

FEBRUARY 2025 | V1.0

Infrastructure Report

1799A GREAT SOUTH ROAD, BOMBAY

VERNON DEVELOPMENTS LIMITED

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Date:	February 2025
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1. INTRODUCTION

TSC Limited has been engaged by Vernon Developments Limited to prepare engineering design plans and this infrastructure report for a retrospective consents for the works carried out at 1799A Great South Road, Bombay. This report addresses the site-specific issues in relation to stormwater, earthworks and erosion and sediment control.

1.1 EXISTING SITE

The site is located at 1799A Great South Road, Bombay and is legally described as Lot 6 DP 156089. The site before any works was carried out will be referred to as the pre-developed site throughout this report. The site as it is now will be referred to as the existing site.

The pre-developed site was mainly in pasture with two sheds in the western corner of the property. The existing site has a large area in pasture, a metalled platform area, metalled track and two new sheds. The land gently slopes towards the north into an overland flowpath that discharges to a 525Ø culvert under State Highway 1 (SH1). The outlet of the 525Ø is unknown however it is inferred that it either drains to the North into an unnamed stream or to the South East, under SH1, into another unnamed stream.

1.2 SCOPE OF REPORT

Vernon Developments Limited seeks to gain a retrospective consents for the works carried out on their site at 1799A Great South Road, Bombay. The scope of this report is to describe the nature and extent of the engineering activities required to remediate the development.

1.3 SOUND ENGINEERING PRACTICE

At all-times, sound engineering practice will be adopted to ensure minimal disturbance to the environment on the subject site and the surrounding areas. Where possible, exposed clay areas will be stabilised at the end of each day and if extended periods of inclement weather have been forecast, no additional areas will be opened for earthworks. At the start and end of each day, the erosion and sediment control measures will be checked and fixed where required.

1.4 CONSTRUCTION METHODOLOGY AND PROGRAMME

It is anticipated that the construction works will proceed in the following sequence:

- Establishment of machinery on site,
- Locate and protect services,
- Install erosion and sediment controls,
- Construct stormwater detention pond,
- Cut to fill to designed subgrade levels,
- Install stormwater pipes and manholes,

- Install subsoil drainage,
- Respread topsoil and sow grass,
- Remove erosion and sediment control devices once site has achieved 80% grass coverage,
- Remove machinery from site.

Work will take place during the earthwork's construction season being between 1st October and 30th April. The scope of the works described above is likely to take approximately 6 to 8 weeks to complete, subject to weather conditions.

2. EARTHWORKS

2.1 GEOTECHNICAL REPORT

Tilsley Engineering have put together a geotechnical report (Reference IZ21923) for the building consent issued for the 2 newly constructed sheds. This report has been attached in Appendix B. The findings in this report look to be indicative of the overall site and all recommendations from this report will be followed as part of the earthworks.

2.2 EARTHWORKS QUANTITIES

It is proposed to undertake cut to fill earthworks, and import some fill material, in order construct the pond, swale and overland flowpaths. For cut to fill operations, the material will be uplifted, transported, placed in 200-300mm layers and then compacted with a sheepsfoot roller to ensure the required compaction is obtained. Our modelling indicates that the total volume of cut material is 508m³ and the total volume of fill is 8,323m³, meaning that 7,815m³ of fill will have to be imported. The imported fill will be cleanfill, void of any contamination. The maximum depth of cut is 1.0m and the maximum depth of fill is 3.0m high. Compaction testing will be carried out by a suitably qualified Geotechnical Engineer to ensure all material meets the relevant specifications. On completion of the bulk earthworks, the subgrade will be trimmed, inspected and tested prior to any permanent pavement construction. Finally, the topsoil will be cultivated and revegetated.

A summary of all the earthworks quantities are shown in Table 2.1. The earthworks areas, heights and volumes are a comparison between the existing site and proposed site.

Earthworks Quantities - Proposed	
Earthworks Area	11,449m ²
Topsoil Volume	2,290m ³
Cut to Fill Volume	8,323m ³
Maximum Fill Depth	3.0m
Maximum Cut Depth	1.0m

Table 2.1 - Earthworks Quantities

2.2.1 RETROSPECTIVE WORKS

Earthworks have been carried out by the client to construct a metallised platform, metallised access track and two new sheds. Details from the client suggested that the works involved stripping topsoil to subgrade, forming topsoil bunds and the importation of metal. The extent and volume of earthworks can be found on the second set of engineering plans attached in Appendix F. Table 2.2 also shows the earthworks quantities for what has been carried out on site to date.

Earthworks Quantities - Retrospective	
Earthworks Area	29,973m ²
Topsoil Volume	9,995 m ³
Cut to Fill Volume	4,491m ³
Maximum Fill Depth	2.0m
Maximum Cut Depth	0.5m

Table 2.2 - Retrospective earthworks quantities

2.3 EROSION AND SEDIMENT CONTROL

The erosion and sediment controls have been designed in accordance with “Auckland Council Guideline Document 2016/005: Earthworks Erosion & Sediment Control (GD05) - Section F Sediment Control Practices” as illustrated on the engineering plans, attached in Appendix A (sheets J2224-5).

Earthworks will be carried out in stages as to reduce the risk of any contamination to the receiving environment.

2.4 EARTHWORKS CATCHMENTS

2.4.1 AREA 1

This area includes the minor works to realign the existing drain from proposed outlet 1 to the existing culvert under SH1. Due to the small area, this area will be progressively stabilised, with coconut matting and hay mulch, as it is constructed.

2.4.2 AREA 2

A silt fence will be installed to manage the initial stages of the construction of the pond. Due to the size of the pond, the pond itself will manage the erosion control as it is constructed progresses. No works in Area 2 should occur until Area 1 is fully stabilised.

2.4.3 AREA 3

The swale/overland flowpath (OLFP) will be progressively stabilised, with coconut matting and hay mulch, as it is constructed. The pond will be used as a contingency measure during the construction of the swale/OLFP. No works in Area 3 should occur until Area 2 is fully stabilised.

3. STORMWATER

The stormwater infrastructure has been designed in accordance with Auckland Council Code of Practice for Land Development and Subdivision Chapter 4 – Stormwater (SWCOP).

3.1 EXISTING STORMWATER

The stormwater runoff on site is currently controlled mostly via sheet flow toward a drain in the Northeastern section of the property, where it is picked up by an existing 525Ø culvert. The outlet of the existing culvert is unknown. There is a small catchment in the Western corner of the property that sheet flows towards the West. Stormwater from the 2 newly constructed sheds has been managed as per their approved building consents. An existing stormwater network is currently connected to the oil and grit separator, which is being discharged to the ground to the west of the proposed pond.

3.2 PROPOSED STORMWATER

The stormwater generated from this site will be picked up by the proposed OLFPs and directed into the treatment swale and stormwater pond. The pond will provide attenuation for SMAF 2, 50%, 10% and 1% AEP storm events. The existing 525Ø is a constraint on the discharge of the stormwater from the site and means that the pond has been sized to over attenuate flows so that the 1% AEP does not impact on the SH1. The grassed swale inside the proposed dry pond will provide treatment for the site. SMAF 2 retention will be provided in the detention component of the pond as it is not practical to reuse the retention component on site. The pond and treatment swale will be utilised to offset the small catchment to the west, that is inside the outstanding natural feature, to reduce the impact that this proposal has on the feature.

3.2.1 OBJECTIVES

- Treatment of runoff from the site (Grassed Treatment Swale),

- Meet SMAF 2 requirements – retention and detention (Dry Pond),
- Attenuation of the 50% and 10% AEP storm event to pre-development rates – Prior to any development. (Dry Pond).
- Over Attenuation of the 1% AEP to accommodate the undersized State Highway culvert (Dry Pond).

3.3 PRIMARY STORMWATER SYSTEM

The proposed primary stormwater system comprises of the following aspects and has been designed in general accordance with Section 4.3 of the SWCOP.

- Piped network,
- Stormwater detention pond (discussed in section 3.5 of this report).

3.4 STORMWATER RETICULATION

Proposed Stormwater Network 1 has been sized to cater for the attenuated flows from the 1% AEP storm event. The purpose of proposed stormwater network 1 is to discharge the attenuated flows from the proposed pond to the existing stormwater drain to the north. The flow rate used to size the pipe for network 1 is taken from the HEC-HMS outputs for the proposed pond. The existing stormwater outlet that is connected to the oil and grit separator will be redirected to the proposed grassed OLFP.

3.4.1 DAILY RAINFALL DEPTHS

Rainfall depths have been determined using the Auckland Regional Council TP108 design rainfall maps. This results in a 10% AEP (1 in 10-year storm event) 24-hour depth of 130mm and a 1% AEP (1 in 100-year storm event) 24-hour depth of 215mm for existing conditions.

3.4.2 CLIMATE CHANGE

In accordance with SWCOP 4.2.10, the rainfall depths have been increased to allow for 2.1°C and 3.8°C climate change for the 10% AEP and 1% AEP storm events respectively, with the percentages shown below in Table 3.1. This increases the 10% AEP depth to 152.1mm and 1% AEP depth to 285.3mm.

Annual Exceedance Probability (AEP)	Percentage Increase in 24-hour Design Rainfall Depth Due to Future Climate Change (2.1°C)	Percentage Increase in 24-hour Design Rainfall Depth Due to Future Climate Change (3.8°C)
50%	15.1%	27.4%
20%	16.4%	29.6%
10%	17.0%	30.8%

5%	17.2%	31.2%
2%	17.6%	31.9%
1%	18.1%	32.7%

Table 3.1 - Percentage Increase in 24-hour Design Rainfall Depth

3.4.3 RAINFALL DEPTH TO INTENSITY

The rainfall depths have been converted to intensities using the percentages shown below in Table 3.2. This results in rainfall intensity for a 10% AEP 10-minute intensity of 105.6 mm/hr and a 1% AEP 10-minute intensity of 198.0 mm/hr.

Duration	Ratio to convert the existing 24-hour design rainfall depth (in mm) into rainfall intensities (in mm/hr) without Climate Change	Ratio to convert the future 24-hour design rainfall depth (in mm) into rainfall Intensities (in mm/hr) with Climate Change allowances
10 min	67.5%	69.4%
20 min	51.9%	53.2%
30 min	42.8%	43.7%
1 hr	30.3%	30.8%
2 hr	20.5%	20.8%
6 hr	10.5%	10.6%
12 hr	6.8%	6.8%
24 hr	4.2%	4.2%

Table 3.2 - Ratio to Convert 24-hour Rainfall Depth to Intensities

3.4.1 STORMWATER NETWORK SUMMARY

A summary of the stormwater networks for this site are shown in table 3.3 below.

Downstream Structure	Upstream Structure	Pipe Diameter (mm)	Design Grade (%)	Pipe Flow Capacity (l/s)	Design Flow (l/s)
Outlet 1	SWMH 1.1	750	1.2	1210	1162

Table 3.3 - Stormwater Network Summary

All stormwater manholes will be approved 1050Ø concrete manholes. Stormwater manholes 1.1 will have a scruffy dome lids. All stormwater pipes will be RCRRJ Class 4 pipes.

3.5 STORMWATER QUANTITY CONTROL

The proposed stormwater dry pond has been sized to provide detention for the first 34mm rain event in accordance with SMAF 2 via an 85mm orifice located at the base of the pond. This includes the required retention and detention volumes. The pond also provides attenuation for the 50%, 10% and 1% AEP storm events via a 350mm spillway located 0.85m above the base of the pond.

Attenuation of the stormwater runoff from the site is required to mitigate any adverse effects that the development has had on the receiving environment. Stormwater has been over attenuated for the 1% AEP because of the undersized 525Ø culvert under SH1. This existing culvert has been included in the HEC-HMS model to get an accurate representation of what will happen during each storm event. In the future this culvert will be upgraded by NZTA, providing further contingency for the proposed stormwater infrastructure for this site. The small catchment to the west of approximately 6,000m² is inside an outstanding natural feature. To protect this feature, no stormwater infrastructure has been proposed inside it. Instead, this area will be offset by the over attenuation that is designed for inside the proposed pond. The main site catchment and this small catchment flow in separate directions but do end up discharging to the same overall outlet point.

HEC-HMS V4.12 has been used to model the proposed stormwater detention system. The runoff was modelled using the SCS Hydrology Method. Time of concentration was assumed as 10 minutes. A summary of the design inputs is given below in Table 3.4. Figures 3.1 and 3.2 show the layout for the pre-development and post development models in HEC-HMS. In the pre-development model, an existing pond has been included with a 525Ø outlet to model the storage in the existing drain and the existing outlet (525Ø culvert). The post development model also includes an extra pond (pond 2) after the proposed pond and a 525Ø outlet for pond 2 to model what will happen to the stormwater after it is discharged from the proposed pond.

A summary of the HEC-HMS outputs can be found in Table 3.5 showing that post development peak stormwater flows for the site are less than pre-development flows for all storm events. HEC-HMS outputs are attached in Appendix D.

	Pre-Development				Post-Development			
	Area (ha)	CN	Lag Time (mins)	Initial Abstraction (mm)	Area (ha)	CN	Lag Time (mins)	Initial Abstraction (mm)
Impervious Area	0.39	98	6.67	0	2.88	98	6.67	0
Pervious Area	8.95	74	6.67	5	6.46	74	6.67	5
Total	9.34				9.34			

Table 3.4 – HEC-HMS Input Summary

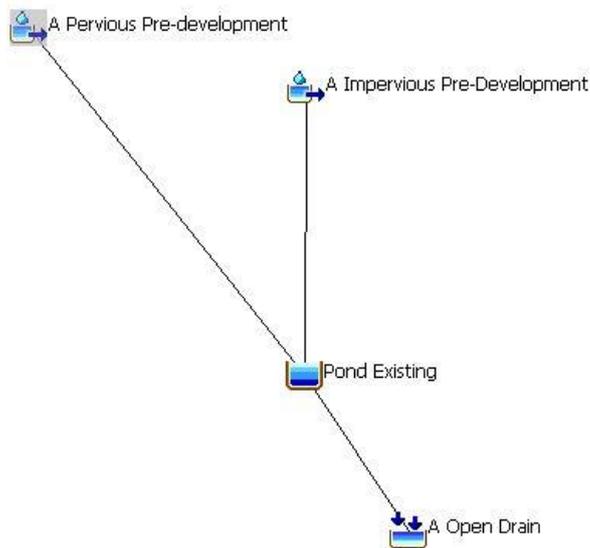


Figure 3.1 - HEC-HMS Pre Development Model

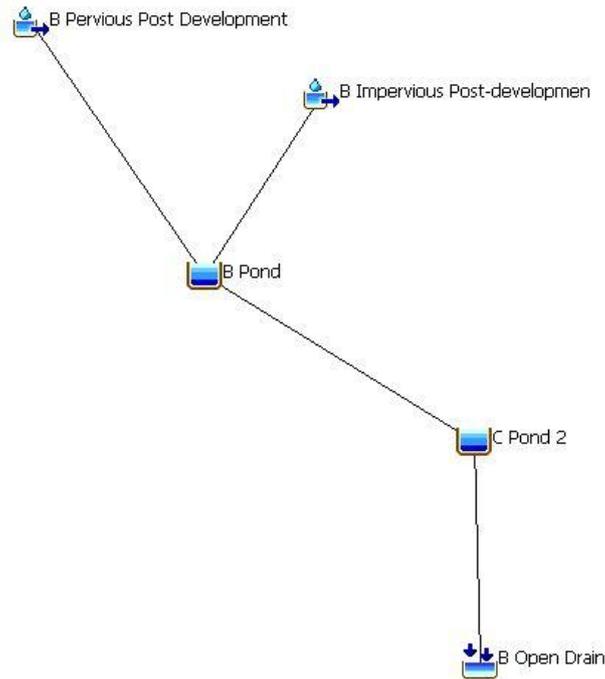


Figure 3.2 - HEC-HMS Post Development Model

Storm Event	Pre-Development Flow (m ³ /s)	Post Development Flow (m ³ /s)	Orifice size (mm)	Discharge slot (mm)	Peak elevation – Proposed Pond (m)	Peak elevation – Pond 2 (m)	Peak storage (m ³)
SMAF 2	-	0.01398	85	-	95.51	94.00	
50% AEP	0.160	0.121	-	350	95.86	94.04	1004
10% AEP	0.503	0.458	-	350	96.38	94.59	2135
1% AEP	1.304	1.162	-	350	97.09	95.99	4162

Table 3.4 - HEC-HMS output summary

The pre-development flow rate for the 1% AEP was determined in HEC-HMS based on the addition of the stormwater runoff from the pervious and impervious runoff flow rates, not the constrained runoff through the 525Ø pipe. Under pre-development conditions for the 1% AEP event, the stormwater backs up to an RL of 95.03. After the proposed development, the 1% AEP event will back up to an RL of 95.99. The survey picked up by TSC did not extend to SH1 but based on GIS contours, the edge of seal is at an RL of around 97.5 in the location of the culvert. Based on the HEC-HMS modelling, there is approximately 1.5m of freeboard between the SH1 and the top of the 1% AEP storm events.

3.6 FLOODING

According to Auckland Council Geomaps, the pre-developed site is shown to partially be inside a flood plain. The undersized culvert is restricting water flow and is therefore likely causing this flooding of the property. The proposed overland flowpath and pond is designed to cater for the 1% AEP with the allowance for freeboard, which should help to mitigate any flooding in the future, downstream or upstream.

3.7 STORMWATER QUALITY

The stormwater quality system has been designed in accordance with the Stormwater Management Device in the Auckland Region Guideline Document 2017/001/ Version 1 (GD01).

Treatment for stormwater runoff from the site is via a treatment swale located inside the dry pond. Swale calculations are attached in appendix E and a typical cross section can be found on the engineering plans attached in appendix A. The small catchment to the west will be offset by the treatment swale inside the proposed pond.

3.8 SECONDARY STORMWATER SYSTEM

A secondary stormwater system is intended to be used in the event of failure of the primary system (i.e., blockage of the pipes) or when the storm event exceeds the design of the primary system. The secondary stormwater system of this development has been designed to cater for storm events up to and including the 1% AEP and is in general accordance with section 4.3 of the SWCOP.

3.8.1 OVERLAND FLOWPATHS (OLFP)

An OLFP has been designed to convey the 1% AEP for the site and the upper catchment. The OLFP has been split up into 3 sections based on the catchment that is draining to it and the material that the OLFP will be constructed of. The treatment swale starts from chainage 0.0 and extends to chainage 93.0. It hasn't been designed to cater for the 1% AEP because it is inside the pond and any stormwater that overtops the pond will be managed inside the pond. From chainage 93.0 to chainage 103.0, the treatment swale transitions to a grassed OLFP (OLFP 1) until chainage 148.0, where it then transitions to a metalised OLFP (OLFP 2) from chainage 148.0 – 153.0. OLFP 2 extends to chainage 210.0. The engineering design plans attached in appendix A show the location of the OLFP/swale and the typical cross sections for each part of the OLFP/swale.

Appendix A: Engineering Designs Plans

**DEVELOPMENT AT 1799A GREAT SOUTH ROAD, BOMABY
FOR VERNON DEVELOPMENTS LIMITED**

ENGINEERING

**SHEET 1, DRAWING No. J2224-1
PRE-DEVELOPMENT CONTOUR PLAN**

**SHEET 2, DRAWING No. J2224-2
EXISTING CONTOUR PLAN**

**SHEET 3, DRAWING No. J2224-3
POST DEVELOPMENT CONTOUR PLAN**

**SHEET 4, DRAWING No. J2224-4
ISOPACH PLAN**

**SHEET 5, DRAWING No. J2224-5
EROSION & SEDIMENT CONTROL PLAN**

**SHEET 6, DRAWING No. J2224-6
OVERALL STORMWATER PLAN**

**SHEET 7, DRAWING No. J2224-7
DEVELOPMENT PLAN 1**

**SHEET 8, DRAWING No. J2224-8
DEVELOPMENT PLAN 2**

**SHEET 9, DRAWING No. J2224-9
STORMWATER DETAILS 1**

**SHEET 10, DRAWING No. J2224-10
STORMWATER DETAILS 2**

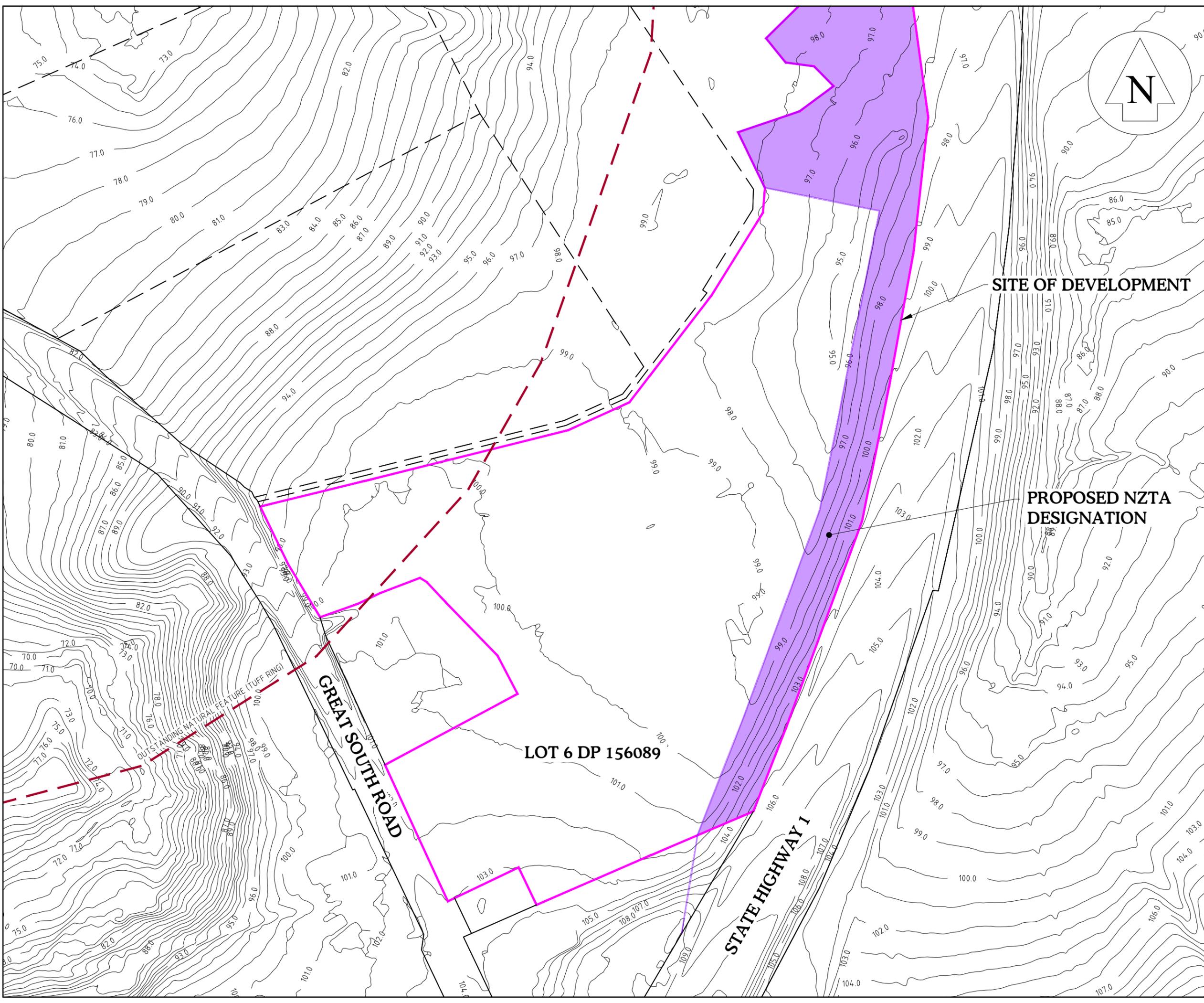
**SHEET 11, DRAWING No. J2224-11
STORMWATER DETAILS 3**

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**FEBRUARY 2025
PROJECT NO: J2224
FOR A RETROSPECTIVE CONSENT
CONTROLLING AUTHORITY:
AUCKLAND COUNCIL**



- GENERAL NOTES**
1. LEVELS ARE IN TERMS OF NZ VERTICAL DATUM 2016.
 2. COORDINATES ARE IN TERMS OF MOUNT EDEN CIRCUIT 2000.
 3. PRE-DEVELOPMENT CONTOURS SOURCED FROM AUCKLAND COUNCIL GEOMAPS.

LEGEND

PRE-DEVELOPMENT CONTOURS (GIS)		(1.0m INTERVALS)
OUTSTANDING NATURAL FEATURE (TUFF RING)		
PROPOSED NZTA DESIGNATION		

Amendments	Name	Date

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	Name	Date
Surveyed	Auckland Council Geomaps	N/A
Designed	Sam Furniss	02/25
Drawn	Sam Furniss	02/25
Checked	Avneet Kumar	02/25
Approved	Craig Forrester	02/25

TSC
 THE SURVEYING COMPANY
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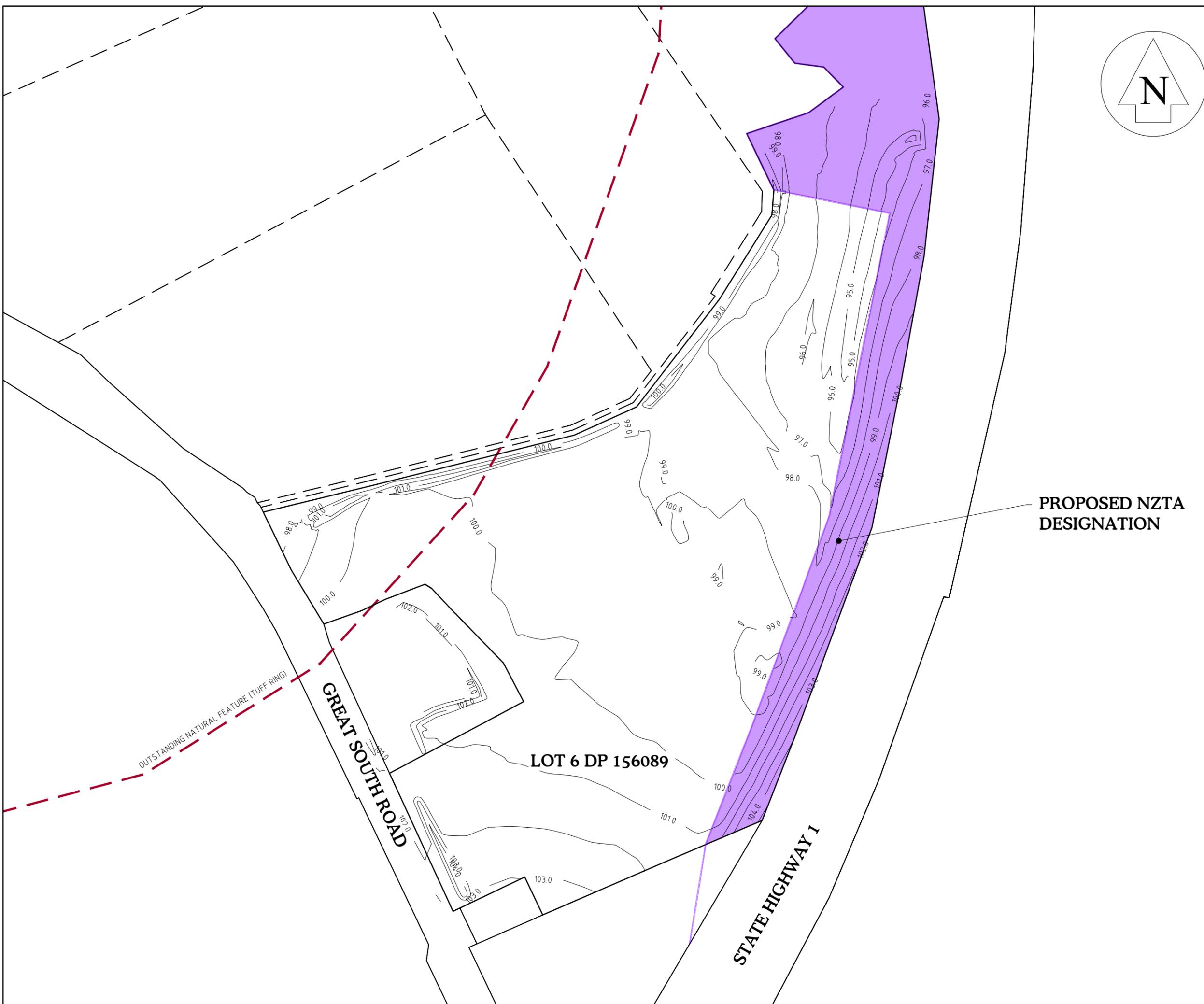
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Job Title
RETROSPECTIVE WORKS AT 1799A GREAT SOUTH ROAD, BOMBAY

Client
VERNON DEVELOPMENTS LTD

Sheet Title
PRE-DEVELOPMENT CONTOUR PLAN

Project	J2224	Drawing	J2224-1
CAD Ref. File	C-502-01	Council Ref.	ABC21680658
Scale (A3 Original)	1:2000	Amendment	----



PROPOSED NZTA DESIGNATION

GENERAL NOTES

1. LEVELS ARE IN TERMS OF NZ VERTICAL DATUM 2016.
2. COORDINATES ARE IN TERMS OF MOUNT EDEN CIRCUIT 2000.

LEGEND

- EXISTING CONTOURS (1.0m INTERVALS)
- OUTSTANDING NATURAL FEATURE (TUFF RING)
- PROPOSED NZTA DESIGNATION

Amendments	Name	Date

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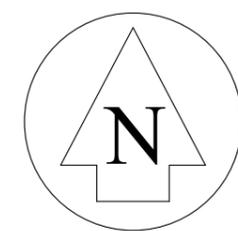
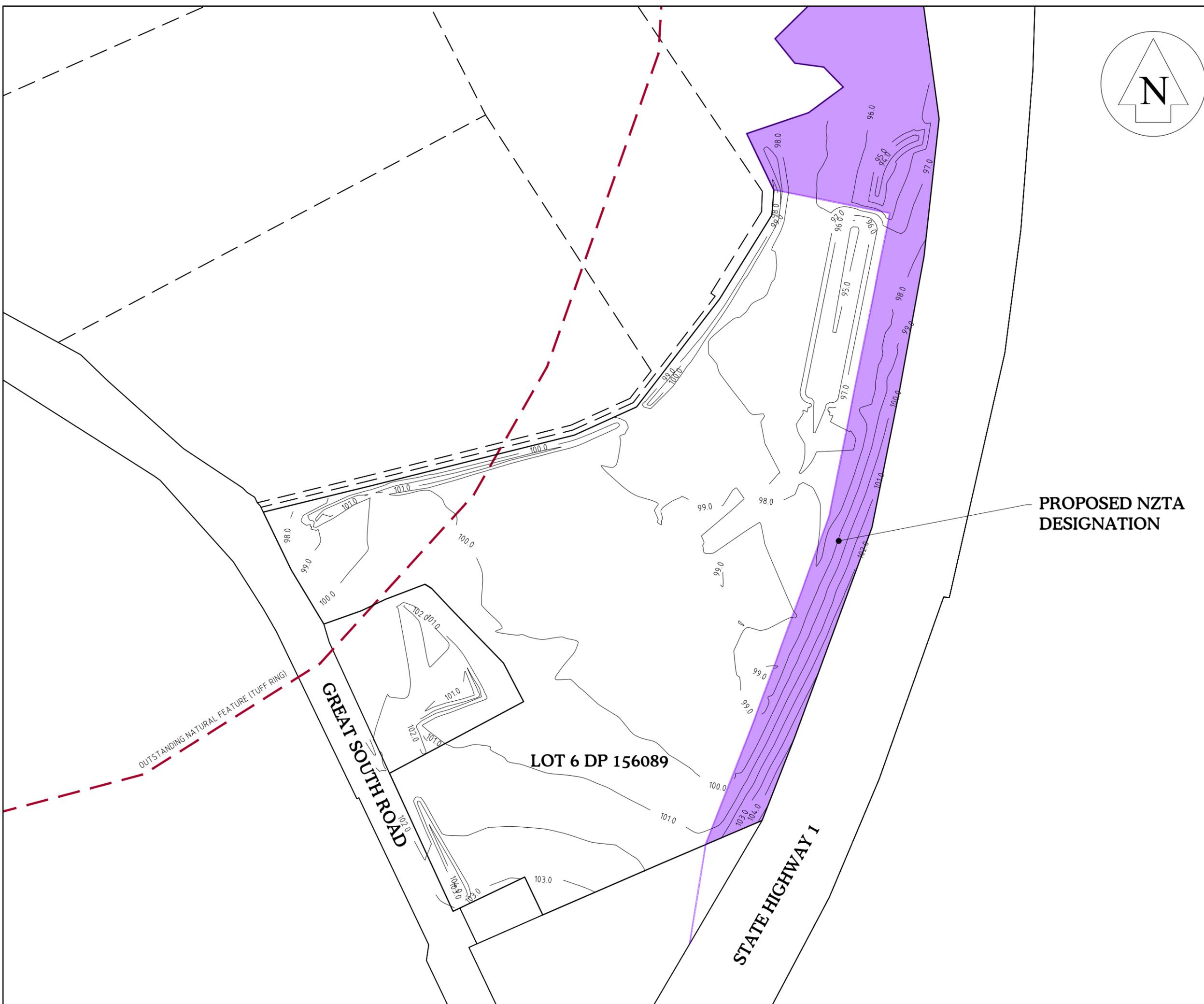
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Job Title
RETROSPECTIVE WORKS AT 1799A GREAT SOUTH ROAD, BOMBAY

Client
VERNON DEVELOPMENTS LTD

Sheet Title
EXISTING CONTOUR PLAN

Project		Drawing	
J2224		J2224-2	
CAD Ref. File		Council Ref.	
C-502-01		ABC21680658	
Scale (A3 Original)		Amendment	
1:2000		----	



- GENERAL NOTES**
1. LEVELS ARE IN TERMS OF NZ VERTICAL DATUM 2016.
 2. COORDINATES ARE IN TERMS OF MOUNT EDEN CIRCUIT 2000.

LEGEND

PROPOSED CONTOURS	(1.0m INTERVALS)
OUTSTANDING NATURAL FEATURE (TUFF RING)	
PROPOSED NZTA DESIGNATION	

Amendments	Name	Date

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	Name	Date
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Approved	Craig Forrester	02/25



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Job Title
**RETROSPECTIVE WORKS
 AT 1799A GREAT SOUTH
 ROAD, BOMBAY**

Client
**VERNON
 DEVELOPMENTS LTD**

Sheet Title
**POST DEVELOPMENT
 CONTOUR PLAN**

Project	J2224	Drawing	J2224-3
CAD Ref. File	C-502-01	Council Ref.	ABC21680658
Scale (A3 Original)	1:2000	Amendment	----

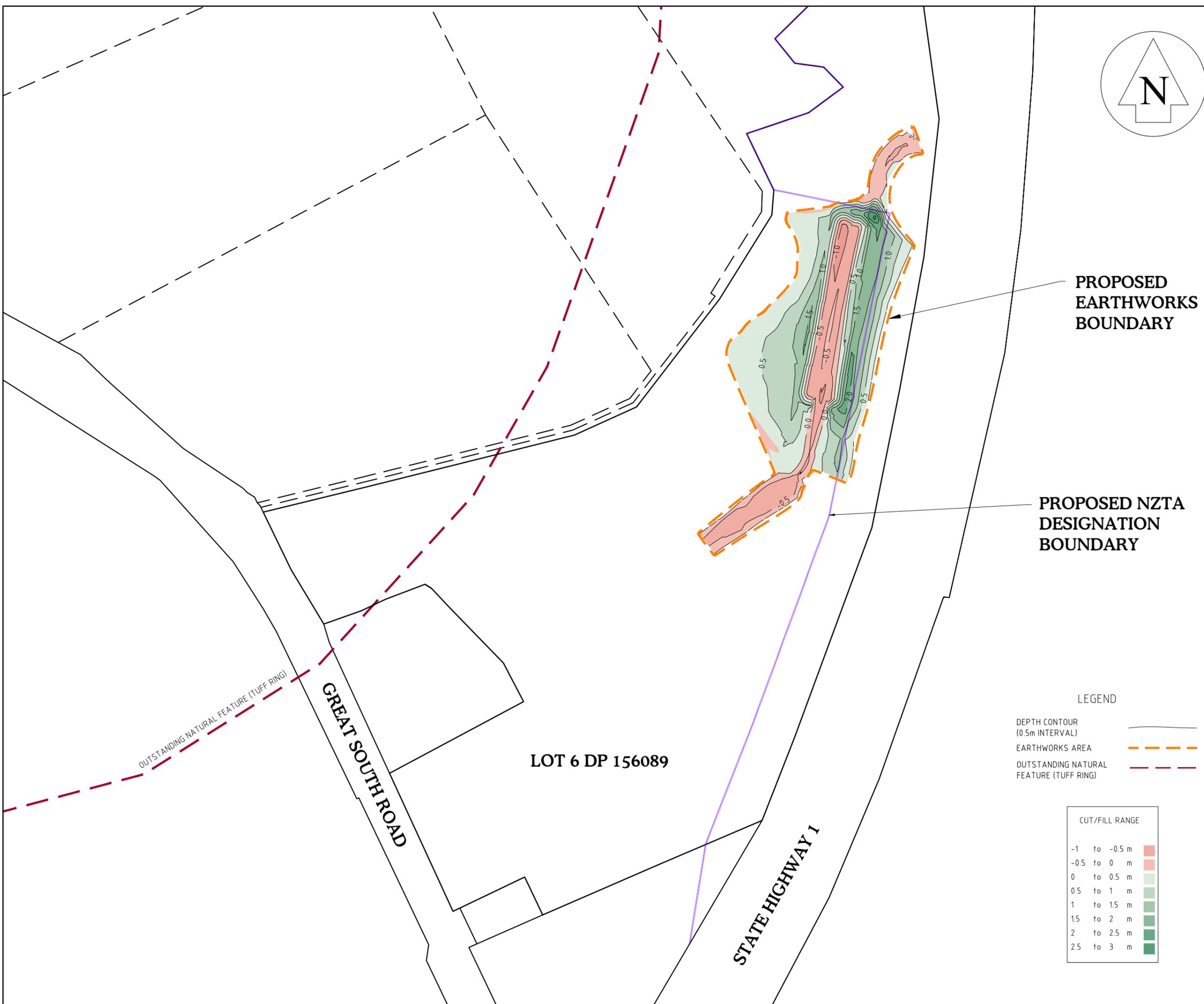
**PROPOSED NZTA
 DESIGNATION**

LOT 6 DP 156089

GREAT SOUTH ROAD

STATE HIGHWAY 1

OUTSTANDING NATURAL FEATURE (TUFF RING)



PROPOSED EARTHWORKS BOUNDARY

PROPOSED NZTA DESIGNATION BOUNDARY

LEGEND

- DEPTH CONTOUR (0.5m INTERVAL)
- EARTHWORKS AREA
- OUTSTANDING NATURAL FEATURE (TUFF RING)

CUT/FILL RANGE	
-1 to -0.5 m	
-0.5 to 0 m	
0 to 0.5 m	
0.5 to 1 m	
1 to 1.5 m	
1.5 to 2 m	
2 to 2.5 m	
2.5 to 3 m	

GENERAL NOTES

1. LEVELS ARE IN TERMS OF NZ VERTICAL DATUM 2016.
2. COORDINATES ARE IN TERMS OF MOUNT EDEN CIRCUIT 2000.
3. EARTHWORKS ARE NOT TO BE EXTENDED INTO ADJOINING SITES UNLESS THE ENGINEER HAS ISSUED SPECIFIC INSTRUCTIONS.
4. ALL EROSION AND SEDIMENT CONTROL DEVICES TO BE INSTALLED, AS-BUILT AND INSPECTED BY THE ENGINEER / COUNCIL PRIOR TO COMMENCING BULK EARTHWORKS ON SITE.
5. ALL EARTHWORKS TO BE INSPECTED BY CLIENT'S GEOTECHNICAL ENGINEER.
6. SUBSOIL DRAINS, IF REQUIRED, ARE TO BE CONFIRMED ON SITE DURING CONSTRUCTION BY ENGINEER.
7. CUT TO FILL OPERATIONS, THE MATERIAL WILL BE LIFTED, TRANSPORTED, PLACED IN 200-300mm LAYERS AND THEN COMPACTED WITH A SHEEPSFOOT ROLLER TO ENSURE THE REQUIRED COMPACTION IS OBTAINED.
8. TOPSOIL WILL BE CULTIVATED AND REVEGETATED.
9. EARTHWORKS VOLUMES ARE FROM EXISTING SURFACE LESS TOPSOIL STRIPPED (200mm) AND FINISHED SUBGRADE LEVELS AND ARE:
 - TOPSOIL VOLUME 2,290m³
 - TOTAL CUT 508m³
 - TOTAL FILL 8,323m³
 - MAX CUT DEPTH 1.0m
 - MAX FILL DEPTH 3.0m
9. EARTHWORKS AREA IS 11,449m².

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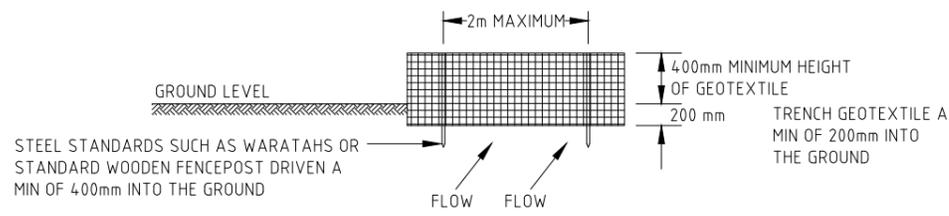
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Job Title
RETROSPECTIVE WORKS AT 1799A GREAT SOUTH ROAD, BOMBAY

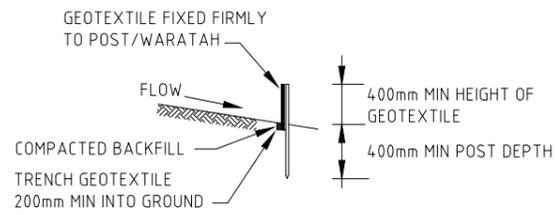
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ISOPACH PLAN

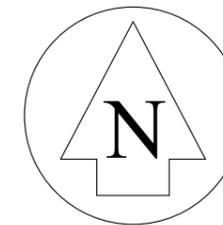
Project	J2224	Drawing	J2224-4
CAD Ref. File	C-502-01	Council Ref.	ABC21680658
Scale (A3 Original)	1:2000	Amendment	----



SILT FENCE ELEVATION



SILT FENCE CROSS SECTION



CATCHMENT 1 AREA: 500m²
- TO BE PROGRESSIVELY STABILISED

INSTALL SILT FENCE DURING CONSTRUCTION OF POND

CATCHMENT 2 AREA: 7,936m²
- TO BE MANAGED INITIALLY WITH SILT FENCE AND THEN WITH THE CONSTRUCTION OF THE POND ITSELF

CATCHMENT 3 AREA: 2,589m²
- TO BE PROGRESSIVELY STABILISED

OUTSTANDING NATURAL FEATURE (TUFF RING)

GREAT SOUTH ROAD

LOT 6 DP 156089

STATE HIGHWAY 1

GENERAL NOTES

1. LEVELS ARE IN TERMS OF NZ VERTICAL DATUM 2016.
2. COORDINATES ARE IN TERMS OF MOUNT EDEN CIRCUIT 2000.

LEGEND

- EXISTING CONTOURS
- OUTSTANDING NATURAL FEATURE (TUFF RING)
- PROPOSED NZTA DESIGNATION
- SILT FENCE
- CATCHMENT AREA

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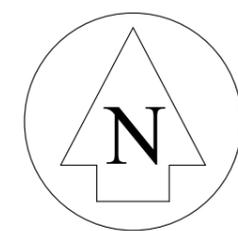
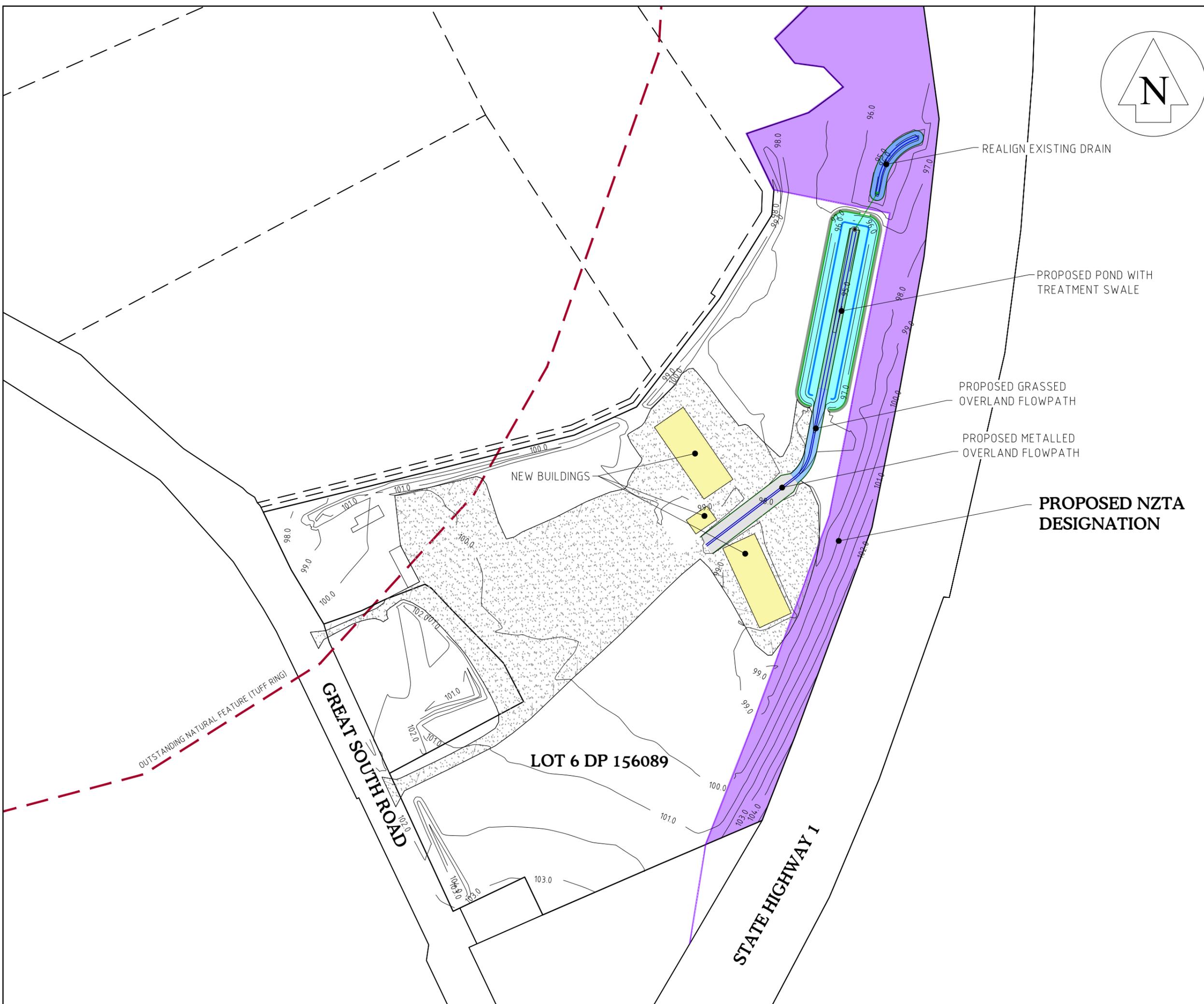
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Sheet Title
EROSION & SEDIMENT CONTROL PLAN

Project	J2224	Drawing	J2224-5
CAD Ref. File	C-502-01	Council Ref.	ABC21680658
Scale (A3 Original)	1:2000	Amendment	----



- GENERAL NOTES**
- LEVELS ARE IN TERMS OF NZ VERTICAL DATUM 2016.
 - COORDINATES ARE IN TERMS OF MOUNT EDEN CIRCUIT 2000.

LEGEND

PROPOSED CONTOURS (1.0m INTERVALS)	
OUTSTANDING NATURAL FEATURE (TUFF RING)	
PROPOSED NZTA DESIGNATION	
METAL	
NEW BUILDINGS	
OVERLAND FLOWPATH (GRASSED)	
OVERLAND FLOWPATH (METALLED)	

Amendments	Name	Date

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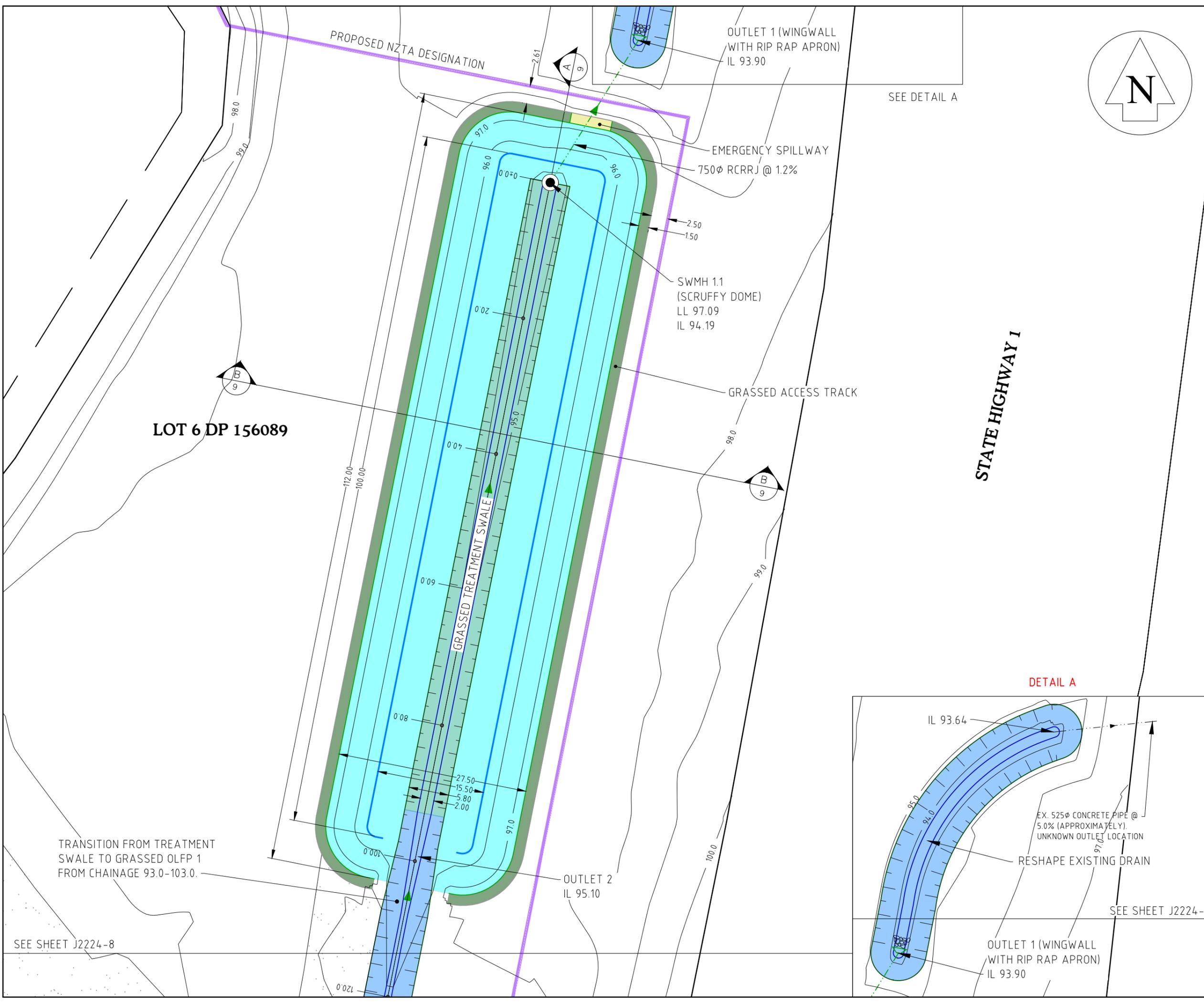
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RETROSPECTIVE WORKS AT 1799A GREAT SOUTH ROAD, BOMBAY

Client
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Sheet Title
OVERALL STORMWATER PLAN

Project	J2224	Drawing	J2224-6
CAD Ref. File	C-502-01	Council Ref.	ABC21680658
Scale (A3 Original)	1:2000	Amendment	----



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LEGEND

PROPOSED CONTOURS	
PROPOSED NZTA DESIGNATION	
PROPOSED STORMWATER	
PROPOSED STORMWATER MANHOLE	
TREATMENT SWALE	
OVERLAND FLOWPATH	

Amendments	Name	Date

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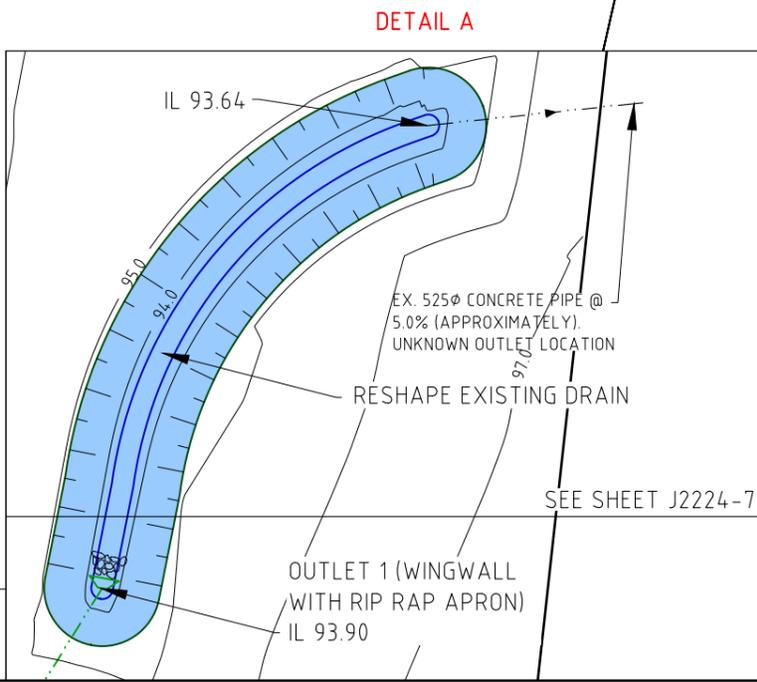
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RETROSPECTIVE WORKS AT 1799A GREAT SOUTH ROAD, BOMBAY

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Sheet Title
DEVELOPMENT PLAN 1

Project	J2224	Drawing	J2224-7
CAD Ref. File	C-502-01	Council Ref.	ABC21680658
Scale (A3 Original)	1:500	Amendment	----



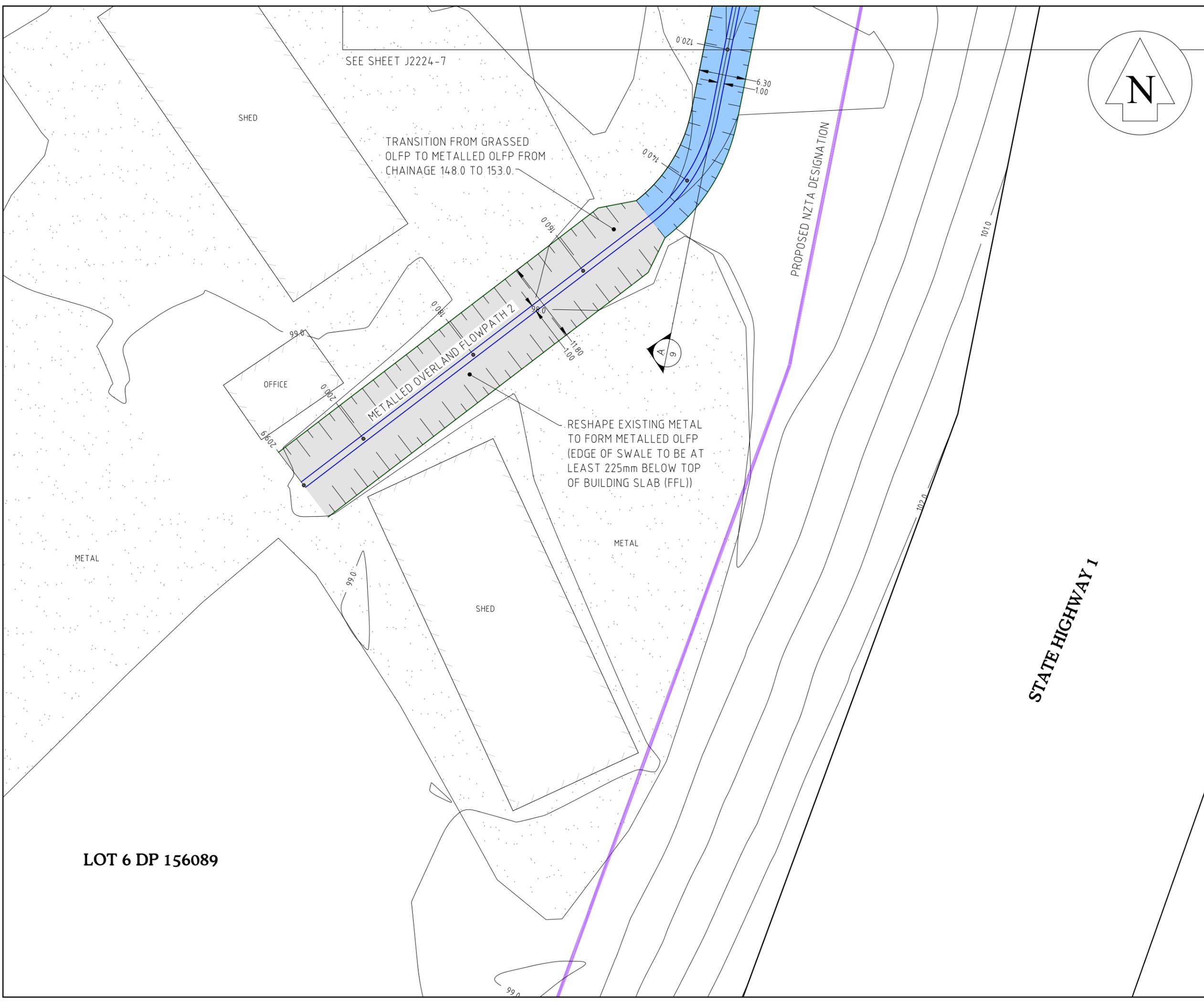
SEE SHEET J2224-8

LOT 6 DP 156089

STATE HIGHWAY 1

SEE DETAIL A





- GENERAL NOTES**
1. LEVELS ARE IN TERMS OF NZ VERTICAL DATUM 2016.
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LEGEND

PROPOSED CONTOURS	
PROPOSED NZTA DESIGNATION	
PROPOSED STORMWATER MANHOLE	
METAL	
OVERLAND FLOWPATH (GRASSED)	
OVERLAND FLOWPATH (METALLED)	

Amendments	Name	Date

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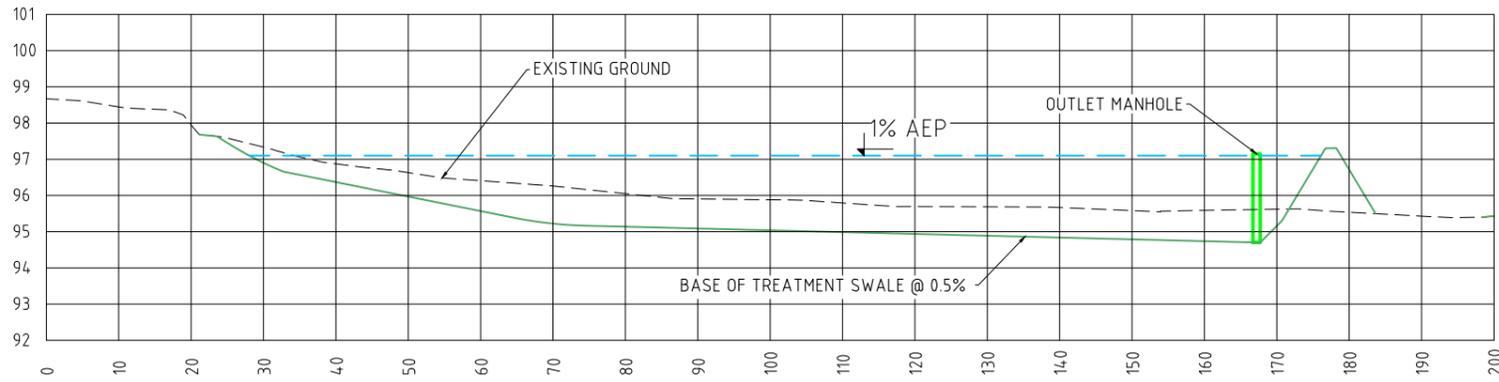
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Sheet Title
DEVELOPMENT PLAN 2

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CAD Ref. File	C-502-01	Council Ref.	ABC21680658
Scale (A3 Original)	1:500	Amendment	----

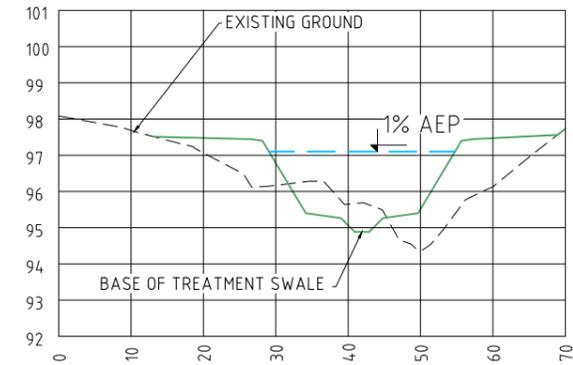
LOT 6 DP 156089

STATE HIGHWAY 1



CROSS SECTION A

HOR. SCALE 1:1000
VERT. SCALE 1:200



CROSS SECTION B

HOR. SCALE 1:1000
VERT. SCALE 1:200

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LEGEND

EXISTING SURFACE	
DESIGN SURFACE	

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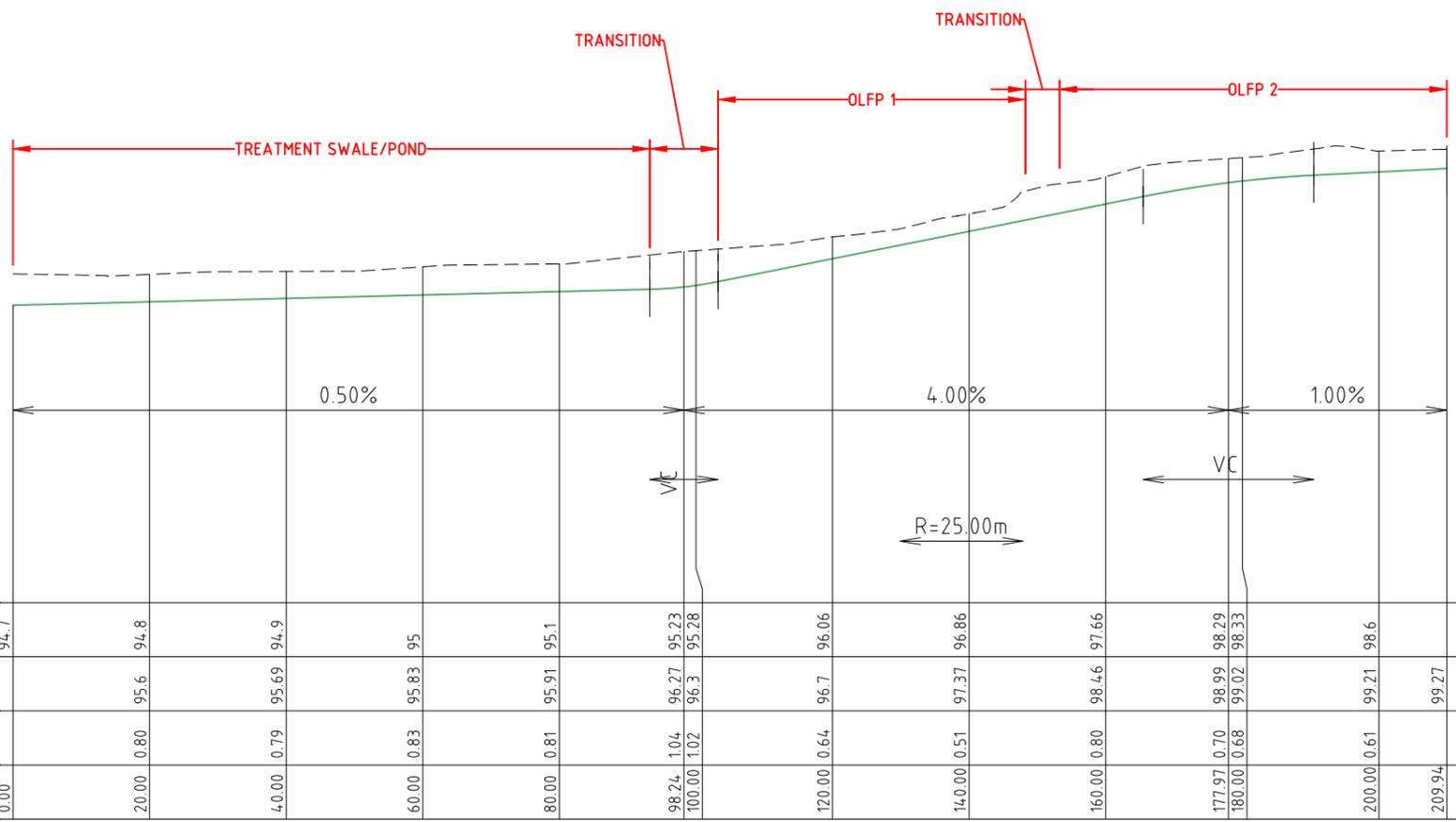
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Job Title
RETROSPECTIVE WORKS AT 1799A GREAT SOUTH ROAD, BOMBAY

Client
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Sheet Title
STORMWATER DETAILS 1

Project	J2224	Drawing	J2224-9
CAD Ref. File	C-502-01	Council Ref.	ABC21680658
Scale (A3 Original)	AS SHOWN	Amendment	----

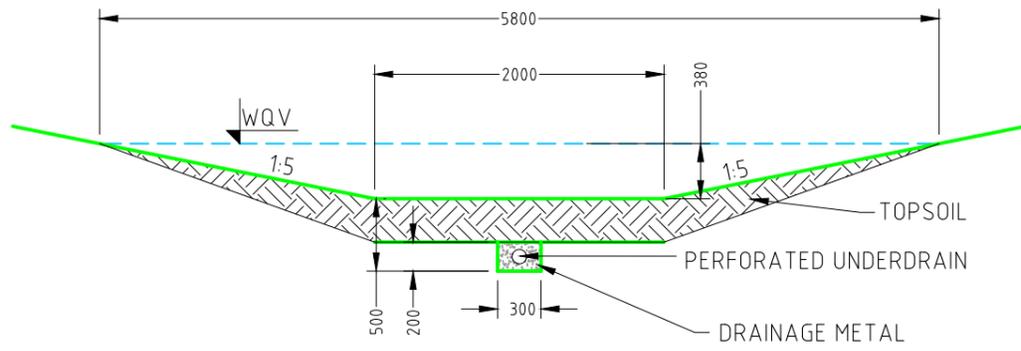


DESIGN GRADELINE
VERTICAL GEOMETRY
HORIZONTAL GEOMETRY
DATUM RL 86.00

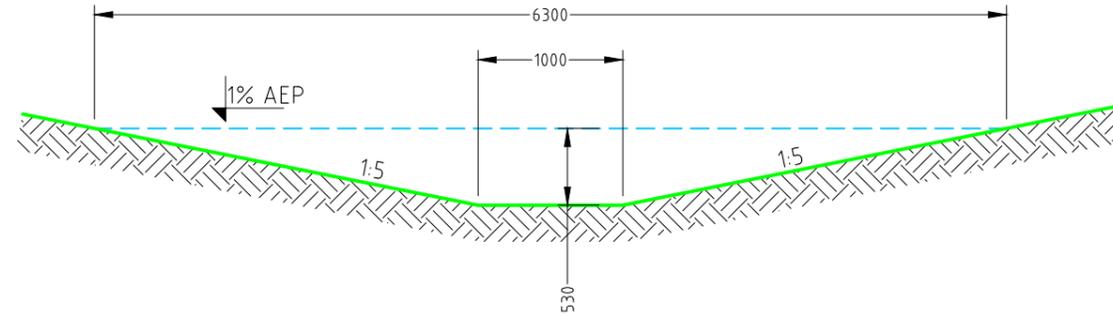
DESIGN LEVELS	94.7	94.8	94.9	95	95.1	95.23 95.28	96.06	96.86	97.66	98.29 98.33	98.6	99.27
EXISTING SURFACE		95.6	95.69	95.83	95.91	96.27 96.3	96.7	97.37	98.46	98.99 99.02	99.21	99.27
DEPTHS		0.80	0.79	0.83	0.81	1.04 1.02	0.64	0.51	0.80	0.70 0.68	0.61	
CHAINAGES	0.00	20.00	40.00	60.00	80.00	98.24 100.00	120.00	140.00	160.00	177.97 180.00	200.00	209.94

SWALE/OVERLAND FLOWPATH LONG SECTION

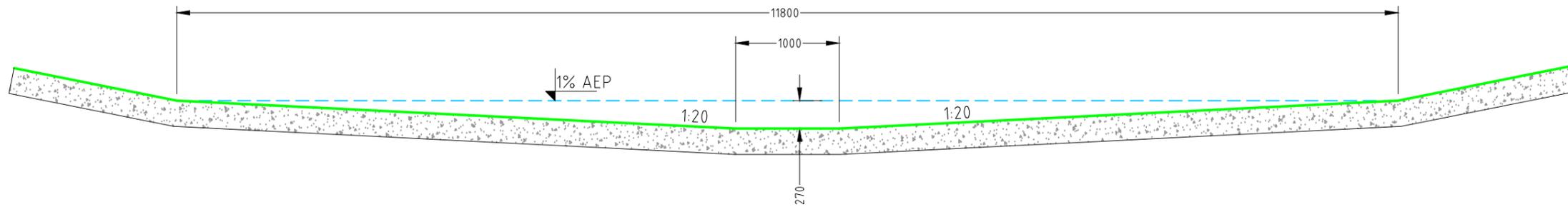
HOR. SCALE 1:1000
VERT. SCALE 1:200



TYPICAL TREATMENT SWALE CROSS SECTION - GRASED
(CHAINAGE 0.0 - 93.0)
 SCALE 1:50

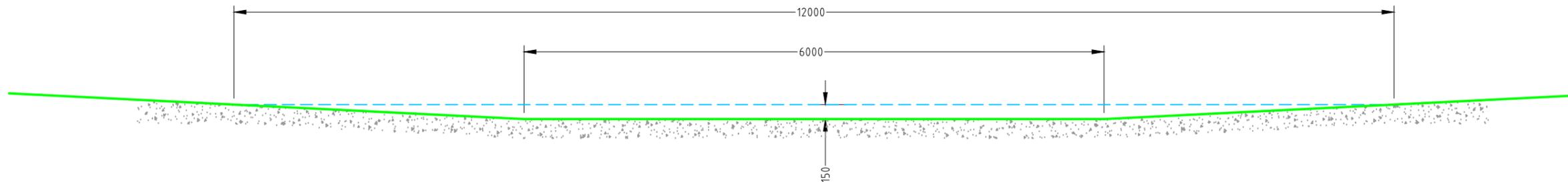


TYPICAL OLFP 1 CROSS SECTION - GRASED
(CHAINAGE 103.0 - 148.0)
 SCALE 1:50



TYPICAL OLFP 2 CROSS SECTION - METALLED
(CHAINAGE 153.0 - 209.9)
 SCALE 1:50

- NOTE:
1. UNDERCUT PROVIDED LEVELS TO ALLOW FOR MINIMUM 100mm OF TOPSOIL FOR OLFP AND MINIMUM 300mm OF TOPSOIL FOR TREATMENT SWALE
 2. SWALE TO BE LINED COCONUT MATTING OR SIMILAR APPROVED MATERIAL
 3. SUBSOIL TO BE PLACED UNDER TREATMENT SWALE



EMERGENCY SPILLWAY
 SCALE 1:50

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Client
VERNON DEVELOPMENTS LTD

Sheet Title
STORMWATER DETAILS 3

Project	J2224	Drawing	J2224-11
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Scale (A3 Original)	AS SHOWN	Amendment	----

Appendix B: Geotechnical Report

1799a Great South Road, Bombay

Geotechnical Assessment and Stormwater Management Report



Vernon Developments Ltd

Job No. IZ21923

21/04/2023



TILSLEY ENGINEERING LTD

CONSULTING ENGINEERS AND ENVIRONMENTAL CONSULTANTS

1799a Great South Road, Bombay

Geotechnical Assessment and Stormwater Management Report

Client: Vernon Developments Ltd

Prepared by:

TILSLEY ENGINEERING LTD, NEW ZEALAND

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21/04/2023

Job No: IZ21923

Quality Information

Rev	Revision Date	Details	Authorised	
			Prepared by	Reviewed by
0	21/04/2023	Issued to Client	 Ivan Zhang BE (Hons) Civil	 R Tilsley (CMEngNZ, CPEng) Director Sig#K344



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1. INTRODUCTION

1.1 Project Overview

Tilsley Engineering Ltd has been engaged by the client to provide a geotechnical assessment and provide stormwater management recommendations for a proposed building site at 1799a Great South Road, Bombay.

The scope of this report encompasses geotechnical suitability, foundation, general site development recommendations and stormwater management recommendations in support of future resource and building consent applications to the Council and for interested parties such as the builder, structural engineer, earthworks, and civil contractors.

This report includes a summary of the investigations undertaken and provides an assessment of:

- Ground conditions
- Groundwater conditions
- Liquefaction
- Ground stability
- Foundation
- Natural hazard risk assessment
- Stormwater management recommendations
- Other constraints and issues identified with the site

2. SITE INFORMATION

2.1 Site description

The property is described legally as Lot 6 Deposited Plan 156089 and is 86730 m² in area. The Lot is located on the eastern side of Great South Road. The Lot is bounded to the West, South and South by other properties. Site photographs and project location are presented in Appendix A.

2.2 Proposed site development

The proposal is construct a new shed at the middle section of the Lot close to the northwest boundary. The location of the proposed shed is shown on the attached site plan.

3. DESKTOP STUDY

We are unaware of any previous geotechnical, wastewater and stormwater reports which have been undertaken on the proposed building site.

Aerial photographs available from Google Earth and Council GeoMaps GIS database dating from 2003 to 2022 were studied to observe the site over time and assess the geomorphological setting. Based on the review of historical aerial images and the site visit, there have not been any ground movements or soil instabilities at the location of the building platform.

3.1 Published Geology

From the geological map of Auckland (Institute of Geological & Nuclear Sciences Ltd, 1:250,000) in Figure 1 together with our experience of the surrounding areas, we infer the soils of the site are designated 'Qvs' undifferentiated Kerikeri Volcanic Group basalt lava of South Auckland Volcanic Field. These are basaltic soils formed from scoria, lapilli, and ash originating from local volcanic events, which took place some 1 – 2 million years ago.



Figure 1 Extract from the published GNS geological map

3.2 Faults

A review of the Institute of Geological and Nuclear Sciences Ltd (GNS) Active Fault Database (GNS Science, 2018) shows that there are no active faults within 10km of the site, although blind or unmapped faults may be present.

4. GEOTECHNICAL INVESTIGATION

4.1 Field investigation

On 18 April 2023, Tilsley Engineering Ltd conducted investigations for the project area, which consisted of the following:

- A detailed walkover inspection of the site.
- Drilling five hand auger holes, HA01, HA02, HA03, HA04 and HA05 at the proposed building area.

The locations of all field tests were measured from existing site features and inferred boundaries without survey control and are therefore approximate only. Test locations are shown in Appendix A.

Measurements of the undrained shear strengths were undertaken in the auger holes at intervals of depth by means of a handheld shear vane.

Visual-tactile field classification of the soils encountered during drilling was carried out in accordance with "Guidelines for the Field Classification and Description of Soil and Rock for Engineering Purposes", issued by the New Zealand Geotechnical Society Inc. (2005). Test results are shown in Appendix B.

No inference on the type of soils or the bearing capacity is made outside the area where the buildings are proposed to be located.

4.2 Site subsurface conditions

Subsurface conditions encountered at the test locations are summarised below and a detailed description of the soils encountered during the investigations are given on the attached investigation logs. Conclusions and recommendations contained in this report are based on the results of our field investigation and in-situ testing within auger holes at point locations and information from geological maps.

The nature and continuity of the soil conditions away from the test locations are inferred, however actual soil conditions could vary from the assumed model. This is particularly so where previous manmade disturbances and placement of non-engineered fill may have occurred in the past, typically associated with landscaping or previous construction activities.

The subsurface conditions and groundwater underlying the site are summarised in Table 1 and Table 2 below:

Table 1 Summary of hand-held vane shear strength

Test Location	Termination Depth (m)	Depth of Topsoil (m)	Peak Shear Strength Range (kPa) Residual Soil	Residual Shear Strength Range (kPa) Residual Soil	Depth to Groundwater (m)
HA01	2.5	0.2	179 - >220	62 - 91	NE
HA02	2.0	0.25	172 - >220	49	NE
HA03	2.0	0.25	>220	-	NE
HA04	2.5	0.25	132 - >220	46	NE
HA05	2.5	0.2	>220	-	NE

All depths measured in meters below present ground level. NE = Not Encountered

Table 2 Recommended geotechnical units strength

Unit	Material	Peak shear strength (kPa) Typical (min-max)	Residual shear strength (kPa) Typical (min-max)	Soil sensitivity
1	Topsoil	-	-	-
2	Residual Soils	132 (155 - >220)	60 (46 - 91)	2.2

Topsoil. Topsoil over the project area generally is to depths of around 0.2m to 0.25m below existing ground level. It is described as brown and friable.

Fill. No Non-Engineered fill was encountered in the auger holes.

Residual soil deposit. Residual soils deposits were encountered underlying the Topsoil within hand auger holes HA01 - HA05. The volcanic soils typically comprised very stiff Clayey SILT to Silty CLAY with traces of ash, scoria, and sand.

Shear Vane Testing. Shear vane testing was carried out in auger holes HA01 - HA05. The results are shown in the tables and bore logs.

Groundwater. No groundwater was encountered in any auger holes. Groundwater level is expected to be at least 2.5m below the surface.

4.3 Geomorphology

The proposed shed is located on the flat section of the Lot. According to observation and the topographical and Council GIS contour map, the land at the location of the proposed building area is gently sloping to the east and northeast with a maximum slope angle of 4 degrees. There are no steep slopes (>14 degrees) within 30m of the proposed building area. The site location with contours and water features is shown in Appendix A.

4.3.1 Site surface water features

Auckland Council GeoMaps shows there are overland flow paths on the Lot. From our site investigation, there is no overland flow path running through the proposed building area.

4.3.2 Flooding

The proposed building platform is above the 1% AEP flood plain as per the Auckland Council GeoMaps. Therefore, there is a low risk of flooding for the proposed development.

4.4 Site services

Site-specific searches are not undertaken for the site utilities and services for the purpose of this report. However, at the time of our site investigation, there was no evidence of any reticulated services in the vicinity of the proposed building site.

4.5 Geotechnical design parameters

The selection of geotechnical strength parameters for use in building foundation design is based on the field investigation data, published correlations and our experience with such materials. The recommended parameters for design are set out in Table 3 for the Lot.

Table 3 Recommended geotechnical design parameters

Unit	Material	Bulk density, γ (kN/m ³)	Design undrained shear strength, S_u (kPa)	Drained effective cohesion, c' (kPa)	Drained effective friction, ϕ' (deg.)
2	Residual Soils	18	70	3	28

Note: The lower bound values have been conservatively used for the design parameters but can be further refined for specific structures with geotechnical data in the vicinity.

5. ENGINEERING CONSIDERATIONS

The recommended parameters for the geotechnical aspects of the proposed development have been considered principally with the aim of demonstrating that safe and stable conditions for the proposed building site are presently available or are achievable with appropriate remedial works/constraints. This has been considered with respect to the following information, standards, guidelines, and codes:



- New Zealand Building Code: Clauses B1, E1, G12 & G13.
- MBIE Guidelines Modules “Earthquake geotechnical engineering practice series”
- NZS 3604:2011: “Timber-framed buildings”.
- AS 2870:2011: “Residential slabs and footings”.
- NZS 1170 Structural Design Action Part 5: Earthquake actions – New Zealand (2004).
- District and Regional Plan provisions on residential development.
- Council development codes, standards, and guides on residential development.

The proposed building site is presently appropriate or achievable with appropriate remedial works/constraints.

5.1 Site subsoil class

Based on the results of the site investigations and our experience in the area, in accordance with NZS 1170.5:2004, the Site is classified as a Class C shallow soil site.

5.2 Soil liquefaction susceptibility

The soil layers comprise of stiff to very stiff cohesive material across most of the site. No groundwater was observed during the investigation. Due to the cohesive nature of the majority of the geotechnical units and low design level earthquake event, the risk of liquefaction is low to negligible. Therefore, no specific design is required in relation to liquefaction effects.

5.3 Expansive soils

5.3.1 Classification

The site can be classified as Class “M” for the expansiveness of the soil for the foundation based on Table 2.1 of AS2870. Characteristic surface movement $22 < (y_s) \leq 44\text{mm}$. Therefore, the soils are not considered to lie within the definition of “good ground” as per NZS3604. Specific engineering design shall be undertaken by a qualified engineer experienced in the design of footing systems.

5.3.2 Subgrade Preparation/Protection

Considering the importance of expansive soils, once the exposed subgrade has been inspected by a Geo-Professional, it shall be covered with 150mm of granular fill such as the GAP40 base course as soon as possible. The footing inverts shall be poured as soon as possible once inspected by a Geo-Professional or covered with a protective layer of site concrete. If subgrade degradation occurs by:

- excessive drying out resulting in desiccation shrinkage cracking or
- subgrade softening after a period of wet weather,

it is recommended to undercut the depth of the degraded zone and replace that material immediately with granular fill.

5.4 Slope stability assessment

5.4.1 Qualitative stability assessment

Global Stability

A walkover inspection of the site was carried out. No signs of deep-seated instability were observed.

Local Stability

The proposed shed is located on the flat section of the Lot. Ground inclinations are generally gentle across the project area, with slopes of up to 4° present at the proposed building area. There are no steep slopes (>14 degrees) within 30m of the proposed building area. Hence ground instability affecting the proposed development is considered to be unlikely. Specific slope stability assessment is not required.

5.5 Bearing capacity

Bearing capacity is based on the ultimate limit state design methods outlined in AS/NZS 1170. As such, in accordance with AS/NZS 1170, The “ultimate”, “dependable” and “allowable bearing capacity” for foundation design is recommended. The foundations shall be designed by a Chartered Professional Engineer, with their design considering the expansiveness of the soils and their effect on the foundations.

5.5.1 Shallow foundations

The design strength of the shallow foundation for the Lot is set out in Table 4. Topsoil shall be stripped beneath and 1m outside the building footprint.

The building platform shall be checked by a Chartered Professional Engineer or their representative who is experienced in geo-mechanics.

Table 4 Shallow foundation design bearing capacity

Type	Ultimate bearing capacity, q_{ult}	Dependable bearing capacity, q_{dbs}	Allowable bearing capacity, q_{abs}
Raft/ Strip/Pad	300kPa	150kPa	100kPa

Notes: Design bearing strength shall be determined using suitable strength reduction factors.
Based on B1/VM4 recommendation for shallow foundations.

5.5.2 Shallow pile foundations

Shallow piles (anchor piles and braced piles) shall be designed as per NZS 3604 and NZD AS2870. They shall be designed by a Chartered Professional Engineer who is familiar with these standards.

5.5.3 Deep pile foundations

The recommended geotechnical capacities are as set out in Table 5. The depth of piles shall be determined by a Chartered Professional Engineer.

Table 5 Pile end bearing design capacity

Design parameter applicable depth	Ultimate (failure) geotechnical pile shaft side	Ultimate (failure) geotechnical pile end	Strength reduction factor, Φ	Pile design shaft side friction strength	Pile design end bearing capacity
-----------------------------------	---	--	-----------------------------------	--	----------------------------------

	friction capacity	bearing capacity			
0.25-0.5m (bgl)	NA	300kPa	0.5	NA	150kPa
0.5-2.5m (bgl)	30kPa	300kPa	0.5	15kPa	150kPa

Notes:

1. End bearing design strengths shall be determined using suitable strength reduction factors. Based on B1/VM4. Strength reduction factor selection may be refined using the risk-based procedure set out in AS 2159.
2. Shaft side friction design strengths shall be determined using suitable strength reduction factors, based on B1/VM4 for bored piles. Strength reduction factor selection may be refined using the risk-based procedure set out in AS 2159.
3. Pile bases need to be cleaned and free of sediment or softened rock prior to concreting.
4. Pile end bearing capacity shall be checked using effective stress parameters provided in Table 7 and standard design pile methods; however calculated capacities exceeding the above values are not recommended unless proven by site-based instrumented pile load testing.
5. Pile load testing would enable adoption of higher strength reduction factors as per the risk-based procedure set out in AS 2159.

5.5.4 Settlement

The differential settlements which could affect future foundations shall be within the tolerable differential settlements of up to 1 in 240 (approximately 25 mm over a six-metre length of building) as required by the New Zealand Building Code Handbook, Appendix B Section B1A/M4, clause B1.0.2, under the serviceability limit state load combinations of NZS 4203 or NZS 1170.0, unless the structure is specifically designed to limit damage under a greater settlement.

5.6 Retaining Wall

The parameters presented in Table 3 shall be used for design of retaining walls for the site. Where possible, it is recommended that building foundations be embedded below or offset horizontally from the 45° zone of influence of the retaining wall to avoid surcharging the retaining wall with building loads.

6. DEVELOPMENT RECOMMENDATIONS

We consider that the subject site is geotechnically suitable for the proposed development. This opinion is furnished on the condition that the following recommendations are implemented during design and construction.

6.1 Earthworks

The earthworks will need to be undertaken in accordance with any applicable Council guidelines and the following requirements.

The ground is acceptable for shallow and deep foundations. The foundations shall be designed by a Chartered Professional Engineer who is familiar with the contents of this report. All pipework entering the building must enter the foundation at 90° and shall not run parallel to the foundation within 1m from the building perimeter. All earthworks shall be undertaken during the summer works period. No earthworks to be undertaken during winter works unless approved by a Chartered Professional Engineer who is experienced in geo-mechanics and is familiar with the contents of this report.



6.1.1 Fill

In areas where structural fill is to be placed to carry building loads, we recommend that all earthworks procedures and compaction testing are carried out in accordance with NZS4404 and NZS4431. Compaction of cohesive fill shall be carried out in loose layers no greater than 150mm thickness. Compaction testing shall be carried out after each 150mm of fill placement. All fill materials shall be clear of unsuitable materials as outlined above. Cohesive soils shall be suitably moisture conditioned prior to compaction, so that once compacted they achieve a minimum vane shear strength of 120kPa and maximum air voids of 10%. A Geotechnical Engineer familiar with the findings of this report shall carry out compaction testing during construction to ensure the correct level of compaction is being achieved.

All un-retained fill batters shall be not steeper than 1V:4H and shall not be higher than 0.6m. Fill batter faces shall be compacted as a separate operation or, alternatively, overfilled and cut back. Any engineered fill higher than 0.6m shall be assessed, supervised, and approved by a Chartered Professional Engineer experienced in Civil Earthworks.

6.1.2 Cut

All new un-retained cut batters shall be graded at a maximum slope of 1V: 3H and shall not be higher than 0.6m. Cut batters shall be located at a distance of at least the cut batter height from the building platform site. All cuts over 0.6m shall be assessed, supervised, and approved by a Chartered Professional Engineer experienced in Civil Earthworks, or their representative. The cut area shall be compacted and tested to a minimum allowable bearing strength of 100kPa. Retaining walls within the zone of influence for the building or surcharge load or neighbouring properties shall be designed by a structural Chartered Professional Engineer who is familiar with the contents of this report.

6.1.3 Earthworks limitation

We recommend that all earthworks procedures and compaction testing be carried out in accordance with NZS4404 and NZS4431. Any cut/fill steeper than the recommended slope may require the construction of a retaining wall specifically designed according to site conditions by a suitably qualified Structural Engineer. No cut or fill depths greater than mentioned in the above sections shall be undertaken without the approval in writing of a Chartered Professional Engineer who is experienced in geo-mechanics and is familiar with the contents of this report. This is because such works may disturb existing equilibrium conditions.

6.2 Adverse effects on foundations

Factors that can adversely influence the ground shrinkage and swelling within the vicinity of the foundations are site drainage, watering of gardens, planting of trees and leaking plumbing. For the life of the foundations, no watering shall be undertaken within 3 m of the foundations. No trees to be placed within 5 m of the foundations or further away from foundations for larger trees. Site drainage and plumbing to be regularly and well maintained. All piping shall be kept in a stiff soil layer to avoid possible differential settlement.

6.3 Driveways and services

No substantial problems are foreseen in relation to driveway construction on the Lot. A minimum CBR of 5 is anticipated. However, we recommend that further investigation of penetration resistance testing shall be conducted when the driveway is being developed to its final level, conforming to designed CBR values.

6.4 Service bridging piles

Where the proposed buildings are to span or be located in close proximity to existing underground drainage, bridging piles will be required. We, therefore, consider that any section of the building located within a 45° zone rising from the invert of the drains shall be supported on pile foundations to Council’s requirements in terms of embedment depths and offsets from the drains. Pile design parameters are provided in the above section.

6.5 Construction observation

A Geotechnical Engineer familiar with the findings of this report shall be engaged to carry out inspections during earthworks, to confirm soil conditions are consistent with those summarized within this report. It is in the interests of all parties that Tilsley Engineering are retained to inspect earthworks during construction, so that ground conditions can be compared with those assumed in formulating this report. In any event, we shall be notified of any variations in ground conditions from those described or assumed to exist. Any subgrade covered with fill or concrete prior to geotechnical inspection will be specifically excluded from completion certification.

7. NATURAL HAZARDS RISK ASSESSMENT

In accordance with Section 106 of the Resource Management Act (RMA), a qualitative natural hazards risk assessment is conducted for the proposed building site. The natural hazard consequence and likelihood of occurrence have been assessed by risk matrix as shown in Table 6, with the risk classifications defined in Table 7.

Table 6 Risk Matrix

Potential Consequences	Likelihood				
	Very Unlikely (0-5%)	Unlikely (5-45%)	Possible (45-55%)	Likely (55-95%)	Almost Certain (95-100%)
Severe	Low	Low	Moderate	High	Very High
Moderate	Negligible	Low	Moderate	Moderate	High
Minor	Negligible	Low	Low	Moderate	Moderate
Negligible	Negligible	Negligible	Negligible	Low	Low

Table 7 Risk Classification

RATING SCALE	SECTION 106 COMPLIANCE	DISCUSSION
Very high	Non-compliant	There is a high probability that severe damage to the proposed building site could arise from an identified source without appropriate remedial action
High	Non-compliant	The proposed building site is likely to experience significant damage from an identified source without remedial action
Moderate	Non-compliant	May be tolerated in certain circumstances, but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk shall be implemented as soon as practicable
Low	Compliant	Usually acceptable
Negligible	Compliant	Acceptable

Table 8 indicates the risk classification for the identified natural hazards is low to negligible for all risks apart from “soil expansivity” where appropriate mitigation measures can be reasonably

provided. As such, we consider the proposed building site fulfils Section 106 of the Resource Management Act.

Table 8 Risk Register

Risk	Potential consequences	Likelihood	Risk class	Comment	Mitigation measures
SLOPE INSTABILITY	Moderate	Unlikely	Low	Ground slopes are less than 4 degrees at the proposed building area.	N/A
SOIL EXPANSIVITY	Moderate	Possible	Moderate	Class M soils.	SED Foundations
GROUND SUBSIDENCE	Severe	Unlikely	Low	No subsidence identified at building platform location.	N/A
EARTHQUAKE	Severe	Possible	Low	See section 3.2 and 5.2	SED foundations
FLOODING	Moderate	Unlikely	Low	Elevated site, no risk	N/A
VOLCANIC ERUPTION	Severe	Very Unlikely	Negligible	Remote from active volcanos	N/A

8. STORMWATER MANAGEMENT

The calculation sheet (see Appendix C) shows that attenuation built into the proposed water tank for the new shed on the Lot will allow for a 1 in 10 year 10% AEP 10 mins storm event with allowance for 2.1 degrees climate change. This gives a value of 20.6mm over a 10 mins period. This information was gathered from Niwa HIRDS data. Stormwater volumes have been calculated in accordance with Auckland Council GD-01 and TP108.

No infrastructure on the Lot or neighbouring Lots will be adversely impacted by the proposed stormwater management design.

8.1 Roof – Proposed Shed

The new shed is proposed to have a roof area of approximately 1125m². The volume of stormwater attenuation required is 17.84m³. This can be achieved by using one 25,000L water tank (such as classic Bailey 25,000L tank or similar) for settling and attenuation. Attenuation shall be provided by a 25mm diameter orifice pipe fixed to the manufacturer's outlet point of the tank. The overflow from the tank shall be piped to the controlled outfall.

8.2 Controlled Outfall

The overflow pipe of the water tank shall be equal to or greater than the inlet pipe and will be connected to a level spreader located to the north of the new shed. The level spreader shall be 20m long and laid to contour. The level spreader may either be pinned to the surface or buried in a bubble up trench 0.3m wide and 0.3m deep. The level spreader shall reinstate sheet flow. There shall be a minimum 5m separation from the property boundary in a downhill flow direction. There is no likelihood of future developments between the level spreader and the overland flow path.



8.3 Construction of stormwater system

The stormwater system for the building shall be operational as soon as the roof is in place. This is to ensure that the ground within the vicinity of the building is not compromised by the negative effects and consequences of soil saturation. The stormwater system shall comply with NZBC clause E1.

9. SYSTEM MAINTENANCE

The equipment suppliers will offer training and maintenance support for the system. However, it is the owner's responsibility to carry out all general maintenance procedures for the system to function as designed. Attached in Appendix E are the operation and maintenance forms for the stormwater.



10. RECOMMENDATIONS

Geotechnical

- The proposed building platform within the Lot is safe and stable in its current state. A suitably qualified Chartered Professional Engineer (CPEng) or their representative shall confirm the foundations meet the required ultimate bearing capacity of 300kPa.
- The assessed AS 2870 expansive Site Class for Lot is M (Moderate) and this needs to be considered in conjunction with the foundation design parameters presented in Section 5 of this report.
- The ground for the proposed building is suitable for all type of foundations stated in Section 5.6 of this report. The soil is not considered as “good ground” in terms of NZS 3604:2011 due to soil expansivity class.
- Any future cut under and around the foundations to be inspected by a suitably qualified engineer. All works shall comply with Section 6 of this report.
- The proposed building area currently has slopes flatter than 4H:1V, therefore a specific slope stability assessment is not required.
- Due to the cohesive nature of the soils and the relatively low seismicity exhibited in the project area, the site is considered to have a low susceptibility to liquefaction under a design level earthquake event.

Stormwater

- Stormwater runoff from the roof area of the new shed shall be piped and released into one 25,000L water tank (such as classic Bailey 25,000L tank or similar) for attenuation. The volume of stormwater attenuation required is 17.84m³. The attenuation shall be provided by a 25mm diameter orifice, 1.85m below the overflow level, allowing water to flow into the overflow pipe. The overflow pipe of the water tank shall be equal to or greater than the inlet pipe and shall be piped to a 20m level spreader. See Section 8 and appendices for more details.
- The stormwater system for the building shall be operational as soon as the roof is in place. This is to ensure that the ground within the vicinity of the building is not compromised by the negative effects and potential consequences of soil saturation.



11. LIMITATIONS

This report has been prepared solely for the benefit of our client with respect to a particular brief given to us, and data or opinions in it may not be used in other contexts, by any other party or for any other purposes. To the maximum extent permitted by law, Tilsley Engineering Ltd disclaims all liability and responsibility (in contract or tort, including negligence, or otherwise) for any loss or damage whatsoever which may be suffered as a result of any reliance by any third party on this report, whether that loss is caused by any fault or negligence on the part of Tilsley Engineering Ltd or otherwise.

Council is able to rely on this report for processing the resource or building consent only for the site mentioned within this report. It may not be used for any other use or purpose without permission from Tilsley Engineering Ltd.

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Notice to Reader/ User of this document

Should the reader be in any doubt as to the applicability of this report and/or its recommendations for the proposed development as described herein, and/or encounter materials on site that differ from those described herein, it is essential that you discuss these issues with the authors before proceeding with any work based on this document.

The recommendations and opinions contained in this report are based upon site observations of the investigation area. Inferences about ground conditions over the site are made using geological principles and engineering judgment, however, it is possible that conditions over the site may vary and therefore it is not possible to guarantee the continuity of ground conditions away from investigation locations and visible areas.

Furthermore, the logs are provided presenting descriptions of the soils and geology based on field observations of the samples recovered in the fieldwork and may not be truly representative of the actual underlying conditions.

Recommendations and opinions in this report are based on data obtained from the investigations and site observations as detailed in this report. The nature and continuity of subsoil conditions at locations other than the investigation bores and tests are inferred and it shall be appreciated that actual conditions could vary from the assumed model.

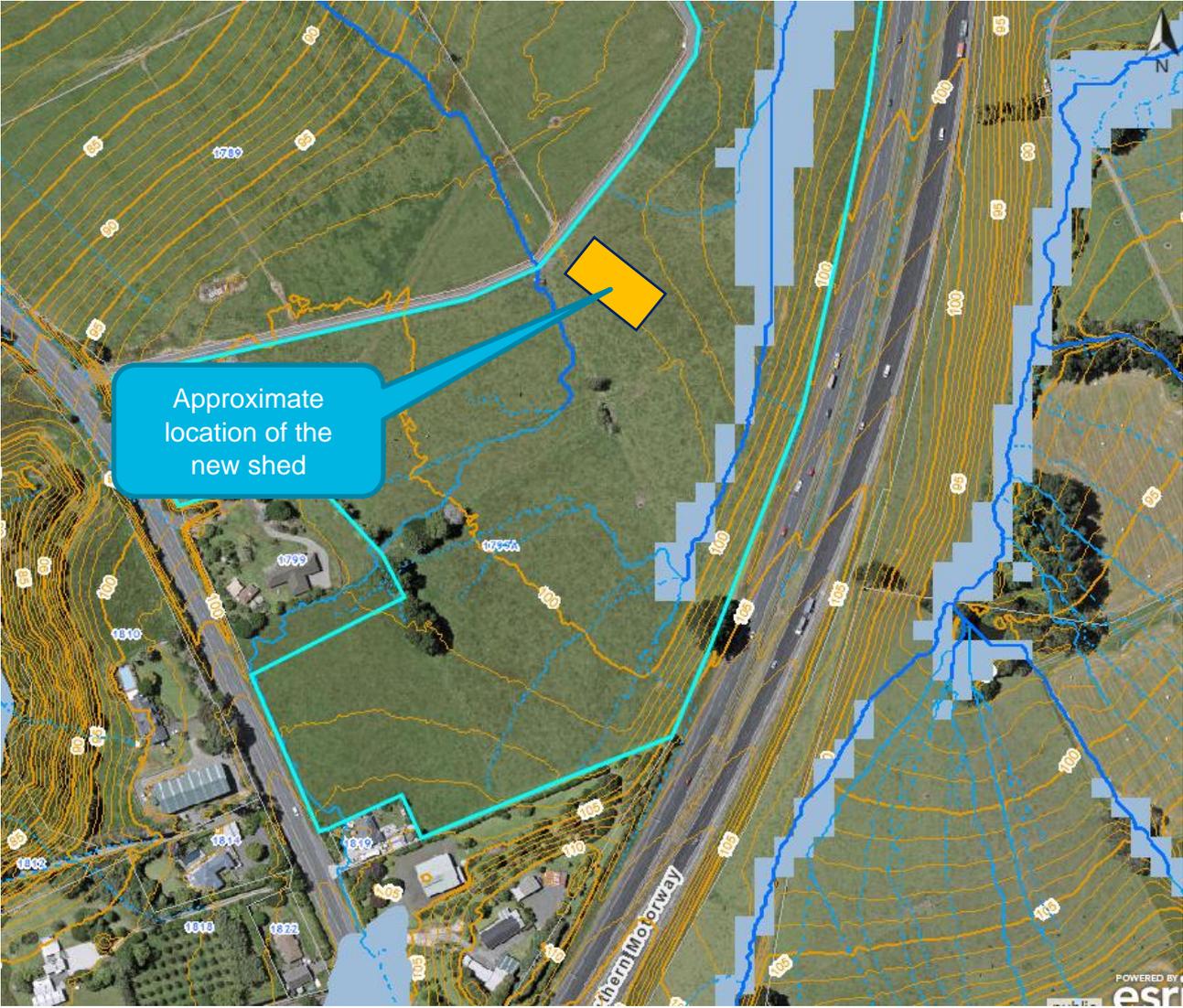
It is recommended that construction activity shall be undertaken in the dry season. If construction activities are undertaken in wet seasons there is a potential risk of reduction of soil strength. Tilsley Engineering Ltd is not responsible for the reduction in soil strength due to construction activities.

Ground conditions can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions that existed at the time of subsurface exploration, decisions shall not be based on a report whose adequacy may have been affected by time. Tilsley Engineering Ltd to be advised how time may have impacted on the project.

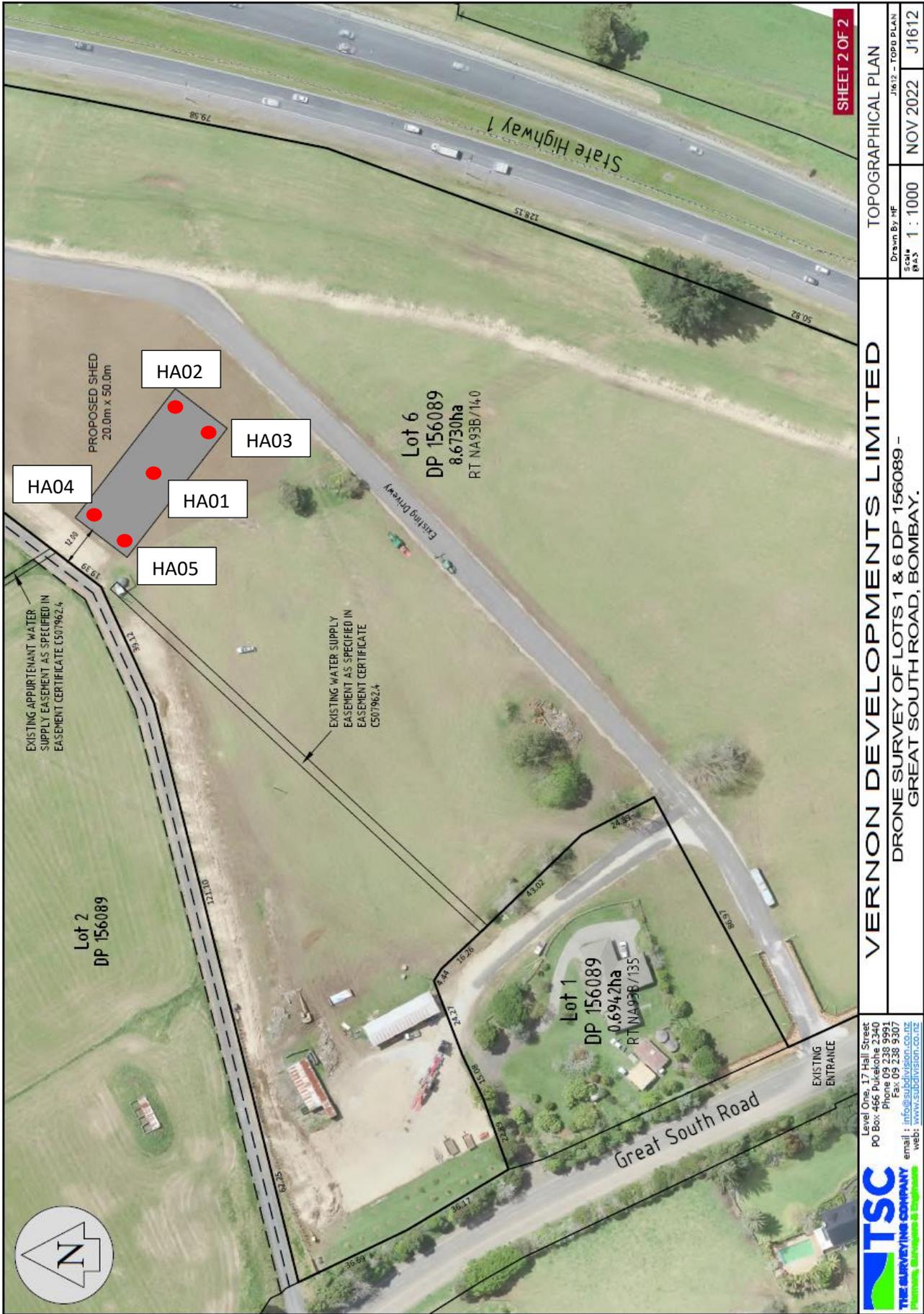
This report is based on the assumption that the site conditions as revealed through investigation stages are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore this report recommendations can only be regarded as preliminary. Only Tilsley Engineering Ltd, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes shall be considered as the project develops. If another party undertakes the implementation of the recommendations of this report, there is a risk that the report will be misinterpreted and Tilsley Engineering Ltd cannot be held responsible for such misinterpretation.



APPENDIX A - BACKGROUND INFORMATION



Site Location with Contours and Water Features



Site Plan and Borehole Location



View of the Soil Profile (HA01)



Looking North -View of the Proposed Building Area of the New Shed

APPENDIX B - INVESTIGATION BORE LOGS





BORE LOG

TILSLEY ENGINEERING LIMITED	Job number: IZ21923	Date: 18/04/2023
27 Roulston Street, Pukekohe	Client: Vernon Developments Ltd	Time: 1:10 pm
info@teng.co.nz	Location: 1799a Great South Road, Bombay	Augered by: IZ
PO Box 392, Pukekohe	Soil type: Qvs	Logged by: IZ
Phone: 09 238 3245		Bore No: HA01

COMMENTS

Depth (m)	Material Description	Soil Symbol	Soil sensitivity	Moisture	Water	Shear Vane Test / Reform (kPa)	Scala Penetrometer Test (blows/100mm - kPa)	
0.1	Topsoil, brown							
0.2	Silty CLAY, yellow brown to light yellow brown, very stiff, low to moderate plasticity, moderately sensitive		2.9	Moist		179/62		
0.3								
0.4								
0.5								
0.6								
0.7								
0.8								
0.9								>220
1.0								
1.1								
1.2	Moist							
1.3								
1.4	2.3							
1.5	Moist				208/91			
1.6								
1.7								
1.8								
1.9							>220	
2.0								
2.1								
2.2								
2.3							>220	
2.4								
2.5	EOB @ 2.5m							
2.6								



BORE LOG

TILSLEY ENGINEERING LIMITED	Job number: IZ21923	Date: 18/04/2023
27 Roulston Street, Pukekohe	Client: Vernon Developments Ltd	Time: 1:10 pm
info@teng.co.nz	Location: 1799a Great South Road, Bombay	Augered by: IZ
PO Box 392, Pukekohe	Soil type: Qvs	Logged by: IZ
Phone: 09 238 3245		Bore No: HA02

COMMENTS

Depth (m)	Material Description	Soil Symbol	Soil sensitivity	Moisture	Water	Shear Vane Test / Reform (kPa)	Scala Penetrometer Test (blows/100mm - kPa)
0.1	Topsoil, brown						
0.2							
0.3	Silty CLAY, yellow brown to light yellow brown, very stiff, low to moderate plasticity, moderately sensitive		3.5	Moist		172/49	
0.4							
0.5							
0.6							
0.7							
0.8							
0.9							
1.0							
1.1							
1.2							
1.3							
1.4							
1.5							
1.6							
1.7							
1.8							
1.9							
2.0	EOB @ 2m						



BORE LOG

TILSLEY ENGINEERING LIMITED

27 Roulston Street, Pukekohe

info@teng.co.nz

PO Box 392, Pukekohe

Phone: 09 238 3245

Job number: IZ21923

Client: Vernon Developments Ltd

Location: 1799a Great South Road, Bombay

Soil type: Qvs

Date: 18/04/2023

Time: 1:10 pm

Augered by: IZ

Logged by: IZ

Bore No: HA03

COMMENTS

Depth (m)	Material Description	Soil Symbol	Soil sensitivity	Moisture	Water	Shear Vane Test / Reform (kPa)	Scala Penetrometer Test (blows/100mm - kPa)
0.1	Topsoil, brown						
0.2							
0.3	Silty CLAY, yellow brown to light yellow brown, very stiff, low to moderate plasticity			Moist		>220	
0.4							
0.5							
0.6							
0.7							
0.8							
0.9							
1.0							
1.1							
1.2							
1.3							
1.4							
1.5							
1.6							
1.7							
1.8							
1.9							
2.0	EOB @ 2m						



BORE LOG

TILSLEY ENGINEERING LIMITED 27 Roulston Street, Pukekohe info@teng.co.nz PO Box 392, Pukekohe Phone: 09 238 3245	Job number: IZ21923 Client: Vernon Developments Ltd Location: 1799a Great South Road, Bombay Soil type: Qvs	Date: 18/04/2023 Time: 1:10 pm Augered by: IZ Logged by: IZ Bore No: HA04
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COMMENTS

Depth (m)	Material Description	Soil Symbol	Soil sensitivity	Moisture	Water	Shear Vane Test / Reform (kPa)	Scala Penetrometer Test (blows/100mm - kPa)	
0.1	Topsoil, charcoals present, brown							
0.2								
0.3	Silty CLAY, charcoals present, yellow brown to light yellow brown, very stiff, low to moderate plasticity, moderately sensitive		2.9	Moist		132/46		
0.4								
0.5								
0.6								
0.7								
0.8								
0.9								>220
1.0								
1.1								
1.2								>220
1.3								
1.4								
1.5								
1.6								
1.7								
1.8								
1.9	>220							
2.0								
2.1								
2.2								
2.3	>220							
2.4								
2.5	EOB @ 2.5m							
2.6								



BORE LOG

TILSLEY ENGINEERING LIMITED	Job number: IZ21923	Date: 18/04/2023
27 Roulston Street, Pukekohe	Client: Vernon Developments Ltd	Time: 1:10 pm
info@teng.co.nz	Location: 1799a Great South Road, Bombay	Augered by: IZ
PO Box 392, Pukekohe	Soil type: Qvs	Logged by: IZ
Phone: 09 238 3245		Bore No: HA05

COMMENTS

Depth (m)	Material Description	Soil Symbol	Soil sensitivity	Moisture	Water	Shear Vane Test / Reform (kPa)	Scala Penetrometer Test (blows/100mm - kPa)
0.1	Topsoil, charcoals present, brown						
0.2	Silty CLAY, yellow brown to light yellow brown, very stiff, low to moderate plasticity, moderately sensitive			Moist		>220	
0.3							
0.4							
0.5							
0.6							
0.7							
0.8							
0.9							
1.0							
1.1							
1.2				Moist			
1.3							
1.4						>220	
1.5							
1.6							
1.7							
1.8							
1.9				Moist		>220	
2.0							
2.1							
2.2							
2.3						>220	
2.4							
2.5	EOB @ 2.5m						
2.6							

APPENDIX C - CALCULATIONS

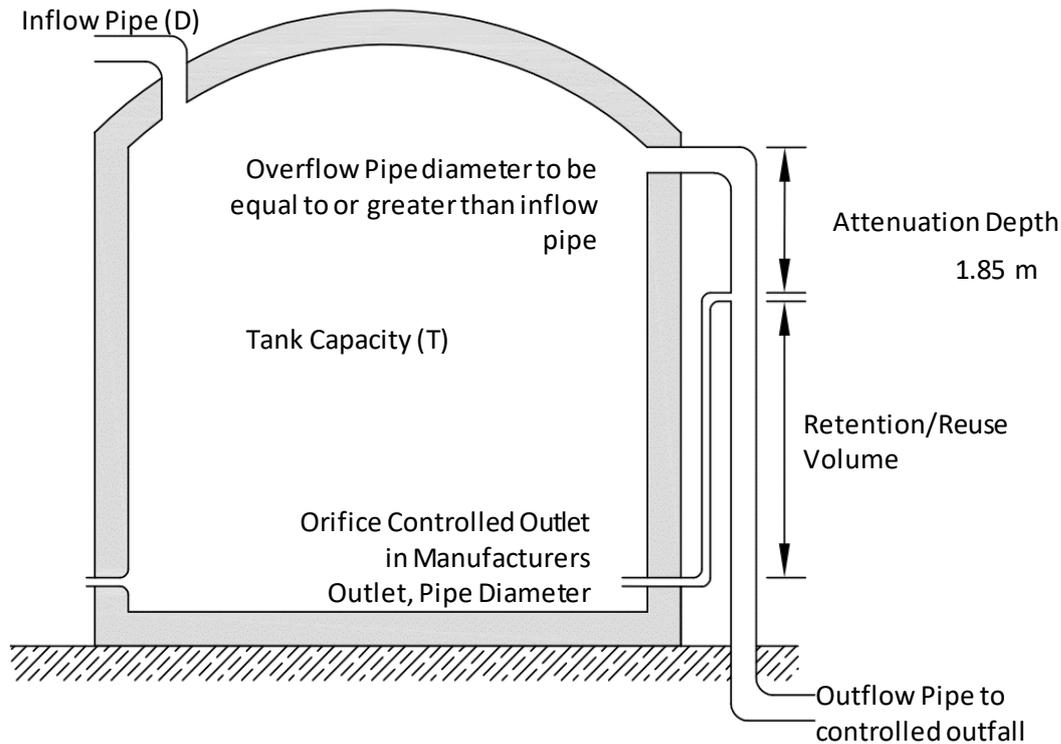
Stormwater Management - 10% AEP allowance		
Client	Vernon Developments Ltd	
Location	1799a Great South Road, Bombay	
Date	21/04/2023	
Development Area	1125	m ²
10% AEP 10min Rainfall Depth (HIRDS)	17.6	mm
cc 2.1° Temperature increase	20.6	mm
Pre Development		
Soil Name and Classification	Cover Description (cover type, treatment, and hydrologic condition)	Curve Number CN*
Group A Soil (volcanic granular loam)	Pasture, lightly grazed, good grass cover	39
* from table 3.3	CN Override	
CN =	39	
la =	5 mm	
Storage ($S = (1000/CN - 10)25.4$)	$= (1000 / 39 - 10) \times 25.4$	S = 397.28 mm
Post Development		
Cover Description	Curve Number CN*	
Impervious (Connected)	98	
CN =	98	
la =	0 mm	
Storage ($S = (1000/CN - 10)25.4$)	$= (1000 / 98 - 10) \times 25.4$	S = 5.18 mm
	Pre	Post
Runoff depth, Q (mm)	0.59	16.45
Runoff volume (m ³)	0.66	18.51
Detention volume	17.84	m ³
	17845	l
Number of tanks	1	
Tank diameter - D(tank)	3.5 m	
Tank base area - A(tank)	9.62 m ²	
Depth of Attenuation	1.85 m	
Average discharge rate (post-development)	0.00021	m ³ /s
Hydraulic head	0.93 m	
Velocity	4.27 m/s	
Minimum area of orifice	0.0000781	m ²
Minimum diameter of orifice	0.0100 m	
Minimum orifice size	10 mm	
Recommended orifice size	25 mm	
Average discharge rate (pre-development)	0.00644	m ³ /s
Hydraulic head	0.93 m	
Velocity	4.27 m/s	
Maximum area of orifice	0.0024332	m ²
Maximum diameter of orifice	0.0557 m	
Maximum orifice size	56 mm	

APPENDIX D - DIAGRAMS AND DETAILS

Tank design - attenuation

Client Vernon Developments Ltd
 Address 1799a Great South Road, Bombay
 Date 21/04/2023

Detention/Retention Tank Detail



Note: Minimum orifice diameter is 20mm. Screening is required for orifice smaller than 25mm

D= 90 to 120 mm
 T= 25,000 litres (x 1 tank)
 E= 25mm

Capacity to be used for attenuation 17.84 m³

Notes:

1. Orifice controlled outlet 'E' is to use an approved manufacturer's outlet point. This may require an internal PVC pipe connected to a base point.
2. If different tank dimensions are used than those specified, the orifice controlled outlet must allow for a minimum attenuation below the overflow pipe of 17.84 m³
3. First flush diverter recommended but not required.
4. Any number of tanks may be used. However, if they are linked attenuation can only be achieved if no valve is placed in-between the tanks



General Notes

NOTES

Level spreader shall not be placed in fill material. Spreader bars to be located a minimum of 10m from toe of fill material.

Attenuation required prior to spreader bar

Spreader bars to discharge on to slopes less than 18degrees in open fields or 28 degrees in bush covered slopes

Spreader bar to be positioned to provide a level discharge to slope

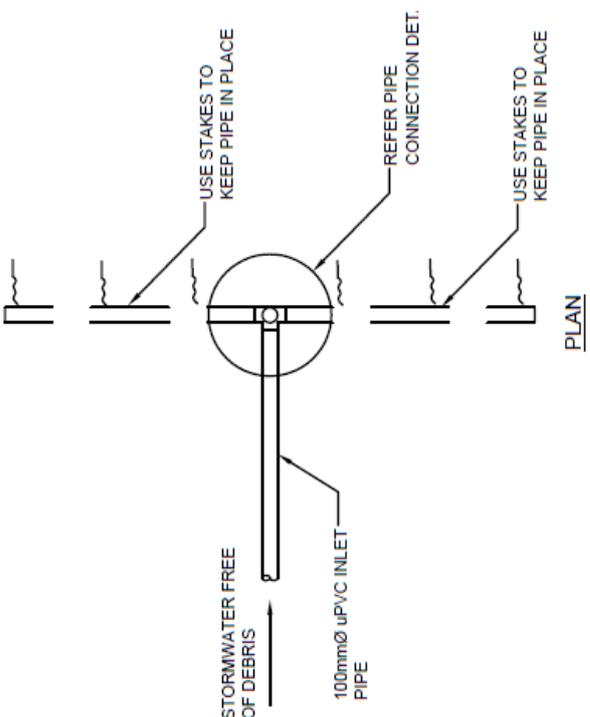
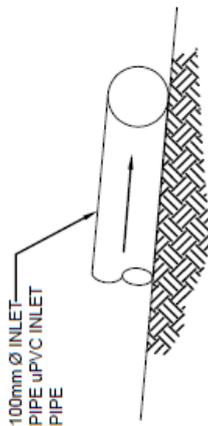
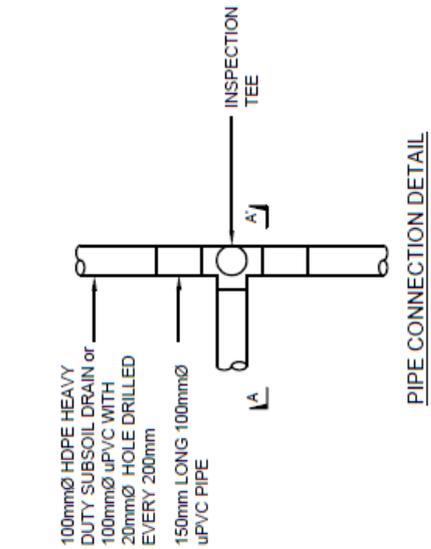


Drawn By	Trishna Gibson
Approved By	Robert Tilsley
No.	Revised/Issue
Date	

TILSLEY ENGINEERING LTD
 75 Seabrook Street, Pukekohe
 PO Box 302, Pukekohe
 Tel: 09 228 2445
 info@tilsleyengineering.co.nz

Project Name and address
 Stormwater Trench
 Standard Disposal
 Level Spreader System
 Above ground

Project	SW	Sheet	01b
Date	29/01/2016	Scale	not to scale



DESIGN PARAMETERS

EFFECTIVE CATCHMENT AREA DRAINED (m ²)	PIPE LENGTH (m)
100	8
200	12
300	14
400	16
500	18
600	20

(NOTE: EFFECTIVE CATCHMENT AREA DRAINED = IMPERVIOUS AREA + 0.72 x PERVIOUS AREA)



General Notes

NOTES

- Spreader bars shall not be placed in fill material.
- Spreader bars to be located a minimum of 5m from toe of fill material.
- Attenuation required prior to spreader bar
- Spreader bars to discharge on to slopes less than 18degrees in open fields or 25 degrees in bush covered slopes
- Spreader bar to be positioned to provide a level discharge to slope

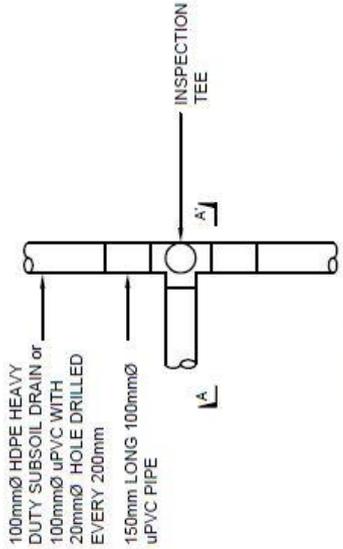
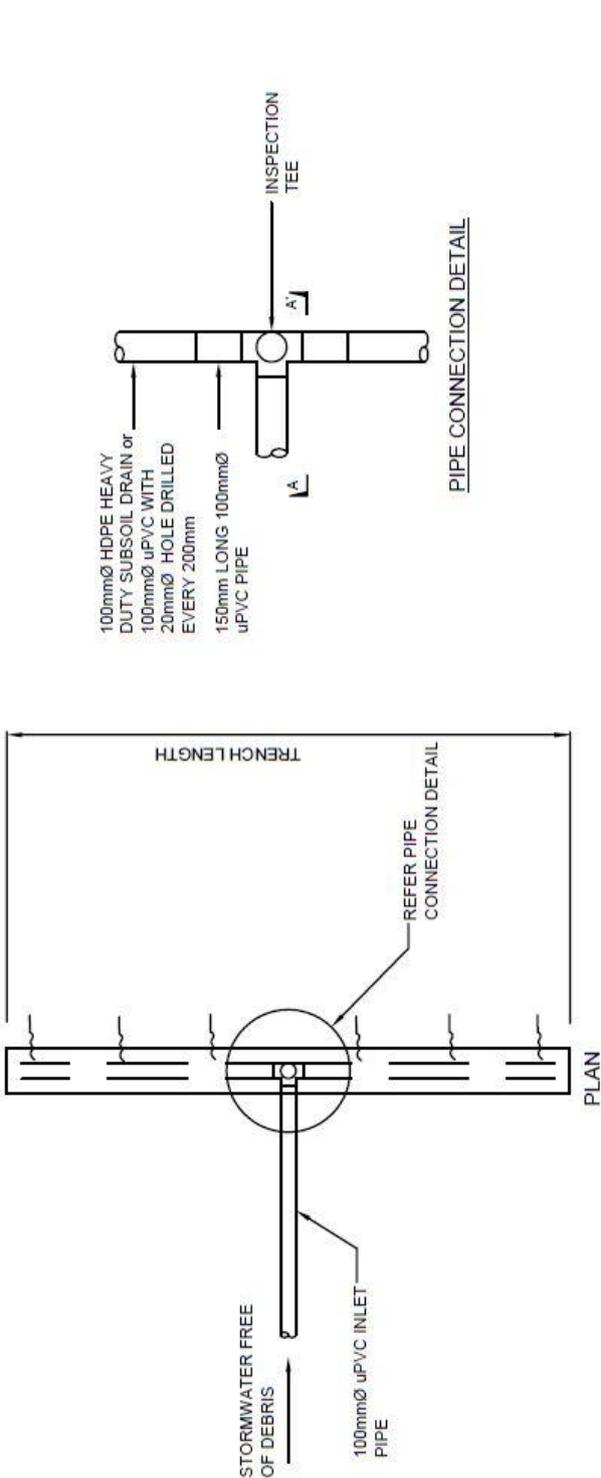
Drawn By: Joliffa Gilhoire
Approved By: Robert Tilsley

No.: _____
Revised/Issue: _____
Date: _____

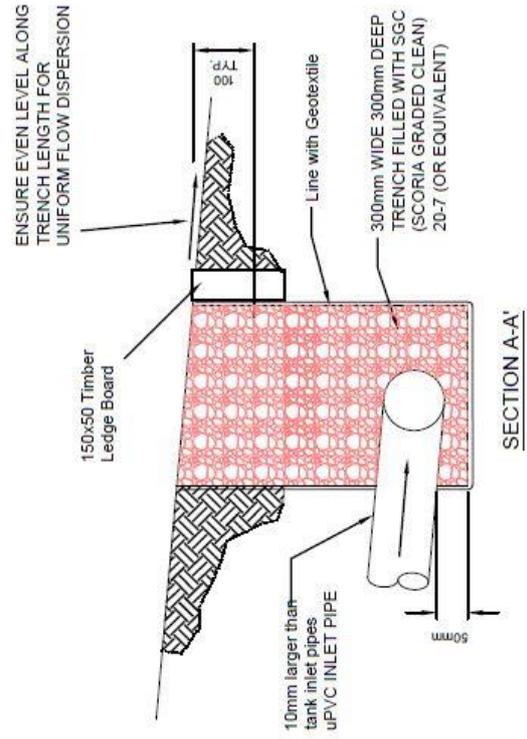
TILSLEY ENGINEERING LTD
 75 Seadon Street, Pukekohe
 PO Box 350, Pukekohe
 Tel: 05 236 2205
 info@tilsleyengineering.co.nz

Project Name and Address:
 Stormwater Trench
 Standard Disposal
 Level Spreader System
 Bubble up trench

Sheet: SW
Date: 20/3/2017
Scale: not to scale
01



PIPE CONNECTION DETAIL



DESIGN PARAMETERS

EFFECTIVE CATCHMENT AREA DRAINED (m ²)	PIPE LENGTH (m)
100	8
200	12
300	14
400	16
500	18
600	20

(NOTE: EFFECTIVE CATCHMENT AREA DRAINED = IMPERVIOUS AREA + 0.72 x PERVIOUS AREA)



APPENDIX E - STORMWATER OPERATION AND MAINTENANCE FORMS

FORM "OSM-O&M-CERT"

(A) SITE & OSM DEVICE DETAILS:

Site Address: _____

Owners Name: _____

Device(s):

Ref. No	Type	Size (eg m2 or m3)	Date Installed

(B) MAINTENANCE CONTRACTOR'S DETAILS:

Firms Name: _____

Firms Address: _____

Name of Serviceperson: _____

Date(s) of Service: _____

(C) SERVICE DETAILS:

Device Ref. No	Checklist Completed	MAINTENANCE ACTION	
		Item	Action (describe, eg "pipe replaced")
1		(a)	
		(b)	
		(c)	
		(d)	
2		(a)	
		(b)	
		(c)	
		(d)	
3		etc....(continue on a separate sheet)	

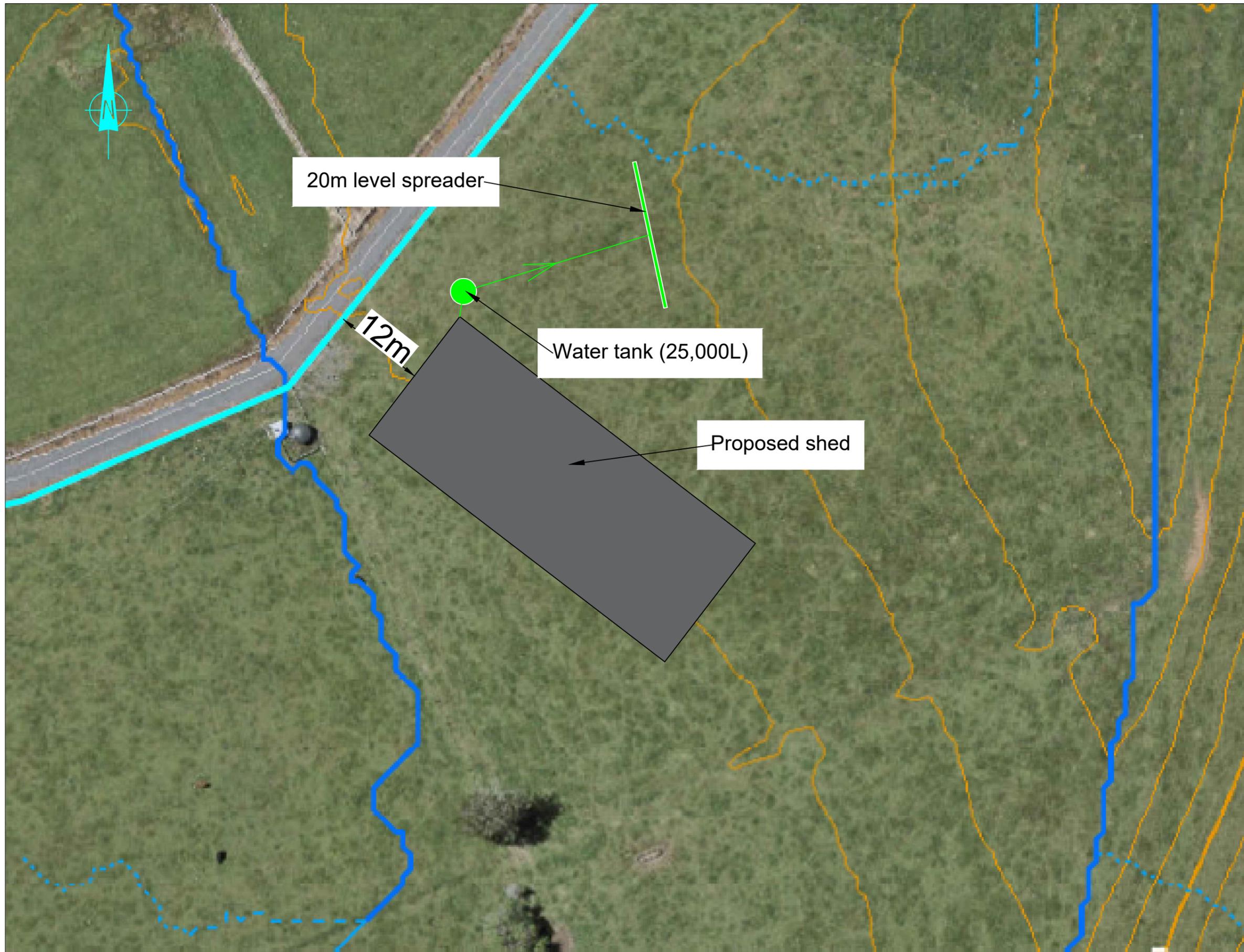
* on attached form "Device-Specific O&M Details"

(D) CERTIFICATION:

I/we hereby certify that:



APPENDIX F - PROPOSED STORMWATER SITE PLAN



General Notes

NOTES

Refer to architects plans for details of building location and layout.

Stormwater runoff from the roof area of the new shed shall be piped and released into one 25,000L water tank for attenuation. The attenuation shall be carried by a 25mm diameter orifice pipe fixed to the manufacturer's outlet point of the tank. The overflow pipe of the water tank shall be equal to or greater than the inlet pipe and shall be piped to a 20m level spreader.

Please refer to the report for details.



Drawn By	Ivan Zhang	
Approved By	Robert Tilsley	
	<i>R. Tilsley</i>	
No.	Revision/Issue	Date

TILSLEY ENGINEERING LIMITED
 27 Roulston Street, Pukekohe
 PO Box 392, Pukekohe
 Tel: 09 238 3245
 info@teng.co.nz

Project Name and Address
 SW Plan
 1799a Great South Road,
 Bombay
 Job NO.: IZ21923

Project	SW Plan	Sheet
Date	21/04/2023	01
Scale	1:500@A3	

Appendix C: Stormwater Network Calculations

STORMWATER PIPELINE CALCULATION

Project	Vernon Development															
Job Number	J2224															
Designed By	Sam Furniss															
Date	17/02/2025															
CURRENT DEVELOPMET																
SWMH	Catchment Desc	Area	Run-off coeff.	Time of conc.	Rainfall intensity	Calc Flow	Upstream Flow	Junction Flow	Junction Description	Design flow	Pipe size	Design velocity	Minimum Pipe slope	Pipe Slope	Pipe flow	Pipe velocity
SWMH 1.1 - Outlet 1	Pond (Flow from HEC-HMS)					1162	0									
	Total					1162	0	0		1162	750	2.63	1.10%	1.20%	1210	2.74

Appendix D: Detention Pond Calculations and HEC-HMS Outputs

Project	Vernon GSR
Job no.	J2224
Designer	Sam Furniss
Date	13/12/2024
Description	Project Inputs & Summary of Outputs

$$\text{Orifice discharge: } Q = 0.62 \times A \times (2g(h - D/2))^{0.5}$$

HEC HMS Inputs	
CN (Pervious)	39 m
CN (Impervious)	98 m
Initial Abstraction (Pervious)	5 mm
Initial Abstraction (Impervious)	0 mm
Lag time	6.67 min
Orifice outlet coefficient:	0.62
Spillway coefficient:	1.705

SMAF 2			
SMAF2 Retention Required	5 mm		
SMAF2 Detention Required	29 mm		
Site Catchment Area	93364 m ²	0.093364	km ²
Pre-Development Pervious Area	89507	0.089507	km ²
Pre-Development Impervious Area	3857	0.003857	km ²
Post-Development Pervious Area	64587 m ²	0.064587	km ²
Post Development Impervious Area	28777 m ²	0.028777	km ²
Retention Volume	143.885 m ³	143,885	l
Detention Volume	524.75 m ³	524,752	l
Average Discharge Rate	0.00774 m ³ /s	7.74	l/s
Peak Discharge Rate	0.01548 m ³ /s	15.48	l/s

SMAF2 Detention orifice Elevation:	94.7 m		
SMAF2 Detention orifice Ø:	85.00000 mm		
SMAF2 Detention orifice area:	0.0056745 m ²		
SMAF2 Post-Development Peak Flow:	0.01398 m ³ /s	13.98	l/s
SMAF2 Peak Elevation:	95.505 m		

2 Year			
2 year Pre-Development Depth:	65 mm		
2 year Post-Development Depth:	74.8 mm		
2 Year Detention Spillway Elevation:	95.55 m		
2 Year Detention Spillway length:	350.0 mm		
2 Year Post-Development Peak Flow:	0.12109 m ³ /s	121.09	l/s
2 Year Peak Elevation:	95.863 m		
2 Year Peak Storage:	1004 m ³		

10 year & 100 year			
10 year Pre-Development Depth:	130 mm		
10 year Post-Development Depth:	152.1 mm		
10 Year Detention Spillway Elevation:	95.55 m		
10 Year Detention Spillway length:	350.00000 mm		
10 Year Post-Development Peak Flow:	0.45787 m ³ /s	457.87	l/s
10 Year Peak Elevation:	96.381 m		
10 Year Peak Storage:	2135 m ³		
100 year Pre-Development Depth:	215 mm		
100 year Post-Development Depth:	285.3 mm		
100 Year Post-Development Peak Flow:	1.16254 m ³ /s	1162.54	l/s

100 Year Peak Elevation:	97.088	m		
100 Year Peak Storage:	4162	m ³		
Total Site				
2 Year Pre-Development Peak Flow:	0.16045	m ³ /s	160.45	l/s
2 Year Post-Development Peak Flow:	0.12109	m ³ /s	121.09	l/s
10 Year Pre-Development Peak Flow:	0.50384	m ³ /s	503.84	l/s
10 Year Post-Development Peak Flow:	0.45787	m ³ /s	457.87	l/s
100 Year Pre-Development Peak Flow:	1.30352	m ³ /s	1303.52	l/s
100 Year Post-Development Peak Flow:	1.16235	m ³ /s	1162.35	l/s

Global Summary Results for Run "SMAF 2"

Project: Pond Project 1 Simulation Run: SMAF 2

Start of Run: 01Jan2000, 00:00 Basin Model: B Post-development
 End of Run: 02Jan2000, 00:00 Meteorologic Model: SMAF 2
 Compute Time: 19Feb2025, 08:36:32 Control Specifications: Control 1

Show Elements: Volume Units: MM 1000 M3 Sorting:

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
B Pervious Post De...	0.065	0.00000	31 December 199...	0.0000
B Impervious Post-...	0.029	0.16800	1 January 2000, 1...	0.8473
B Pond	0.093	0.01398	1 January 2000, 1...	0.7382
C Pond 2	0.093	0.01398	1 January 2000, 1...	0.7402
B Open Drain	0.093	0.01398	1 January 2000, 1...	0.7402

Summary Results for Reservoir "B Pond"

Project: Pond Project 1 Simulation Run: SMAF 2
Reservoir: B Pond

Start of Run: 01Jan2000, 00:00 Basin Model: B Post-development
 End of Run: 02Jan2000, 00:00 Meteorologic Model: SMAF 2
 Compute Time: 19Feb2025, 08:36:32 Control Specifications: Control 1

Volume Units: MM 1000 M3

Computed Results

Peak Inflow: 0.16800 (M3/S) Date/Time of Peak Inflow: 01Jan2000, 12:12
 Peak Discharge: 0.01398 (M3/S) Date/Time of Peak Discharge: 01Jan2000, 14:13
 Inflow Volume: 0.8473 (1000 M3) Peak Storage: 0.3601 (1000 M3)
 Discharge Volume: 0.7382 (1000 M3) Peak Elevation: 95.505 (M)

Summary Results for Reservoir "C Pond 2"

Project: Pond Project 1 Simulation Run: SMAF 2
Reservoir: C Pond 2

Start of Run: 01Jan2000, 00:00 Basin Model: B Post-development
 End of Run: 02Jan2000, 00:00 Meteorologic Model: SMAF 2
 Compute Time: 19Feb2025, 08:36:32 Control Specifications: Control 1

Volume Units: MM 1000 M3

Computed Results

Peak Inflow: 0.01398 (M3/S) Date/Time of Peak Inflow: 01Jan2000, 14:11
 Peak Discharge: 0.01398 (M3/S) Date/Time of Peak Discharge: 01Jan2000, 14:11
 Inflow Volume: 0.7382 (1000 M3) Peak Storage: 0.0022 (1000 M3)
 Discharge Volume: 0.7402 (1000 M3) Peak Elevation: 94.001 (M)

Global Summary Results for Run "F 2 Y pre-dev"

Project: Pond Project 1 Simulation Run: F 2 Y pre-dev

Start of Run: 01Jan2000, 00:00 Basin Model: A Pre-development - Copy (1)
 End of Run: 02Jan2000, 00:00 Meteorologic Model: 2 Year Post-Dev
 Compute Time: 18Feb2025, 10:56:22 Control Specifications: Control 1

Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Pervious Pre-dev...	0.090	0.11955	1 January 2000, 1...	0.7012
A Impervious Pre-...	0.004	0.04095	1 January 2000, 1...	0.2316
Pond Existing	0.093	0.16045	1 January 2000, 1...	1.1918
A Open Drain	0.093	0.16045	1 January 2000, 1...	1.1918

Global Summary Results for Run "G 2 Y post-dev"

Project: Pond Project 1 Simulation Run: G 2 Y post-dev

Start of Run: 01Jan2000, 00:00 Basin Model: B Post-development
 End of Run: 02Jan2000, 00:00 Meteorologic Model: 2 Year Post-Dev
 Compute Time: 18Feb2025, 10:56:25 Control Specifications: Control 1

Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
B Pervious Post-De...	0.065	0.12625	1 January 2000, 1...	0.6708
B Impervious Post-...	0.029	0.38590	1 January 2000, 1...	2.0087
B Pond	0.093	0.12109	1 January 2000, 1...	2.2109
C Pond 2	0.093	0.12109	1 January 2000, 1...	2.2099
B Open Drain	0.093	0.12109	1 January 2000, 1...	2.2099

Summary Results for Reservoir "B Pond"

Project: Pond Project 1 Simulation Run: G 2 Y post-dev
Reservoir: B Pond

Start of Run: 01Jan2000, 00:00 Basin Model: B Post-development
 End of Run: 02Jan2000, 00:00 Meteorologic Model: 2 Year Post-Dev
 Compute Time: 18Feb2025, 10:56:25 Control Specifications: Control 1

Volume Units: MM 1000 M3

Computed Results

Peak Inflow: 0.51127 (M3/S) Date/Time of Peak Inflow: 01Jan2000, 12:13
 Peak Discharge: 0.12109 (M3/S) Date/Time of Peak Discharge: 01Jan2000, 12:42
 Inflow Volume: 2.6795 (1000 M3) Peak Storage: 1.0037 (1000 M3)
 Discharge Volume: 2.2109 (1000 M3) Peak Elevation: 95.863 (M)

Summary Results for Reservoir "C Pond 2"

Project: Pond Project 1 Simulation Run: G 2 Y post-dev
Reservoir: C Pond 2

Start of Run: 01Jan2000, 00:00 Basin Model: B Post-development
 End of Run: 02Jan2000, 00:00 Meteorologic Model: 2 Year Post-Dev
 Compute Time: 18Feb2025, 10:56:25 Control Specifications: Control 1

Volume Units: MM 1000 M3

Computed Results

Peak Inflow: 0.12109 (M3/S) Date/Time of Peak Inflow: 01Jan2000, 12:42
 Peak Discharge: 0.12109 (M3/S) Date/Time of Peak Discharge: 01Jan2000, 12:42
 Inflow Volume: 2.2109 (1000 M3) Peak Storage: 0.0030 (1000 M3)
 Discharge Volume: 2.2099 (1000 M3) Peak Elevation: 94.042 (M)

Global Summary Results for Run "A 10 Y pre-dev"

Project: Pond Project 1 Simulation Run: A 10 Y pre-dev

Start of Run: 01Jan2000, 00:00 Basin Model: A Pre-development - Copy (1)
 End of Run: 02Jan2000, 00:00 Meteorologic Model: 10 year predevelopment
 Compute Time: 18Feb2025, 10:56:10 Control Specifications: Control 1

Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Previous Pre-dev...	0.090	0.46885	1 January 2000, 1...	2.6658
A ImperVIOUS Pre-...	0.004	0.08309	1 January 2000, 1...	0.4810
Pond Existing	0.093	0.50384	1 January 2000, 1...	3.2247
A Open Drain	0.093	0.50384	1 January 2000, 1...	3.2247

Global Summary Results for Run "B 10 Y post-dev"

Project: Pond Project 1 Simulation Run: B 10 Y post-dev

Start of Run: 01Jan2000, 00:00 Basin Model: B Post-development
 End of Run: 02Jan2000, 00:00 Meteorologic Model: 10 Year Post-Dev
 Compute Time: 18Feb2025, 10:56:14 Control Specifications: Control 1

Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
B Previous Post De...	0.065	0.49649	1 January 2000, 1...	2.5571
B ImperVIOUS Post-...	0.029	0.79375	1 January 2000, 1...	4.2235
B Pond	0.093	0.47221	1 January 2000, 1...	6.1494
C Pond 2	0.093	0.45787	1 January 2000, 1...	6.1483
B Open Drain	0.093	0.45787	1 January 2000, 1...	6.1483

Summary Results for Reservoir "B Pond"

Project: Pond Project 1 Simulation Run: B 10 Y post-dev
 Reservoir: B Pond

Start of Run: 01Jan2000, 00:00 Basin Model: B Post-development
 End of Run: 02Jan2000, 00:00 Meteorologic Model: 10 Year Post-Dev
 Compute Time: 18Feb2025, 10:56:14 Control Specifications: Control 1

Volume Units: MM 1000 M3

Computed Results

Peak Inflow:	1.28818 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:13
Peak Discharge:	0.47221 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:31
Inflow Volume:	6.7807 (1000 M3)	Peak Storage:	2.1345 (1000 M3)
Discharge Volume:	6.1494 (1000 M3)	Peak Elevation:	96.381 (M)

Summary Results for Reservoir "C Pond 2"

Project: Pond Project 1 Simulation Run: B 10 Y post-dev
 Reservoir: C Pond 2

Start of Run: 01Jan2000, 00:00 Basin Model: B Post-development
 End of Run: 02Jan2000, 00:00 Meteorologic Model: 10 Year Post-Dev
 Compute Time: 18Feb2025, 10:56:14 Control Specifications: Control 1

Volume Units: MM 1000 M3

Computed Results

Peak Inflow:	0.47221 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:31
Peak Discharge:	0.45787 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:40
Inflow Volume:	6.1494 (1000 M3)	Peak Storage:	0.0719 (1000 M3)
Discharge Volume:	6.1483 (1000 M3)	Peak Elevation:	94.593 (M)

Global Summary Results for Run "D 100 y pre-dev"

Project: Pond Project 1 Simulation Run: E 100 y pre-dev

Start of Run: 01Jan2000, 00:00 Basin Model: A Pre-development - Copy (1)
 End of Run: 02Jan2000, 00:00 Meteorologic Model: 100 year predevelopment
 Compute Time: 18Feb2025, 10:56:17 Control Specifications: Control 1

Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Pervious Pre-dev...	0.090	1.16561	1 January 2000, 1...	6.4730
A Impervious Pre-...	0.004	0.13791	1 January 2000, 1...	0.8077
Pond Existing	0.093	0.71118	1 January 2000, 1...	7.3928
A Open Drain	0.093	0.71118	1 January 2000, 1...	7.3928

Summary Results for Reservoir "B Pond"

Project: Pond Project 1 Simulation Run: E 100 y post-dev
 Reservoir: B Pond

Start of Run: 01Jan2000, 00:00 Basin Model: B Post-development
 End of Run: 02Jan2000, 00:00 Meteorologic Model: 100 year Post Development
 Compute Time: 18Feb2025, 10:56:19 Control Specifications: Control 1

Volume Units: MM 1000 M3

Computed Results

Peak Inflow: 2.98005 (M3/S) Date/Time of Peak Inflow: 01Jan2000, 12:13
 Peak Discharge: 1.16254 (M3/S) Date/Time of Peak Discharge: 01Jan2000, 12:29
 Inflow Volume: 15.5084 (1000 M3) Peak Storage: 4.1618 (1000 M3)
 Discharge Volume: 14.6507 (1000 M3) Peak Elevation: 97.088 (M)

Global Summary Results for Run "E 100 y post-dev"

Project: Pond Project 1 Simulation Run: E 100 y post-dev

Start of Run: 01Jan2000, 00:00 Basin Model: B Post-development
 End of Run: 02Jan2000, 00:00 Meteorologic Model: 100 year Post Development
 Compute Time: 18Feb2025, 10:56:19 Control Specifications: Control 1

Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
B Pervious Post De...	0.065	1.49068	1 January 2000, 1...	7.4625
B Impervious Post-...	0.029	1.49340	1 January 2000, 1...	8.0459
B Pond	0.093	1.16254	1 January 2000, 1...	14.6507
C Pond 2	0.093	0.83837	1 January 2000, 1...	14.6500
B Open Drain	0.093	0.83837	1 January 2000, 1...	14.6500

Summary Results for Reservoir "C Pond 2"

Project: Pond Project 1 Simulation Run: E 100 y post-dev
 Reservoir: C Pond 2

Start of Run: 01Jan2000, 00:00 Basin Model: B Post-development
 End of Run: 02Jan2000, 00:00 Meteorologic Model: 100 year Post Development
 Compute Time: 18Feb2025, 10:56:19 Control Specifications: Control 1

Volume Units: MM 1000 M3

Computed Results

Peak Inflow: 1.16254 (M3/S) Date/Time of Peak Inflow: 01Jan2000, 12:29
 Peak Discharge: 0.83837 (M3/S) Date/Time of Peak Discharge: 01Jan2000, 13:16
 Inflow Volume: 14.6507 (1000 M3) Peak Storage: 1.1616 (1000 M3)
 Discharge Volume: 14.6500 (1000 M3) Peak Elevation: 95.989 (M)

Appendix E: Swale and Overland Flowpath Calculations

TREATMENT SWALE DESIGN - GD01

Project	Vernon GSR
Job No	J2224
Designer	Sam Furniss
Date	17/12/2024
Description	Entire Catchment

A	Area Impervious	28777	m ²
A	Area Pervious	64587	m ²
A	Area Total	93364	m ²
I_{wQ}	Rainfall Intensity - Water Quality	10	mm/hr
C_{wQ}	Runoff Coefficient - Water Quality	0.638701	
Q_{wS}	Flow Rate - Water Quality	0.1656	m ³ /s
S	Longitudinal Slope	0.005	m/m
z	Side slope	5	1V:XH
n_{wQ}	Manning Coefficient - Water Quality	0.25	
d_{wQ}	Depth - Water Quality	0.38	m
b_{wQ}	Base Width - Water Quality	2	m
l	Swale Effective Length	93	m
A_{wQ}	Cross-Sectional Area - Water Quality	1.4820	m ²
R_{wQ}	Hydraulic Radius - Water Quality	0.2522	m
v_{wQ}	Velocity - Water Quality	0.1124	m/s
DQ_{wS}	Design Swale Flow Rate - Water Quality	0.1666	m ³ /s
HRT_{wQ}	Hydraulic Residents Time - Water Quality	13.8	min

Design Flow > Required Flow Rate	OK
Velocity < 0.8m/s	OK
Hydraulic Residence Time > 9mins	OK

GRASSED OLFP 1 - GD01

Project Vernon GSR
Job No J2224
Designer Sam Furniss
Date 17/12/2024
Description Second third of catchment (chainage 210 - 378)

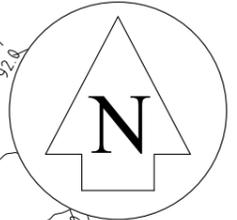
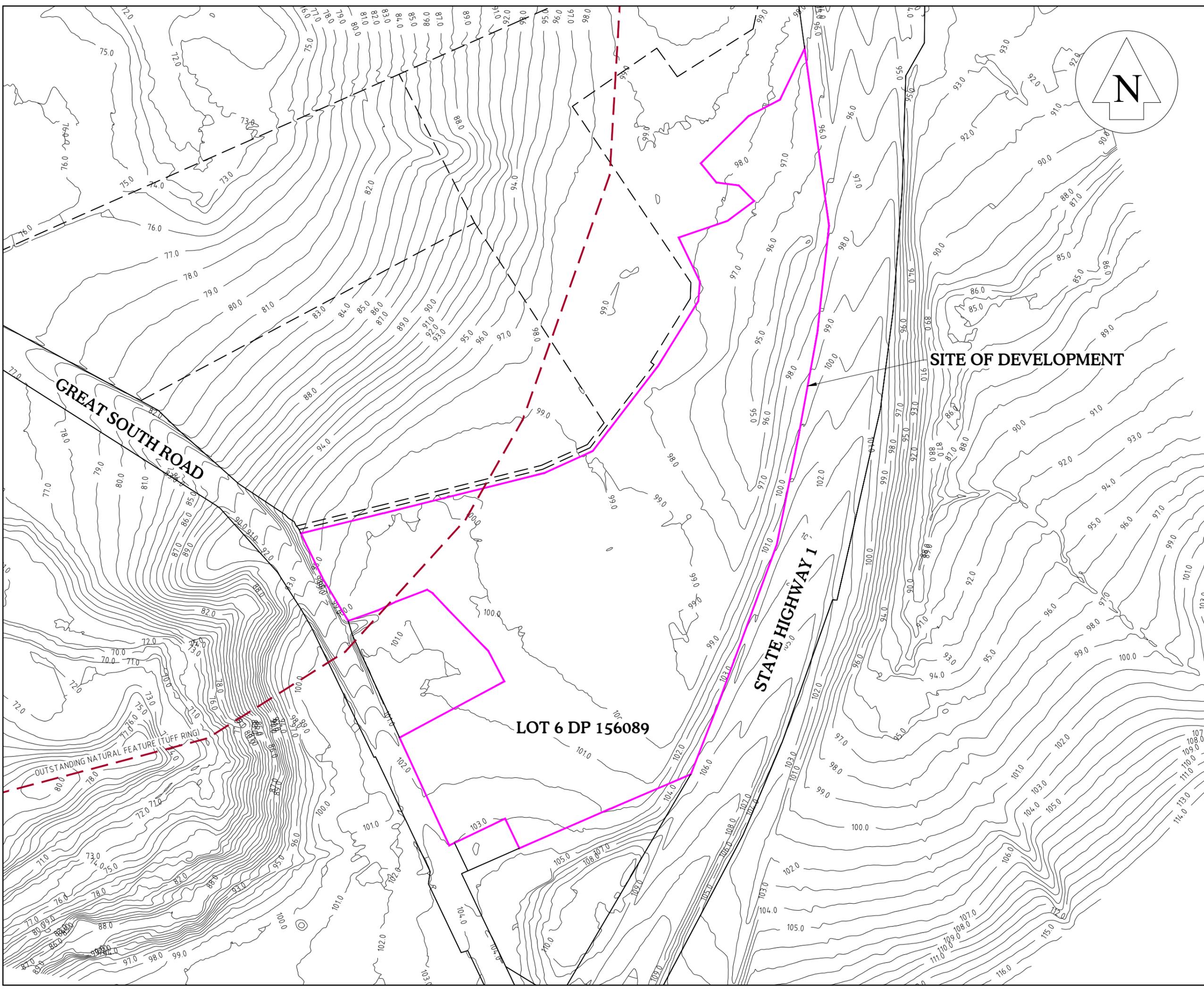
A	Area Impervious	17805 m ²
A	Area Pervious	40376 m ²
A	Area Total	58181 m ²
C _{WQ}	Runoff Coefficient - Water Quality	0.637712
S	Longitudinal Slope	0.005 m/m
z	Side slope	5 1V:XH
d _{WQ}	Depth - Water Quality	0.37 m
b _{WQ}	Base Width - Water Quality	1 m
l	Swale Effective Length	70 m
P _{10%AEP}	Rainfall Depth - 10% AEP	130 mm
I _{10%AEP}	Rainfall Intensity - 10% AEP	105.5574 mm/hr
Q _{10%AEP}	Flow Rate - 10% AEP	1.0879 m ³ /s
n _{WQ}	Manning Coefficient - 10% AEP	0.03
d _{WQ}	Depth - 10% AEP	0.41 m
A _{WQ}	Cross-Sectional Area - 10% AEP	1.2505 m ²
R _{WQ}	Hydraulic Radius - 10% AEP	0.2414 m
v _{WQ}	Velocity - 10% AEP	0.9094 m/s
DQ _{WS}	Design Swale Flow Rate - 10% AEP	1.1372 m ³ /s
Design Flow > Required Flow Rate		OK
Velocity < 1.5m/s		OK
P _{10%AEP}	Rainfall Depth - 1% AEP	215 mm
I _{10%AEP}	Rainfall Intensity - 1% AEP	198.0017 mm/hr
Q _{10%AEP}	Flow Rate - 1% AEP	2.0407 m ³ /s
n _{WQ}	Manning Coefficient - 1% AEP	0.03
d _{WQ}	Depth - 1% AEP	0.53 m
A _{WQ}	Cross-Sectional Area - 1% AEP	1.9345 m ²
R _{WQ}	Hydraulic Radius - 1% AEP	0.3020 m
v _{WQ}	Velocity - 1% AEP	1.0568 m/s
DQ _{WS}	Design Swale Flow Rate - 1% AEP	2.0444 m ³ /s
Design Flow > Required Flow Rate		OK

Metalled OLFP 2 - GD01

Project	Vernon GSR
Job No	J2224
Designer	Sam Furniss
Date	17/12/2024
Description	Catchment going through metalled OLFP

<i>A</i>	Area Impervious	17805 m ²
<i>A</i>	Area Pervious	40376 m ²
<i>A</i>	Area Total	58181 m ²
<i>C_{wQ}</i>	Runoff Coefficient - Water Quality	0.637712
<i>S</i>	Longitudinal Slope	0.01 m/m
<i>z</i>	Side slope	20 1V:XH
<i>b_{wQ}</i>	Base Width - Water Quality	1 m
<i>P_{10%AEP}</i>	Rainfall Depth - 1% AEP	215 mm
<i>I_{10%AEP}</i>	Rainfall Intensity - 1% AEP	198.0017 mm/hr
<i>Q_{10%AEP}</i>	Flow Rate - 1% AEP	2.0407 m ³ /s
<i>n_{wQ}</i>	Manning Coefficient - 1% AEP	0.023
<i>d_{wQ}</i>	Depth - 1% AEP	0.27 m
<i>A_{wQ}</i>	Cross-Sectional Area - 1% AEP	1.7280 m ²
<i>R_{wQ}</i>	Hydraulic Radius - 1% AEP	0.1463 m
<i>v_{wQ}</i>	Velocity - 1% AEP	1.1993 m/s
<i>DQ_{ws}</i>	Design Swale Flow Rate - 1% AEP	2.0724 m ³ /s
	Design Flow > Required Flow Rate	OK

Appendix F: Retrospective Earthworks Plans



- GENERAL NOTES**
1. LEVELS ARE IN TERMS OF NZ VERTICAL DATUM 2016.
 2. COORDINATES ARE IN TERMS OF MOUNT EDEN CIRCUIT 2000.
 3. PRE-DEVELOPMENT CONTOURS SOURCED FROM AUCKLAND COUNCIL GEOMAPS.

LEGEND

EXISTING CONTOURS	
OUTSTANDING NATURAL FEATURE (TUFF RING)	

Amendments	Name	Date

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 Contractor to:
 Verify all dimensions on site before commencing any work. Refer to all figured dimensions. Refer all discrepancies to TSC Ltd.

	Name	Date
Surveyed	Auckland Council Geomaps	N/A
Designed	--	N/A
Drawn	Sam Furniss	02/25
Checked	Avneet Kumar	02/25
Approved	Craig Forrester	02/25



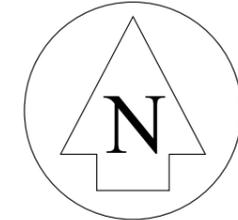
0800 TO SURVEY (0800 86 78 78)
 e-mail: info@subdivision.co.nz
 LEVEL 1, 17 HALL STREET, PUKEKOHE, NEW ZEALAND
 PH: 09 238 9991, FAX: 09 238 9307

Job Title
RETROSPECTIVE WORKS AT 1799A GREAT SOUTH ROAD, BOMBAY

Client
VERNON DEVELOPMENTS LTD

Sheet Title
PRE-DEVELOPMENT CONTOUR PLAN

Project	J2224	Drawing	J2224-1
CAD Ref. File	C-501-01	Council Ref.	----
Scale (A3 Original)	1:2500	Amendment	----



GENERAL NOTES

1. LEVELS ARE IN TERMS OF NZ VERTICAL DATUM 2016.
2. COORDINATES ARE IN TERMS OF MOUNT EDEN CIRCUIT 2000.

LEGEND

- EARTHWORKED CONTOURS
- OUTSTANDING NATURAL FEATURE (TUFF RING)
- NEW METAL
- NEW BUILDINGS

Amendments	Name	Date

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 Contractor to:
 Verify all dimensions on site before commencing any work. Refer to all figured dimensions. Refer all discrepancies to TSC Ltd.

	Name	Date
Surveyed	Lewis Jones	07/24
Designed	--	N/A
Drawn	Sam Furniss	02/25
Checked	Avneet Kumar	02/25
Approved	Craig Forrester	02/25



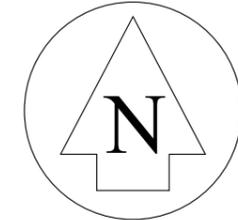
0800 TO SURVEY (0800 86 78 78)
 e-mail: info@subdivision.co.nz
 LEVEL 1,17 HALL STREET, PUKEKOHE, NEW ZEALAND
 PH:09 238 9991, FAX: 09 238 9307

Job Title
**RETROSPECTIVE WORKS
 AT 1799A GREAT SOUTH
 ROAD, BOMBAY**

Client
**VERNON
 DEVELOPMENTS LTD**

Sheet Title
**EARTHWORKED
 CONTOUR PLAN**

Project	J2224	Drawing	J2224-2
CAD Ref. File	C-501-01	Council Ref.	----
Scale (A3 Original)	1:2500	Amendment	----



- GENERAL NOTES**
- LEVELS ARE IN TERMS OF NZ VERTICAL DATUM 2016.
 - COORDINATES ARE IN TERMS OF MOUNT EDEN CIRCUIT 2000.
 - EARTHWORKS VOLUMES ARE FROM EXISTING SURFACE TO THE EARTHWORKED SURFACE AND ARE:
 - TOPSOIL VOLUME 9,995m³
 - TOTAL CUT 1,542m³
 - TOTAL FILL 4,491m³
 - MAX CUT DEPTH 0.5m
 - MAX FILL DEPTH 2.0m
 - EARTHWORKS AREA IS 29,973m².

LEGEND

DEPTH CONTOUR (0.5m INTERVAL)

EARTHWORKS AREA

OUTSTANDING NATURAL FEATURE (TUFF RING)

CUT/FILL RANGE	
-1.0 to -0.5m	
-0.5 to 0.0m	
0.0 to 0.5m	
0.5 to 1.0m	

Amendments	Name	Date

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Contractor to:
Verify all dimensions on site before commencing any work. Refer to all figured dimensions. Refer al discrepancies to TSC Ltd.

	Name	Date
Surveyed	Lewis Jones	07/24
Designed	--	N/A
Drawn	Sam Furniss	02/25
Checked	Avneet Kumar	02/25
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LEVEL 1,17 HALL STREET, PUKEKOHE, NEW ZEALAND
PH:09 238 9991, FAX: 09 238 9307

Job Title
**RETROSPECTIVE WORKS
AT 1799A GREAT SOUTH
ROAD, BOMBAY**

Client
**VERNON
DEVELOPMENTS LTD**

Sheet Title
ISOPACH PLAN

Project		Drawing	
J2224	J2224	J2224-3	J2224-3
CAD Ref. File		Council Ref.	
C-501-01	C-501-01	----	----
Scale (A3 Original)		Amendment	
1:2500	1:2500	----	----