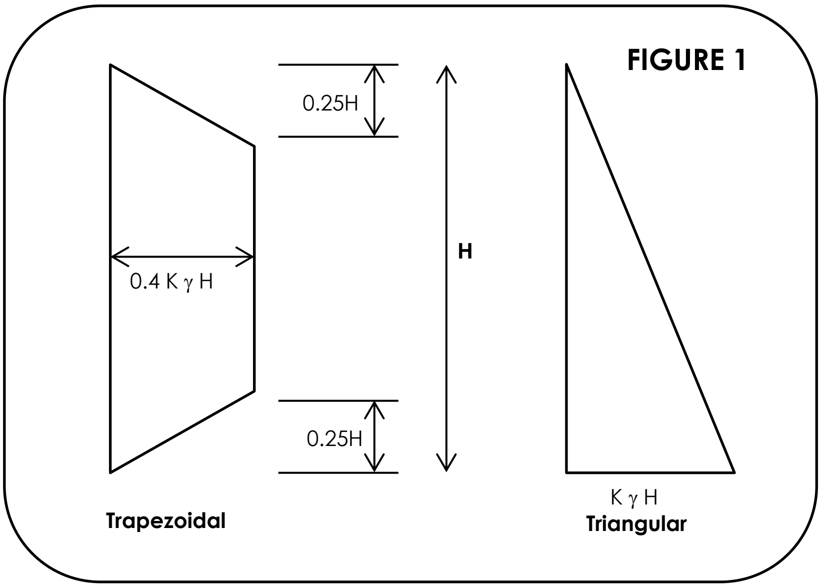
Drilling piles is not only dependent on the subsurface profile characteristics, but also the type (power and size) of the bored pile drilling rig, drilling teeth, size of pile, etc. It is recommended that a specialist drilling contractor be consulted to be able to manage the above conditions and materials encountered.

During construction, it is recommended that footing inspections be undertaken by Pacific Geotech, following excavation, to confirm the specified founding strata has been reached.

10.0 RETAINING WALLS

Retaining walls should be specifically engineer designed in accordance with AS 4678-2002 (Ref 9).

The design of flexible retaining walls could be undertaken using a triangular pressure distribution and the earth pressure parameters given in Table 5. Flexible walls are those which are free to rotate or tilt (such as cantilevered walls) and should be designed using active (Ka) earth pressure coefficient. Rigid walls are those which are restrained against rotation or tilt (i.e. single anchored/propped walls) and should be designed using the at-rest earth pressure (Ko) and a trapezoidal pressure distribution as per Figure 1.



Passive resistance (Kp) at the toe of the wall should be ignored in the zone where future disturbance (e.g. services trenches) could occur.

The effects of surcharge in the retained zone should be included by multiplying the vertical pressure developed by the surcharge by the appropriate lateral earth pressure coefficient. Allowance should also be made for the surcharge due to sloping crests if applicable.

TABLE 5 – EARTH PRESSURE COEFFICIENTS (NON-SLOPING CREST BACKFILL)

Material	Unit Weight (kN/m^3)	Cohesion c' (kPa)	Friction Angle (degrees)	Active Ka	At Rest Ko	Passive Kp
Controlled Fill*	19	2	24	0.42	0.59	2.39
Clays – Very Stiff/Hard	20	5	26	0.39	0.56	2.57
XW/HW Bedrock	23	8	34	0.28	0.44	3.55

Notes: * Depends on fill material type and level of compaction.

The generalized lateral earth pressure distribution is given as:

$p = K\gamma H + Kq + \sigma L$ (kPa)

- K is either K_a, K_o, or K_p for "active", "at rest" or "passive" earth pressure conditions, respectively
- γ (kN/m^3) is the relevant density of the soil or rock
- H (m) is the distance down from the top of the wall
- q (kPa) is any uniform surface surcharge load behind the wall
- σL (kPa) is the lateral pressure on the wall resulting from adjacent surcharges.

Walls should be designed for adequate hydrostatic pressure, regardless of drainage provisions provided behind the wall.

It is recommended that the design parameters for retaining walls presented in this section be confirmed by on-site inspection when the subsurface conditions are exposed during construction.

Preference should be given to adopting thin soil layers and using small hand-controlled compaction equipment during backfilling against retaining walls. This is in order to limit the stress applied to the walls during construction. Should heavy compaction be required, then wall stresses will be well in excess of Ko and temporary propping should be used.

Clay backfill should not be placed dry of optimum moisture content, as this can lead to increased future swelling with changes to moisture content or inundation from water creating additional load on the back of the wall.

It is recommended that all retaining walls be drained for full height in order to minimise hydrostatic pressure build-up behind the wall. Additional guidelines on wall drainage are provided in Appendix G of AS 4689-2002.

11.0 GENERAL RECOMMENDATIONS FOR DEVELOPMENT

To maintain the long term performance of the proposed development, good management of the soil conditions and the development is vital throughout the life of the development.

The following are some specific comments with respect to site management and general development at the site:

- The ground surface around the perimeter of the building should slope away from the structure and fall to the stormwater system. Water should not be allowed to pond adjacent to the building.

- Founding soils should not be allowed to become saturated. Saturation of the on-site material will result in an increase in potential ground surface movements.
- Service trenches under the building should be kept to a minimum.
- Footings should be poured immediately after excavation. If footings cannot be poured on the same day as excavation, a blinding layer of 50mm thickness is recommended.
- Trees, garden beds and other vegetation should be planted at a distance at least equivalent to three quarters of their mature height away from the structures. This will assist in minimising shrinkage movements in the potentially expansive onsite soils.
- All permanent batters exceeding 1.0m must be supported by engineered retaining walls incorporating drainage or be battered at appropriate angles.
- If retaining walls above 1m in height are proposed, all retaining walls must be individually designed to have a factor of safety of at least 1.5 with respect to internal stability, including sliding and overturning. This is the responsibility of the retaining wall designer. The global stability of the wall profiles should be assessed by Pacific Geotech when the wall profile has been determined.
- When earthworks have been finalised, a global stability assessment must be carried out for retaining walls or batters above 1.0m to confirm that a long term factor of safety in excess of 1.5 against geotechnical instability can be achieved for all proposed earthworks including all cut and fill batters and retaining structures.
- The residential development must be designed, constructed and maintained in accordance with the attached Guidelines for Hillside Construction and the development examples of good and poor hillside practice.
- Revegetation must commence immediately after the completion of any potential earthworks to minimise future erosion.
- The feasibility of the site for the proposed residential development based on existing geotechnical conditions of the site is considered satisfactory providing the recommendations stated in this report are followed and implemented.

12.0 LIMITATIONS

We have prepared this report for the Geotechnical Investigation and Slope Stability Assessment for Proposed Alterations and Additions at 51 Brownell Drive, Wategos. The report is provided for the exclusive use of Rianon Mateer, for this project only and for the purposes outlined in the report. It should not be used by, or relied upon, for other projects on the same or different sites or by a third party. In preparing this report, we have relied upon information provided by the client or their agents.

The results are indicative of the subsurface conditions on site only at the specific testing locations. Subsurface conditions can change between test locations and the design and construction should take the spacing of the testing and testing methods adopted and the potential for variation between the test locations.

It is recommended that Pacific Geotech be engaged to provide advice and ensure the development is undertaken in accordance with the assumptions made in writing this report.

This is not to reduce the level of responsibility accepted by Pacific Geotech, but rather to ensure that the parties who may rely on the information contained in this report are aware of the responsibilities they assume in doing so.

L. BEXLEY **P. ELKINGTON (RPEQ 7226)**

For and on behalf of
PACIFIC GEOTECH PTY LTD

APPENDICES

APPENDIX A

NOTES RELATING TO THIS REPORT

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis.

Every care has been taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical conditions and contains recommendations or suggestions for design and construction. However, unexpected variations in ground conditions will occur. The potential for this will depend partly on testing, spacing and sampling frequency.

If variations are identified, Pacific Geotech would be pleased to assist with additional investigations or advice to resolve the matter.

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Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Description and Classification Methods

The description and classification of soils and rocks used in this report are based on AS 1726.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the percent of other particles present (e.g. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silty	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density which can be correlated from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very Loose	less than 4
Loose	4 – 10
Medium Dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) and can be quantified by the Pocket Penetrometer test, Vane Shear test, laboratory testing or engineering examination. The strength terms are defined as follows:

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 - 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 - 400
Hard	greater than 400
Friable	strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc.

Sampling

Sampling is undertaken during the fieldwork to allow examination of the soil or rock and to allow laboratory testing to be undertaken.

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content and minor constituents. Bulk samples are similar but of greater volume required for some test procedures such as CBR testing.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and collecting a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

Investigation Methods

Test Pits: These are typically undertaken with a backhoe or a tracked excavator, allowing examination of the insitu soils. Limitations of test pits are the problems associated with collapse of the pits, disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of typical diameter of between 50mm to 75mm advance manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as fill, gravel, hard clays and collapse of the borehole (typically in non-cohesive soil).

Continuous Spiral flight Augers: The borehole is advanced using 65mm to 100mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. Augers of up to 300mm in diameter are used to recover larger volumes of sample. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights. Samples can be disturbed and layers may become mixed. Augering below the groundwater table can be less reliable than augering above the water table.

A Tungsten Carbide (TC) bit for auger drilling into rock can be used to indicate rock strength and continuity by variation in drilling resistance and from examination of recovered rock fragments but provides only an indication of the likely rock strength. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is advanced by a bit attached to the end of a hollow rod string, with water being pumped down the drill rods and returned up the annulus of the borehole, carrying the drill cuttings. Changes in stratification can be determined from the return, together with information from "feel" and rate of penetration.

The borehole can be stabilised through the use of drilling mud as a circulating fluid. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. This technique provides a reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel is used, which gives a core of about 50mm diameter. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a disturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposed", Test 6.3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer, with a free fall of 760mm. The sample is driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense soils, hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of , say, 4, 6 and 7 blows, as
  N = 13
  4, 6, 7
- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as
  N > 30
  15, 30/40mm

Cone Penetrometer Testing (CPT): Cone Penetrometer Testing with or without pore pressure measurement (CPTu) is carried out using a Cone Penetrometer in general accordance with AS 1289 6.5.1, 1999.

In the tests, a 36mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the fractional resistance on a separate 135mm long sleeve, immediately behind the cone. Pore Pressure is recovered through a pore ring located either within, or more usually immediately behind the cone/tip.

As penetration occurs (at a rate of approximately 20mm per second) and data is recorded every 20mm of penetration, the results are presented graphically.

The information provided on the plot comprises:

- Cone resistance – expressed in mPa
- Sleeve friction – expressed in kPa
- Friction ratio – the ratio of sleeve friction to cone resistance expressed as a percentage.
- Pore pressure in kPa
- Tilt of probe (in degrees).

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and rising to 2% to as high as 8%, and higher in organic soils. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes, etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive.

Dynamic Cone Penetrometers:

Dynamic Cone Penetrometer (DCP) tests are carried out by driving a 16mm diameter rod into the ground with a 9kg sliding hammer dropping 510mm and counting the blows for successive 100mm increments of penetration.

Logs

The borehole or test pit logs are an interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of the boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

Groundwater

Where groundwater levels are measured in boreholes, there are several potential problems:

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.

- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be flushed from the hole and drilling mud must be washed out of the hole or 'reverted' chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes from which ongoing monitoring can be undertaken.

Fill

The present of fill materials can often be determined only by the inclusion of foreign objects (e.g. bricks, steel ,etc.) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult to reliably determine the extent of the fill.

Laboratory Testing

Laboratory testing is carried out in general accordance with Australian Standard 1289 'Methods of Testing Soil for Engineering Purposes'.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage.

Review of Design

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/constraints are quite complex, it is prudent to have a design review.

Site Inspection

Pacific Geotech would be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related:

Requirements could range from:

i. a site visit to confirm that conditions exposed are no worse than those interpreted, to
ii. a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or
iii. full time engineering present on site.

APPENDIX B

BOREHOLE RECORD SHEETS

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH01
Page 1 of 1

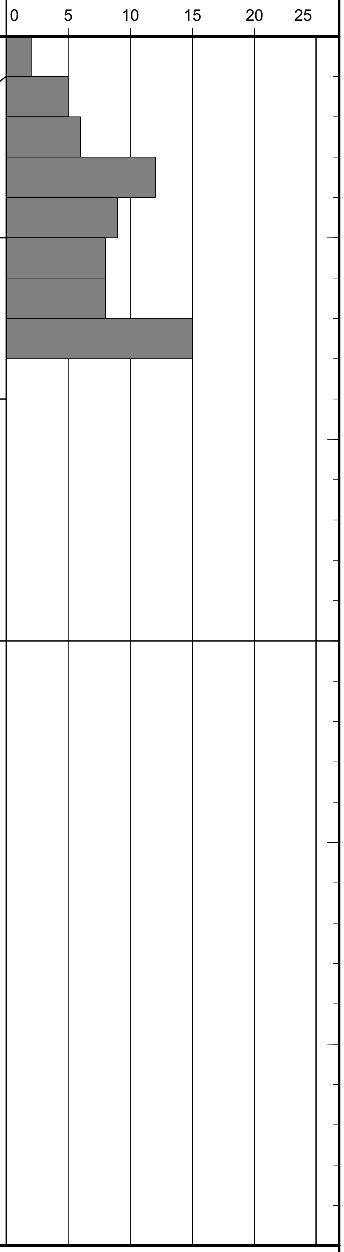
Project No.: PG-5091

Client:	Rianon Mateer	Commenced:	02/07/2021
Project Name:	Proposed Alterations and Additions	Logged By:	SR
Hole Location:	51 Brownell Drive, Wategos	Checked By:	
Hole Position:	561969.1 m E 6831863.6 m N MGA94 Zone 56		
Drill Model and Mounting:	Compac 018	RL Surface:	No survey
Hole Diameter:		Datum:	AHD — Operator: SR

Drilling Information | ***Soil Description*** | ***DCP***

Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T						0.10	GP	FILL GRAVEL (GP) Loose, coarse sized, orange brown and grey, dry (driveway).
						0.50	CL-CI	FILL Silty CLAY (CL-CI) Very stiff, low to medium plasticity, orange brown, w>pl.
						0.90	CI	NATURAL Silty CLAY (CI) Very stiff, medium plasticity, orange brown mottled grey, w>pl.
						1.50		SILTSTONE (HW) Highly weathered, very low strength, orange brown, dry.
								Hole Terminated at 1.50 m

DCP TEST
(AS 1289.6.3.2-1997)
Blows per 100 mm



Method
AS - Auger
RR - Rock Roller
WB - Washbore

Support
C - Casing

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

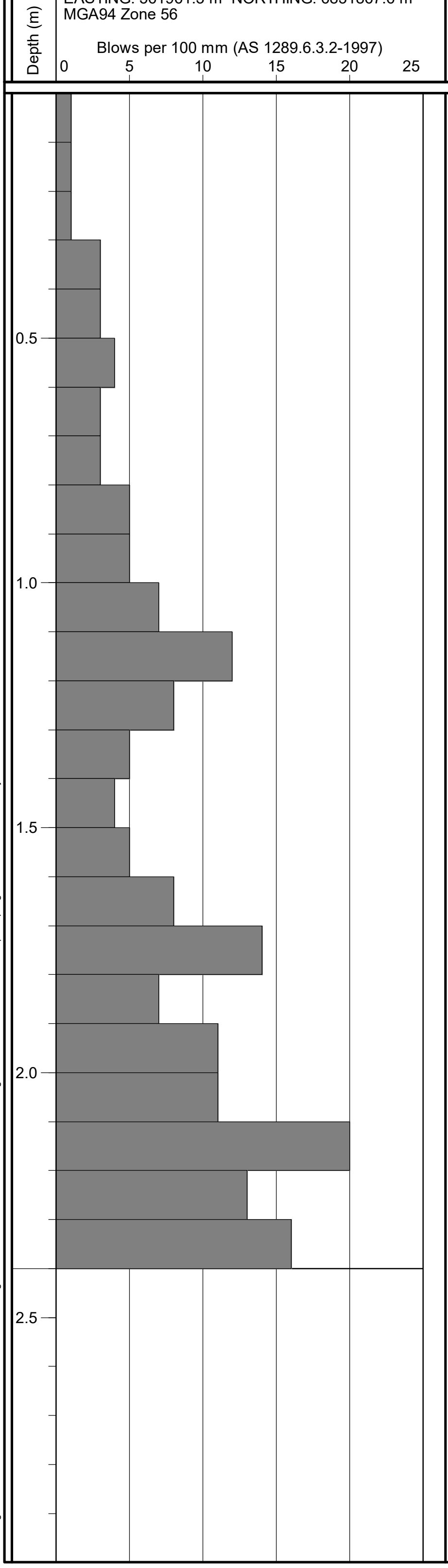
Remarks
1. Groundwater not encountered.
2. Maximum 'TC' bit refusal met at 1.5m.

Pacific Geotech

CLIENT : Rianon Mateer CONTRACTOR : PROJECT : Proposed Alterations and Additions LOCATION : 51 Brownell Drive, Wategos PROJECT No. : PG-5091		SHEET : 1 OF 1

TEST: DCP02

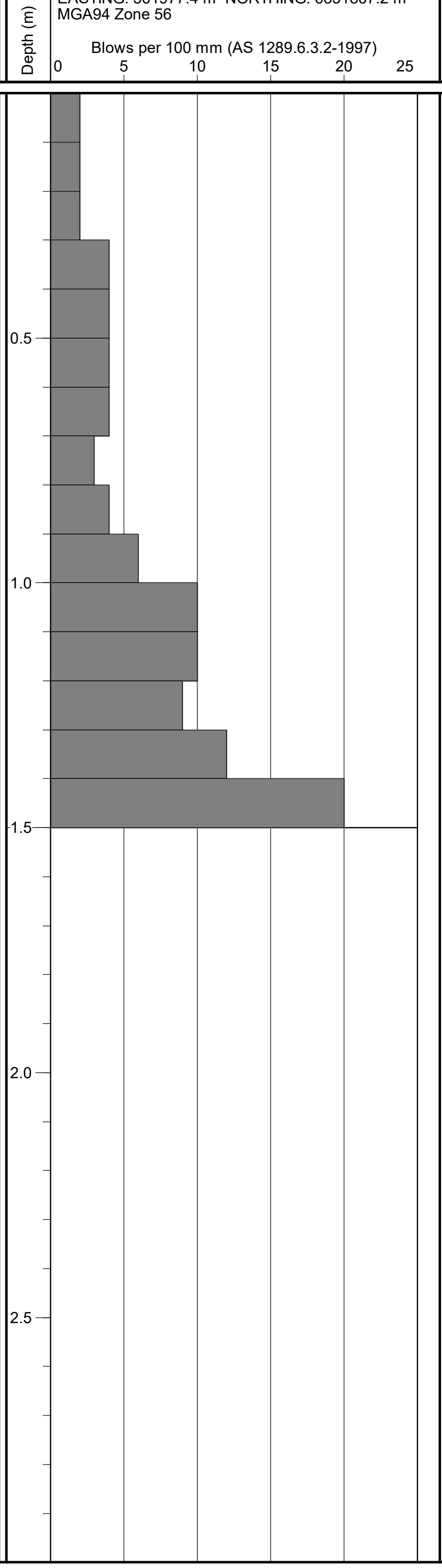
LOGGED: SR 02/07/2021
EASTING: 561961.3 m NORTHING: 6831867.6 m
MGA94 Zone 56



Comments

TEST: DCP03

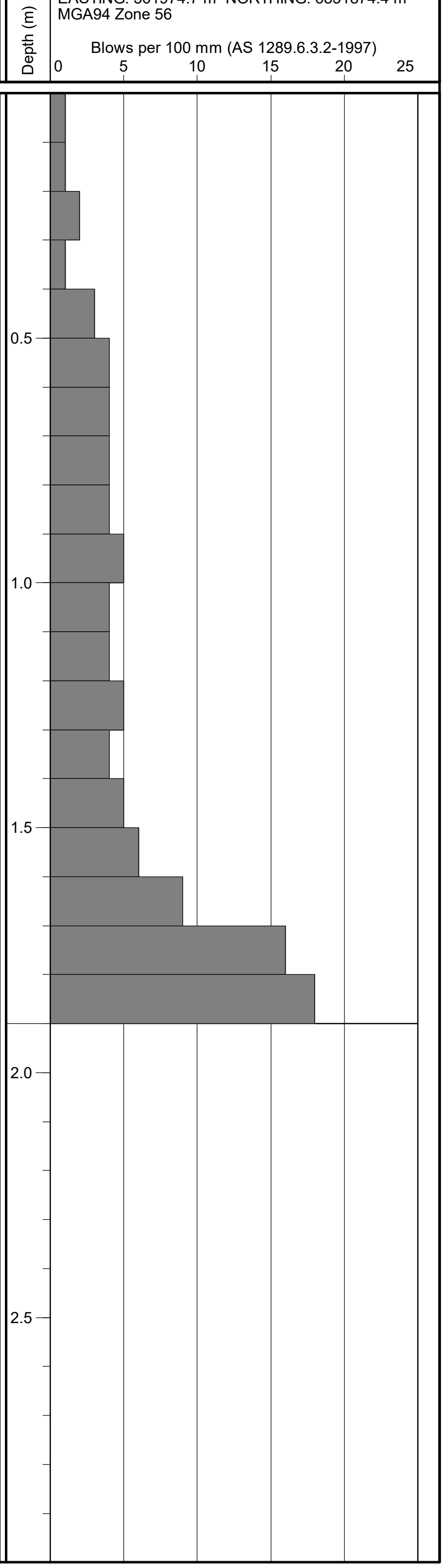
LOGGED: SR 02/07/2021
EASTING: 561977.4 m NORTHING: 6831867.2 m
MGA94 Zone 56



Comments

TEST: DCP04

LOGGED: SR 02/07/2021
EASTING: 561974.7 m NORTHING: 6831874.4 m
MGA94 Zone 56



Comments

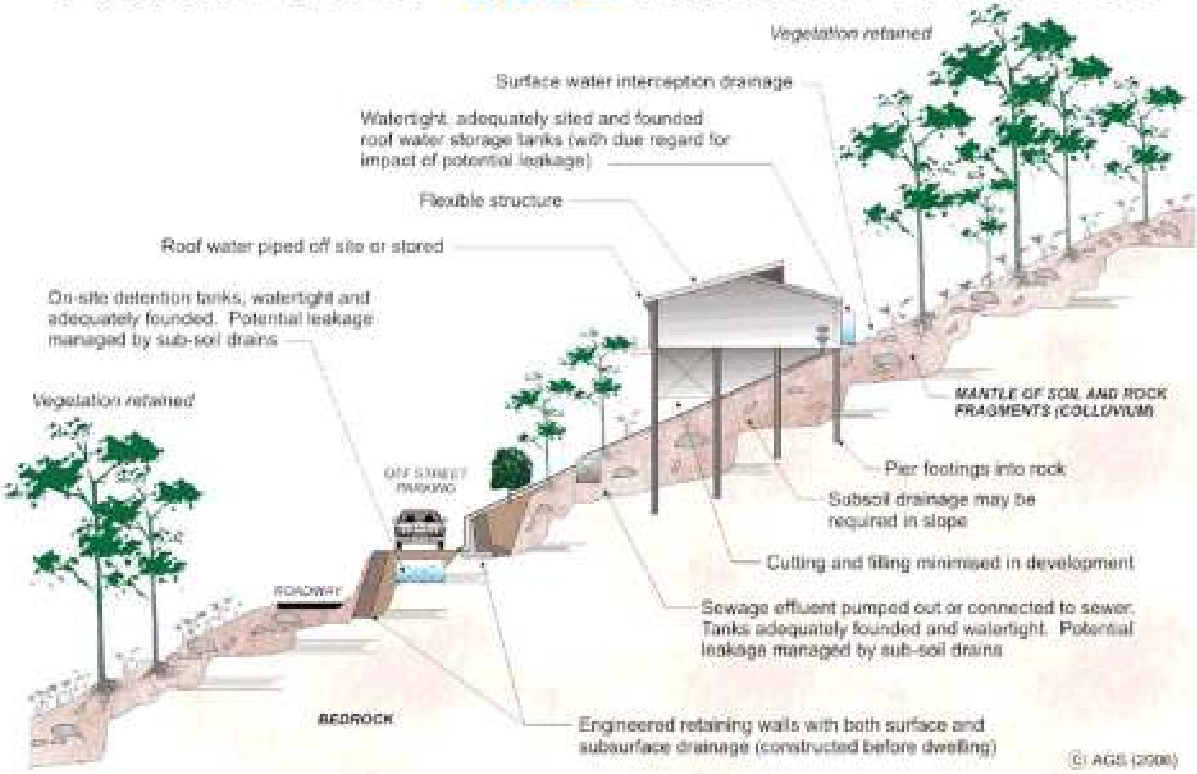
APPENDIX C

GUIDELINES FOR HILLSIDE CONSTRUCTION

APPENDIX G - SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical practitioner at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminatory bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	

EXAMPLES OF GOOD HILLSIDE PRACTICE



EXAMPLES OF POOR HILLSIDE PRACTICE