PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

Approval no: DEV2023/1445

21-000307.3058

Date: 17 September 2024

Queensland Government

ENGINEERING SERVICES REPORT

AURA PRECINCT 15 'WEST'

Prepared for **Stockland Development Pty Ltd**

Document information

GENERAL INFORMATION

Author(s)	Ben Gear
Version	D
Path/file name	\\sunnas01\H:\17\000934 - Aura P7 - 10\000934 AURA\3000 Other Works\3058 - Precinct 15\2_Docs\Reports\Engineering Services Report\P15 West\17-000934-3058-ESR02 Rev D.docx
Prepared by (author)	Ben Gear
Reviewed by	Ben Gear
Approved by	Ben Gear
Security classification	Commercial-in-Confidence

HISTORY OF CHANGES

Version	Date	Checked by
A	30/08/2023	Stockland
B	21/12/2023	Ben Gear
C	09/05/2024	Ben Gear
D	24/07/2024	Ben Gear

Version	Date	Approved by
A	27/09/2023	Ben Gear
B	21/12/2023	Ben Gear
C	09/05/2024	Ben Gear
D	24/07/2024	Ben Gear

TABLE OF CONTENTS

1 INTRODUCTION 5
1.1 Existing Planning and Approvals 5
1.2 Site Description 6
1.3 Amendments to Engineering Services Report – Revision B 6
1.4 Amendments to Engineering Services Report – Revision C 7
1.5 Amendments to Engineering Services Report – Revision D 7

2 BULK EARTHWORKS 8
2.1 Earthworks Objectives 8
2.2 Geotechnical 8
2.3 Wallum Sedge Frog Ponds and Staged Relocation 9
2.4 Waterways and Fish Passage 9
2.5 Vegetation 10

3 ROAD NETWORK 12
3.1 Road Hierarchy and Cross Sections 12
3.2 Access 12
3.3 Intersections – Four-Way 13
3.4 Swept Paths 15

4 STATE CONTROLLED INFRASTRUCTURE 17
4.1 CAMCOS Corridor 17
4.2 Bruce Highway Interface 17

5 STORMWATER NETWORK 19
5.1 Regional Flooding 19
5.2 External Catchment Flows 20
5.3 Local Drainage 20
5.4 No Worsening Impact on the Pre-Development Condition 20
5.5 Stormwater Quality 21

6 WASTEWATER AND WATER 22
6.1 Water and Wastewater Reticulation 22

7 UTILITIES 23

APPENDIX A: URBIS DEVELOPMENT APPLICATION PLANS 24

APPENDIX B: REPORT ON ADDITIONAL GEOTECHNICAL INVESTIGATION, AURA PRECINCTS 6-16, PREPARED BY DOUGLAS PARTNERS 25

APPENDIX C: STORMWATER QUANTITY MANAGEMENT PLAN BY EGIS 26

APPENDIX D: STORMWATER QUALITY MANAGEMENT PLAN BY EGIS 27

APPENDIX E: ENGINEERING DRAWINGS BY EGIS 28

APPENDIX F: STATE CONTROLLED INFRASTRUCTURE INTERFACE REPORT FOR PRECINCT 15 WEST BY EGIS 29

TABLE OF FIGURES

Figure 1 - Site Locality 6
Figure 2. DAF Waterway Barrier Risk of Impact 10
Figure 3. ARUP Ecological Enhancement Strategy Mapping 11
Figure 4. Access Locations 13
Figure 5. Location of four-way intersections 14
Figure 6. Extract from Economic Development Queensland PDA Guideline No. 0.6 15
Figure 7. Swept Path Analysis reference numbers 16
Figure 8. 1% AEP + CC Flood Extents, Based on BMT Flood Modelling and Modified for Site Filling 19

1 INTRODUCTION

Egis Consulting has prepared this Engineering Services Report to accompany the submission of a Development Application for Reconfiguration of a Lot over the western portion of the subject site known as Aura Precinct 15 'West'.

The application proposes to subdivide the site into various land uses as defined in the proposed development layout. Refer to Appendix A for the proposed application extents and lot layout.

The concept urban designs presented with this application includes:

- Approximately ~300 residential dwellings (mixture of standard residential and multiple residential);
- Sports Park;
- Medium Density;
- Neighbourhood Centre;
- Community Facilities; and
- Open Space.

The aim of the Engineering Services Report is to identify site opportunities and constraints and provide design solutions which comply with the relevant guidelines and demonstrate that the proposed development can be serviced for road access, stormwater drainage, water reticulation and sewerage reticulation while addressing the environmental and flood impacts.

1.1 Existing Planning and Approvals

Egis's concept design has been developed in accordance with a number of Approvals, Planning Documents, Investigations and Studies.

These documents include but are not limited to:

- Caloundra South Priority Development Area Infrastructure Agreement – State Transport Infrastructure (STIA, 2015);
- Caloundra South Priority Development Area Infrastructure Agreement - Local Government Infrastructure (LGIA, 2015);
- Caloundra South Infrastructure Agreement (Water and Wastewater Infrastructure) (UWIA, 2017);
- Caloundra South Development: Flood Risk Management Strategy (BMT WBM, 2015);
- Caloundra South Water Quality Management Plan (BMT, May 2017);
- Environmental Management Plan (BMT, August 2017);
- Ultimate Caloundra South Traffic Model (MWH, 2015);
- Construction Environment Management Plan (Egis, Oct 2017);
- Wallum Sedge Frog Management Plan (Stockland, 2017);
- Operational work for Waterway barrier works Preliminary Approval and Development Permit (partial only), subject to conditions (SARA, 2018);
- Additional Geotechnical Investigation, Aura Precincts 6-16 (Douglas Partners, August 2017);
- Infrastructure Master Plan (Water & Sewer) (Parsons Brinckerhoff, Aug 2016);
- Aura Precincts 11 – 14 Stormwater Quality Management Plan (Design Flow, July 2020);
- Aura Precincts 6, 11 (Part), 12 (Part) and 14 Engineering Services Report (Egis Consulting, July 2021);
- State Controlled Infrastructure Interface Report for Aura Precincts 11 (Part), 12 (Part), 13 (Part) and 14 (reference 17-000934.3015TMRR01.AM.RI (Egis Consulting, July 2020); and
- Aura Precinct 15 'East' Engineering Services Report (Egis Consulting, March 2022).

1.2 Site Description

Precinct 15 is located in the Western locality of Aura. The Precinct is bound by the Bruce Highway to the West, the future CAMCOS corridor to the North and Bells Creek South to the South. The western portion of this Precinct forms Precinct 15 'West'.

The site forms part of the Caloundra South Priority Development Area (Aura). The Master Plan was approved by the (former) Urban Land Development Authority (ULDA reference No. DEV2011/200) now Economic Development Queensland (EDQ).

Please refer to Figure 1 following showing the locality of Precinct 15 'West' known within this report as the 'Site'.

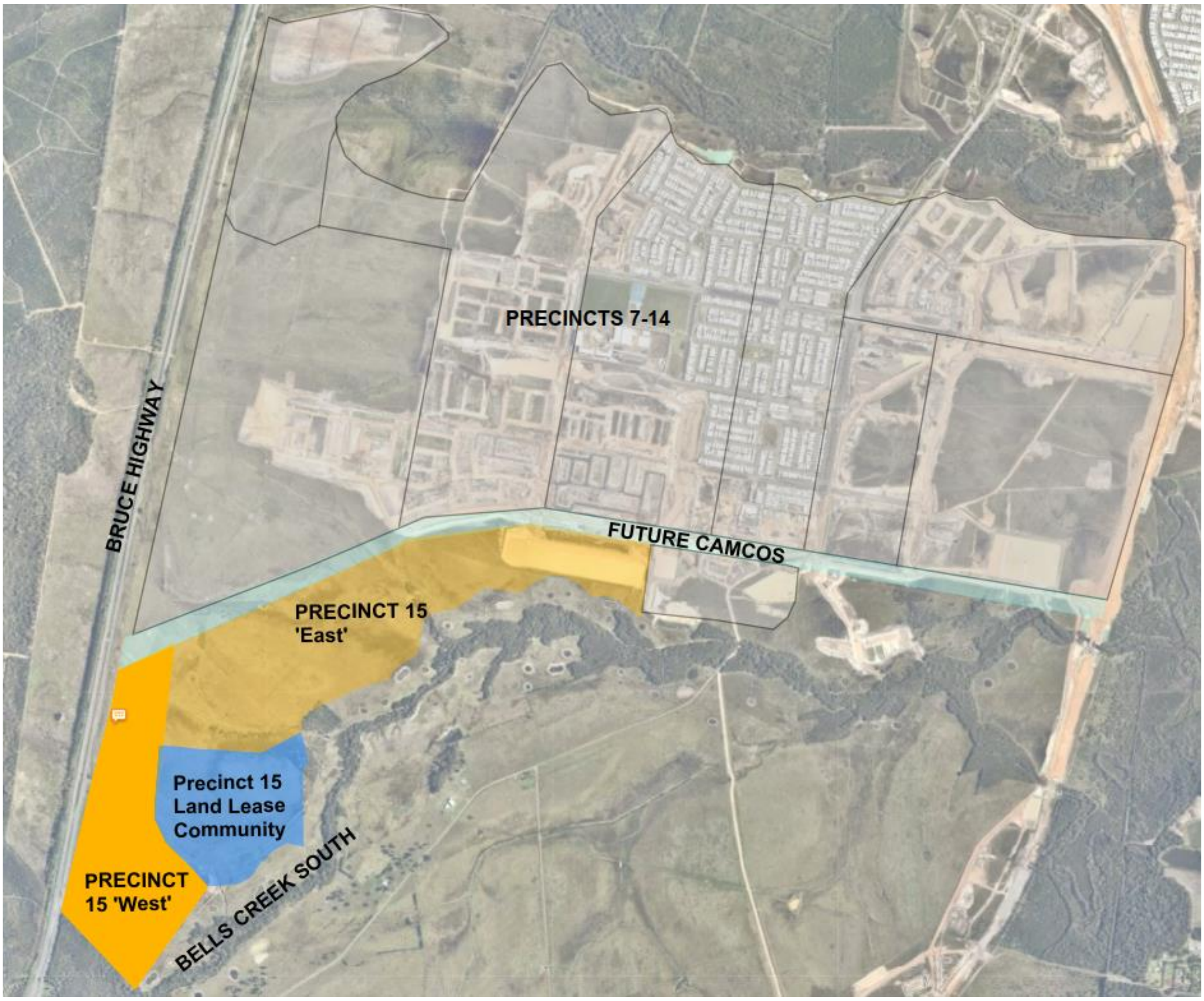


FIGURE 1 - SITE LOCALITY

1.3 Amendments to Engineering Services Report – Revision B

Amendments have been made to the Engineering Services Report, Revision B, in response to the Further Issues Letter dated 20 November in relation to Development Approval DEV2023/1445.

Changes to the ESR are summarised below:

- Figures updated to reflect revised layout.
- Section 2.1 – Reference to 0.3% road grading removed and 500mm freeboard provided in accordance with Sunshine Coast Planning Scheme Policy.

1.4 Amendments to Engineering Services Report – Revision C

Amendments have been made to the Engineering Services Report, Revision C, in response to the Further Issues Letter dated 13 March 2024 in relation to Development Approval DEV2023/1445.

Changes to the ESR are summarised below:

- Figures updated to reflect revised layout.
- Section 2.1 – Minimum habitable floor replaced with minimum finished earthwork.

1.5 Amendments to Engineering Services Report – Revision D

Amendments have been made to the Engineering Services Report, Revision D, in response to the Further Issues Letter dated 11 June 2024 in relation to Development Approval DEV2023/1445.

Changes to the ESR are summarised below:

- Drawing 3058-DA036 removed from drawing set
- Stormwater Quality Management Plan updated
- STI Report in Appendix F amended

2 BULK EARTHWORKS

2.1 Earthworks Objectives

The proposed earthworks strategy within the development boundary comply has the following design objectives and principles:

- Facilitate the Stockland development phasing and current ROL approvals;
- Comply with approved documentation;
- To be in accordance with flood immunity requirements set by regional flood levels along Bells Creek North and Bells Creek South;
- To be in accordance with local flood levels from the internal stormwater catchments;
- Optimise the use of developable area through efficient design;
- Efficient Design and utilisation of the natural topography of the site as best as possible;
- Be economical and cost effective;
- All allotments to be graded at minimum and 1 in 200 towards the road;
- Cut/fill volumes to be developed to best match requirements of other Precincts; and
- To be consistent with the Additional Geotechnical Investigation report for Aura Precincts 6-16 by Douglas Partners.

Regional flood levels have been established for Bells Creek South through modelling undertaken by BMT (TUFLOW Model ID245). To comply with the Aura Regional Flood Model 2020 (Model ID245) prepared by BMT, the minimum finished earthwork levels for allotments is based on providing 500mm freeboard to the 1% AEP (100 year ARI) peak flood level with increased rainfall intensity and sea levels taken into account for climate change to a planning horizon of the year 2100.

The concept bulk earthworks design provides appropriate flood immunity for various land uses in accordance with the master plan as flows:

- Allotments and roads are designed for immunity to the 1% AEP (100 year ARI) peak flood level with climate change;
- Major and district sports parks have been designed for 5% AEP (20 year ARI) flood immunity (with 1% AEP flood immunity for structures); and
- Recreational areas have been designed for the 18% AEP (5 year ARI) flood immunity (with 1% AEP flood immunity for structures).

Refer to the drawings in Appendix E for an overview of the proposed conceptual bulk earthworks for the Site.

2.2 Geotechnical

Geotechnical investigations have been undertaken by Douglas Partners comprising a broadscale investigation in 2014 and a second Additional Geotechnical Investigation of Precincts 6 -16 in 2017. Key findings from these reports are summarised as follows:

- Broadly, the area is gently undulating of low relief, with the ground surface overall falling gradually from west to east with several localised knolls associated with the larger trending ridgeline on the western side of the Bruce Highway;
- Subsurface conditions generally comprise topsoil of between 100mm to 350mm overlying silty and clayey sands;
- It is anticipated that the majority of material won from excavations on site will generally be suitable for reuse as bulk filling provided they are placed in a controlled manner;
- Groundwater seepage was typically encountered between 1.2m and 2.8m depth;

- CBR testing (16 samples) returned results of between 0.5% to 18.0% with an average result of 7% across the greater Aura Development;
- Emerson class dispersion tests (8 samples) returned values of 5 and 6 on a scale of 1 to 8 indicating a slight potential for erosion;
- Topsoil depth varies from 0.1m to 0.35m. Quality of topsoil is poor and it is anticipated that treatment would be needed to improve nutrient value;
- Drainage for the site during construction is necessary to maintain site trafficability. Consideration for providing a working platform may be necessary in some instances;
- Recommended compaction factors in the calculation of fill volumes vary between 0.80 and 1.10 with the silty/ clayey sands which comprise the majority of the site being 0.80 to 0.85; and
- Site classification of 'Class S' would be anticipated under normal soil moisture conditions.

Further detail regarding existing ground condition and geotechnical suitability for development can be found within the aforementioned geotechnical reports.

2.3 Wallum Sedge Frog Ponds and Staged Relocation

For the detailed management strategy of the Wallum Sedge Frogs, reference should be made to the Wallum Sedge Frog Management Plan – August 2016 (ARUP) submitted to the Department of Environment and Energy, in support of the underlying development.

There are a number of Wallum Sedge Frog habitats to be retained across all the precincts of Aura, including Precinct 15. Retained and recreated Wallum Sedge Frog habitat traverse the riparian zones of Bells Creek North and South.

The works within these precincts are phased in such a way that were impacted habitat exists, recreated habitat is delivered prior to the removal of existing habitat zones. Likewise, the phasing of the works considers conveyance and discharge of stormwater (both construction and developed) to ensure that runoff does not compromise Wallum Sedge Frog habitat. These works do not form part of the proposed Precinct 15 development application.

The proposed development layout and stormwater quality Water Sensitive Urban Design Strategy have been detailed to comply with the requirements of the Wallum Sedge Frog Management Plan. Refer to the reports from the relevant consultants for further details on this matter.

2.4 Waterways and Fish Passage

Reference has been made to the Department of State Development, Manufacturing, Infrastructure and Planning approval (1710-2004 SDA dated 28 February 2018) which provides a conditional approval for the proposed earthworks across the site. Figure 2 below is a snapshot of the DAF identified waterway barrier risk of impact mapping.

Mapping indicates that there is no declared fish habitat anywhere in the vicinity of Aura. There is, however, Waterway Barrier mapped tributaries within Precinct 15 (with a rating of 'low'). The treatment and removal of these waterways is required to be strictly in accordance with the existing DAF approval conditions. Risk to impact to waterway barriers in accordance with the DAF waterway approval have been identified in the image below.

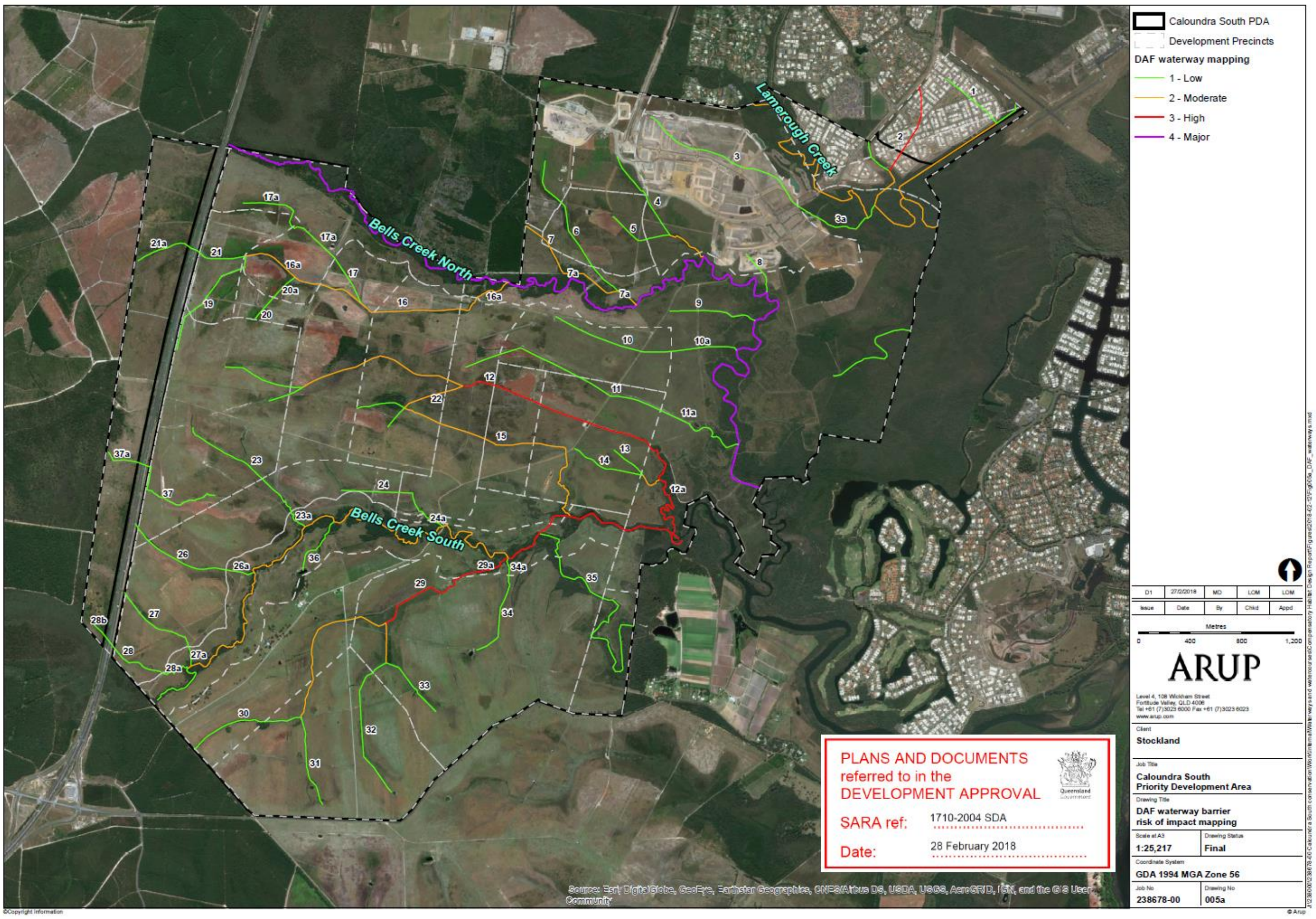


FIGURE 2. DAF WATERWAY BARRIER RISK OF IMPACT

2.5 Vegetation

Vegetation management is detailed in the VMP prepared by Arup. Within Precinct 15, there are no EPBC listed threatened flora species. The Bells Creek South corridor has been identified for conservation and rehabilitation to improve habitat value.

Weed management throughout earthworks operations and rehabilitation works is important to ensure successful regeneration of native vegetation.

The mapping prepared by ARUP detailing the proposed Ecological Enhancement Strategy is shown below in Figure 3.

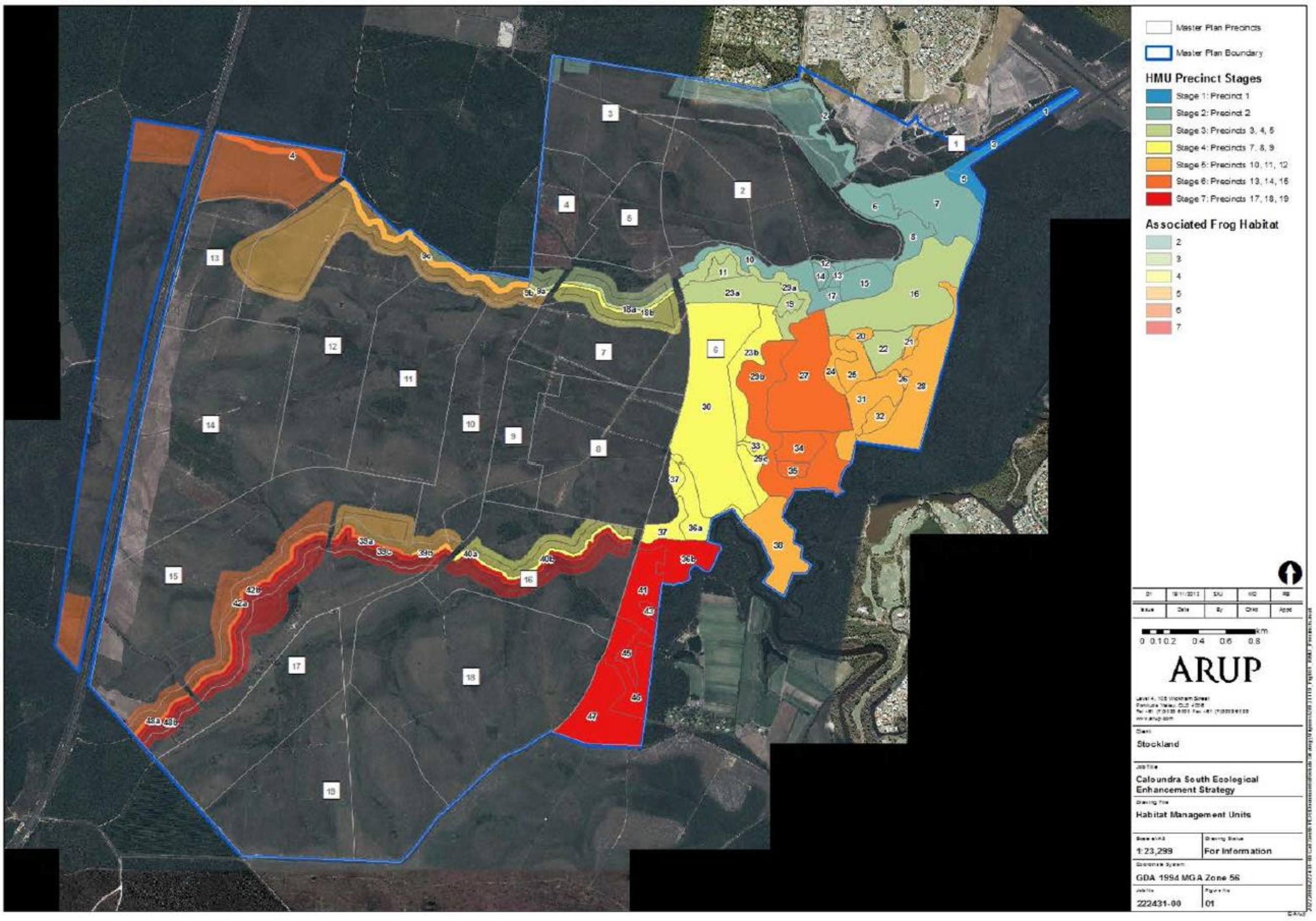


FIGURE 3. ARUP ECOLOGICAL ENHANCEMENT STRATEGY MAPPING

3 ROAD NETWORK

3.1 Road Hierarchy and Cross Sections

Urbis have undertaken a road hierarchy plan containing access streets, and laneways for Precinct 15. PwC have completed a detailed traffic report and modelling based on Urbis' road hierarchies and development yield to determine final design requirements for traffic, parking and intersections.

PwC's Traffic Modelling Report assumptions for Precinct 15 are reflected in the Urbis planned road hierarchy, provided by appropriate lane types and . The Precinct is fully serviced with pedestrian networks to comply with the LGIA (Map 11).

The PwC Traffic modelling makes an assumption of a 20% modal shift to cycle movements. This is consistent with previous traffic modelling for the Aura Development. Final assessment of the proposed road intersections and geometry will be assessed in detail as part of the detailed design.

3.2 Access

In accordance with the Sunshine Coast Planning Scheme Schedule 6 Section 17 Table SC6.17E, there will be two vehicular accesses into Precinct 15 West, the first via the roundabout located on Trunk Connector C (outside the eastern boundary of the application) and the second as a emergency vehicle access across the Sports Park.

The emergency vehicle access is proposed over the Sports Park in the Northern part of the site. This access is proposed to be trafficable in a 1% AEP plus climate change flood event and will provide access for emergency vehicles only. Bollards/lockrails are proposed to prevent day to day access for residents, with details to be provided at the design compliance phase.

The western enclave of Precinct 15 West is proposed to be serviced by one road connection across the open channel. To satisfy Sunshine Coast Planning Scheme Schedule 6 Section 17 Table SC6.17E, a secondary egress is proposed via the linear park. The 3m path will be designed to facilitate the emergency access, be trafficable in a 1% AEP plus climate change flood event and will provide access for emergency vehicles only. Bollards/lockrails are proposed to prevent day to day access for residents, with details to be provided at the design compliance phase.

Refer to Figure 4 below for the location of the proposed accesses and to drawing 3058-DA058 in Appendix E.

FIGURE 4. ACCESS LOCATIONS

3.3 Intersections – Four-Way

One four-way intersection has been proposed throughout Precinct 15 'West' for the intersection of roads with a hierarchy no higher than an 'access street'.

The four-way intersection is between two access streets. Refer to Figure 5 below for the location of these intersections.

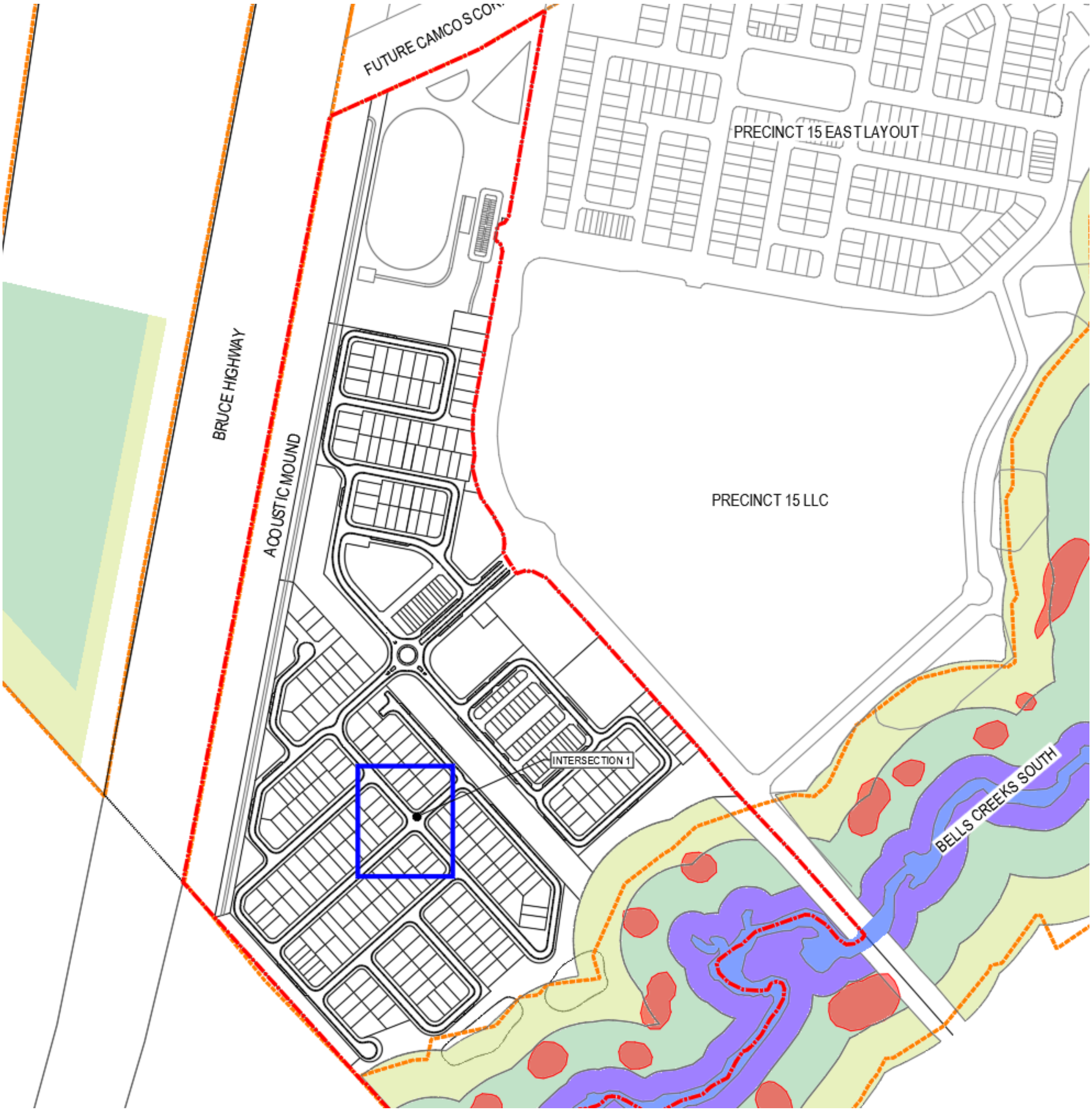


FIGURE 5. LOCATION OF FOUR-WAY INTERSECTIONS

These proposed intersections are consistent with Economic Development Queensland PDA Guideline No. 06 which indicates that four-way intersections of access streets are typical for neighbourhoods (refer to extract below in Figure 6) where they are situated a minimum depth of two lots away from the closest intersection.

FIGURE 6. EXTRACT FROM ECONOMIC DEVELOPMENT QUEENSLAND PDA GUIDELINE NO. 0.6

Four-way intersection #1 is proposed to be a priority yield intersection, where traffic signs will be required on the lessor priority road to provide clarity to drivers on who has right of way. Confirmation of the lessor priority road will be made during the Design Compliance Phase by providing a 'Signs and Linemarking' drawing, including traffic signs and surface treatments on the lessor priority road as necessary. Sight distances will also be reviewed during the Design Compliance Phase to determine whether parking limits will be required on the higher priority road, to ensure adequate sight distance for the lessor priority road.

3.4 Swept Paths

Three key areas of the proposed development have been assessed using the turning path of a 12.5m long Heavy Rigid Vehicle to determine whether parking limits are required or if an alternative strategy for refuse collection is required.

Referring to Figure 7 below, these four areas have been identified.

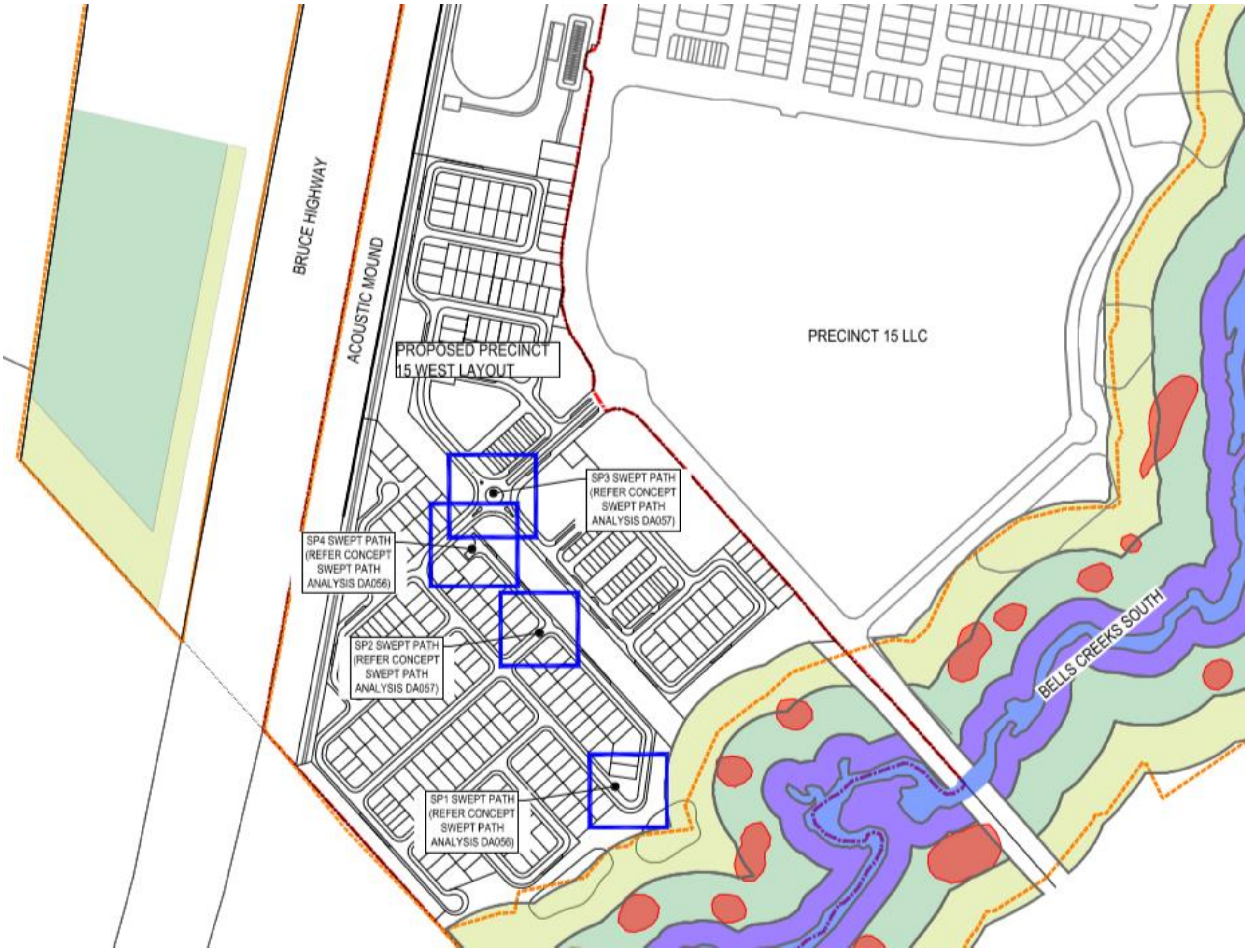


FIGURE 7. SWEPT PATH ANALYSIS REFERENCE NUMBERS

This Swept Path review has conceptually identified:

- At Swept Path SP1, a refuse vehicle can manoeuvre within the proposed roadway;
- At Swept Path SP2, a refuse vehicle can manoeuvre within the proposed roadway; and
- At Swept Path SP3, a refuse vehicle can manoeuvre within the proposed roundabout configuration.
- At Swept Path SP3, a refuse vehicle can manoeuvre within the proposed turnaround configuration.

Refer to drawings within Appendix E for details of the swept path analysis.

These swept path analyses will be further confirmed during the Design Compliance Phase, considering the location of parking bays and lanes.

4 STATE CONTROLLED INFRASTRUCTURE

Egis Consulting has previously undertaken a State Controlled Infrastructure Interface Report for Aura Precincts 11 (Part), 12 (Part), 13 (Part) and 14 (reference 17-000934.3015TMRR01.AM.Rl, July 2020).

The purpose of this State Controlled Infrastructure Interface report was to accompany the submission of the Development Application over the precincts listed within its title and provide information related to the interface to the Caboolture to Maroochydore railway line (CAMCOS Corridor) Interface as well as the Bruce Highway Interface.

The land that is to become the CAMCOS Corridor is not situated within Precinct 15, however the CAMCOS corridor forms the northern boundary of Precinct 15. The western boundary of the site interfaces with the Bruce Highway and requires noise attenuation.

4.1 CAMCOS Corridor

4.1.1 Interface

Egis prepared an CAMCOS Corridor Alignment Study in 2015 (Reference 15-002608CER01C) that investigated the proposed Caboolture to Maroochydore railway line (CAMCOS) against adjacent land uses and transport and planning principles.

This past study was commissioned to review the proposed design with consideration to the planning and environment requirements and refine the alignment for effective integration with Aura. The identified horizontal and vertical alignments from the study were designed to maximise potential patronage, respect topography and reduce environmental impact.

Ultimately Queensland Rail will construct and deliver the CAMCOS rail line, however it is integral to Precinct 15 that the proposed planning for rail geometry be considered in full to ensure a best practice master planned outcome.

The CAMCOS Corridor interface was then reviewed again within the Precinct 11 (Part), 12 (Part), 13 (Part) and 14 Development Application and are detailed within report 17-000934.3015TMRR01.AM.Rl.

To allow for the different timing of Precincts 11-14, 15 and the CAMCOS Railway works, an interim bulk earthworks design was also discussed within report 17-000934.3015TMRR01.AM.Rl. Appropriate acoustic treatment will be constructed within the CAMCOS Corridor in accordance with acoustic modelling and Queensland Rail standards, by others.

4.1.2 Drainage and Service Crossings

The drainage crossing at location X detailed within report 17-000934.3015TMRR01.AM.Rl as a 750 RCP, has been investigated further within detailed design development. This crossing has been removed and stormwater flows redirected to crossing C2.

4.2 Bruce Highway Interface

The development presents an approximate 900m interface along the State Controlled Road - Bruce Highway. The indicative State Controlled Road (SRC) Chainages along the proposed Bruce Highway interface are detailed in Calibre State Controlled Infrastructure Interface Report, Reference 17-000934.3015TMRR01.AMP.Rl dated July 2020, drawing 17000934.3015-SK101 and as follows in Table below:

SCR Chainage (indicative) – Bruce Highway	Development Attribute
50,960	Existing Interchange at Roys Road. (External to the forthcoming Development Application area)

52310	Aura Precinct 15 (Southern Development Application Boundary)
53,160	CAMCOS Corridor Centreline intersecting with the Bruce Highway. (Northern Development Application Boundary)

Detailed assessment of the Bruce Highway Interface is addressed in State Controlled Infrastructure Interface Report, Reference 21-000307.305-STIR01 dated September 2023 in Appendix F.

4.2.1.1 Highway Buffer

The highway buffer is addressed in the State Controlled Infrastructure Interface Report, Reference 21-000307.305-STIR01 dated September 2023 in Appendix F and ASK Consulting 2021 Transport Noise Impact Assessment. Sketch plan 21-000307.3058-STI sheets SK02 & SK03 indicate the proposed acoustic bund and fence in accordance with Trinity 2023 Reporting. Sketch plan 21-000307.3058-STI sheets SK04 & SK05 provide sections along the bund and fence, heights are provided for the top of Acoustic attenuation and can be considered further during detailed design, and as part of the Highway Buffer Plan assessment.

4.2.2 Drainage

There are a number of culverts that cross underneath the Bruce Highway and outlet into Precinct 15. The flows from these culverts have a direct impact on Precinct 15 and need to be considered as site constraints.

These flows have been explored in further detail within Egis Consulting Aura Precinct 15 West: Acoustic Bund Drainage Design, 21-000307.11.WRE.TM01A.DY.kv.

5 STORMWATER NETWORK

5.1 Regional Flooding

A regional flood investigation has been undertaken by BMT to assess the affects the proposed development would have on regional flooding. The subsequent report prepared by BMT, Aura Flood Risk Management Report 2020 (Dated October 2021, using model ID245) has guided Egis's civil design and stormwater modelling for the development. From this, regional flood levels have been established for Bells Creek North, Bells Creek South and the future proposed Aura Brook. In general, these flood levels have directly influenced the minimum earthworks levels at the stormwater outlets, embankments and the tailwater conditions for Aura Brook's discharge to Bells Creek South.

The minimum habitable floor levels for allotments are based on providing 500mm freeboard to the 1% AEP peak flood level with increased rainfall intensity and sea levels taken into account for climate change to a planning horizon of the year 2100.

Refer to Figure 8. 1% AEP + CC Flood Extents, Based on BMT Flood Modelling and Modified for Site Filling

below indicating the proposed 1% AEP + CC flood extents, with the extents based on the BMT flood modelling and modified for proposed site filling. This is to be confirmed during bulk earthworks detailed design but is not required for the Reconfiguration of a Lot application.

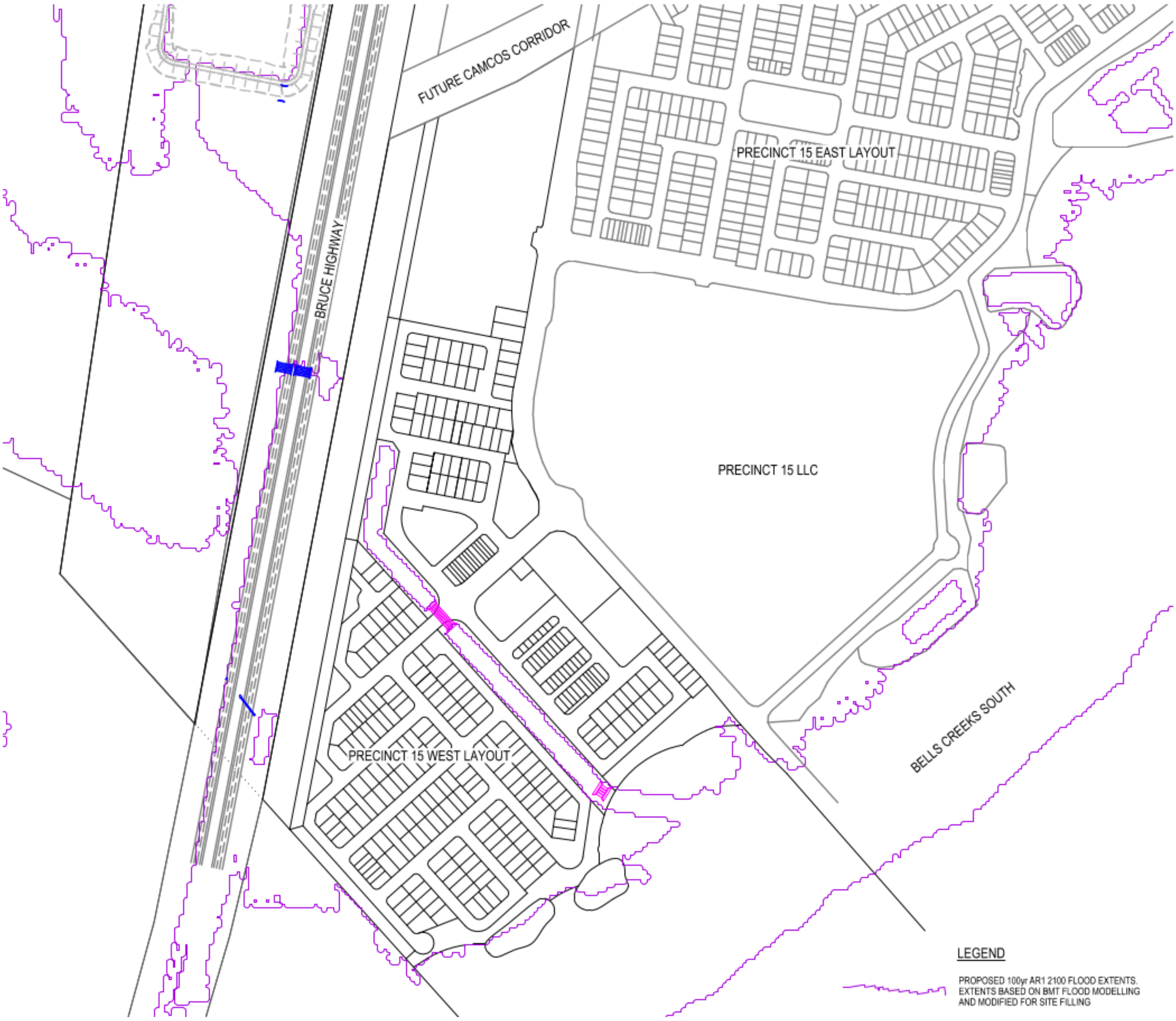


FIGURE 8. 1% AEP + CC FLOOD EXTENTS, BASED ON BMT FLOOD MODELLING AND MODIFIED FOR SITE FILLING

This report will not provide any further commentary of the regional flood investigation, however tailwater levels and Bells Creek flooding constraints will be addressed in the site network modelling.

5.2 External Catchment Flows

Egis Consulting have undertaken a detailed stormwater assessment to understand the hydraulic modelling of external flows to Precinct 15. These flows have been explored in further detail within Egis Consulting Aura Precinct 15 West: Acoustic Bund Drainage Design, 21-000307.11.WRE.TM01A.DY.kv.

Referring to Drawing 17-000934-3058-DA030 within Appendix E, the external flows conveyance to and through Precinct 15 have been detailed, noting how they will integrate with the wider Precinct 15 development. General commentary on this integration into the proposed Site layout has been detailed below.

5.2.1 Bruce Highway and Precinct 15 flows

In the existing scenario, there are five stormwater culverts that cross under the Bruce Highway with an outlet in either Precinct 14 or Precinct 15. Referring to Drawing 21-000307.3058-STI-SK01 within Appendix F, three of these culverts will drain into a Precinct 14 and have been documented with approvals under DEV2018/987 and accordingly have been removed from this report.

For the two highway culverts that drain to Precinct 15, the 1% AEP flows will be piped through the acoustic bund into Precinct 15. The northern Culvert denoted as Culvert W will discharge into a large open channel which will convey the 1% AEP flows to Bells Creek South. Local catchments within Precinct 15 west will discharge and be conveyed through this infrastructure to Bells Creek South. The Second Culvert denoted as Culvert X will convey the 1% AEP flows to Bells Creek South via piped drainage.

For details on these drainage infrastructure items, refer to Egis Consulting Aura Precinct 15 West: Acoustic Bund Drainage Design, 21-000307.11.WRE.TM01A.DY.kv for further details on their integration into the Site.

5.3 Local Drainage

The proposed development area drains southward towards Bells Creek South via local stormwater drainage network. These flows follow an internal network of major drainage elements through a series of piped and surface flow channels. In accordance with Aura's Local Government Infrastructure Agreement, the lower order road network is designed to convey 2 year ARI storm flows through the piped system with the higher order roads designed to pipe 10% AEP (10 year ARI) storm flows. In locations where the road capacity is reached, the 1% AEP (100 year ARI) flows will be piped.

Refer to Appendix E for the indicative stormwater catchments and conceptual outflow locations. As with other major infrastructure elements, location and details of stormwater drainage elements are conceptual only and subject to further detailed design for operational works.

5.4 No Worsening Impact on the Pre-Development Condition

As the proposed development increases impervious area, without mitigation measures, and has the potential to impact pre-development flooding conditions. The flood risks impact of the proposed development was assessed by comparing modelled peak flood levels of the developed case vs base case (pre-development).

To mitigate the adverse implications for flood risk resulting from the proposed development, flood risk mitigation strategies were developed. These includes but is not limited to the integration of dedicated flood detention storage, flood conveyance and other appropriate mitigation measures to ensure no adverse offsite flooding impacts.

Reference should be made to the Aura Flood Risk Management Report (prepared by BMT, dated October 2021), for further details on elements of the Flood Risk Management Strategy, including flood detention basins formed by road infrastructure crossing Bells Creek South.

This report shows that holistic flood-constraints for the broader development have been considered in developing flood mitigation measures. This is to ensure that the proposed development does not worsen flood risk or flood warning times external to the site-wide Priority Development Area (PDA).

5.5 Stormwater Quality

Precinct 15 West is located within the previously nominated catchments of S2 and S5, since the preparation and endorsed of Precinct 15 Stormwater Quality Management Plan prepared by DesignFlow an augmented strategy from end of line to at-source treatment has been developed and included in Precinct 15 West.

Refer to drawing 17-000934-3058-DA030 in Appendix E for reference on the proposed stormwater catchments. Runoff from the area associated with this application will drainage to the Waster Sensitive Urban Design infrastructure for at-source treatment prior to discharge to Bells Creek South.

Refer to Egis Stormwater Quality Management Plan for details on the proposed Stormwater Quality treatment strategy. It is noted that the changes to the layout plan associated with Precinct 15 West will require an amendment to the Endorsed Precinct 15 Stormwater Quality Management Plan prepared by DesignFlow.

6 WASTEWATER AND WATER

6.1 Water and Wastewater Reticulation

The proposed trunk water and sewer servicing within Precinct 15 has previously been detailed within the Aura – Precinct 15 Final Precinct Network Plan undertaken by Egis Consulting (Aug, 2022). In addition, the overall water and sewer servicing strategy for Aura and Aura South has been recently updated by Egis Consulting Pty Ltd in the Infrastructure Master Plan (February 2022).

The Aura – Precinct 15 Final Precinct Network Plan prepared by Egis Consulting (August 2022) has previously been approved by Unitywater and indicates trunk sewer and water infrastructure within Precinct 15. Referring to Appendix E the below isan overview of the servicing infrastructure,

- DN160 wastewater main flows north along the alignment of the proposed North-South Trunk Connector road and an additional DN160 wastewater main flowing south towards the esplanade road bounding the south eastern side of the LLC , both connecting to the existing infrastructure constructed within Precinct 15 East.
- DN500 water main along the proposed North-South Trunk Connector road, connecting to infrastructure within Precinct 14 (the Integrated Master Plan identified a reduction from DN600 as proposed in the Precinct 11 – 14 Final Precinct Network Plan). The Infrastructure Master Plan has indicated this infrastructure can be reduced to a DN500 water main.

Referring to Drawings 21-000307.3058-DA060 and 21-000307.3058-DA060 within Appendix E, the proposed internal sewer and water networks are shown indicatively. All main sizing and alignments are subject to approval by Unitywater via a Final Precinct Network Plan and may change from what is currently indicated on the drawings.

All water and wastewater infrastructure is proposed to be designed generally in accordance with Unitywater Standards, the SEQ Water Supply and Sewerage Design and Construction Code or as otherwise agreed with Unitywater.

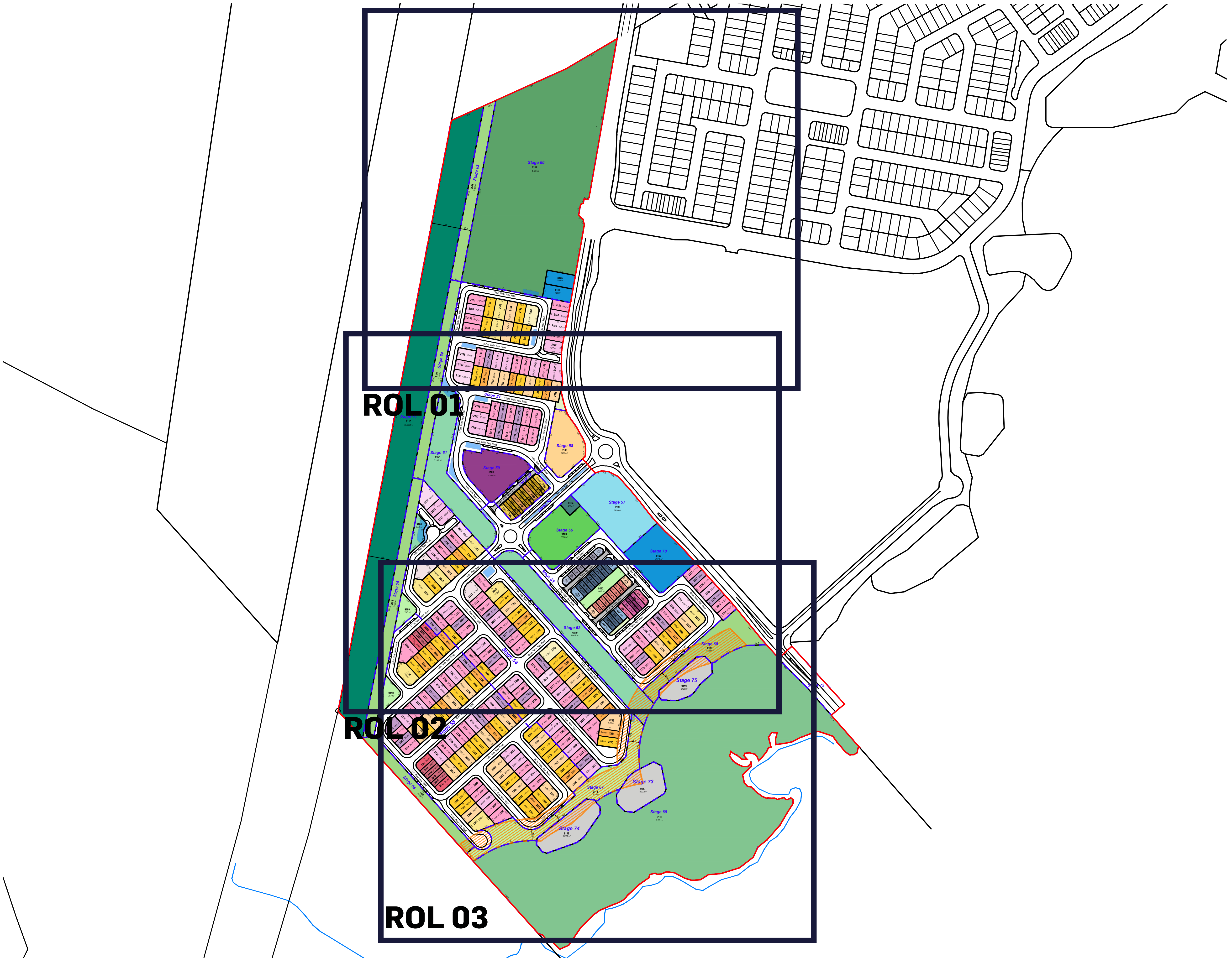
7 UTILITIES

The development will be serviced with electrical and telecommunications (National Broadband Network).

As per previous precincts with Aura the services are proposed to be co-located on a standard alignment within a corridor 0-900mm from the property boundary. Detailed design may determine that alternative alignments are required in some instances and these will be detailed on an as required basis.

These services will be provided in accordance with conditions of, and through agreement with, the relevant service providers.

APPENDIX A:
URBIS DEVELOPMENT APPLICATION PLANS



LEGEND

GENERAL

- 🟥 Application Boundary
- ╍ Stage Boundary

LAND USE

- 🟪 Multiple Residential Sites
- 🟦 Centres
- 🟦 Community
- 🟧 Childcare Centre
- ▨ Indicative Bio Basin Location

OPEN SPACE

- 🟩 Neighbourhood Sports Park
- 🟩 Neighbourhood Recreation Park
- 🟩 Civic Park
- 🟩 District Linear Park
- 🟩 Local Linear Park
- 🟩 Landscape Buffer (Road Reserve)
- 🟩 Drainage
- 🟩 Conservation
- 🟩 Highway Buffer
- ⬜ Drainage (WSUD)

YIELD SUMMARY

28 Deep Lots

- 🟧 4.6m - Terrace
- 🟧 6.6m - Terrace
- 🟨 7.6m+ - End Terrace
- 🟧 10.0m - Villa
- 🟨 12.5m - Premium Villa
- 🟧 14.0m - Courtyard
- 🟨 16.0m - Traditional
- 🟨 18.0m - Premium Traditional

25 Deep Lots

- 🟥 7.5m - Front Loaded Terrace
- 🟥 9.0m+ - Front Loaded End Terrace
- 🟪 10.0m - Villa
- 🟪 12.5m - Premium Villa
- 🟪 14.0m - Courtyard
- 🟪 16.0m - Traditional
- 🟪 18.0m - Traditional

21 Deep Lots

- 🟦 6.6m - Terrace
- 🟦 7.8m+ - End Terrace

16.5 Deep Lots

- 🟥 6.6m - Terrace
- 🟧 9.0m+ - End Terrace

Urban Lots

- ⬜ Urban Loft - Type H
- ⬜ Urban Loft - Type G

URBIS

AURA - Precinct 15

Reconfiguring of a Lot - Overall

1:6000 @ A3

0 50 100 150 200 250 300

DATE: 09.05.2024
JOB NO: P0037213
DWG NO: ROL-00

LEGEND

GENERAL

- 🟥 Application Boundary
- ┅ Stage Boundary

LAND USE

- 🟪 Multiple Residential Sites
- 🟦 Centres
- 🟦 Community
- 🟧 Childcare Centre
- ▨ Indicative Bio Basin Location

OPEN SPACE

- 🟩 Neighbourhood Sports Park
- 🟩 Neighbourhood Recreation Park
- 🟩 Civic Park
- 🟩 District Linear Park
- 🟩 Local Linear Park
- 🟨 Landscape Buffer (Road Reserve)
- 🟩 Drainage
- 🟩 Conservation
- 🟩 Highway Buffer
- ⬜ Drainage (WSUD)

YIELD SUMMARY

28 Deep Lots

- 🟧 4.6m - Terrace
- 🟧 **6.6m - Terrace**
- 🟨 **7.6m+ - End Terrace**
- 🟧 10.0m - Villa
- 🟨 12.5m - Premium Villa
- 🟧 14.0m - Courtyard
- 🟨 16.0m - Traditional
- 🟨 18.0m - Premium Traditional

25 Deep Lots

- 🟥 7.5m - Front Loaded Terrace
- 🟥 9.0m+ - Front Loaded End Terrace
- 🟪 10.0m - Villa
- 🟪 12.5m - Premium Villa
- 🟪 14.0m - Courtyard
- 🟪 16.0m - Traditional
- ⬜ 18.0m - Traditional

21 Deep Lots

- 🟦 6.6m - Terrace
- 🟦 7.8m+ - End Terrace

16.5 Deep Lots

- 🟥 6.6m - Terrace
- 🟧 9.0m+ - End Terrace

Urban Lots

- ⬜ Urban Loft - Type H
- 🟦 Urban Loft - Type G

URBIS

AURA - Precinct 15

Reconfiguring of a Lot - Overall

1:6000 @ A3

0 50 100 150 200 250 300

DATE: 09.05.2024
JOB NO: P0037213
DWG NO: ROL-01

LEGEND

GENERAL

🟥 Application Boundary
- - - Stage Boundary

LAND USE

🟦 Community
▨ Indicative Bio Basin Location

OPEN SPACE

🟩 Neighbourhood Sports Park
🟩 District Linear Park
🟨 Landscape Buffer (Road Reserve)
🟩 Drainage
🟩 Highway Buffer

YIELD SUMMARY

28 Deep Lots

🟧 10.0m - Villa
🟨 12.5m - Premium Villa
🟧 14.0m - Courtyard
🟨 16.0m - Traditional
🟨 18.0m - Premium Traditional

25 Deep Lots

🟪 10.0m - Villa
🟥 12.5m - Premium Villa
🟪 14.0m - Courtyard
🟪 16.0m - Traditional

URBIS

AURA - Precinct 15

Reconfiguring of a Lot - SHEET 01

1:2000 @ A3

0 20 40 60 80 100

DATE: 09.05.2024
JOB NO: P0037213
DWG NO: ROL - 02

LEGEND

GENERAL

- 🟥 Application Boundary
- - - Stage Boundary

LAND USE

- 🟪 Multiple Residential Sites
- 🟦 Centres
- 🟦 Community
- 🟧 Childcare Centre
- ▨ Indicative Bio Basin Location

OPEN SPACE

- 🟩 Neighbourhood Recreation Park
- 🟩 Civic Park
- 🟩 District Linear Park
- 🟩 Local Linear Park
- 🟩 Landscape Buffer (Road Reserve)
- 🟩 Drainage
- 🟩 Conservation
- 🟩 Highway Buffer

YIELD SUMMARY

28 Deep Lots

- 🟧 4.6m - Terrace
- 🟧 6.6m - Terrace
- 🟨 7.6m+ - End Terrace
- 🟧 10.0m - Villa
- 🟨 12.5m - Premium Villa
- 🟧 14.0m - Courtyard
- 🟨 16.0m - Traditional
- 🟨 18.0m - Premium Traditional

25 Deep Lots

- 🟥 7.5m - Front Loaded Terrace
- 🟥 9.0m+ - Front Loaded End Terrace
- 🟪 10.0m - Villa
- 🟪 12.5m - Premium Villa
- 🟪 14.0m - Courtyard
- 🟪 16.0m - Traditional
- 🟪 18.0m - Traditional

21 Deep Lots

- 🟦 6.6m - Terrace
- 🟦 7.8m+ - End Terrace

16.5 Deep Lots

- 🟥 6.6m - Terrace
- 🟧 9.0m+ - End Terrace

Urban Lots

- 🟪 Urban Loft - Type H
- 🟦 Urban Loft - Type G

URBIS

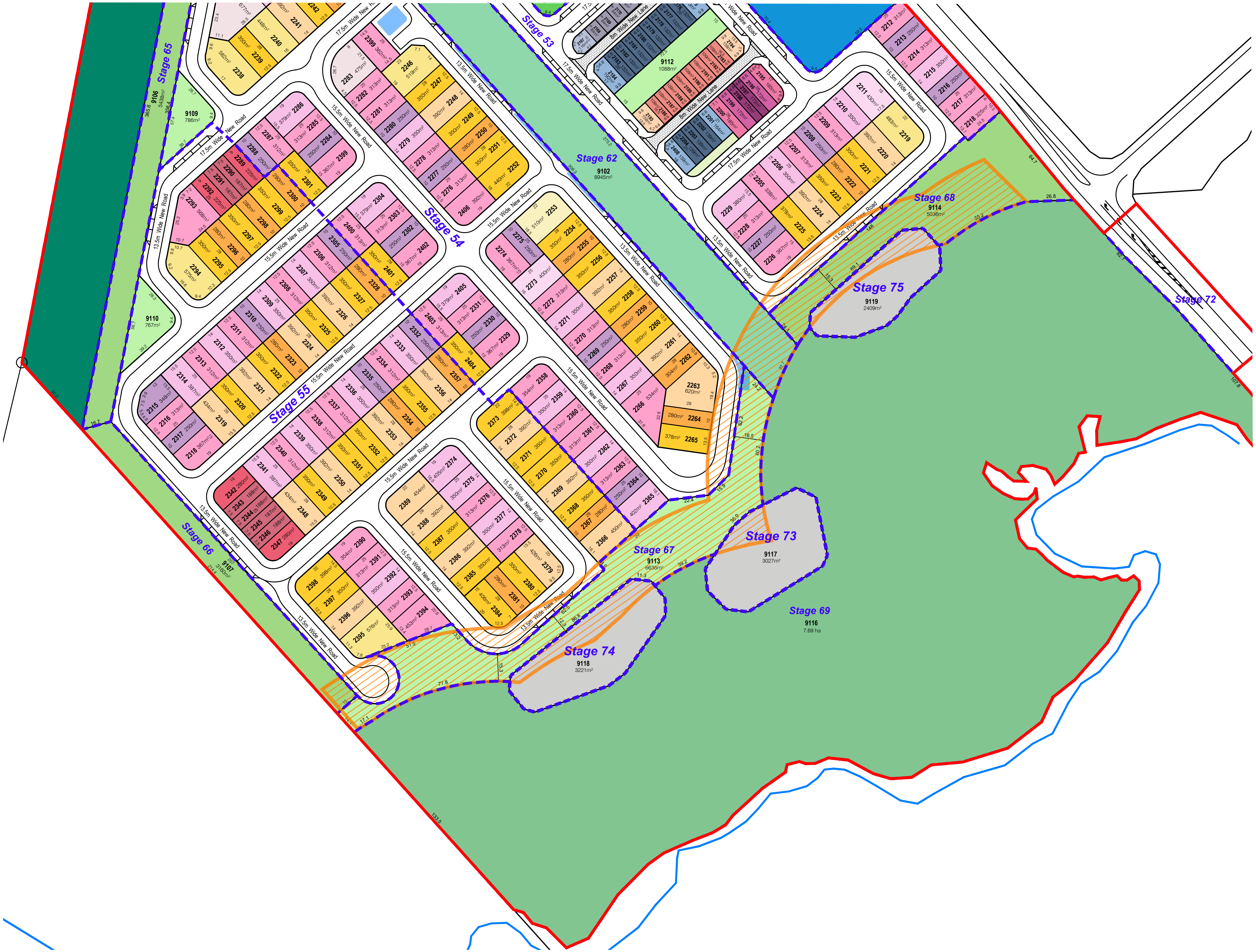
AURA - Precinct 15

Reconfiguring of a Lot - SHEET 02

1:2000 @ A3

0 20 40 60 80 100

DATE: 09.05.2024
JOB NO: P0037213
DWG NO: ROL-03



LEGEND

GENERAL

- 🟥 Application Boundary
- ▬ Stage Boundary

LAND USE

- 🟦 Community
- ▨ Indicative Bio Basin Location

OPEN SPACE

- 🟩 District Linear Park
- 🟩 Local Linear Park
- 🟨 Landscape Buffer (Road Reserve)
- 🟩 Drainage
- 🟩 Conservation
- 🟩 Highway Buffer
- ⬜ Drainage (WSUD)

YIELD SUMMARY

28 Deep Lots

- 🟧 10.0m - Villa
- 🟨 12.5m - Premium Villa
- 🟧 14.0m - Courtyard
- 🟨 16.0m - Traditional
- 🟨 18.0m - Premium Traditional

25 Deep Lots

- 🟥 7.5m - Front Loaded Terrace
- 🟥 9.0m+ - Front Loaded End Terrace
- 🟪 10.0m - Villa
- 🟪 12.5m - Premium Villa
- 🟪 14.0m - Courtyard
- 🟪 16.0m - Traditional
- 🟪 18.0m - Traditional

21 Deep Lots

- 🟦 6.6m - Terrace
- 🟦 7.8m+ - End Terrace

16.5 Deep Lots

- 🟥 6.6m - Terrace
- 🟧 9.0m+ - End Terrace

Urban Lots

- 🟪 Urban Loft - Type H
- 🟦 Urban Loft - Type G

URBIS

AURA - Precinct 15

Reconfiguring of a Lot - SHEET 03

1:2000 @ A3

0 20 40 60 80 100

DATE: 09.05.2024
JOB NO: P0037213
DWG NO: ROL-04

APPENDIX B:
REPORT ON ADDITIONAL GEOTECHNICAL INVESTIGATION, AURA PRECINCTS 6-16, PREPARED BY DOUGLAS PARTNERS

Douglas Partners
Geotechnics | Environment | Groundwater

Report on
Additional Geotechnical Investigation

Proposed Subdivision
Aura Precincts 6-16, Bells Creek

Prepared for
Stockland Development Pty Ltd

Project 80967.05
August 2017

Integrated Practical Solutions

Douglas Partners
Geotechnics | Environment | Groundwater

Document History

Document details

Project No.	80967.05	Document No.	R.001.docx
Document title	Report on Additional Geotechnical Investigation Proposed Subdivision		
Site address	Aura Precincts 6-16, Bells Creek		
Report prepared for	Stockland Development Pty Ltd		
File name	80967.05.R.001		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Billy Blake	Brett Egen	21 August 2017

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	-	Paul.Morgan@stockland.com.au

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		21 August 2017
Reviewer		21 August 2017

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
1/28 Kessling Avenue
Kunda Park QLD 4556
Phone (07) 5351 0400
Fax (07) 5351 0499

Table of Contents

Page

1. Introduction 1
2. Site Description 1
3. Regional Geology 2
4. Field Work Methods 2
5. Field Work Results 3
6. Laboratory Testing 4
    6.1 Shrink-Swell 4
    6.2 Plasticity and Particle Size Distribution 5
    6.3 Compaction and Soaked CBR 6
    6.4 Dispersivity 8
    6.5 Agronomy 8
    6.6 Groundwater 8
7. Comments 9
    7.1 Earthworks 9
        7.1.1 Trafficability 9
        7.1.2 Stripping 10
        7.1.3 Excavation 10
        7.1.4 Batter Slopes 10
        7.1.5 Re-Use of Cut Materials 11
        7.1.6 Compaction 12
        7.1.7 Volume Change and Settlement 13
        7.1.8 Potential for Soil Dispersion 14
    7.2 Reactivity and Site Classification 15
    7.3 Foundations 16
    7.4 Pavements 16
8. References 17
9. Limitations 17

Appendix A:	About this Report
Appendix B:	Drawings 1 to 6 - Test Location Plans
Appendix C:	Sampling Methods
	Soil Descriptions
	Rock Descriptions
	Symbols & Abbreviations
	Borehole Log Sheets
Appendix D:	Laboratory Test Results

Report on Additional Geotechnical Investigation
Proposed Subdivision
Aura Precincts 6-16, Bells Creek

1. Introduction

This report presents the results of an additional geotechnical investigation carried out by Douglas Partners Pty Ltd (DP) for Precincts 6 to 16 (the site) as part of the Aura development.

The investigation was undertaken at the request of Stockland Development Pty Limited (Stockland) following authorisation to proceed received on 4 July 2017, and was undertaken in general accordance with DP's proposal SSC170177 dated 30 June 2017.

DP previously undertook a broadscale geotechnical investigation for the proposed development in 2014. The aim of this additional geotechnical investigation is to provide additional information and provide greater coverage across the site to assist with the detailed earthworks planning. The results of the previous investigation have been used to supplement this additional investigation and been included for completeness where relevant.

This investigation comprised the drilling and sampling of 55 bores followed by laboratory testing, engineering assessment and reporting. The details of the field work and laboratory testing are presented in this report.

This report must be read in conjunction with the notes entitled "About This Report" in Appendix A along with any other attached explanatory notes and should be kept in its entirety without separation of individual pages or sections.

2. Site Description

Precincts 6 to 16 as part of the Aura development is centrally located as part of the overall development and is bounded by the northern tributary of Bells Creek to the north, Bells Creek to the south, the future alignment of Bells Creek Arterial Road to the east and the Bruce Highway to the west (refer Drawing 1 in Appendix B).

Broadly, the area is gently undulating of low relief, with the ground surface overall falling gradually from west to east with several localised knolls associated with the larger trending ridgeline on the western side of the Bruce Highway.

3. Regional Geology

Reference to the Geological Survey of Queensland's 1:100,000 series maps indicate that Precincts 6 to 16 is occupied by two geological units. The low lying areas generally consist of Quaternary aged floodplain alluvium which typically comprises *"clay, silt, sand, gravel".* The remaining elevated areas consist of the Triassic to Jurassic aged Landsborough Sandstone formation typically comprising *"Lithofeldspathic labile and quartzose sandstone, siltstone, shale, minor coal, ferruginous oolite marker".* The alluvium is expected to be underlain by the Landsborough Sandstone formation.

The natural subsurface conditions encountered typically during the field work generally comprised silty and clayey sands overlying sandy clays, with sandstone encountered locally at depth. The upper sand and clay soils are inferred to alluvial soils, with the lower clays likely to be residual soils derived from the underlying sandstone.

4. Field Work Methods

The field work as part of the initial geotechnical investigation carried out in early 2014 comprised the drilling and sampling of 40 bores (designated Bores 47 to 86) within the area of Precincts 6 to 16. As part of this investigation, an additional 55 bores (designated Bores 138 to 198) were drilled between 13 July and 4 August 2017. Proposed bore locations 153, 159, 163, 164, 165 and 170 were not accessible at the time of the investigation due to soft, boggy conditions and/or vegetation.

The bore locations were set out by experienced geotechnical personnel at the time of the investigation, with locations recorded using a hand held GPS. The approximate bore locations are indicated on Drawings 2 to 6 in Appendix B.

The bores were drilled using a 4WD mounted Jacro 200 drilling rig using continuous flight augers fitted with a tungsten carbide (TC) bit. Dynamic cone penetrometer (DCP) tests were carried out within the bores in order to assess the relative consistency of the subsurface soils.

Strata identification was undertaken through observation of cutting returns and recovered samples. On completion, the bores were observed for groundwater seepage and then backfilled with spoil tamped into the holes.

The field work was undertaken by experienced geotechnical personnel who logged the bores and collected samples for visual and tactile assessment and for subsequent laboratory testing.

5. Field Work Results

The subsurface conditions encountered in the bores are described in detail on the borehole logs in Appendix C, together with notes defining the classification methods and descriptive terms used. The depths were measured below existing surface levels at the time of investigation.

In summary, the subsurface conditions encountered in Precincts 6 to 16 generally comprised localised filling and topsoil overlying silty and clayey sands. In the eastern, low-lying part of the site, the sands were encountered to the termination of bores (in areas of proposed filling) at 3 m depth with interbedded layers of sandy clay locally. In the western, elevated parts of site, silty sand was encountered typically to between 1 m and 2 m depth, overlying sandy clay which continued to termination of bores (in areas of proposed cut) at 6 m depth.

The relative density of the sands was typically very loose to loose in the upper 1 m depth, grading medium dense with depth. Dense to very dense sands were encountered locally, typically at depth.

The strength consistency of the sandy clay encountered in the bores was typically stiff to very stiff. Firm, water softened clays were encountered locally at the sand/clay interface or where groundwater seepage was encountered.

As part of the initial investigation, ironstone was encountered in Bore 53 below 2.6 m depth. The ironstone was extremely weathered in parts. Very low strength sandstone was encountered in Bore 79 below 0.55 m depth and in Bore 84 below 4.45 m depth. The sandstone in Bore 79 graded low strength at 1.4 m depth where auger refusal was achieved at the time of investigation.

During the initial investigation, groundwater seepage was typically encountered between 1.2 m and 2.55 m depth within the sands or/and along the sand/clay interface. During this additional investigation groundwater seepage was generally encountered perched in the upper sands between 0.15 m and 0.6 m depth and at depth locally typically within the clays approximately 3.4 m to 4.55 m depth where ironstone gravel was encountered. It was noted that groundwater levels are affected by climatic conditions and soil permeability, and will therefore vary with time.

6. Laboratory Testing

6.1 Shrink-Swell

Shrink-swell index tests were carried out on selected 'undisturbed' recovered from the bores, as well remoulded bulk samples recovered from the bores within the same strata. The results of the testing are summarised in Table 1 with detailed material test reports in Appendix D.

Table 1: Results of Shrink-Swell Testing

Bore No.	Depth (m)	Material	Unit Weight (t/m^3)	FMC (%)	Shrinkage (%)	Swell (%)	Shrink-Swell Index (% per ΔpF)
64	1.0	Silty sandy clay	2.22	10.2	0.3	0.0	0.2
64	0.6-1.0*	Silty sandy clay	2.10	11.1	1.6	0.1	0.9
66	1.5	Sandy clay	1.97	23.9	3.6	2.5	2.7
66	1.3-1.6*	Sandy clay	1.94	18.3	1.9	2.8	1.8
73	0.95-1.3*	Silty sandy clay	1.94	18.0	1.9	0.6	1.2
74	1-1.1	Gravelly clayey sand	1.84	21.6	3.1	0.0	1.7
74	1-1.5*	Gravelly clayey sand	2.07	16.8	0.8	0.2	0.5
84	1.0	Silty sandy clay	1.98	23.9	3.6	2.5	2.7
84	0.8-1.2*	Silty sandy clay	1.90	20.4	3.0	2.6	2.4
160	3.0-3.19	Sandy clay	2.00	20.4	2.6	1.0	1.7
167	1.5-1.65	Sandy clay	1.96	21.7	3.4	2.6	2.6
176	1.5-1.66	Clayey sand	2.12	27.6	2.4	0.0	1.3
184	2.0-2.13	Sandy clay	1.97	23.8	3.4	2.9	2.7
187	2.0-2.2	Sandy clay	1.93	24.1	3.0	1.8	2.2
190	4.5-4.76	Sandy clay	1.83	30.3	5.8	0.1	3.3
191	1.5-1.7	Sandy clay	1.95	25.0	3.2	2.3	2.4

Notes: * = bulk sample remoulded near 98% Standard compaction at near optimum moisture content
FMC = Field moisture content

6.2 Plasticity and Particle Size Distribution

Selected samples recovered from the bores were tested in the laboratory for engineering properties of plasticity and particle size distribution for classification purposes. The results of this testing are summarised in Table 2 with detailed material test reports in Appendix D.

Table 2: Results of Plasticity and Particle Size Distribution Testing

Bore No.	Depth (m)	Material	FMC (%)	Plasticity				Particle Size Distribution (%)		
				LL (%)	PL (%)	PI (%)	LS (%)	Gravel	Sand	Silt/Clay
52	0.3-0.9	Silty sand	6.8	18	15	3	1.5	1	66	33
53	0.7-1.2	Silty sand	9.1	18	15	3	2.5	0	68	32
54	1.5-1.7	Silty sand	-	16	14	2	1.0	0	81	19
55	0.8-1.4	Gravelly clayey sand	10.3	41	16	25	11.5	21	53	26
58	1.0-1.4	Silty sand	-	-	-	NP	0.2	0	85	15
63	1.6-1.9	Gravelly clayey sand	-	32	15	17	10	22	48	30
64	0.6-1.0	Silty sandy clay	13.7	30	11	19	11	0	49	51
65	0.2-0.6	Silty sand	-	13	11	2	0.5	0	70	30
66	1.3-1.6	Sandy clay	21.7	60	20	40	16.5	2	42	56
69	1.6-2.0	Sand	-	-	-	NP	0.0	0	96	4
72	0.75-0.9	Clayey sand	-	27	13	14	8.5	0	63	37
73	0.95-1.3	Silty sandy clay	18.6	54	19	35	15.5	1	47	52
74	1.0-1.5	Gravelly clayey sand	18.8	41	21	20	11	30	37	33
80	0.6-0.9	Sandy clay	-	23	10	13	8.0	0	49	51
84	0.8-1.2	Silty sandy clay	22.5	60	19	41	17	0	39	61
150	1.7-1.83	Gravelly clayey sand	16.3	46	26	20	10.0	35	33	32
150	1.65-2.1	Gravelly clayey sand	18.6	43	22	21	10.0	19	42	39
150	4.1-4.4	Sandy clay	18.3	73	23	50	17.5	1	38	61
157	2.9-3.4	Sandy clay	27.4	69	19	50	16.0	0	29	71
160	3.0-3.8	Sandy clay	29.6	60	22	38	14.5	3	46	51
166	1.6-1.9	Sandy clay/clayey sand	14.1	33	12	21	9.0	0	60	40
167	0.4-0.7	Silty sand	12.9	17	15	2	0.5	1	71	28
167	1.5-1.9	Sandy clay	14.9	49	15	34	14.0	0	54	46
169	2.1-2.4	Sandy clay	23.0	90	26	64	19.5	3	31	66
175	1.7-2.2	Sandy clay	20.1	62	18	44	16.5	1	56	43

Table 2 Cont'd: Results of Plasticity and Particle Size Distribution Testing

Bore No.	Depth (m)	Material	FMC (%)	Plasticity				Particle Size Distribution (%)		
				LL (%)	PL (%)	PI (%)	LS (%)	Gravel	Sand	Silt/Clay
176	1.25-1.6	Clayey sand	17.5	40	17	23	10.5	8	49	43
184	0.8-1.3	Clayey sand	13.1	29	16	13	5.5	0	63	37
186	5.5-5.9	Sandy clay	27.5	89	23	66	19.5	0	35	65
187	1.5-2.0	Sandy clay	23.1	43	16	27	10.0	0	50	50
190	3.6-4.5	Sandy clay	36.8	65	22	43	16.0	0	43	57
196	1.1-1.4	Sandy clay	23.2	70	20	50	17.0	1	41	58
198	1.35-1.8	Sandy clay	28.7	86	27	59	19.0	1	32	67

Where FMC = Field Moisture Content, LL = Liquid Limit, PL = Plastic Limit, PI = Plasticity Index, LS = Linear Shrinkage, NP = Non-plastic

6.3 Compaction and Soaked CBR

Standard compaction and single point soaked California bearing ratio (CBR) tests were undertaken on selected bulk samples recovered from the bores. The samples were first screened over the 19 mm sieve, as required by the test standard, and were then compacted to 98% Standard dry density ratio at near to optimum moisture content (OMC). The samples were soaked for four days under a 4.5 kg surcharge.

The results of the compaction and CBR testing are summarised in Table 3 with detailed material test reports in Appendix D.

Table 3: Results of Compaction and CBR Testing

Bore No.	Depth (m)	Material	FMC (%)	OMC (%)	MV (%)	MDD (t/m^3)	Swell (%)	CBR (%)
52	0.3-0.9	Silty sand	6.8	11.0	-4.2	1.94	0.4	13
53	0.7-1.2	Silty sand	9.1	11.0	-1.9	1.94	0.4	18
55	0.8-1.4	Gravelly clayey sand	10.3	10.4	-0.1	2.01	0.6	9
64	0.6-1.0	Silty sandy clay	13.7	11.9	1.8	1.93	1.0	7
66	1.3-1.6	Sandy clay	21.7	19.1	2.6	1.68	5.0	2.5
73	0.95-1.3	Silty sandy clay	18.6	19.3	-0.7	1.68	2.1	7
74	1.0-1.5	Gravelly clayey sand	18.8	17.6	1.2	1.83	0.5	9
84	0.8-1.2	Silty sandy clay	22.5	21.9	0.6	1.61	3.7	2.5
150	1.65-2.1	Gravelly clayey sand	18.6	15.0	3.6	1.87	0.0	18
160	3.0-3.8	Sandy clay	29.6	17.0	12.6	1.73	5.0	2.0
167	1.5-1.9	Sandy clay	14.9	14.5	0.4	1.80	2.5	3.0
176	1.25-1.6	Clayey sand	17.5	14.0	3.5	1.85	0.5	9
184	0.8-1.3	Clayey sand	13.1	12.5	0.6	1.90	0.0	14
187	1.5-2.0	Sandy clay	23.1	15.5	7.6	1.77	8.0	0.5
190	3.6-4.5	Sandy clay	36.8	18.5	18.3	1.69	6.0	2.0
198	1.35-1.8	Sandy clay	28.7	21.5	7.2	1.67	6.5	1.0

Where FMC = Field Moisture Content; MV = Moisture Variation (FMC-OMC); MDD = Maximum Dry Density, OMC = Optimum Moisture Content

6.4 Dispersivity

Emerson class dispersion tests were performed on selected disturbed samples recovered from the initial investigation. The results are summarised in Table 4 with detailed material test reports in Appendix D.

Table 4: Results of Dispersivity Testing

Bore No.	Depth (m)	Material	Emerson Class
52	0.3-0.9	Silty sand	5
53	0.7-1.2	Silty sand	5
55	0.8-1.4	Gravelly clayey sand	6
64	0.6-1.0	Silty sandy clay	6
66	1.3-1.6	Sandy clay	6
73	0.95-1.3	Silty sandy clay	6
74	1.0-1.5	Gravelly clayey sand	6
84	0.8-1.2	Silty sandy clay	6

6.5 Agronomy

Agronomical testing was carried out by Bio-Track Pty Ltd on selected topsoil samples recovered from the bores. The results of the testing, along with an interpretive report by the laboratory is included in Appendix D. In summary, the report suggests the topsoil material has been leached of any significant nutrient value and the addition of fertilizer would be required.

6.6 Groundwater

Groundwater seepage was encountered in a number of the bores during this investigation. Field parameters were measured in the field using an Aquaread water quality meter in selected bores where groundwater seepage was encountered. The results are summarised in Table 5.

Table 5: Results of Groundwater Field Testing

Bore No.	pH	EC (µS/cm)	DO (% Sat)	TDS (mg/L)
158	6.5	425	66	274
168	6.4	221	72	144
189	6.3	252	81	163
191	6.3	160	-	103

7. Comments

7.1 Earthworks

7.1.1 Trafficability

The field work for the initial investigation was carried out following a period of favourable dry weather conditions and trafficability was considered to be good for the 4WD mounted drill rig. However, the field work for this investigation was carried out following less favourable weather conditions and trafficability was restricted in parts of the site with the upper silty sand material being wet and boggy. Proposed bore locations 153, 159, 163, 164, 165 and 170 were not accessible at the time of the investigation due to soft, boggy conditions and/or vegetation, with the drilling rig getting bogged at Bore 181 and at other locations between bores. A number of the bores were also shifted from their original proposed locations to locations which were accessible at the time.

The subsurface conditions encountered on site typically comprise silty and/or clayey sands overlying relatively impermeable clays at shallow depth. Following periods of wet weather, it is expected that moisture will tend to be perched in the upper sands above the clays and along the sand/clay interface. It should be noted that the silty and clayey sands in wet conditions are sensitive to vibrations or trafficking from heavy equipment and will lose strength.

Groundwater seepage was also encountered at depth within the bores, particularly where ironstone gravel was encountered within the clays. The underlying clays will also soften during prolonged wet weather or changes in moisture condition.

Rubber tyred vehicles in particular will have trafficability problems during and after periods of rainfall or other increases in subgrade moisture content as encountered during this recent investigation. In some cases tracked plant may also experience some difficulty especially in areas where silt is at or near the surface.

It will be essential to keep the site well drained during construction. The installation of drains to intercept seepage and facilitate drying out will be required should construction commence during or following an extended period of wet weather.

Conditioning of wet silty and clayey sands is typically difficult to achieve during periods of prolonged and intermittent rainfall events, where the moisture content of the subsurface soils are continually allowed to be kept saturated from surface infiltration (eg.rain) as well as subsurface seepage. Drying out of the silty and clayey sands using surface and subsurface drains may take considerable time of favourable weather conditions with little or no rainfall before any positive effect is achieved. Unfavourable, cooler climatic conditions (eg.winter) will also make the drying out process more difficult and lengthy to achieve.

Where filling is proposed, significant works to ‘bridge’ over these weakened soils using overburden gravel material, or rock filling, would be required if weather conditions are unfavourable. A granular working platform in low lying and poorly drained areas may also need to be considered.

7.1.2 Stripping

Any deleterious, soft, wet or highly compressible material or topsoil material rich in organics or root matter should be removed and only be reused as landscaping. Depth of topsoil (eg. stripping depth) was measured to between 0.1 m and 0.6 m (average 0.2 m). The variance in the topsoil thickness is due to the surface rutting from the previous use as pine forestry plantation with topsoil thickness generally greater at the crest of the rutting and in the low lying parts of the site to the east.

It is suggested that an average 0.2 m stripping depth be allowed in estimates for the works. Stripping and grubbing depths due to the previous use as pine forestry plantation may vary significant locally in order to remove all root matter. Deep tyning (typically 0.3 m) of subgrade is recommended to detect grubbing depths to remove roots. Stripping depths will also varying in low-lying, poorly drained areas as well.

It is recommended that the stripped surface be inspected prior to commencing any filling operations.

7.1.3 Excavation

Based on the conditions encountered the subsurface conditions typically encountered silty and clayey sands, and stiff to hard sandy clay. Sandstone was encountered locally in Bores 79 and 84 as part of the initial investigation. It is estimated that excavation of the natural soils and extremely low to very low strength sandstone could be undertaken using medium sized earthmoving equipment, such as drotts, backhoes or 15-20t (or larger) excavators.

Scrapers would likely need dozer push loading by dozers in the very stiff (or stronger) clays and sandstone with pre-ripping to assist with production rates. Low strength materials (if encountered) would be more difficult to excavate (especially in confined excavations) and could require a larger excavator (30t+) with tiger teeth buckets with slowed excavation rates.

Excavations in the low strength sandstone will require larger equipment (eg. up to 30t excavators) fitted with a ripping tyne and/or rock breaker tools for confined trench excavations.

The assessment of excavation characteristics of soil has been based on the depth of penetration of the drilling rig using various bit attachments, which are attached to the solid spiral flight augers. It should be recognised that the excavatability estimates are based on materials encountered at the bore locations only and that conditions may prove more difficult (or easier) for excavatability beyond these bore locations and the depths drilled as part of this investigation.

7.1.4 Batter Slopes

Near vertical temporary excavations less than 1.5 m depth in dry, stiff (or stronger) clays are likely to be suitable for the short term installation of underground services provided there are no sensitive services or structures, or vehicular trafficked areas close to the excavation.

It should be noted that excavations in wet sands have the potential to ‘collapse’ unexpectedly in a trenching situation, particularly where groundwater seepage is encountered.

It is recommended that excavations in wet sands and all trench excavations deeper than 1.5 m be either positively supported (eg. shoring boxes, sheet piles, etc), benched or battered in combination with dewatering (if required) whenever personnel are to enter the trench.

Suitable unsurcharged temporary and permanent dry cut batter slopes for excavations up to 3 m in height are presented in Table 6. Where water seeps from the faces, batters will need to be considerably flatter.

Table 6: Batter Slopes

Material	Safe Batter Slope (H:V)	
	Short Term	Long Term
Engineered filling* or natural sands	1.5:1	2:1
Natural stiff (or stronger) clays	1:1	2:1
Extremely low (or stronger) strength rock	1:1	1.5:1

Notes: * Depends on fill material type and level of compaction. Assumes a clayey fill material compacted under ‘Level 1’ Inspection and Testing.

For cuts greater than 3 m in depth, permanent slopes should be constructed at no steeper than 2.5H:1V.

Filled batters should also be overfilled and then cut back to the required design batter angles. This will provide greater stability of the filling and allow for adequate compaction to be achieved throughout the full depth of the filling.

The above temporary batter slopes are suggested with respect to slope stability only, and do not allow for lateral stress relaxation which may result in movement of nearby inground services or shallow footings. If such services or footings are settlement sensitive, and are located near the crest of the cut face, then the excavation may have to be positively supported.

Long term slopes may need to be flattened to 3H:1V or less, in order to allow vehicle access for maintenance of grass. It is recommended that all batters incorporate crest and toe drainage leading runoff into concrete lined longitudinal drains to reduce the risk of erosion of the batters. The batters should also be covered with topsoil and vegetation to provide long term erosion protection.

7.1.5 Re-Use of Cut Materials

It is considered that the majority of materials won from excavations on site, free of any organic and deleterious material, will generally be suitable for reuse as bulk filling provided the moisture content of the soils on placement approximates the optimum moisture content (OMC).

Soils containing organic and deleterious matter should be stripped from the construction area and stockpiled for landscaping purposes or spoiled from site. This material is not considered suitable for reuse as structural filling. Revegetation of borrow pits, batters and all exposed soils should be undertaken as the earthworks progress, using the topsoil and mulch salvaged during the initial clearing process.

The results of the laboratory testing indicate that the samples tested as part of this investigation were mostly wet of OMC. Difficulties with trafficability and workability are expected where material are too far over optimum. Materials which are up to 2% to 3% wet of OMC may be reused immediately as during the course of excavation, handling and placement of these material will dry out to some extent. However, wet silty and clayey sand or clayey materials greater than 3% to 4% wet of OMC are considered unsuitable for immediate reuse as controlled filling without being appropriately moisture conditioned (eg. dried back to near optimum moisture content). To facilitate drying out of any wet material, the material would need to be tyned and exposing the surface material to sun and wind or mixed with dry suitable materials won from excavations on site. These processes involve a considerable amount of double handling and favourable weather conditions.

For borrow areas where groundwater seepage is encountered, attention must be given to pit design and excavation methods to allow for adequate drainage outfall both within, and from, the borrow pit. Otherwise, the pit may be inundated by groundwater seepage or from rainfall. Where this occurs, the direction of pit operation and floor level control may be relevant in preventing water from ponding in the pit base.

It is also recommended that the cohesive material be placed at depth and granular material or weathered rock (if available) be placed close to subgrade level. This will reduce the effects of seasonal moisture change and foundation soil reactivity, and will also improve subgrade CBR for roads.

Filling should not be allowed to be stockpiled for extended periods of time following excavation prior to placement as structural filling without moisture conditioning.

7.1.6 Compaction

Prior to the placement of filling, the stripped surface should be test rolled using a smooth drum roller with a minimum static weight of 12-tonne to detect the presence of any soft or loose spots. Areas demonstrating excessive movement under test rolling will be required to be either tyned, dried and recompacted or removed and replaced with compacted select filling. Treatment should be to a standard sufficient so that the subgrade passes test rolling and that compaction can be achieved in the first layer of filling.

Approved bulk filling should be placed in layers not exceeding 0.3 m ‘loose’ thickness, with each layer compacted to a minimum dry density ratio of 95% relative to Standard compaction in proposed residential areas and 98% relative to Standard compaction in any proposed commercial areas. Where filling has significant clay content, moisture content within the filling should be maintained within 2% of OMC during and after compaction. The upper 0.3 m of pavement subgrade and unbound pavement gravels should be compacted to a minimum dry density ratio of 100% relative to Standard compaction and to within the same moisture content range as given above.

Care should be taken not to over-wet clayey soils as this can lead to problems associated with trafficability and workability. Clayey soils should not be over-compacted (eg. not more than 102% Standard) or placed too dry of OMC, as this can lead to future swelling and softening with changes to moisture content or inundation from water.

It is recommended that where filling is to be carried out over sloping ground (exceeding 10H:1V in slope), the slope should be benched to allow for the filling to be 'keyed' into the existing batters. These procedures will provide greater stability of the filling and allow for adequate compaction to be achieved throughout the full depth of the filling. Filled batters should also be overfilled and then cut back to the required design batter angles in order to maximise compaction of the material in the batter faces.

Field density testing should be carried out to confirm the standard of compaction achieved and the placement moisture content has been achieved. The frequency of testing should be carried out in accordance with AS 3798-2007 (Ref 1) and distributed reasonably evenly throughout the full depth and area of filling.

To ensure adequate performance of the earthworks, careful Level 1 inspection and testing of filling must be undertaken by an experienced Geotechnical Inspection and Testing Authority (GITA) where the filling is to support buildings, pavements or settlement sensitive structures. The GITA needs to have competent personnel on site at all times while earthworks operations are undertaken. Because of the significant engineering implications for the earthworks, it is recommended that the GITA be required to include an experienced geotechnical engineer (with RPEQ registration) to oversee the inspection and testing. DP is suitably qualified to conduct earthworks testing and supervision services that will be required during earthworks construction.

7.1.7 Volume Change and Settlement

Volume change is to be expected upon excavation and compaction of material, compared to the insitu volume of the material.

Excavation increases the volume of material during handling and stockpiling. The increase in volume (from ‘insitu’ to ‘loose’) is commonly referred to as the ‘bulking factor’. For clays, the bulking factor is typically between 1.3 and 1.4, between 1.2 and 1.3 for sands, and between 1.4 and 1.6 for weathered sandstone.

Similarly, compaction results in a decrease in material volume. The compaction factor is the ratio of the insitu dry density to the maximum dry density. Based on the laboratory test results, the insitu dry density ranged between 1.4 t/m^3 and 2.0 t/m^3. The maximum dry density relative to Standard compaction varied between 1.6 t/m^3 and 2.0 t/m^3. The volume changes expected for the various soil types are shown in Table 7.

Table 7: Compaction Characteristics

Material	Bank Volume	Dried and Compacted Volume	Other losses	Compaction Factor
Stiff (or stronger) clays	1.0	0.90 – 0.95	0.05	0.85 – 0.90
Silty/Clayey sands	1.0	0.85 – 0.9	0.03 – 0.05	0.80 – 0.85
Weathered sandstone	1.0	1.05-1.20	0.05 – 0.1	1.0 – 1.10

The above compaction factors are based on experience with similar conditions. These are estimates only and planning should allow for some variability in this factor (say+/- 0.1).

Where bulk filling is placed under controlled conditions, there is potential for ‘creep’ of the filling material as it settles over time under self-weight. Estimates of creep settlement of bulk filling under self-weight will vary in accordance with the depth of filling. This may lead to differential settlements where filling thickness are varied, such as over existing sloping ground.

Potential movements for such controlled filling are estimated as a percentage of the layer thickness. Such settlement may be in the order of 0.5% to 1% of the filling thickness. This range is presented for sensitivity checks and is dependent upon the nature of the filling. Where the filling predominately comprises granular materials, a lower percentage is appropriate, and where the filling predominately comprises clayey material, a higher percentage is appropriate.

Typically, about half of the creep settlement in well compacted filling occurs within about one year of placement and most of the remainder over a period of about 10 to 20 years.

7.1.8 Potential for Soil Dispersion

Emerson class tests provide an indication of potential dispersivity. The Emerson class test involves the observed behaviour of an air-dried crumb of soil placed in distilled water. Based on whether the soil crumb breaks up (eg. slakes) and/or disperses is classified a number from 1 to 8, where 1 is the most dispersive and 8 the least dispersive.

Emerson class dispersion tests generally indicate the samples tested to have slight potential for erosion with Emerson class numbers of 5 and 6.

Some silty soils, while not classified as dispersive, may actually slake readily and as such are susceptible to piping, tunnelling and scouring erosional process.

It is recommended, as a minimum, erosion control measures during bulk earthworks construction and final design should include the following:

- ensure erosion and sediment control measures are in place prior to works commencing;
- stage works to minimise the area and the duration of exposure at any given time, including exposure to seasonal weather;
- stage works to install the permanent drainage network as soon as practical;
- divert water away from disturbed areas;
- divert clean water offsite at non-erosive velocities, minimising stormwater runoff velocities;
- direct site runoff to stabilised outlets designed for expected peak velocities;
- undertake stabilisation of temporary and permanent channels;
- undertake roughening of disturbed areas to encourage infiltration;
- develop a program for progressive revegetation and maintenance of exposed areas as they are completed; and
- provide erosion control blankets and other methods depending on the steepness of slope and soil type.

7.2 Reactivity and Site Classification

The results of the laboratory testing were input into Douglas Partners' in-house program *REACTIVE*, to calculate the characteristic surface movement value (y_s) in general accordance with AS 2870-2011 (Ref 2). It should be noted that AS 2870-2011 provides recommended values of change in suction (Δ_u) and depth of suction (H_s) for major and regional centres throughout Australia. However, based on published data by Fox (Ref 3), relating climatic conditions to suction, a value of 1.2 pF was adopted for Δ_u and 1.5 m for H_s in the *REACTIVE* calculations. This is based on a "wet coastal" climatic zone.

A cracking depth of 0.75 m based on $0.5H_s$ was also used in the analysis for natural soils in their current state. The designer should also consider the effects of earthworks on site classification (eg. reduced cracking depth).

The results of the analysis indicate that, provided 'abnormal' soil moisture conditions are not experienced, y_s values for the silty sand on site are calculated to typically be less than 20 mm, consistent with 'Class S' conditions. For a full clay profile in areas of filling and/or cut with a reduced cracking depth, y_s values are calculated to typically be in the order of 30 mm to 55 mm, consistent with 'Class M' and 'Class H1' conditions. These values would be reduced where the thickness of clay is reduced by placing non-reactive filling material (ie. a maximum shrink-swell index value (Iss) of 1.0% per pF or less) over the clays or where weathered sandstone is encountered within the upper 1.5 m.

If 'abnormal' soil moisture conditions are experienced at the site, the site classification would change to 'Class P' (problem site) which would require more extensive foundation works or could result in adverse foundation performance. 'Abnormal' soil moisture conditions are defined in AS 2870 (Clause 1.3.3) and in summary comprise:

- Recent removal of buildings or structures likely to affect soil moisture conditions;
- Unusual moisture caused by drains, channels, ponds, dams or tanks;
- Recent removal of large trees;
- Growth of trees too close to a structure;
- Excessive or irregular watering of gardens adjacent to the structure;
- Lack of maintenance of site drainage;
- Failure to repair plumbing leaks.

It should be noted that no assessment of the effect of soil moisture change by trees has been made in estimating the above y_s values (either with respect to the removal of established trees prior to development of building pads, or the proximity of established or new trees to proposed buildings). Reference to the requirements in AS 2870 should be made by the building designer in this regard. It should be further noted that the presence or removal of trees can result in additional surface movement, due to tree-induced suction changes and tree-induced centre heave. Such tree-induced movement is not included in the y_s calculations used to classify the site.

7.3 Foundations

The extent of earthworks and the choice of footings will depend on development loads and what is considered acceptable in terms of settlement and cost.

Provided that site preparation is carried out in accordance with the recommendations in this report, otherwise with good practice, it is considered that high level pad and/or strip footings founded in either controlled engineered filling or natural soils be adopted. Slabs supported on high level foundations should be stiffened to suit the expected ground surface movements.

Based on the ground conditions encountered within the bores, high level footings may be preliminary designed for an allowable bearing pressure of 100 kPa for engineered filling or competent natural soils. Higher bearing capacities may be adopted where weathered rock is encountered. All footing excavations should be inspected and tested by an experienced geotechnical engineer from DP to confirm bearing pressures prior to casting of concrete.

Experience indicates that properly designed and constructed high level footings loaded as above are likely to undergo settlements in the order of 1% of the footing width.

7.4 Pavements

Subgrade conditions are expected to typically consist of controlled filling, natural silty and clayey sands, and sandy clays.

The results of the laboratory testing indicate soaked CBR values range between 0.5% and 7% for the sandy clays and between 9% and 18% for the silty and clayey sands.

The higher laboratory CBR values achieved in some of the sands are under ideal preparation and lateral confinement conditions experienced as part of the laboratory test method and are not likely to be achieved in the field. Therefore it is suggested that a maximum value of 10% be used for these sands based on experience with similar soils.

The low CBR value in the sandy clay is a result of the softened material that swelled following saturation. Swell values of between 2.5% and 8% were recorded for samples following soaking which returned CBR values of less than 3%. This saturated condition could occur in the long term if proper site drainage and maintenance procedures are not adopted. It is essential that sufficient drainage be installed and maintained in areas where there is potential for water to enter the subgrade.

It is recommended that a controlled subgrade be established over any untreated insitu subgrade material with a CBR value of less than 3%, or where swell values greater than 2.5% occur. A minimum cover of 0.6 m is recommended for swell values of between 2.5% and 5.0%, and up to 1.0 m for swell values greater than 5%.

Following the improvement to the subgrade, a modulus of subgrade reaction (k) of 25 kPa/mm or a CBR value of 3% could be used for design. Where no granular filling is placed over the silty clay subgrade, the lower bound CBR values are recommended. Soaked CBR testing will need to be carried out at the time of construction to confirm subgrade CBR design values.

For composite subgrades (eg. where imported filling is less than 1m thick) the Japan Road Association method of assessing a weighted subgrade strength should be used:

$$CBR_W = (D_F \text{ x } CBR_F^{0.33} + (1\text{-}D_F) \text{ x } CBR_S^{0.33})^3$$

where:
CBR_W = weighted subgrade CBR (%)
D_F = depth of filling (m)
CBR_F = CBR of filling material (%)
CBR_S = CBR of natural subgrade (%)

Stabilisation of subgrade soils with lime may also be considered in order to increase CBR values, but also to reduce plasticity and movements due to changes in moisture content, and to reduce moisture sensitivity. For lime to be effective, the material being treated must contain clay particles or pozzolanic materials that will react with the lime. Generally, soils with a plasticity index of greater than 10 will respond better with the addition of lime. CBR values should be limited to a design CBR value of 10% following stabilisation with lime. Trials at the time of stabilisation will be required to determine the optimum liming rates, expected to typically range between 2% and 4%.

8. References

1. Australian Standard AS 3798-2007 “Guidelines on Earthworks for Commercial and Residential Developments”, Standards Australia.
2. Australian Standard AS 2870-2011 “Residential Slabs and Footings”, Standards Australia
3. Fox E, “A Climate-Based Design Depth of Moisture Change Map of Queensland and the Use of Such Maps to Classify Sites Under AS 2870-1996”’ Australian Geomechanics, Vol 35, No 4, December 2000.

9. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for Precincts 6 to 16 as part of the Aura development at Bells Creek. This report is provided for the exclusive use of Stockland Development Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the subsurface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP’s field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

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

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

Site Anomalies

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

Information for Contractual Purposes

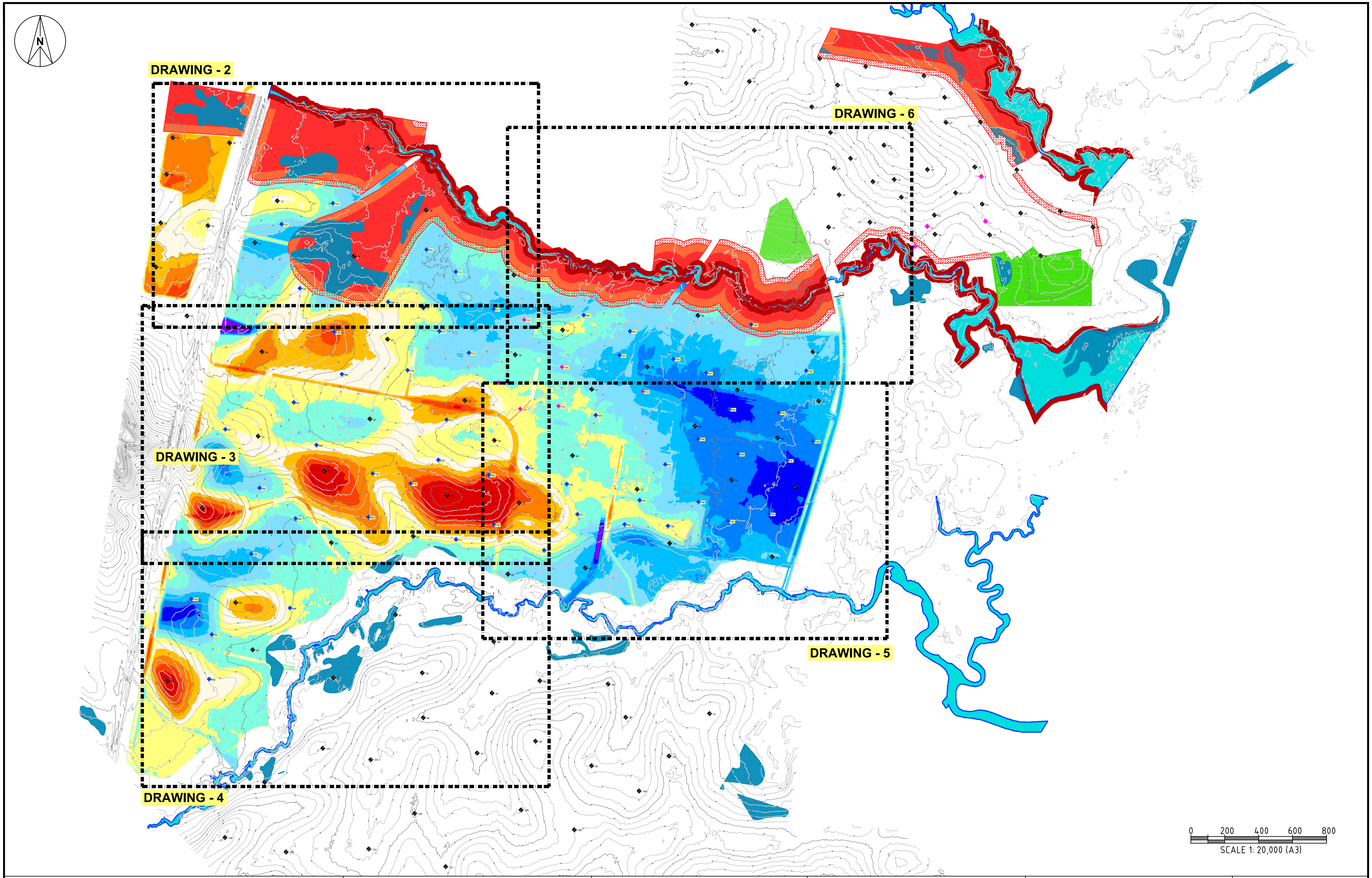
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawings 1 to 6 – Test Location Plans



Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Stockland Development Pty Ltd
OFFICE: Sunshine Coast
DRAWN BY: JST
SCALE: As shown
DATE: August 2017

NOTE:-

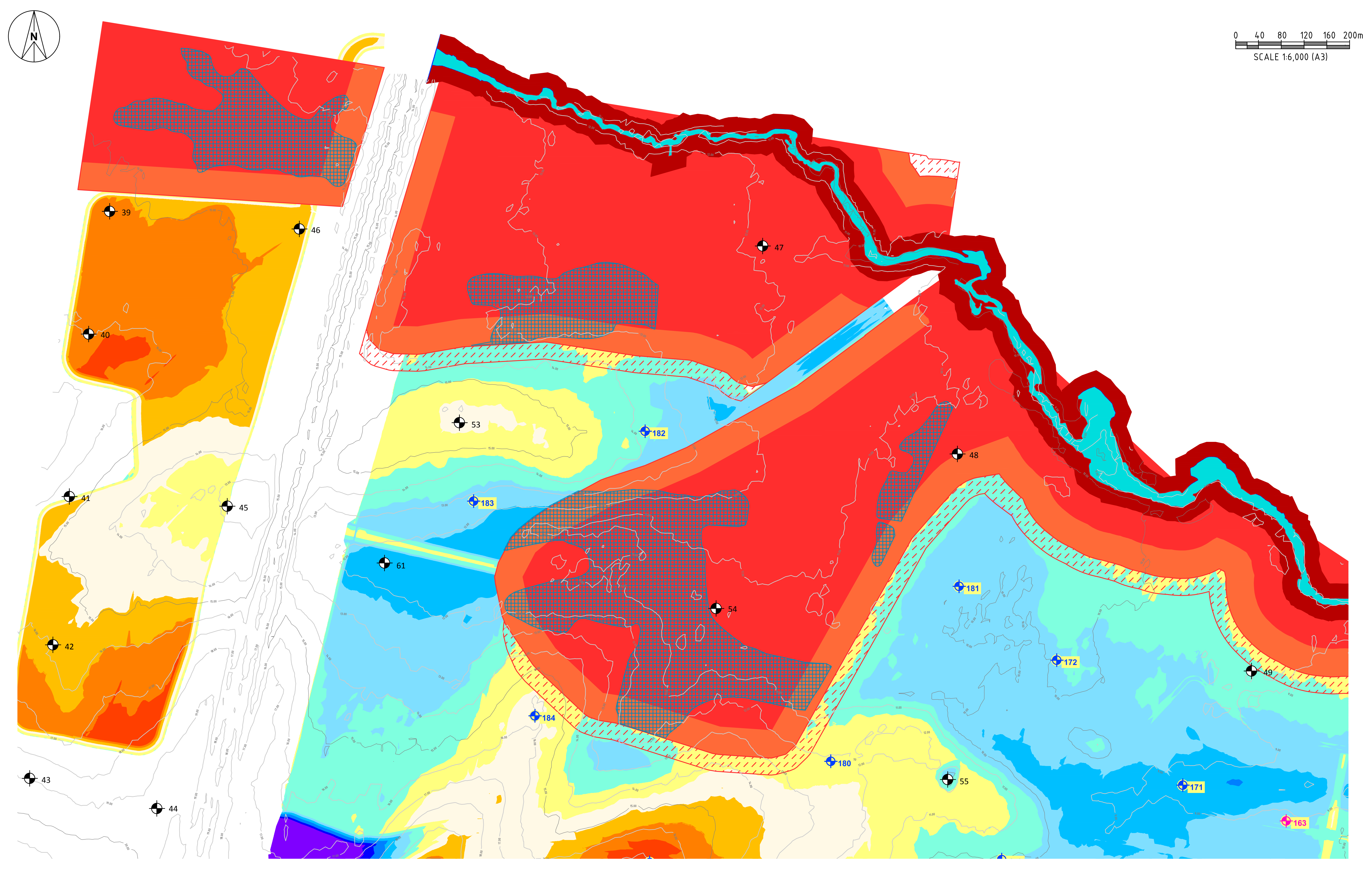
1. Plan adapted from Drawing X-N13058-CONT-NAT-1M INTERVAL provided by Stockland Development Pty Ltd.

LEGEND:-

TITLE: **Site Plan**
Proposed Subdivision
Aura Precincts 6 - 16

PROJECT No: 80679.05
DRAWING No: 1
REVISION: 0

P:\Sunshine Coast Projects\00000.00-90000.00\80679.05\80679.05.D.001.Rev0.dwg



Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Stockland Development Pty Ltd

OFFICE: Sunshine Coast
DRAWN BY: JST

SCALE: As shown
DATE: August 2017

NOTE:-

1. Test locations are approximate only and are shown with reference to existing site features.
2. Plan adapted from Drawing X-N13058-CONT-NAT-1M INTERVAL provided by Stockland Development Pty Ltd.

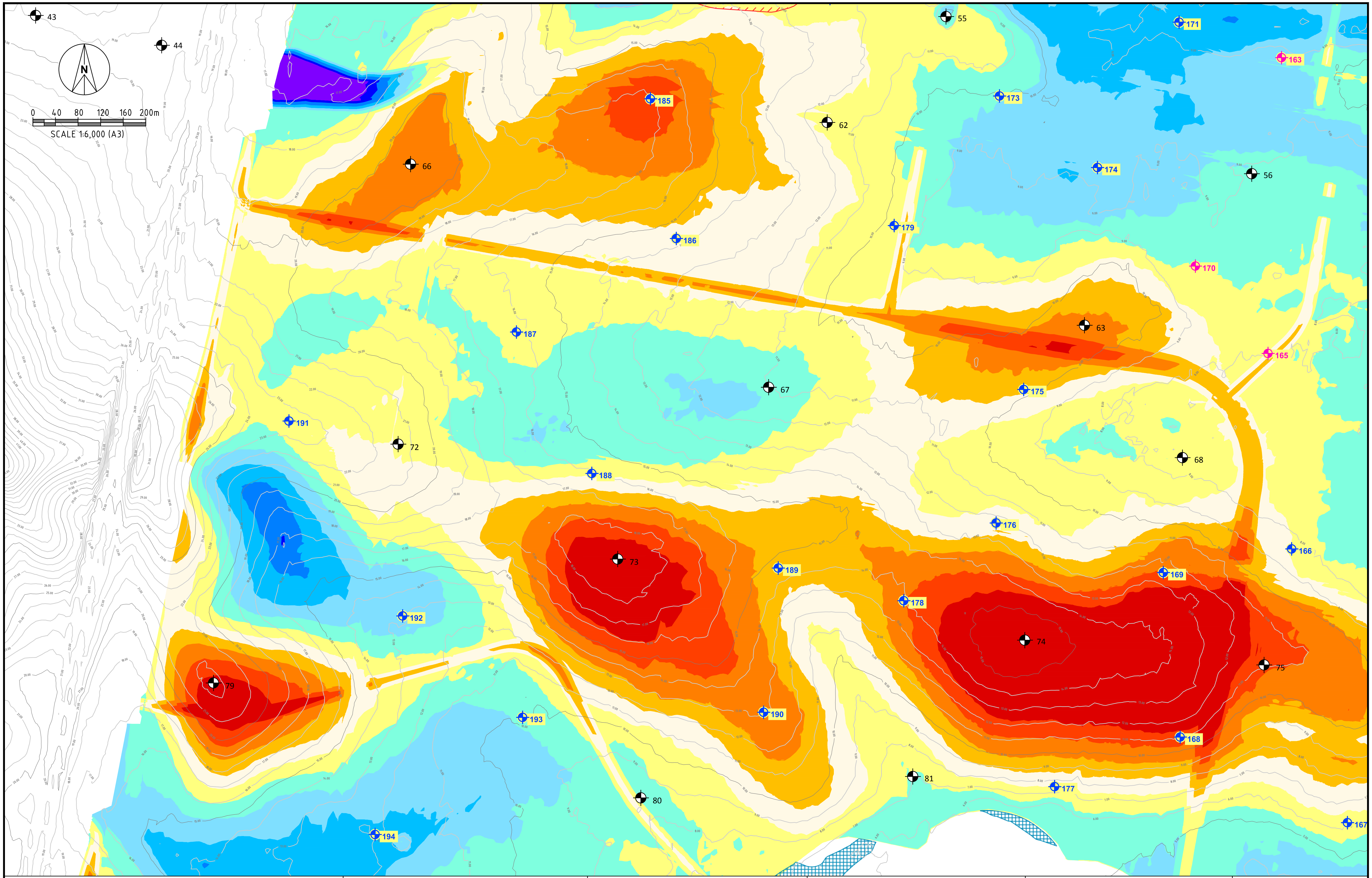
LEGEND:-

⊕ Bore Location and Number
⊕ Bore Location and Number (No Access)
⊕ Previous Bore Location and Number

TITLE: **Test Location Plan**
Proposed Subdivision
Aura Precincts 6 - 16

PROJECT No: 80679.05
DRAWING No: 2
REVISION: 0

P:\Sunshine Coast Projects\00000.00-90000.00\80679.05\80679.05.D.002-006.Rev0.dwg



Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Stockland Development Pty Ltd
OFFICE: Sunshine Coast
DRAWN BY: JST
SCALE: As shown
DATE: August 2017

NOTE:-
1. Test locations are approximate only and are shown with reference to existing site features.
2. Plan adapted from Drawing X-N13058-CONT-NAT-1M INTERVAL provided by Stockland Development Pty Ltd.

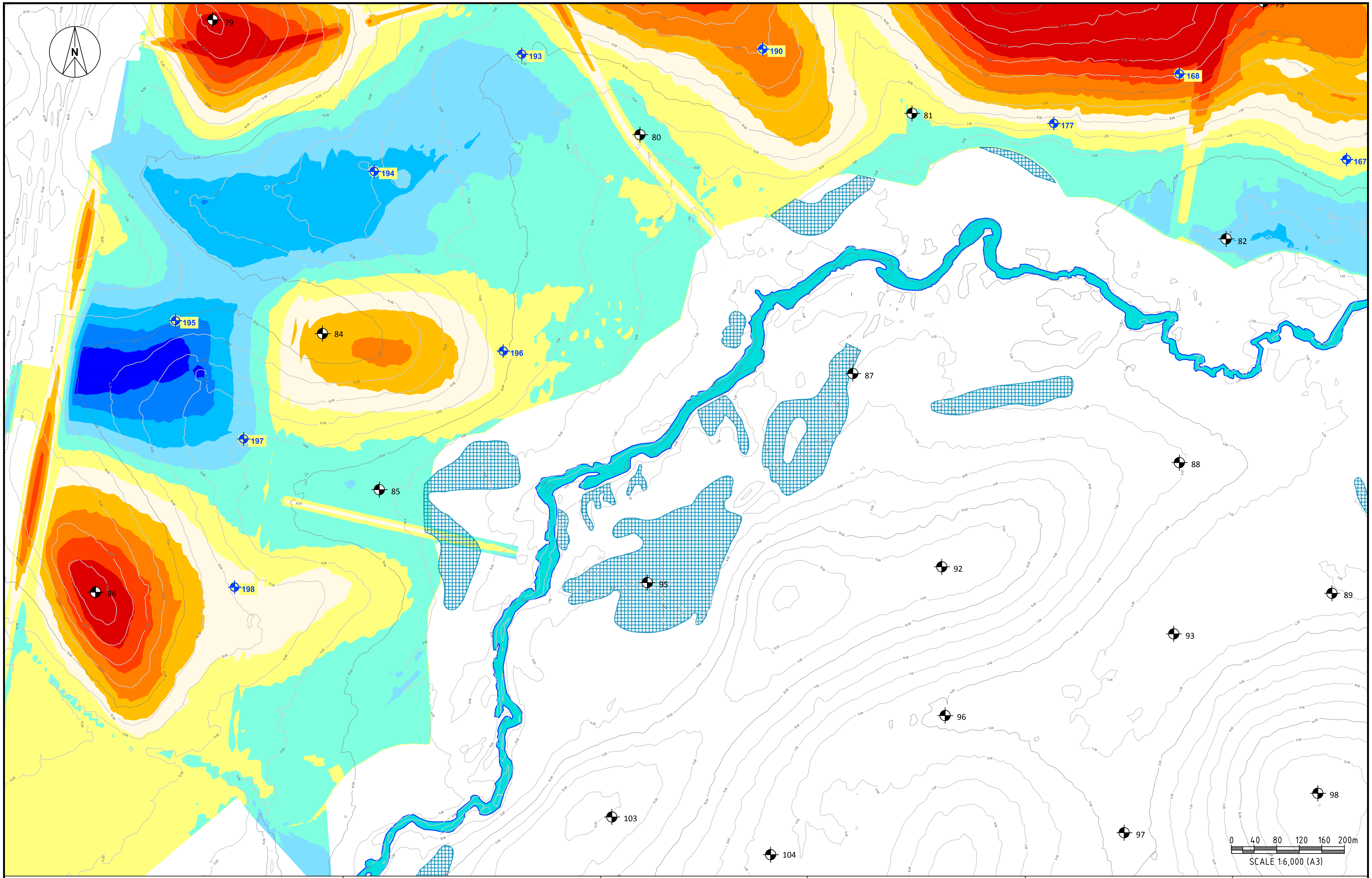
LEGEND:-

⊕	Bore Location and Number
⊕	Bore Location and Number (No Access)
⊕	Previous Bore Location and Number

TITLE: **Test Location Plan**
Proposed Subdivision
Aura Precincts 6 - 16

PROJECT No: 80679.05
DRAWING No: 3
REVISION: 0

P:\Sunshine Coast Projects\00000.00-90000.00\80679.05\80679.05.D.002-006.Rev0.dwg



Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Stockland Development Pty Ltd

OFFICE: Sunshine Coast

DRAWN BY: JST

SCALE: As shown

DATE: August 2017

NOTE:-

1. Test locations are approximate only and are shown with reference to existing site features.
2. Plan adapted from Drawing X-N13058-CONT-NAT-1M INTERVAL provided by Stockland Development Pty Ltd.

LEGEND:-

⊕ Bore Location and Number

⊕ Bore Location and Number (No Access)

⊕ Previous Bore Location and Number

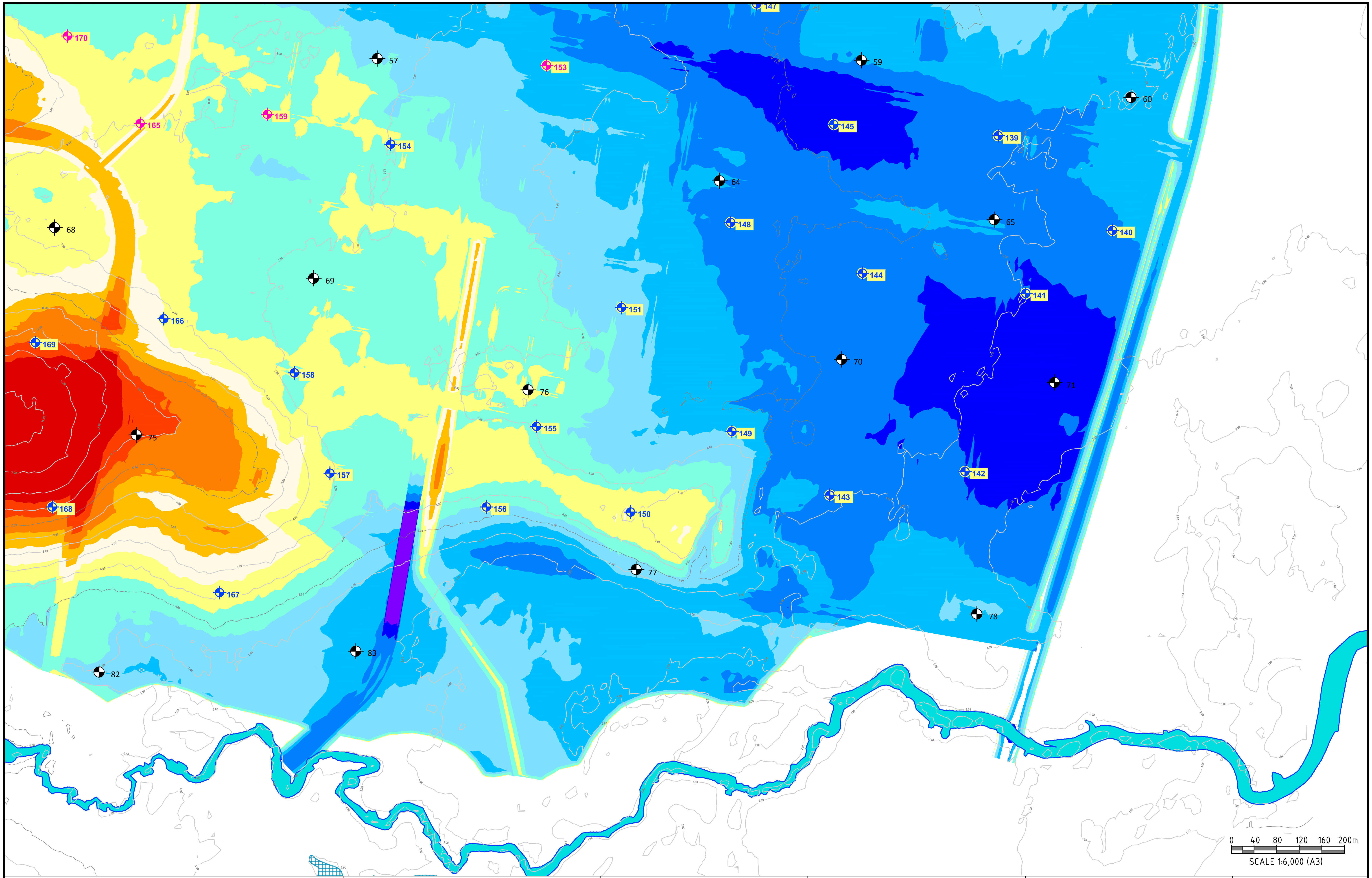
TITLE: **Test Location Plan**
Proposed Subdivision
Aura Precincts 6 - 16

PROJECT No: 80679.05

DRAWING No: 4

REVISION: 0

P:\Sunshine Coast Projects\00000.00-90000.00\80679.05\80679.05.D.002-006.Rev0.dwg



Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Stockland Development Pty Ltd
OFFICE: Sunshine Coast
DRAWN BY: JST
SCALE: As shown
DATE: August 2017

NOTE:-

1. Test locations are approximate only and are shown with reference to existing site features.
2. Plan adapted from Drawing X-N13058-CONT-NAT-1M INTERVAL provided by Stockland Development Pty Ltd.

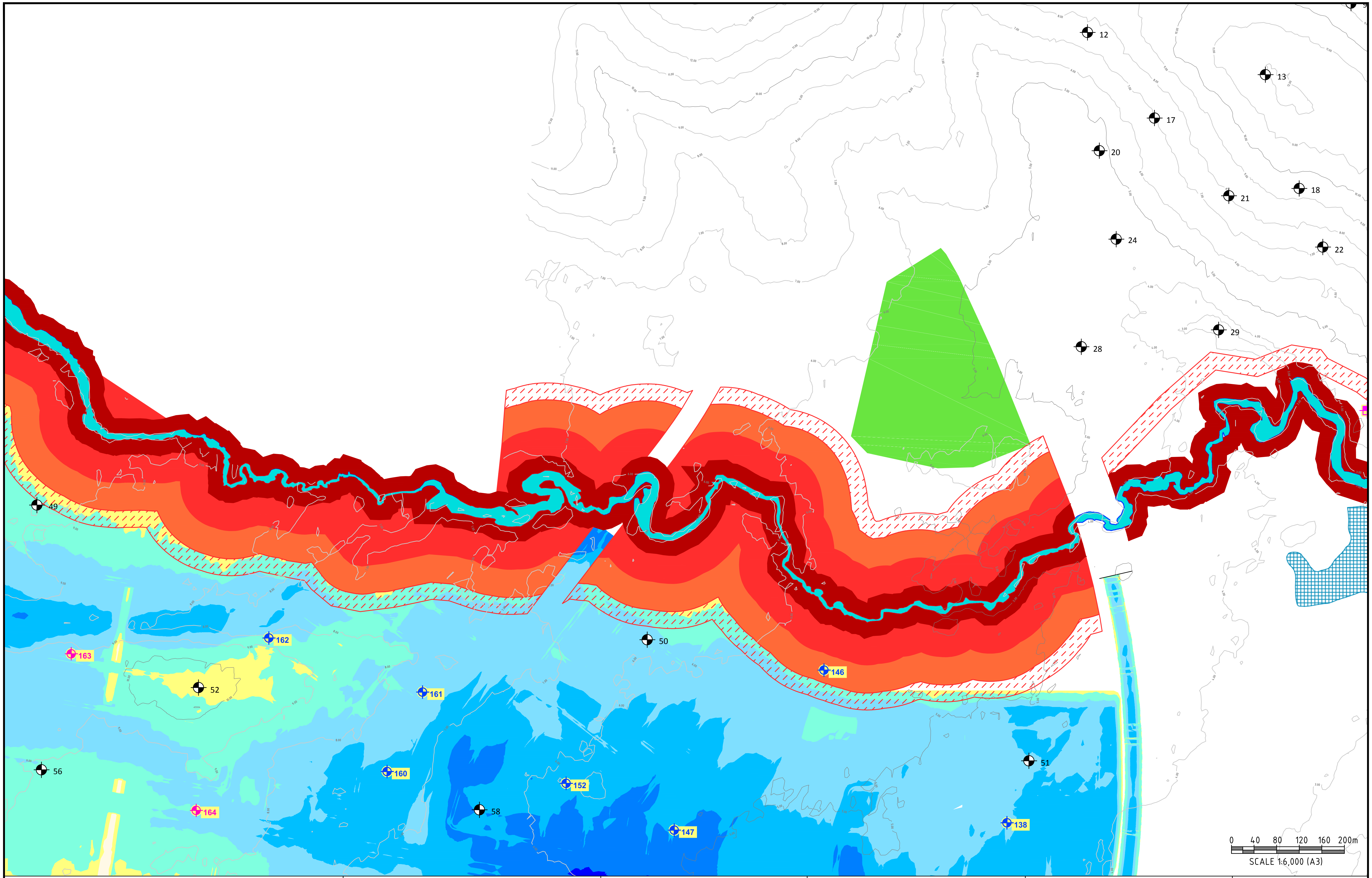
LEGEND:-

⊕	Bore Location and Number
⊕	Bore Location and Number (No Access)
⊕	Previous Bore Location and Number

TITLE: **Test Location Plan**
Proposed Subdivision
Aura Precincts 6 - 16

PROJECT No: 80679.05
DRAWING No: 5
REVISION: 0

P:\Sunshine Coast Projects\00000.00-90000.00\80679.05\80679.05.D.002-006.Rev0.dwg



Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Stockland Development Pty Ltd

OFFICE: Sunshine Coast | DRAWN BY: JST

SCALE: As shown | DATE: August 2017

NOTE:-

1. Test locations are approximate only and are shown with reference to existing site features.
2. Plan adapted from Drawing X-N13058-CONT-NAT-1M INTERVAL provided by Stockland Development Pty Ltd.

LEGEND:-

⊕	Bore Location and Number
⊕	Bore Location and Number (No Access)
⊕	Previous Bore Location and Number

TITLE: **Test Location Plan**
Proposed Subdivision
Aura Precincts 6 - 16

PROJECT No: 80679.05

DRAWING No: 6

REVISION: 0

P:\Sunshine Coast Projects\00000.00-90000.00\80679.05\80679.05.D.002-006.Rev0.dwg

Appendix C

Sampling Methods
Soil Descriptions
Rock Descriptions
Symbols & Abbreviations
Borehole Logs

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

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

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Descriptions

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

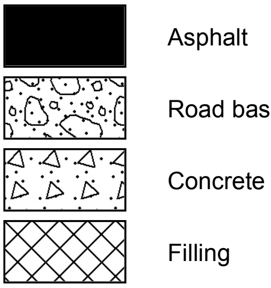
Other

fg	fragmented
bnd	band
qtz	quartz

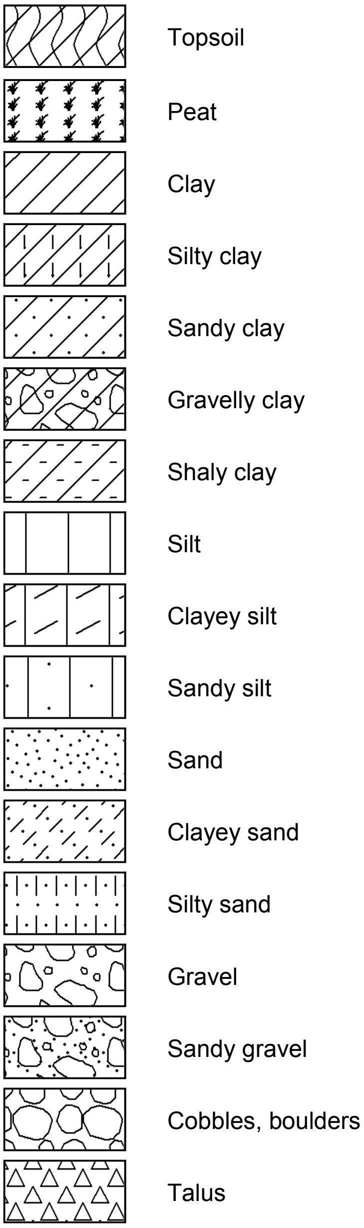
Symbols & Abbreviations

Graphic Symbols for Soil and Rock

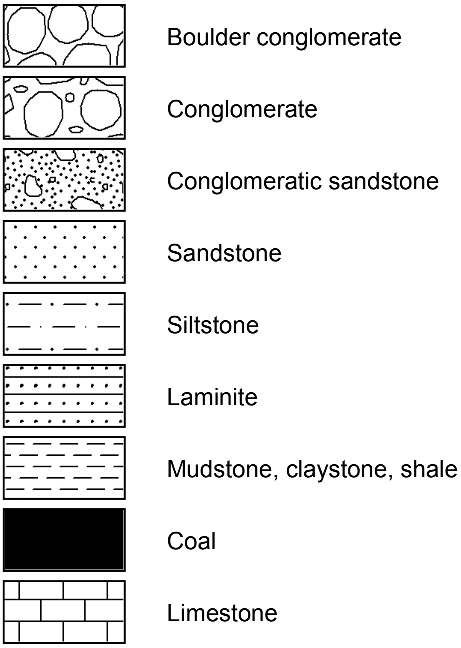
General



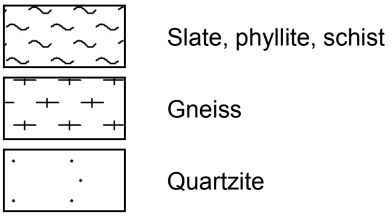
Soils



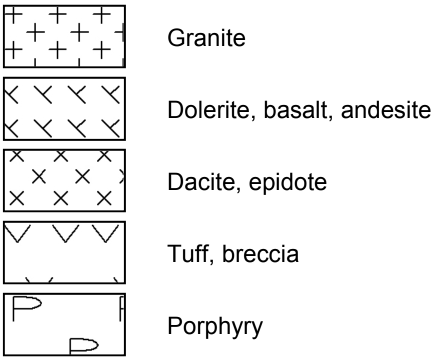
Sedimentary Rocks



Metamorphic Rocks



Igneous Rocks



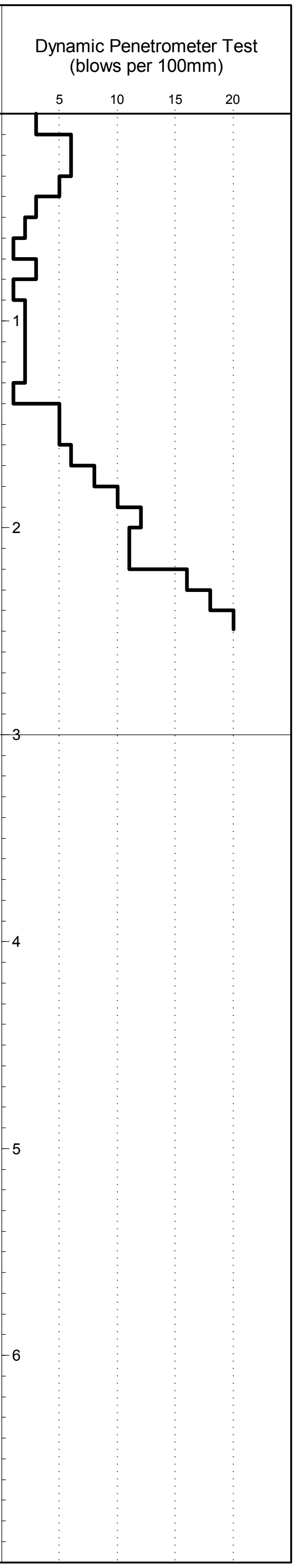
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 11.7*
EASTING: 504641
NORTHING: 7034761
DIP/AZIMUTH: 90°/--

BORE No: 47
PROJECT No: 80967
DATE: 10/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - medium dense, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.35	SANDY CLAY - stiff, grey mottled orange brown, medium plasticity sandy clay with fine to medium grained sand, moist			0.5		pp = 340	
					0.9		pp = 220	
	1	- stiff, high plasticity						
					1.4		pp = 130	
					1.9		pp = 110	
	2							
	2.2	SILTY SAND - dense to very dense, grey, fine to medium grained silty sand, wet						▷
	3 3.0	Bore discontinued at 3.0m Limit of investigation						
	4							
	5							
	6							



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage was observed at 2.2 m depth at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

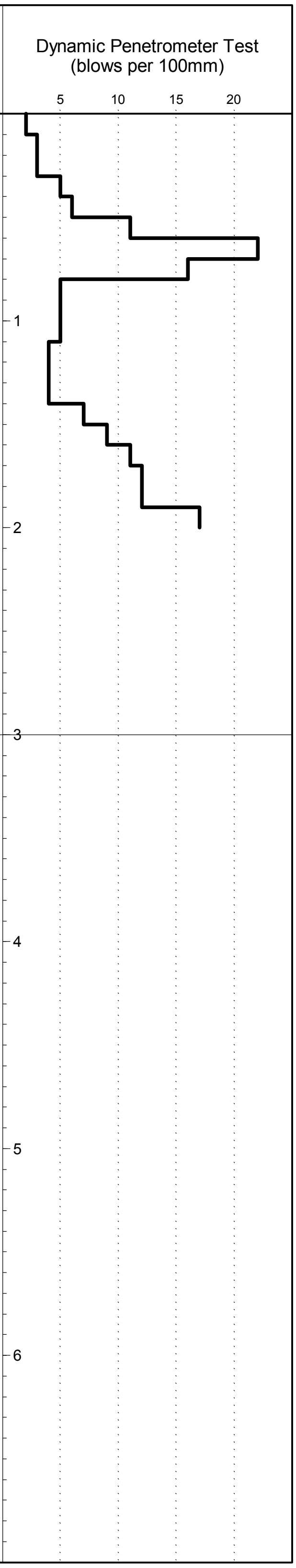
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 10.5*
EASTING: 504984
NORTHING: 7034395
DIP/AZIMUTH: 90°/--

BORE No: 48
PROJECT No: 80967
DATE: 10/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - medium dense, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.3	SILTY SAND - medium dense, grey mottled orange brown, fine to medium grained silty sand, moist - dense						
	0.85	SANDY CLAY - stiff, grey mottled orange brown, high plasticity sandy clay with fine grained sand, moist			0.9		pp = 190	
	1							
		- grey mottled red brown			1.4		pp = 140	
		- very stiff			1.9		pp = 350	
	2							
					2.4		pp = 310	
		- grey			2.9		pp = 350	
	3 3.0	Bore discontinued at 3.0m Limit of investigation						
	4							
	5							
	6							



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

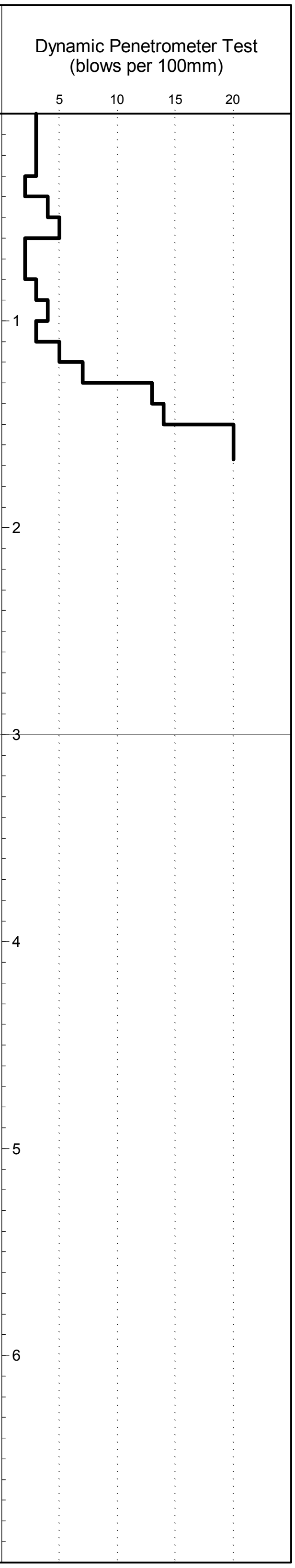
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 9.25*
EASTING: 505502
NORTHING: 7034013
DIP/AZIMUTH: 90°/--

BORE No: 49
PROJECT No: 80967
DATE: 10/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.2	TOPSOIL - medium dense, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.35	SILT - firm, grey mottled orange brown, high plasticity silt, moist						
		SILTY CLAY - stiff, grey mottled orange brown, high plasticity silty clay with some fine grained sand, moist						
					0.9		pp = 180	
	1.15	SANDY CLAY - stiff, grey mottled orange brown, high plasticity sandy clay with fine grained sand, moist						
		- very stiff, medium plasticity, fine to medium grained sand						
					1.9		pp = 230	
					2.4		pp = 340	
		- grey, medium to high plasticity, fine grained sand						
					2.9		pp = 310	
	3.0	Bore discontinued at 3.0m Limit of investigation						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

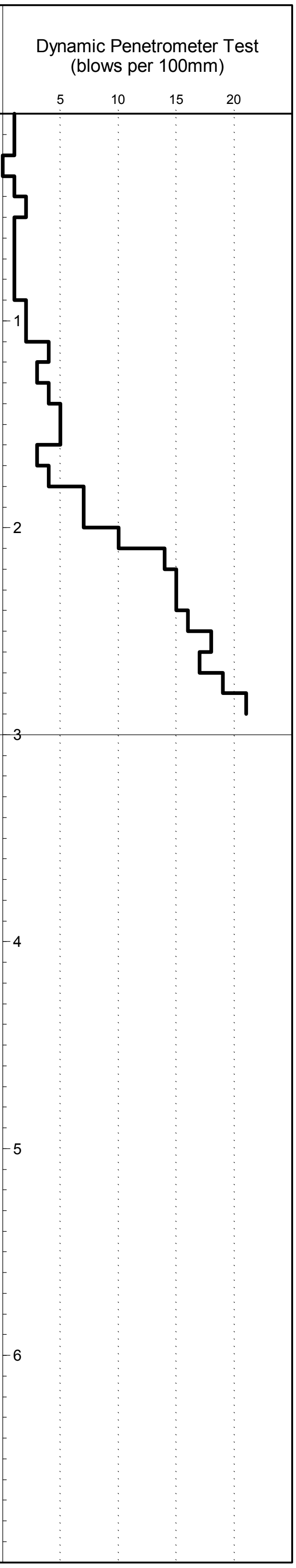
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 6*
EASTING: 506586
NORTHING: 7033774
DIP/AZIMUTH: 90°/--

BORE No: 50
PROJECT No: 80967
DATE: 10/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water
		TOPSOIL - very loose to loose, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.15	SILTY SAND - very loose to loose, grey mottled orange brown, fine to medium grained silty sand, moist						
	0.75	SANDY CLAY - stiff, grey mottled orange brown red brown, medium to high plasticity sandy clay with fine to medium grained sand, moist			0.9		pp = 230	
1								
					1.4		pp = 390	
	1.6	SILTY SAND - medium dense to dense, grey, fine to medium grained silty sand, wet						▷
2								
		- dense, grey brown, trace of clay fines						
3	3.0	Bore discontinued at 3.0m Limit of investigation						
4								
5								
6								



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage was observed at 1.6 m depth at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

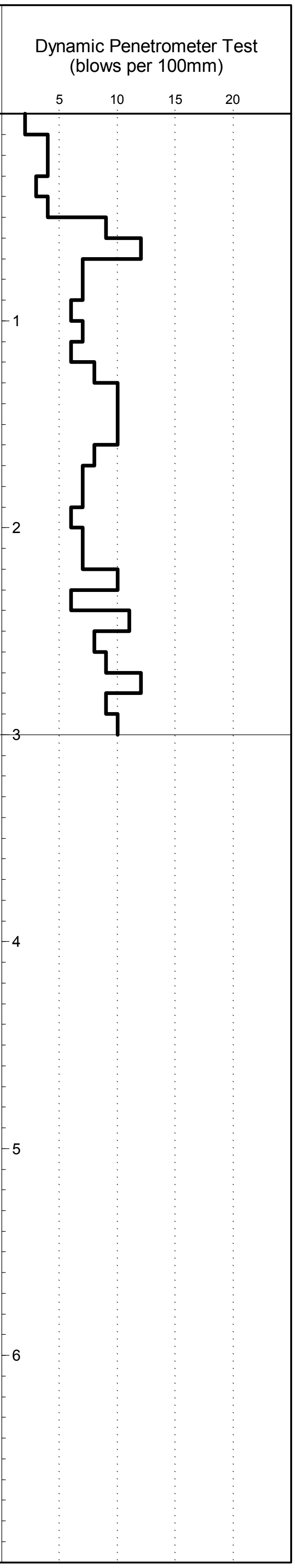
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 4.6*
EASTING: 507264
NORTHING: 7033559
DIP/AZIMUTH: 90°/--

BORE No: 51
PROJECT No: 80967
DATE: 6/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose to medium dense, grey brown, fine to medium grained silty sand topsoil, organics, moist			0.25		ASS samples collected at 0.25 m intervals to 2.0 m	
	0.6	SILTY SAND - medium dense, grey, fine to medium grained silty sand with some clay fines, moist - no clay fines - wet						▷ ▼
3	3.0	Bore discontinued at 3.0m Limit of investigation						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage was observed at 1.2 m depth at time of drilling. Steady at 1.4 m depth

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

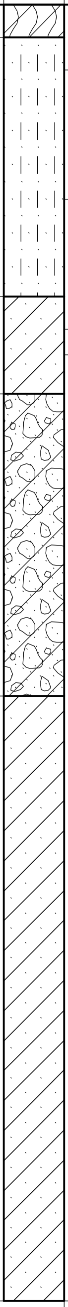
BOREHOLE LOG

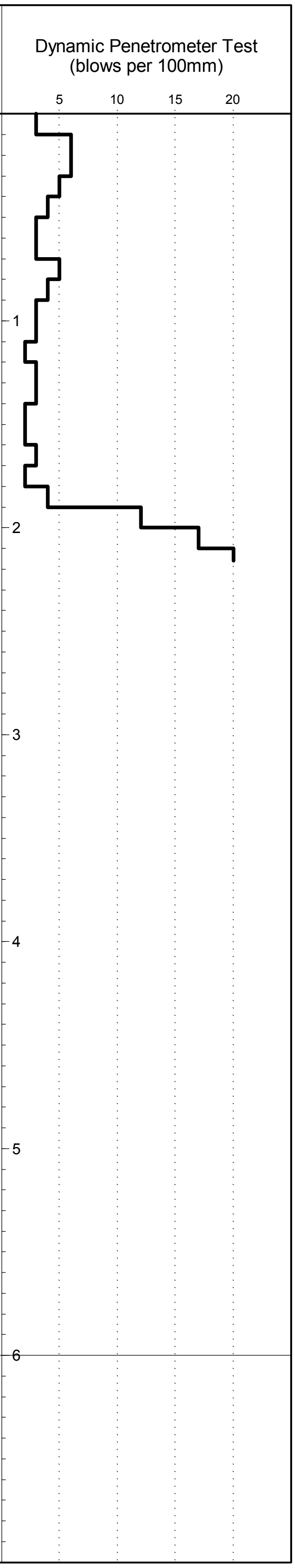
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 10.4*
EASTING: 505789
NORTHING: 7033689
DIP/AZIMUTH: 90°/--

BORE No: 52
PROJECT No: 80967
DATE: 10/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - medium dense, dark brown, fine to medium grained silty sand topsoil, organics, moist					
	0.15	SILTY SAND - medium dense, red brown, fine to medium grained silty sand, moist	B	0.3 0.9			
	1.35	SANDY CLAY - very stiff, brown, medium plasticity sandy clay with fine to medium grained sand, moist	U_{50}	1.4 1.5 1.62		pp = 260 pp = 520	
	1.8	GRAVELLY CLAYEY SAND - medium dense, red brown, fine to medium grained gravelly clayey sand with fine to medium gravel and low plasticity clay fines, moist					
	3.2	SANDY CLAY - stiff to very stiff, orange brown, medium plasticity sandy clay with fine to medium grained sand, moist		3.4		pp = 210	
		- orange brown and red brown		3.9		pp = 220	
		- orange brown red brown and grey, some ironstone lensing					
		- very stiff		4.9		pp = 310	
	6.0	Bore discontinued at 6.0m Limit of investigation					





RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

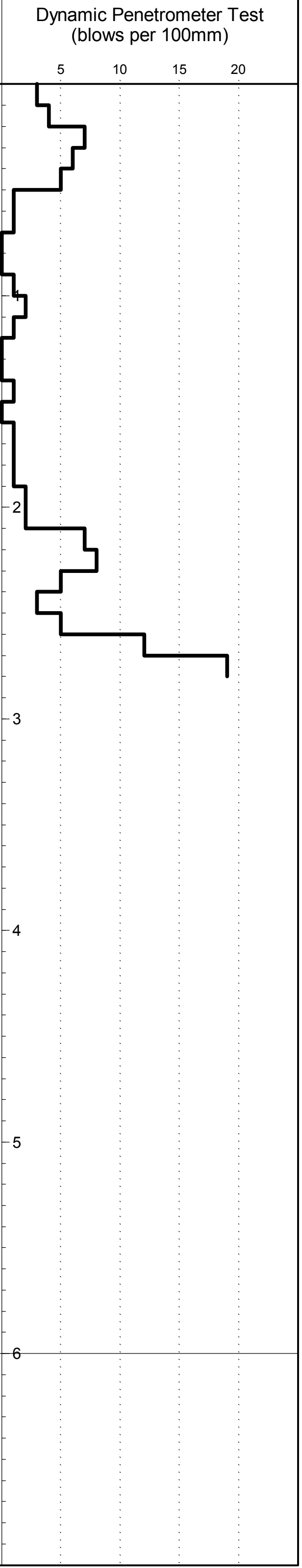
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 15*
EASTING: 504107
NORTHING: 7034450
DIP/AZIMUTH: 90°/--

BORE No: 53
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - medium dense, dark brown, fine to medium grained silty sand topsoil, organics, moist						
	0.15	SILTY SAND - medium dense, orange brown, fine to medium grained silty sand, moist						
		- very loose to loose		B	0.7 1.2			
		- trace clay fines						
	1.95	GRAVELLY SILTY SAND - medium dense, orange brown, fine to medium grained gravelly silty sand with fine to medium gravel, moist						
	2.6	IRONSTONE - very low strength, extremely weathered, red brown ironstone						
	3.1	SANDY CLAY - very stiff, grey mottled orange brown, medium plasticity sandy clay with fine to medium grained sand, moist			3.4		pp = 310	
		- grey mottled red brown, some ironstone						
	3.9	IRONSTONE - extremely low strength, extremely weathered, red brown ironstone with clay layering			4.9		pp = 320	
	5.7	SANDY CLAY - hard, grey mottled red brown, high plasticity sandy clay with fine grained sand, ironstone layering, moist			5.9		pp = 440	
	6.0	Bore discontinued at 6.0m Limit of investigation						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

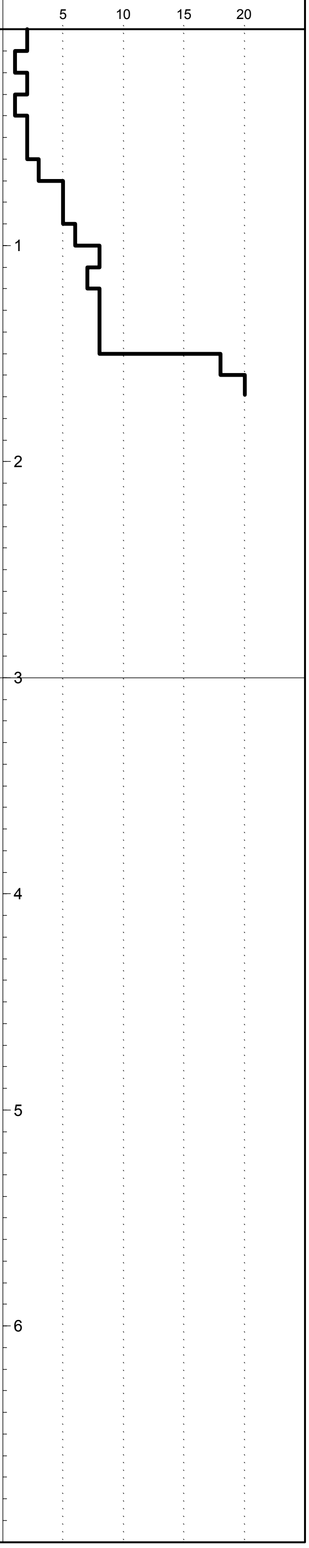
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 10.6*
EASTING: 504559
NORTHING: 7034123
DIP/AZIMUTH: 90°/--

BORE No: 54
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose to medium dense, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.5	SILTY SAND - medium dense, grey mottled orange brown, fine to medium grained silty sand with trace clay fines, moist		D	0.7 0.9			
1				D	1.0 1.3			
		- grey, wet						▷
		- dense		D	1.5 1.7			
2								
				D	2.7 2.9			
3	3.0	Bore discontinued at 3.0m Limit of investigation						
4								
5								
6								

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage was observed at 1.4 m depth at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

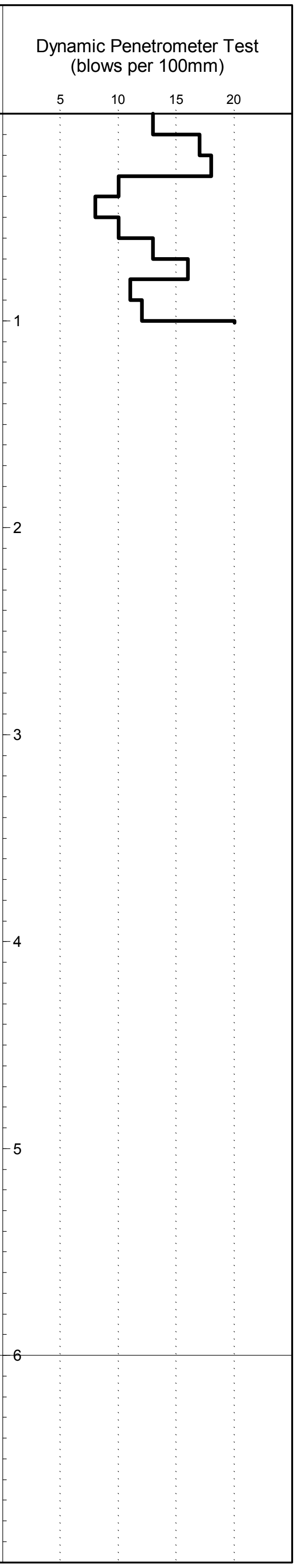
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 11.4*
EASTING: 504967
NORTHING: 7033822
DIP/AZIMUTH: 90°/--

BORE No: 55
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Sampling & In Situ Testing Depth	Sampling & In Situ Testing Sample	Sampling & In Situ Testing Results & Comments	Water
		TOPSOIL - dense, red brown mottled orange brown, fine to medium grained gravelly sand with fine to medium gravel and some clay fines, moist						
	0.4	SILTY SAND - dense, red brown mottled orange brown, fine to medium grained silty sand with some fine gravel and some clay fines, moist						
	0.8	GRAVELLY CLAYEY SAND - dense, red brown mottled orange brown, fine to medium grained gravelly clayey sand with fine to medium gravel and medium plasticity clay fines, moist		B	0.8 1.4			
	1.2	SILTY SAND - dense, red brown mottled orange brown, fine to medium grained silty sand with some fine gravel and some clay fines, moist						
	1.55	SANDY CLAY - hard, grey mottled orange brown, low to medium plasticity sandy clay with fine to medium with some coarse grained sand, moist			1.9		pp = 410	
		- grey mottled red brown, fine grained sand, ironstone lensing		U_{50}	2.0 2.1		pp >600	
		- stiff			3.3		pp = 160	
					3.9		pp = 180	
		- very stiff			4.4		pp = 210	
		- stiff, grey mottled orange brown, high plasticity, no ironstone lensing			5.4		pp = 120	
		- stiff to very stiff			5.9		pp = 200	
	6.0	Bore discontinued at 6.0m Limit of investigation						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

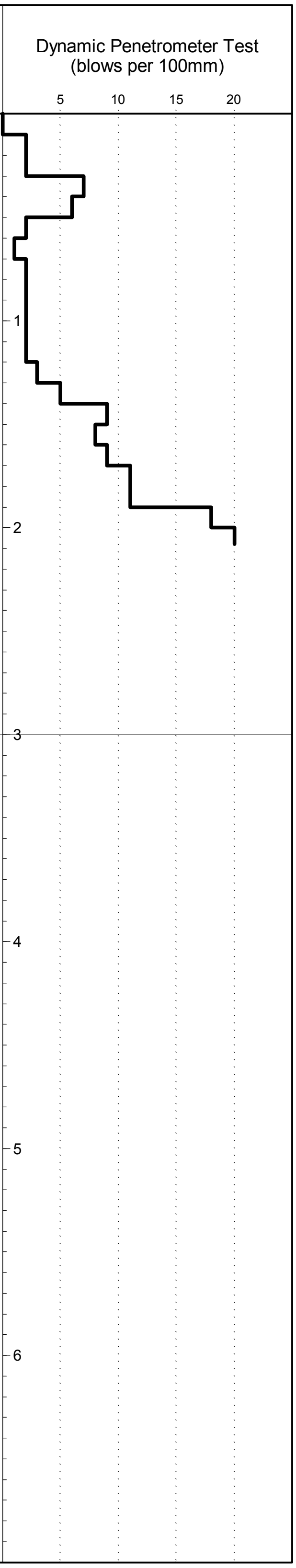
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 9*
EASTING: 505510
NORTHING: 7033543
DIP/AZIMUTH: 90°/--

BORE No: 56
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.3	SILTY SAND - medium dense, grey brown, fine to medium grained silty sand, moist						
	0.5	SANDY CLAY - stiff, grey mottled orange brown, high plasticity sandy clay with fine grained sand, moist			0.5		pp = 700	
					0.9		pp = 290	
					1.4		pp = 120	
	1.9	SILTY SAND - dense, grey, fine to medium grained silty sand, wet						▷
	3.0	Bore discontinued at 3.0m Limit of investigation						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage was observed at 1.9 m depth at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

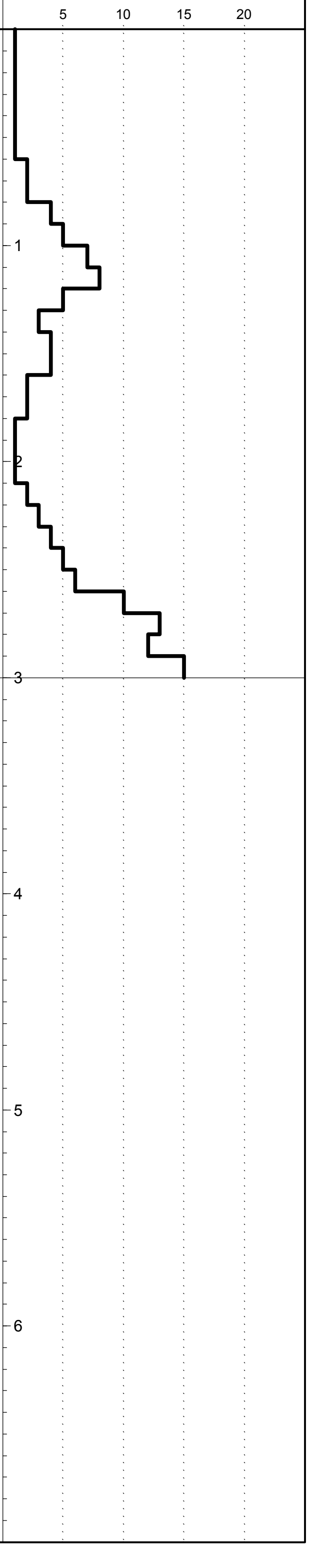
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 7.3*
EASTING: 505960
NORTHING: 7033339
DIP/AZIMUTH: 90°/--

BORE No: 57
PROJECT No: 80967
DATE: 10/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.35	SILTY SAND - loose, grey mottled orange brown, fine to medium grained silty sand, moist - medium dense - grey						
	1.7	SANDY CLAY - stiff, grey mottled orange brown, medium to high plasticity sandy clay with fine to medium and trace coarse grained sand, moist			1.9		pp = 170	
					2.4		pp = 100	
					2.9		pp = 130	
	3.0	Bore discontinued at 3.0m Limit of investigation						

Dynamic Penetrometer Test
(blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

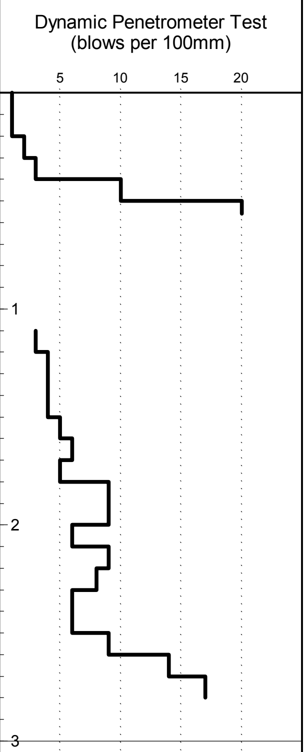
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 6.5*
EASTING: 506288
NORTHING: 7033472
DIP/AZIMUTH: 90°/--

BORE No: 58
PROJECT No: 80967
DATE: 10/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, dark grey, fine to medium grained silty sand topsoil, organics, moist	D	0.1 0.4			
		SILTY SAND - loose, grey, fine to medium grained silty sand, moist - dense to very dense, grey brown	D	0.6 0.9			
1		- medium dense, orange brown	D	1.0 1.4			
2	1.8	CLAYEY SAND - medium dense, grey, fine to medium grained clayey sand with low plasticity clay fines, wet	D	2.0 2.3			▷
	2.3	SANDY CLAY - very stiff, grey, medium to high plasticity sandy clay with fine to medium grained sand, moist		2.4		pp = 220	
			D	2.6 2.9		pp = 220	
3	3.0	Bore discontinued at 3.0m Limit of investigation					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage was observed at 1.8 m depth at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

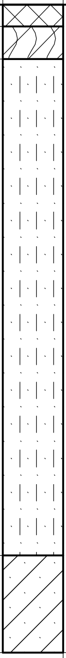
BOREHOLE LOG

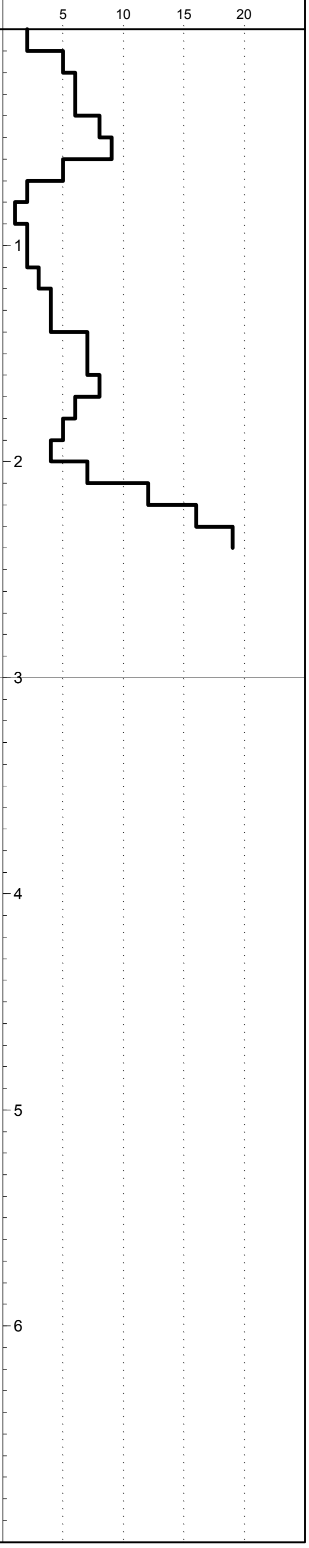
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 4.7*
EASTING: 506820
NORTHING: 7033336
DIP/AZIMUTH: 90°/--

BORE No: 59
PROJECT No: 80967
DATE: 10/2/2014
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling & In Situ Testing Depth	Results & Comments	Water
0.1	FILLING - loose, grey, medium to coarse gravel, dry			
0.25	TOPSOIL - medium dense, grey brown, fine to medium grained silty sand topsoil, organics, moist	0.25	ASS samples collected at 0.25 m intervals to 2.0 m	
	SILTY SAND - medium dense, brown mottled orange brown, fine to medium grained silty sand, moist			
	- loose to medium dense			
	- some clay fines			
	- medium dense, wet			▷
	dense			
2.55	SANDY CLAY - very stiff, grey mottled orange brown, medium plasticity sandy clay with fine to medium grained sand, moist	2.9	pp = 240	
3.0	Bore discontinued at 3.0m Limit of investigation			


Graphic Log


Dynamic Penetrometer Test (blows per 100mm)

RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage was observed at 1.4 m depth at time of drilling
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

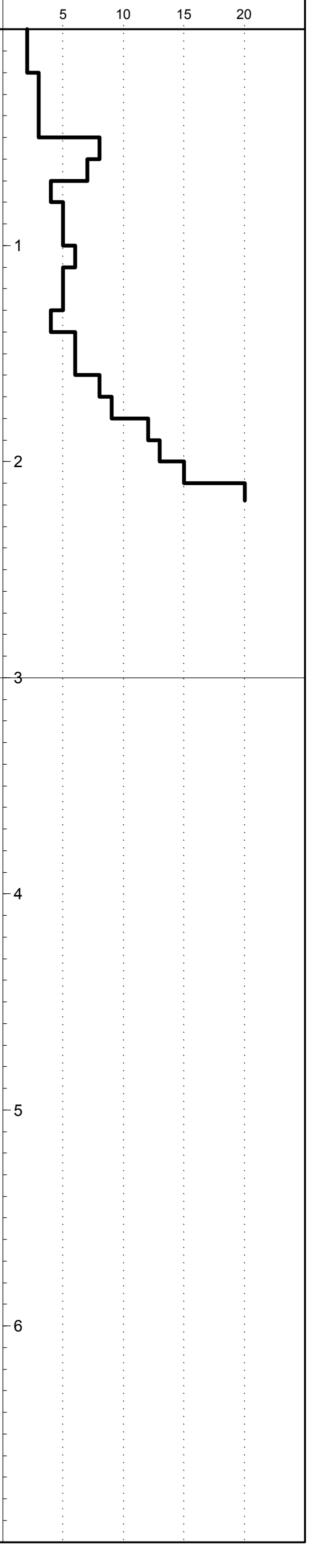
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 4*
EASTING: 507299
NORTHING: 7033270
DIP/AZIMUTH: 90°/--

BORE No: 60
PROJECT No: 80967
DATE: 6/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - medium dense, dark brown, fine to medium grained silty sand topsoil, organics, moist						
	0.15	SILTY SAND - medium dense, orange brown, fine to medium grained silty sand, moist			0.25		ASS samples collected at 0.25 m intervals to 2.0 m	
	0.55	SANDY CLAY - very stiff, grey mottled orange brown, high plasticity sandy clay with fine to medium grained sand, moist			0.9		pp = 370	
1					1.4		pp = 280	
	1.7	SILTY SAND - dense, grey, fine to medium grained silty sand, moist						
2		- medium dense, wet						▷
	2.7	CLAYEY SAND - medium dense, grey mottled orange brown, fine to medium grained clayey sand with low to medium plasticity clay fines, moist						
3	3.0	Bore discontinued at 3.0m Limit of investigation						
4								
5								
6								

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage was observed at 2.2 m depth at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⊻	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

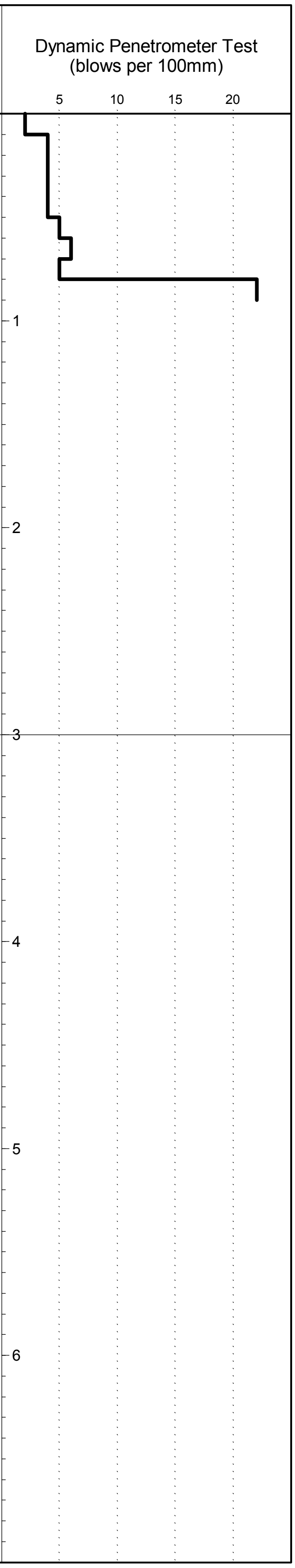
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 11.8*
EASTING: 503975
NORTHING: 7034203
DIP/AZIMUTH: 90°/--

BORE No: 61
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - medium dense, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.5	SILTY SAND - medium dense, grey mottled orange brown, fine to medium grained silty sand with trace clay fines, moist - dense, grey						
	1.7	SANDY CLAY - hard, grey, medium plasticity sandy clay with fine to medium grained sand, moist			1.9		pp = 430	
		- very stiff			2.4		pp = 330	
		- low to medium plasticity						
	3.0	Bore discontinued at 3.0m Limit of investigation						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

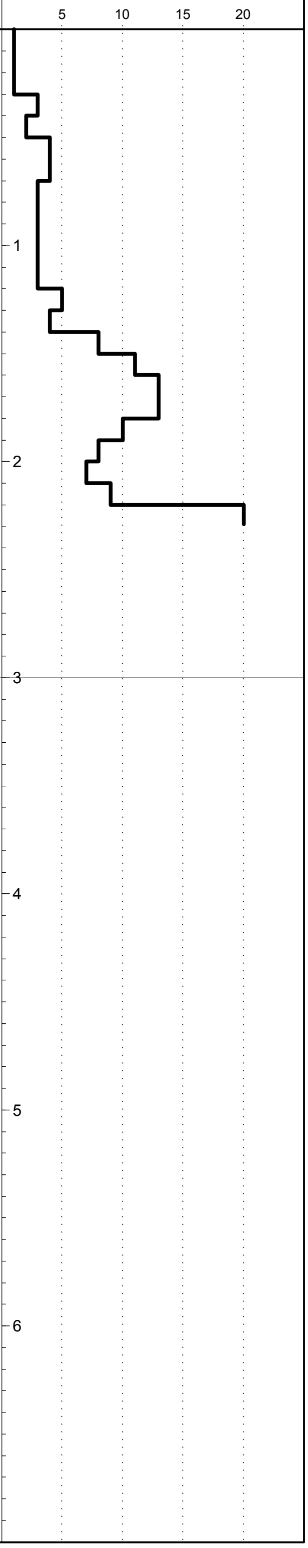
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 11.5*
EASTING: 504756
NORTHING: 7033634
DIP/AZIMUTH: 90°/--

BORE No: 62
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.35	SILTY SAND - loose, grey, fine to medium grained silty sand with trace clay fines, moist - medium dense						
		- fine to coarse grained sand, wet						▷
		- dense, grey brown						
	2.35	SANDY CLAY - hard, grey mottled brown, medium plasticity sandy clay with fine to medium grained sand, moist			2.4		pp >600	▷
	2.8	SILTY SAND - dense, dark grey, fine to medium grained silty sand, wet						
	3.0	Bore discontinued at 3.0m Limit of investigation						

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage was observed at 1.25 m and 2.8 m depth at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

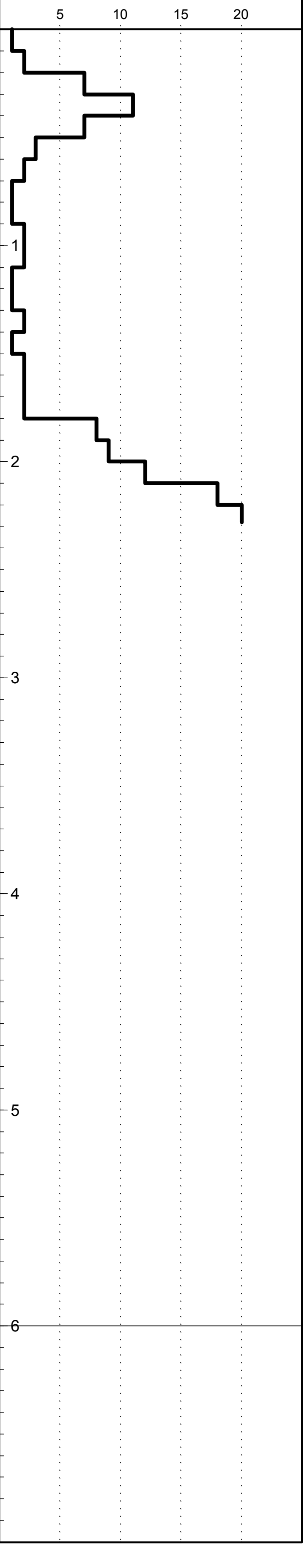
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 10.2*
EASTING: 505213
NORTHING: 7033274
DIP/AZIMUTH: 90°/--

BORE No: 63
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, dark grey, fine to medium grained silty sand topsoil, organics, moist					
	0.2	SILTY SAND - medium dense, orange brown, fine to medium grained silty sand, moist	D	0.4 0.6			
		- some clay fines	D	1.4 1.6			
	1.6	GRAVELLY CLAYEY SAND/GRAVELLY SANDY CLAY - stiff, dark grey orange brown, low plasticity gravelly sandy clay with fine to medium grained sand and fine to medium gravel, moist	D	1.6 1.9			▷
		- very stiff, dark grey mottled red brown, some ironstone, wet	D	1.9 2.3			
	2.8	SANDY CLAY - stiff, grey mottled orange brown red brown, medium plasticity sandy clay with fine to medium grained sand, trace ironstone layering, moist	D	2.9 3.2		pp = 180	
		- very stiff to hard, medium to high plasticity		3.8		pp = 520	
		- grey, no lensing	D	4.9 4.95 5.0		pp = 490	
	5.1	SILTY CLAY - very stiff to hard, grey, high plasticity silty clay, moist	D	5.3 5.4 5.6		pp = 410	
	6.0	Bore discontinued at 6.0m Limit of investigation					

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage was observed at 1.9 m depth at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

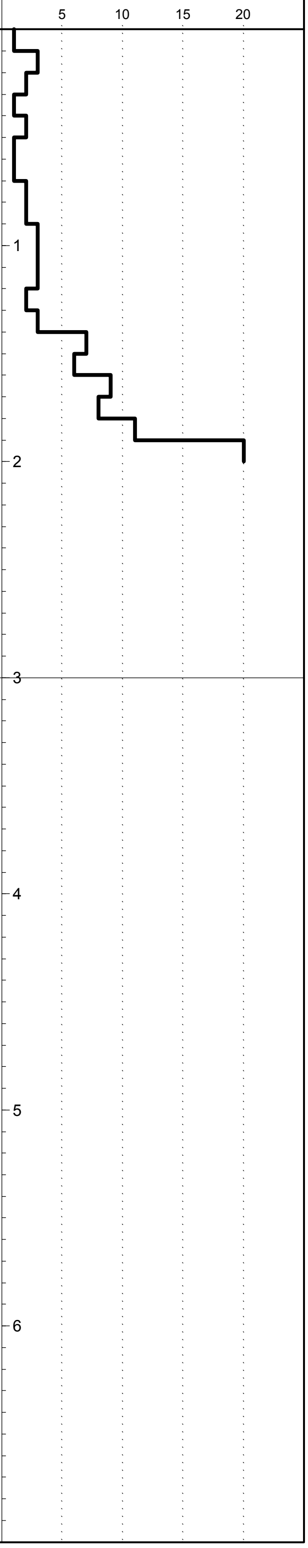
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 5.4*
EASTING: 506568
NORTHING: 7033122
DIP/AZIMUTH: 90°/--

BORE No: 64
PROJECT No: 80967
DATE: 10/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.15	SILTY SAND - loose to medium dense, grey, fine to medium grained silty sand, moist			0.25		ASS samples collected at 0.25 m intervals to 2.0 m	
	0.6	SILTY SANDY CLAY - stiff, grey mottled orange brown, low plasticity sandy clay with fine and some medium grained sand, moist			0.9		pp = 210	
					0.95			
	1			U_{50}	1.0		pp = 380	
					1.3			
					1.4		pp = 110	
		- very stiff, medium plasticity, grey mottled orange brown red brown			1.9		pp = 440	
	2	- grey						
					2.4		pp = 390	
		- stiff			2.9		pp = 180	
	3 3.0	Bore discontinued at 3.0m Limit of investigation						
	4							
	5							
	6			B	6.0			

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

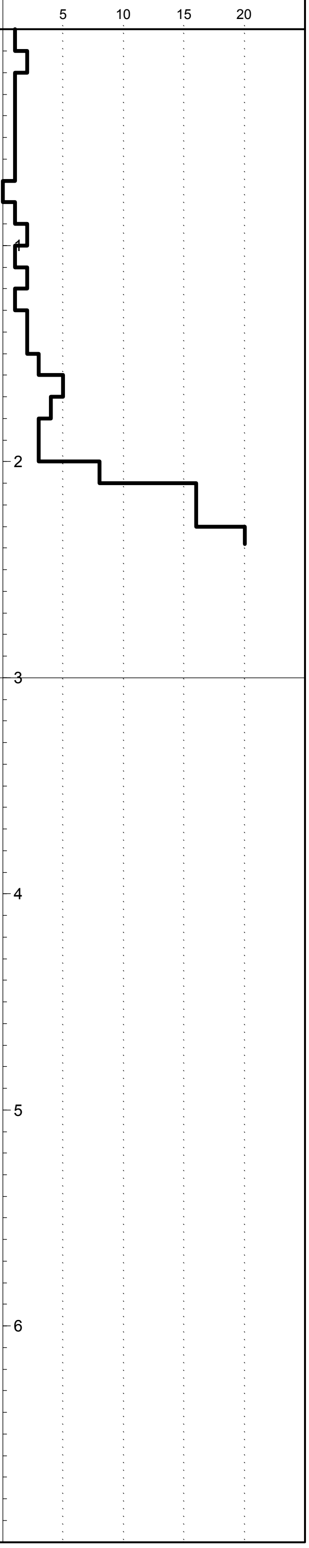
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 4.1*
EASTING: 507056
NORTHING: 7033053
DIP/AZIMUTH: 90°/--

BORE No: 65
PROJECT No: 80967
DATE: 6/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, dark brown, fine to medium grained silty sand topsoil, organics, moist						
		SILTY SAND - loose, dark brown, fine to medium grained silty sand, moist - some clay fines		D	0.2 0.6			
1	0.85	SANDY CLAY - very stiff, brown mottled grey, medium to high plasticity sandy clay with fine to medium grained sand and some fine gravel, moist		D	0.9 1.4		pp = 260 pp = 300	
2	1.6	SILTY SAND - medium dense, grey, fine to medium grained silty sand, wet - dense		D	1.8 2.2			▷
	2.3	SANDY CLAY - very stiff, grey mottled orange brown, high plasticity sandy clay with fine to medium grained sand, moist		D	2.4 2.41 2.8 2.9		pp = 280 pp = 270	
3	3.0	Bore discontinued at 3.0m Limit of investigation						
4								
5								
6								

Dynamic Penetrometer Test
(blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage was observed at 1.6 m depth at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⊻	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

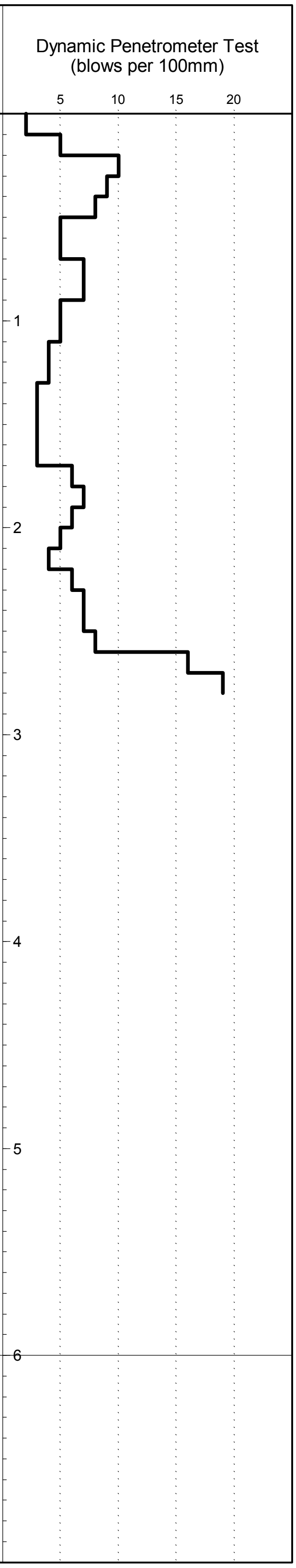
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 20*
EASTING: 504016
NORTHING: 7033560
DIP/AZIMUTH: 90°/--

BORE No: 66
PROJECT No: 80967
DATE: 12/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - medium dense, grey brown, fine to medium grained silty sand topsoil, organics, moist						
	1.25	SILTY SAND - medium dense, orange brown, fine to medium grained silty sand, moist - trace clay fines						
		SANDY CLAY - very stiff, grey mottled orange brown and red brown, high plasticity sandy clay with fine to medium grained sand, some ironstone layering, moist		B	1.3 1.4		pp = 250	
				U_{50}	1.5 1.6		pp >600	
					1.9		pp = 440	
					2.4		pp = 420	
					2.9		pp = 410	
					3.4		pp = 240	
					3.9		pp = 220	
					4.4		pp = 200	
		- stiff			5.5		pp = 160	
	6.0	Bore discontinued at 6.0m Limit of investigation						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

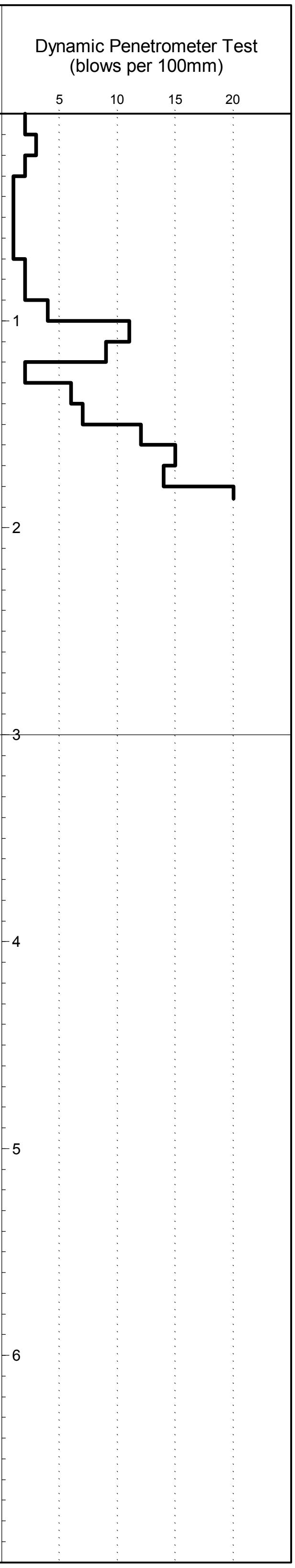
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 11*
EASTING: 504652
NORTHING: 7033164
DIP/AZIMUTH: 90°/--

BORE No: 67
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Sampling & In Situ Testing Depth	Sampling & In Situ Testing Sample	Sampling & In Situ Testing Results & Comments	Water
		TOPSOIL - loose, dark grey mottled brown, fine to medium grained silty sand topsoil, organics, moist						
	0.45	SILTY SAND - loose, grey brown, fine to medium grained silty sand, moist						
1		- medium dense, grey						
	1.4	SANDY CLAY - very stiff, grey, medium to high plasticity sandy clay with fine to medium grained sand, moist			1.5		pp = 240	
2		- stiff			1.9		pp = 190	
		- very stiff, grey mottled green blue			2.4		pp = 240	
					2.9		pp = 230	
3	3.0	Bore discontinued at 3.0m Limit of investigation						
4								
5								
6								



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

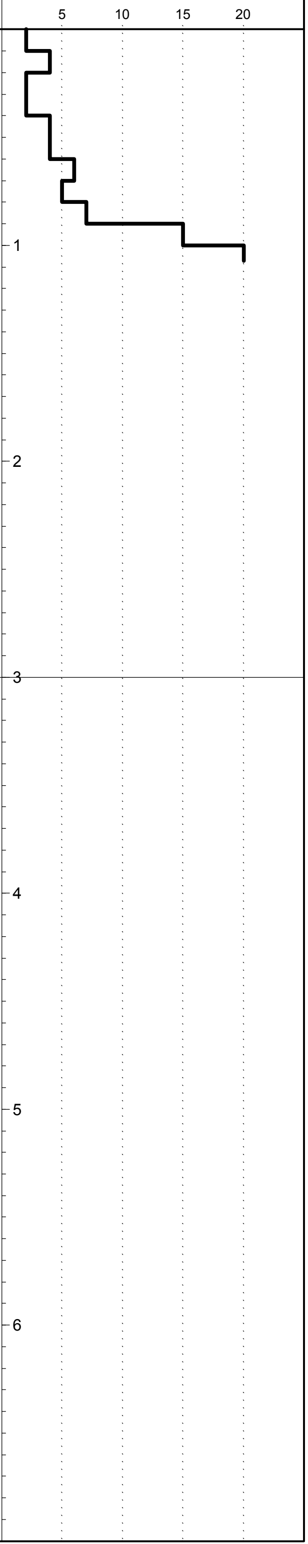
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 8*
EASTING: 505387
NORTHING: 7033039
DIP/AZIMUTH: 90°/--

BORE No: 68
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - medium dense, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.4	SILTY SAND - medium dense, grey brown, fine to medium grained silty sand, moist						
	1	- dense, orange brown						
		- grey, trace clay fines						
	1.5	SANDY CLAY - stiff, grey mottled orange brown, high plasticity sandy clay with fine grained sand, moist						
					1.9		pp = 170	
	2							
		- very stiff						
					2.9		pp = 260	
3	3.0	Bore discontinued at 3.0m Limit of investigation						
	4							
	5							
	6							

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

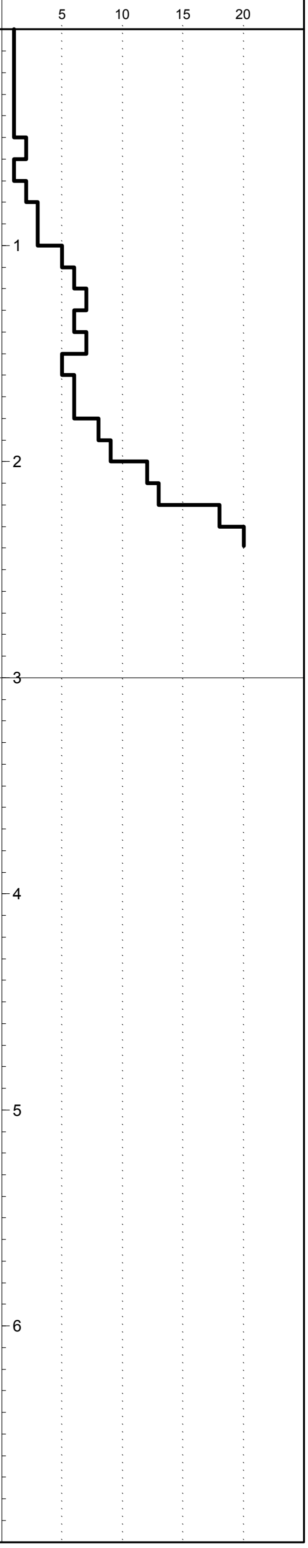
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 6.9*
EASTING: 505847
NORTHING: 7032949
DIP/AZIMUTH: 90°/--

BORE No: 69
PROJECT No: 80967
DATE: 10/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water
		TOPSOIL - loose, dark grey, fine to medium grained silty sand topsoil, organics, moist		D	0.0 0.35			
	0.45	SAND - loose, grey, fine to medium grained sand, moist		D	0.4 0.6			
1		- medium dense		D	0.9 1.3			
		- grey brown, trace coarse grained sand		D	1.6 2.0			
2		- dense		D	2.3 2.6			
3	3.0	Bore discontinued at 3.0m Limit of investigation						
4								
5								
6								

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

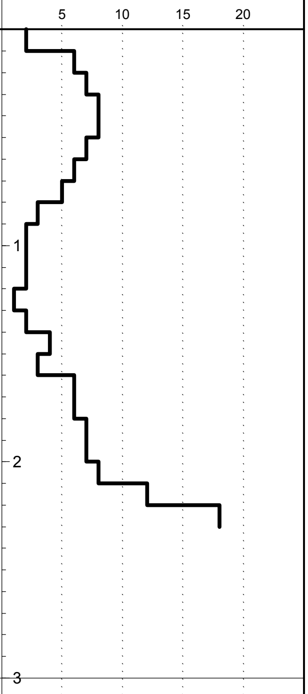
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 4.85*
EASTING: 506785
NORTHING: 7032805
DIP/AZIMUTH: 90°/--

BORE No: 70
PROJECT No: 80967
DATE: 6/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
	0.15	TOPSOIL - loose to medium dense, dark brown, fine to medium grained silty sand topsoil, moist						
		SILTY SAND - medium dense, grey orange brown, fine to medium grained silty sand, moist			0.25		ASS samples collected at 0.25 m intervals to 2.0 m	
	1 0.95	SANDY CLAY - stiff, grey mottled orange brown, medium plasticity sandy clay with fine to medium grained sand, moist						
		- high plasticity			1.4		pp = 160	
		- medium to high plasticity						
	2				1.9		pp = 200	
		- very stiff, high plasticity, fine grained sand						
					2.4		pp = 370	
	3 3.0	Bore discontinued at 3.0m Limit of investigation						

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

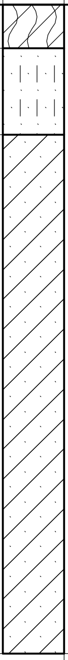
BOREHOLE LOG

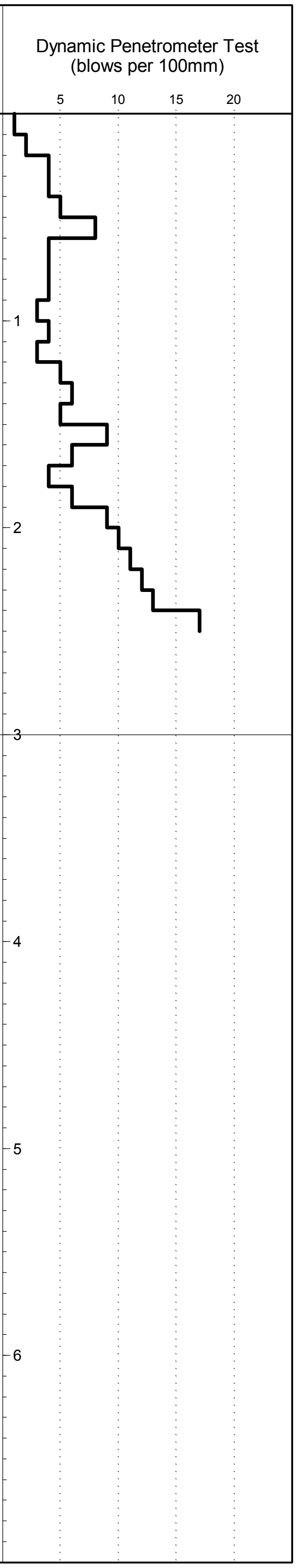
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 3.5*
EASTING: 507163
NORTHING: 7032764
DIP/AZIMUTH: 90°/--

BORE No: 71
PROJECT No: 80967
DATE: 6/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, grey brown, fine to medium grained silty sand topsoil, organics, moist					
	0.2	SILTY SAND - medium dense, grey orange brown, fine to medium grained silty sand, moist		0.25		ASS samples collected at 0.25 m intervals to 2.0 m	
	0.6	SANDY CLAY - stiff, grey mottled orange brown, medium plasticity sandy clay with fine to medium grained sand, moist - very stiff, high plasticity		0.9		pp = 260	
1				1.4		pp = 350	
				1.9		pp = 240	
2		- grey mottled brown		2.4		pp = 360	
		- hard		2.9		pp = 440	
3	3.0	Bore discontinued at 3.0m Limit of investigation					
4							
5							
6							





RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

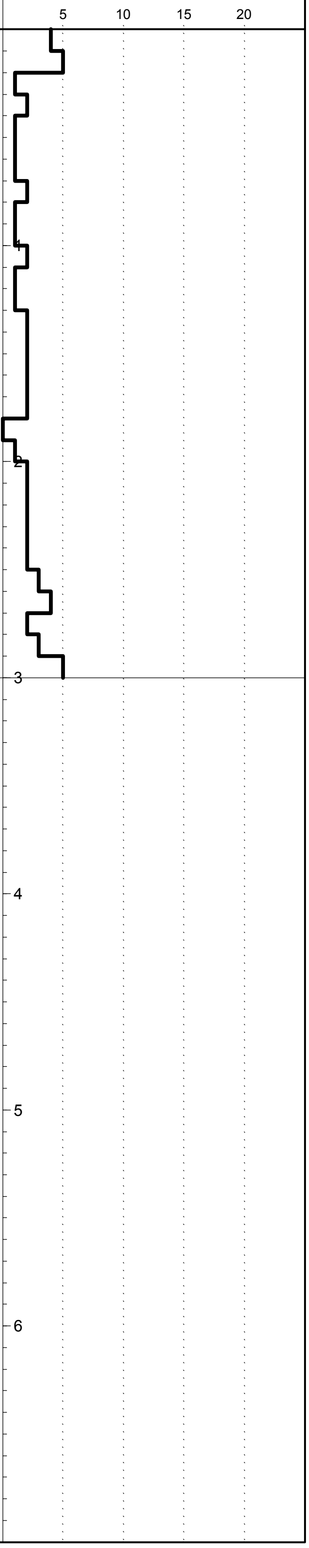
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 21.4*
EASTING: 503994
NORTHING: 7033063
DIP/AZIMUTH: 90°/--

BORE No: 72
PROJECT No: 80967
DATE: 12/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - medium dense, grey brown, fine to medium grained silty sand topsoil, organics, moist					
		SILTY SAND - loose, orange brown, fine to medium grained silty sand, moist	D	0.2 0.3			
	0.75	CLAYEY SAND - loose to medium dense, orange brown mottled red brown, fine to medium grained clayey sand with low plasticity fines, moist	D	0.75 0.9			
	1.1	SANDY CLAY - stiff, grey mottled orange brown and red brown, medium plasticity sandy clay with fine grained sand, moist	D	1.2 1.3			
				1.4		pp = 270	
				1.9		pp = 300	
	2.1	SILTY CLAY - stiff, grey mottled red brown and orange brown, high plasticity silty clay, moist	D	2.2 2.4 2.5		pp = 280	
				2.9		pp = 390	
	3.0	Bore discontinued at 3.0m Limit of investigation					

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

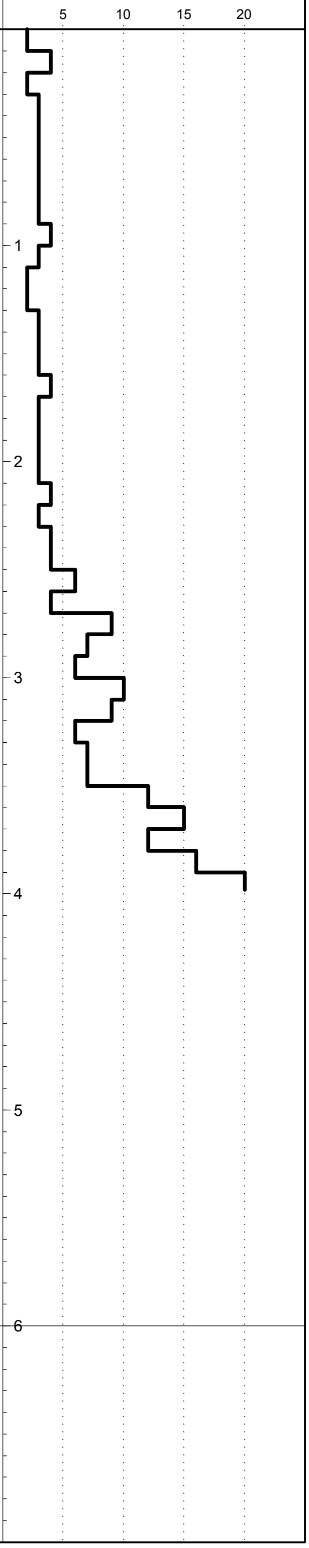
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 18*
EASTING: 504384
NORTHING: 7032859
DIP/AZIMUTH: 90°/--

BORE No: 73
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	0.2	TOPSOIL - medium dense, dark grey, fine to medium grained silty sand topsoil, organics, moist					
	0.45	SILTY SAND - medium dense, orange brown, fine to medium grained silty sand, moist					
		SILTY SANDY CLAY - hard, orange brown mottled red brown, high plasticity silty sandy clay with fine to medium grained sand, moist					
			B	0.95			
				1.0		pp = 430	
			U_{50}	1.2			
				1.3		pp = 500	
				1.33		pp = 250	
		- grey mottled red brown, medium to high plasticity, some ironstone lensing		1.4			
				1.9		pp = 340	
				2.4		pp = 380	
		- hard					
				2.9		pp = 580	
		- very stiff					
				3.4		pp = 220	
				3.9		pp = 260	
				4.4		pp = 220	
		- stiff, brown					
				5.4		pp = 170	
	6.0			5.9		pp = 140	
		Bore discontinued at 6.0m Limit of investigation					

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

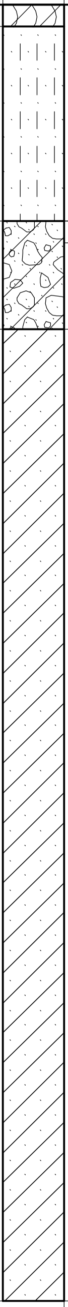
BOREHOLE LOG

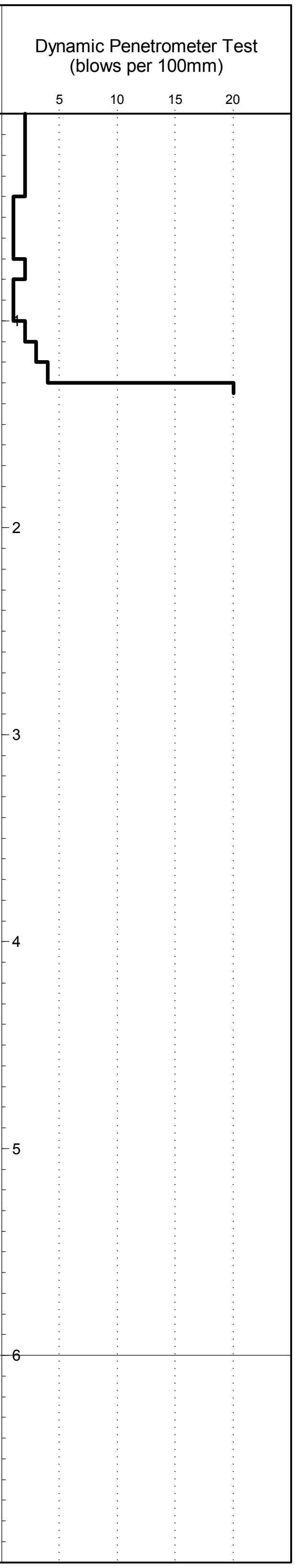
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 15*
EASTING: 505107
NORTHING: 7032715
DIP/AZIMUTH: 90°/--

BORE No: 74
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, dark grey, fine to medium grained silty sand topsoil, organics, moist					
		SILTY SAND - loose, orange brown, fine to medium grained silty sand, moist					
1	1.0	GRAVELLY CLAYEY SAND - medium dense, orange brown mottled red brown, fine to medium grained gravelly clayey sand with fine to medium gravel and medium plasticity fines, some ironstone layering, moist	U_{50}	1.0 1.1		pp >600	
			B	1.4 1.5		pp = 320	
	1.5	SANDY CLAY - very stiff, orange brown mottled red brown, low to medium plasticity sandy clay with fine to medium grained sand, some ironstone lensing, moist - low plasticity - high plasticity, fine grained sand		1.9		pp = 190	
2		- orange brown mottled grey, medium to high plasticity		2.9		pp = 310	
3				3.4		pp = 310	
				3.9		pp = 240	
4				4.4		pp = 290	
				4.9		pp = 250	
5				5.9		pp = 340	
6	6.0	Bore discontinued at 6.0m Limit of investigation					





RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

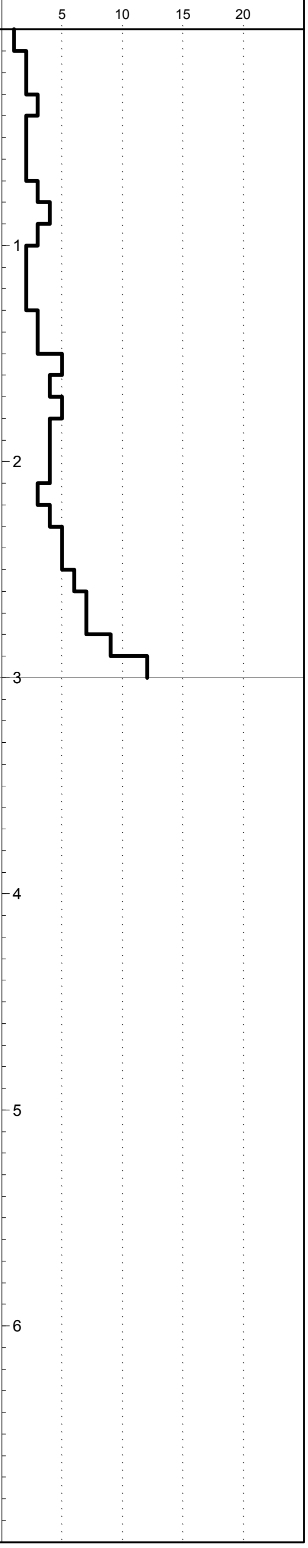
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 11*
EASTING: 505532
NORTHING: 7032671
DIP/AZIMUTH: 90°/--

BORE No: 75
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.3	SILTY SAND - loose to medium dense, orange brown, fine to medium grained silty sand, moist						
	0.8	SANDY CLAY - very stiff, orange brown, medium plasticity sandy clay with fine to medium grained sand, moist			0.9		pp = 280	
		- stiff, grey mottled red brown, high plasticity, some ironstone lensing			1.4		pp = 320	
		- very stiff to hard			1.9		pp = 450	
		- very stiff			2.4		pp = 380	
					2.9		pp = 330	
3	3.0	Bore discontinued at 3.0m Limit of investigation						

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

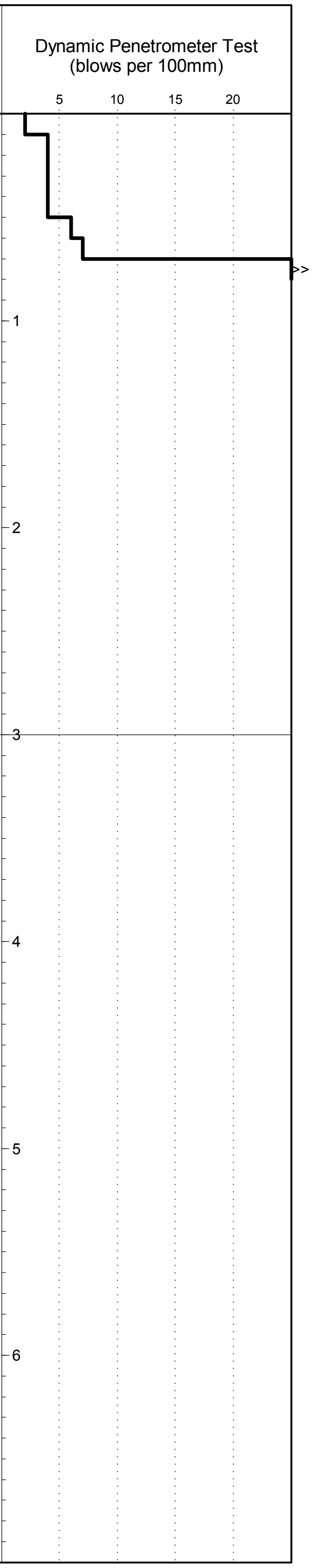
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 5.8*
EASTING: 506228
NORTHING: 7032751
DIP/AZIMUTH: 90°/--

BORE No: 76
PROJECT No: 80967
DATE: 10/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - medium dense, dark grey, fine to medium grained silty sand topsoil, organics, moist						
	0.45	SILTY SAND - medium dense, grey, fine to medium grained silty sand, moist - very dense						
1	1.0	SANDY CLAY - stiff, grey mottled orange brown and red brown, high plasticity sandy clay with fine grained sand, moist			1.4		pp = 190	
					1.9		pp = 180	
2		- very stiff, fine to medium grained sand			2.4		pp = 270	
		- grey mottled orange brown, fine grained sand and trace fine gravel			2.9		pp = 410	
3	3.0	Bore discontinued at 3.0m Limit of investigation						
4								
5								
6								



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

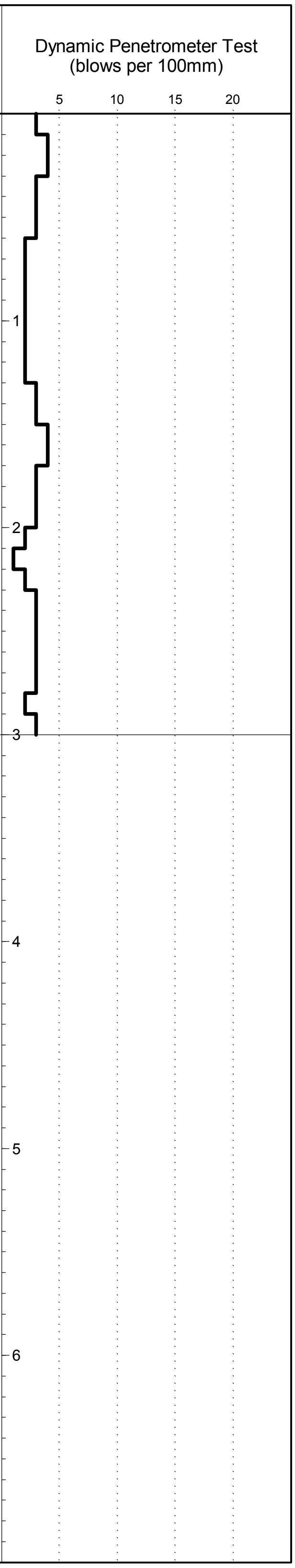
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 4.4*
EASTING: 506420
NORTHING: 7032432
DIP/AZIMUTH: 90°/--

BORE No: 77
PROJECT No: 80967
DATE: 6/2/2014
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	TOPSOIL - medium dense, dark brown, fine to medium grained silty sand topsoil, organics, moist					
0.15	SILTY SAND - medium dense, orange brown, fine to medium grained silty sand with trace of clay fines, moist		0.25		ASS samples collected at 0.25 m intervals to 2.0 m	
1.15	SANDY CLAY - stiff to very stiff, brown mottled orange brown, low to medium plasticity sandy clay with fine to medium grained sand and some fine gravel, moist		1.4		pp = 220	
	- brown mottled grey, medium to high plasticity, trace fine gravel		1.9		pp = 370	
			2.4		pp = 370	
	- high plasticity, fine grained sand, no gravel		2.8		pp = 300	
3.0	Bore discontinued at 3.0m Limit of investigation					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

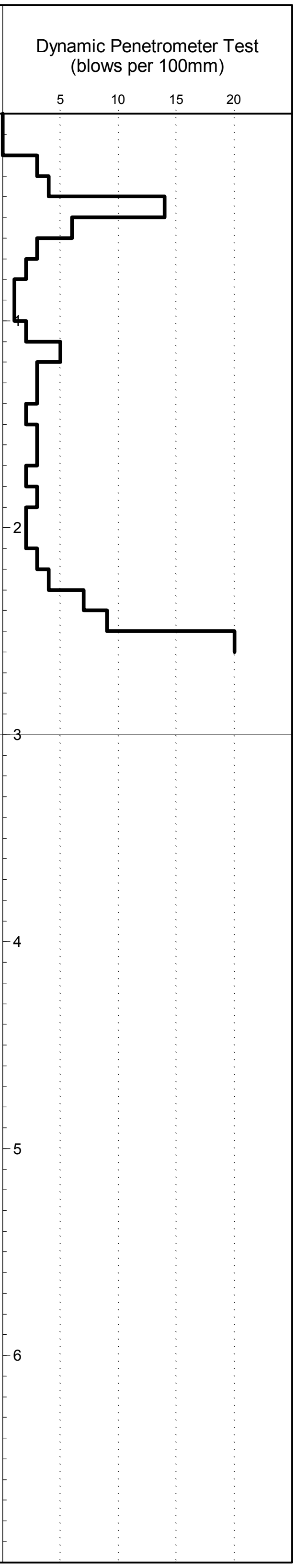
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 3.2*
EASTING: 507025
NORTHING: 7032353
DIP/AZIMUTH: 90°/--

BORE No: 78
PROJECT No: 80967
DATE: 6/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - very loose, grey brown, fine to medium grained silty sand topsoil, organics, moist			0.25		ASS samples collected at 0.25 m intervals to 2.0 m	
	0.3	SILTY SAND - medium dense, dark brown, fine to medium grained silty sand, moist						
		- loose, grey orange brown						
	1							
		- medium dense, some clay fines						
	1.55	SANDY CLAY - stiff, grey mottled orange brown, medium to high plasticity sandy clay with fine to medium grained sand, moist			1.7		pp = 190	
	2							
		- very stiff, grey mottled orange			2.4		pp = 240	
	2.55	SILTY SAND - very dense, grey, fine to medium grained silty sand, moist						
	3 3.0	Bore discontinued at 3.0m Limit of investigation						
	4							
	5							
	6							



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

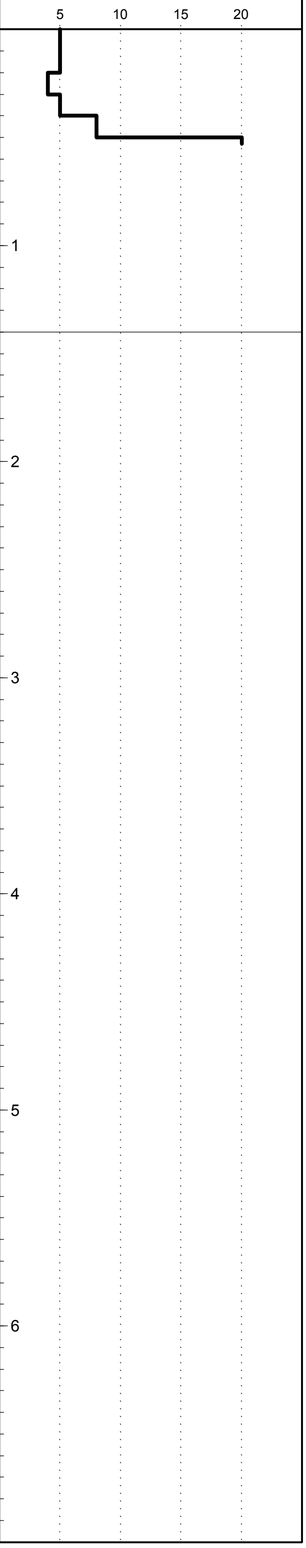
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 22*
EASTING: 503666
NORTHING: 7032639
DIP/AZIMUTH: 90°/--

BORE No: 79
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - medium dense, brown, fine to medium grained silty sand topsoil, organics, moist						
	0.3	SANDY CLAY - stiff, orange brown mottled grey, medium plasticity sandy clay with fine to medium grained sand, moist						
	0.55	SANDSTONE - very low strength, extremely weathered, grey mottled orange brown, fine to medium grained sandstone - low strength						
	1.4	Bore discontinued at 1.4m Auger refusal						

Dynamic Penetrometer Test
(blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

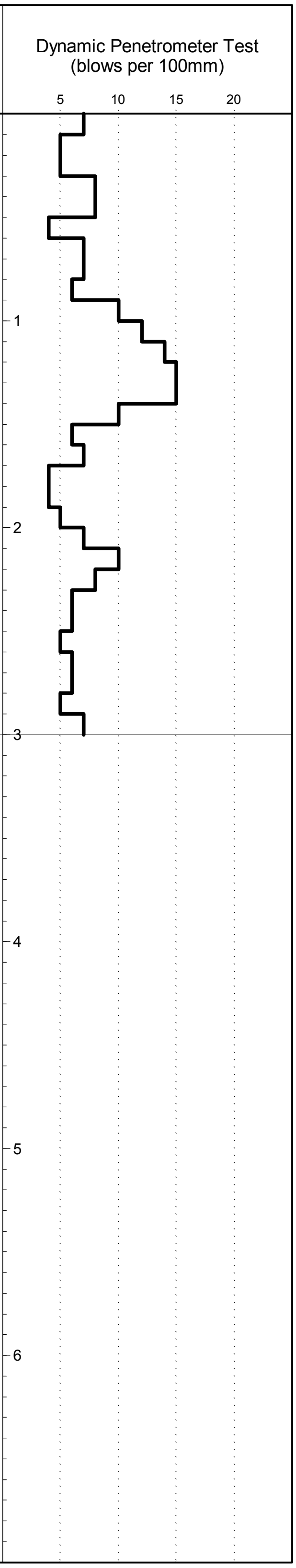
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 8.5*
EASTING: 504425
NORTHING: 7032435
DIP/AZIMUTH: 90°/--

BORE No: 80
PROJECT No: 80967
DATE: 12/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		TOPSOIL - medium dense, grey brown, fine to medium grained silty sand topsoil, organics, moist		D	0.2 0.4			
	0.5	SANDY CLAY - very stiff, grey mottled orange brown, low plasticity sandy clay with fine to medium grained sand, moist		D	0.6 0.9			
	1.1	SILTY SAND - dense, grey, fine to medium grained silty sand, trace clay fines, moist		D	1.1 1.4			
	1.45	SANDY CLAY - very stiff, grey mottled orange brown, high plasticity sandy clay with fine to medium grained sand, moist		D	1.5 1.7			
					1.9		pp = 260	
					2.4		pp = 280	
					2.9		pp = 320	
	3.0	Bore discontinued at 3.0m Limit of investigation						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

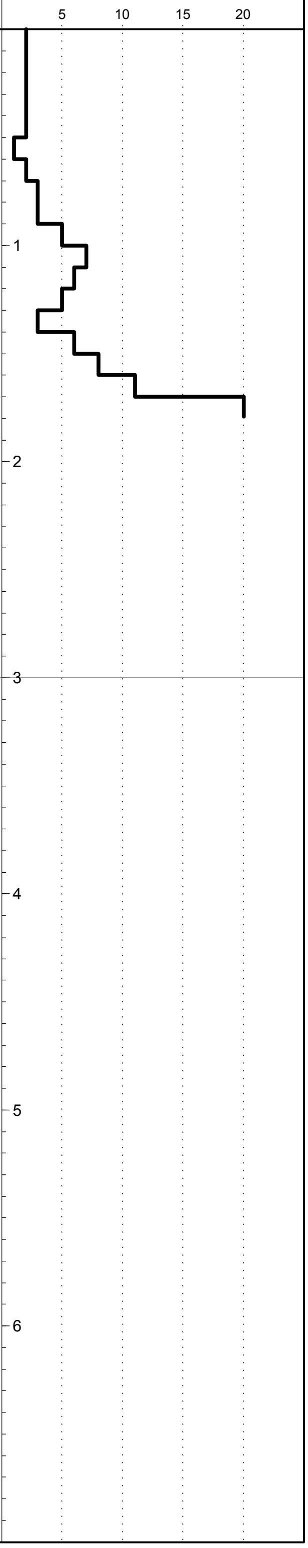
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 7.1*
EASTING: 504908
NORTHING: 7032473
DIP/AZIMUTH: 90°/--

BORE No: 81
PROJECT No: 80967
DATE: 12/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, dark grey brown, fine to medium grained silty sand topsoil, organics, moist					
	0.5	SILTY SAND - loose, grey, fine to medium grained silty sand, trace clay fines, moist					
	0.95	CLAYEY SAND - medium dense, grey mottled orange brown, fine to medium grained clayey sand with low plasticity clay fines, moist					
	1.5	SILTY SAND - medium dense, grey, fine to medium grained silty sand, trace clay fines, wet - dense, moist					▷
	2.2	SANDY CLAY - hard, grey mottled orange brown, medium plasticity sandy clay with fine to medium grained sand, moist		2.4 2.9		pp = 540 pp = 500	
	3.0	Bore discontinued at 3.0m Limit of investigation					

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage was observed at 1.5 m depth at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

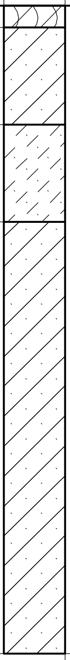
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 3.9*
EASTING: 505466
NORTHING: 7032250
DIP/AZIMUTH: 90°/--

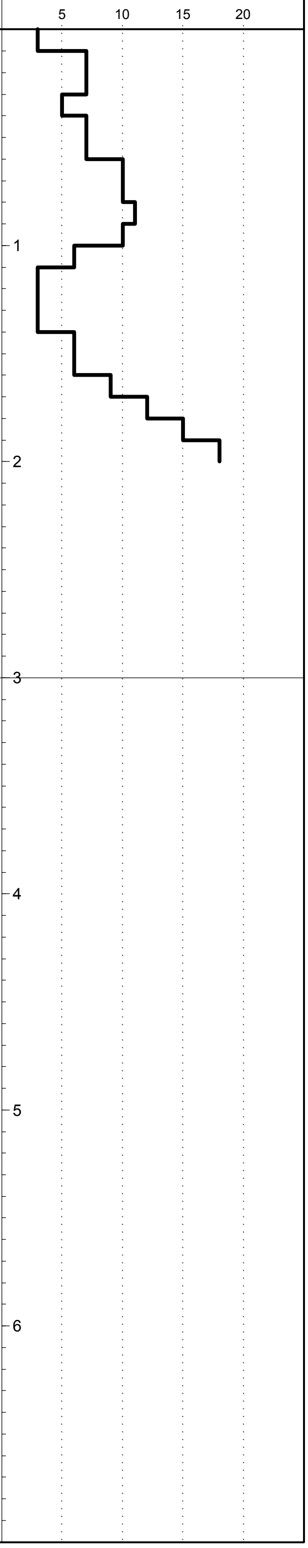
BORE No: 82
PROJECT No: 80967
DATE: 6/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - medium dense, grey brown, fine to medium grained silty sand topsoil, organics, moist					
	0.55	SANDY CLAY - very stiff, grey mottled orange brown, medium to high plasticity sandy clay with fine to medium grained sand, moist		0.25 0.4		ASS samples collected at 0.25 m intervals to 2.0 m pp >600	
	1.0	CLAYEY SAND - medium dense, grey, fine to medium grained clayey sand with low plasticity clay fines, moist		0.9		pp = 200	
	3.0	SANDY CLAY - very stiff, grey mottled orange brown, high plasticity sandy clay with fine to medium grained sand, moist - stiff, grey - very stiff, medium plasticity		1.4 1.9 2.4 2.9		pp = 180 pp = 110 pp = 170 pp = 290	
		Bore discontinued at 3.0m Limit of investigation					

Graphic Log



Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

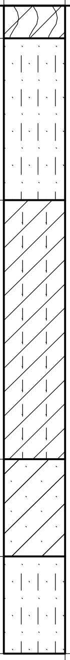
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

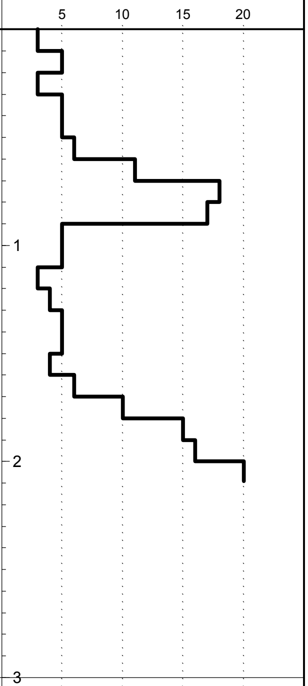
SURFACE LEVEL: 3.4*
EASTING: 505922
NORTHING: 7032287
DIP/AZIMUTH: 90°/--

BORE No: 83
PROJECT No: 80967
DATE: 6/2/2014
SHEET 1 OF 1



RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	0.15	TOPSOIL - medium dense, dark brown, fine to medium grained silty sand topsoil with some clay fines, organics, moist		0.25		ASS samples collected at 0.25 m intervals to 2.0 m	
		SILTY SAND - medium dense, dark brown, fine to medium grained silty sand, moist - dense, grey brown					
	0.9	SILTY CLAY - very stiff, grey mottled orange brown, high plasticity silty clay with some fine grained sand, moist		1.4		pp = 340	
		- stiff, grey		1.9		pp = 170	
	2.1	SANDY CLAY - stiff, grey, high plasticity sandy clay with fine to medium grained sand, moist		2.4		pp = 170	
	2.55	SILTY SAND - medium dense, grey, fine to medium grained silty sand with some clay fines, wet					▷
	3.0	Bore discontinued at 3.0m Limit of investigation					

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage was observed at 2.55 m depth at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

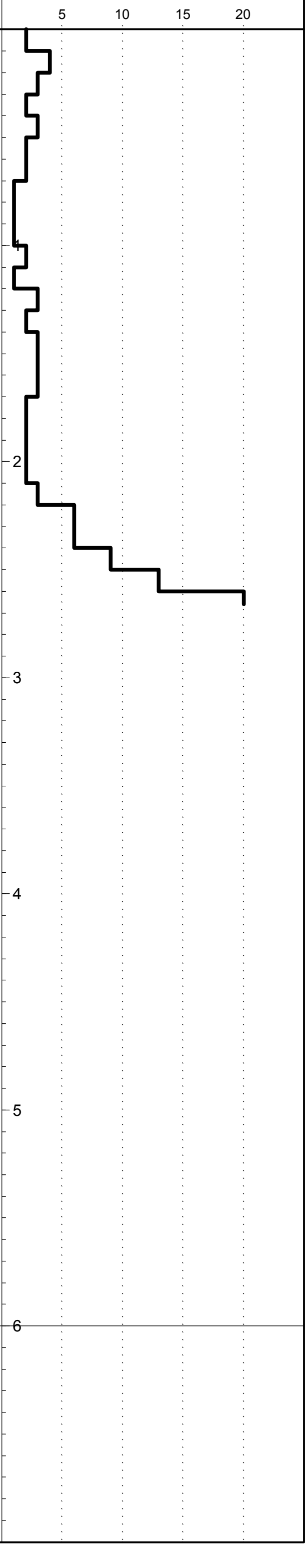
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 15.4*
EASTING: 503861
NORTHING: 7032082
DIP/AZIMUTH: 90°/--

BORE No: 84
PROJECT No: 80967
DATE: 12/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, grey brown, fine to medium grained silty sand topsoil, organics, moist					
	0.55	SILTY SAND - loose, orange brown, fine to medium grained silty sand, trace clay fines, moist					
		SILTY SANDY CLAY - stiff to very stiff, grey mottled orange brown red brown, medium to high plasticity silty sandy clay with fine to medium grained sand, some ironstone layering, moist	B	0.8 0.9 1.0		pp = 360	
			U_{50}	1.1 1.2		pp = 410	
				1.9		pp = 360	
		- stiff, grey mottled orange brown, no ironstone lensing		2.4		pp = 170	
				2.9		pp = 220	
		- low to medium plasticity					
		- low plasticity					
		- very stiff, medium plasticity					
	4.45			4.4		pp = 220	
	6.0	SANDSTONE - very low strength, extremely weathered, orange brown, fine to medium grained sandstone					
		Bore discontinued at 6.0m Limit of investigation					

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

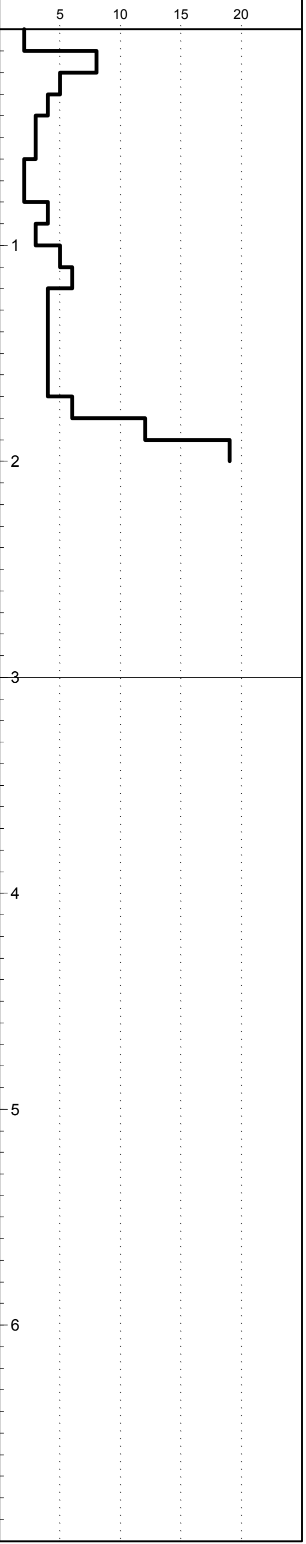
CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 9.3*
EASTING: 503962
NORTHING: 7031805
DIP/AZIMUTH: 90°/--

BORE No: 85
PROJECT No: 80967
DATE: 12/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - medium dense, dark grey brown, fine to medium grained silty sand topsoil, organics, moist					
	0.5	SILTY SAND - medium dense, grey, fine to medium grained silty sand, trace clay fines, moist					
	1.35	SANDY CLAY - very stiff, grey, medium to high plasticity sandy clay with fine to medium grained sand, moist		1.4		pp = 250	
	1.8	CLAYEY SAND - dense, grey, fine to coarse grained clayey sand with low plasticity fines, moist - grey mottled orange brown					
	3.0	Bore discontinued at 3.0m Limit of investigation					

Dynamic Penetrometer Test
(blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

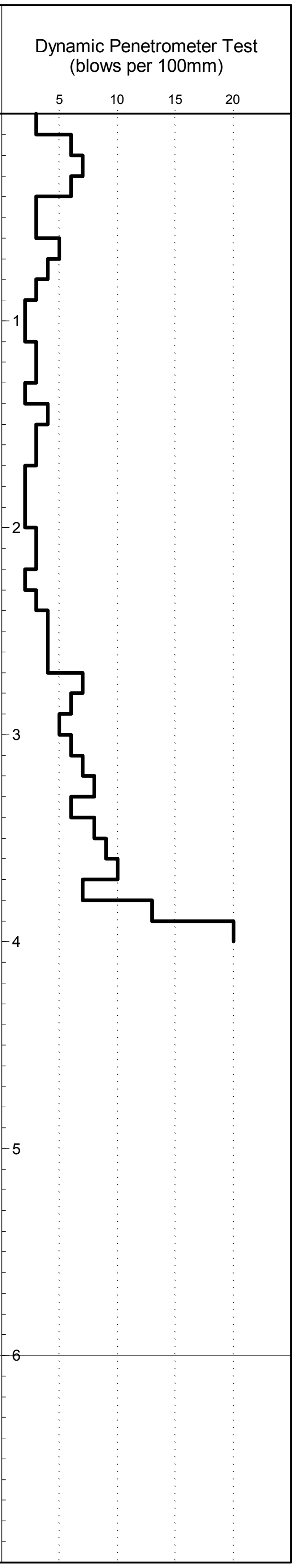
BOREHOLE LOG

CLIENT: Stockland Development Pty Limited
PROJECT: Proposed Residential Subdivision
LOCATION: 167 Bells Creek Road, Bells Creek

SURFACE LEVEL: 19.3*
EASTING: 503458
NORTHING: 7031623
DIP/AZIMUTH: 90°/--

BORE No: 86
PROJECT No: 80967
DATE: 11/2/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - medium dense, grey mottled orange brown, fine to medium grained silty sand topsoil, organics, moist						
	0.2	SANDY CLAY - very stiff, orange brown mottled red brown, medium plasticity sandy clay with fine grained sand, trace fine gravel, moist						
		- red brown mottled grey, medium to high plasticity, some ironstone lensing			0.9		pp = 400	
1								
					1.4		pp = 400	
					1.9		pp >600	
2	2.0	SILTY CLAY - very stiff, grey mottled red brown, high plasticity silty clay, some ironstone lensing, moist						
					2.4		pp = 560	
					2.9		pp = 450	
3								
					3.4		pp = 520	
					3.9		pp >600	
4								
					4.4		pp = 590	
					4.9		pp >600	
5								
		- very stiff						
					5.4		pp = 270	
					5.9		pp = 220	
6	6.0	Bore discontinued at 6.0m Limit of investigation						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage was observed at time of drilling

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

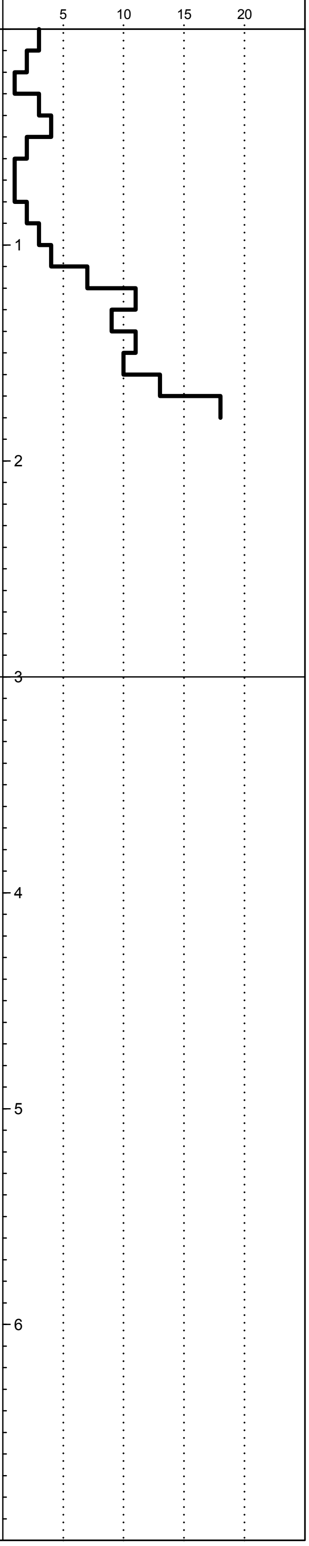
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 4.5*
EASTING: 507225
NORTHING: 7033449
DIP/AZIMUTH: 90°/--

BORE No: 138
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.2	TOPSOIL - loose, dark grey-brown, fine to medium grained silty sand topsoil, moist						
	0.7	SILTY SAND - loose to medium dense, grey, fine to medium grained silty sand, moist						
	1.1	SANDY CLAY - firm, grey mottled orange-brown, medium plasticity sandy clay, fine to medium grained sand, moist			0.9		pp = 70	
	3.0	SILTY SAND - medium dense, grey, fine to medium grained silty sand, wet - dense, some clay fines						▷
		Bore discontinued at 3.0m Limit of Investigation.						

Dynamic Penetrometer Test
(blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 1.1 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

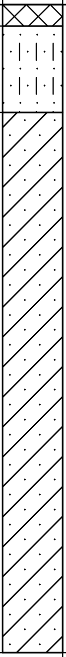
BOREHOLE LOG

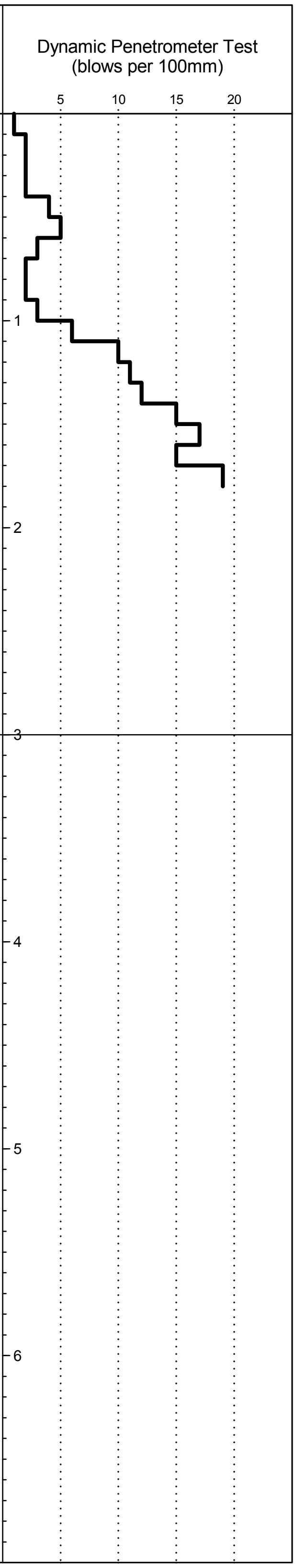
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 4.2*
EASTING: 507063
NORTHING: 7033202
DIP/AZIMUTH: 90°/--

BORE No: 139
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.1	FILLING - loose, brown, fine to medium grained silty gravelly sand filling, fine to medium with some coarse gravel, moist						
	0.5	SILTY SAND - loose, grey-brown, fine to medium grained silty sand, moist						
		SANDY CLAY - stiff, grey, medium to high plasticity sandy clay, fine to medium grained sand, moist			0.9		pp = 170	
					1.4		pp = 130	
		- stiff, grey mottled red-brown, high plasticity			1.9		pp = 160	
		- very stiff, medium to high plasticity			2.4		pp = 260	
	3.0				2.9		pp = 240	
		Bore discontinued at 3.0m Limit of Investigation.						





RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No groundwater seepage observed during drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

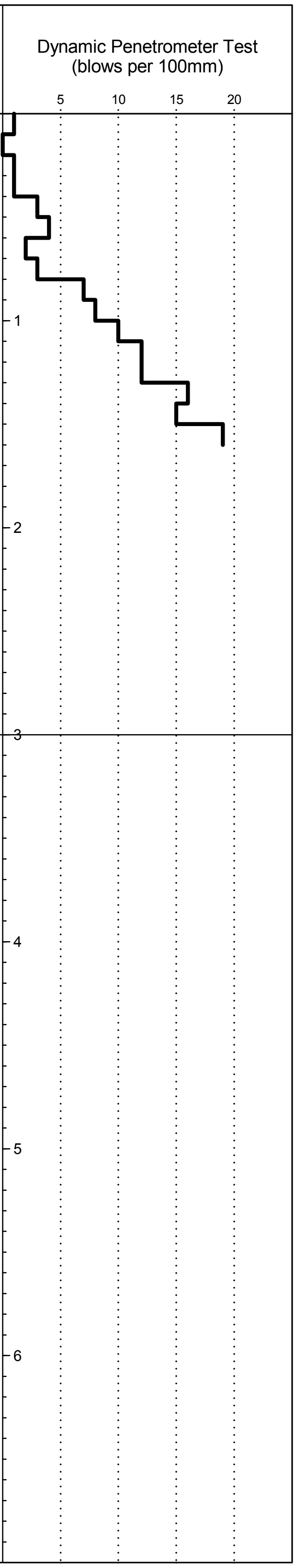
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 3.8*
EASTING: 507266
NORTHING: 7033034
DIP/AZIMUTH: 90°/--

BORE No: 140
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Sampling & In Situ Testing Depth	Sampling & In Situ Testing Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, dark grey-brown, fine to medium grained silty sand topsoil, moist						
		SILTY CLAY - firm to stiff, grey-brown, high plasticity silty clay, some fine grained sand, moist			0.3		pp = 110	
		- stiff, grey streaked orange-brown			0.9		pp = 180	
1	1.1	SANDY CLAY - very stiff, grey, high plasticity sandy clay, fine grained sand, moist			1.4		pp = 340	
	1.7	SILTY SAND - dense, grey, fine to medium grained silty sand, some clay fines						
2								
3	3.0	Bore discontinued at 3.0m Limit of Investigation.						
4								
5								
6								



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage observed during drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

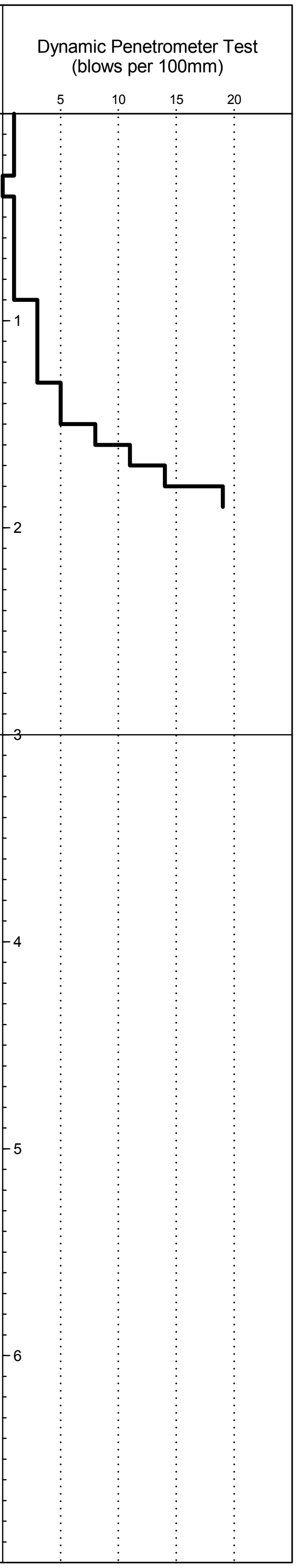
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 4.0*
EASTING: 507112
NORTHING: 7032922
DIP/AZIMUTH: 90°/--

BORE No: 141
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist					
0.15	SILTY SAND - loose, orange-brown, fine to medium grained silty sand, wet					▷
0.75	SANDY CLAY - stiff, grey mottled orange-brown, low to medium plasticity sandy clay, fine to medium grained sand, moist		0.9		pp = 100	
	- grey, high plasticity, fine grained sand		1.4		pp = 170	
	- very stiff, grey streaked orange-brown		1.9		pp = 300	
	- hard, grey mottled red-brown, some ironstone gravel					
	- grey streaked orange-brown					
3.0	Bore discontinued at 3.0m Limit of Investigation.					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.15 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

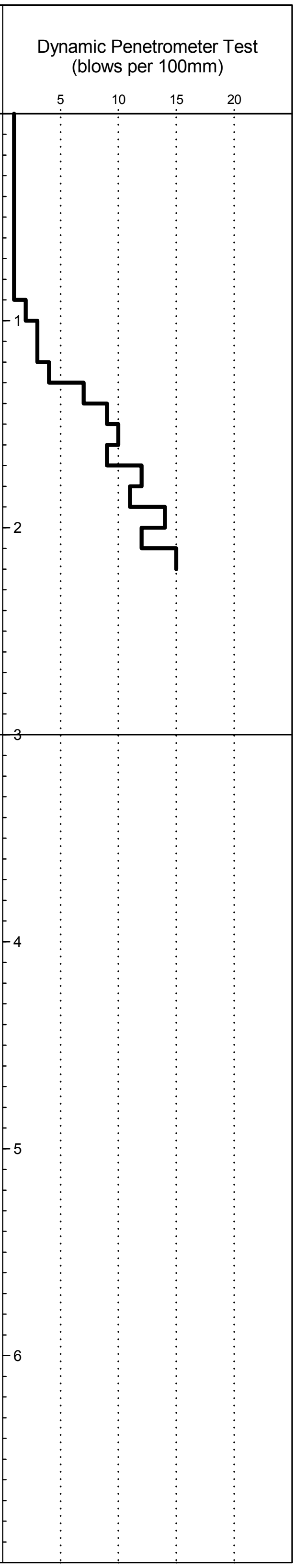
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 3.5*
EASTING: 507004
NORTHING: 7032606
DIP/AZIMUTH: 90°/--

BORE No: 142
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, dark grey-brown, fine to medium grained silty sand topsoil, moist						
	0.4	SILTY SAND - loose, grey, fine to medium grained silty sand, wet - medium dense						▷
	2.3	SANDY CLAY - hard, grey, medium plasticity sandy clay, fine to medium grained sand, moist			2.4		pp = 440	
	2.6	SILTY SAND - dense, light grey streaked orange-brown, fine to medium grained silty sand, some clay fines, moist						
3	3.0	Bore discontinued at 3.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.2 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

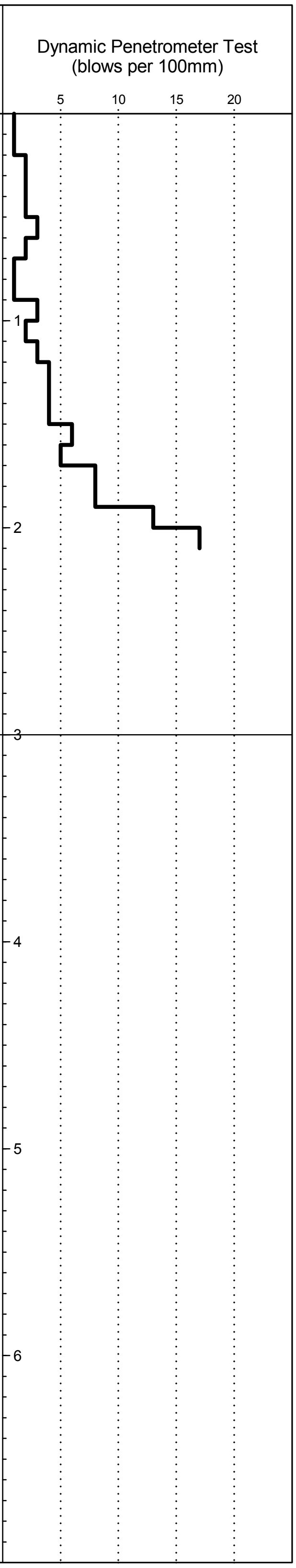
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 4.0*
EASTING: 506764
NORTHING: 7032564
DIP/AZIMUTH: 90°/--

BORE No: 143
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Results & Comments	Water
		TOPSOIL - loose, dark grey-brown, fine to medium grained silty sand topsoil, moist						
	0.35	SILTY SAND - loose, brown, fine to medium grained silty sand, moist - light grey streaked, some clay fines						
	1.3	SANDY CLAY - stiff, grey, low to medium plasticity sandy clay, fine to medium grained sand, moist			1.4		pp = 140	
	1.8	SILTY SAND - medium dense, dark grey-brown, fine to medium grained silty sand, some clay fines, moist						
	2.2	SANDY CLAY - stiff, grey, low to medium plasticity sandy clay, fine to medium grained sand, moist			2.4		pp = 120	
	2.6	SILTY SAND - medium dense, grey, fine to medium grained silty sand, wet						▷
	3.0	Bore discontinued at 3.0m Limit of Investigation.						


Dynamic Penetrometer Test (blows per 100mm)

RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 2.6 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

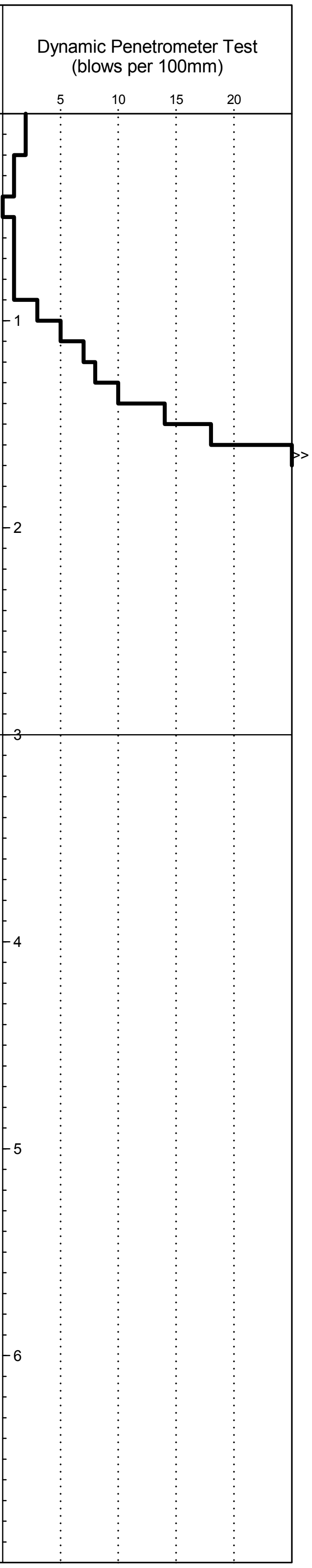
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 4.6*
EASTING: 506822
NORTHING: 7032958
DIP/AZIMUTH: 90°/--

BORE No: 144
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		SILTY SAND - loose, dark grey-brown, fine to medium grained silty sand, some clay fines, moist - grey, wet						▷
	0.8	SANDY CLAY - stiff, grey, medium plasticity sandy clay, fine to medium grained sand, moist			0.9 1.4		pp = 120 pp = 130	
	1.65	SILTY SAND - medium dense, grey, fine to medium grained silty sand, wet						
	3.0	Bore discontinued at 3.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.5 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

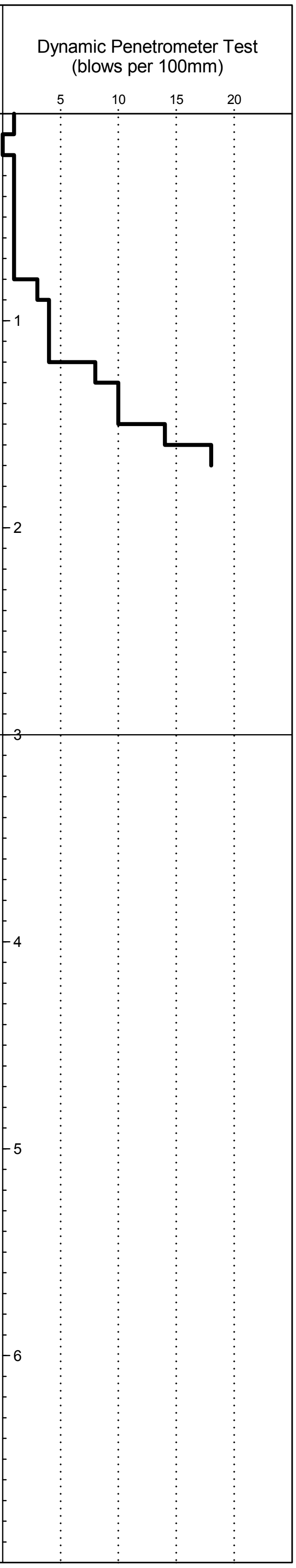
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 4.8*
EASTING: 506771
NORTHING: 7033222
DIP/AZIMUTH: 90°/--

BORE No: 145
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Sampling & In Situ Testing Depth	Sampling & In Situ Testing Sample	Results & Comments	Water
		TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist						
	0.3	SILTY SAND - loose, grey, fine to medium grained silty sand, wet						▷
	0.85	SANDY CLAY - stiff, grey mottled orange-brown some red-brown, medium plasticity sandy clay, fine to medium grained sand, moist			0.9		pp = 130	
					1.4		pp = 190	
					1.9		pp = 210	
		- very stiff, grey						
					2.4		pp = 260	
		- stiff, grey with some red-brown mottling						
					2.9		pp = 170	
	3.0	Bore discontinued at 3.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.3 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

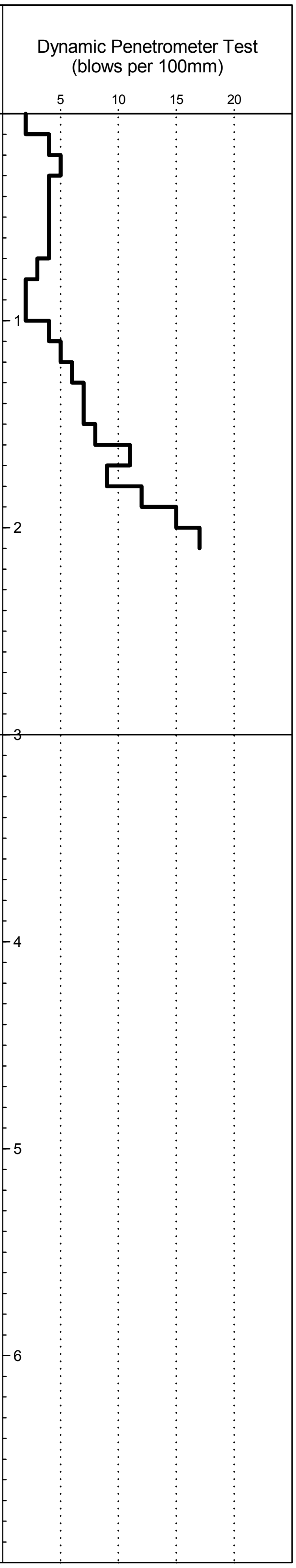
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 5.8*
EASTING: 506900
NORTHING: 7033720
DIP/AZIMUTH: 90°/--

BORE No: 146
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.2	TOPSOIL - loose, dark grey-brown, fine to medium grained silty sand topsoil, moist						
	1.7	SILTY SAND - medium dense, grey, fine to medium grained silty sand, moist - loose, some clay fines - medium dense, grey streaked orange-brown, wet						▷
	2.4	SANDY CLAY - stiff, grey mottled orange-brown, low to medium plasticity sandy clay, fine to medium grained sand, moist			1.9		pp = 130	
	3.0	SILTY SAND - dense, grey, fine to medium grained silty sand, some clay fines, moist						
		Bore discontinued at 3.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 1.0 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

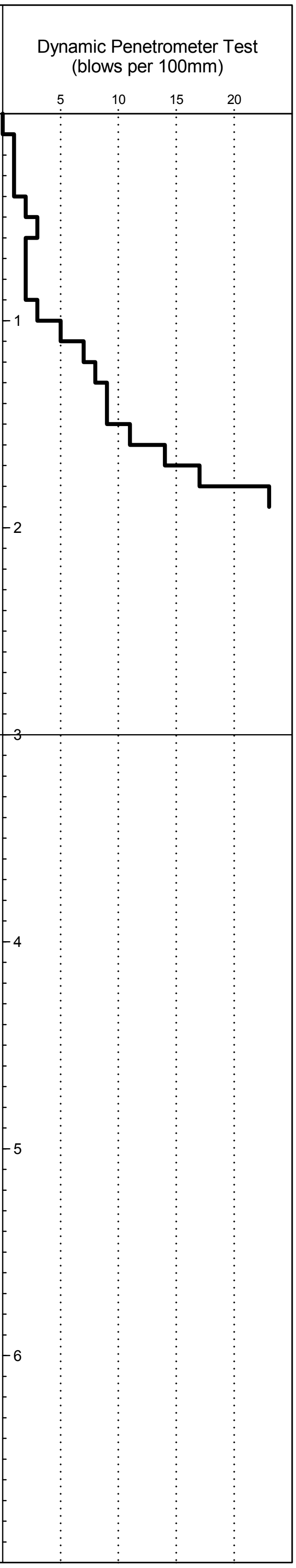
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 5.2*
EASTING: 506634
NORTHING: 7033436
DIP/AZIMUTH: 90°/--

BORE No: 147
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist					
	0.3	SILTY SAND - loose, grey, fine to medium grained silty sand, wet					▷
		- medium dense, grey streaked orange-brown, some clay fines					
	1.4	SANDY CLAY - stiff, grey mottled red-brown, high plasticity sandy clay, fine to medium grained sand, moist		1.5		pp = 140	
				1.9		pp = 180	
		- very stiff, some ironstone gravel		2.4		pp = 220	
				2.9		pp = 340	
	3.0	Bore discontinued at 3.0m Limit of Investigation.					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.3 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

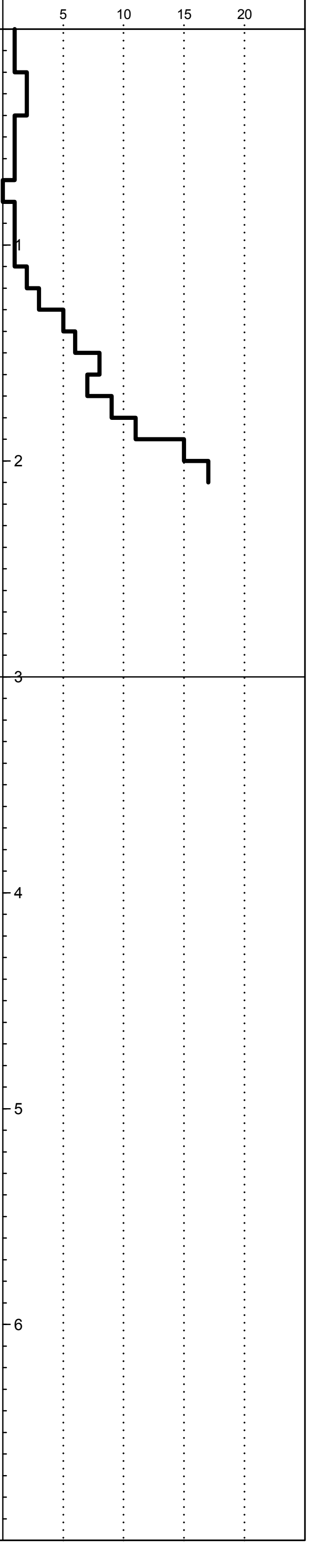
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 5.3*
EASTING: 506588
NORTHING: 7033048
DIP/AZIMUTH: 90°/--

BORE No: 148
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
		SILTY SAND - loose, dark grey-brown, fine to medium grained silty sand, moist					
		- grey-brown, wet					▷
	0.95	SANDY CLAY - stiff, orange-brown mottled grey, medium to high plasticity sandy clay, fine to medium grained sand, moist		1.0		pp = 130	
				1.4		pp = 120	
		- very stiff, grey		1.9		pp = 230	
				2.4		pp = 230	
				2.9		pp = 340	
	3.0	Bore discontinued at 3.0m Limit of Investigation.					

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.55 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

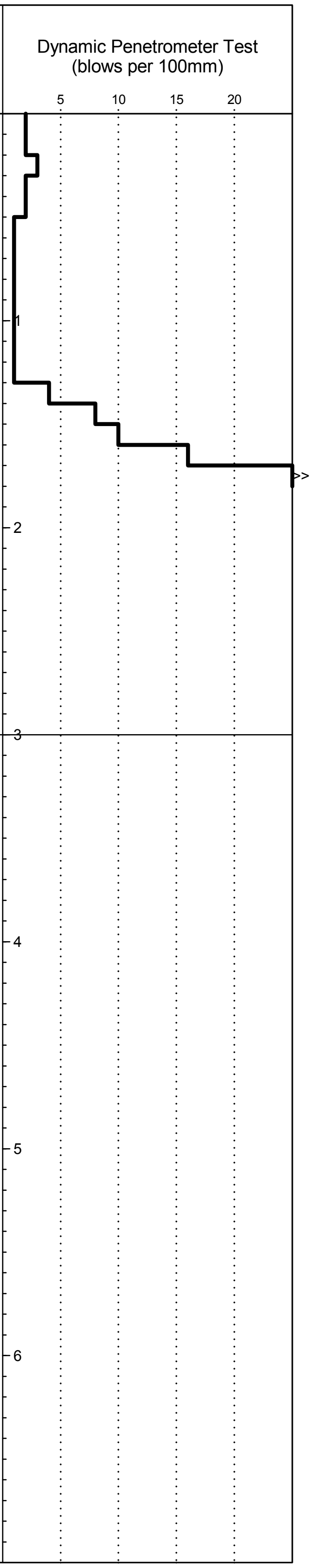
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 5.5*
EASTING: 506590
NORTHING: 7032677
DIP/AZIMUTH: 90°/--

BORE No: 149
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist						
	0.15	CLAYEY SAND - loose, brown, fine to medium grained clayey sand, low to medium plasticity clay fines, moist						
	1.3	SANDY CLAY - stiff, brown mottled red-brown, medium plasticity sandy clay, fine to medium grained sand, some ironstone gravel, moist - very stiff, brown mottled grey, high plasticity			1.4		pp = 120	
					1.9		pp = 270	
					2.4		pp = 290	
					2.9		pp = 420	
	3.0	Bore discontinued at 3.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 3.6 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

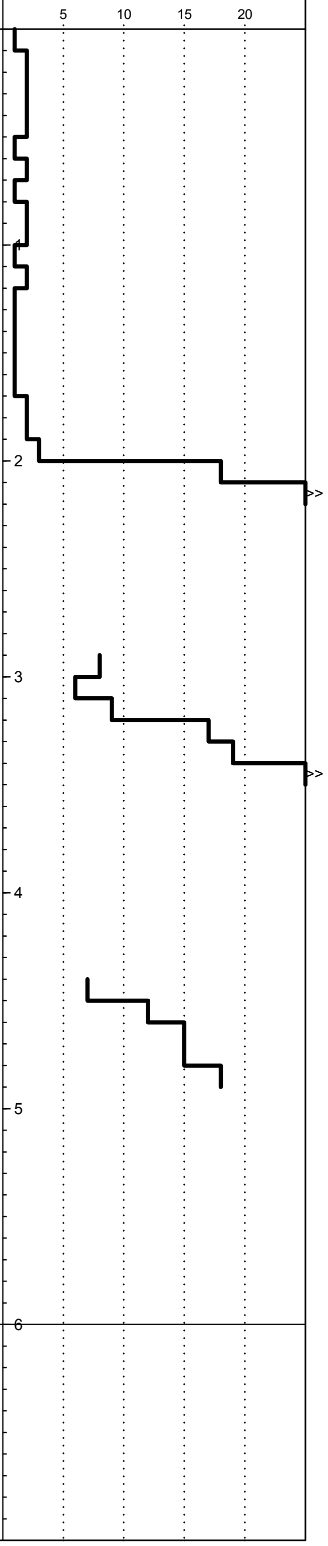
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 6.0*
EASTING: 506410
NORTHING: 7032534
DIP/AZIMUTH: 90°/--

BORE No: 150
PROJECT No: 80967.05
DATE: 19/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		SILTY SAND - loose, grey-brown, fine to medium grained silty sand, moist - orange-brown, trace of clay fines						
	0.8	CLAYEY SAND - loose, orange-brown, fine to medium grained clayey sand, low plasticity clay fines, moist		D	0.8 1.2			
	1.3	GRAVELLY CLAYEY SAND - loose, orange-brown, fine to medium grained gravelly clayey sand, medium plasticity fines, some ironstone gravel, moist			1.4		pp = 120	
		- medium to high plasticity		U_{50}	1.65 1.7		pp >600	
				B	1.83 2.1			
		- dense						
	2.75	SANDY CLAY - very stiff, grey mottled red-brown some orange-brown, high plasticity sandy clay, fine with some medium grained sand, some ironstone gravel, moist			2.9		pp = 320	
		- orange-brown mottled grey, high plasticity, no ironstone gravel			3.4		pp = 270	
					3.9		pp = 330	
				D	4.1 4.4		pp = 310	
					4.9		pp = 240	
		- very stiff, grey mottled red-brown some orange-brown, fine with some medium grained sand, some ironstone gravel			5.4		pp = 320	
					5.9		pp = 330	
	6.0	Bore discontinued at 6.0m Limit of Investigation.						

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage observed during drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

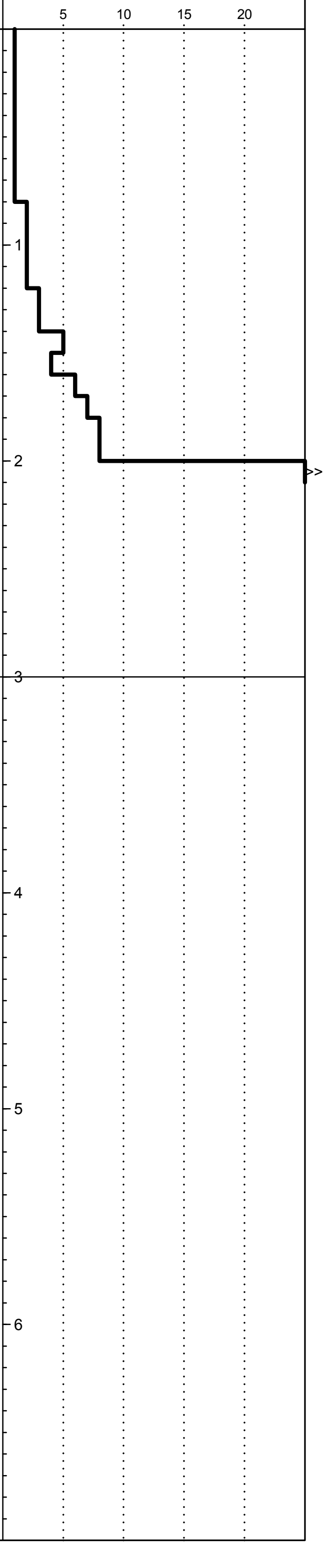
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 5.8*
EASTING: 506394
NORTHING: 7032897
DIP/AZIMUTH: 90°/--

BORE No: 151
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
	0.15	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist						▷
		SILTY SAND - loose, orange-brown, fine to medium grained silty sand, wet - grey orange-brown - medium dense, grey, fine to medium with some coarse grained sand - very dense - fine to medium grained sand, some clay fines						
	3.0	Bore discontinued at 3.0m Limit of Investigation.						

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 0.15 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

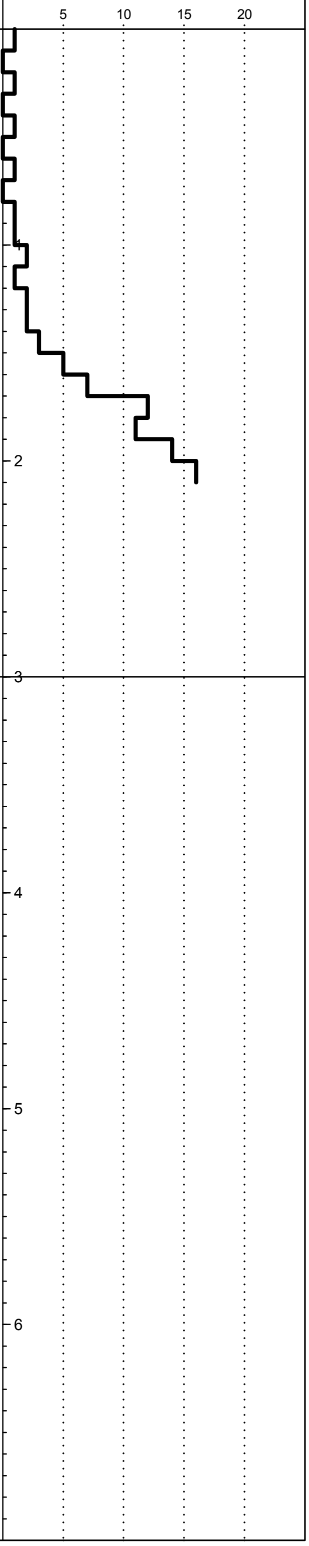
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 6.0*
EASTING: 506442
NORTHING: 7033519
DIP/AZIMUTH: 90°/--

BORE No: 152
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - very loose to loose, grey-brown, fine to medium grained silty sand topsoil, moist						
	0.35	SILTY SAND - very loose to loose, grey, fine to medium grained silty sand, wet						▷
	1	- loose grey streaked orange-brown, some clay fines						
	1.35	SANDY CLAY - stiff, grey mottled orange-brown some red-brown, medium plasticity sandy clay, fine to medium grained sand, moist			1.5		pp = 160	
					1.9		pp = 110	
	2	- very stiff, grey mottled red-brown, high plasticity, some fine ironstone						
					2.4		pp = 240	
					2.9		pp = 180	
	3 3.0	Bore discontinued at 3.0m Limit of Investigation.						
	4							
	5							
	6							

Dynamic Penetrometer Test
(blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.35 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

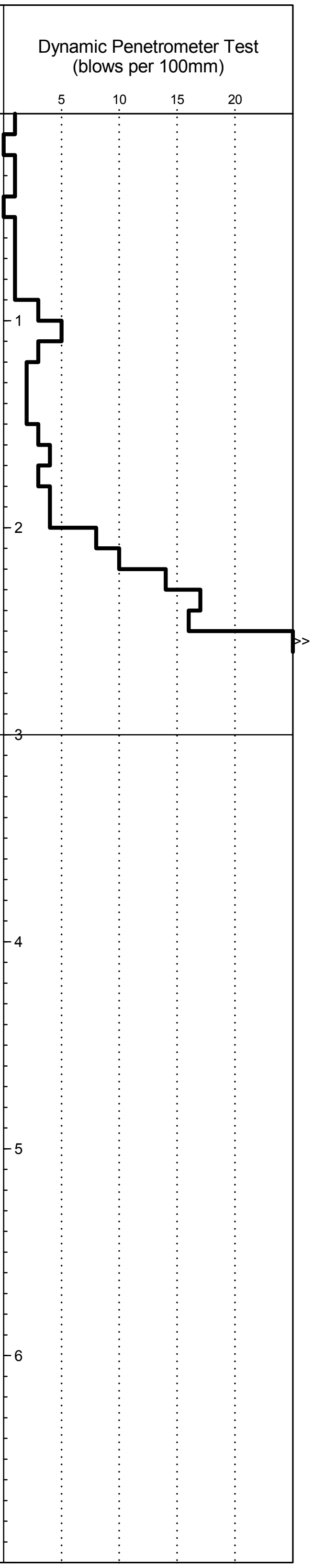
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 6.5*
EASTING: 505984
NORTHING: 7033187
DIP/AZIMUTH: 90°/--

BORE No: 154
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SILTY SAND - loose, dark grey-brown, fine to medium grained silty sand, moist - wet - grey orange-brown, some fine gravel						▷
	1.11	CLAYEY SAND - loose, grey streaked orange-brown, fine to medium grained clayey sand, low to medium plasticity clay fines, wet						
	1.8	SILTY SAND - medium dense, grey orange-brown, fine to medium grained silty sand, some fine gravel, wet - dense						
	3.0	Bore discontinued at 3.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.35 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

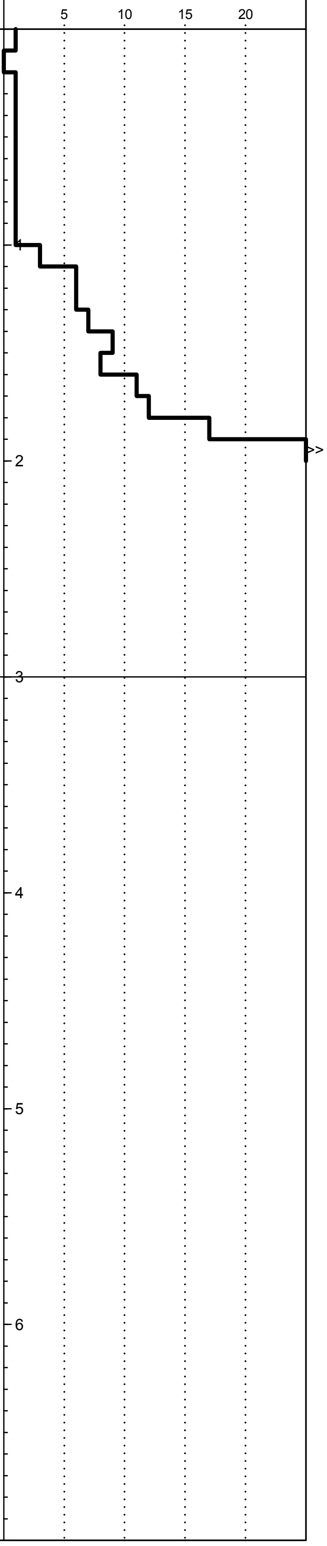
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 6.5*
EASTING: 506243
NORTHING: 7032686
DIP/AZIMUTH: 90°/--

BORE No: 155
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, dark grey-brown, fine to medium grained silty sand topsoil, moist						▷
	0.95	SILTY SAND - loose, grey, fine to medium grained silty sand, wet - grey orange-brown						
		SANDY CLAY - firm to stiff, orange-brown mottled grey, medium plasticity sandy clay, fine to medium grained sand, wet			1.4		pp = 80	
		- grey, high plasticity			1.9		pp = 60	
		- stiff, medium plasticity			2.4		pp = 180	
	3.0				2.9		pp = 180	
		Bore discontinued at 3.0m Limit of Investigation.						

Dynamic Penetrometer Test
(blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.1 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

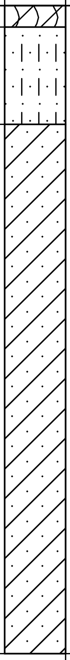
BOREHOLE LOG

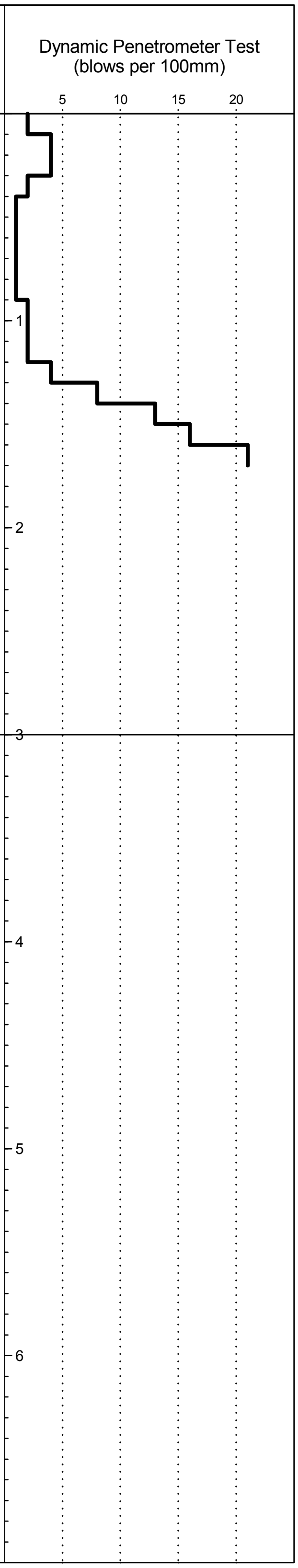
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 5.5*
EASTING: 506154
NORTHING: 7032543
DIP/AZIMUTH: 90°/--

BORE No: 156
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, dark grey-brown, fine to medium grained silty sand topsoil, moist						
		SILTY SAND - medium dense, orange-brown, fine to medium grained silty sand, some clay fines, moist						
	0.55	SANDY CLAY - stiff, orange-brown mottled grey, medium plasticity sandy clay, fine to medium grained sand, moist			0.9		pp = 120	
		- very stiff, orange-brown mottled red-brown			1.4		pp = 210	
		- orange-brown mottled grey, high plasticity, some ironstone gravel			1.9		pp = 380	
		- no ironstone			2.4		pp = 330	
					2.9		pp = 430	
	3.0	Bore discontinued at 3.0m Limit of Investigation.						





RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage observed during drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

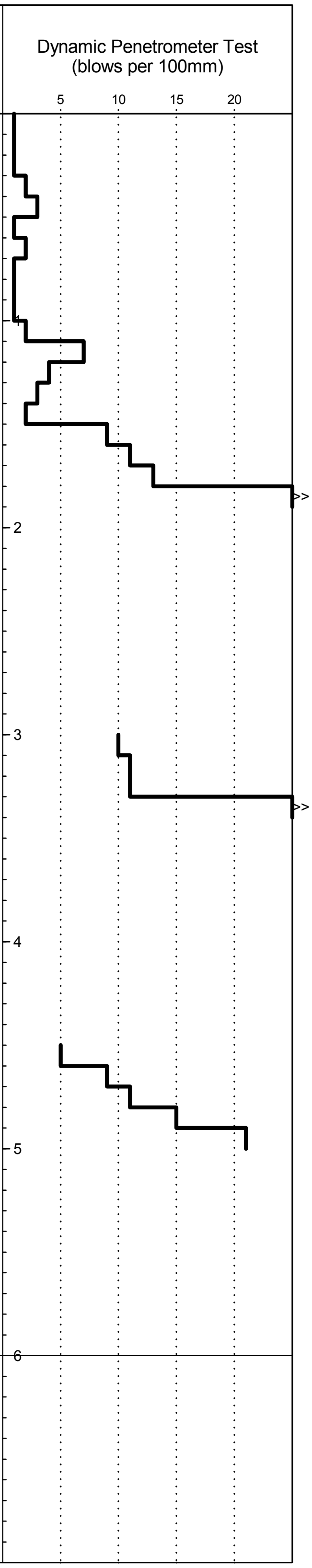
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 7.0*
EASTING: 505876
NORTHING: 7032603
DIP/AZIMUTH: 90°/--

BORE No: 157
PROJECT No: 80967.05
DATE: 19/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist					▷
		SILTY SAND - loose, grey orange-brown, fine to medium grained silty sand, wet - some clay fines					
	1.2	SANDY CLAY - stiff, grey mottled red-brown, high plasticity sandy clay, fine with some medium grained sand, some fine ironstone gravel, moist	D	1.2			
				1.4		pp = 170	
		- very stiff		1.6			
				1.9		pp = 260	
				2.4		pp = 280	
		- increase in ironstone gravel, wet layers					
			D	2.9		pp = 340	
				3.4		pp = 230	
				3.9		pp = 210	
		- grey streaked red-brown, some ironstone gravel		4.4		pp = 260	
		- stiff					
				4.9		pp = 220	
				5.4		pp = 170	
				5.9		pp = 160	
	6.0	Bore discontinued at 6.0m Limit of Investigation.					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 0.1 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

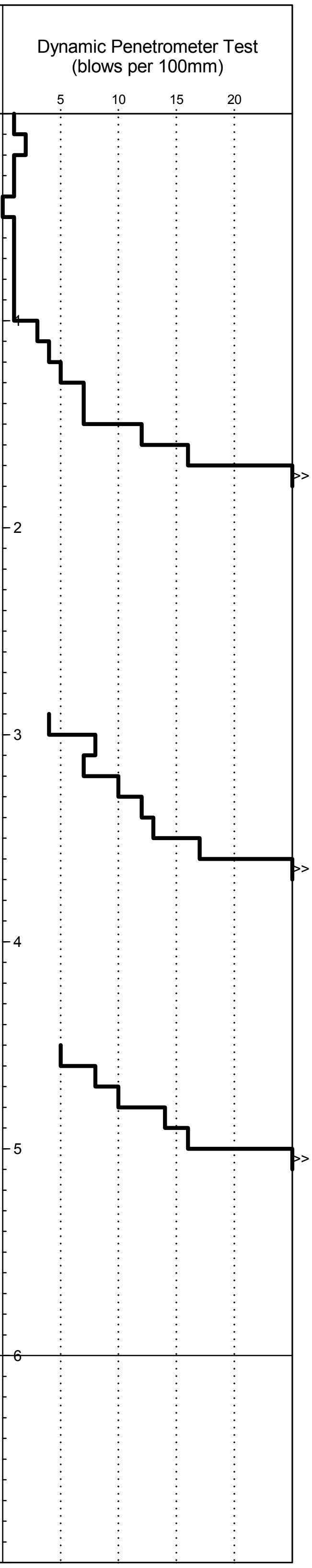
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 6.8*
EASTING: 505813
NORTHING: 7032781
DIP/AZIMUTH: 90°/--

BORE No: 158
PROJECT No: 80967.05
DATE: 19/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		SILTY SAND - very loose to loose, dark grey-brown, fine to medium grained silty sand, moist		D	0.1 0.4			
		- grey-brown, trace of clay fines, wet						▷
	1.35	SANDY CLAY - firm, grey streaked orange-brown, medium plasticity sandy clay, fine to medium grained sand, wet - stiff, most			1.4		pp = 50	
					1.9		pp = 170	
		- very stiff to hard, high plasticity			2.4		pp = 460	
		- very stiff, grey mottled red-brown some orange-brown, some ironstone gravel			2.9		pp = 220	
					3.4		pp = 260	
					3.9		pp = 230	
		- grey mottled red-brown			4.4		pp = 210	
					4.9		pp = 130	
					5.9		pp = 110	
	6.0	Bore discontinued at 6.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.6 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

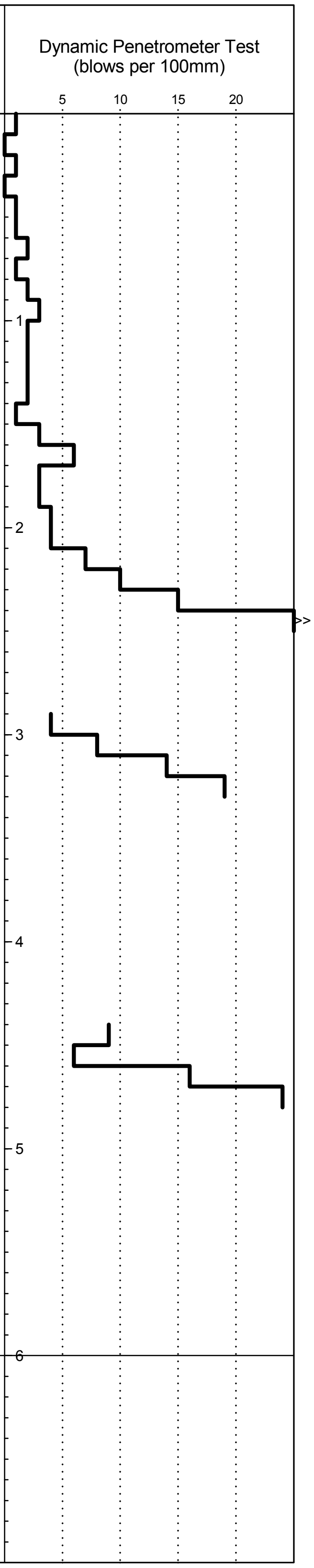
SURFACE LEVEL: 7.8*
EASTING: 506124
NORTHING: 7033540
DIP/AZIMUTH: 90°/--

BORE No: 160
PROJECT No: 80967.05
DATE: 19/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Water
	0.2	TOPSOIL - very loose to loose, dark grey-brown, fine to medium grained silty sand topsoil, moist	▷ (0.2)
	1.4	SILTY SAND - loose, grey-brown, fine to medium grained silty sand, wet - medium dense - orange-brown, trace of fine gravel, moist	
	6.0	SANDY CLAY - firm, orange-brown mottled grey, medium plasticity sandy clay, fine to medium grained sand, wet - stiff, high plasticity, fine with some medium grained sand, moist - stiff, grey mottled red-brown some orange-brown, some ironstone gravel - ironstone gravel increasing	
		Bore discontinued at 6.0m Limit of Investigation.	

Sampling & In Situ Testing

Type	Depth	Sample	Results & Comments
	1.5		pp = 80
	1.9		pp = 170
	2.4		pp = 110
	2.9		pp = 180
U_{50}	3.0 3.19		pp = 430
B	3.4 3.8		pp = 140
	4.0		pp = 110
	5.9		pp = 120



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.2 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

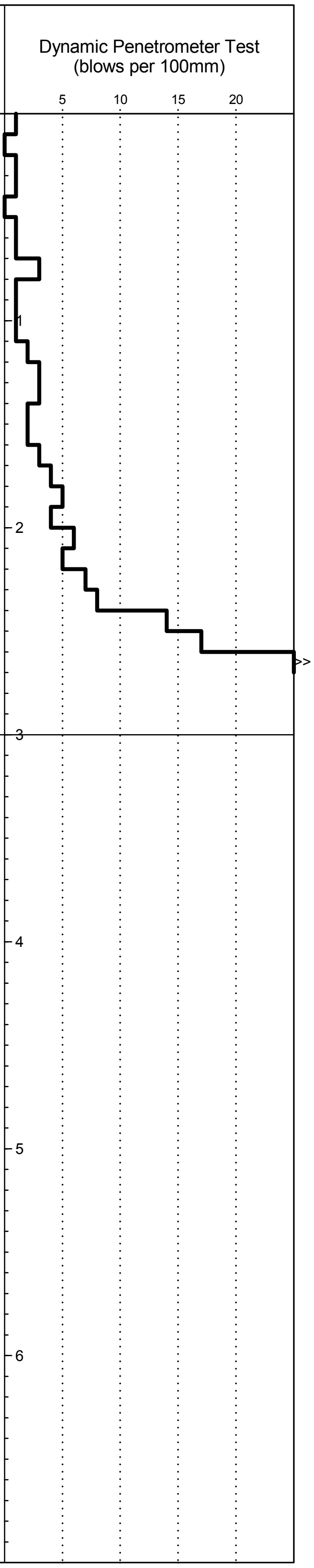
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 7.5*
EASTING: 506187
NORTHING: 7033681
DIP/AZIMUTH: 90°/--

BORE No: 161
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
	0.2	TOPSOIL - loose, dark grey-brown, fine to medium grained silty sand topsoil, moist						▷
	1.9	SILTY SAND - loose, grey, fine to medium grained silty sand, wet - medium dense, orange-brown, some clay fines						
	3.0	SANDY CLAY - very stiff, red-brown mottled grey, medium plasticity sandy clay, fine to medium grained sand, some fine ironstone, moist			2.0		pp = 130	
					2.4		pp = 370	
					2.9		pp = 210	
		Bore discontinued at 3.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 0.2 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

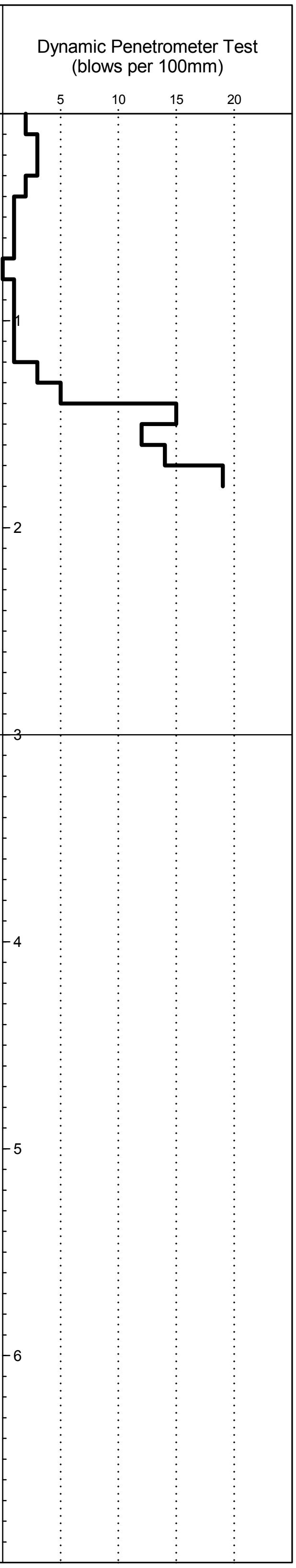
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 7.5*
EASTING: 505914
NORTHING: 7033777
DIP/AZIMUTH: 90°/--

BORE No: 162
PROJECT No: 80967.05
DATE: 4/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.15	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist						
		SILTY SAND - loose, orange-brown, fine to medium grained silty sand, some clay fines, moist - orange-brown, fine to medium grained sand, low plasticity clay fines						
1	1.1	SANDY CLAY - firm, orange-brown, medium plasticity sandy clay, fine to medium grained sand, some fine ironstone gravel, wet - very stiff, red-brown mottled grey			1.4		pp = 70	▷
2					1.9		pp = 430	
					2.4		pp = 410	
3	3.0				2.9		pp = 350	
		Bore discontinued at 3.0m Limit of Investigation.						
4								
5								
6								



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 1.1 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

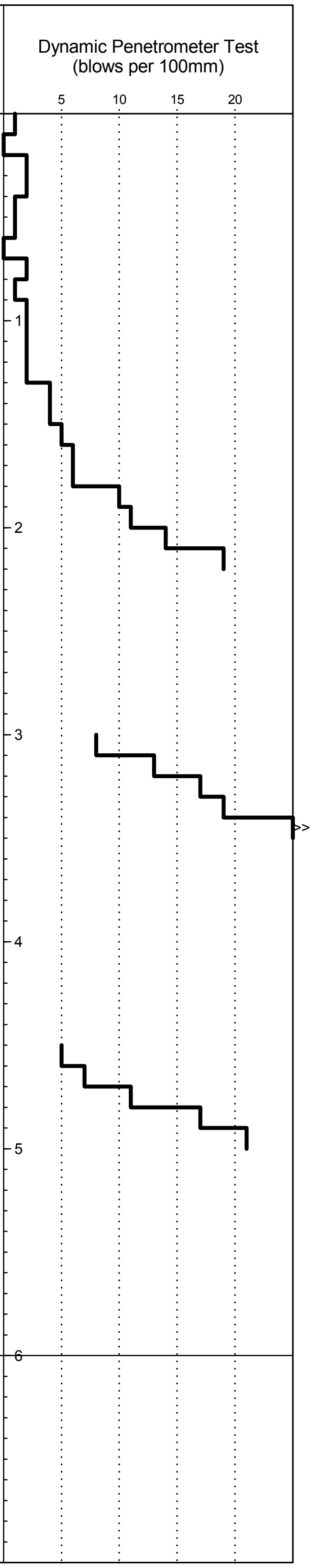
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 8.0*
EASTING: 505581
NORTHING: 7032877
DIP/AZIMUTH: 90°/--

BORE No: 166
PROJECT No: 80967.05
DATE: 19/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water
		TOPSOIL - very loose, dark grey-brown, fine to medium grained silty sand topsoil, moist						
	0.25	SILTY SAND - loose, grey-brown, fine to medium grained silty sand, trace of clay fines, wet						▷
		- grey orange-brown						
	1.25	SANDY CLAY - stiff, grey streaked orange-brown, high plasticity sandy clay, fine to medium grained sand, moist			1.4		pp = 120	
		- low plasticity, some clayey sand layers		D	1.6			
					1.9		pp = 150	
		- very stiff, high plasticity						
					2.4		pp = 430	
		- very stiff, grey mottled red-brown some orange-brown, some ironstone gravel			2.9		pp = 350	
					3.4		pp = 230	
		- grey streaked orange-brown, no ironstone			3.9		pp = 210	
		- grey mottled red-brown						
					4.4		pp = 180	
					4.9		pp = 180	
					5.4		pp = 130	
					5.9		pp = 110	
	6.0	Bore discontinued at 6.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.25 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

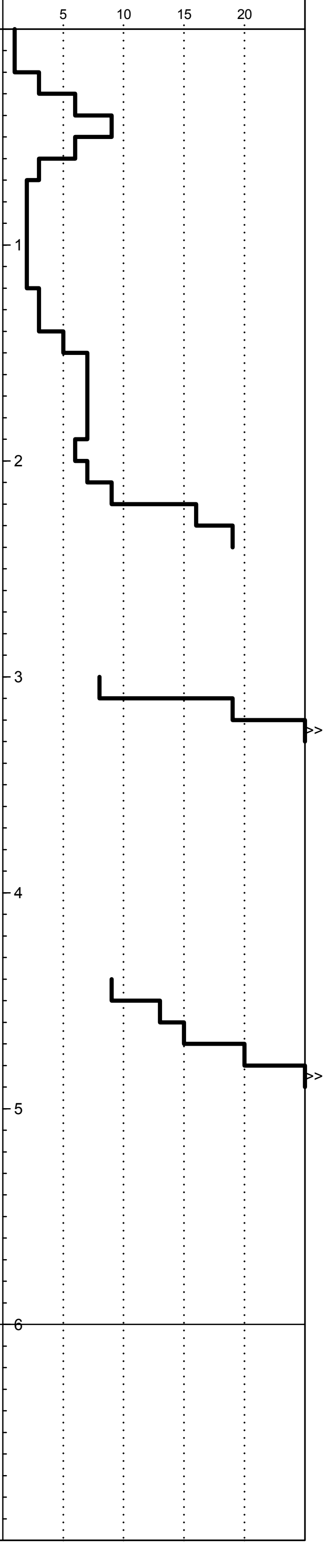
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 6.0*
EASTING: 505680
NORTHING: 7032391
DIP/AZIMUTH: 90°/--

BORE No: 167
PROJECT No: 80967.05
DATE: 13/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.2	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist		D	0.0 0.2			
	0.85	SILTY SAND - medium dense, orange-brown streaked grey, fine to medium grained silty sand, trace of clay fines, moist		D	0.4 0.7			
	1	SANDY CLAY - firm, orange-brown mottled grey, low to medium plasticity sandy clay, fine to medium grained sand, moist		D	0.9 1.0 1.2		pp = 40	
		- stiff, red-brown mottled grey and some orange-brown, medium to high plasticity			1.4		pp = 170	
		- very stiff		U_{50}	1.5 1.65		pp = 380	
				B	1.7			
	2			D	1.9 2.1		pp = 380	
					2.4		pp = 360	
	3	- grey mottled orange-brown, fine grained sand		D	2.7 2.9 3.0		pp = 280	
		- grey streaked orange-brown and brown, fine with some medium grained sand			3.4		pp = 290	
	4			D	3.6 3.9 4.1		pp = 280	
		- stiff, red-brown mottled grey, fine grained sand			4.4		pp = 260	
	5			D	4.9 5.4		pp = 210 pp = 140	
					5.9		pp = 150	
	6 6.0	Bore discontinued at 6.0m Limit of Investigation.						

Dynamic Penetrometer Test
(blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No groundwater seepage observed during drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	₹	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

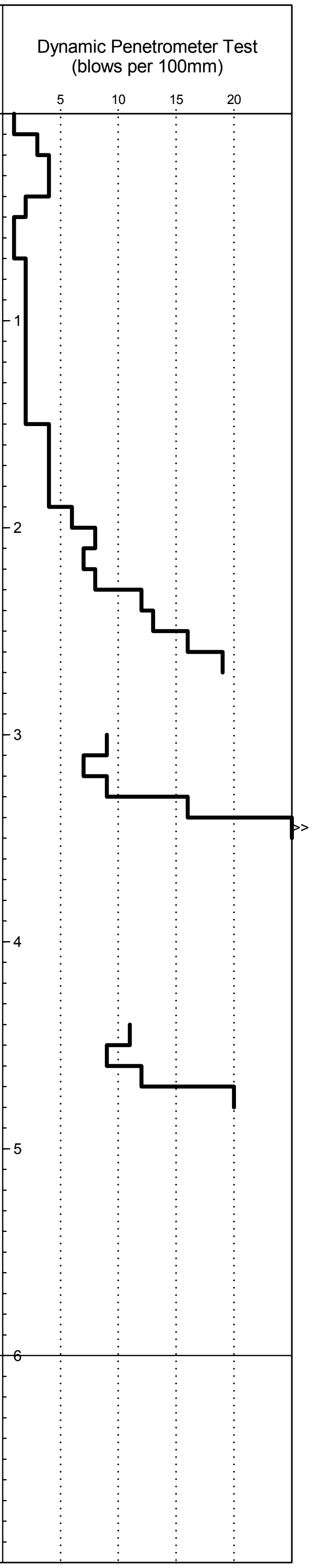
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 11.0*
EASTING: 505383
NORTHING: 7032543
DIP/AZIMUTH: 90°/--

BORE No: 168
PROJECT No: 80967.05
DATE: 13/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, dark grey-brown, fine to medium grained silty sand topsoil, moist					
	0.4	SILTY SAND - medium dense, orange-brown streaked grey, fine to medium grained silty sand, trace of clay fines, moist					
		SANDY CLAY - stiff, orange-brown mottled grey, low to medium plasticity sandy clay, fine to medium grained sand, moist		0.6		pp = 190	
		- medium plasticity		0.9		pp = 180	
		- stiff, red-brown mottled grey and some orange-brown, medium to high plasticity, trace of ironstone gravel	D	1.1			
				1.4		pp = 220	
		- very stiff					
				1.9		pp = 340	
				2.4		pp = 320	
				2.9		pp = 280	
		- fine grained sand, increase in ironstone gravel					
				3.4		pp = 310	
				3.9		pp = 360	
				4.4		pp = 270	
		- stiff, some wet ironstone gravel lenses					▷
				4.9		pp = 180	
				5.4		pp = 120	
				5.9		pp = 130	
	6.0	Bore discontinued at 6.0m Limit of Investigation.					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 4.7 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

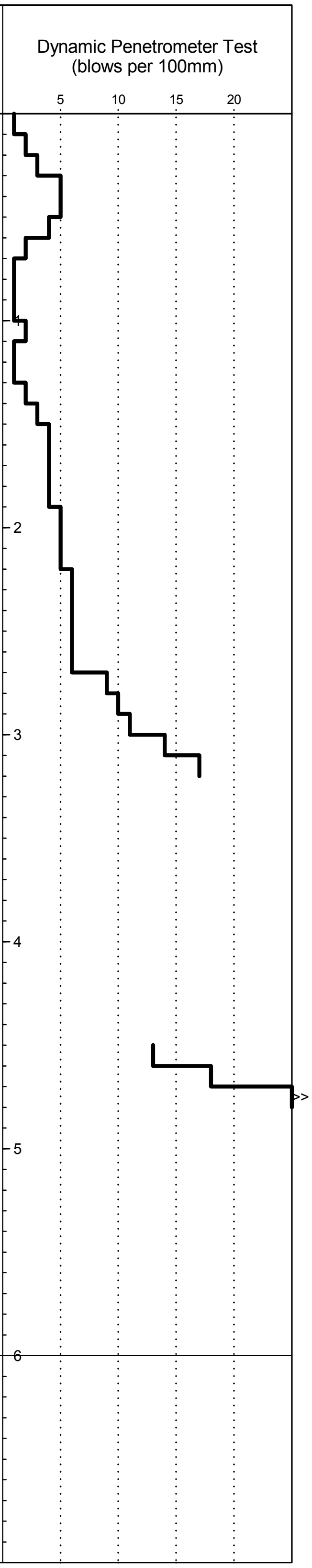
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 12.5*
EASTING: 505353
NORTHING: 7032835
DIP/AZIMUTH: 90°/--

BORE No: 169
PROJECT No: 80967.05
DATE: 21/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, dark brown, fine to medium grained silty sand topsoil, moist						
	0.15	SILTY SAND - medium dense, orange-brown, fine to medium grained silty sand, moist - some clay fines						
	0.7	CLAYEY SAND - loose, orange-brown, fine to medium grained clayey sand, medium plasticity clay fines, moist						
	1							
	1.35	SANDY CLAY - stiff, orange-brown, medium plasticity sandy clay, fine to medium grained sand, moist			1.5		pp = 110	
		- very stiff, grey mottled red-brown, high plasticity, fine with some medium grained sand			1.9		pp = 320	
	2							
				D	2.1			
					2.4		pp = 240	
		- some ironstone gravel			2.9		pp = 340	
	3							
		- medium to high plasticity			3.4		pp = 230	
					3.9		pp = 260	
	4							
		- stiff, some seepage						▷
					4.4		pp = 180	
					4.9		pp = 270	
	5							
					5.4		pp = 220	
					5.9		pp = 210	
	6 6.0	Bore discontinued at 6.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 4.2 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

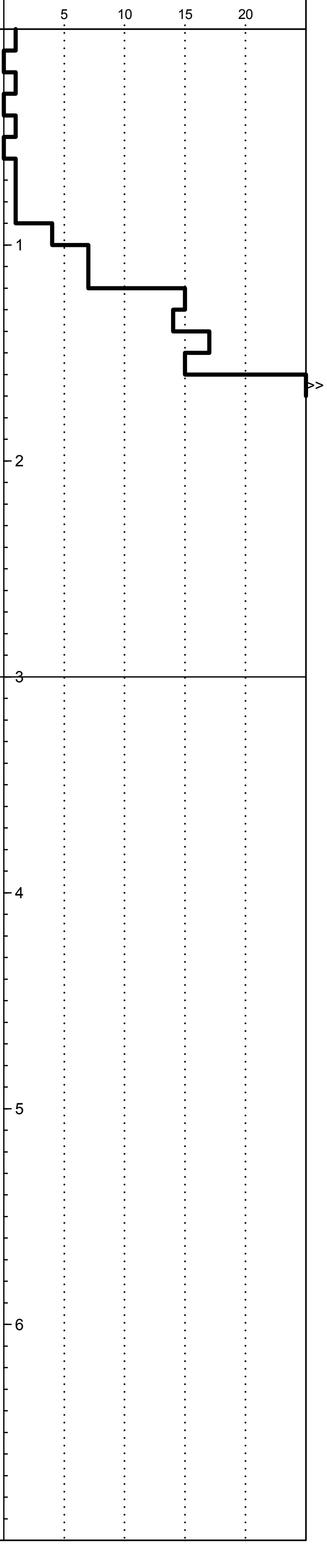
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 8.5*
EASTING: 505381
NORTHING: 7033812
DIP/AZIMUTH: 90°/--

BORE No: 171
PROJECT No: 80967.05
DATE: 2/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		CLAYEY SAND - very loose to loose, dark grey-brown, fine grained clayey sand, medium plasticity clay fines, high in silt, moist to wet - loose, grey-brown, fine to medium grained sand, low plasticity clay fines - medium dense, grey, moist - dense, wet						▷
	2.6	SANDY CLAY - very stiff, grey, medium plasticity sandy clay, fine to medium grained sand, moist			2.9		pp = 320	
	3.0	Bore discontinued at 3.0m Limit of Investigation.						

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 1.2 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

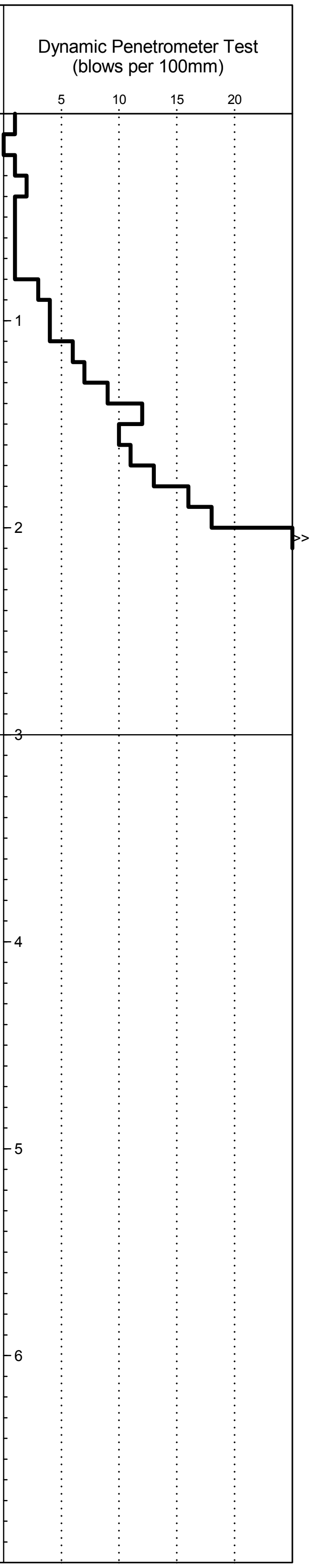
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 9.5*
EASTING: 505159
NORTHING: 7034032
DIP/AZIMUTH: 90°/--

BORE No: 172
PROJECT No: 80967.05
DATE: 2/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, dark grey-brown, fine to medium grained silty sand topsoil, moist					
		SILTY SAND - loose, orange-brown grey, fine to medium grained silty sand, moist					
	0.8	SANDY CLAY - stiff, grey mottled red-brown, high plasticity sandy clay, fine to medium grained sand, moist		0.9		pp = 130	
	1			1.4		pp = 200	
		- very stiff, grey, fine grained sand		1.9		pp = 330	
	2	- stiff		2.4		pp = 170	
				2.9		pp = 130	
	3 3.0	Bore discontinued at 3.0m Limit of Investigation.					
	4						
	5						
	6						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.2 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

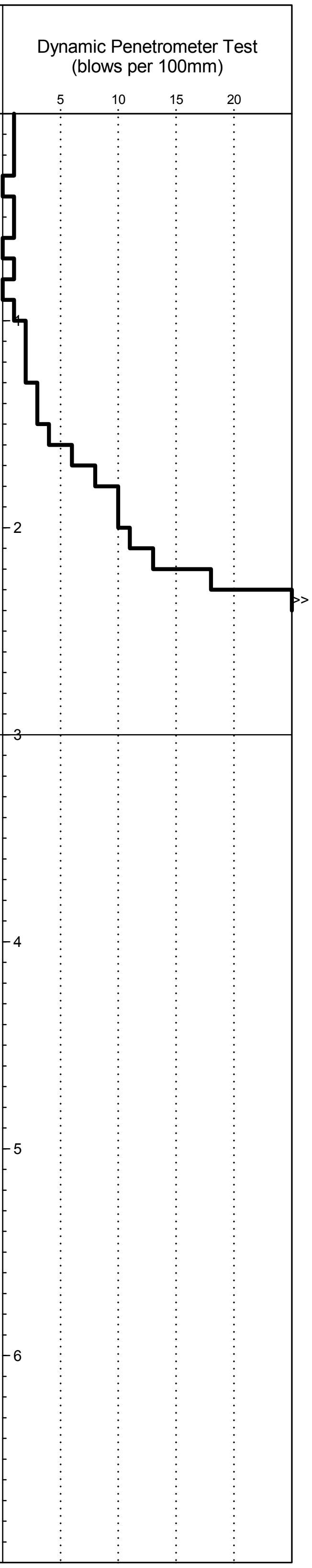
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 10.0*
EASTING: 505062
NORTHING: 7033681
DIP/AZIMUTH: 90°/--

BORE No: 173
PROJECT No: 80967.05
DATE: 2/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, some clay fines, moist						
	0.35	SILTY SAND - loose, orange-brown, fine to medium grained silty sand, some clay fines, wet						▷
1	1.2	SANDY CLAY - stiff, grey mottled orange-brown and some red-brown, medium plasticity sandy clay, fine to medium grained sand, moist			1.3		pp = 130	
					1.9		pp = 140	
2		- some ironstone gravel						
		- very stiff, grey			2.4		pp = 270	
					2.9		pp = 340	
3	3.0	Bore discontinued at 3.0m Limit of Investigation.						
4								
5								
6								



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.35 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

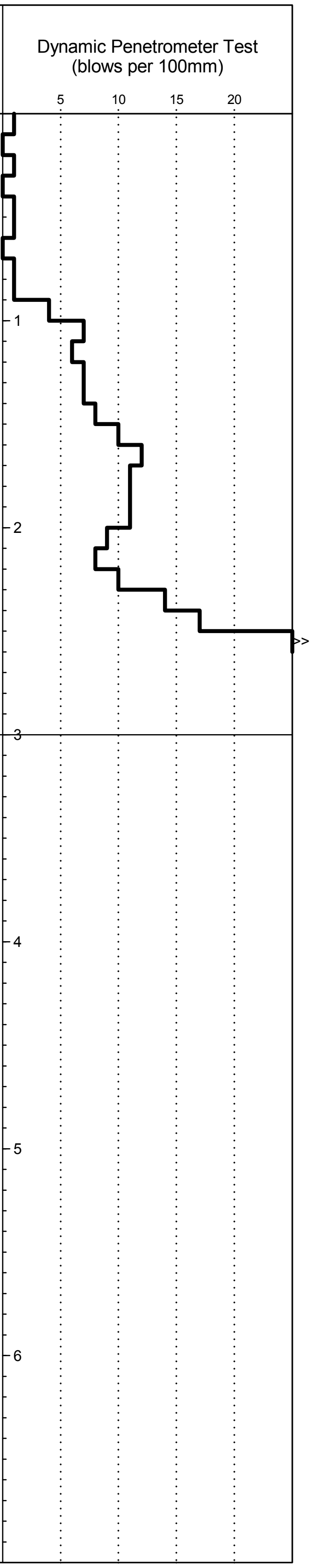
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 9.0*
EASTING: 505236
NORTHING: 7033554
DIP/AZIMUTH: 90°/--

BORE No: 174
PROJECT No: 80967.05
DATE: 2/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		SILTY SAND - loose, dark grey-brown, fine to medium grained silty sand, moist - grey-brown, wet - medium dense, grey orange-brown, some clay fines, moist - no clay fines - grey - dense to very dense						▷
	3.0	Bore discontinued at 3.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 0.4 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

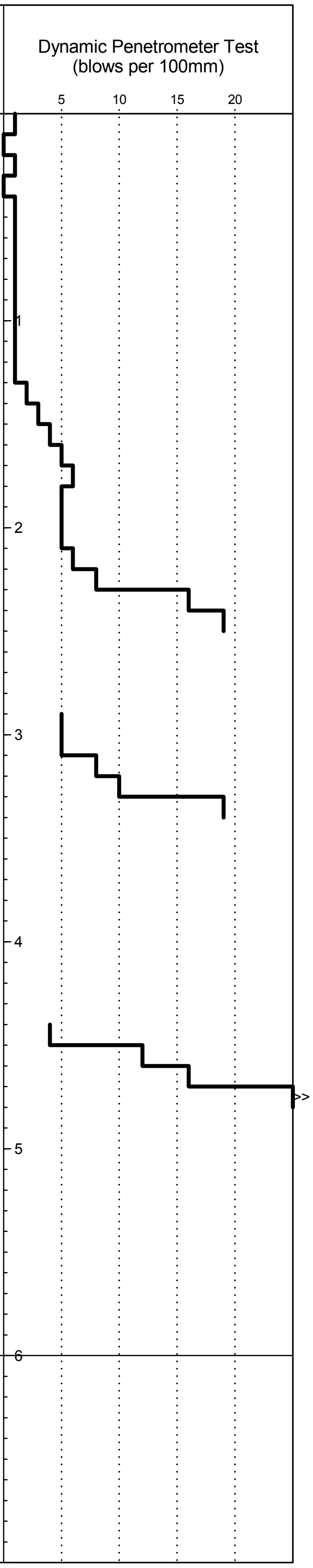
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 10.0*
EASTING: 505105
NORTHING: 7033160
DIP/AZIMUTH: 90°/--

BORE No: 175
PROJECT No: 80967.05
DATE: 18/7/2017
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
0.1	TOPSOIL - very loose to loose, grey-brown, fine to medium grained silty sand topsoil, moist					
1.2	SILTY SAND - loose, orange-brown, fine to medium grained silty sand, trace of clay fines, wet					▷
1.55	CLAYEY SAND - loose, orange-brown, fine to medium grained clayey sand, low to medium plasticity clay fines, moist					
	SANDY CLAY - stiff, orange-brown mottled red-brown, high plasticity sandy clay, fine to medium grained sand, some fine rounded gravel, moist		1.7			
		D	1.9		pp = 130	
			2.2			
	- very stiff, some ironstone gravel		2.4		pp = 200	
			2.8		pp = 470	
			3.4		pp = 240	
			3.9		pp = 260	
			4.4		pp = 320	
	- increasing ironstone gravel		4.9		pp = 290	
			5.4		pp = 220	
6.0			5.9		pp = 180	
	Bore discontinued at 6.0m Limit of Investigation.					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.3 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

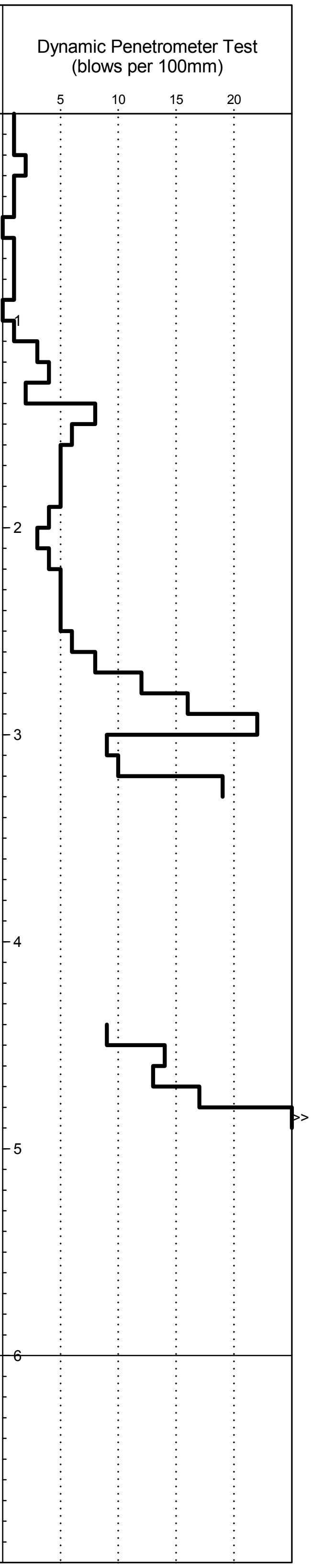
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 12.0*
EASTING: 505056
NORTHING: 7032923
DIP/AZIMUTH: 90°/--

BORE No: 176
PROJECT No: 80967.05
DATE: 18/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist					
		SILTY SAND - loose, orange-brown, fine to medium grained silty sand, trace of clay fines, moist					
	0.5	CLAYEY SAND - very loose to loose, orange-brown, fine to medium grained clayey sand, low to medium plasticity clay fines, moist					
	1						
				1.25			
		- medium dense, orange-brown mottled red-brown, medium plasticity fines, some fine rounded gravel	B	1.4 1.5		pp = 110	
	1.6	SANDY CLAY - very stiff, grey mottled red-brown some orange-brown, high plasticity sandy clay, moist	U_{50}	1.6 1.66		pp = 380	
				1.9		pp = 230	
	2						
				2.4		pp = 300	
		- hard, grey streaked orange-brown some red-brown					
				2.9		pp = 500	
	3						
		- very stiff, orange-brown mottled grey					
				3.4		pp = 280	
				3.9		pp = 260	
	4						
				4.4		pp = 360	
							▷
		- stiff, red-brown mottled grey, some wet ironstone gravel lenses					
				4.9		pp = 150	
	5						
				5.4		pp = 130	
				5.9		pp = 160	
	6.0	Bore discontinued at 6.0m Limit of Investigation.					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 4.55 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

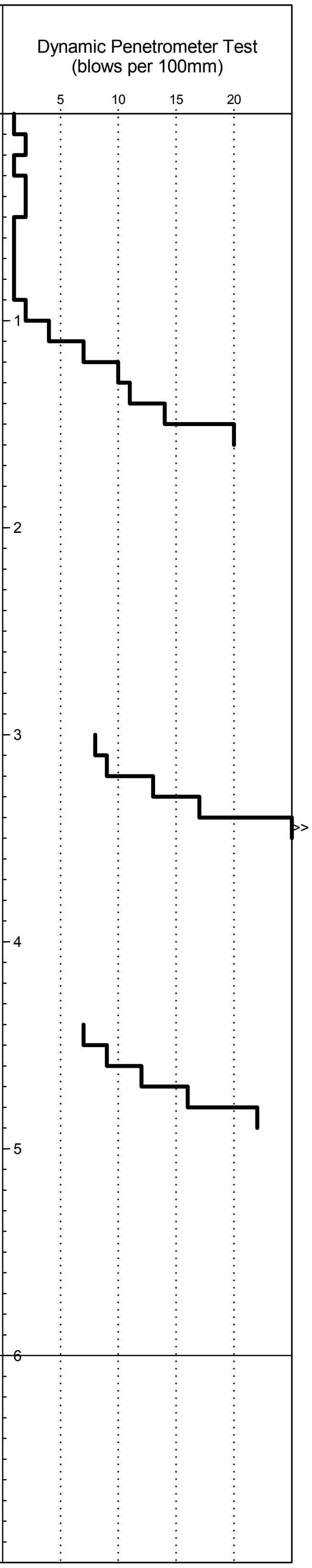
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 7.5*
EASTING: 505160
NORTHING: 7032455
DIP/AZIMUTH: 90°/--

BORE No: 177
PROJECT No: 80967.05
DATE: 13/7/2017
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling & In Situ Testing				Water
		Type	Depth	Sample	Results & Comments	
0.15	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist					
	SILTY SAND - loose, grey-brown and orange-brown, fine to medium grained silty sand, moist to wet					
0.85	SANDY CLAY - stiff, orange-brown mottled grey, medium plasticity sandy clay, fine to medium grained sand, moist		0.9		pp = 120	
	- very stiff, grey mottled red-brown, some orange-brown, medium to high plasticity, some ironstone gravel layering, moist		1.4		pp = 380	
			1.9		pp = 250	
			2.4		pp = 260	
			2.9		pp = 330	
	- stiff, brown mottled grey, fine grained sand		3.2			
		D	3.4		pp = 150	
			3.6			
						▷
	- brown mottled red-brown, some wet ironstone gravel lenses		3.9		pp = 130	
			4.4		pp = 120	
	- orange-brown, no ironstone gravel					
			4.9		pp = 130	
	- firm, wet					
			5.4		pp = 90	
			5.9		pp = 80	
6.0	Bore discontinued at 6.0m Limit of Investigation.					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 3.7 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

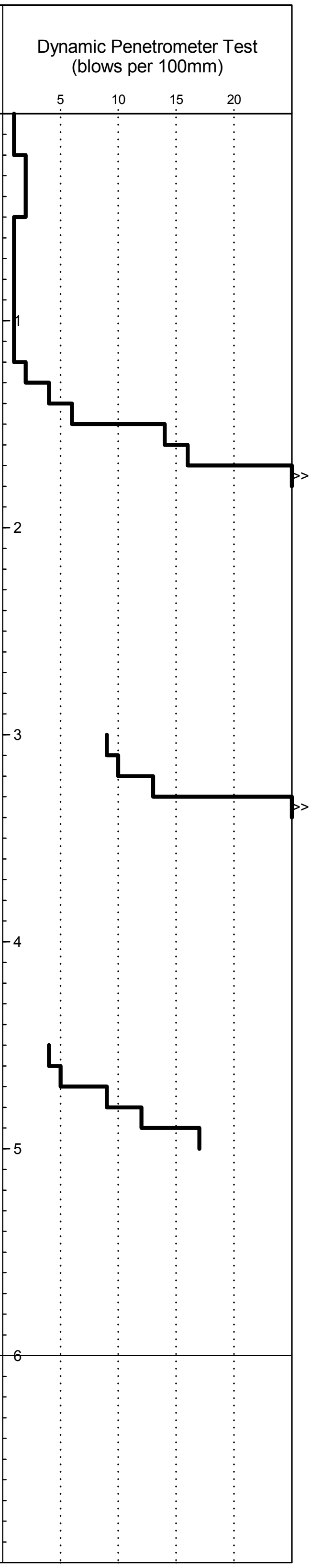
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 14.0*
EASTING: 504892
NORTHING: 7032785
DIP/AZIMUTH: 90°/--

BORE No: 178
PROJECT No: 80967.05
DATE: 18/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist					
	0.15	SILTY SAND - loose, grey orange-brown, fine to medium grained silty sand, some clay fines, moist					
	0.65	SANDY CLAY - firm to stiff, grey streaked orange-brown, medium to high plasticity sandy clay, fine to medium grained sand, moist		0.7			
			D	0.9		pp = 110	
				1.1			
		- very stiff, grey mottled red-brown and some orange-brown, trace of fine ironstone gravel		1.4		pp = 260	
				1.9		pp = 290	
				2.4		pp = 340	
		- grey streaked orange-brown and some red-brown, no ironstone gravel		2.9		pp = 340	
		- some wet ironstone gravel lenses		3.4		pp = 180	▷
				3.9		pp = 150	
				4.4		pp = 120	
				4.9		pp = 130	
		- firm		5.4		pp = 90	
				5.9		pp = 90	
	6.0	Bore discontinued at 6.0m Limit of Investigation.					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 3.4 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

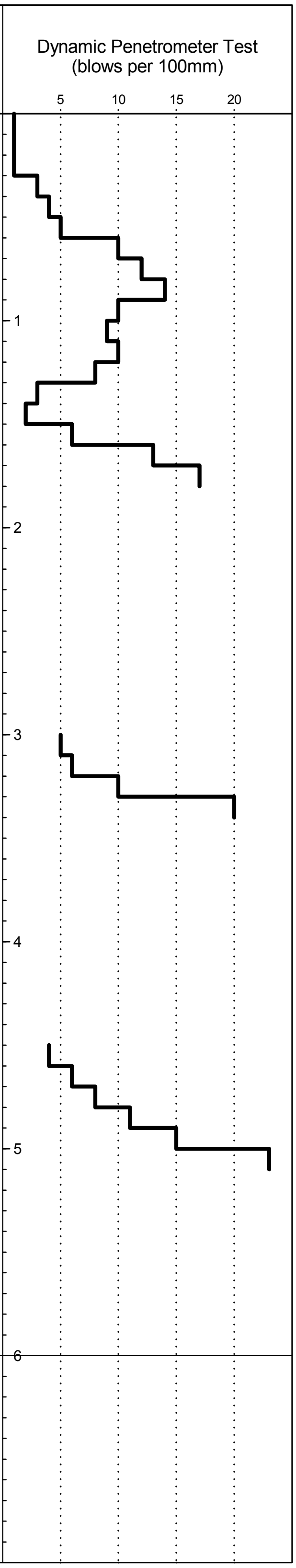
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 9.0*
EASTING: 504875
NORTHING: 7033451
DIP/AZIMUTH: 90°/--

BORE No: 179
PROJECT No: 80967.05
DATE: 18/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist		B	0.0 0.25			
	0.25	SILTY SAND - medium dense, grey, fine to medium grained silty sand, wet - trace of tree roots						▷
	1	- brown streaked grey, fine to medium with some coarse grained sand, some clay fines		D	1.1 1.4			
	1.25	SANDY CLAY - very stiff, grey streaked orange-brown, high plasticity sandy clay, fine with some medium grained sand, moist						
					1.9		pp = 320	
	2							
					2.4		pp = 230	
		- stiff to very stiff						
					2.9		pp = 170	
	3							
					3.4		pp = 230	
		- very stiff, red-brown mottled grey, some ironstone gravel layers						
					3.9		pp = 210	
	4	- stiff						
					4.4		pp = 170	
					4.9		pp = 110	
	5							
					5.4		pp = 150	
					5.9		pp = 130	
	6 6.0	Bore discontinued at 6.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.25 m at time of drillng.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

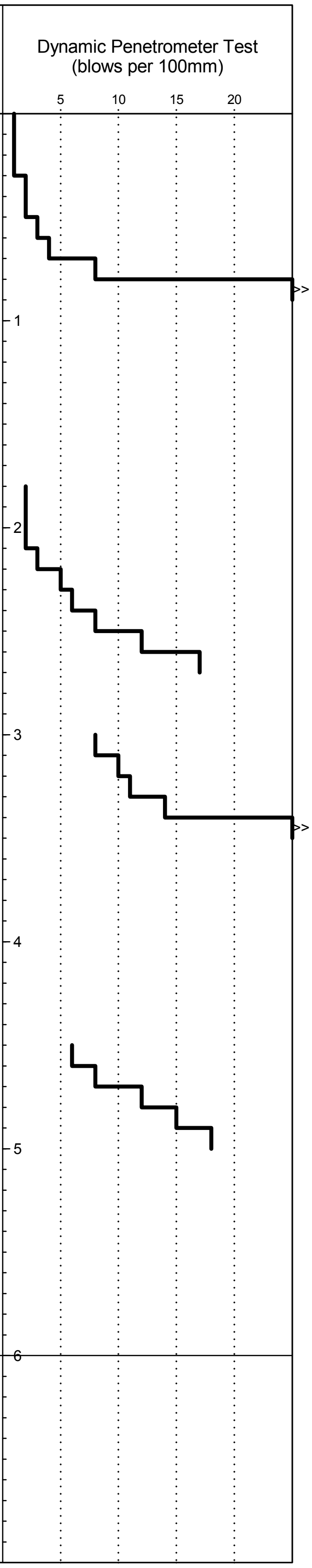
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 12.2*
EASTING: 504761
NORTHING: 7033854
DIP/AZIMUTH: 90°/--

BORE No: 180
PROJECT No: 80967.05
DATE: 18/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
	0.2	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist						▷
		SILTY SAND - loose, grey, fine to medium grained silty sand, wet		B	0.4 0.8			
		- medium dense						
		- very dense, dark grey-brown, moist		D	0.9 1.3			
1								
	1.6	- brown						
		SANDY CLAY - stiff, orange-brown mottled grey, high plasticity sandy clay, fine with some medium grained sand, some fine gravel, moist			1.7		pp = 220	
2								
					2.4		pp = 130	
		- very stiff, fine to medium grained sand			2.9		pp = 180	
3								
					3.4		pp = 240	
					3.9		pp = 220	
4								
					4.4		pp = 200	
		- grey streaked orange-brown, medium to high plasticity						
5								
6	6.0	Bore discontinued at 6.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 0.2 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

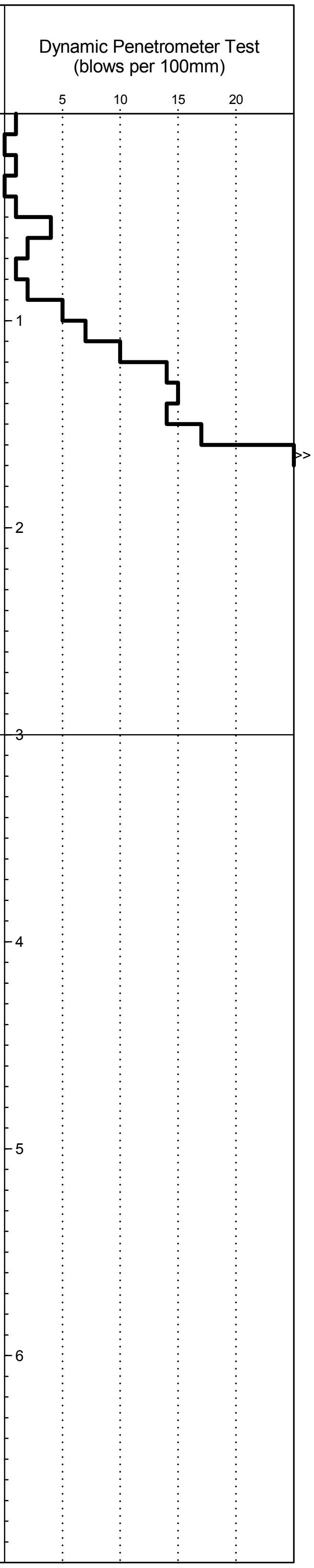
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 10.5*
EASTING: 504987
NORTHING: 7034162
DIP/AZIMUTH: 90°/--

BORE No: 181
PROJECT No: 80967.05
DATE: 2/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SILTY SAND - very loose to loose, dark grey-brown, fine to medium grained silty sand, moist						
		- grey-brown, some clay fines, wet						▷
	0.55	SANDY CLAY - stiff, grey mottled orange-brown, high plasticity sandy clay, fine grained sand, moist						
					0.9		pp = 110	
	1							
					1.4		pp = 130	
					1.9		pp = 170	
	2							
		- very stiff, grey, fine to medium grained sand						
					2.4		pp = 270	
					2.9		pp = 220	
	3.0	Bore discontinued at 3.0m Limit of Investigation.						


Dynamic Penetrometer Test
(blows per 100mm)

RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.35 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	₮	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

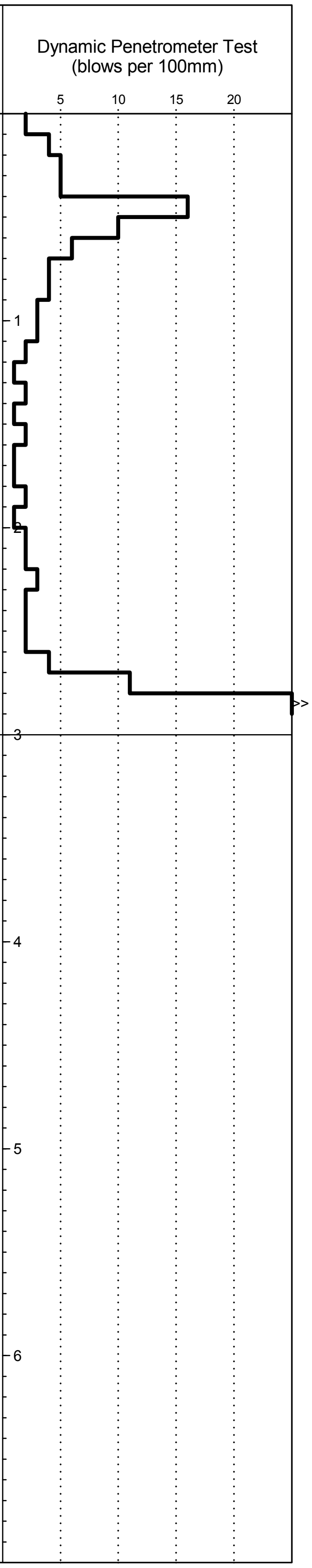
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 13.8*
EASTING: 504434
NORTHING: 7034435
DIP/AZIMUTH: 90°/--

BORE No: 182
PROJECT No: 80967.05
DATE: 2/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.15	TOPSOIL - medium dense, grey-brown, fine to medium grained silty sand topsoil, some clay fines, moist					
		SILTY SAND - medium dense, orange-brown, fine to medium grained silty sand, some clay fines, moist					
1		- loose, some clay fines					
2		- grey-brown and some red-brown, trace of ironstone					
	2.3	SANDY CLAY - firm, grey, medium plasticity sandy clay, fine to medium grained sand, moist		2.4		pp = 80	
		- stiff		2.9		pp = 130	
3	3.0	Bore discontinued at 3.0m Limit of Investigation.					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No groundwater seepage observed during drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

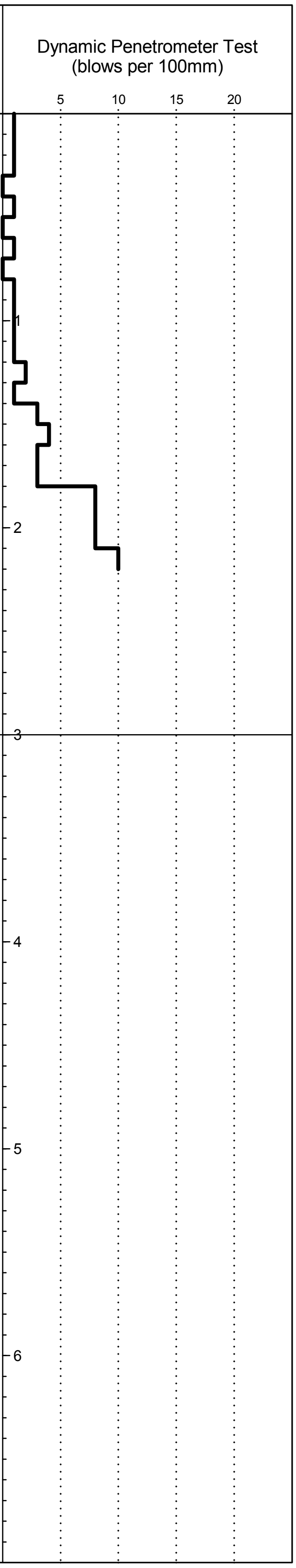
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 11.5*
EASTING: 504132
NORTHING: 7034312
DIP/AZIMUTH: 90°/--

BORE No: 183
PROJECT No: 80967.05
DATE: 2/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	0.2	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, some clay fines, moist					▷
		SILTY SAND - very loose to loose, grey, fine to medium grained silty sand, some clay fines, wet					
1		- some orange-brown streaking					
	1.2	SANDY CLAY - stiff, grey, medium plasticity sandy clay, fine to medium grained sand, moist		1.4		pp = 100	
		- very stiff, grey mottled red-brown and orange-brown, high plasticity, fine grained sand		1.9		pp = 280	
2							
		- some ironstone		2.4		pp = 330	
				2.9		pp = 300	
3	3.0	Bore discontinued at 3.0m Limit of Investigation.					
4							
5							
6							



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 0.3 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

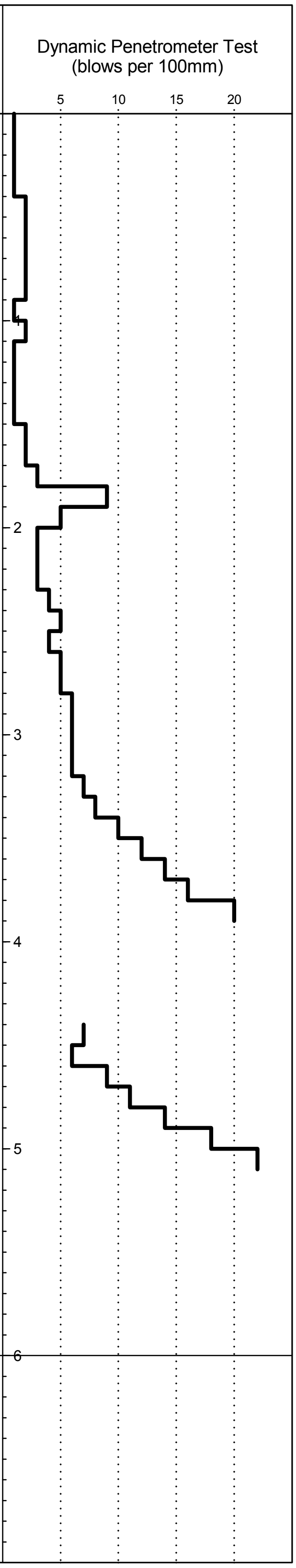
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 14.8*
EASTING: 504240
NORTHING: 7033934
DIP/AZIMUTH: 90°/--

BORE No: 184
PROJECT No: 80967.05
DATE: 19/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist					
		SILTY SAND - loose, orange-brown, fine to medium grained silty sand, moist					
	0.5	CLAYEY SAND - loose, orange-brown, fine to medium grained clayey sand, low plasticity clay fines, moist	B	0.8 1.4			
	1.7	SANDY CLAY - very stiff, grey mottled red-brown, high plasticity sandy clay, fine with some medium grained sand, trace of ironstone gravel, moist		1.9		pp = 310	
	2		U_{50}	2.0 2.13		pp = 460	
		- orange-brown mottled grey		2.4		pp = 380	
				2.9		pp = 310	
	3			3.4		pp = 220	
				3.9		pp = 220	
	4	- grey mottled red-brown, some ironstone gravel		4.4		pp = 230	
		- stiff, moist to wet		4.9		pp = 140	▷
	5			5.4		pp = 110	
				5.9		pp = 130	
	6.0	Bore discontinued at 6.0m Limit of Investigation.					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 4.7 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

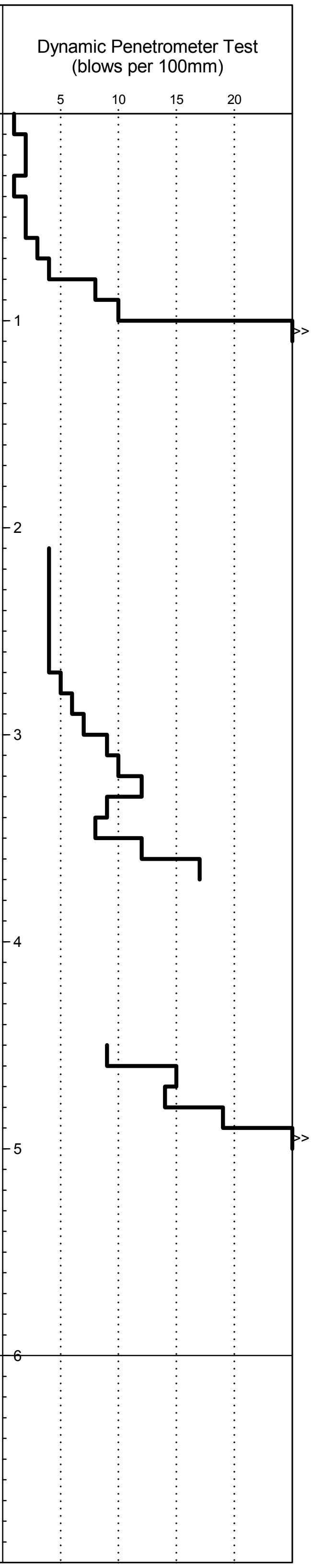
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 15.0*
EASTING: 504442
NORTHING: 7033676
DIP/AZIMUTH: 90°/--

BORE No: 185
PROJECT No: 80967.05
DATE: 18/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water
	0.1	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist						
		SILTY SAND - loose, orange-brown, fine to medium grained silty sand, moist						
		- very dense, brown						
	1.3	SANDY CLAY - firm, orange-brown mottled grey, medium to high plasticity sandy clay, fine with some medium grained sand, moist			1.4		pp = 60	
				U_{50}	1.5 1.73		pp = 480	
		- very stiff, grey mottled red-brown, high plasticity			1.9		pp = 270	
					2.4		pp = 280	
		- grey streaked orange-brown			2.9		pp = 360	
					3.4		pp = 290	
		- grey mottled red-brown			3.8		pp = 310	
		- medium plasticity, fine to medium grained sand, some ironstone gravel			4.3		pp = 370	
					4.9		pp = 280	
					5.4		pp = 220	
					5.9		pp = 230	
	6.0	Bore discontinued at 6.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: No groundwater seepage observed during drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

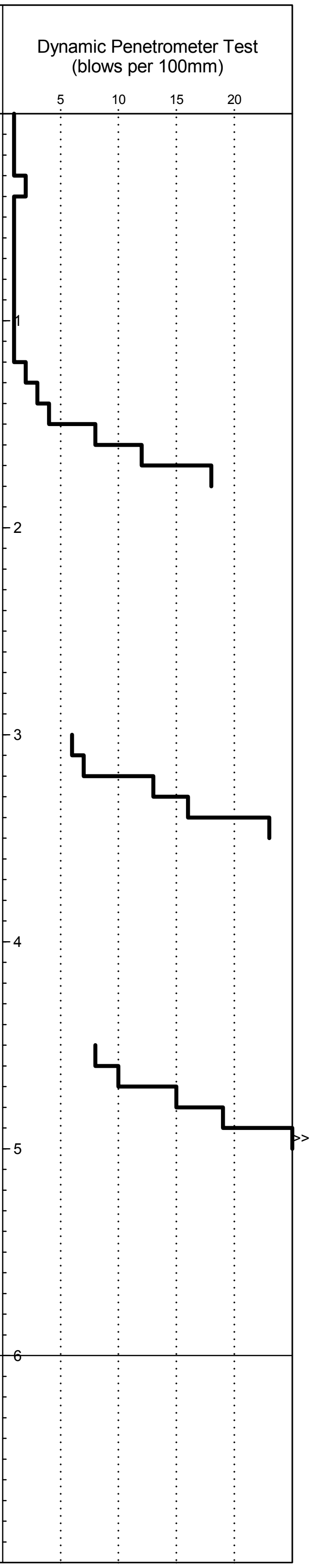
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 14.2*
EASTING: 504488
NORTHING: 7033428
DIP/AZIMUTH: 90°/--

BORE No: 186
PROJECT No: 80967.05
DATE: 21/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		TOPSOIL - loose, dark grey-brown, fine to medium grained silty sand topsoil, moist						
	0.2	SILTY SAND - loose, grey, fine to medium grained silty sand, wet						▷
		- grey streaked orange-brown						
	1.25	SANDY CLAY - stiff, grey mottled orange-brown, medium to high plasticity sandy clay, fine to medium grained sand, moist			1.4		pp = 110	
		- very stiff, high plasticity						
					1.9		pp = 220	
				D	2.1			
					2.4		pp = 330	
		- stiff						
					2.9		pp = 150	
		- very stiff, grey mottled red-brown						
					3.4		pp = 220	
					3.9		pp = 230	
					4.4		pp = 210	
		- stiff, grey streaked orange-brown						
					4.9		pp = 170	
		- some seepage						
					5.4		pp = 130	
		- grey mottled red-brown		D	5.5			
					5.9		pp = 100	
	6.0	Bore discontinued at 6.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.2 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

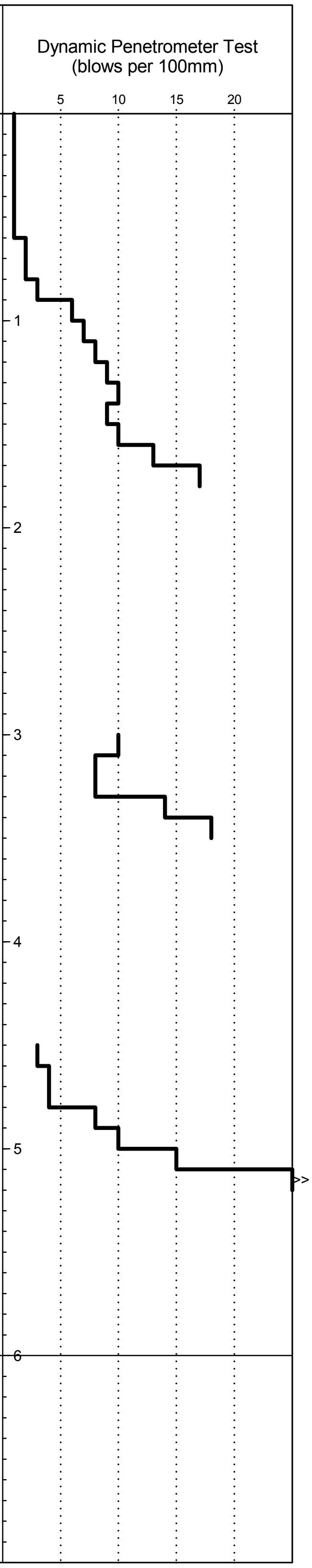
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 16.2*
EASTING: 504204
NORTHING: 7033262
DIP/AZIMUTH: 90°/--

BORE No: 187
PROJECT No: 80967.05
DATE: 21/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		TOPSOIL - loose, dark grey-brown, fine to medium grained silty sand topsoil, moist						
	0.25	SILTY SAND - loose, grey, fine to medium grained silty sand, wet						
	0.55	SANDY CLAY - firm, grey mottled orange-brown, medium to high plasticity sandy clay, fine to medium grained sand, moist - stiff			0.9		pp = 120	
					1.4		pp = 130	
		- very stiff, fine with some medium grained sand		B	1.5			
					1.9		pp = 230	
				U$_{50}$	2.0		pp = 280	
					2.2			
		- stiff			2.4		pp = 190	
					2.9		pp = 180	
					3.4		pp = 180	
								▷
		- grey mottled red-brown, moist to wet			3.9		pp = 120	
					4.4		pp = 110	
		- firm to stiff, grey mottled orange-brown, wet						
					5.4		pp = 90	
					5.9		pp = 110	
	6.0	Bore discontinued at 6.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 3.8 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

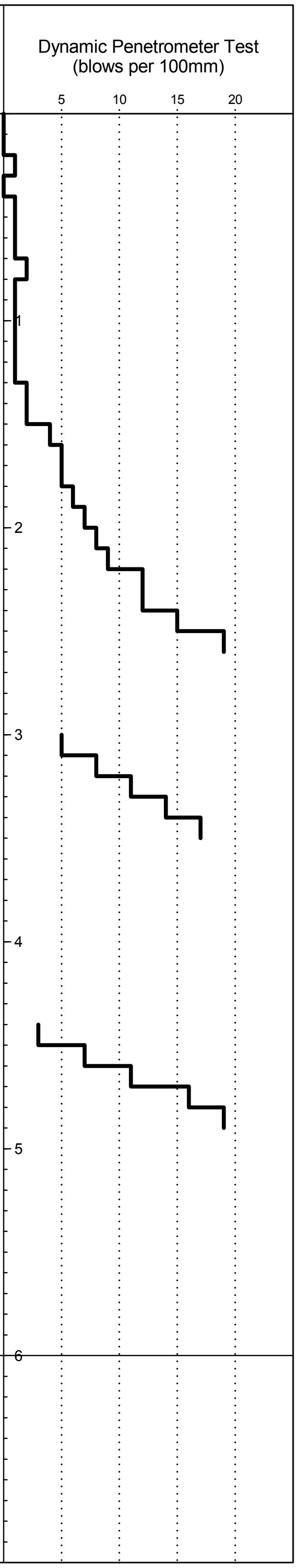
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 16.0*
EASTING: 504338
NORTHING: 7033011
DIP/AZIMUTH: 90°/--

BORE No: 188
PROJECT No: 80967.05
DATE: 21/7/2017
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
	TOPSOIL - very loose, dark brown, fine to medium grained silty sand topsoil, moist		0.0			
0.2	SILTY SAND - very loose, dark brown, fine to medium grained silty sand, wet - loose, grey-brown - grey streaked orange-brown	B				▷
			0.45			
1.3	CLAYEY SAND - medium dense, grey streaked orange-brown, fine to medium grained clayey sand, medium plasticity clay fines, moist					
1.6	SANDY CLAY - stiff, grey mottled orange-brown, medium plasticity sandy clay, fine to medium grained sand, moist		1.9		pp = 180	
	- very stiff, grey mottled red-brown and some orange-brown, high plasticity, fine with some medium grained sand		2.4		pp = 250	
			2.9		pp = 240	
	- stiff, some wet ironstone gravel layers		3.4		pp = 130	
	- grey mottled orange-brown, fine with some medium grained sand, no ironstone gravel layers		4.4		pp = 110	
	- stiff to very stiff		4.9		pp = 200	
			5.4		pp = 210	
			5.9		pp = 180	
6.0	Bore discontinued at 6.0m Limit of Investigation.					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 0.2 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

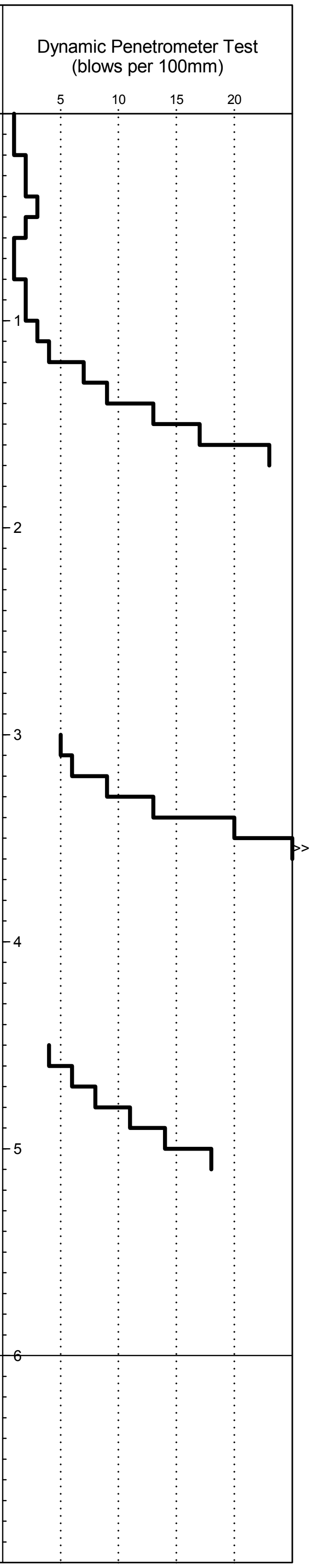
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 14.5*
EASTING: 504669
NORTHING: 7032843
DIP/AZIMUTH: 90°/--

BORE No: 189
PROJECT No: 80967.05
DATE: 18/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist					
	0.25	SILTY SAND - loose, grey orange-brown, fine to medium grained silty sand, wet					▷
	0.85	SANDY CLAY - firm, grey streaked orange-brown, medium to high plasticity sandy clay, fine to medium grained sand, moist		0.9		pp = 80	
		- very stiff, orange-brown mottled grey and some red-brown, high plasticity, fine with some medium grained sand	D	1.2 1.4 1.5		pp = 240	
		- grey mottled red-brown and some orange-brown, trace of fine ironstone gravel		1.9		pp = 310	
				2.4		pp = 330	
				2.9		pp = 330	
		- some wet ironstone gravel lenses		3.4		pp = 260	
		- stiff, orange-brown mottled grey some red-brown		3.9		pp = 170	
				4.4		pp = 140	
				4.9		pp = 130	
		- very stiff		5.4		pp = 330	
				5.9		pp = 460	
	6.0	Bore discontinued at 6.0m Limit of Investigation.					



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 0.25 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

BOREHOLE LOG

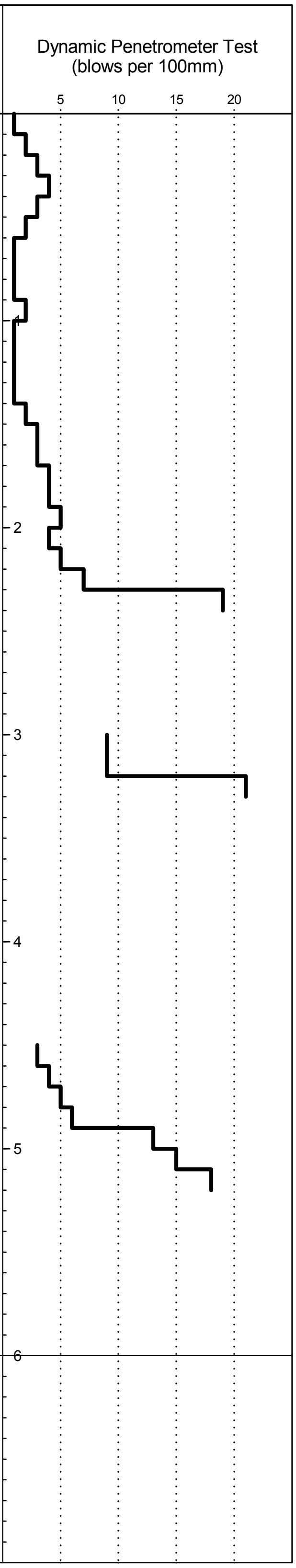
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 12.2*
EASTING: 504643
NORTHING: 7032587
DIP/AZIMUTH: 90°/--

BORE No: 190
PROJECT No: 80967.05
DATE: 13/7/2017
SHEET 1 OF 1

Depth (m)	Description of Strata
0.1	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist
1.1	SILTY SAND - loose, orange-brown, fine to medium grained silty sand, moist to wet - some clay fines
6.0	SANDY CLAY - stiff, red-brown mottled grey, high plasticity sandy clay, fine with some medium grained sand, moist - very stiff, some fine ironstone gravel - stiff, some orange-brown mottling - firm, orange-brown mottled grey, fine to medium grained sand
	Bore discontinued at 6.0m Limit of Investigation.

Type	Depth	Sample	Results & Comments	Water
D	0.4 0.7			
D	1.1 1.4 1.5		pp = 230	
	1.9		pp = 330	
	2.4		pp = 280	
	2.9		pp = 340	
	3.4		pp = 220	
B	3.6 3.9 4.4 4.5		pp = 200 pp = 120	▷ (3.6)
U_{50}	4.5 4.76		pp = 210	
	5.4		pp = 80	
	5.9		pp = 70	



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 3.6 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

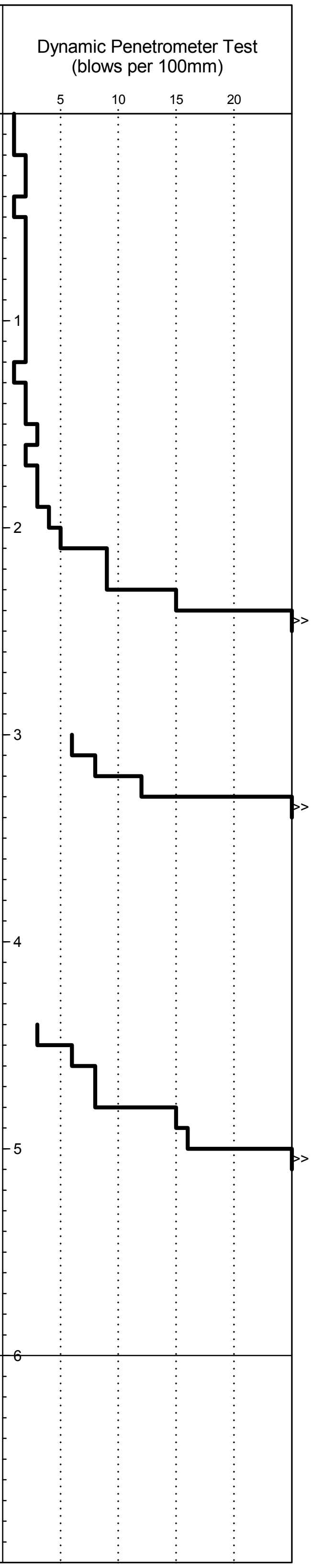
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 13.5*
EASTING: 503800
NORTHING: 7033104
DIP/AZIMUTH: 90°/--

BORE No: 191
PROJECT No: 80967.05
DATE: 19/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
	0.1	TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist						
		SILTY SAND - loose, orange-brown, fine to medium grained silty sand, moist - some clay fines						
	0.8	SANDY CLAY - stiff to very stiff, grey mottled red-brown and some orange-brown mottled, high plasticity sandy clay, fine with some medium grained sand, trace of ironstone, moist			0.9		pp = 230	
					1.4		pp = 290	
				UU_{50}	1.5		pp = 430	
					1.7			
		- very stiff, grey mottled red-brown			1.9		pp = 380	
					2.4		pp = 390	
		- stiff, grey mottled orange-brown, no ironstone gravel, moist to wet						
					2.9		pp = 360	
								▷
					3.4		pp = 190	
					3.9		pp = 160	
				B	4.0			
					4.4		pp = 110	
					4.9		pp = 120	
					5.0			
					5.4		pp = 100	
					5.9		pp = 170	
	6.0	Bore discontinued at 6.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 3.1 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

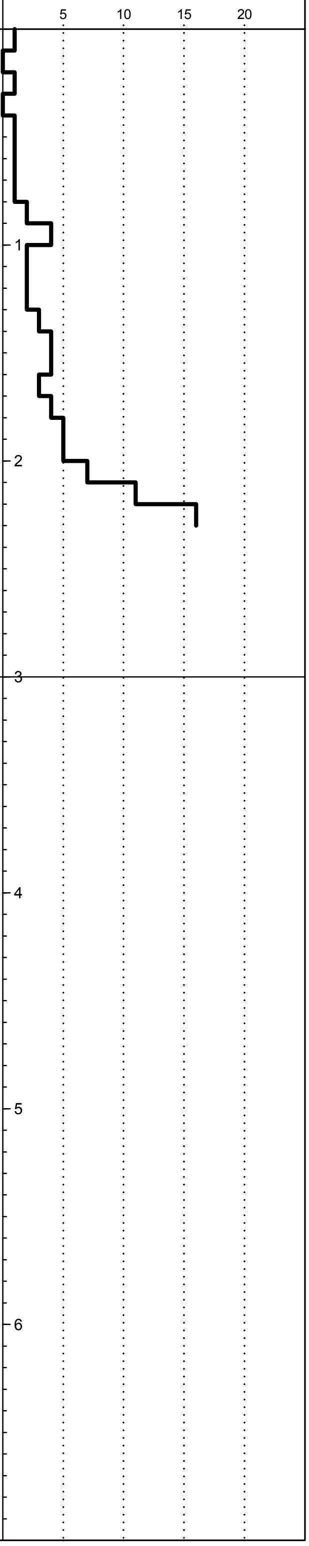
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 13.0*
EASTING: 504002
NORTHING: 7032758
DIP/AZIMUTH: 90°/--

BORE No: 192
PROJECT No: 80967.05
DATE: 2/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water
		CLAYEY SAND - loose, dark grey, fine grained clayey sand, medium plasticity clay fines, moist						
	0.7	SILTY SAND - medium dense, grey, fine to medium grained silty sand, wet - some clay fines						▷
	1.7	SANDY CLAY - stiff, grey, medium plasticity sandy clay, fine to medium grained sand, moist			1.9 2.4 2.9		pp = 120 pp = 130 pp = 190	
3	3.0	Bore discontinued at 3.0m Limit of Investigation.						

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 0.7 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

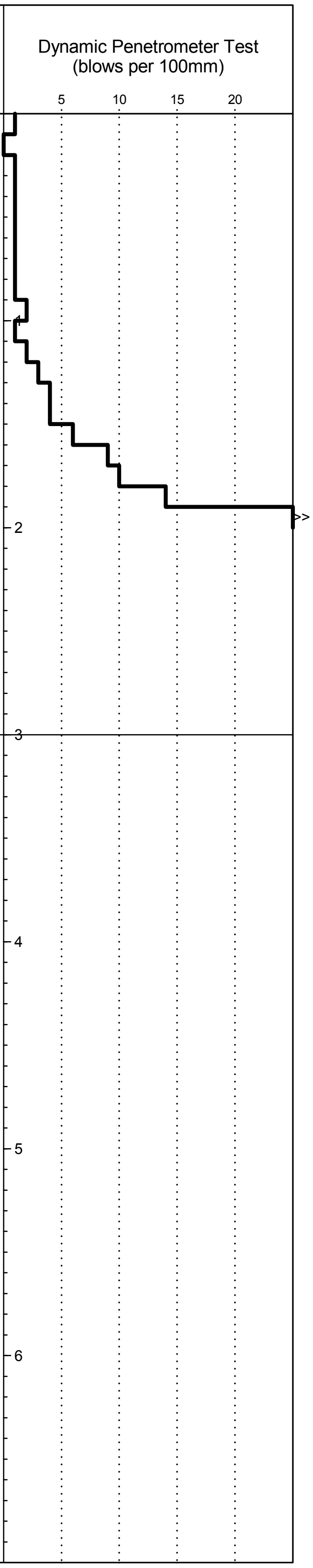
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 10.2*
EASTING: 504215
NORTHING: 7032578
DIP/AZIMUTH: 90°/--

BORE No: 193
PROJECT No: 80967.05
DATE: 2/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		CLAYEY SAND - loose, dark grey, fine grained clayey sand, low plasticity clay fines, moist						
	0.8	SILTY SAND - loose, grey, fine to medium grained silty sand, wet - some clay fines, trace of fine gravel						▷
	1.3	SANDY CLAY - stiff, grey, medium plasticity sandy clay, fine to medium grained sand, moist			1.9		pp = 130	
		- very stiff			2.4		pp = 310	
		- low plasticity			2.9		pp = 320	
	3.0	Bore discontinued at 3.0m Limit of Investigation.						


Dynamic Penetrometer Test (blows per 100mm)

RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 0.25 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

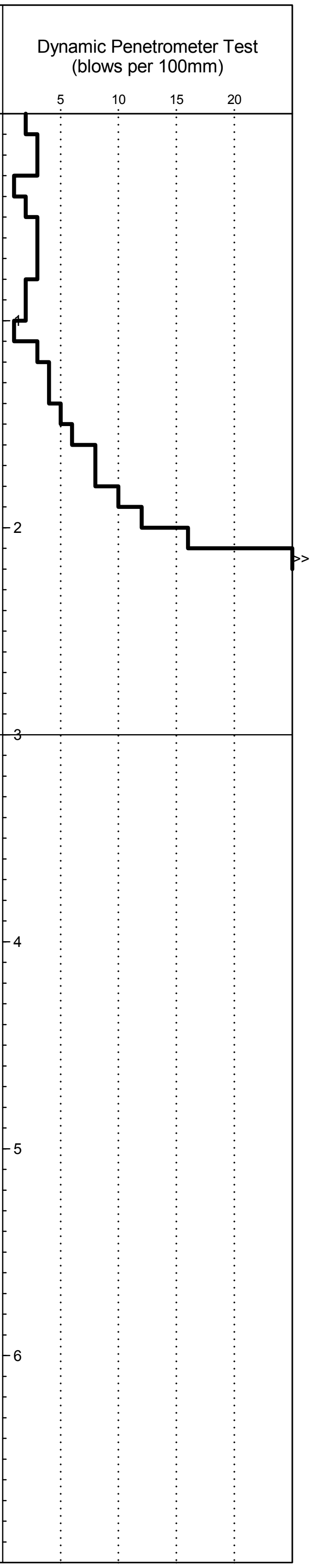
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 12.0*
EASTING: 503953
NORTHING: 7032370
DIP/AZIMUTH: 90°/--

BORE No: 194
PROJECT No: 80967.05
DATE: 2/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Depth	Sample	Results & Comments	Water
	0.2	FILLING - loose orange-brown and grey, fine to medium grained silty sand filling, wet						
	0.35	FILLING - stiff, grey, medium plasticity sandy clay filling, fine to medium grained sand, moist			0.3		pp = 190	
	1.15	SILTY SAND - loose, orange-brown and grey, fine to medium grained silty sand, moist - wet						▷
	3.0	SANDY CLAY - very stiff, grey, medium plasticity sandy clay, fine to medium grained sand, moist			1.4 1.9 2.4 2.9		pp = 240 pp = 240 pp = 320 pp = 310	
		Bore discontinued at 3.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil
TYPE OF BORING: Auger
WATER OBSERVATIONS: Groundwater seepage observed at 0.9 m at time of drilling.
REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

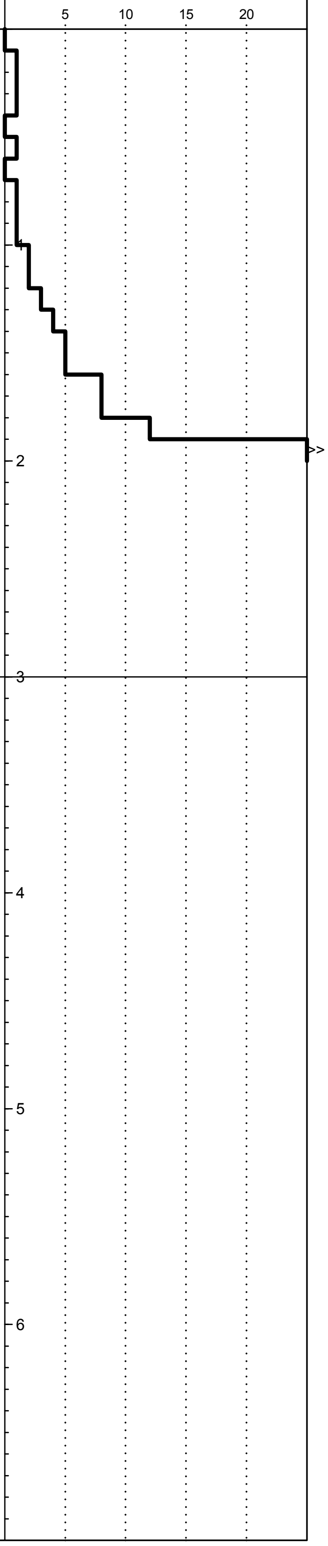
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 15.0*
EASTING: 503600
NORTHING: 7032105
DIP/AZIMUTH: 90°/--

BORE No: 195
PROJECT No: 80967.05
DATE: 2/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SILTY SAND - loose, orange-brown bleached grey, fine to medium grained silty sand, moist - wet - some clay fines						
	1.25	SANDY CLAY - firm, orange-brown mottled grey, medium plasticity sandy clay, fine to medium grained sand, moist			1.4		pp = 60	
		- stiff			1.9		pp = 110	
		- very stiff			2.4		pp = 290	
					2.9		pp = 320	
	3.0	Bore discontinued at 3.0m Limit of Investigation.						

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: No groundwater seepage observed during drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

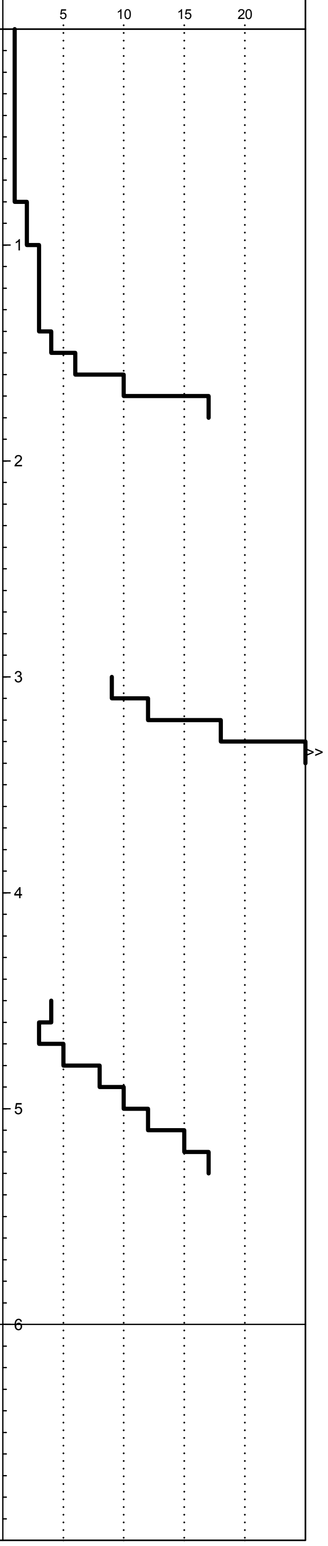
CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 10.3*
EASTING: 504182
NORTHING: 7032051
DIP/AZIMUTH: 90°/--

BORE No: 196
PROJECT No: 80967.05
DATE: 21/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist		B	0.0 0.15			
	0.15	SILTY SAND - loose, orange-brown streaked grey, fine to medium grained silty sand, wet						
	0.9	SANDY CLAY - stiff, grey mottled orange-brown and some red-brown, high plasticity sandy clay, fine to medium grained sand, moist			1.0		pp = 150	
				D	1.1 1.4		pp = 160	
		- very stiff, grey mottled red-brown, some ironstone gravel			1.9		pp = 390	
					2.4		pp = 370	
					2.9		pp = 340	
					3.4		pp = 260	
					3.9		pp = 220	
		- stiff, moist to wet						▷
					4.4		pp = 190	
		- firm, wet			4.9		pp = 100	
					5.4		pp = 90	
					5.9		pp = 60	
	6.0	Bore discontinued at 6.0m Limit of Investigation.						

Dynamic Penetrometer Test (blows per 100mm)



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 4.2 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

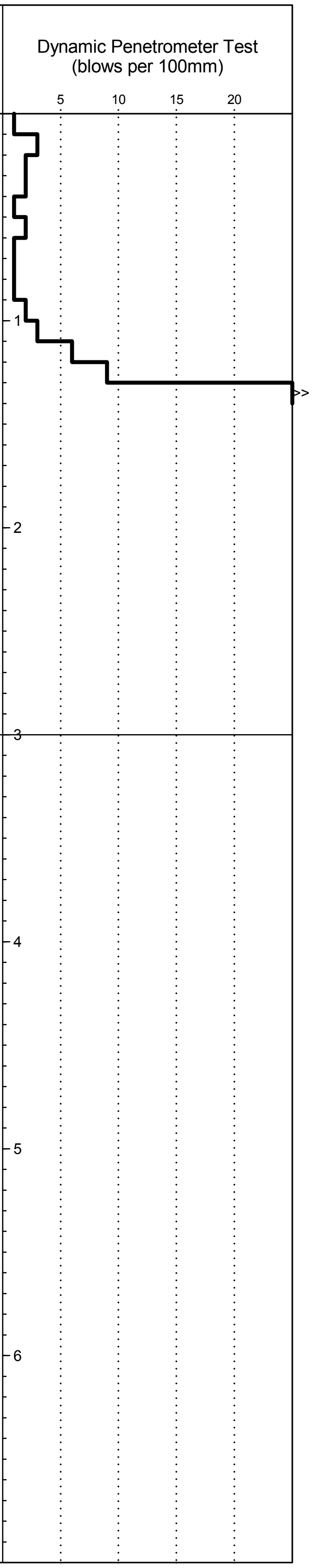
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 11.0*
EASTING: 503721
NORTHING: 7031895
DIP/AZIMUTH: 90°/--

BORE No: 197
PROJECT No: 80967.05
DATE: 2/8/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		SILTY SAND - loose, dark grey-brown, fine to medium grained silty sand, some clay fines, moist						
	0.7	CLAYEY SAND - loose, grey-brown, fine to medium grained clayey sand, medium plasticity clay fines, moist						
	1.1	SANDY CLAY - stiff, grey, medium plasticity sandy clay, fine to medium grained sand, moist			1.4		pp = 130	
		- very stiff, medium to high plasticity			1.9		pp = 290	
					2.4		pp = 360	
					2.9		pp = 410	
	3.0	Bore discontinued at 3.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 4.2 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	⊳	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

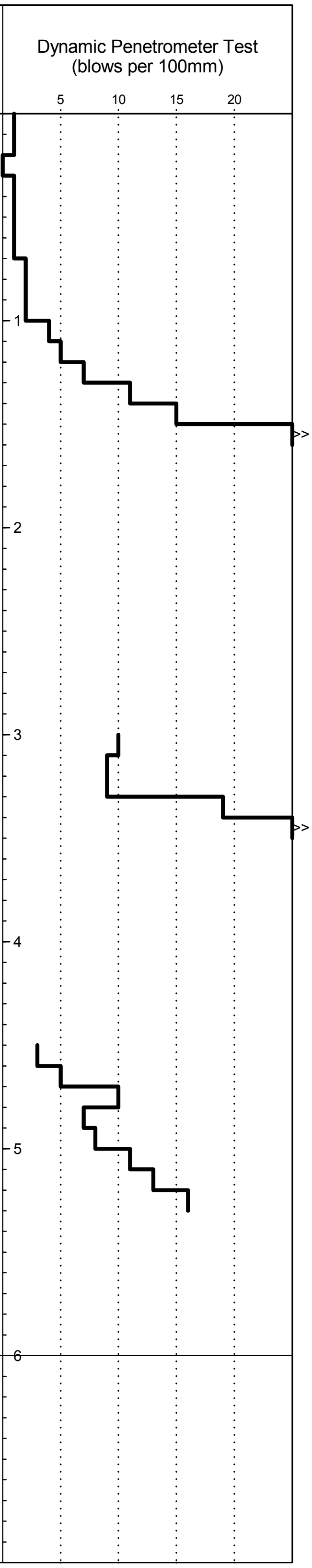
BOREHOLE LOG

CLIENT: Stockland Development Pty Ltd
PROJECT: Aura Precincts P6-P16
LOCATION: Bells Creek

SURFACE LEVEL: 13.0*
EASTING: 503705
NORTHING: 7031632
DIP/AZIMUTH: 90°/--

BORE No: 198
PROJECT No: 80967.05
DATE: 21/7/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water
				Type	Depth	Sample	Results & Comments	
		TOPSOIL - loose, grey-brown, fine to medium grained silty sand topsoil, moist						
	0.2	SILTY SAND - loose, grey, fine to medium grained silty sand, moist						
	0.8	SANDY CLAY - firm, orange-brown mottled grey, medium plasticity sandy clay, fine to medium grained sand, moist			0.8		pp = 80	
				B	1.35			
		- very stiff, grey mottled red-brown, high plasticity, fine with some medium grained sand, some ironstone gravel			1.4		pp = 270	
					1.8			
					1.9		pp = 340	
					2.4		pp = 260	
					2.9		pp = 360	
				U_{50}	3.0		pp >600	
					3.21			
		- stiff, some seepage, no ironstone gravel			3.4		pp = 190	▷
					3.9		pp = 180	
		- firm, wet						
					4.4		pp = 80	
					4.9		pp = 60	
					5.4		pp = 40	
					5.9		pp = 30	
	6.0	Bore discontinued at 6.0m Limit of Investigation.						



RIG: Jacro 200 **DRILLER:** RB **LOGGED:** RB **CASING:** Nil

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 3.4 m at time of drilling.

REMARKS: Location coordinates are in MGA94 Zone 56 J. * Approximate surface level interpolated from survey plan provided by Stockland

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix D

Laboratory Test Results

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

WORLD RECOGNISED ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032A
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 150 (1.7 - 1.83 m)**

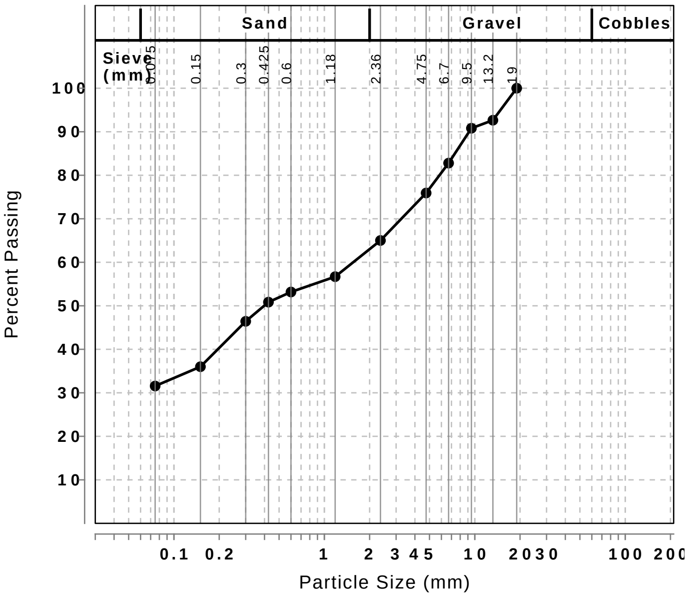
Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**93**		
9.5 mm	**91**		
6.7 mm	**83**		
4.75 mm	**76**		
2.36 mm	**65**		
1.18 mm	**57**		
0.6 mm	**53**		
0.425 mm	**51**		
0.3 mm	**46**		
0.15 mm	**36**		
0.075 mm	**32**		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	46		
Plastic Limit (%)	26		
Plasticity Index (%)	**20**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	10.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	16.3

Particle Size Distribution



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

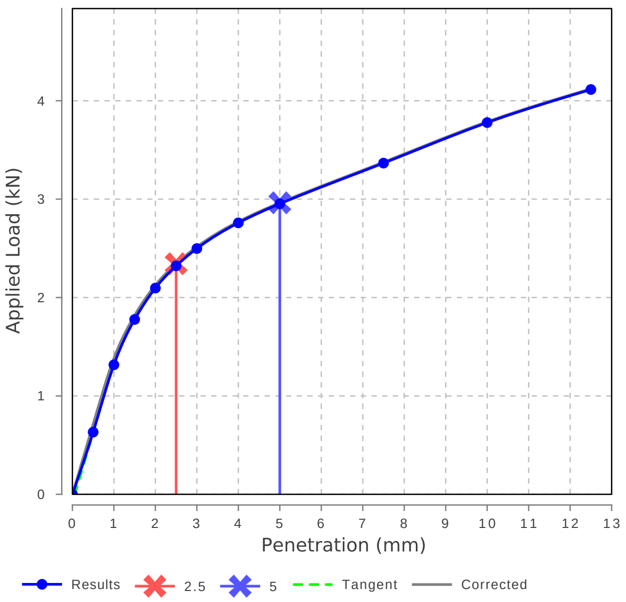
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032I
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 150 (1.65 - 2.1 m)**

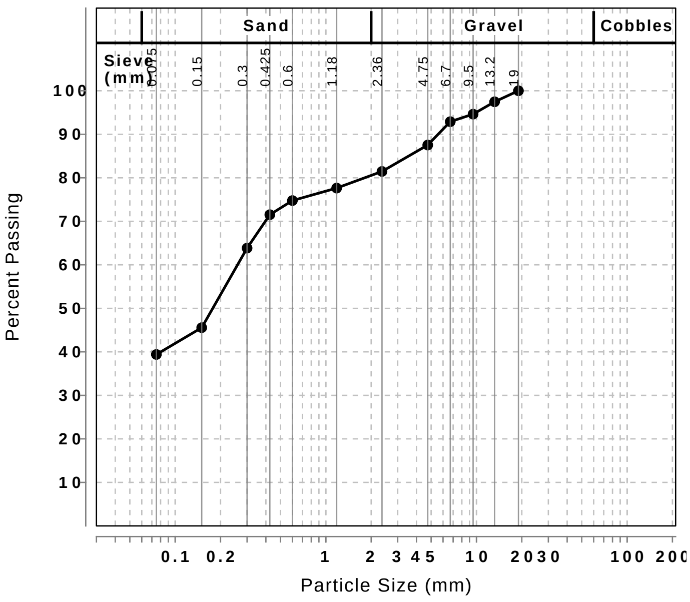
California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**18**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.87		
Optimum Moisture Content (%)	15.0		
Laboratory Density Ratio (%)	98.0		
Laboratory Moisture Ratio (%)	101.5		
Dry Density after Soaking (t/m^3)	1.83		
Field Moisture Content (%)	18.6		
Moisture Content at Placement (%)	15.3		
Moisture Content Top 30mm (%)	17.2		
Moisture Content Rest of Sample (%)	16.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

California Bearing Ratio



Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**97**		
9.5 mm	**95**		
6.7 mm	**93**		
4.75 mm	**88**		
2.36 mm	**81**		
1.18 mm	**78**		
0.6 mm	**75**		
0.425 mm	**72**		
0.3 mm	**64**		
0.15 mm	**46**		
0.075 mm	**39**		

Particle Size Distribution



Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	43		
Plastic Limit (%)	22		
Plasticity Index (%)	**21**		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	18.6

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	10.0		
Cracking Crumbling Curling	Cracking		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au
Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032J
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 160 (3.0 - 3.8 m)**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**2.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.73		
Optimum Moisture Content (%)	17.0		
Laboratory Density Ratio (%)	97.5		
Laboratory Moisture Ratio (%)	103.0		
Dry Density after Soaking (t/m^3)	1.62		
Field Moisture Content (%)	29.6		
Moisture Content at Placement (%)	17.7		
Moisture Content Top 30mm (%)	27.8		
Moisture Content Rest of Sample (%)	21.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	5.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

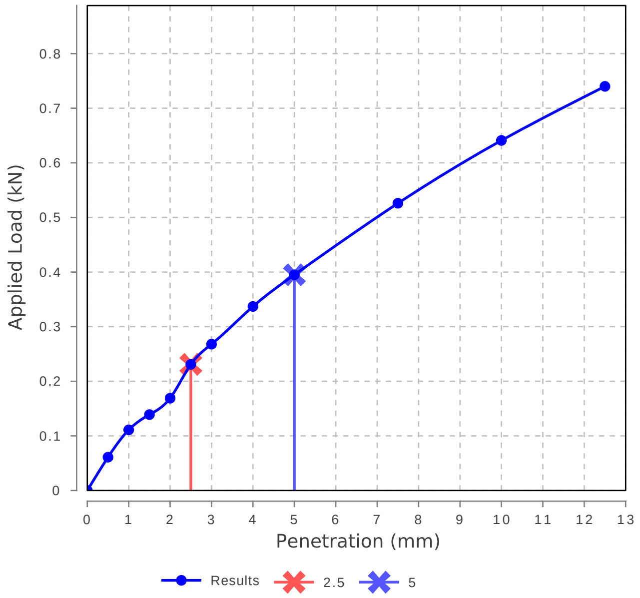
Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
9.5 mm	**100**		
6.7 mm	**99**		
4.75 mm	**98**		
2.36 mm	**97**		
1.18 mm	**95**		
0.6 mm	**92**		
0.425 mm	**88**		
0.3 mm	**82**		
0.15 mm	**60**		
0.075 mm	**51**		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	60		
Plastic Limit (%)	22		
Plasticity Index (%)	**38**		

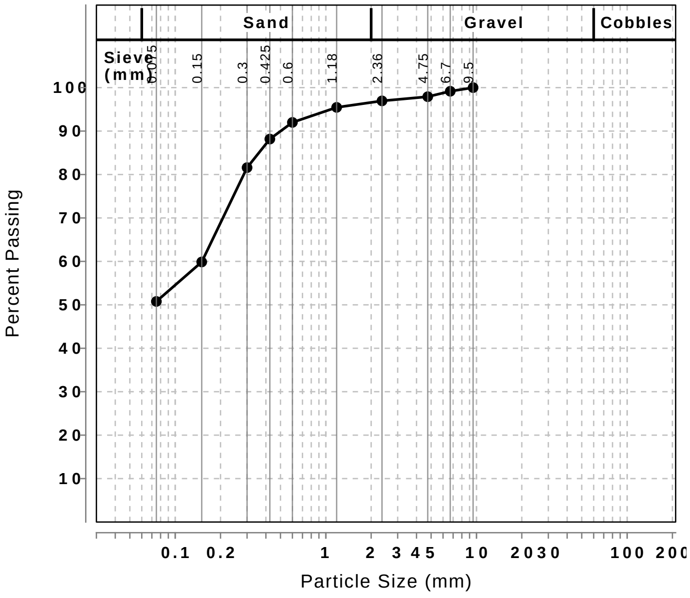
Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	14.5		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	29.6

California Bearing Ratio



Particle Size Distribution



Material Test Report

Douglas Partners
Geotechnics | Environment | Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

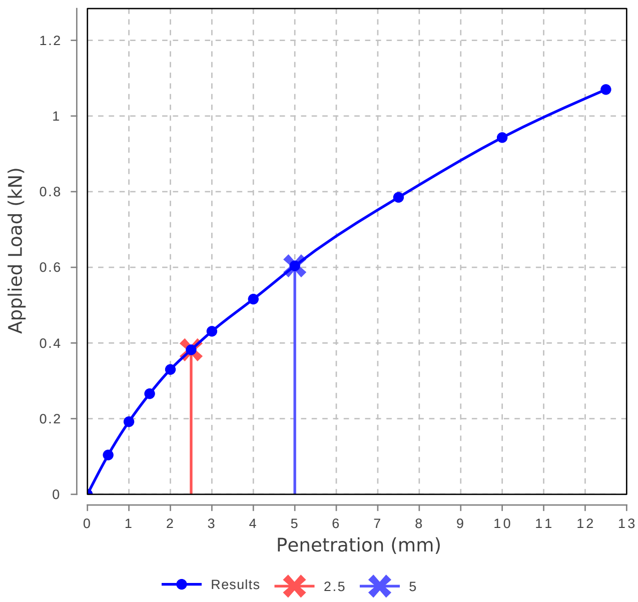
NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032K
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 167 (1.5 - 1.9 m)**

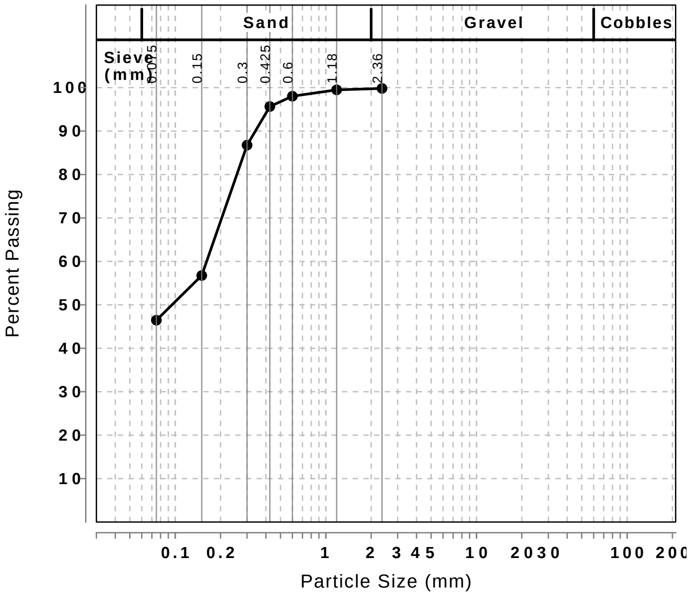
California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**3.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.80		
Optimum Moisture Content (%)	14.5		
Laboratory Density Ratio (%)	98.0		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.72		
Field Moisture Content (%)	14.9		
Moisture Content at Placement (%)	14.6		
Moisture Content Top 30mm (%)	19.3		
Moisture Content Rest of Sample (%)	18.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	2.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

California Bearing Ratio



Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
2.36 mm	**100**		
1.18 mm	**99**		
0.6 mm	**98**		
0.425 mm	**96**		
0.3 mm	**87**		
0.15 mm	**57**		
0.075 mm	**46**		

Particle Size Distribution



Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	49		
Plastic Limit (%)	15		
Plasticity Index (%)	**34**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	14.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	14.9

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

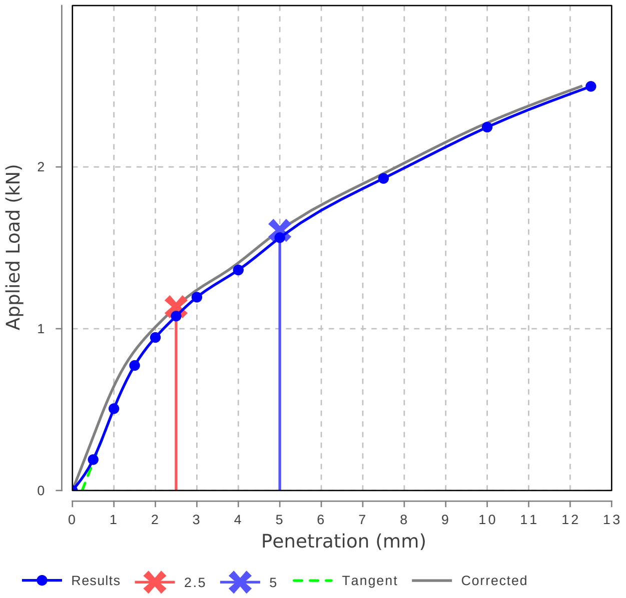
NATA WORLD RECOGNISED ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032L
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 176 (1.25 - 1.6 m)**

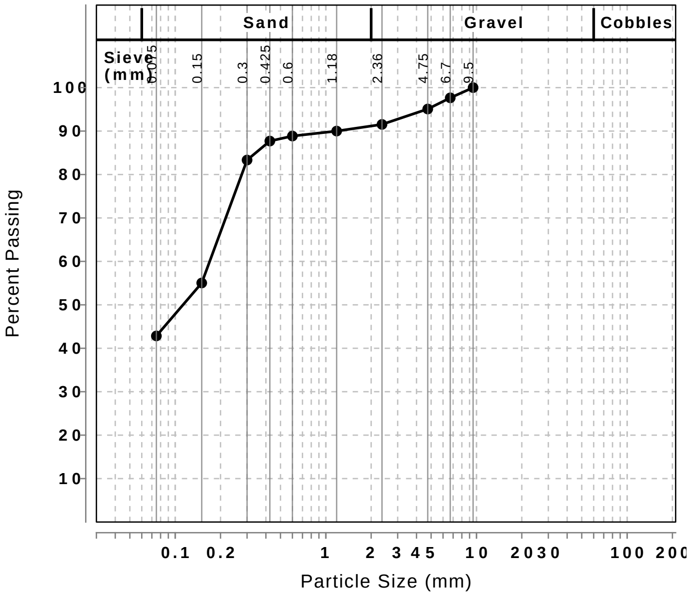
California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**9**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.85		
Optimum Moisture Content (%)	14.0		
Laboratory Density Ratio (%)	98.5		
Laboratory Moisture Ratio (%)	95.0		
Dry Density after Soaking (t/m^3)	1.81		
Field Moisture Content (%)	17.6		
Moisture Content at Placement (%)	13.3		
Moisture Content Top 30mm (%)	17.3		
Moisture Content Rest of Sample (%)	16.0		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

California Bearing Ratio



Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
9.5 mm	**100**		
6.7 mm	**98**		
4.75 mm	**95**		
2.36 mm	**92**		
1.18 mm	**90**		
0.6 mm	**89**		
0.425 mm	**88**		
0.3 mm	**83**		
0.15 mm	**55**		
0.075 mm	**43**		

Particle Size Distribution



Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	40		
Plastic Limit (%)	17		
Plasticity Index (%)	**23**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	10.5		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	17.5

Material Test Report

Douglas Partners
Geotechnics | Environment | Groundwater

Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

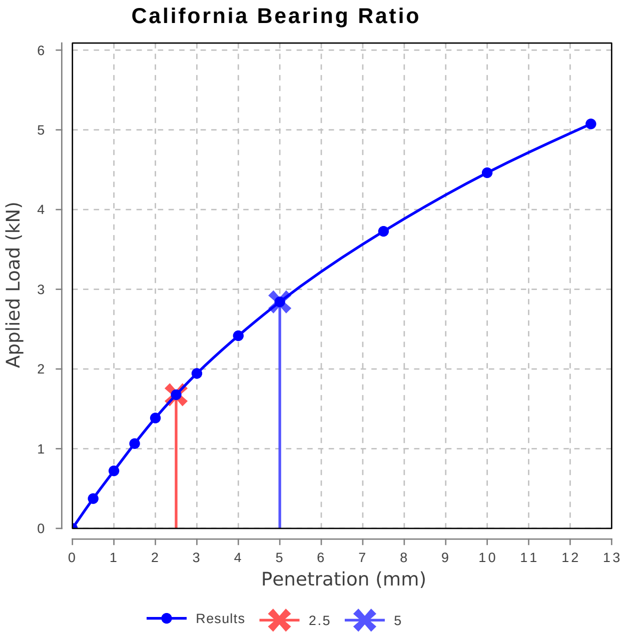
Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

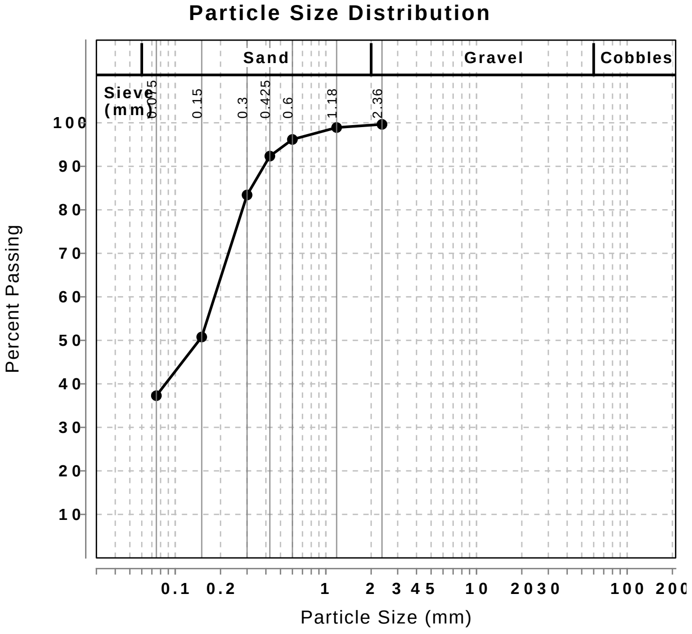
Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number:	**80967.05-1**
Issue Number:	1
Date Issued:	16/08/2017
Client:	Stockland Development Pty Ltd PO Box 6020, Meridan Plains QLD 4551
Contact:	Paul Morgan
Project Number:	80967.05
Project Name:	Proposed Subdivision
Project Location:	Aura Precincts 6-16, Bells Creek
Work Request:	1032
Sample Number:	17-1032M
Date Sampled:	13/07/2017
Sampling Method:	Sampled by Engineering Department
Sample Location:	**Bore 184 (0.8 - 1.3 m)**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**14**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.90		
Optimum Moisture Content (%)	12.5		
Laboratory Density Ratio (%)	98.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.86		
Field Moisture Content (%)	13.1		
Moisture Content at Placement (%)	12.3		
Moisture Content Top 30mm (%)	13.7		
Moisture Content Rest of Sample (%)	13.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
2.36 mm	**100**		
1.18 mm	**99**		
0.6 mm	**96**		
0.425 mm	**92**		
0.3 mm	**83**		
0.15 mm	**51**		
0.075 mm	**37**		



Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	29		
Plastic Limit (%)	16		
Plasticity Index (%)	**13**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	5.5		
Cracking Crumbling Curling	Cracking		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	13.1

Material Test Report

Douglas Partners
Geotechnics | Environment | Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number:	**80967.05-1**
Issue Number:	1
Date Issued:	16/08/2017
Client:	Stockland Development Pty Ltd PO Box 6020, Meridan Plains QLD 4551
Contact:	Paul Morgan
Project Number:	80967.05
Project Name:	Proposed Subdivision
Project Location:	Aura Precincts 6-16, Bells Creek
Work Request:	1032
Sample Number:	17-1032N
Date Sampled:	13/07/2017
Sampling Method:	Sampled by Engineering Department
Sample Location:	**Bore 187 (1.5 - 2.0 m)**

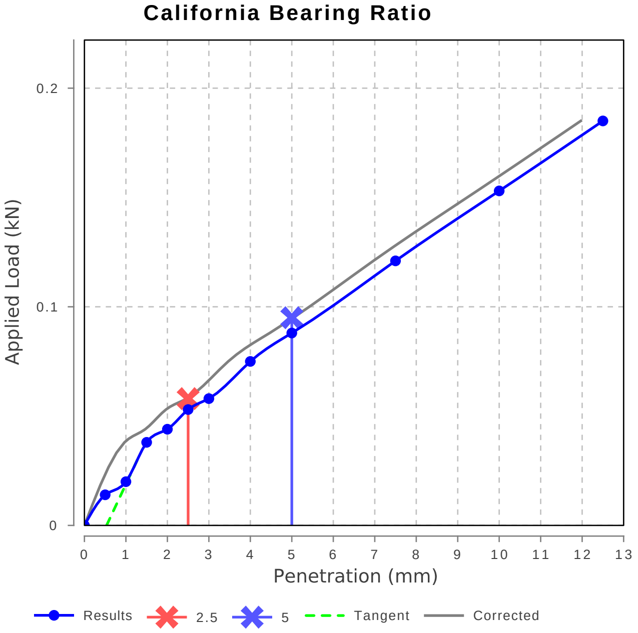
California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**0.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.77		
Optimum Moisture Content (%)	15.5		
Laboratory Density Ratio (%)	98.0		
Laboratory Moisture Ratio (%)	100.5		
Dry Density after Soaking (t/m^3)	1.60		
Field Moisture Content (%)	23.1		
Moisture Content at Placement (%)	15.8		
Moisture Content Top 30mm (%)	32.0		
Moisture Content Rest of Sample (%)	20.4		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	8.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

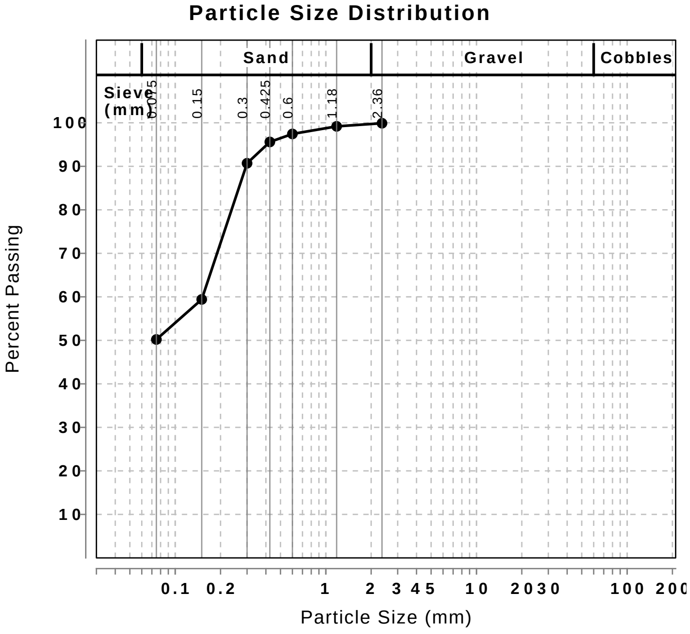
Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
2.36 mm	**100**		
1.18 mm	**99**		
0.6 mm	**97**		
0.425 mm	**96**		
0.3 mm	**91**		
0.15 mm	**59**		
0.075 mm	**50**		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	43		
Plastic Limit (%)	16		
Plasticity Index (%)	**27**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	10.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	23.1





Material Test Report

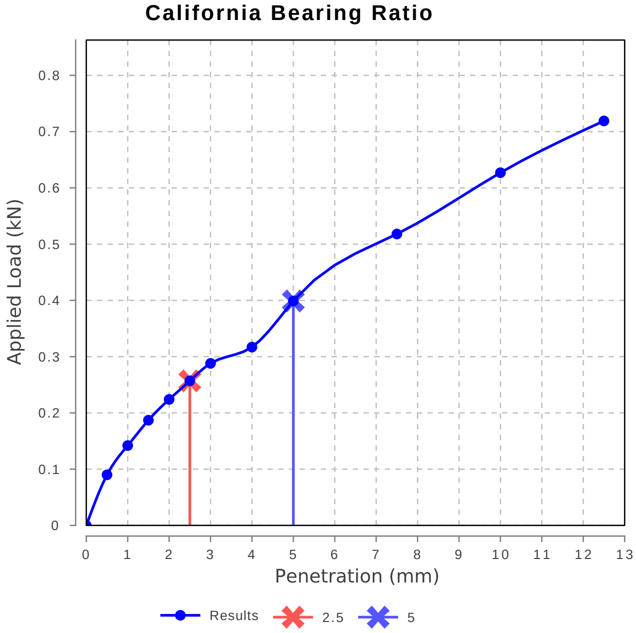
Douglas Partners
Geotechnics | Environment | Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

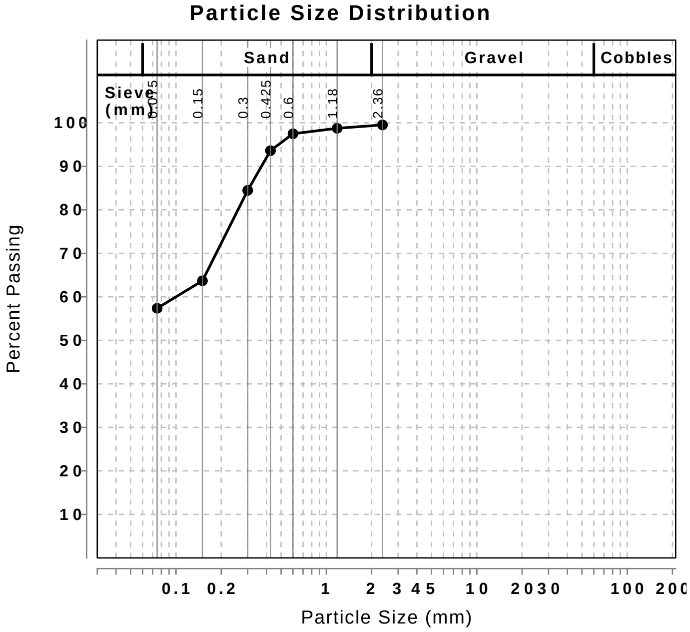
Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032O
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 190 (3.6 - 4.5 m)**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**2.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.69		
Optimum Moisture Content (%)	18.5		
Laboratory Density Ratio (%)	98.5		
Laboratory Moisture Ratio (%)	97.0		
Dry Density after Soaking (t/m^3)	1.57		
Field Moisture Content (%)	36.8		
Moisture Content at Placement (%)	18.1		
Moisture Content Top 30mm (%)	30.9		
Moisture Content Rest of Sample (%)	23.7		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	6.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		


California Bearing Ratio

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
2.36 mm	**100**		
1.18 mm	**99**		
0.6 mm	**97**		
0.425 mm	**94**		
0.3 mm	**84**		
0.15 mm	**64**		
0.075 mm	**57**		


Particle Size Distribution

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	65		
Plastic Limit (%)	22		
Plasticity Index (%)	**43**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	16.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	36.8

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

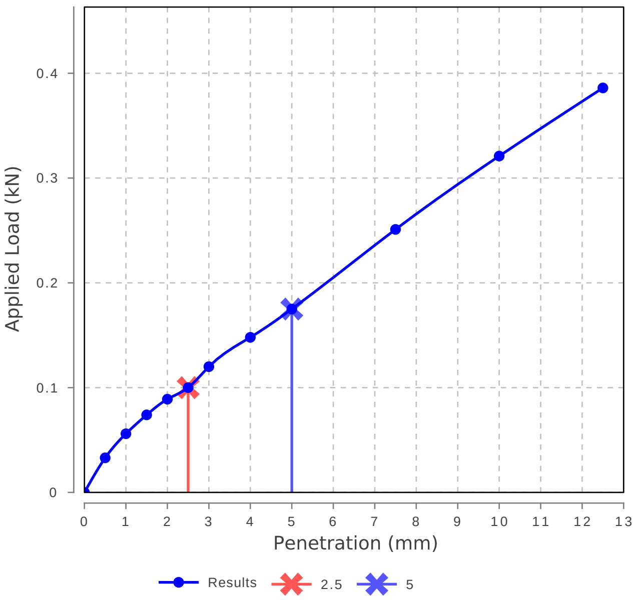
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032P
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 198 (1.35 - 1.8 m)**

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**1.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m^3)	1.67		
Optimum Moisture Content (%)	21.5		
Laboratory Density Ratio (%)	98.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.53		
Field Moisture Content (%)	28.7		
Moisture Content at Placement (%)	21.4		
Moisture Content Top 30mm (%)	35.9		
Moisture Content Rest of Sample (%)	26.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	6.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

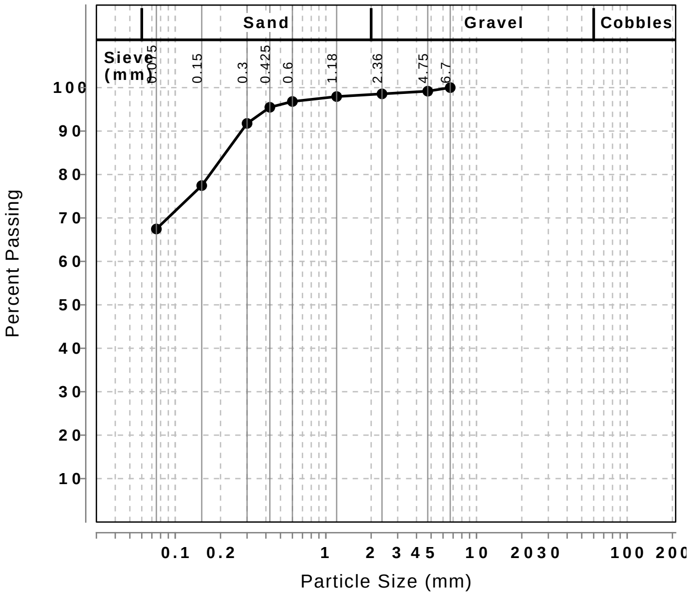
California Bearing Ratio



Particle Distribution (AS1289 3.6.1)

Sieve	Passed %	Passing Limits	
6.7 mm	**100**		
4.75 mm	**99**		
2.36 mm	**99**		
1.18 mm	**98**		
0.6 mm	**97**		
0.425 mm	**95**		
0.3 mm	**92**		
0.15 mm	**77**		
0.075 mm	**67**		

Particle Size Distribution



Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	86		
Plastic Limit (%)	27		
Plasticity Index (%)	**59**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	19.0		
Cracking Crumbling Curling	Cracking		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	28.7

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

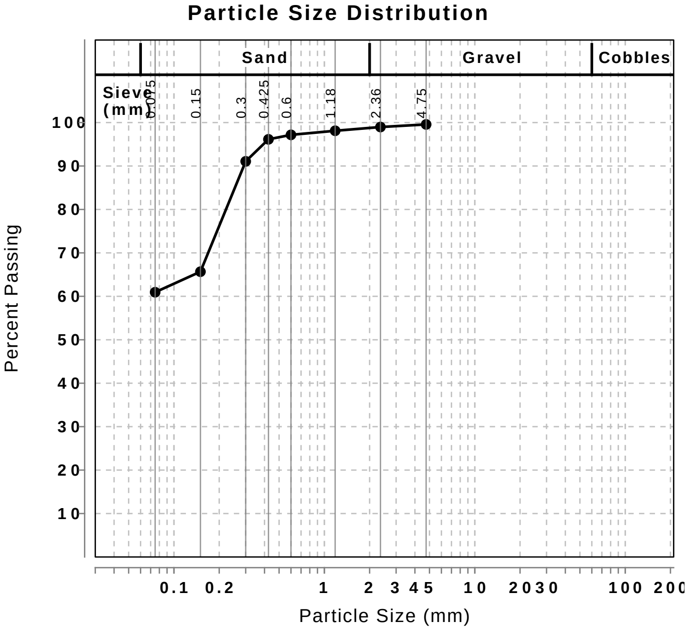
Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032Q
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 150 (4.1 - 4.4 m)**

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
4.75 mm	**100**		
2.36 mm	**99**		
1.18 mm	**98**		
0.6 mm	**97**		
0.425 mm	**96**		
0.3 mm	**91**		
0.15 mm	**66**		
0.075 mm	**61**		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	73		
Plastic Limit (%)	23		
Plasticity Index (%)	**50**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	17.5		
Cracking Crumbling Curling	Cracking		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	18.3



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032R
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 157 (2.9 - 3.4 m)**

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

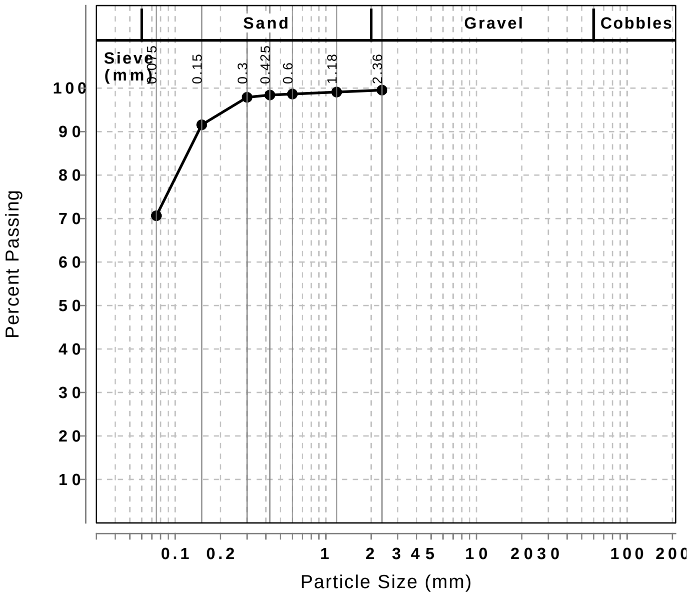
Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
2.36 mm	**100**		
1.18 mm	**99**		
0.6 mm	**99**		
0.425 mm	**98**		
0.3 mm	**98**		
0.15 mm	**92**		
0.075 mm	**71**		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	69		
Plastic Limit (%)	19		
Plasticity Index (%)	**50**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	16.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	27.4

Particle Size Distribution



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032S
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 166 (1.6 - 1.9 m)**

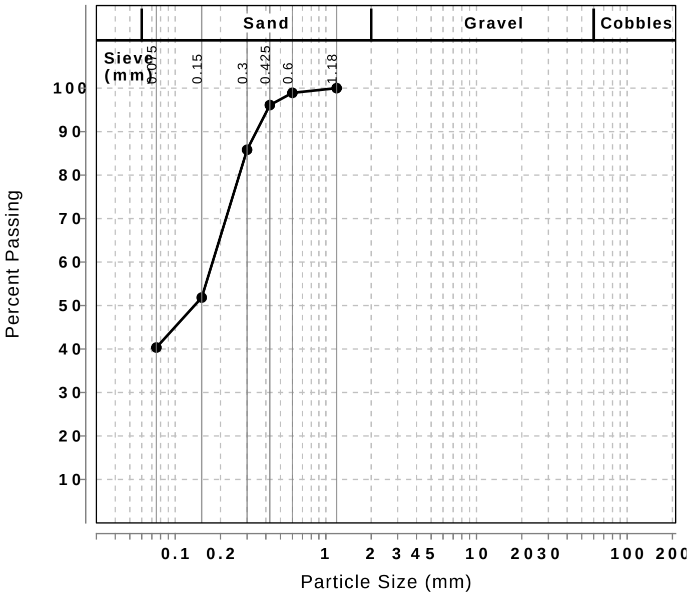
Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
1.18 mm	**100**		
0.6 mm	**99**		
0.425 mm	**96**		
0.3 mm	**86**		
0.15 mm	**52**		
0.075 mm	**40**		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	33		
Plastic Limit (%)	12		
Plasticity Index (%)	**21**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	9.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	14.1

Particle Size Distribution



Material Test Report

Douglas Partners
Geotechnics | Environment | Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED
ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

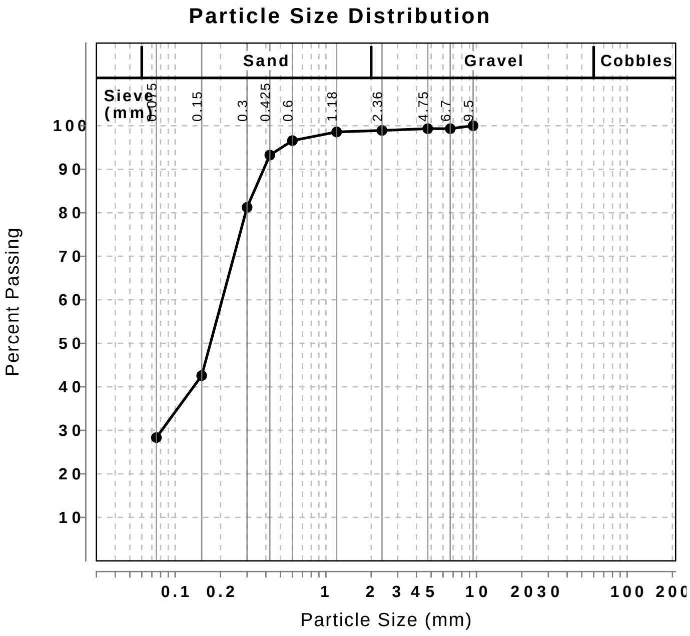
Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032T
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 167 (0.4 - 0.7 m)**

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
9.5 mm	**100**		
6.7 mm	**99**		
4.75 mm	**99**		
2.36 mm	**99**		
1.18 mm	**99**		
0.6 mm	**97**		
0.425 mm	**93**		
0.3 mm	**81**		
0.15 mm	**43**		
0.075 mm	**28**		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	17		
Plastic Limit (%)	15		
Plasticity Index (%)	**2**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	0.5		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	12.9



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032U
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 169 (2.1 - 2.4 m)**

Particle Distribution (AS1289 3.6.1)

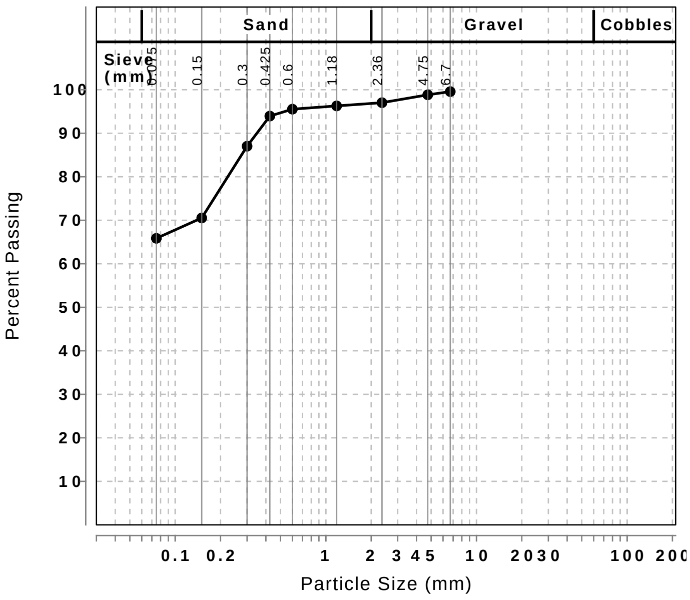
Sieve	Passed %	Passing Limits	
6.7 mm	**100**		
4.75 mm	**99**		
2.36 mm	**97**		
1.18 mm	**96**		
0.6 mm	**96**		
0.425 mm	**94**		
0.3 mm	**87**		
0.15 mm	**71**		
0.075 mm	**66**		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	90		
Plastic Limit (%)	26		
Plasticity Index (%)	**64**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	19.5		
Cracking Crumbling Curling	Cracking		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	23.0

Particle Size Distribution



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

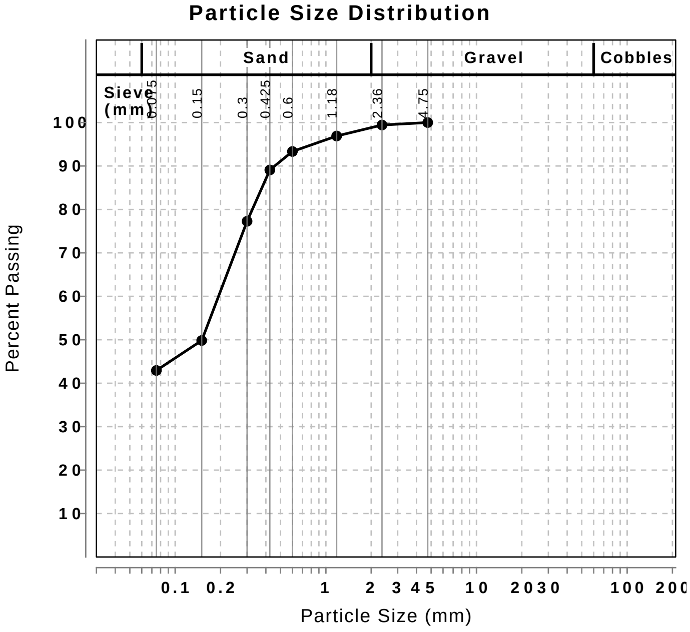
Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Sample Number: 17-1032V
Date Sampled: 13/07/2017
Sampling Method: Sampled by Engineering Department
Sample Location: **Bore 175 (1.7 - 2.2 m)**

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
4.75 mm	**100**		
2.36 mm	**99**		
1.18 mm	**97**		
0.6 mm	**93**		
0.425 mm	**89**		
0.3 mm	**77**		
0.15 mm	**50**		
0.075 mm	**43**		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	62		
Plastic Limit (%)	18		
Plasticity Index (%)	**44**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	16.5		
Cracking Crumbling Curling	Cracking		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	20.1



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au
Accredited for compliance with ISO/IEC 17025 - Testing

WORLD RECOGNISED ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

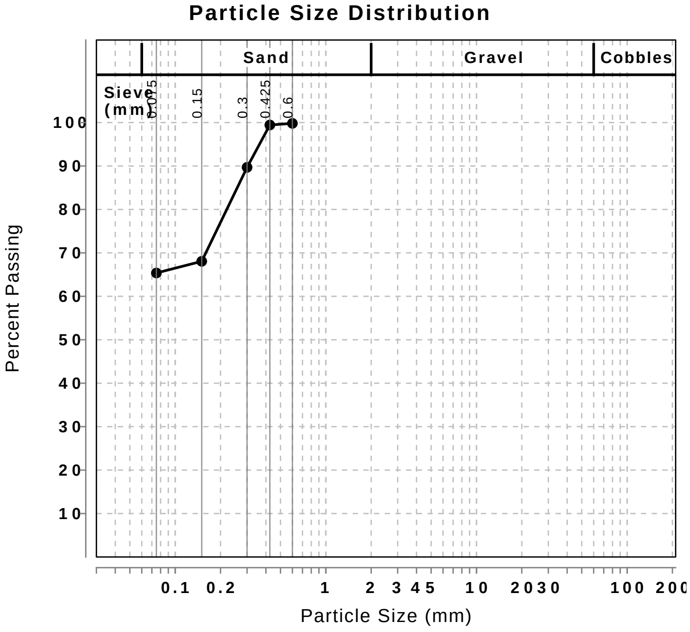
Report Number:	**80967.05-1**
Issue Number:	1
Date Issued:	16/08/2017
Client:	Stockland Development Pty Ltd PO Box 6020, Meridan Plains QLD 4551
Contact:	Paul Morgan
Project Number:	80967.05
Project Name:	Proposed Subdivision
Project Location:	Aura Precincts 6-16, Bells Creek
Work Request:	1032
Sample Number:	17-1032W
Date Sampled:	13/07/2017
Sampling Method:	Sampled by Engineering Department
Sample Location:	**Bore 186 (5.5 - 5.9 m)**

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
0.6 mm	**100**		
0.425 mm	**99**		
0.3 mm	**90**		
0.15 mm	**68**		
0.075 mm	**65**		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	89		
Plastic Limit (%)	23		
Plasticity Index (%)	**66**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	19.5		
Cracking Crumbling Curling		None	

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	27.5



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number:	**80967.05-1**
Issue Number:	1
Date Issued:	16/08/2017
Client:	Stockland Development Pty Ltd PO Box 6020, Meridan Plains QLD 4551
Contact:	Paul Morgan
Project Number:	80967.05
Project Name:	Proposed Subdivision
Project Location:	Aura Precincts 6-16, Bells Creek
Work Request:	1032
Sample Number:	17-1032X
Date Sampled:	13/07/2017
Sampling Method:	Sampled by Engineering Department
Sample Location:	**Bore 196 (1.1 - 1.4 m)**

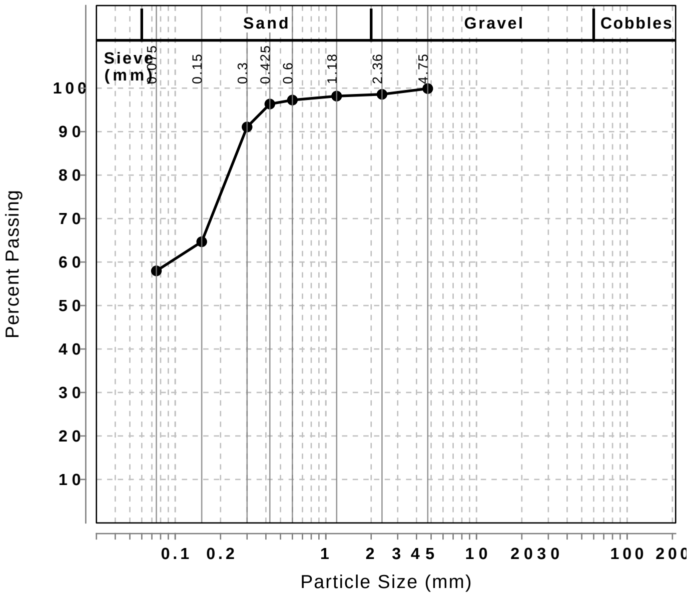
Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
4.75 mm	**100**		
2.36 mm	**99**		
1.18 mm	**98**		
0.6 mm	**97**		
0.425 mm	**96**		
0.3 mm	**91**		
0.15 mm	**65**		
0.075 mm	**58**		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Preparation Method	Dry Sieve		
Sample History	Oven Dried		
Liquid Limit (%)	70		
Plastic Limit (%)	20		
Plasticity Index (%)	**50**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	17.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	23.2

Particle Size Distribution



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Remarks: Unit Weight = 2.00 t/m3

Shrink Swell Index AS 1289 7.1.1 & 2.1.1					
Sample Number	17-1032B	17-1032C	17-1032D	17-1032E	17-1032F
Sampling Method	Sampled by Engineering Department	Sampled by Engineering Department	Sampled by Engineering Department	Sampled by Engineering Department	Sampled by Engineering Department
Date Sampled	13/07/2017	13/07/2017	13/07/2017	13/07/2017	13/07/2017
Date Tested	01/08/2017	01/08/2017	01/08/2017	02/08/2017	02/08/2017
Material Source	Insitu	Insitu	Insitu	insitu	Insitu
Sample Location	Bore 160 (3.0 - 3.19 m)	Bore 167 (1.5 - 1.65 m)	Bore 176 (1.5 - 1.66 m)	Bore 184 (2.0 - 2.13 m)	Bore 187 (2.0 - 2.2 m)
Inert Material Estimate (%)	0	0	0	0	0
Pocket Penetrometer before (kPa)	430	370	380	460	280
Pocket Penetrometer after (kPa)	310	190	150	300	280
Shrinkage Moisture Content (%)	20.4	21.7	27.6	23.8	24.1
Shrinkage (%)	**2.6**	**3.4**	**2.4**	**3.4**	**3.0**
Swell Moisture Content Before (%)	18.9	23.5	19.6	22.3	25.5
Swell Moisture Content After (%)	20.3	27.8	20.0	27.3	28.2
Swell (%)	**1.0**	**2.6**	**-0.0**	**2.9**	**1.8**
Shrink Swell Index Iss (%)	**1.7**	**2.6**	**1.3**	**2.7**	**2.2**
Visual Description	**	**	**	**	**
Cracking	Uncracked	Uncracked	Slightly Cracked	Uncracked	Highly Cracked
Crumbling	No	No	No	No	No
Remarks	Unit Weight = 2.00 t/m3	Unit Weight = 1.96 t/m3	Unit Weight = 2.12 t/m3	Unit Weight = 1.97 t/m3	Unit Weight = 1.93 t/m3

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.
NATA Accreditation does not cover the performance of pocket penetrometer readings.

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sunshine Coast Laboratory
1/28 Kessling Avenue Kunda Park QLD 4556
Phone: (07) 5351 0400
Fax: (07) 5351 0499
Email: Shae.Harry@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Shae Harry
NATA Accredited Laboratory Number: 828

Report Number: **80967.05-1**
Issue Number: 1
Date Issued: 16/08/2017
Client: Stockland Development Pty Ltd
PO Box 6020, Meridan Plains QLD 4551
Contact: Paul Morgan
Project Number: 80967.05
Project Name: Proposed Subdivision
Project Location: Aura Precincts 6-16, Bells Creek
Work Request: 1032
Remarks: Unit Weight = 2.00 t/m3

Shrink Swell Index AS 1289 7.1.1 & 2.1.1

Sample Number	17-1032G	17-1032H
Sampling Method	Sampled by Engineering Department	Sampled by Engineering Department
Date Sampled	13/07/2017	13/07/2017
Date Tested	02/08/2017	04/08/2017
Material Source	Insitu	Insitu
Sample Location	Bore 190 (4.5 - 4.76 m)	Bore 191 (1.5 - 1.70 m)
Inert Material Estimate (%)	0	3
Pocket Penetrometer before (kPa)	210	430
Pocket Penetrometer after (kPa)	210	220
Shrinkage Moisture Content (%)	30.3	25.0
Shrinkage (%)	**5.8**	**3.2**
Swell Moisture Content Before (%)	27.0	22.7
Swell Moisture Content After (%)	31.8	29.9
Swell (%)	**0.1**	**2.3**
Shrink Swell Index Iss (%)	**3.3**	**2.4**
Visual Description	**	**
Cracking	Uncracked	Moderately Cracked
Crumbling	No	No
Remarks	Unit Weight = 1.83 t/m3	Unit Weight = 1.95 t/m3

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.
NATA Accreditation does not cover the performance of pocket penetrometer readings.

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Shrink Swell Index Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 110/1** **Page 1 of 1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**	Report Date:	**24/02/2014**
Job Number:	**G14001**	Order Number:	
Project:	**Proposed Subdivision**	Test Method :	**AS1289.7.1.1**
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**		
Lab No:	**98567**	**Sample Location**	**Bore 64** **Depth 1.0m** **Supplied 11/02/14**
Date Sampled:			
Date Tested:	**13/02/2014**		
Sampled By:	**Client**		
Sample Method:	**N/A**		
Material Source:			
For Use As:		Lot Number:	-
Remarks:		Item Number :	-

Page 1 of 1

Shrinkage Moisture Content (%) :	**10.2**	Swell MC Before(%):	**10.5**
Shrinkage (%) :	**0.3**	Swell MC After(%) :	**11.5**
Unit Weight (t/m³) :	**2.22**	PP Before (kPa):	
Swell (%) :	**0.0**	PP After (kPa):	
Shrink Swell Index (Iss %):	**0.2**		

Visual Classification :	**Clayey Sand(SC)-fine to coarse grained,grey,low to medium plasticity fines**
Inert Material Estimate(%):	**0**
Cracking :	**No Cracking**
Crumbling :	**No Crumbling**

NATA WORLD RECOGNISED ACCREDITATION	**Accredited for compliance with ISO/IEC 17025**	APPROVED SIGNATORY Mel Burnett NATA Accred No:1551	FORM NUMBER **REP ASS-1-4**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Shrink Swell Index Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 109/1** **Page 1 of 1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**		
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	Test Method :	**AS1289.7.1.1**
Lab No:	**98566**	**Sample Location**	
Date Sampled:		**Bore 64**	
Date Tested:	**18/02/2014**	**Depth 0.6 -1.0m**	
Sampled By:	**Client**	**Supplied 11/02/14**	
Sample Method:	**N/A**		
Material Source:			
For Use As:		Lot Number:	-
Remarks:	**Remoulded at 98% Std at OMC.**	Item Number :	-

Page 1 of 1

Shrinkage Moisture Content (%) :	**11.1**	Swell MC Before(%):	**11.0**
Shrinkage (%) :	**1.6**	Swell MC After(%) :	**13.3**
Unit Weight (t/m³) :	**2.1**	PP Before (kPa):	
Swell (%) :	**0.1**	PP After (kPa):	
Shrink Swell Index (Iss %):	**0.9**		

Visual Classification :	**Sandy Clay(CI)-low to medium plasticity,grey/grey brown,**
Inert Material Estimate(%):	**0**
Cracking :	**No Cracking**
Crumbling :	**No Crumbling**

NATA WORLD RECOGNISED ACCREDITATION	**Accredited for compliance with ISO/IEC 17025**	APPROVED SIGNATORY Mel Burnett NATA Accred No:1551	FORM NUMBER **REP ASS-1-4**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Shrink Swell Index Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 115/1** **Page 1 of 1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**		
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	Test Method :	**AS1289.7.1.1**
Lab No:	**98582**	**Sample Location**	
Date Sampled:		**Bore 66**	
Date Tested:	**15/02/2014**	**Depth 1.5m**	
Sampled By:	**Client**	**Supplied 13/02/14**	
Sample Method:	**N/A**		
Material Source:			
For Use As:		Lot Number:	-
Remarks:		Item Number :	-

Page 1 of 1

Shrinkage Moisture Content (%) :	**23.9**	Swell MC Before(%):	**23.5**
Shrinkage (%) :	**3.6**	Swell MC After(%) :	**27.1**
Unit Weight (t/m³) :	**1.97**	PP Before (kPa):	
Swell (%) :	**2.5**	PP After (kPa):	
Shrink Swell Index (Iss %):	**2.7**		

Visual Classification :	**Silty Sandy Clay(CH)-high plasticity,pale grey mottled red/orange,fine to med sand**
Inert Material Estimate(%):	**0**
Cracking :	**No Cracking**
Crumbling :	**No Crumbling**

NATA WORLD RECOGNISED ACCREDITATION	**Accredited for compliance with ISO/IEC 17025**	APPROVED SIGNATORY Mel Burnett NATA Accred No:1551	FORM NUMBER **REP ASS-1-4**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech
Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Shrink Swell Index Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 114/1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**		**Page 1 of 1**
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	Test Method :	**AS1289.7.1.1**
Lab No:	**98581**	**Sample Location**	
Date Sampled:		**Bore 66**	
Date Tested:	**20/02/2014**	**Depth 1.3 - 1.6m**	
Sampled By:	**Client**	**Supplied 13/02/14**	
Sample Method:	**N/A**		
Material Source:			
For Use As:		Lot Number:	-
Remarks:	**Remoulded at 98% Std. at OMC.**	Item Number :	-

Page 1 of 1

Shrinkage Moisture Content (%) :	**18.3**	Swell MC Before(%):	**18.5**
Shrinkage (%) :	**1.9**	Swell MC After(%) :	**25.0**
Unit Weight (t/m³) :	**1.94**	PP Before (kPa):	
Swell (%) :	**2.8**	PP After (kPa):	
Shrink Swell Index (Iss %):	**1.8**		

Visual Classification :	**Sandy Clay(CH)-high plasticity,oramge/grey/red brown,fine to medium sand**
Inert Material Estimate(%):	**0**
Cracking :	**No Cracking**
Crumbling :	**No Crumbling**

NATA WORLD RECOGNISED ACCREDITATION	**Accredited for compliance with ISO/IEC 17025**	APPROVED SIGNATORY Mel Burnett NATA Accred No:1551	FORM NUMBER **REP ASS-1-4**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Shrink Swell Index Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 111/1** **Page 1 of 1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**	Report Date:	**24/02/2014**
Job Number:	**G14001**	Order Number:	
Project:	**Proposed Subdivision**	Test Method :	**AS1289.7.1.1**
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**		
Lab No:	**98573**	**Sample Location**	
Date Sampled:		**Bore 73**	
Date Tested:	**18/02/2014**	**Depth 0.95 - 1.3m**	
Sampled By:	**Client**	**Supplied 12/02/14**	
Sample Method:	**N/A**		
Material Source:			
For Use As:		Lot Number:	-
Remarks:	**Remoulded at 98% Std at OMC.**	Item Number :	-

Page 1 of 1

Shrinkage Moisture Content (%) :	**18.0**	Swell MC Before(%):	**17.8**
Shrinkage (%) :	**1.9**	Swell MC After(%) :	**21.2**
Unit Weight (t/m³) :	**1.94**	PP Before (kPa):	
Swell (%) :	**0.6**	PP After (kPa):	
Shrink Swell Index (Iss %):	**1.2**		

Visual Classification :	**Silty Sandy Clay(CH)-high plasticity,orange/red/yellow,fine to med sand**
Inert Material Estimate(%):	**0**
Cracking :	**Minor Cracking**
Crumbling :	**No Crumbling**

NATA WORLD RECOGNISED ACCREDITATION	**Accredited for compliance with ISO/IEC 17025**	APPROVED SIGNATORY Mel Burnett NATA Accred No:1551	FORM NUMBER **REP ASS-1-4**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Shrink Swell Index Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 113/1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**		**Page 1 of 1**
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	Test Method :	**AS1289.7.1.1**
Lab No:	**98576**	**Sample Location**	
Date Sampled:		**Bore 74**	
Date Tested:	**13/02/2014**	**Depth 1.0 - 1.1m**	
Sampled By:	**Client**	**Supplied 12/02/14**	
Sample Method:	**N/A**		
Material Source:			
For Use As:		Lot Number:	-
Remarks:		Item Number :	-

Page 1 of 1

Shrinkage Moisture Content (%) :	**21.6**	Swell MC Before(%):	**20.4**
Shrinkage (%) :	**3.1**	Swell MC After(%) :	**28.0**
Unit Weight (t/m³) :	**1.84**	PP Before (kPa):	
Swell (%) :	**0.0**	PP After (kPa):	
Shrink Swell Index (Iss %):	**1.7**		

Visual Classification :	**Gravelly Sandy Clay(CI)-medium plasticity,orange/red brown,fine to med sand/gravel**
Inert Material Estimate(%):	**20**
Cracking :	**No Cracking**
Crumbling :	**No Crumbling**

NATA WORLD RECOGNISED ACCREDITATION	**Accredited for compliance with ISO/IEC 17025**	APPROVED SIGNATORY Mel Burnett NATA Accred No:1551	FORM NUMBER **REP ASS-1-4**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech
Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Shrink Swell Index Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 112/1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**		**Page 1 of 1**
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	Test Method :	**AS1289.7.1.1**
Lab No:	**98575**	**Sample Location**	
Date Sampled:		**Bore 74**	
Date Tested:	**18/02/2014**	**Depth 1.0 - 1.5m**	
Sampled By:	**Client**	**Supplied 12/02/14**	
Sample Method:	**N/A**		
Material Source:			
For Use As:		Lot Number:	-
Remarks:	**Remoulded at 98% Std. At OMC.**	Item Number :	-

Page 1 of 1

Shrinkage Moisture Content (%) :	**16.8**	Swell MC Before(%):	**16.8**
Shrinkage (%) :	**0.8**	Swell MC After(%) :	**19.1**
Unit Weight (t/m³) :	**2.07**	PP Before (kPa):	
Swell (%) :	**0.2**	PP After (kPa):	
Shrink Swell Index (Iss %):	**0.5**		

Visual Classification :	**Clayey Sand(SC)-fine to coarse grained,red brown,med to high plasticity fines**
Inert Material Estimate(%):	**0**
Cracking :	**No Cracking**
Crumbling :	**No Crumbling**

NATA WORLD RECOGNISED ACCREDITATION	**Accredited for compliance with ISO/IEC 17025**	APPROVED SIGNATORY Mel Burnett NATA Accred No:1551	FORM NUMBER **REP ASS-1-4**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Shrink Swell Index Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 117/1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**		**Page 1 of 1**
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	Test Method :	**AS1289.7.1.1**
Lab No:	**98586**	**Sample Location**	
Date Sampled:		**Bore 84**	
Date Tested:	**15/02/2014**	**Depth 1.0m**	
Sampled By:	**Client**	**Supplied 13/02/14**	
Sample Method:	**N/A**		
Material Source:			
For Use As:		Lot Number:	-
Remarks:		Item Number :	-

Page 1 of 1

Shrinkage Moisture Content (%) :	**23.9**	Swell MC Before(%):	**23.8**
Shrinkage (%) :	**3.6**	Swell MC After(%) :	**26.1**
Unit Weight (t/m³) :	**1.98**	PP Before (kPa):	
Swell (%) :	**2.5**	PP After (kPa):	
Shrink Swell Index (Iss %):	**2.7**		

Visual Classification :	**Silty Sandy Clay(CH)-high plasticity,pale grey mottled orange/red,fine to med sand**
Inert Material Estimate(%):	**0**
Cracking :	**Minor Cracking**
Crumbling :	**No Crumbling**

NATA WORLD RECOGNISED ACCREDITATION	**Accredited for compliance with ISO/IEC 17025**	APPROVED SIGNATORY Mel Burnett NATA Accred No:1551	FORM NUMBER **REP ASS-1-4**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Kawana Laboratory
Author: Mel Burnett
Project No: 14001

Certificate Number: 14001-124

25 February, 2014

Douglas Partners
1/28 Kessling Avenue
Kunda Park Q. 4556

Dear Sir,

RE: Certificate of Laboratory Testing – Project 80967, Proposed Subdivision Caloundra Downs – 167 Bells Creek Road.

1.0 Laboratory Work

Determination of the Emerson Class No. of a Soil (Test Procedure AS1289.3.8.1)

2.0 Laboratory Results

All results are contained in Table 1 attached.

We trust the above meets your requirements, however, should you have any queries, please do not hesitate to contact Mel Burnett at our Kawana laboratory.

Yours faithfully,

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/OEC 17025

M.N. Burnett
Director
<u>GEOTECH (SC) PTY LTD</u>

Table 1

Certificate of Laboratory Testing – Project 80967, Proposed Subdivision Caloundra Downs – 167 Bells Creek Road.

Sample No.	98570	98571	98577	98566	98581	98573	98575	98585	98620	98612	98618	98616	98588
Date Supplied	11.02.14	11.02.14	12.02.14	11.02.14	13.02.14	12.02.14	12.02.14	13.02.14	17.02.14	17.02.14	17.02.14	17.02.14	13.02.14
Borehole	BH52	BH53	BH55	BH64	BH66	BH73	BH74	BH84	BH92	BH98	BH105	BH112	BH114
Depth (m)	0.3-0.9	0.7-1.2	0.8-1.4	0.6-1.0	1.3-1.6	0.95-1.3	1.0-1.5	0.8-1.2	1.05-1.4	0.85-1.2	0.9-1.2	1.0-1.4	0.8-1.1
Emerson Class No:	5	5	6	6	6	6	6	6	6	6	6	6	6
Type of Water	Distilled	Distilled	Distilled	Distilled	Distilled	Distilled	Distilled	Distilled	Distilled	Distilled	Distilled	Distilled	Distilled

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Shrink Swell Index Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 116/1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**		**Page 1 of 1**
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	Test Method :	**AS1289.7.1.1**
Lab No:	**98585**	**Sample Location**	
Date Sampled:		**Bore 84**	
Date Tested:	**20/02/2014**	**Depth 0.8 - 1.2m**	
Sampled By:	**Client**	**Supplied 13/02/14**	
Sample Method:	**N/A**		
Material Source:			
For Use As:		Lot Number:	-
Remarks:	**Remoulded at 98% Std. At OMC.**	Item Number :	-

Page 1 of 1

Shrinkage Moisture Content (%) :	**20.4**	Swell MC Before(%):	**20.7**
Shrinkage (%) :	**3.0**	Swell MC After(%) :	**25.2**
Unit Weight (t/m³) :	**1.9**	PP Before (kPa):	
Swell (%) :	**2.6**	PP After (kPa):	
Shrink Swell Index (Iss %):	**2.4**		

Visual Classification :	**Sandy Clay(CH)-high plasticity,grey/red/orange/yellow,fine to med sand**
Inert Material Estimate(%):	**0**
Cracking :	**No Cracking**
Crumbling :	**No Crumbling**

NATA WORLD RECOGNISED ACCREDITATION	**Accredited for compliance with ISO/IEC 17025**	APPROVED SIGNATORY Mel Burnett NATA Accred No:1551	FORM NUMBER **REP ASS-1-4**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979
Geotech
Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client:	**Douglas Partners Pty. Ltd.**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**
Job Number:	**G14001**
Project:	**Proposed Subdivision**
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**
Lab No:	**98570**
Date Sampled:	
Date Tested:	**17/02/2014**
Sampled By:	**Client**
Sample Method:	**N/A**
Material Source:	**Site**
For Use As:	-
Remarks:	-

Report Number:	**G14001 - 83/1**
Report Date:	**24/02/2014**
Order Number:	-

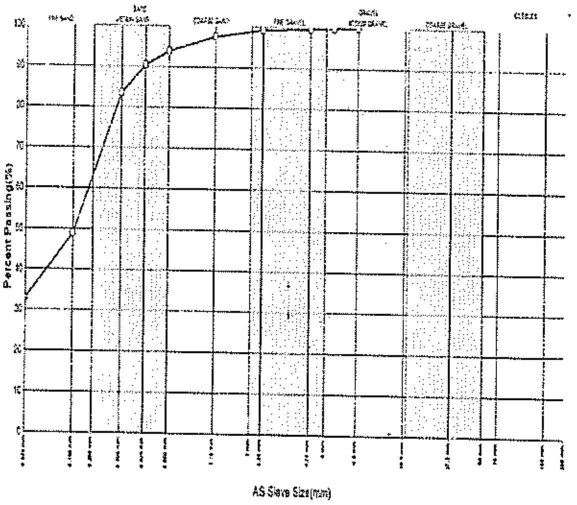
Page 1 of 1

Sample Location

Bore 52
Depth 0.3 - 0.9m
Supplied 11/02/14

Spec Description: -
Lot Number: -
Spec Number: -

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm		**100**	
2.36 mm		**99**	
1.18 mm		**97**	
0.600 mm		**94**	
0.425 mm		**90**	
0.300 mm		**84**	
0.150 mm		**49**	
0.075 mm		**33**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**18**	
Plastic Limit (%)	**AS1289.3.2.1**		**15**	
Plasticity Index	**AS1289.3.3.1**		**3**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**1.5**	

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP AQUAL-1-7

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client: **Douglas Partners Pty. Ltd.**
Client Address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Bells Creek Rd**

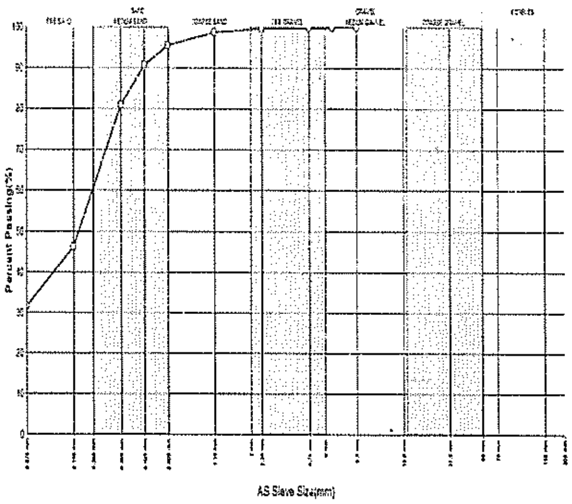
Report Number: **G14001 - 84/1**
Report Date: **24/02/2014**
Order Number: -
Page 1 of 1

Lab No: **98571**
Date Sampled:
Date Tested: **17/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: -
Remarks: -

Sample Location
Bore 53
Depth 0.7 - 1.2m
Supplied 11/02/14

Spec Description: -
Lot Number: -
Spec Number: -

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm			
2.36 mm		**100**	
1.18 mm		**99**	
0.600 mm		**96**	
0.425 mm		**91**	
0.300 mm		**81**	
0.150 mm		**46**	
0.075 mm		**32**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**18**	
Plastic Limit (%)	**AS1289.3.2.1**		**15**	
Plasticity Index	**AS1289.3.3.1**		**3**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**2.5**	

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP AQUAL-1-7

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client: **Douglas Partners Pty. Ltd.**
Client Address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Bells Creek Rd**

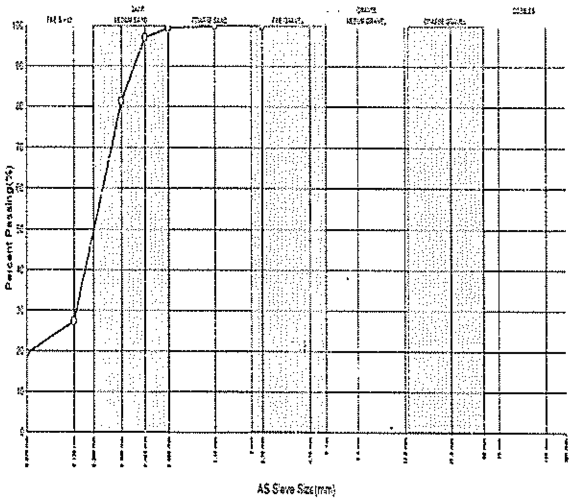
Report Number: **G14001 - 89/1**
Report Date: **24/02/2014**
Order Number: -
Page 1 of 1

Lab No: **98578**
Date Sampled:
Date Tested: **15/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: -
Remarks: -

Sample Location
Bore 54
Depth 1.5 - 1.7m
Supplied 12/02/14

Spec Description: -
Lot Number: -
Spec Number: -

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm			
2.36 mm			
1.18 mm		**100**	
0.600 mm		**99**	
0.425 mm		**97**	
0.300 mm		**81**	
0.150 mm		**27**	
0.075 mm		**19**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**16**	
Plastic Limit (%)	**AS1289.3.2.1**		**14**	
Plasticity Index	**AS1289.3.3.1**		**2**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**1.0**	

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP AQUAL-1-7

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client: **Douglas Partners Pty. Ltd.**
Client Address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Beils Creek Rd**

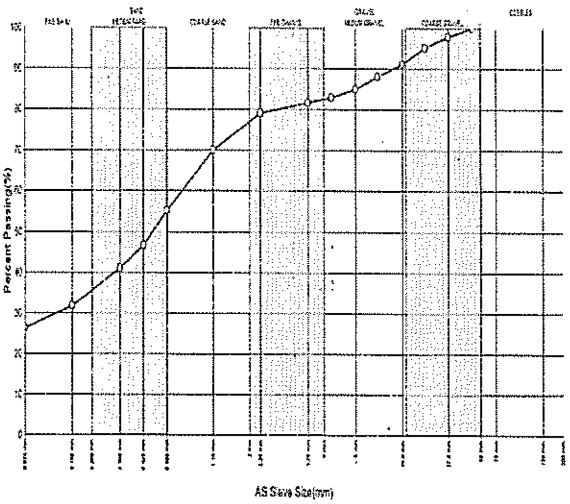
Report Number: **G14001 - 88/1**
Report Date: **24/02/2014**
Order Number: -
Page 1 of 1

Lab No: **98577**
Date Sampled:
Date Tested: **17/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: -
Remarks: -

Sample Location
Bore 55
Depth 0.8 - 1.4m
Supplied 12/02/14

Spec Description: -
Lot Number: -
Spec Number: -

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm		**100**	
37.50 mm		**98**	
26.50 mm		**95**	
19.00 mm		**91**	
13.2 mm		**88**	
9.50 mm		**85**	
6.7 mm		**83**	
4.75 mm		**82**	
2.36 mm		**79**	
1.18 mm		**70**	
0.600 mm		**55**	
0.425 mm		**47**	
0.300 mm		**41**	
0.150 mm		**32**	
0.075 mm		**26**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**41**	
Plastic Limit (%)	**AS1289.3.2.1**		**16**	
Plasticity Index	**AS1289.3.3.1**		**25**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**11.5**	

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP AQUAL-1-7

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client: **Douglas Partners Pty. Ltd.**
Client Address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Bells Creek Rd**

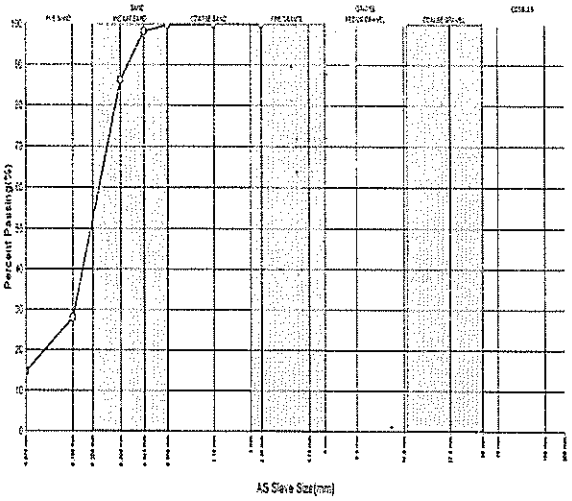
Report Number: **G14001 - 82/1**
Report Date: **24/02/2014**
Order Number: -
Page 1 of 1

Lab No: **98569**
Date Sampled:
Date Tested: **15/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: **-**
Remarks: **-**

Sample Location
Bore 58
Depth 1.0 - 1.4m
Supplied 11/02/14

Spec Description: -
Lot Number: -
Spec Number: -

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm			
2.36 mm			
1.18 mm			
0.600 mm		**100**	
0.425 mm		**98**	
0.300 mm		**86**	
0.150 mm		**28**	
0.075 mm		**15**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**-**	
Plastic Limit (%)	**AS1289.3.2.1**		**-**	
Plasticity Index	**AS1289.3.3.1**		**Non Plastic**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**0.2**	

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP AQUAL-1-7

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979
Geotech
Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client: **Douglas Partners Pty. Ltd.**
Client Address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Bells Creek Rd**

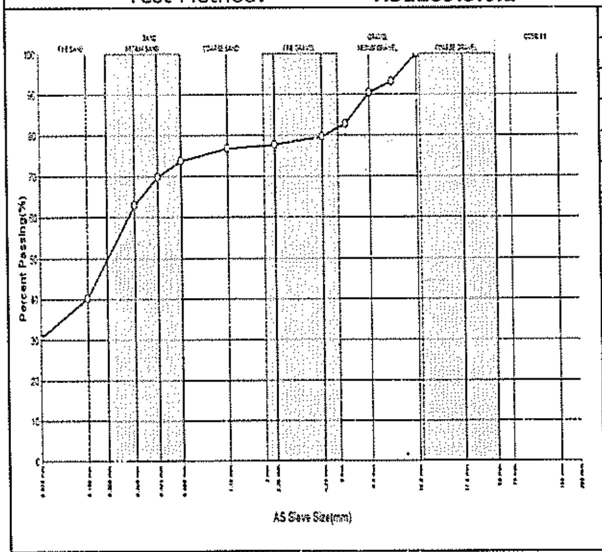
Report Number: **G14001 - 85/1**
Report Date: **24/02/2014**
Order Number: -
Page 1 of 1

Lab No: **98572**
Date Sampled:
Date Tested: **15/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: -
Remarks: -

Sample Location
Bore 63
Depth 1.6 - 1.9m
Supplied 12/02/14

Spec Description: -
Lot Number: -
Spec Number: -

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm		**100**	
13.2 mm		**93**	
9.50 mm		**90**	
6.7 mm		**83**	
4.75 mm		**80**	
2.36 mm		**78**	
1.18 mm		**77**	
0.600 mm		**74**	
0.425 mm		**70**	
0.300 mm		**63**	
0.150 mm		**40**	
0.075 mm		**30**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**32**	
Plastic Limit (%)	**AS1289.3.2.1**		**15**	
Plasticity Index	**AS1289.3.3.1**		**17**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**10.0**	

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP AQUAL-1-7

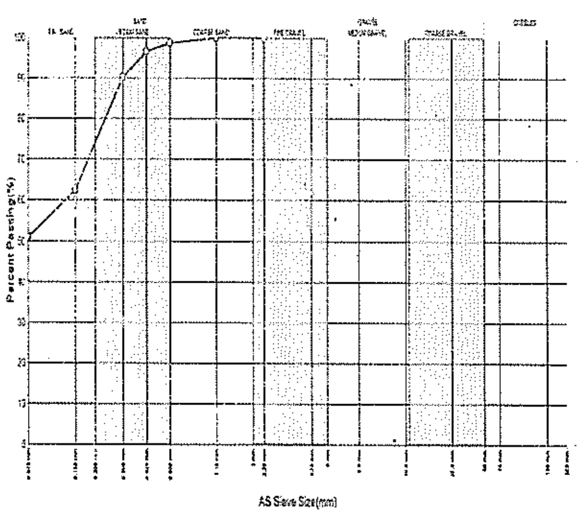
Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979
Geotech
Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 80/1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**		
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	**-**
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	**Page 1 of 1**	
Lab No:	**98566**	**Sample Location**	
Date Sampled:	**11/02/2014**	**Bore 64**	
Date Tested:	**17/02/2014**	**Depth 0.6 -1.0m**	
Sampled By:	**Client**	**Supplied 11/02/14**	
Sample Method:	**N/A**		
Material Source:	**Site**	Spec Description:	-
For Use As:	-	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm			
2.36 mm			
1.18 mm		**100**	
0.600 mm		**99**	
0.425 mm		**97**	
0.300 mm		**90**	
0.150 mm		**62**	
0.075 mm		**51**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**30**	
Plastic Limit (%)	**AS1289.3.2.1**		**11**	
Plasticity Index	**AS1289.3.3.1**		**19**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**11.0**	

NATA WORLD RECOGNISED ACCREDITATION	**Accredited for compliance with ISO/IEC 17025**	Approved Signatory Mel Burnett NATA Accred No:1551	Form Number **REP AQUAL-1-7**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

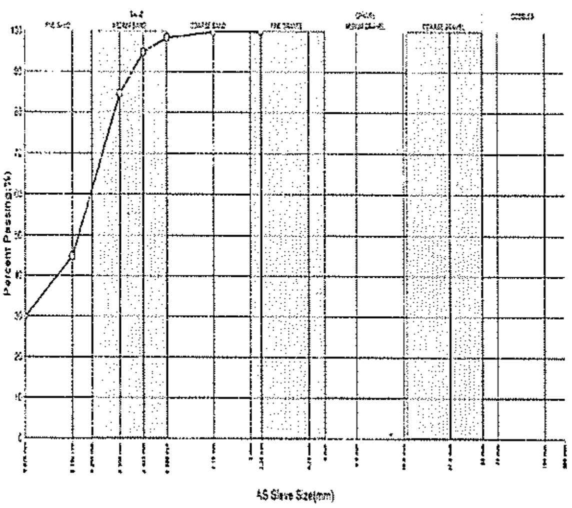
3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 79/1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**		
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	-
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	**Page 1 of 1**	

Lab No:	**98565**	**Sample Location**
Date Sampled:		**Bore 65**
Date Tested:	**15/02/2014**	**Depth 0.2 - 0.6m**
Sampled By:	**Client**	**Supplied 11/02/14**
Sample Method:	**N/A**	
Material Source:	**Site**	Spec Description: -
For Use As:	-	Lot Number: -
Remarks:	-	Spec Number: -

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm			
2.36 mm			
1.18 mm		**100**	
0.600 mm		**98**	
0.425 mm		**95**	
0.300 mm		**85**	
0.150 mm		**45**	
0.075 mm		**30**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**13**	
Plastic Limit (%)	**AS1289.3.2.1**		**11**	
Plasticity Index	**AS1289.3.3.1**		**2**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**0.5**	

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP AQUAL-1-7

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client: **Douglas Partners Pty. Ltd.**
Client Address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Bells Creek Rd**

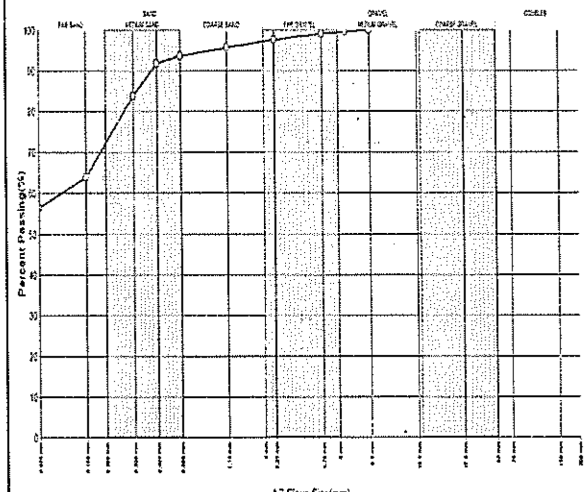
Report Number: **G14001 - 90/1**
Report Date: **24/02/2014**
Order Number: -
Page 1 of 1

Lab No: **98581**
Date Sampled:
Date Tested: **18/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: -
Remarks: -

Sample Location
Bore 66
Depth 1.3 - 1.6m
Supplied 13/02/14

Spec Description: -
Lot Number: -
Spec Number: -

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm		**100**	
4.75 mm		**99**	
2.36 mm		**98**	
1.18 mm		**96**	
0.600 mm		**94**	
0.425 mm		**92**	
0.300 mm		**84**	
0.150 mm		**64**	
0.075 mm		**56**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**60**	
Plastic Limit (%)	**AS1289.3.2.1**		**20**	
Plasticity Index	**AS1289.3.3.1**		**40**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**16.5**	

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP AQUAL-1-7

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

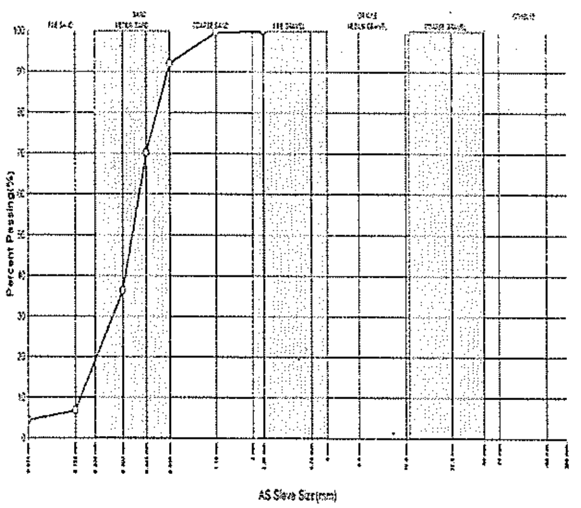
Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 81/1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**		
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	-
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	**Page 1 of 1**	
Lab No:	**98568**	**Sample Location**	
Date Sampled:		**Bore 69** **Depth 1.6 - 2.0m** **Supplied 11/02/14**	
Date Tested:	**15/02/2014**		
Sampled By:	**Client**		
Sample Method:	**N/A**		
Material Source:	**Site**	Spec Description:	-
For Use As:	-	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm			
2.36 mm			
1.18 mm		**100**	
0.600 mm		**92**	
0.425 mm		**70**	
0.300 mm		**36**	
0.150 mm		**7**	
0.075 mm		**4**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**-**	
Plastic Limit (%)	**AS1289.3.2.1**		**-**	
Plasticity Index	**AS1289.3.3.1**		**Non Plastic**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**0.0**	

NATA WORLD RECOGNISED ACCREDITATION **Accredited for compliance with ISO/IEC 17025**	Approved Signatory Mel Burnett NATA Accred No:1551	Form Number **REP AQUAL-1-7**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client: **Douglas Partners Pty. Ltd.**
Client Address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Bells Creek Rd**

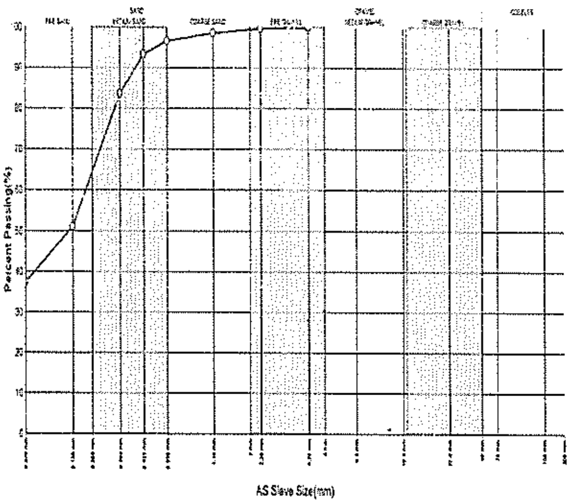
Report Number: **G14001 - 91/1**
Report Date: **24/02/2014**
Order Number: **-**
Page 1 of 1

Lab No: **98583**
Date Sampled:
Date Tested: **18/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: **-**
Remarks: **-**

Sample Location
Bore 72
Depth 0.75m
Supplied 13/02/14

Spec Description: -
Lot Number: -
Spec Number: -

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm			
2.36 mm		**100**	
1.18 mm		**99**	
0.600 mm		**97**	
0.425 mm		**93**	
0.300 mm		**84**	
0.150 mm		**51**	
0.075 mm		**37**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**27**	
Plastic Limit (%)	**AS1289.3.2.1**		**13**	
Plasticity Index	**AS1289.3.3.1**		**14**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**8.5**	

NATA WORLD RECOGNISED ACCREDITATION	**Accredited for compliance with ISO/IEC 17025**	Approved Signatory Mel Burnett NATA Accred No:1551	Form Number **REP AQUAL-1-7**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

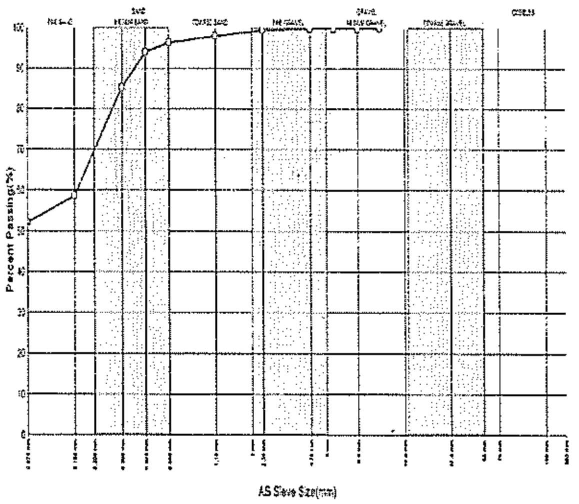
Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 86/1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**		
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	-
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	**Page 1 of 1**	
Lab No:	**98573**	**Sample Location**	
Date Sampled:		**Bore 73**	
Date Tested:	**17/02/2014**	**Depth 0.95 - 1.3m**	
Sampled By:	**Client**	**Supplied 12/02/14**	
Sample Method:	**N/A**		
Material Source:	**Site**	Spec Description:	-
For Use As:	-	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm		**100**	
2.36 mm		**99**	
1.18 mm		**98**	
0.600 mm		**96**	
0.425 mm		**94**	
0.300 mm		**85**	
0.150 mm		**59**	
0.075 mm		**52**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**54**	
Plastic Limit (%)	**AS1289.3.2.1**		**19**	
Plasticity Index	**AS1289.3.3.1**		**35**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**15.5**	

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP AQUAL-1-7

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client: **Douglas Partners Pty. Ltd.**
Client Address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Bells Creek Rd**

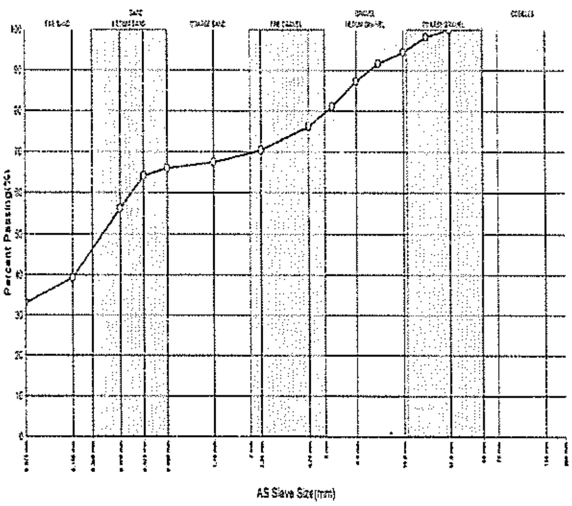
Report Number: **G14001 - 87/1**
Report Date: **24/02/2014**
Order Number: **-**
Page 1 of 1

Lab No: **98575**
Date Sampled:
Date Tested: **17/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: -
Remarks: -

Sample Location
Bore 74
Depth 1.0 - 1.5m
Supplied 12/02/14

Spec Description: -
Lot Number: -
Spec Number: -

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm		**100**	
26.50 mm		**98**	
19.00 mm		**94**	
13.2 mm		**92**	
9.50 mm		**87**	
6.7 mm		**81**	
4.75 mm		**76**	
2.36 mm		**70**	
1.18 mm		**68**	
0.600 mm		**66**	
0.425 mm		**64**	
0.300 mm		**56**	
0.150 mm		**39**	
0.075 mm		**33**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**41**	
Plastic Limit (%)	**AS1289.3.2.1**		**21**	
Plasticity Index	**AS1289.3.3.1**		**20**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**11.0**	

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP AQUAL-1-7

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client: **Douglas Partners Pty. Ltd.**
Client Address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Bells Creek Rd**

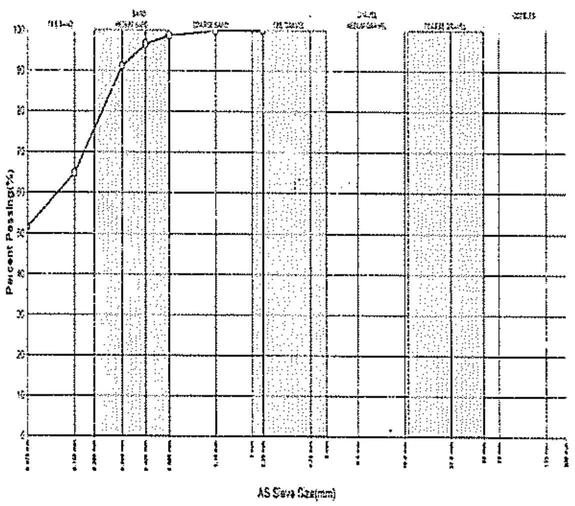
Report Number: **G14001 - 92/1**
Report Date: **24/02/2014**
Order Number: -
Page 1 of 1

Lab No: 98584
Date Sampled:
Date Tested: **18/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: -
Remarks: -

Sample Location
Bore 80
Depth 0.6m
Supplied 13/02/14

Spec Description: -
Lot Number: -
Spec Number: -

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm			
2.36 mm			
1.18 mm		**100**	
0.600 mm		**99**	
0.425 mm		**97**	
0.300 mm		**91**	
0.150 mm		**65**	
0.075 mm		**51**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**23**	
Plastic Limit (%)	**AS1289.3.2.1**		**10**	
Plasticity Index	**AS1289.3.3.1**		**13**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**8.0**	

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP AQUAL-1-7

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

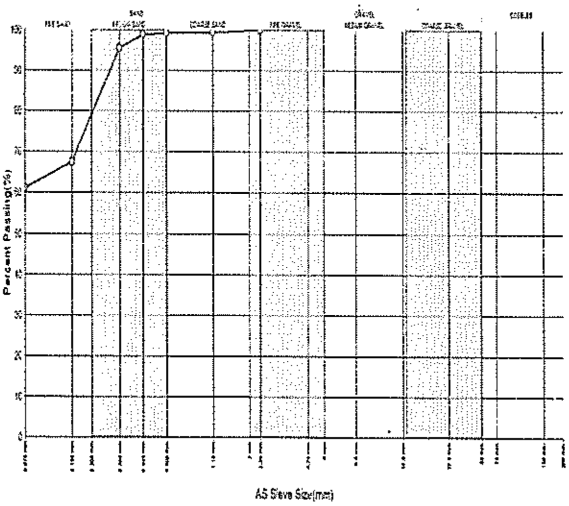
Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

Quality of Materials Report

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 93/1**
Client Address:	**1/28 Kessling Ave Kunda Park Qld 4556**		
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	-
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	**Page 1 of 1**	
Lab No:	**98585**	**Sample Location**	
Date Sampled:		**Bore 84**	
Date Tested:	**18/02/2014**	**Depth 0.8 - 1.2m**	
Sampled By:	**Client**	**Supplied 13/02/14**	
Sample Method:	**N/A**		
Material Source:	**Site**	Spec Description:	-
For Use As:	-	Lot Number:	-
Remarks:	-	Spec Number:	-

Test Method: **AS1289.3.6.1**



A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
75.00 mm			
53.00 mm			
37.50 mm			
26.50 mm			
19.00 mm			
13.2 mm			
9.50 mm			
6.7 mm			
4.75 mm			
2.36 mm			
1.18 mm		**100**	
0.600 mm		**99**	
0.425 mm		**99**	
0.300 mm		**96**	
0.150 mm		**68**	
0.075 mm		**61**	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	**AS1289.3.1.2**		**60**	
Plastic Limit (%)	**AS1289.3.2.1**		**19**	
Plasticity Index	**AS1289.3.3.1**		**41**	
Linear Shrinkage (%)	**AS1289.3.4.1**		**17.0**	

NATA WORLD RECOGNISED ACCREDITATION	**Accredited for compliance with ISO/IEC 17025**	Approved Signatory Mel Burnett NATA Accred No:1551	Form Number **REP AQUAL-1-7**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575

PO Box 2
Buddina Qld 4575

Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

California Bearing Ratio Report (1 Point)

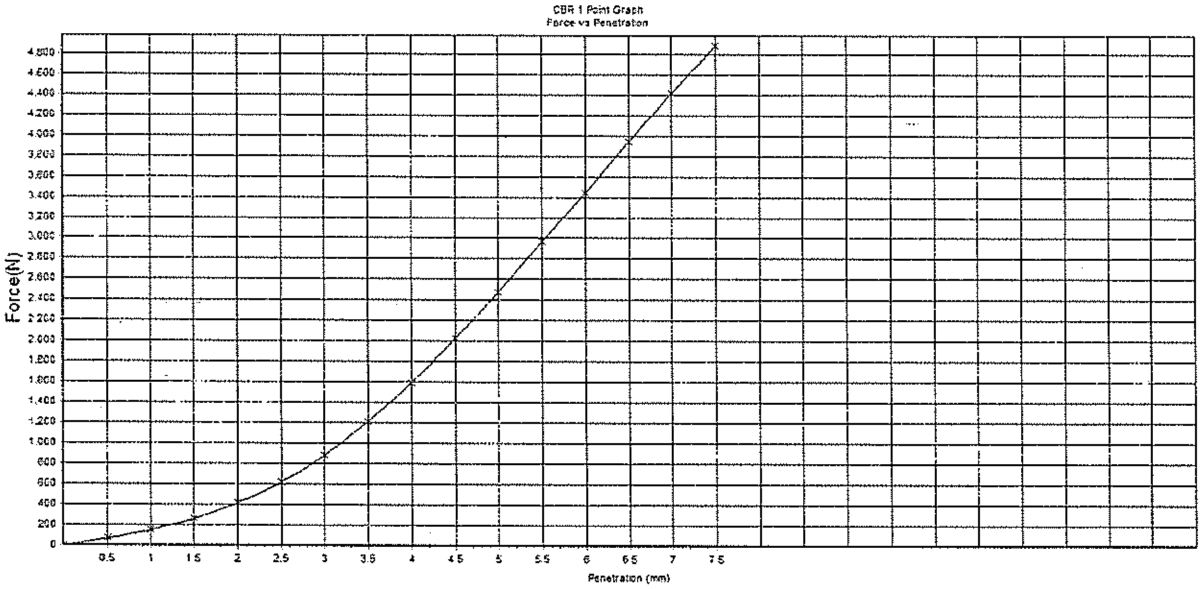
Client: **Douglas Partners Pty. Ltd.**
Client address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Bells Creek Rd**

Report Number: **G14001 - 101/1**
Report Date: **24/02/2014**
Order Number:
Page 1 of 1

Lab No: **98570**
Date Sampled:
Date Tested: **18/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: **-**
Remarks: **-**

Sample Location
Bore 52
Depth 0.3 - 0.9m
Supplied 11/02/14

Test Method : AS1289.6.1.1
Lot Number: **-**
Item Number : **-**



Maximum Dry Density - MDD (t/m³) :	**1.937**	Dry Density after Soak (t/m³) :	**1.889**
Optimum Moisture Content - OMC (%) :	**11.0**	Moisture Content after Soak (%) :	**11.5**
Compactive Effort :	**Standard**	Density Ratio after Soak (%) :	**98**
Nominated % Maximum Dry Density Compaction :	**98**	Field Moisture Content (%) :	**6.8**
Nominated % Optimum Moisture Content Compaction :	**100**	Moisture Content (Top) after Penetration (%) :	**-**
Achieved Dry Density before Soak (t/m³) :	**1.896**	Moisture Content (Total) after Penetration (%) :	**-**
Achieved Percentage of Maximum Dry Density (%) :	**98**	CBR 2.5mm (%) :	**4.5**
Achieved Moisture Content (%) :	**10.5**	CBR 5.0mm (%) :	**13**
Achieved Percentage of Optimum Moisture Content (%) :	**95**	Minimum Specified CBR Value (%) :	**-**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**	**CBR Value (%) :**	**13.0**
Swell (%) / Surcharge (kg):	**0.4 / 4.5 kg**		

Soil Description : Clayey Silty Sand(SM)-fine to medium grained,orange brown,low plasticity fines

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP ACBR_1_3-

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979
Geotech
Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

California Bearing Ratio Report (1 Point)

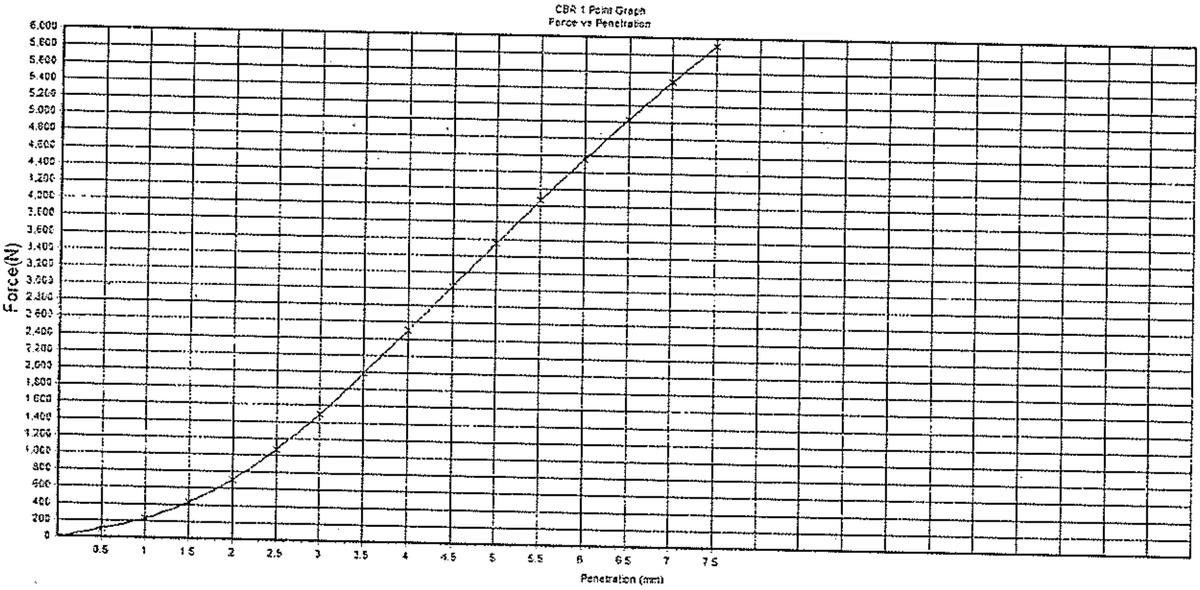
Client:	**Douglas Partners Pty. Ltd.**
Client address:	**1/28 Kessling Ave Kunda Park Qld 4556**
Job Number:	**G14001**
Project:	**Proposed Subdivision**
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**
Lab No:	**98571**
Date Sampled:	
Date Tested:	**18/02/2014**
Sampled By:	**Client**
Sample Method:	**N/A**
Material Source:	**Site**
For Use As:	-
Remarks:	-

Report Number:	**G14001 - 102/1**
Report Date:	**24/02/2014**
Order Number:	

Page 1 of 1

Sample Location
Bore 53
Depth 0.7 - 1.2m
Supplied 11/02/14

Test Method :	AS1289.6.1.1
Lot Number:	-
Item Number :	-



Maximum Dry Density - MDD (t/m³) :	**1.942**	Dry Density after Soak (t/m³) :	**1.898**
Optimum Moisture Content - OMC (%) :	**11.0**	Moisture Content after Soak (%) :	**11.9**
Compactive Effort :	**Standard**	Density Ratio after Soak (%) :	**98**
Nominated % Maximum Dry Density Compaction :	**98**	Field Moisture Content (%) :	**9.1**
Nominated % Optimum Moisture Content Compaction :	**100**	Moisture Content (Top) after Penetration (%) :	
Achieved Dry Density before Soak (t/m³) :	**1.905**	Moisture Content (Total) after Penetration (%) :	-
Achieved Percentage of Maximum Dry Density (%) :	**98**	CBR 2.5mm (%) :	**8**
Achieved Moisture Content (%) :	**10.9**	CBR 5.0mm (%) :	**18**
Achieved Percentage of Optimum Moisture Content (%) :	**99**	Minimum Specified CBR Value (%) :	-
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**	**CBR Value (%) :**	**18.0**
Swell (%) / Surcharge (kg):	**0.4 / 4.5 kg**		

Soil Description : Clayey Silty Sand(SM)-fine to medium grained,orange brown,low plasticity fines

NATA

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP ACBR_1_3-

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

California Bearing Ratio Report (1 Point)

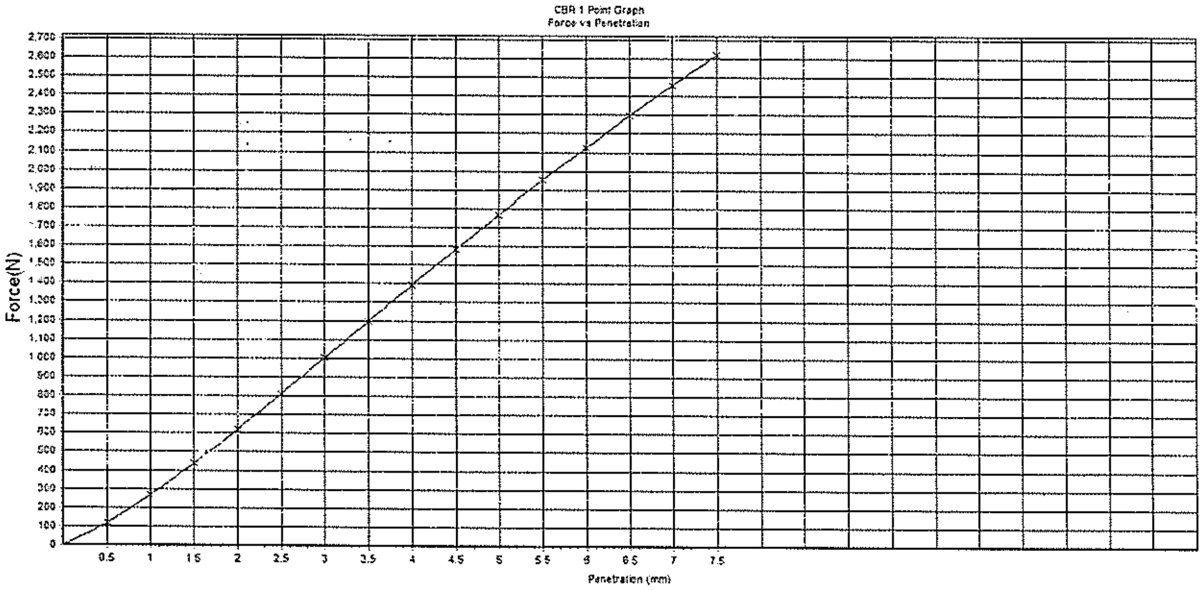
Client: **Douglas Partners Pty. Ltd.**
Client address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Bells Creek Rd**

Report Number: **G14001 - 105/1**
Report Date: **24/02/2014**
Order Number:
Page 1 of 1

Lab No: **98577**
Date Sampled:
Date Tested: **18/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: -
Remarks: -

Sample Location
Bore 55
Depth 0.8 - 1.4m
Supplied 12/02/14

Test Method : AS1289.6.1.1
Lot Number: -
Item Number : -



Maximum Dry Density - MDD (t/m³) :	2.012	Dry Density after Soak (t/m³) :	1.963
Optimum Moisture Content - OMC (%) :	10.4	Moisture Content after Soak (%) :	11.6
Compactive Effort :	Standard	Density Ratio after Soak (%) :	98
Nominated % Maximum Dry Density Compaction :	98	Field Moisture Content (%) :	10.3
Nominated % Optimum Moisture Content Compaction :	100	Moisture Content (Top) after Penetration (%) :	-
Achieved Dry Density before Soak (t/m³) :	1.975	Moisture Content (Total) after Penetration (%) :	-
Achieved Percentage of Maximum Dry Density (%) :	98	CBR 2.5mm (%) :	7.0
Achieved Moisture Content (%) :	10.3	CBR 5.0mm (%) :	9.0
Achieved Percentage of Optimum Moisture Content (%) :	99	Minimum Specified CBR Value (%) :	-
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	Soaked / 4 days	**CBR Value (%) :**	9.0
Swell (%) / Surcharge (kg):	0.6 / 4.5 kg		

Soil Description : Gravelly Clayey Sand(SC)-fine to coarse gr,pale orange,med plasticity fines,fine to coarse gravel

NATA

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP ACBR_1_3-

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

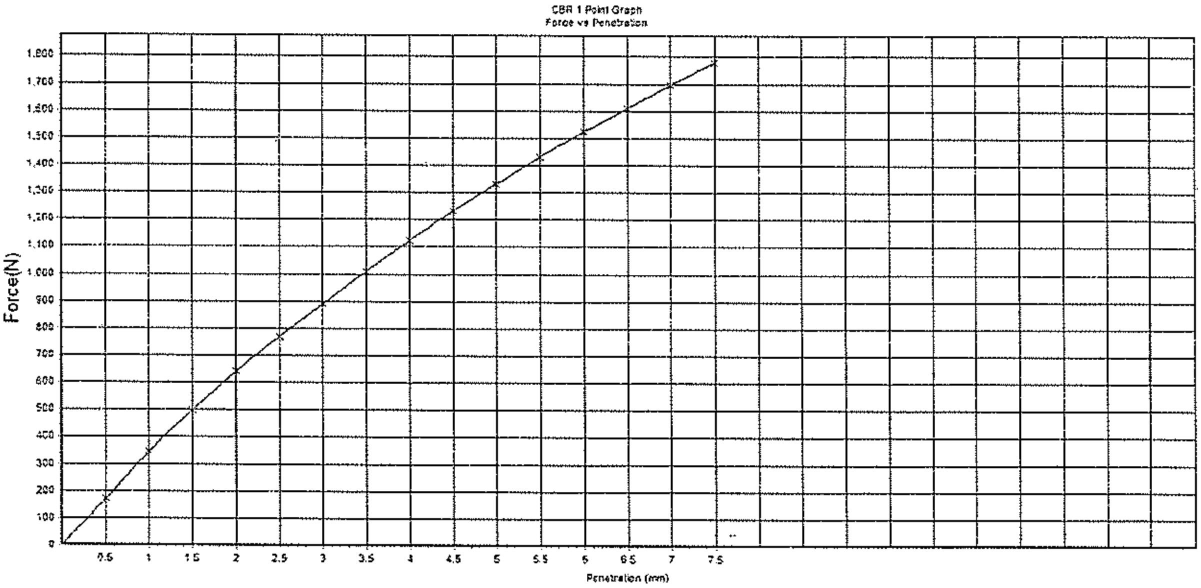
3 Bearing Ave
Warana Qld 4575

PO Box 2
Buddina Qld 4575

Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

California Bearing Ratio Report (1 Point)

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 100/1**
Client address:	**1/28 Kessling Ave Kunda Park Qld 4556**		
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**		**Page 1 of 1**
Lab No:	**98566**	**Sample Location**	
Date Sampled:		**Bore 64**	
Date Tested:	**18/02/2014**	**Depth 0.6 -1.0m**	
Sampled By:	**Client**	**Supplied 11/02/14**	
Sample Method:	**N/A**		
Material Source:	**Site**	**Test Method :**	**AS1289.6.1.1**
For Use As:	**-**	Lot Number:	**-**
Remarks:	**-**	Item Number :	**-**



Maximum Dry Density - MDD (t/m³) :	**1.927**	Dry Density after Soak (t/m³) :	**1.868**
Optimum Moisture Content - OMC (%) :	**11.9**	Moisture Content after Soak (%) :	**13.9**
Compactive Effort :	**Standard**	Density Ratio after Soak (%) :	**97**
Nominated % Maximum Dry Density Compaction :	**98**	Field Moisture Content (%) :	**13.7**
Nominated % Optimum Moisture Content Compaction :	**100**	Moisture Content (Top) after Penetration (%) :	**-**
Achieved Dry Density before Soak (t/m³) :	**1.887**	Moisture Content (Total) after Penetration (%) :	**-**
Achieved Percentage of Maximum Dry Density (%) :	**98**	CBR 2.5mm (%) :	**6.0**
Achieved Moisture Content (%) :	**12.2**	CBR 5.0mm (%) :	**7.0**
Achieved Percentage of Optimum Moisture Content (%) :	**103**	Minimum Specified CBR Value (%) :	**-**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**	**CBR Value (%) :**	**7.0**
Swell (%) / Surcharge (kg):	**1.0 / 4.5 kg**		

Soil Description : Silty Sandy Clay(CI)-low to medium plasticity,grey,fine to medium sand

NATA	**Accredited for compliance with ISO/IEC 17025**	Approved Signatory Mel Burnett NATA Accred No:1551	Form Number **REP ACBR_1_3-**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

California Bearing Ratio Report (1 Point)

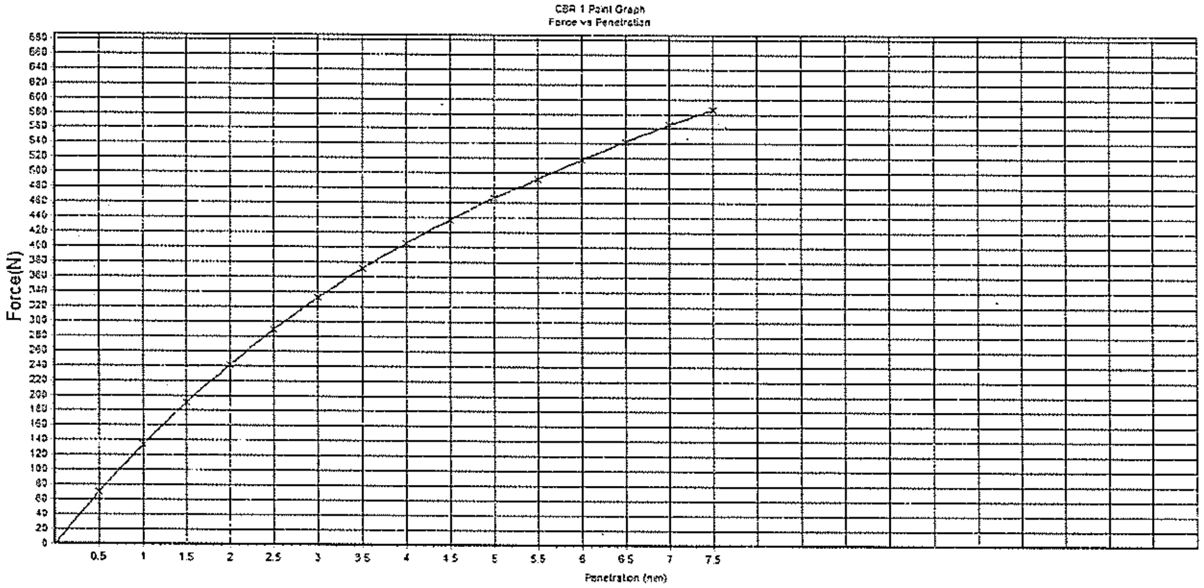
Client: **Douglas Partners Pty. Ltd.**
Client address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Bells Creek Rd**

Report Number: **G14001 - 106/1**
Report Date: **24/02/2014**
Order Number:
Page 1 of 1

Lab No: **98581**
Date Sampled:
Date Tested: **21/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: **-**
Remarks: **-**

Sample Location
Bore 66
Depth 1.3 - 1.6m
Supplied 13/02/14

Test Method : **AS1289.6.1.1**
Lot Number: **-**
Item Number : **-**



Maximum Dry Density - MDD (t/m³) :	**1.683**	Dry Density after Soak (t/m³) :	**1.577**
Optimum Moisture Content - OMC (%) :	**19.1**	Moisture Content after Soak (%) :	**25.8**
Compactive Effort :	**Standard**	Density Ratio after Soak (%) :	**94**
Nominated % Maximum Dry Density Compaction :	**98**	Field Moisture Content (%) :	**21.7**
Nominated % Optimum Moisture Content Compaction :	**100**	Moisture Content (Top) after Penetration (%) :	**-**
Achieved Dry Density before Soak (t/m³) :	**1.656**	Moisture Content (Total) after Penetration (%) :	**-**
Achieved Percentage of Maximum Dry Density (%) :	**98**	CBR 2.5mm (%) :	**2.0**
Achieved Moisture Content (%) :	**18.6**	CBR 5.0mm (%) :	**2.5**
Achieved Percentage of Optimum Moisture Content (%) :	**97**	Minimum Specified CBR Value (%) :	**-**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**	**CBR Value (%) :**	**2.5**
Swell (%) / Surcharge (kg):	**5.0 / 4.5 kg**		

Soil Description : Sandy Clay(CH)-high plasticity,orange mottled red/yellow/grey,fine to med sand

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP ACBR_1_3-

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotechnical Testing Authority

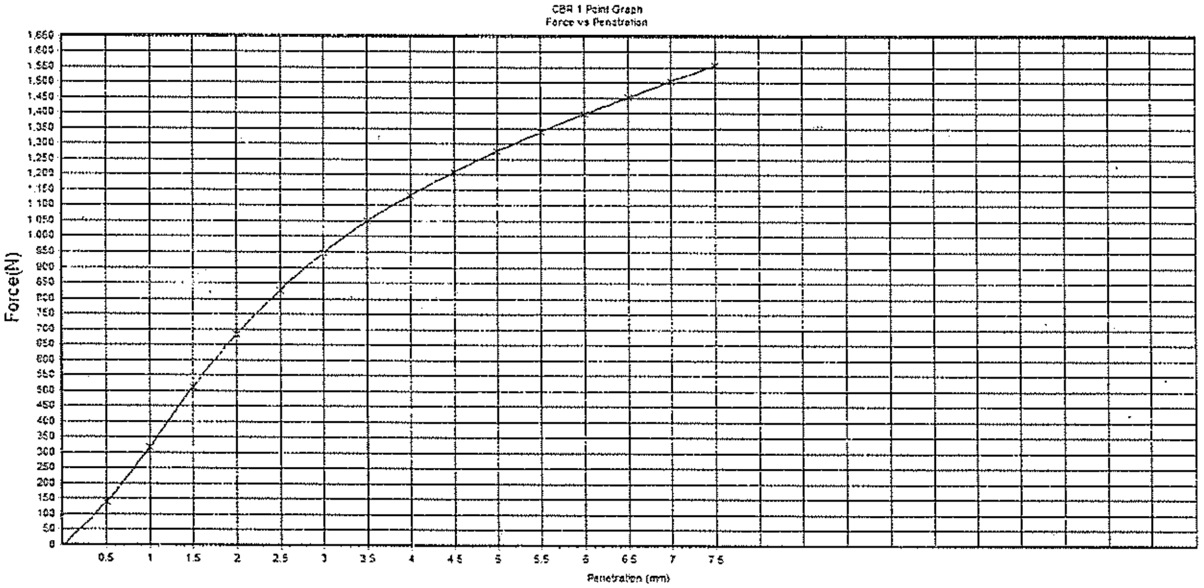
3 Bearing Ave
Warana Qld 4575

PO Box 2
Buddina Qld 4575

Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

California Bearing Ratio Report (1 Point)

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 103/1**
Client address:	**1/28 Kessling Ave Kunda Park Qld 4556**		
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**		**Page 1 of 1**
Lab No:	**98573**	**Sample Location**	
Date Sampled:		**Bore 73**	
Date Tested:	**18/02/2014**	**Depth 0.95 - 1.3m**	
Sampled By:	**Client**	**Supplied 12/02/14**	
Sample Method:	**N/A**		
Material Source:	**Site**	**Test Method :**	**AS1289.6.1.1**
For Use As:	**-**	Lot Number:	**-**
Remarks:	**-**	Item Number :	**-**



Maximum Dry Density - MDD (t/m³) :	**1.678**	Dry Density after Soak (t/m³) :	**1.615**
Optimum Moisture Content - OMC (%) :	**19.3**	Moisture Content after Soak (%) :	**21.6**
Compactive Effort :	**Standard**	Density Ratio after Soak (%) :	**96**
Nominated % Maximum Dry Density Compaction :	**98**	Field Moisture Content (%) :	**18.6**
Nominated % Optimum Moisture Content Compaction :	**100**	Moisture Content (Top) after Penetration (%) :	
Achieved Dry Density before Soak (t/m³) :	**1.648**	Moisture Content (Total) after Penetration (%) :	**-**
Achieved Percentage of Maximum Dry Density (%) :	**98**	CBR 2.5mm (%) :	**7.0**
Achieved Moisture Content (%) :	**18.8**	CBR 5.0mm (%) :	**7.0**
Achieved Percentage of Optimum Moisture Content (%) :	**97**	Minimum Specified CBR Value (%) :	**-**
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	**Soaked / 4 days**	**CBR Value (%) :**	**7.0**
Swell (%) / Surcharge (kg):	**2.1 / 4.5 kg**		

Soil Description : Sandy Clay(CH)-high plasticity,pale yellow/orange brown,fine to medium sand

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory	Form Number
Mel Burnett NATA Accred No:1551	**REP ACBR_1_3-**

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotechnical Testing Authority

3 Bearing Ave
Warana Qld 4575
PO Box 2
Buddina Qld 4575
Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

California Bearing Ratio Report (1 Point)

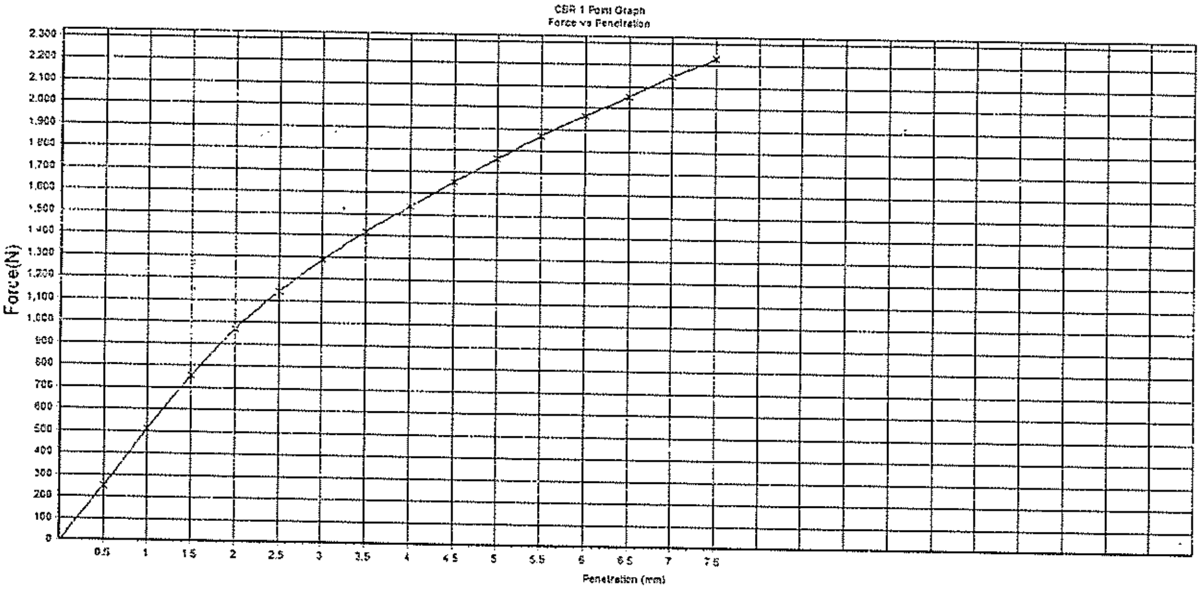
Client: **Douglas Partners Pty. Ltd.**
Client address: **1/28 Kessling Ave Kunda Park Qld 4556**
Job Number: **G14001**
Project: **Proposed Subdivision**
Location **Project No:80967 , Caloundra Downs,167 Bells Creek Rd**

Report Number: **G14001 - 104/1**
Report Date: **24/02/2014**
Order Number:
Page 1 of 1

Lab No: **98575**
Date Sampled:
Date Tested: **18/02/2014**
Sampled By: **Client**
Sample Method: **N/A**
Material Source: **Site**
For Use As: -
Remarks: -

Sample Location
Bore 74
Depth 1.0 - 1.5m
Supplied 12/02/14

Test Method : AS1289.6.1.1
Lot Number: -
Item Number : -



Maximum Dry Density - MDD (t/m^3) :	1.826	Dry Density after Soak (t/m^3) :	1.784
Optimum Moisture Content - OMC (%) :	17.6	Moisture Content after Soak (%) :	19.2
Compactive Effort :	Standard	Density Ratio after Soak (%) :	98
Nominated % Maximum Dry Density Compaction :	98	Field Moisture Content (%) :	18.8
Nominated % Optimum Moisture Content Compaction :	100	Moisture Content (Top) after Penetration (%) :	-
Achieved Dry Density before Soak (t/m^3) :	1.792	Moisture Content (Total) after Penetration (%) :	-
Achieved Percentage of Maximum Dry Density (%) :	98	CBR 2.5mm (%) :	9.0
Achieved Moisture Content (%) :	17.5	CBR 5.0mm (%) :	9.0
Achieved Percentage of Optimum Moisture Content (%) :	99	Minimum Specified CBR Value (%) :	-
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	Soaked / 4 days	**CBR Value (%) :**	9.0
Swell (%) / Surcharge (kg):	0.5 / 4.5 kg		

Soil Description : Gravelly Clayey Sand(SC)-fine to coarse gr,orange brown,med plasticity fines,fine to coarse gravel

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

Form Number
REP ACBR_1_3-

Geotech (S.C.) Pty Ltd ACN 074 982 979 ABN 39 074 982 979

Geotech

Geotechnical Testing Authority

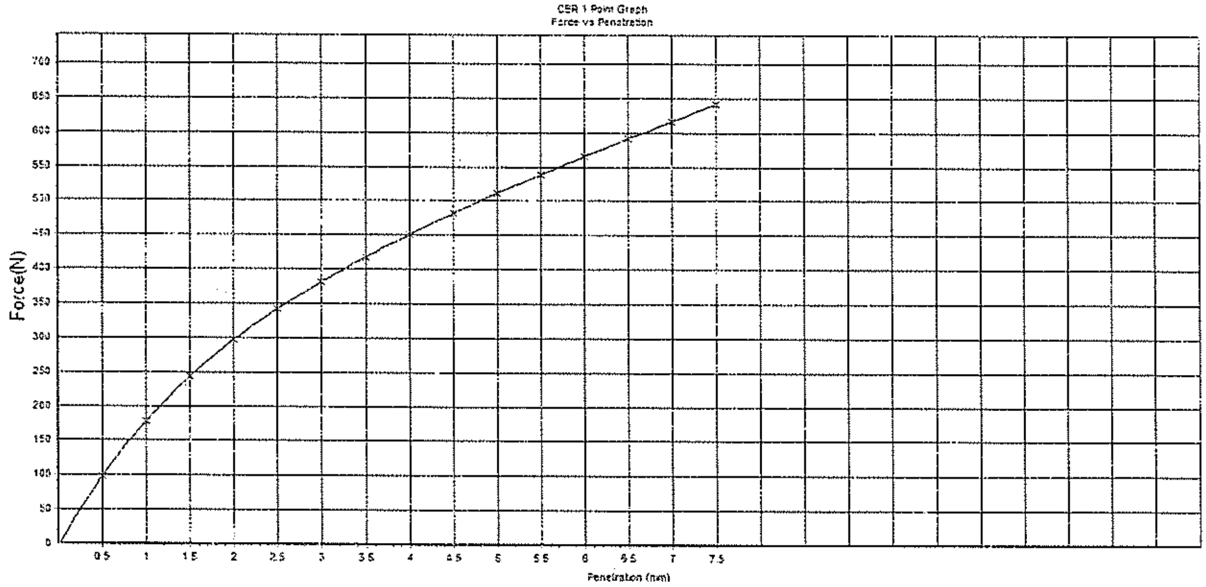
3 Bearing Ave
Warana Qld 4575

PO Box 2
Buddina Qld 4575

Telephone: (07) 5493 1733
Facsimile: (07) 5493 6019
Email: geotechs@ozemail.com.au

California Bearing Ratio Report (1 Point)

Client:	**Douglas Partners Pty. Ltd.**	Report Number:	**G14001 - 107/1**
Client address:	**1/28 Kessling Ave Kunda Park Qld 4556**		
Job Number:	**G14001**	Report Date:	**24/02/2014**
Project:	**Proposed Subdivision**	Order Number:	
Location	**Project No:80967 , Caloundra Downs,167 Bells Creek Rd**	**Page 1 of 1**	
Lab No:	**98585**	**Sample Location**	
Date Sampled:		**Bore 84**	
Date Tested:	**21/02/2014**	**Depth 0.8 - 1.2m**	
Sampled By:	**Client**	**Supplied 13/02/14**	
Sample Method:	**N/A**		
Material Source:	**Site**	**Test Method :**	**AS1289.6.1.1**
For Use As:	-	Lot Number:	-
Remarks:	-	Item Number :	-



Maximum Dry Density - MDD (t/m³) :	1.614	Dry Density after Soak (t/m³) :	1.529
Optimum Moisture Content - OMC (%) :	21.9	Moisture Content after Soak (%) :	27.2
Compactive Effort :	Standard	Density Ratio after Soak (%) :	95
Nominated % Maximum Dry Density Compaction :	98	Field Moisture Content (%) :	22.5
Nominated % Optimum Moisture Content Compaction :	100	Moisture Content (Top) after Penetration (%) :	-
Achieved Dry Density before Soak (t/m³) :	1.586	Moisture Content (Total) after Penetration (%) :	-
Achieved Percentage of Maximum Dry Density (%) :	98	CBR 2.5mm (%) :	2.5
Achieved Moisture Content (%) :	21.8	CBR 5.0mm (%) :	2.5
Achieved Percentage of Optimum Moisture Content (%) :	100	Minimum Specified CBR Value (%) :	-
Test Condition (Soaked/Unsoaked) / Soaking Period (Days) :	Soaked / 4 days	**CBR Value (%) :**	2.5
Swell (%) / Surcharge (kg):	3.7 / 4.5 kg		
Soil Description :	Silty Sandy Clay(CH)-high plasticity,pale red/grey brown,fine to med sand		

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025

Approved Signatory
Mel Burnett
NATA Accred No:1551

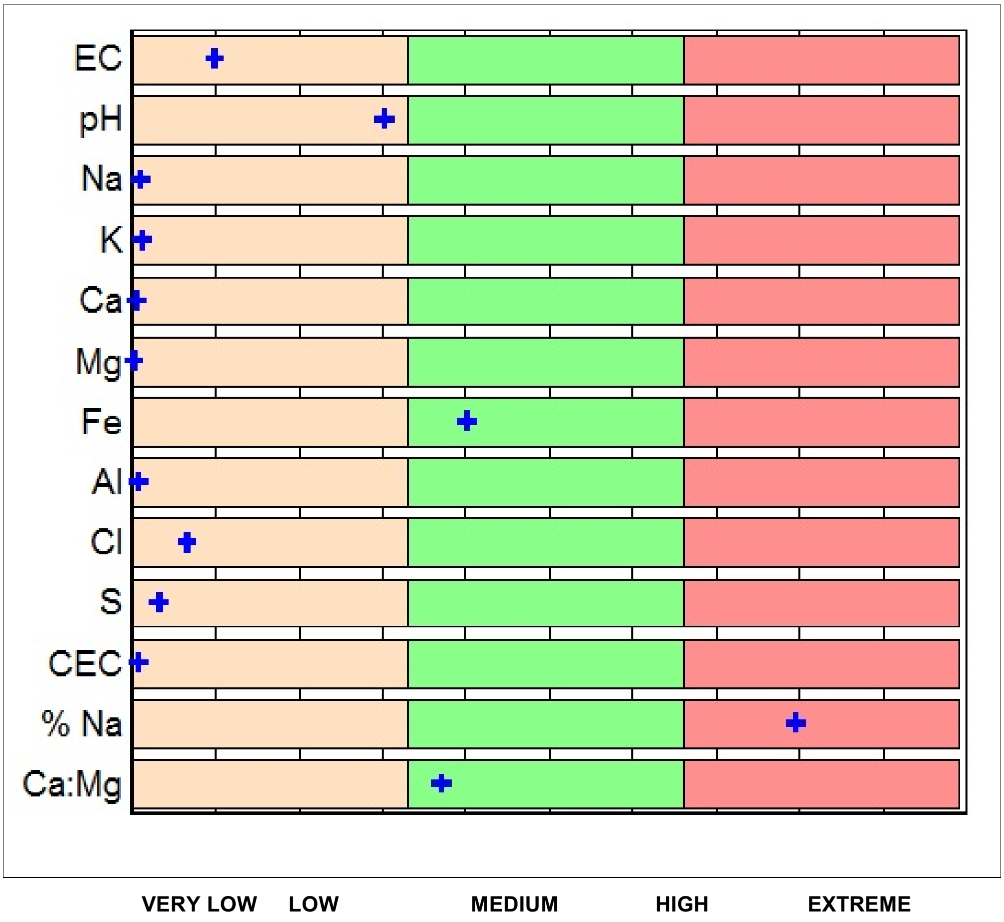
Form Number
REP ACBR_1_3-3

Lab Ref	LR280717.469	Project	80679.05		Sample composite results	Management
Analyte	**Units**	**Test Value**	**Common Range**	**Target Range**	**Comment**	**Code**
EC	**dS/m**	0.03	0.05-0.6	<0.5	low, highly leached	
pH	**ratio**	5.0	5-7.5	6-7	weakly acid	1
Na	**meq/100 g**	0.1	0.1-5	<3	low	
K	**meq/100 g**	0.02	0.1-3	1-5	deficient	4
Ca	**meq/100 g**	0.1	0.3-8	2-5	deficient	1,2
Mg	**meq/100 g**	0.02	0.2-5	1-3	deficient	1
Fe	**mg/kg**	30	5-30	3-30	OK	
Al	**mg/kg**	0.5	10-50	<50	low, OK	
Cl	**mg/kg**	10	5-300	<200	low, OK	
S	**mg/kg**	1	2-60	10-50	deficient	2
CEC	**meq/100 g**	0.2	2-20	-15	low, prone to leaching	
SAR	**ratio**	0.4	0.1-3.0		low	
% Na	**ratio**	50	5-20	<15	low CEC & E.C. so ratio has no value	1,2
Ca:Mg	**ratio**	1.5	0.5-3.0	1.5-2.5	low test results, ratio has no value	
Organic Matter	**%**	0.01	0.05-3	2.5	very low	3
Total N	%	0.03	0.01-0.3	1-3	deficient	4
Nitrate N	**mg/kg**	0.1	<10	1-5	very low	4
Phosphorus	**mg/kg**	7	0.1-20	2-20	low	4
Boron	**mg/kg**	0.02	0.1-2.0	0.2-1.0	low/deficient	4
Copper	**mg/kg**	0.5	0.1-10	0.2-2	OK	
Manganese	**mg/kg**	0.2	1-50	1-5	low/deficient	4
Zinc	**mg/kg**	0.5	0.1-20	1-5	OK	
Emerson Class		8	1-8	>3	good, stable	

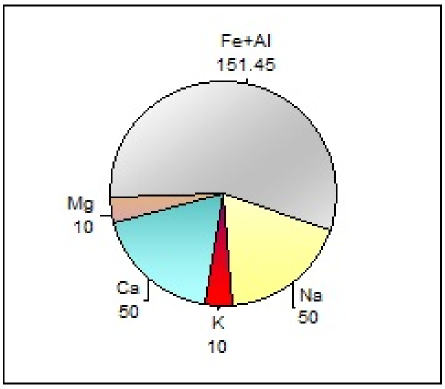
Test Value=measured value **Common Range**=range of concentration commonly encountered **Target Range**=desirable concentration for good plant growth

Summary

Extremely leached soil with almost zero nutrient and organic matter. Will require the addition of dolomite, gypsum, complete NPK+ trace elements as a slow release fertiliser and organic matter



% Cation Distribution



Code	Recommended Management
1	Add 10 tons/ha of dolomite
2	Add 0.5 tons/ha of gypsum
3	Heavy mulch (150-200 mm)
4	Apply 200 kg N, 50 kg P, 100 kg K + trace elements as a slow release (12 month) fertiliser. Also supply 100 kg/ha of Crop King 88 as a pre-plant starter, broadcast before mulching.
5	

Use slow release fertiliser if possible. Equivalent organic products are suitable. In-organic starter NPK

BLENDED FERTILISERS

Requirement: 100 kg N, 50 kg P & 100 kg K per hectare per 30 cm soil depth treated.
Suggested fertilisers listed below. Others can be used. Variation of +/- 20% is acceptable.

The following recommendations apply to the soil analysis LR280717.569

A number of blended fertilisers are listed below.
ANALYSIS -- N P K S Ca Mg Zn Cu Fe B Mo Mn
GF 503-- 30.3 2.2 13.8 0 0 0 0 0 0 0 0 0
GF 526-- 28.5 3.5 13.8 0 0 0 0 0 0 0 0 0
GF 500-- 25.3 3.6 17 0 0 0 0 0 0 0 0 0
GF 518-- 24.9 2.6 19 0 0 0 0 0 0 0 0 0
GF 502-- 25.8 1.6 16.2 2.9 0 0 0 0 0 0 0 0
GF 508-- 24.6 2.4 17.8 1.8 0 0 0 0 0 0 0 0
GF 501-- 23.3 4 16.2 2.4 0 0 0 0 0 0 0 0
GF 504-- 22.1 2.1 22.8 0 0 0 0 0 0 0 0 0
GF 506-- 22.7 2 17.2 4.4 0 0 0 0 0 0 0 0
Tecfeed 880-- 22.2 2 16.8 4.5 0 0 0.6 0.6 0 0 0 0
GF 525-- 21.8 1.6 15.5 7.3 0 0 0 0 0 0 0 0

These are potentially useful as a nutrient source. The list is only some of the commercially available fertilisers and it is expected other types will be as good and possibly better to use. A larger list is attached at the end of this document.

Commercial fertiliser will show the nutrient content on the label. Blended fertilisers typically have a "NPK" value that describes the nitrogen (N), phosphorus (P) and potassium (K) content. For example Crop King 88 has a N-P-K value of 15-4.3-11.3. These indicate that it contains 15% nitrogen, 4. 3% phosphorus and 11. 3% potassium.

The elemental ***content*** is a good starting point. It allows you to calculate the cost in terms of kg element per dollar. The range is considerable and it helps you decide what is a well priced product.

However the ***form*** of the nutrient is also important. For example nitrogen can be present as organic and inorganic nitrogen. inorganic nitrogen can be present as nitrate or the ammonium form. Organic forms can be plant and animal materials as well as synthetic products such as urea, IBDU and a large range of coated products.

The forms in which the nutrients are present are indicated in the following table for one product (Crop King 88):

15%	Nitrogen (N) Ammonia form
4.1%	Phosphorus (P) Water Soluble
0.1%	Phosphorus (P) Citrate Soluble
0.1%	Phosphorus (P) Citrate Insoluble
4.3%	Phosphorus (P) Total
11.3%	Potassium as Muriate of Potash (i.e. the chloride form)
13.6%	Sulphur (S) as Sulphates

The analysis (such as above) should be on the product labelling and should be studied.

The form is important for plant uptake. Some forms are readily utilised by plants (e.g. nitrate N) whilst other need to be transformed (broken down) before plants can utilise them (e.g. urea N). Some forms are highly soluble and are well suited for liquid fertilisers (e.g. nitrate) and others dissolve slowly (e.g. IBDU) and resist leaching by rain and irrigation.

The "best" fertiliser is an affordable product that suits the economic conditions, crop requirements, and environment in which it is used. This can change as the crop grows or seasons change. There is no universal recommendation for plant nutrition.

Rarely will just one fertiliser provide exactly the correct amount and range of nutrients for best plant growth. However in many cases this may be good enough for the performance required. This particularly applies to once off projects such as plant establishment or amateur/ornamental horticulture where optimal plant growth is not required and the cost of fertiliser is a modest consideration.

The agronomy report will have specified a nutrient requirement as kilograms of element (e.g. 50 kg Nitrogen/hectare and 25 kg Potassium/hectare).

If you are lucky you can obtain a blended fertiliser that is close enough to suit your purposes. Be careful to avoid using a fertiliser containing an element that is already high or toxic in the soil. Adding more will not help and is a waste of money!

"Straight or single " fertilisers contain just one compound (e.g. urea has just got nitrogen). You can use urea to "top up" a nutrient mix. For example select a N:P:K fertiliser that supplies all of the phosphorus and is a reasonably close fit for potassium. Now check the nitrogen. If it is low then "top up" using urea.

You can use potassium sulfate to top up potassium and or sulphur. You can use ammonium phosphate to supply nitrogen and phosphorus. If you have a lot of time you can blend your own fertilisers to get just what you want.

The fertiliser list at the end has the product name and then percentage of nutrient listed.

Codes.

N	Nitrogen
P	Phosphorus
K	Potassium
S	Sulphur
Ca	Calcium
Mg	Magnesium
Zn	Zinc
Cu	Copper
Fe	Iron
B	Boron
Mo	Molybdenum
Mn	Manganese

SELECTION OF FERTILISER TYPE

There is no one best fertiliser to suit the application. The fertiliser analysis, form and release period are of most importance. Availability and cost are also important. Whilst slow release and organic fertilisers are more expensive per kilogram of nutrient they suffer less from leaching, are less likely to burn plant roots and provide a significant period of nutrient supply and thus save on labour costs associated with repeated application of fertiliser. Fertiliser with a low nitrogen content (eg. less than 10%) will need to be applied either more often or in larger quantities. Processed poultry manure is a good, all purpose fertiliser but application rates need to be 3-5 times higher than for high analysis inorganic fertiliser.

Grass Areas (playing field intense/not intense traffic, planting areas with a mix of exotic and native species that are not phosphorus sensitive)

Example of a suitable fertiliser for grass: Barmac Links High N 12:1:12 NPK + trace elements, 10-16 week release period.

Notes:

* If the soil can not be irrigated and low soil moisture is anticipated reduce the fertiliser rate by 75% for establishment and 50% for maintenance.

* Do not mow the grass for 4 days after broadcast application

Landscape Areas (planting areas with phosphorus sensitive plants, tube stock planting areas using native plants indigenous to the site and surrounding areas)

A zero or very low P fertiliser is recommended.

Example of a fertiliser for shrubs: Scotts Landscape Special 21.1.9 NPK, 8-9 month release period
For species regarded as highly sensitive to phosphorus (eg. many Australian Proteaceae) then a zero phosphorus fertiliser is recommended eg. Osmocote 18.0.9.3 NPK fertiliser.

REVIEW

The concentration of plant nutrients and other growth factors will change over time in the soil. Careful observation of the plants for an extended period of time combined with periodic soil analysis (eg. every 2-3 years) is recommended if optimal soil conditions are required. The fertiliser program will require routine adjustment to suit the growing conditions, plant condition and expectations for plant growth.

CALCULATIONS

A simple method for calculating the fertiliser requirement is provided. This applies to blended, NPK or straight nitrogen fertiliser.

For a simple management plan base the fertiliser rate on the nitrogen concentration and assume the potassium and phosphorus rates will suffice. This works provided nitrogen is the major element and you have identified whether you need a conventional NPK ratio or a low P fertiliser (eg. for P sensitive plants). Commercial growers will carefully select from a wide range of fertilisers to get the best match between the crop requirements and fertiliser supply. For routine landscape establishment and maintenance where dozens of plant species are involved a highly specialised program can be extremely difficult to implement.

1 Identify the required nitrogen application rate using units of kg N/ha.
For example **N=75 kg/ha**

2 Identify the nitrogen concentration of your fertiliser as a percentage.
For example: **percentage=15%**

3 To calculate the fertiliser treatment rate required per hectare divide the nitrogen application rate by the percentage (%N) and multiply by 100.
For example 75 / 15 x 100 = 500 kg of fertiliser required per hectare

In this example if you apply 500 kg of a fertiliser containing 15% nitrogen to one hectare you will end up applying 75 kg of nitrogen per hectare.

4 Identify the area of treatment in hectares. There are 10,000 square metres per hectare.
For example the area is 200 m long and 40 m wide = 8000 m2 = 0.8 hectares

5 To calculate the fertiliser you apply to the land multiply the area of land by the fertiliser treatment rate
For example 0.8 ha x 500 kg fertiliser/ha = 400 kg of fertiliser.

If you are comfortable with maths then the above calculations can be combined using the following values:

N=nitrogen required per hectare	units of kg N/ha
P=percentage nitrogen in fertiliser	percentage points not as a decimal fraction
A=area to be fertilised	units of hectares

Fertiliser Required = N*100*A/P units of kg fertiliser to be applied

Using the above example
N=75 kg/ha
P=15 percentage (not as a decimal fraction)
A=0.8 ha

Fertiliser Required = 75*100*0.8/15
= 400 kg

Product	N	P	K	S	Ca	Mg	Zn	Cu	Fe	B	Mo
Organo Tecfeed 101	4.5	5.5	6.9	10.5	10.6	1.1	0.06	0.05	0.13	0.05	0.007
Organo Tecfeed 201	10.5	3.3	10	12.1	3.1	1.1	0.06	0.05	0.13	0.05	0.007
Tecfeed 356	7.4	10.7	11	8.1	5.4	0	0.1	0	0.1	0.05	0.007
Tecfeed 509*	12.3	5	13.5	15.6	0	1.1	0.06	0.05	0.13	0.05	0.007
Tecfeed 801**	9.7	21.2	0	1.9	0	0	1.8	0	0	0	0
Tecfeed 802**	9.5	20.7	0	1.9	0	0	3.5	0	0	0	0
Tecfeed 804	17.2	19.1	0	1.6	0	0	1	1.9	0	0	0
Tecfeed 806	17.5	19.4	0	1.6	0	0	1.8	0	0	0	0
Tecfeed 807	17.1	18.9	0	1.6	0	0	3.5	0	0	0	0
Tecfeed 810	44.8	0	0	0	0	0	1.8	0	0	0	0
Tecfeed 815	45.6	0	0	0	0	0	0	0.4	0	0	0
Tecfeed 818	11.6	11.3	16.2	2.6	0	0	0.6	1.8	0	0	0
Tecfeed 821	12.3	13.1	13.2	1.7	0	0	1.7	1.7	0	0	0
Tecfeed 822	8.2	6.1	25.2	3.8	0	0	1.7	1.7	0	0	0
Tecfeed 824	11.4	9.4	17	4.3	0	0	1	1	0	0	0
Tecfeed 827	11.4	9.4	17	4.3	0	0	2.6	0.2	0	0	0
Tecfeed 828	11.4	9.4	17.1	4.4	0	0	0.6	1.8	0	0	0
Tecfeed 829	11.7	9.6	17.5	4.5	0	0	0.6	0.2	0	0	0
Tecfeed 830**	11.8	16.9	0	6.4	0	0	1.8	0	0	0	0
Tecfeed 833	29.1	9.5	0	3	0	0	1.8	0	0	0	0
Tecfeed 842**	32.2	7.9	0	0.7	0	0	1	0	0	0	0
Tecfeed 845	10.7	11.9	18	1	0	0	2.6	0.2	0	0	0
Tecfeed 851	7.8	8.6	26	0.7	0	0	2.6	0.3	0	0	0
Tecfeed 852	7.8	8.7	26	0.7	0	0	0.9	1.8	0	0	0
Tecfeed 854	12.7	14	12.5	1.2	0	0	2.6	0.3	0	0	0
Tecfeed 855	12.7	14.1	12.6	1.2	0	0	0.9	1.8	0	0	0
Tecfeed 858	0	8.7	0	10.5	19.1	0	0.9	0.9	0.3	0	0.02
Tecfeed 865	12.7	1.7	13.7	18.9	0	0	0.8	0.8	0	0	0
Tecfeed 870	11.7	9.2	17	4.8	0	0	0.8	0.4	0.1	0.05	0.008
Tecfeed 871**	28.8	9.7	0	0.9	0	0	1.8	0	0	0	0
Tecfeed 875	10.4	7.4	20.2	5	0	0	2.6	0	0	0	0
Tecfeed 880	22.2	2	16.8	4.5	0	0	0.6	0.6	0	0	0
Tecfeed 887	12	7.8	14.6	6.5	0	0	2.6	2.1	0	0	0
Tecfeed 888**	8.6	12.3	13.1	4.7	0	0	1.8	0	0	0	0
Tecfeed 890	13.3	11.8	12.5	4.1	0	0	1.7	0	0	0	0
Tecfeed 891	14	11.1	11	5.6	0	0	0.4	0	0.1	0.2	0.008
Tecfeed 892	11.1	6.1	19.2	7.2	0	0	0.6	0	0.1	0.2	0.008
Tecfeed 893	15.2	3.1	10.2	14.9	0	0	0.5	0	0.1	0.2	0.008
Tecfeed 895	11.2	2.1	20.2	11.2	0	0	0.4	0	0.1	0.2	0.008
Tecfeed 896*	12.3	12.6	12.2	7.1	0	0	0.5	0	0	0.2	0
Tecfeed 897*	13	2.1	13.2	18.7	0	0	0.5	0	0	0.2	0
Tecfeed 898*	12.4	12.6	12.3	7.6	0	0	0.5	0	0.08	0.05	0.005
Organo 102	7.5	8.4	14.2	3.1	3.4	4	0	0	0	0	0
Organo 103	4.1	5.5	6.4	10.6	12.3	0	0	0	0	0	0
Organo 107	9.4	10.9	10	1.7	3.5	0	0	0	0	0	0
Organo 110	5.3	6	5.2	8.4	10.3	0	0	0	0	0	0
Organo 120	6.3	6.4	12.5	5.1	6.1	0	0	0	0	0	0
Organo 125	10.7	8.7	16	4	1	0	0	0	0	0	0
Organo 128	10.8	3.9	17.1	8.9	1	0	0	0	0	0	0
Organo 130	10	11	16.6	0.9	1.1	0	0	0	0	0	0
Organo 135	11.8	13	11.6	1.1	1.1	0	0	0	0	0	0
Organo 155	12.2	9	9.3	5.3	1.5	0	0	0	0	0	0
Organo 210	11	5.3	6.4	9.6	3.9	0	0	0	0	0	0
Organo 215	4.3	4.3	33.2	0.7	1	0	0	0	0	0	0
Organo 217	7.3	8	24.1	0.7	1.1	0	0	0	0	0	0
Organo 225	8.2	6.1	22.9	3.6	1	0	0	0	0	0	0
Organo 260	6.3	4.5	28.2	2.9	1	0	0	0	0	0	0
Organo Vermicom 102	7.4	8.2	14	3.1	2.6	4.1	0	0	0.24	0	0
Organo Vermicom 120	5.7	6.1	12.2	5.2	4.7	0	0	0	0.48	0	0
Organo Vermicom 125	10.4	8.6	15.8	4	0	0	0	0	0.24	0	0
Organo Vermicom 128	10.5	3.7	17	8.9	0	0	0	0	0.24	0	0
Organo Vermicom 130	9.6	10.7	16.6	0.9	0	0	0	0	0.26	0	0
Organo Vermicom 135	11.5	12.8	11.5	1.1	0	0	0	0	0.26	0	0
Organo Vermicom 156	11.7	8.8	9	5.4	0	0	0	0	0.38	0	0
Organo Vermicom 301	10.7	11.9	10.7	1	0	0	0	0	0.38	0	0
Organo Vermicom 303	12.5	2.6	8.8	12.4	0	0	0	0	0.38	0	0
Organo Vermicom 304	9.8	9.6	13.6	2.3	0	0	0	0	0.38	0	0
Organo Vermicom 306	4.3	4.9	4	10.7	10.6	0	0	0	0.38	0	0
Organo Vermicom 351	9.7	8	14.2	3.7	0	0	0	0	0.38	0	0
Organo Vermicom 352	9.3	2.8	16.6	8.4	0	0	0	0	0.38	0	0
Organo Vermicom 364	10.3	8.9	12	3.7	0	0	0.35	0	0.38	0	0
Organo Vermicom 401	7.4	5.7	20.4	3.3	0	0	0	0	0.38	0	0
GF 301	13.2	14.7	13.2	1.2	0	0	0	0	0	0	0
GF 302	11.2	12.4	19	1.1	0	0	0	0	0	0	0
GF 303	15.4	3	11	15.4	0	0	0	0	0	0	0
GF 304	12	11.7	17	2.8	0	0	0	0	0	0	0
GF 305	11.9	4.4	19.2	9.9	0	0	0	0	0	0	0
GF 306	5.3	5.8	5	13.2	12.8	0	0	0	0	0	0
GF 307	11.9	5.4	19	8.9	0	0	0	0	0	0	0
GF 310	8	9	8.5	10.1	6.5	0	0	0	0	0	0
GF 312	8.1	10.6	10	7.8	4.5	0	0	0	0	0	0
GF 320	0	15.2	0	6	17.4	0	0	0	0	0	0
GF 321	6.5	14.1	0	8.6	10.2	0	0	0	0	0	0
GF 350**	12.1	17.3	0	6.6	0	0	0	0	0	0	0
GF 351	12	9.8	17.8	4.6	0	0	0	0	0	0	0
GF 352	11.5	3.2	20.8	10.5	0	0	0	0	0	0	0

Product	**N**	**P**	**K**	**S**	**Ca**	**Mg**	**Zn**	**Cu**	**Fe**	**B**	**Mo**
GF 353	5.3	6.4	1.8	14	14.1	0	0	0	0	0	0
GF 354	0	14.4	15	1	10.5	0	0	0	0	0	0
GF 357	5.3	9.3	12.5	7.4	6.8	0	0.88	0	0	0.18	0
GF 358	0	8.5	0	10.8	18.8	0	0.88	0.94	0	0	0
GF 361	6.3	11.8	6	8.2	8.6	0	0	0	0	0	0
GF 363 (Scheduled Poison)	9.5	7.5	20	5.4	0	0	3	0	0	0	0
GF 364	12.7	10.9	15	4.6	0	0	0.44	0	0	0	0
GF 365 (Scheduled Poison)	13	14.4	11.1	2.2	0	0	2	0	0	0	0
GF 366	18.9	11.8	0	10.8	0	0	0	0	0	0	0
GF 367**	14.2	12.9	0	11	0	0	0	0	0	0	0
GF 369* (Scheduled Poison)	11.1	12.4	8.6	6.1	0	0	2.5	2.5	0	0	0
GF 401	9.1	6.9	25.5	4.1	0	0	0	0	0	0	0
GF 402	6.5	6.1	32.2	1.7	0	0	0	0	0	0	0
GF 403	8.2	9.1	27.2	0.8	0	0	0	0	0	0	0
GF 404	4.5	5	37.5	0	0	0	0	0	0	0	0
GF 405	30	9.8	0	3	0	0	0	0	0	0	0
GF 406	10.2	3.3	6.8	16	7.2	0	0	0	0	0	0
GF 407	10	1.6	24.8	10.3	0	0	0	0	0	0	0
GF 410	4	8.7	19	5.4	6.3	0	0	0	0	0	0
GF 411	0	6.1	16.5	7.4	13.4	0	0	0	0	0	0
GF 420***	11.3	3.6	20.1	7.8	1.9	3.5	0	0	0	0	0
GF 449*	14.5	8	9.8	13.6	0	0	0	0	0	0	0
GF 450*	13	1.8	14.1	19.4	0	0	0	0	0	0	0
GF 451*	13.4	13.7	10.6	6.8	0	0	0	0	0	0	0
GF 454	11.6	2.5	17.8	16.4	0	0	0	0	0	0	0
GF 456	18.8	13	0	9.4	0	0	0	0	0	0	0
GF 460	19.7	4.9	0	18.5	0	0	0	0	0	0	0
GF 461	10.9	2	18	13.1	1.5	0	0	0	0	0	0
GF 462	15.4	1.4	11.5	16.9	0	0	0	0	0	0	0
GF 463	10.8	8.6	17	4.3	0	4.3	0	0	0	0	0
GF 470**	29.8	9.9	0	0.9	0	0	0	0	0	0	0
GF 500	25.3	3.6	17	0	0	0	0	0	0	0	0
GF 501	23.3	4	16.2	2.4	0	0	0	0	0	0	0
GF 502	25.8	1.6	16.2	2.9	0	0	0	0	0	0	0
GF 503	30.3	2.2	13.8	0	0	0	0	0	0	0	0
GF 504	22.1	2.1	22.8	0	0	0	0	0	0	0	0
GF 505	29	0	18.5	0	0	0	0	0	0	0	0
GF 506	22.7	2	17.2	4.4	0	0	0	0	0	0	0
GF 507	40.2	0	0	5.4	0	0	0	0	0	0	0
GF 508	24.6	2.4	17.8	1.8	0	0	0	0	0	0	0
GF 518	24.9	2.6	19	0	0	0	0	0	0	0	0
GF 520	34	3.8	0	6.6	0	0	0	0	0	0	0
GF 525	21.8	1.6	15.5	7.3	0	0	0	0	0	0	0
GF 526	28.5	3.5	13.8	0	0	0	0	0	0	0	0
GF 535	27.9	1.6	17.2	0	0	0	0	0	0	0	0
GF 540	23.9	0	24	0	0	0	0	0	0	0	0
GF 541	21.6	0	21.5	4.3	0	0	0	0	0	0	0
GF 542	29.1	2	12	3	0	0	0	0	0	0	0
GF 545	28	3.4	13	1.5	0	0	0	0	0	0	0
GF 549	14.7	0	34	0	0	0	0	0	0	0	0
GF 550	19.6	0	28.8	0	0	0	0	0	0	0	0
GF 551	40.7	3.8	0	0	0	0	0	0	0	0	0
GF 552	27.5	2.1	13.2	3.3	0	0	0	0	0	0	0
GF 553	32.9	0	14.2	0	0	0	0	0	0	0	0
GF 554	27.4	0	16.8	3	0	0	0	0	0	0	0
GF 555	29	0	14	3.8	0	0	0	0	0	0	0
GF 560	25	2.7	14.8	3.6	0	0	0	0	0	0	0
GF 562	37.2	3.6	0	3.8	0	0	0	0	0	0	0
GF 564	36	1.2	6.8	2	0	0	0	0	0	0	0
GF 565	36.8	0	10	0	0	0	0	0	0	0	0
GF 567	33.1	0	0	12	0	0	0	0	0	0	0
GF 571	35.2	0	7.5	3.6	0	0	0	0	0	0	0
GF 572	35.7	0	0	9.6	0	0	0	0	0	0	0
GF 573	31.7	2.8	8.2	2.9	0	0	0	0	0	0	0
GF 575	25.3	5	12	2.9	0	0	0	0	0	0	0
GF 581	31.8	5.2	7.5	0	0	0	0	0	0	0	0
GF 582	29.1	5	7.5	3.2	0	0	0	0	0	0	0
GF 584	18.4	1.8	27.2	0	0	0	0	0	0	0	0
GF 585	26.4	3.4	12.5	3.4	0	0	0	0	0	0	0
GF 586	31.1	1.6	10.2	3.1	0	0	0	0	0	0	0
GF 588	32.8	0	11	2.8	0	0	0	0	0	0	0
CAN 655	13.5	0	25	0	4	0	0	0	0	0	0
CAN 656*	12.2	0	22.6	9.1	3.6	0	0	0	0	0	0
CAN 657	13.1	2.5	23.8	0	3.2	0	0	0	0	0	0
CAN 658	20.3	0	12.5	0	6	0	0	0	0	0	0
CAN 659	18.8	2.7	13	0	4.8	0	0	0	0	0	0
CAN 660	16.7	2	17.5	0	4.4	0	0	0	0	0	0
CAN 661	19.6	1.8	10.5	3.3	4.6	0	0	0	0	0	0
CAN 662	20.5	2.4	10	0	5.4	0	0	0	0	0	0
CAN 663	25.7	3	0	0	6.8	0	0	0	0	0	0
CAN 664	24.5	3.2	0	3.9	5.5	0	0	0	0	0	0
CAN 665	19.8	0	12	2.6	5.2	0	0	0	0	0	0
CAN 667	18.8	2	13.5	0	5	0	0	0	0	0	0

Product	N	P	K	S	Ca	Mg	Zn	Cu	Fe	B	Mo
CAN 668	18.2	1.6	13.5	3	4.2	0	0	0	0	0	0
CAN 669	18.9	2	12	2.8	4.4	0	0	0	0	0	0
CAN 670	22.6	2.6	6	0	6	0	0	0	0	0	0
CAN 671	17.6	0	17.5	0	5.2	0	0	0	0	0	0
CAN 672	20.2	2.6	9.5	2.1	4.8	0	0	0	0	0	0
CAN 673	18.2	3.6	12	2.7	3.8	0	0	0	0	0	0
CAN 674	20.8	1.8	9	2.1	5.2	0	0	0	0	0	0
CAN 675	19.4	0	13	2.2	5.2	0	0	0	0	0	0
CAN 676	20	0	13	0	5.9	0	0	0	0	0	0
CAN 677	20.2	12	0	5.8	1.6	0	0	0	0	0	0
CAN 678	21.6	0	10	0	6.4	0	0	0	0	0	0
Flowfeed N46	46	0	0	0	0	0	0	0	0	0	0
GF Ammonium Nitrate	34	0	0	0	0	0	0	0	0	0	0
GF CAN (Calcium Ammonium Nitrate)	27	0	0	0	8	0	0	0	0	0	0
GF DAP	18	20	0	1.6	0	0	0	0	0	0	0
GF Hi P Super	0	20.7	0	1.4	15	0	0	0	0	0	0
GF MAP	10	21.9	0	1.5	0	0	0	0	0	0	0
GF Muriate of Potash	0	0	50	0	0	0	0	0	0	0	0
GF Stockfeed Urea	46	0	0	0	0	0	0	0	0	0	0
GF Sulphate of Ammonia	20.2	0	0	24	0	0	0	0	0	0	0
GF Sulphate of Potash	0	0	41	18	0	0	0	0	0	0	0
GF Super	0	8.8	0	11	20	0	0	0	0	0	0
GF Super Mo 250 (Ex Bris. & Cairns)	0	8.8	0	11	20	0	0	0	0	0	0.025
GF Super Mo 500 (Ex Newcastle)	0	8.8	0	11	20	0	0	0	0	0	0.05
GF Urea Granular	46	0	0	0	0	0	0	0	0	0	0
Incitec Easy ATS (Analysis is w/v)	16	0	0	34	0	0	0	0	0	0	0
Incitec Easy Cal (Analysis is w/v)	12.6	0	0	0	18.1	0	0	0	0	0	0
Incitec Easy KS (Analysis is w/v)	0	0	30	25	0	0	0	0	0	0	0
Incitec Easy N (Analysis is w/v)	42.5	0	0	0	0	0	0	0	0	0	0
Incitec Easy PK (Analysis is w/v)	1	12	24	0	0	0	0	0	0	0	0
Incitec Granulock STZ	10.5	19.5	0	2.2	0	0	2.5	0	0	0	0
Incitec Liquifert Pinnacle	34	0	0	0	0	0	0	0	0	0	0
Incitec Phosphogypsum	0	0	0	14.5	18.5	0	0	0	0	0	0
Incitec Prilled Potassium Nitrate	13.2	0	38.2	0	0	0	0	0	0	0	0
Incitec Starter Z Lite	10.3	20.5	0	1.9	0	0	1.5	0	0	0	0
Incitec Stockfeed Sulfur	0	0	0	98.8	0	0	0	0	0	0	0
BASF Nitrophoska Blue Special	12	5.2	14.1	6	4.3	1.2	0.01	0	0.05	0.02	0
Copper Oxy Sulfate	0	0	0	1.3	0	0	0	25	0	0	0
Incitec Granomag AL7	0	0	0	0	0	54	0	0	0	0	0
Granubor	0	0	0	0	0	0	0	0	0	15	0
Manganese Sulfate	0	0	0	18	0	0	0	0	0	0	0
Incitec Zinc Sulfate Monohydrate	0	0	0	17.2	0	0	35	0	0	0	0
Incitec Sulfate of Ammonia (Crystalline)	20.5	0	0	24	0	0	0	0	0	0	0

CERTIFICATE OF ANALYSIS

Analysis By: Bio-Track Pty Ltd
ABN 91 056 237 275
Mt. Glorious Road
Highvale, Brisbane, Australia, 4520
Ph. 07 3289 7179 Fx. 07 3289 7155

DATE OF REPORT 18 AUGUST 2017
CLIENT NAME Brett Egen c/o Douglas Partners Pty Ltd
CLIENT ADDRESS 439 Montague Rd West End Brisbane 4101
PROJECT NAME Agronomic Testing
SAMPLING DATE NUMBER OF SAMPLES 4 SAMPLE TYPE:Soil/Solid
PACKAGING Plastic Bag ** SAMPLES DISPOSED ON 26/09/2017
DATE RECEIVED 28/07/2017 11:14:43 AM LAB REF. LR280717.469

Page 1 of 1 Report Pages.

YOUR PROJECT/JOB REFERENCE 80679.05

METHODOLOGY: EC pH Cl as 1:5 air dried soil in water, 30 minute rolling shake, Cl by ion selective electrode. Na K Mg Ca Fe Al S as 1:20 soil dried soil in 1 N NH4Cl, 60 minute rolling shake, Na K Mg Ca Fe Al S measured by ICP OES CEC (cation exchange capacity) as the sum of extracted cations (no pretreatment for soluble salts), SAR (sodium adsorption ratio) as Na/((Ca+Mg)/2)^0.5, %Na as Na% of CEC. (meq/100 =milli-equivalents/100 g soil)

SAMPLE ID Site depth	**EC dS/m**	**pH**	**Na meq/100**	**K meq/100**	**Ca meq/100**	**Mg meq/100**	**Fe mg/kg**	**Al mg/kg**	**Cl mg/kg**	**S mg/kg**	**ECEC meq/100**	**SAR ratio**	**%Na ratio**	**Ca:Mg ratio**
Site179 0-0.25	0.02	5.0	0.2	<0.1	0.3	<0.1	1	2	12	<1	0.5	0.42	32.6	3.8
Site158 0-0.4	0.05	5.1	0.1	<0.1	<0.1	<0.1	<1	<1	28	3	0.2	0.46	49.2	1.4
Site196 0-0.15	0.04	4.8	<0.1	<0.1	<0.1	<0.1	<1	<1	8	<1	0.1	0.30	42.1	1.4
Site188 0-0.4	0.02	5.0	<0.1	<0.1	<0.1	<0.1	<1	<1	5	<1	<0.1	0.39	62.0	0.7

Signatory

For and behalf of Bio-Track Pty Ltd

Determination of Trace Elements in Soil

CERTIFICATE OF ANALYSIS

Analysis By: Bio-Track Pty Ltd ABN 91 056 237 275781 Mt. Glorious Road Highvale, Brisbane, Australia, 4520 Ph. 07 3289 7179 Fx. 07 3289 7155

DATE OF REPORT	18 AUGUST 2017
CLIENT NAME	Brett Egen c/o Douglas Partners Pty Ltd
CLIENT ADDRESS	439 Montague Rd West End Brisbane 4101
PROJECT NAME	Agronomic Testing
SAMPLING DATE	NUMBER OF SAMPLES 4
PACKAGING	Plastic Bag
DISPOSAL	SAMPLES DISPOSED ON 26/09/2017
LOG-IN DATE	28/07/2017 11:14:43 AM LAB REF. LR280717.469
METHOD	As per Aust Lab Handbook of Soil & Water Chemical Methods Method 12A1, 12C1
METHOD	Results gravimetric, oven dry

SAMPLE ID SAMPLE ID	B mg/kg	Cu mg/kg	Fe mg/kg	Mn mg/kg	Zn mg/kg
Site 179 0-0.25	0.4	0.5	42	< 1	1.7
Site 158 0-0.4	< 0.1	0.6	20	< 1	0.2
Site 196 0-0.15	< 0.1	0.5	50	< 1	0.9
Site 188 0-0.4	< 0.1	0.4	26	< 1	0.1

Signatory For and behalf of Bio-Track Pty Ltd

www.biotrack.com.au
781 Mt Glorious Rd Highvale 4520

Certificate of Analysis

Signatory:

Phone: +617 3289 7179 Bio-Track Pty Ltd ABN 91 056 237 275

Test Code/Name	**[20] Agronomic Test Suite #4**		
Lab Reference (LR)	**280717.469**	Client Name	Douglas Partners Pty Ltd
SampleID	**All Samples**	Client Contact	Brett Egen
		Project Name	Agronomic Testing
Report Date	11/08/2017	Job Number	80679.05
Sample Received Date	28/07/2017	Order Number	
Sample Disposal Date	26/09/2017	Chain of Custody	
Sample Packaging	Plastic Bag	Client Email	brett.egen@douglaspartners.com.au
Temperature	Ambient	Client Address	439 Montague Rd West End Brisbane Queensland 4101

***Organic Carbon to Organic Matter Conversion Factor: 1.724**

S#	SampleID	Organic Carbon %	*Organic Matter %	Total Nitrogen %	C/N Ratio
1	Site 179 0-0.25	**0.004**	**0.007**	**0.037**	**0.10**
2	Site 158 0-0.4	**0.004**	**0.007**	**0.035**	**0.11**
3	Site 196 0-0.15	**0.004**	**0.007**	**0.034**	**0.11**
4	Site 188 0-0.4	**0.016**	**0.028**	**0.035**	**0.46**

www.biotrack.com.au
781 Mt Glorious Rd Highvale 4520

Certificate of Analysis

Signatory:

Phone: +617 3289 7179   Bio-Track Pty Ltd   ABN 91 056 237 275

Test Code/Name	**[20] Agronomic Test Suite #4**		
Lab Reference (LR)	**280717.469**	Client Name	Douglas Partners Pty Ltd
SampleID	**All Samples**	Client Contact	Brett Egen
		Project Name	Agronomic Testing
Report Date	18/08/2017	Job Number	80679.05
Sample Received Date	28/07/2017	Order Number	
Sample Disposal Date	26/09/2017	Chain of Custody	
Sample Packaging	Plastic Bag	Client Email	brett.egen@douglaspartners.com.au
Temperature	Ambient	Client Address	439 Montague Rd West End Brisbane Queensland 4101

Analytical Method: **As per Olsen-P (9C), Colwell-P (9B), Soil Chemical Methods - Australasia, Raymont & Lyons, 2001.**

S#	SampleID	Olsen P mg P/kg
1	Site 179 0-0.25	**3**
2	Site 158 0-0.4	**7**
3	Site 196 0-0.15	**10**
4	Site 188 0-0.4	**7**

www.biotrack.com.au
781 Mt Glorious Rd Highvale 4520

Certificate of Analysis

Signatory:

Phone: +617 3289 7179 Bio-Track Pty Ltd ABN 91 056 237 275

Test Code/Name	**[20] Agronomic Test Suite #4**		
Lab Reference (LR)	**280717.469**	Client Name	Douglas Partners Pty Ltd
SampleID	**All Samples**	Client Contact	Brett Egen
		Project Name	Agronomic Testing
Report Date	18/08/2017	Job Number	80679.05
Sample Received Date	28/07/2017	Order Number	
Sample Disposal Date	26/09/2017	Chain of Custody	
Sample Packaging	Plastic Bag	Client Email	brett.egen@douglaspartners.com.au
Temperature	Ambient	Client Address	439 Montague Rd West End Brisbane Queensland 4101

Analytical Method: As per Emerson, WW 1967, A classification of soil aggregrates based on their coherence in water.
Australian Journal of Soil Research, 5: 47-57.

S#	SampleID	Emerson Class
1	Site 179 0-0.25	**8**
2	Site 158 0-0.4	**8**
3	Site 196 0-0.15	**8**
4	Site 188 0-0.4	**8**

www.biotrack.com.au
781 Mt Glorious Rd Highvale 4520

Certificate of Analysis

Signatory:

Phone: +617 3289 7179   Bio-Track Pty Ltd   ABN 91 056 237 275

Test Code/Name	**[20] Agronomic Test Suite #4**		
Lab Reference (LR)	**280717.469**	Client Name	Douglas Partners Pty Ltd
SampleID	**All Samples**	Client Contact	Brett Egen
		Project Name	Agronomic Testing
Report Date	14/08/2017	Job Number	80679.05
Sample Received Date	28/07/2017	Order Number	
Sample Disposal Date	26/09/2017	Chain of Custody	
Sample Packaging	Plastic Bag	Client Email	brett.egen@douglaspartners.com.au
Temperature	Ambient	Client Address	439 Montague Rd West End Brisbane Queensland 4101

Analytical Method: 1:5 in 0.01M CaCl2. 2 hour rolling shake. Measurement by ICP.

S#	SampleID	Nitrate mg P/kg
1	Site 179 0-0.25	0.1
2	Site 158 0-0.4	0.3
3	Site 196 0-0.15	< 0.1
4	Site 188 0-0.4	< 0.1

APPENDIX C:
STORMWATER QUANTITY MANAGEMENT PLAN BY EGIS

21-000307.11

STORMWATER MANAGEMENT PLAN

AURA PRECINCT 15 WEST

Prepared for **Stockland Development Pty Ltd**

Document information

GENERAL INFORMATION

Author(s)	Kyle Vaughan
Version	B
Path/file name	..\21\000307.11 - Aura Precinct15 DA\2_Docs\P15_West_Local_Flooding_Aug2023\21-000307.11.SWMP02B.DY.kv.docx
Prepared by (author)	Kyle Vaughan
Reviewed by	Daniel Yates
Approved by	Daniel Yates
Security classification	Staff-in-Confidence

HISTORY OF CHANGES

Version	Date	Checked by
DRAFT	06-Sep-2023	Daniel Yates
A	27-Sep-2023	Daniel Yates
B	08-Dec-2023	Daniel Yates

Version	Date	Approved by
A	27-Sep-2023	Daniel Yates
B	08-Dec-2023	Daniel Yates

TABLE OF CONTENTS

1 INTRODUCTION 4
1.1 Site Description 4
2 HYDROLOGY MODELLING 7
2.1 Catchment Delineation 7
2.2 Design Rainfall 7
2.3 Critical Duration and Temporal Patterns 8
2.4 Verification 8
2.5 Infiltration Losses, Manning's, and Storage (Bx) Factor Values 8
3 OPEN CHANNEL 9
3.1 Design Criteria 9
3.2 Hydraulic Modelling 11
3.3 Results 13
3.4 Conclusion 23
4 SOUTHERN PIPE NETWORK (PIPE X) 24
4.1 Design Criteria 24
4.2 Hydraulic Modelling 24
4.3 Results 25
4.4 Conclusion 25
5 CONCLUSION 26
6 RECOMMENDATIONS 26
APPENDIX A: OPEN CHANNEL DESIGN DRAWINGS 27
APPENDIX B: DRAINAGE LAYOUT PLANS 29

TABLE OF FIGURES

Figure 1-1 Site Locality 4
Figure 1-2 Drainage Layout 5
Figure 3-1 Open Channel Typical Section 12
Figure 3-2 Road Crossing Section 12
Figure 3-3 Pedestrian Crossing Section 13
Figure 3-4 Open Channel Reporting SECTION Locations Plan 14
Figure 4-1 Southern Drainage Pipe X Plan and Section 24

1 INTRODUCTION

Egis Consulting has been engaged by Stockland Development Pty Ltd to prepare this Stormwater Management Plan report to accompany the submission of a Development Application for Reconfiguration of a Lot over the western portion of the subject site known as Aura Precinct 15 West. The purpose of this report is to investigate the required conveyance methodologies required to direct the external flows documented within Egis's Technical Memorandum '*Aura Precinct 15 West: Acoustic Bund Drainage Design*' (Egis reference *21-000307.11.WRE.TM01B.DY.kv.docx*, dated 8/12/2023), through Precinct 15 West and how they can be incorporated into the proposed site layout. The aim of this Stormwater Management Plan is to identify external drainage opportunities, constraints and provide design solutions which comply with the relevant Aura Local Government Infrastructure Agreement and relevant guidelines, demonstrating that the proposed development can mitigate any adverse flooding impacts.

The design development for Precinct 15 West includes an open channel that bisects the site and an underground drainage pipeline that traverses the southern site boundary. Both the open channel and the underground pipeline have been designed to safely convey design flows from the external catchments west of and including the Bruce Highway through the subject site to Bells Creek South. External upstream catchment flows enter the site via cross drainage within the Department of Transport and Main Roads (TMR) corridor and proposed drainage structures within an acoustic bund that straddles the TMR corridor and the western site boundary, these are further discussed within Egis's Technical Memorandum '*Aura Precinct 15 West: Acoustic Bund Drainage Design*' (Egis reference *21-000307.11.WRE.TM01B.DY.kv.docx*, dated 8/12/2023).

1.1 Site Description

Refer to the following **Figure 1-1** showing the locality of Precinct 15 'West' known within this report as the 'Site'.

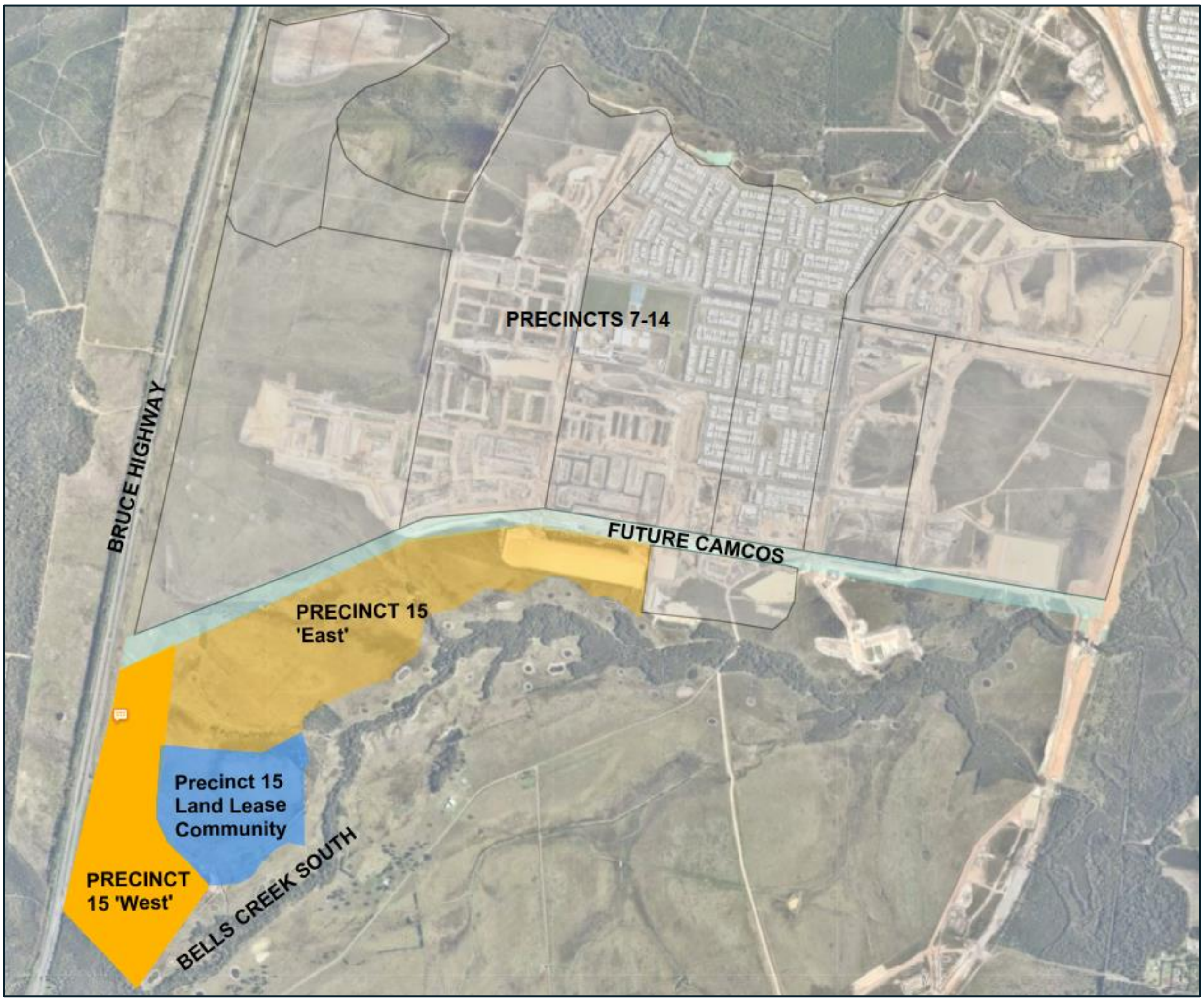


FIGURE 1-1 SITE LOCALITY

Precinct 15 is located within the Western locality of Aura. The Precinct is bound by the Bruce Highway to the West, the future CAMCOS corridor to the North and Bells Creek South to the South. The western portion of this Precinct forms Precinct 15 'West'.

The site forms part of the Caloundra South Priority Development Area (Aura). The Master Plan was approved by the (former) Urban Land Development Authority (ULDA reference No. DEV2011/200) now Economic Development Queensland (EDQ).

Figure 1-2 below depicts the proposed drainage configuration detailed within this report.

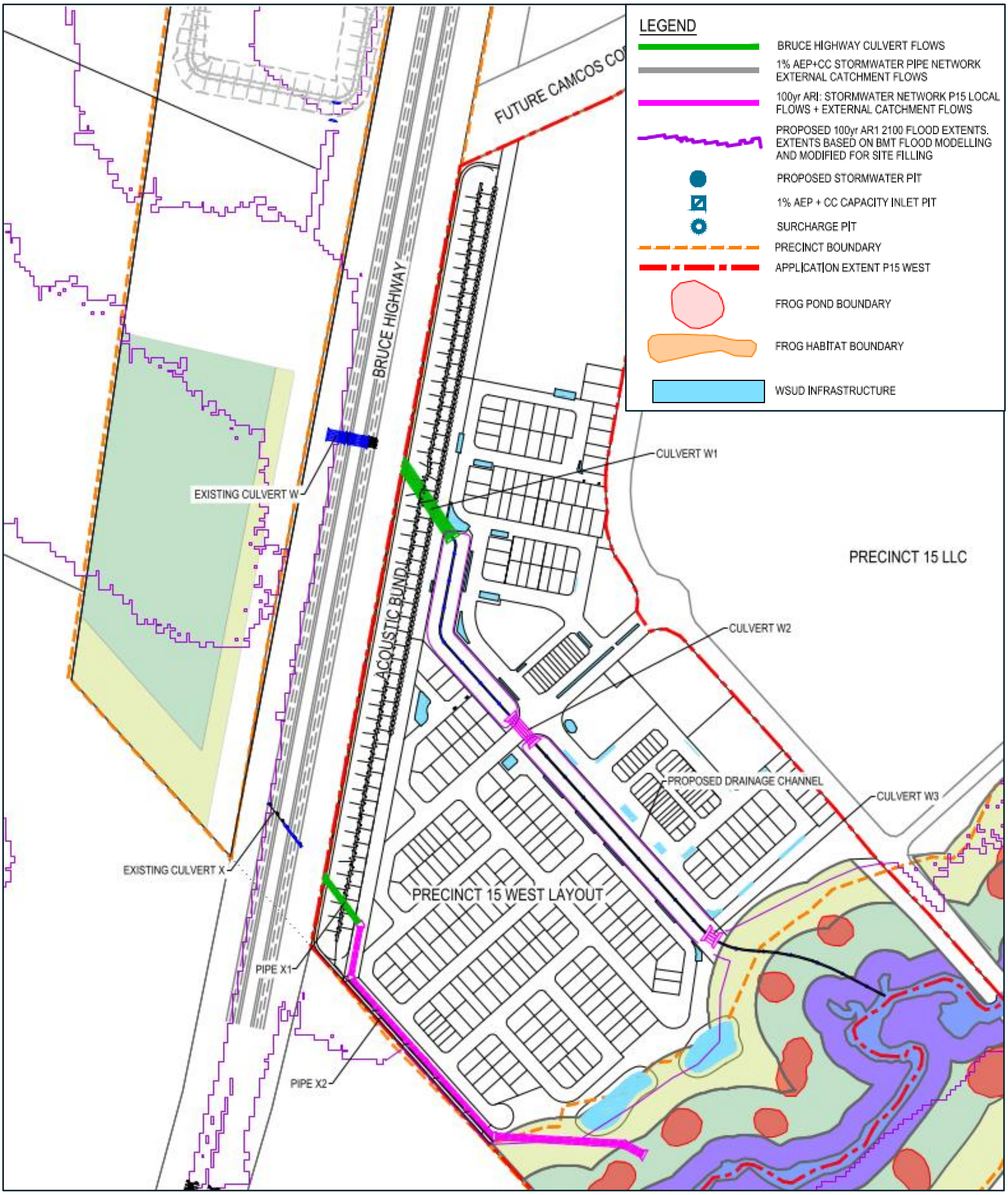


FIGURE 1-2 DRAINAGE LAYOUT

There are several existing and proposed drainage features that have been considered as part of this assessment. An acoustic bund is proposed to the east of the Bruce Highway's southbound carriageway bordering the western boundary of Aura Precinct 15 West. If unmitigated the acoustic bund will impede existing overland flow paths immediately downstream of two TMR cross drainage culverts. These culverts have nominally been referred to as Culvert W and Culvert X herein. The corresponding acoustic bund drainage structures immediately downstream of these TMR culverts have nominally been referred to as Culvert W1 and Pipe X1. Culvert W1 conveys external upstream catchment flows to the proposed open channel and Pipe X1 conveys externals flows via underground drainage (nominally Pipe X2) to Bells Creek South.

The hydraulic conditions for the open channel design are controlled by the configuration of the proposed custom pit inlet structure at Culvert W1. Similarly, the hydraulic conditions for the underground drainage Pipe X2 design are controlled by the configuration of the proposed custom pit inlet structure at Pipe X1. In this regard, this report should be read in conjunction with Egis's Technical Memorandum '*Aura Precinct 15 West: Acoustic Bund Drainage Design*' (Egis reference *21-000307.11.WRE.TM01B.DY.kv.docx*, dated 8/12/2023), which details how the proposed acoustic bund drainage has been hydraulically designed to achieve no adverse flood impacts within the TMR corridor.

The post-development scenario flood modelling described herein also relies on the approved drainage works further upstream to the west of the Bruce Highway corridor adjacent to Aura Precinct 14. These drainage works associated with Aura Precinct 14 West are referred to as the *western diversion drain (south)* and the *western detention basin (south)* and are detailed in the approved Technical Memorandum titled *Aura Western Detention Basin (South) and Acoustic Bund (South) Drainage Diversions* (Calibre Ref: 18-000340-TM05E_AURA_WDB.DOCX), dated 26 October 2022 by Calibre (now Egis). No change to the configurations of these previously approved drainage works is proposed.

As such, the flood modelling and analysis presented in this document builds on the flood modelling described in the October 2022 Technical Memorandum prepared by Calibre, and is consistent with the Egis Technical Memorandum '*Aura Precinct 15 West: Acoustic Bund Drainage Design*' (Egis reference *21-000307.11.WRE.TM01B.DY.kv.docx*, dated 8/12/2023), prepared in conjunction with this report.

2 HYDROLOGY MODELLING

The hydrological and hydraulic analysis was undertaken using XP-SWMM modelling software. The below sub-sections describe the hydrological parameters adopted in the XP-SWMM model in 'Runoff' mode, which are consistent with the previously verified XP-SWMM model described in the approved Technical Memorandum titled *Aura Western Detention Basin (South) and Acoustic Bund (South) Drainage Diversions* (Calibre Ref: 18-000340-TM05E_AURA_WDB.DOCX), dated 26 October 2022 by Calibre (now Egis).

2.1 Catchment Delineation

Catchments were delineated generally in accordance with the site layout, preliminary bulk earthworks design, concept drainage and discharge locations to the open channel as at the time of preparing the Aura Precinct 15 'West' Development Approval submission. Refer to **Table 2-1** for the catchment parameters adopted for the hydrological input in the XP-SWMM model.

TABLE 2-1 DEVELOPED SCENARIO SUB-CATCHMENT PARAMETERS

Sub-catchment ID	Area (ha)	Fraction Impervious (%)	Vectored Slope (%)	Comments
G	6.24	0.25	0.062	Western External Sub-catchments
H	1.275	0.49	0.078	
M	2.81	0.24	0.116	
N	15.501	0	0.124	
Q	10.32	0	0.024	
R	98.785	0	0.08	
S	314.192	0	0.028	
W	3.392	0	0.052	
X	1.906	0	0.05	
W.1	1.218	0	0.003	Aura Precinct 15 West Sub-catchments
Section 1	2.369	0.8	0.005	
Section 2	1.341	0.8	0.005	
Section 3	0.714	0.8	0.005	
Section 4	0.829	0	0.005	
Section 5 (RoadUS)	1.06	0.54	0.005	
Section 6 (RoadDS)	0.462	0	0.005	
Section 7	2.632	0.8	0.005	
Section 8	4.441	0.8	0.005	
Section 9	4.441	0.8	0.005	
Section 10	3.03	0.8	0.005	
Section 11 (PedUS)	3.03	0.8	0.005	

2.2 Design Rainfall

The ARR19 ensemble method was used in this investigation in accordance with the *Sunshine Coast Planning Scheme Policy 2014* (Amended 24 May 2021). Accordingly, site-specific Intensify-Frequency-Duration (IFD) data has been sourced from the *Bureau of Meteorology* (BoM) *Design Rainfall Data System (2016)*. The IFD data was sourced from the location provided below:

- Latitude: 26.836 [S]
- Longitude: 153.036 [E]

To ensure compliance with the *Sunshine Coast Planning Scheme* (amended 24 May 2021), the rainfall intensity in the 1% AEP storm event must be increased by 20% to adequately account for climate change at 2100. Accordingly, a multiplication factor of 1.2 was applied to 1% AEP rainfall to demonstrate compliance with the abovementioned guideline.

2.3 Critical Duration and Temporal Patterns

The ensembles used in this investigation contain ten (10) unique storm temporal patterns obtained from AR&R data hub. Temporal patterns define the time-varying distribution of rainfall for the storm duration, which varies depending on the duration and AEP of the design storm event. Temporal pattern ensembles were loaded into the XP-SWMM model for each design AEP event for the following standard storm durations, 30 minutes to 12 hours. The critical duration event for the open channel is 90-minutes upstream of the road crossing and 2-hours for the lower reaches of the channel downstream of the road crossing for the DFE. The critical duration for underground drainage Pipe X1 and Pipe X2 is 90-minutes for the DFE.

2.4 Verification

The XP-SWMM model verification is detailed in the approved Technical Memorandum titled *Aura Western Detention Basin (South) and Acoustic Bund (South) Drainage Diversions* (Calibre Ref: 18-000340-TM05E_AURA_WDB.DOCX), dated 26 October 2022 by Calibre (now Egis), whereby Rational Method calculations in accordance with QUDM were undertaken for a range of existing scenario sub-catchments with varying size and flow path length. As detailed in TM05E, satisfactory correlation was achieved between the XP-SWMM model Runoff Mode calculations and those calculated using the Rational Method, and the XP-SWMM model was therefore adopted and further developed for this analysis.

2.5 Infiltration Losses, Manning's, and Storage (Bx) Factor Values

The XP-SWMM hydrological parameters which were adopted for the major storm AEPs in accordance with Technical Memorandum TM05E and are presented in Table 2.2.

TABLE 2.2. XP-SWMM MODEL VERIFIED PARAMETERS

XP-SWMM Model Parameter	Major Storm Events (1% to 0.05% AEP)
Pervious Area – Initial Loss (mm/hr)	5
Pervious Area – Continuing Loss (mm/hr)	5
Impervious Area – Initial Loss (mm/hr)	1
Impervious Area – Continuing Loss (mm/hr)	0
BX Factor	1.0

The impervious and pervious portions of each catchment were allocated distinct Manning's roughness 'n' values in accordance with previous Aura investigations. Manning's 'n' values are listed below:

- Impervious area Manning's 'n': 0.025
- Pervious area Manning's 'n': 0.045

3 OPEN CHANNEL

3.1 Design Criteria

The design criteria was established generally in accordance with the guidelines recognised by EDQ. Accordingly, the *Queensland Urban Drainage Manual* (QUDM, 2017) was used as the primary guideline. The 1% AEP Climate Change event was used as the Defined Flood Event (DFE) for this analysis. Further analysis of sensitivity scenarios including varying culvert blockage scenarios, varying coincident regional tailwater levels within Bells Creek South, and varying hydraulic roughness values were also analysed.

The investigation aims to demonstrate that the Open Channel achieves a minimum freeboard of 300 mm to the channel's top of bank (TOB) in the design event. This criterion is consistent with previous Aura flood investigations and is generally in accordance with QUDM. Further to the above, the criteria is in accordance with the *Sunshine Coast Planning Scheme 2014* (amended 24 May 2021), which states freeboard provisions must be applied in accordance with *QUDM*.

Seven sensitivity scenarios, including severe storm assessments were undertaken to determine the robustness of the proposed open channel design. The various proposed scenarios were determined in accordance with *QUDM* and the *Sunshine Coast Flooding and Stormwater Management Guideline.* Sensitivity events and severe storm assessments were applied to the open channel to ensure a comprehensive check of various scenarios has been undertaken in compliance with the abovementioned guidelines.

The sensitivity assessments are provided in the following sections.

3.1.1 Design Development

The open channel design is influenced by several factors which are discussed below.

- No works are to occur within the TMR road corridor. Hence, any structures must be constructed within the Aura development property boundary.
- No adverse flooding impacts are permitted within the TMR corridor.
- The position and footprint of the open channel has been determined by the current lot layout of the proposed development to maximise the provision of lots while complying with the design requirements listed below.
- Tailwater levels at the downstream model boundary representing the channel outlet to Bells Creek South have been derived from the Bells Creek South regional flood model run in January 2022 by BMT WBM. For the defined flood event of 1% AEP with *circa* 2100 climate change a downstream channel tailwater level of 10.43 m AHD was adopted, which corresponds to a 1% AEP (without climate change) coincident regional event.
- The post-development model scenarios adopted an 80% impervious area for the proposed urban development footprint of Precinct 15 West catchment discharging to the open channel.
- The lawful point of discharge for the open channel is identified as Bells Creek South which is consistent with the existing point of discharge on the site.
- The open channel design is to cater for the proposed road layout which connects the north and south portions of the site, hence requiring a culvert crossing. The road location and crown level has been utilised to inform the culvert design to ensure that the road is not overtopped in the 1% AEP with *circa* 2100 climate change event.
- A pedestrian crossing has been proposed at the eastern extent of the Precinct 15 West urban area, which traverses the downstream reach of the proposed open channel, hence requiring a culvert crossing. The culverts have been sized to ensure the depth-velocity (D.V.) product of flow across the pedestrian path is within safe limits for pedestrians in the 1% AEP with *circa* 2100 climate change event (i.e., D.V. ≤0.4 m^2/s as per Section 7.4.6(a), QUDM).

3.1.2 Model Scenarios and Design Criteria

Various model scenarios were carried out for the design and sensitivity scenarios including:

- Design Scenario 1 – Major Storm (DFE)

- Design Scenario 2 – Minor Storm
- Sensitivity Scenario 1 – Low Manning's n
- Sensitivity Scenario 2 – High Manning's n
- Sensitivity Scenario 3 – High Blockage
- Sensitivity Scenario 4 – Severe Blockage
- Sensitivity Scenario 5 – Severe Storm
- Sensitivity Scenario 6 – High Manning's n, High Tailwater
- Sensitivity Scenario 7 – High Manning's n, High Tailwater, Low Blockage

Each model scenario and corresponding design criteria is described below.

Design Scenario 1 – A hydrological and hydraulic model was built for developed conditions and a 1% AEP with *circa* 2100 climate change event with a design Manning's n value of 0.12 and design inlet blockage factors. These include 25% blockage for cross drainage within the proposed channel and 50% blockage for the inlet structures upstream of the proposed acoustic bund. The design intent for this scenario is to demonstrate:

- Road crossing is not overtopped.
- D.V. product across pedestrian crossing is less than or equal to the QUDM requirement of 0.4 m^2/s as per Section 7.4.6(a).
- 300 mm freeboard to top of bank.

Design Scenario 2 – A hydrological and hydraulic model was built for developed conditions and a 10% AEP with *circa* 2100 climate change event with a design Manning's n value of 0.12 and design inlet blockage factors. These include 25% blockage for cross drainage within the proposed channel and 50% blockage for the inlet structures upstream of the proposed acoustic bund. The design intent for this scenario is to demonstrate:

- Road crossing is not overtopped.
- Pedestrian crossing is not overtopped

Sensitivity Scenario 1 (Low Manning's n) – represents the site in developed conditions and a 1% AEP with *circa* 2100 climate change event, adopting a low Manning's n value 0f 0.06. Additionally, blockage for both the cross drainage within the proposed channel and for the inlet structures upstream of the proposed acoustic bund were set to 0%. The design intent for this scenario is to demonstrate:

- Flood levels are at or below top of bank level.
- Velocities within the channel are below permissible scour velocities for the proposed channel bed material (being 100% grass cover over erosion resistant soils and a 1.5 m wide concrete invert) of 2.8 m/s (QUDM, Table 9.5.2).

Sensitivity Scenario 2 (High Manning's n) – represents the site in developed conditions and a 1% AEP with *circa* 2100 climate change event, adopting a high Manning's n value of 0.15 and design inlet blockage factors as per Design Scenario 1. The design intent for this scenario is to demonstrate flood levels are at or below top of bank level.

Sensitivity Scenario 3 (High Blockage) – represents the site in developed conditions and a 1% AEP with *circa* 2100 climate change event, while adopting 50% blockage for the cross drainage within the proposed channel. Design inlet blockage of 50% was adopted for the inlet structures upstream of the proposed acoustic bund and design Manning's n values of 0.12 for the open channel as per Design Scenario 1. The design intent for this scenario is to demonstrate:

- Flood levels are at or below top of bank level.
- Flow depth and D.V. product across road crossing is less than or equal to the QUDM requirement of 0.2 m and 0.3 m^2/s, respectively, as per Table 7.4.5.
- D.V. product across pedestrian crossing is less than or equal to the QUDM requirement of 0.6 m^2/s as per Section 7.4.6(a).

Sensitivity Scenario 4 (Severe Blockage) – represents the site in developed conditions and a 1% AEP with *circa* 2100 climate change event, while adopting 100% blockage for the cross drainage within the proposed channel. Design inlet blockage of 50% was adopted for the inlet structures upstream of the proposed acoustic bund and design Manning's n values of 0.12 for the open channel as per Design Scenario 1. The design intent for this scenario is to demonstrate:

- Flood levels are at or below minimum floor levels for adjacent lots.
- A Severe Storm Impact Statement (refer QUDM Section 7.2.4), which includes a check that D.V. products are within safe limits for pedestrians and Emergency Services as per the QUDM requirement of 0.6 m^2/s as per Section 7.4.6(a).

Sensitivity Scenario 5 (Severe Storm) – represents the site in developed conditions and a 0.05% AEP with *circa* 2100 climate change event, adopting a coincident regional 1% AEP with *circa* 2100 climate change tailwater level of 10.55 m AHD at Bells Creek South. This sensitivity scenario adopts a design Manning's n value of 0.12 and design inlet blockage factors as per Design Scenario 1. The design intent for this scenario is to demonstrate:

- Flood levels are at or below minimum floor levels for adjacent lots.
- A Severe Storm Impact Statement (refer QUDM Section 7.2.4), which includes a check that D.V. products are within safe limits for pedestrians and Emergency Services as per the QUDM requirement of 0.6 m^2/s as per Section 7.4.6(a).

Sensitivity Scenario 6 (High Manning's n, High Tailwater) – represents the site in developed conditions and a 1% AEP with *circa* 2100 climate change event, adopting regional 1% AEP with *circa* 2100 climate change tailwater levels at Bells Creek South. This sensitivity scenario adopts a high Manning's n value of 0.15 and design inlet blockage factors as per Design Scenario 1. The design intent for this scenario is to demonstrate flood levels have 300 mm freeboard to minimum floor levels for adjacent lots.

Sensitivity Scenario 7 (High Manning's n, High Tailwater, Low Blockage) – represents the site in developed conditions and a 1% AEP with *circa* 2100 climate change event, adopting regional 1% AEP with *circa* 2100 climate change tailwater levels at Bells Creek South. This sensitivity scenario adopts a high Manning's n value of 0.15 with 0% blockage for the inlet structures upstream of the proposed acoustic bund to allow the maximum upstream external catchment flow to discharge into Precinct 15 West. A 25% design culvert blockage of the cross drainage within Aura P15 West (i.e. the road crossing and the shared path crossing) has also been adopted. The design intent for this scenario is to demonstrate flood levels have 300 mm freeboard to minimum floor levels for adjacent lots.

3.2 Hydraulic Modelling

The aim of this investigation was to analyse the concept channel design, determine the conveyance capacity of the channel / major stormwater infrastructure and to demonstrate adequate freeboard to the top of bank generally in accordance with *QUDM*. This analysis was undertaken using the XP-SWMM modelling software to provide accurate results throughout while incorporating the relevant aspects of the latest regional flood analysis.

To maintain consistency with the previous reports the hydraulic capacity of the channel was designed based on a minimum Manning's roughness value of 0.12. In the sensitivity analyses undertaken, Manning's roughness values of 0.15 (high) and 0.06 (low) were adopted to ensure the freeboard is not exceeded and to ensure that the scour thresholds are not exceeded, respectively.

Furthermore, the open channel contains a 1.5 metre concrete invert at the channel invert due to a 0.5% grade. The 1.5 metre concrete invert was allocated a Manning's roughness value of 0.013 in all design and sensitivity analyses.

3.2.1 Channel Design

The key elements of the nominal channel cross section are listed below.

- 1:4 batter slopes;
- 1:20 batter slopes within the extent of the channel base;
- Approximate 12 metre base width; and
- 1.5 metre concrete invert at the channel invert.

Further details on the nominal cross section are provided within the drawings provided in **Appendix A: Open Channel Design** Drawings, and a typical section of the open channel is presented below in **Figure 3-1**.

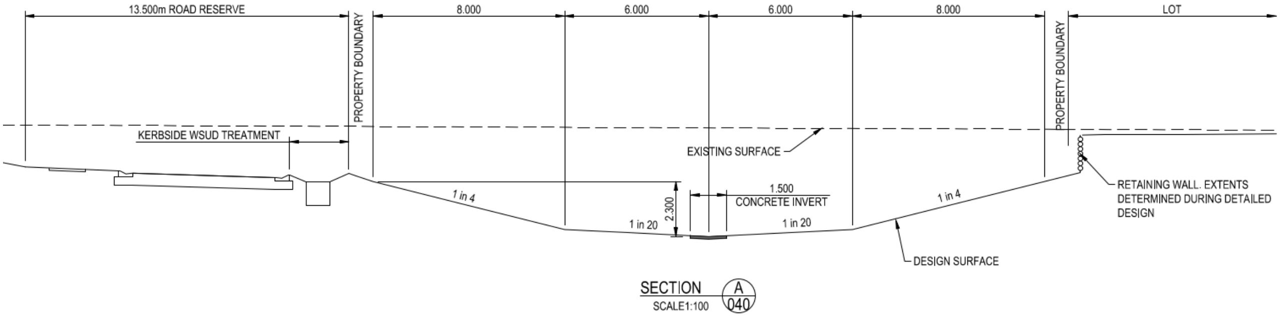


FIGURE 3-1 OPEN CHANNEL TYPICAL SECTION

The open channel is traversed by one road cross and one pedestrian crossing, details on these structures are provided below.

3.2.2 Road Crossing Design

The hydraulic structure proposed under the channel road crossing within Precinct 15 West consists of 4/2.4x1.2 RCBC culverts running in line with the direction of flow as per the drawings provided in **Appendix B: Drainage Layout Plans**. Inlet and outlet configurations for the culvert precast headwalls (45* wingwall) with standard entry and exit loss conditions in accordance with QUDM. The overtopping point for the road crossing is assumed to be 12.37 mAHD. The road crossing configuration is presented in **Table 3-1** and depicted in **Figure 3-2**.

TABLE 3-1 ROAD CROSSING CONFIGURATION

	4 x 2.4m x 1.2m RCBC
U/S IL (mAHD)	9.69
D/S IL (mAHD)	9.45
Dimensions (m)	2.4 x 1.2
Number	4
Length (m)	33.6
Overtopping Point for Crossing (mAHD)	12.37

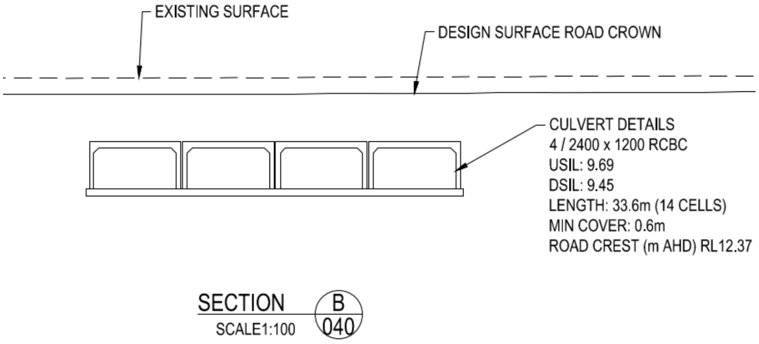


FIGURE 3-2 ROAD CROSSING SECTION

3.2.3 Pedestrian Crossing Design

The hydraulic structure proposed under the channel pedestrian crossing consists of 3/3.0x1.8 RCBC culverts running in line with the direction of flow as per the drawings provided in **Appendix B: Drainage Layout Plans**. Inlet and outlet configurations for the culverts include precast headwalls (45* wingwall) with standard entry and exit loss conditions as per QUDM. The overtopping point for the pedestrian crossing is assumed to be 10.389 mAHD. The pedestrian crossing configuration is presented in **Table 3-2** and depicted in **Figure 3-3**.

TABLE 3-2 PEDESTRIAN CROSSING CONFIGURATION

4 x 3.0m x 1.8m RCBC	
U/S IL (mAHD)	8.122
D/S IL (mAHD)	8.074
Dimensions (m)	3.0 x 1.8
Number	4
Length (m)	9.6
Overtopping Point for Crossing (mAHD)	10.389

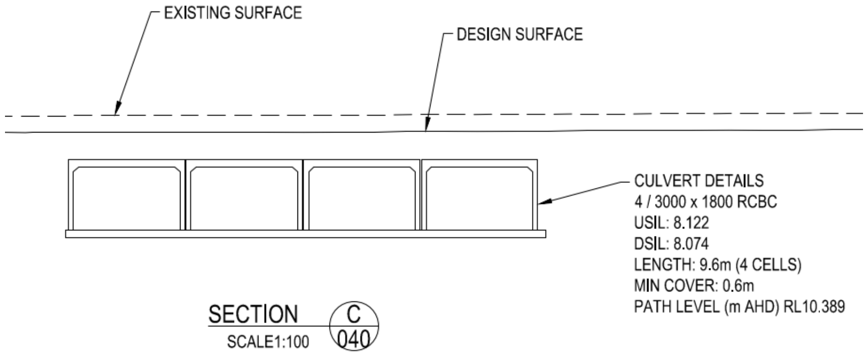


FIGURE 3-3 PEDESTRIAN CROSSING SECTION

3.3 Results

Using the ARR19 method, 10 unique temporal patterns were simulated per storm duration. Therefore, each storm duration is referred to as an ensemble as it comprises of 10 unique temporal patterns. For each ensemble, the mean hydraulic result, which is determined from the spectrum of temporal patterns, represents the average hydraulic result for the given storm duration. The maximum hydraulic result is subsequently selected from the selection of mean results that were determined for the various simulated storm durations. In accordance with the concept described above, the maximum WSL results provided represent the maximum WSL selected from the range of mean WSLs that were determined from the range of critical storm durations.

Within the XP-SWMM model, the following reporting points layout was utilised as provided in **Figure 3-4**, with corresponding cross sections of each reporting point provided in **Appendix A: Open Channel Design** Drawings.

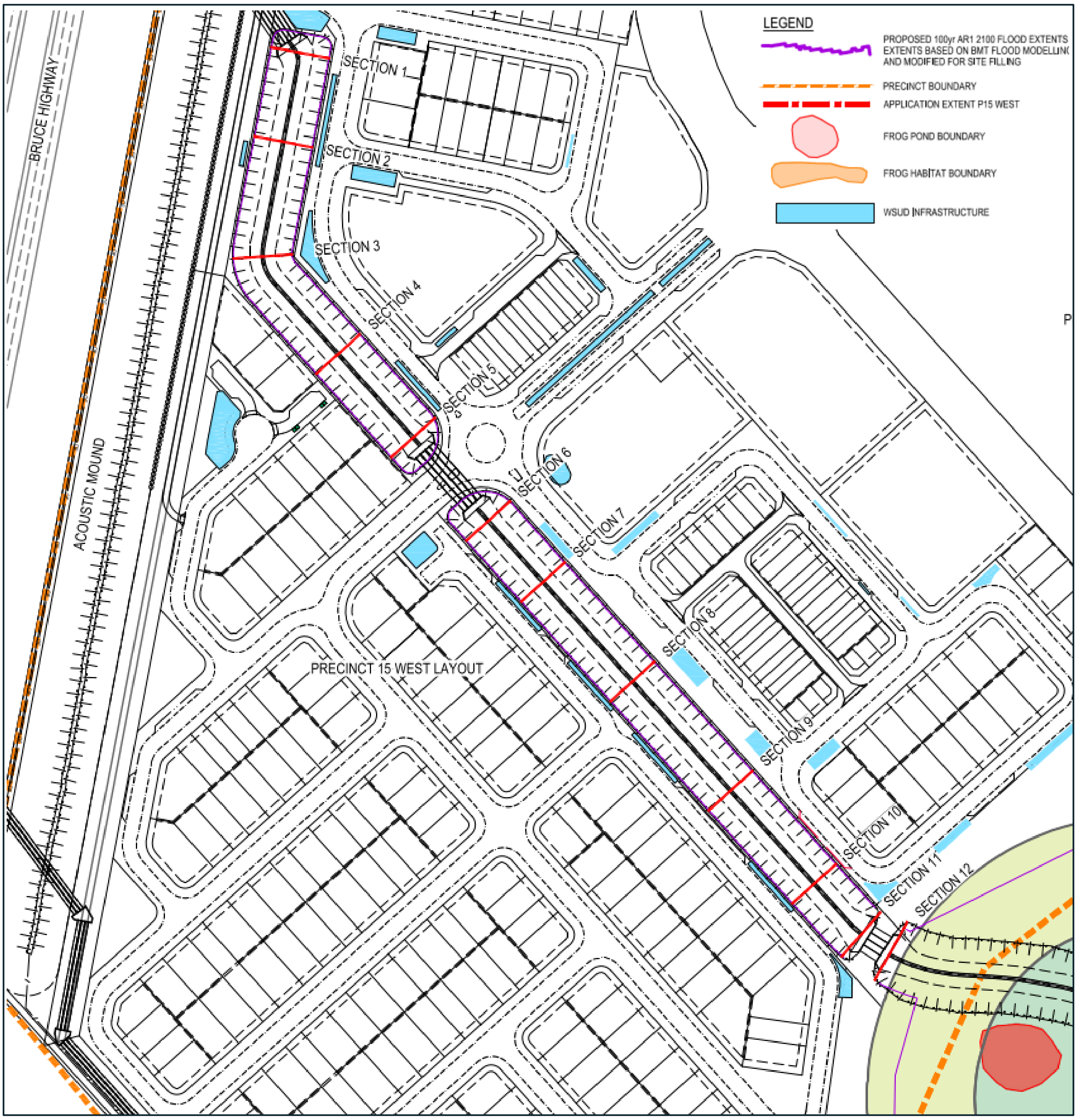


FIGURE 3-4 OPEN CHANNEL REPORTING SECTION LOCATIONS PLAN

The physical properties for the reporting point sections corresponding to the layout above are provided within **Table 3-3**.

TABLE 3-3 PHYSICAL PROPERTIES OF REPORTING POINT SECTIONS

REPORTING POINTS	CHANNEL INVERT LEVEL (m AHD)	TOP OF BANK (m AHD)
Section 1	10.719	13.223
Section 2	10.509	13.037
Section 3	10.239	12.957
Section 4	9.949	12.600
Section 5 (RoadUS) *Road Crest RL12.37*	9.690	12.410
Section 6 (RoadDS)	9.450	11.795
Section 7	9.239	11.609
Section 8	8.929	11.289
Section 9	8.589	11.134
Section 10	8.299	10.973
Section 11 (PedUS) *Path Level RL10.39*	8.122	10.931
Section 12 (PedUS)	8.074	NA

3.3.1 Design Scenario 1

The peak water surface level (WSL) results relative to the top of bank levels for the 1% AEP with *circa* 2100 climate change storm event (Design Scenario 1, **Section 3.1.2**) are provided in **Table 3-4**. Refer to **Table 3-3** above for details of the reporting points layout and properties from the XP-SWMM model.

TABLE 3-4 DESIGN SCENARIO 1

REPORTING POINTS	WATER SURFACE LEVEL (mAHD)	FREEBOARD TO TOP OF BANK (m)	MEAN VELOCITY (m/s)
Section 1	12.101	1.122	NA
Section 2	11.947	1.090	0.870
Section 3	11.799	1.158	0.816
Section 4	11.684	0.883	0.749
Section 5(RoadUS) *Road Crest RL12.37*	11.597	0.729	0.656
Section 6(RoadDS)	10.994	0.801	2.298
Section 7	10.766	0.843	0.796
Section 8	10.766	0.523	0.734
Section 9	10.681	0.453	0.686
Section 10	10.628	0.345	0.569
Section 11(PedUS) *Path Level RL10.39*	10.610	0.321	0.527
Section 12 (PedUS)	10.504	NA	NA

The peak WSL results provided in **Table 3-4** demonstrate that the open channel design meets the required 300mm freeboard from the peak WSL to the top of bank levels at all reporting points throughout the section of channel within Precinct 15 West. The road crossing at Section 5 has a crest level of RL 12.37 m AHD and is not overtopped. The D.V. product across pedestrian crossing (Path Level RL 10.389 m AHD) at Section 11 is 0.12 m^2/s with an overtopping depth of 0.22 m and a mean velocity of 0.53 m/s. While this D.V. product across pedestrian crossing is less than the QUDM requirement of 0.4 m^2/s as per Section 7.4.6(a), pedestrian movements at this crossing are likely to be very infrequent during a 1% AEP storm event.

3.3.2 Design Scenario 2

The peak water surface level (WSL) results and freeboard to the crest levels at the two crossings for the 10% AEP with *circa* 2100 climate change storm event (Design Scenario 2, **Section 3.1.2**) are provided in **Table 3-5**. The XP-SWMM model was configured and run for the 10% AEP + Climate Change event with a 10 % AEP tailwater level in Bells Creek South of 10.14 m AHD. Refer to **Table 3-3** above for details of the reporting points layout and properties from the XP-SWMM model.

TABLE 3-5 DESIGN SCENARIO 2

REPORTING POINTS	WATER SURFACE LEVEL (mAHD)	FREEBOARD TO CREST OF CROSSING (m)	MEAN VELOCITY (m/s)
Section 1	11.767	NA	NA
Section 2	11.557	NA	0.843
Section 3	11.333	NA	0.838
Section 4	11.137	1.233	0.789
Section 5(RoadUS) *Road Crest RL12.37*	10.98	1.390	0.711
Section 6(RoadDS)	10.635	NA	1.660
Section 7	10.51	NA	0.715
Section 8	10.383	NA	0.648
Section 9	10.301	NA	0.540
Section 10	10.262	0.127	0.437
Section 11(PedUS) *Path Level RL10.39*	10.249	0.140	0.374
Section 12 (PedUS)	10.184	NA	NA

The peak WSL results for Design Scenario 2 provided in **Table 3-5** confirm that the shared path crossing the drainage channel on the southeast part of the POD achieves the required 10% AEP flood immunity as per Table 1 – Park Profiles Local Lineal Park of the Aura Infrastructure Agreement. The path level of RL10.39 is above the modelled XP-SWMM water surface level of 10.272 m AHD at the Section 11 (PedUS) reporting location.

3.3.3 Sensitivity Scenario 1

The peak WSL and corresponding mean velocity results for a 1% AEP with circa 2100 climate change storm event with the adaptation of a low Manning's n value (Sensitivity Scenario 1, **Section 3.1.2**) relative to the top of bank, are provided in . Refer to **Table 3-3** above for details of the reporting points layout and properties from the XP-SWMM model.

TABLE 3-6 SENSITIVITY SCENARIO 1

REPORTING POINTS	WATER SURFACE LEVEL (mAHD)	FREEBOARD TO TOP OF BANK (m)	MEAN VELOCITY (m/s)
Section 1	11.743	1.480	0.816
Section 2	11.551	1.486	0.758
Section 3	11.355	1.602	0.688
Section 4	11.200	1.367	0.614
Section 5 (RoadUS) *Road Crest RL12.37*	11.089	1.237	2.247
Section 6 (RoadDS)	10.760	1.036	0.738
Section 7	10.684	0.925	0.685
Section 8	10.611	0.678	0.614
Section 9	10.569	0.565	0.501
Section 10	10.546	0.427	0.447
Section 11 (PedUS) *Path Level RL10.39*	10.539	0.392	1.620
Section 12 (PedUS)	10.458	NA	NA

The results from the low Manning's roughness sensitivity scenario provided in **Table 3-66** demonstrated that the peak WSL does not overtop the top of bank levels, thus meeting the design criteria for this sensitivity scenario. The peak mean velocity for Sensitivity Scenario 1 does not exceed the critical scour velocity threshold of 2.8 m/s as per QUDM (2017).

3.3.4 Sensitivity Scenario 2 and 3

The peak WSL results for a 1% AEP with circa 2100 climate change storm event with the adaptation of a high Manning's n value and high blockage scenarios (Sensitivity Scenario 2 and 3 respectively, **Section 3.1.2**) relative to the top of bank, are provided in **Table 3-77**. Refer to **Table 3-3** above for details of the reporting points layout and properties from the XP-SWMM model.

TABLE 3-7 SENSITIVITY SCENARIO 2 AND 3

	SENSITIVITY SCENARIO 2		SENSITIVITY SCENARIO 3	
REPORTING POINTS	WATER SURFACE LEVEL (mAHD)	FREEBOARD TO TOP OF BANK (m)	WATER SURFACE LEVEL (mAHD)	FREEBOARD TO TOP OF BANK (m)
Section 1	12.193	1.030	12.548	0.675
Section 2	12.037	1.000	12.494	0.543
Section 3	11.885	1.072	12.451	0.506
Section 4	11.762	0.838	12.420	0.180
Section 5 (RoadUS) *Road Crest RL12.37*	11.667	0.743	12.398	0.012
Section 6 (RoadDS)	11.066	0.729	10.999	0.796
Section 7	10.948	0.661	10.900	0.709
Section 8	10.812	0.477	10.793	0.496
Section 9	10.711	0.423	10.720	0.414
Section 10	10.646	0.327	10.675	0.298
Section 11 (PedUS) *Path Level RL10.39*	10.624	0.307	10.660	0.271
Section 12 (PedUS)	10.525	NA	10.498	NA

As demonstrated by the peak WSL results provided in **Table 3-7**, during both Sensitivity Scenarios 2 and 3 the peak WSL does not overtop the top of bank levels. In Sensitivity Scenario 3, the road crossing is overtopped by 0.03 m with a velocity of 0.99 m/s, giving a D.V. product of 0.03 m^2/s. These Sensitivity Scenario 3 flow conditions at the road crossing are less than the QUDM requirement of 0.2 m and 0.3 m^2/s for flow depth and D.V. product, respectively, as outlined in **Section 3.1.2**.

In Sensitivity Scenario 3, the pedestrian crossing is overtopped by 0.27 m with a velocity of 0.12 m/s, giving a D.V. product of 0.03 m^2/s. These Sensitivity Scenario 3 flow conditions at the pedestrian crossing are less than the QUDM requirement of 0.6 m^2/s for D.V. product as outlined in **Section 3.1.2**.

3.3.5 Sensitivity Scenario 4 and 5

The peak WSL results for a 1% AEP with circa 2100 climate change storm event with the adaptation of a severe blockage scenario (Sensitivity Scenario 4, **Section 3.1.2**) in addition to the peak WSL results for a 0.05% AEP with *circa* 2100 climate change severe storm event representing developed conditions (Sensitivity Scenario 5, **Section 3.1.2**), relative to the minimum lot levels are provided in **Table 3-88**. Refer to **Table 3-3** above for details of the reporting points layout and properties from the XP-SWMM model.

TABLE 3-8 SENSITIVITY SCENARIO 4 AND 5

	SENSITIVITY SCENARIO 4			**SENSITIVITY SCENARIO 5**		
REPORTING POINTS	WATER SURFACE LEVEL (mAHD)	FREEBOARD TO TOP OF BANK (m)	D.V. PRODUCT (m^2/s)	WATER SURFACE LEVEL (mAHD)	FREEBOARD TO TOP OF BANK (m)	D.V. PRODUCT (m^2/s)
Section 1	12.980	0.243		12.212	1.011	
Section 2	12.959	0.078		12.079	0.958	
Section 3	12.942	0.015		11.954	1.003	
Section 4	12.931	-0.331		11.858	0.742	
Section 5(RoadUS) *Road Crest RL12.37*	12.922	-0.512	0.67	11.786	0.624	NA
Section 6(RoadDS)	11.142	0.653		11.085	0.710	
Section 7	11.077	0.532		10.984	0.625	
Section 8	11.007	0.282		10.869	0.420	
Section 9	10.960	0.174		10.787	0.347	
Section 10	10.931	0.042		10.733	0.240	
Section 11(PedUS) *Path Level RL10.39*	10.921	0.010	0.59	10.716	0.215	0.25
Section 12 (PedUS)	10.497	NA		10.626	NA	

Within the severe blockage scenario (Sensitivity Scenario 4), the results in **Table 3-88** indicate that the peak WSL will overtop the channel top of bank level and encroach into the adjacent road reserve at Section 4 and Section 5 (RoadUS). Minimum floor levels for the lots adjacent to Section 4 and Section 5 (RoadUS) must be above these peak flood levels to meet the design criteria set out within **Section 3.1.2**.

In Sensitivity Scenario 5, the road crossing is not overtopped, but the pedestrian crossing is overtopped by 0.33 m with a velocity of 0.77 m/s, giving a D.V. product of 0.25 m^2/s during severe storm conditions. For this scenario, a coincident regional 1% AEP with *circa* 2100 climate change tailwater level of 10.55 m AHD was derived from the BMT WBM Regional Bells Creek South model, which is above the pedestrian path level of RL10.39. These flood conditions are considered safe for pedestrians as D.V. products are below the safe limits as per the QUDM recommendation of 0.6 m^2/s as per Section 7.4.6(a). However, it is likely that pedestrian movements at this crossing will be very infrequent during the assumed occurrence of coincident regional flood that will be visible within Bells Creek South.

In Sensitivity Scenario 4, the road crossing is overtopped by 0.55 m with a velocity of 1.22 m/s, giving a D.V. product of 0.67 m^2/s. These Sensitivity Scenario 4 severe blockage flow conditions at the road crossing are not trafficable for road users as D.V. products are beyond safe limits for pedestrians and Emergency Services as per the QUDM recommendation of 0.6 m^2/s as per Section 7.4.6(a).

In Sensitivity Scenario 4, the pedestrian crossing is overtopped by 0.53 m with a velocity of 1.12 m/s, giving a D.V. product of 0.59 m^2/s. The Sensitivity Scenario 4 (severe blockage) flow conditions at the pedestrian crossing are not safe for pedestrians as the D.V. product is beyond the safe limit as per the QUDM recommendation of 0.6 m^2/s as per Section 7.4.6(a).

Due to the large heights and widths of the culvert cells at both proposed channel crossing locations, the probability of a severe (100%) blockage occurrence is considered unlikely. Considering the highly urbanised nature of the post-development upstream catchment area within the Aura P15 site, the most likely cause of culvert blockage at either crossing location is from a large vehicle entering the channel. However, a large vehicle would still be unlikely to result in complete blockage of either culvert crossing. It is recommended that both culvert crossings be regularly inspected and maintained to ensure debris and other potential sources of blockage are removed from the channel and from within the culvert cells.

It is also recommended that a flood depth marker post be installed at the pedestrian crossing. Furthermore, installation of appropriately designed signage is recommended at both banks of the channel at the pedestrian crossing and the road crossing warning pedestrians and road users of the potentially hazardous flood conditions during severe weather events.

3.3.6 Sensitivity Scenario 6 and 7

The peak WSL results for Sensitivity Scenarios 6 and 7 (refer to **Section 3.1.2** for scenario definitions) relative to the minimum lot levels are provided in **Table 3-99**. Refer to **Table 3-3** above for details of the reporting points layout and properties from the XP-SWMM model.

TABLE 3-9 SENSITIVITY SCENARIO 6 AND 7

	SENSITIVITY SCENARIO 6		**SENSITIVITY SCENARIO 7**	
REPORTING POINTS	WATER SURFACE LEVEL (m AHD)	FREEBOARD TO TOP OF BANK (m)	WATER SURFACE LEVEL (m AHD)	FREEBOARD TO TOP OF BANK (m)
Section 1	12.206	1.017	12.222	1.178
Section 2	12.047	0.990	12.066	1.154
Section 3	11.908	1.049	11.884	2.366
Section 4	11.792	0.808	11.717	1.063
Section 5(RoadUS) *Road Crest RL12.37*	11.702	0.708	11.580	1.120
Section 6(RoadDS)	11.102	0.693	11.194	1.286
Section 7	10.993	0.616	11.057	1.383
Section 8	10.870	0.419	10.905	0.795
Section 9	10.779	0.355	10.765	0.628
Section 10	10.721	0.253	10.691	0.585
Section 11(PedUS) *Path Level RL10.39*	10.701	0.230	10.671	0.604
Section 12(PedDS)	10.627	NA	10.666	NA

For both Sensitivity Scenario 6 and 7 results presented in **Table 3-99** the peak WSL results demonstrate freeboard to the top of bank, which implies that flood levels have 300 mm freeboard to minimum floor levels for adjacent lots, therefore complying with the design criteria outlined within **Section 3.1.2**.

3.3.7 Required Minimum Lot Levels

The sensitivity scenarios were modelled to determine the minimum lot levels adjacent to the open channel throughout Precinct 15 West. **Table 3-1010** presents the maximum peak WSL results from all modelled scenarios and the corresponding freeboard criteria to lots as outlined in **Section 3.1.2**.

TABLE 3-10 REQUIRED MINIMUM LOT LEVELS

REPORTING POINTS	CHANNEL INVERT LEVEL (m AHD)	MAXIMUM WATER SURFACE LEVEL (m AHD)	SCENARIO	FREEBOARD CRITERIA TO LOTS (mm)	REQUIRED MINIMUM LOT LEVEL (m AHD)
Section 1	10.719	12.980	Sensitivity Scenario 4	0	12.980
Section 2	10.509	12.959	Sensitivity Scenario 4	0	12.959
Section 3	10.239	12.942	Sensitivity Scenario 4	0	12.942
Section 4	9.949	12.931	Sensitivity Scenario 4	0	12.931
Section 5(RoadUS) *Road Crest RL12.37*	9.690	12.922	Sensitivity Scenario 4	0	12.922
Section 6(RoadDS)	9.450	11.142	Sensitivity Scenario 4	0	11.142
Section 7	9.239	11.077	Sensitivity Scenario 4	0	11.077
Section 8	8.929	11.007	Sensitivity Scenario 4	0	11.007
Section 9	8.589	10.960	Sensitivity Scenario 4	0	10.960
Section 10	8.299	10.931	Sensitivity Scenario 4	0	10.931
Section 11(PedUS) *Path Level RL10.39*	8.122	10.921	Sensitivity Scenario 4	0	10.921
Section 12(PedDS)	8.074	10.635	Sensitivity Scenario 7	NA	NA

3.4 Conclusion

The aim of this section has been to investigate the flooding capacity of the Open Channel and demonstrate adequate freeboard to the top of banks throughout the open channel in the DFE. Additionally, various sensitivity scenarios have been used to inform the open channel design and to set the minimum pad levels for lots adjacent to the channel. This investigation has concluded the following:

- Through the development of a 1D hydrological and hydraulic XP-SWMM model, the water surface levels throughout the open channel for various design, sensitivity, and severe storm scenarios were determined.
- As per **Section 3.1.1**, which discussed the results of Design Scenario 1 modelling, the minimum 300 mm freeboard requirement was achieved throughout the Open Channel in the DFE.
- Various sensitivity scenarios have been considered to investigate the peak flow behaviour in scenarios with minimal and excessive vegetation, as well as in events where potential blockage scenarios have been applied to culvert structures. The simulation results from these events demonstrate that the Precinct 15 West open channel has been designed in accordance with the design criteria; and,

The XP-SWMM hydraulic results presented are subject to change during detailed design. Accordingly, channel refinements and surrounding minimum allotment levels are to be confirmed at the detailed design stage to ensure that they achieve freeboard requirements as defined herein.

4 SOUTHERN PIPE NETWORK (PIPE X)

4.1 Design Criteria

The key design criteria for external flows from the Bruce Highway is the conveyance of the peak flows (1% AEP + CC) through Precinct 15 without causing backwater impacts on the TMR Corridor. It is important to note that the proposed pipeline does not account for any local flows generated within Precinct 15.

4.2 Hydraulic Modelling

The proposed pipeline design within Precinct 15 West, nominally referred to as Pipe X1 and Pipe X2, aims to adequately convey peak flows from TMR Culvert X in the 1% AEP + CC storm event. Accordingly, the concept design has been prepared to convey the peak flow to Bells Creek South. The drainage configuration of the southern pipe network is depicted on **Figure 4-1** and the constraints of the drainage network are described below.

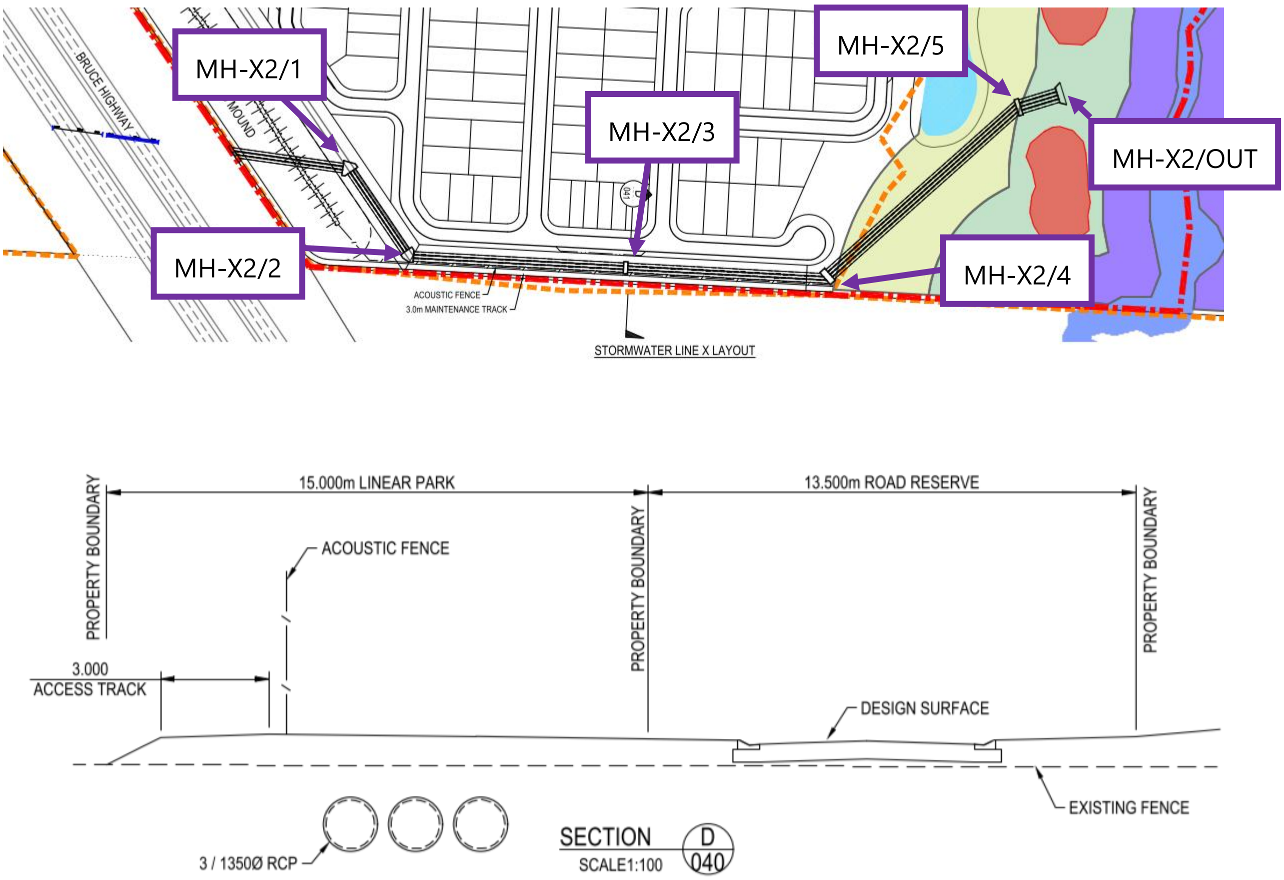


FIGURE 4-1 SOUTHERN DRAINAGE PIPE X PLAN AND SECTION

The hydraulic properties of Pipe X2 adopted in the XP-SWMM model are detailed in **Table 4-1** with the following hydraulic constraints.

- Constant pipeline slope: 0.60%; and
- Pipeline tailwater level of 11.08 m AHD at the downstream model boundary derived from the Bells Creek South regional flood model run in January 2022 by BMT WBM for the 1% AEP coincident storm event.

TABLE 4-1 SOUTHERN DRAINAGE PIPE X DESIGN

Node ID	Invert Level (m AHD)	Surface Level (m AHD)	D/S Pipe Size
MH X2/1	9.701	14.885	3/1350 RCP
MH X2/2	9.569	13.138	3/1350 RCP
MH X2/3	9.269	12.507	3/1350 RCP
MH X2/4	9.085	12.044	3/1350 RCP
MH X2/5	8.792	10.929	4/1350 RCP
MH X2/out	8.613	10.334	4/1500 RCP

A high-level approach has been taken in setting up the XP-SWMM model at the time of this DA submission. Due to this, the design of the pipeline conveying the upstream flows from the Pipe X through P15 will be refined during detailed design.

4.3 Results

Results for the Southern Pipeline Network within P15 West are provided in **Table 4-2**. The corresponding downstream pipe design has also been provided.

TABLE 4-2 PIPE X2 WSL RESULTS

Node ID	Invert Level (m AHD)	Peak Water Depth in MH (m)	Peak WSL (mAHD)	Freeboard to Surface Level (m)
MH X2/1	9.701	1.379	11.08	3.805
MH X2/2	9.569	1.511	11.08	2.058
MH X2/3	9.269	1.811	11.08	1.427
MH X2/4	9.085	1.995	11.08	0.964
MH X2/5	8.792	2.288	11.08	-0.151
MH X2/out	8.613	2.467	11.08	-0.746

Upon review of the peak WSL within all manholes it is evident that Pipe X2 is dominated by the tailwater level of 11.08 m AHD at the outlet derived from the Bells Creek South regional flood model. The manhole lids within the regional flood extents are to be bolted down to prevent dislodgement during the DFE.

4.4 Conclusion

The XP-SWMM results demonstrate that the proposed pipeline configuration has adequate capacity to convey peak flows. In future detailed design of Precinct 15 West, the subsequent design is to be undertaken with respect to the design surface levels provided.

5 CONCLUSION

The aim of this Stormwater Management Plan was to identify external drainage site opportunities and constraints and provide design solutions which comply with the relevant guidelines, demonstrating that the proposed development can mitigate any impacts.

This Stormwater Management Plan has reviewed external catchment flows from:

- Bruce Highway; and
- Western Catchments;

For each external catchment considered, this report has identified that a suitable solution which mitigates potential impacts is possible, whilst complying with the relevant guidelines.

6 RECOMMENDATIONS

It is recommended that both culvert crossings of the proposed open channel be regularly inspected and maintained to ensure debris and other potential sources of blockage are removed from the channel and from within the culvert cells.

It is also recommended that a flood depth marker post be installed at the pedestrian crossing of the open channel.

Furthermore, installation of appropriately designed signage is recommended at both banks of the proposed open channel at both the pedestrian crossing and the road crossing warning pedestrians and road users of the potentially hazardous flood conditions during severe weather events.

APPENDIX A: OPEN CHANNEL DESIGN DRAWINGS

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	BE	BE	BG		21.09.23	
A	AT	NV	BG	BG	20.12.23	AMENDED TO SUIT RFI

AMENDMENTS

STATUS

PRELIMINARY

APPROVED

BY:
RPEQ NO:
SIGN:
DATE:

SCALE

0 10 20 30 40 50 60 70 80
SCALE 1:1000 (A1)
SCALE 1:2000 (A3)

egis

www.egis-group.com

CLIENT

STOCKLAND
DEVELOPMENTS PTY
LTD

Stockland AURA

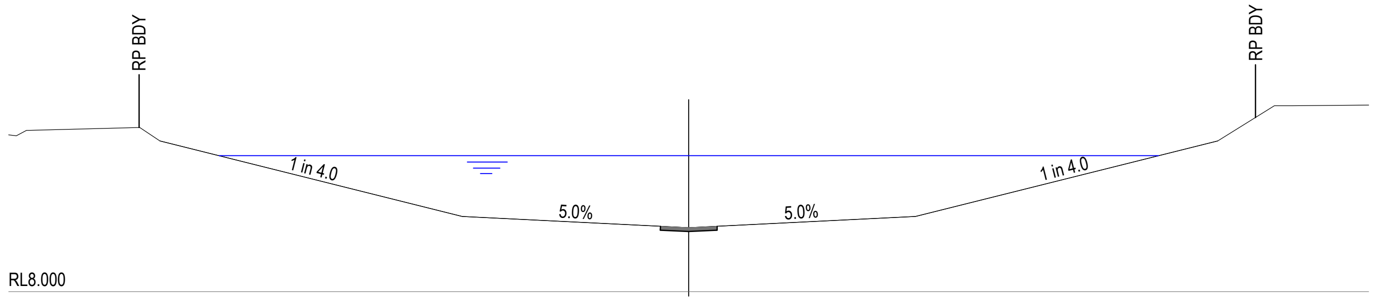
PROJECT

STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

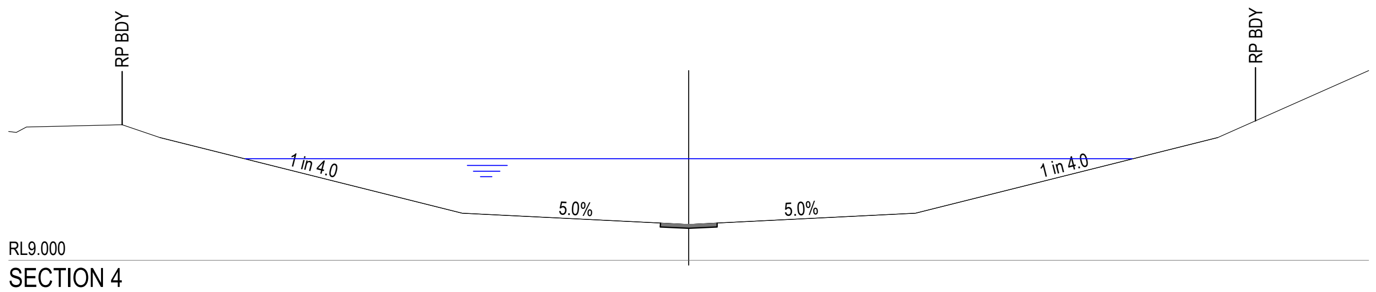
DRAWING TITLE

DRAINAGE CHANNEL LAYOUT

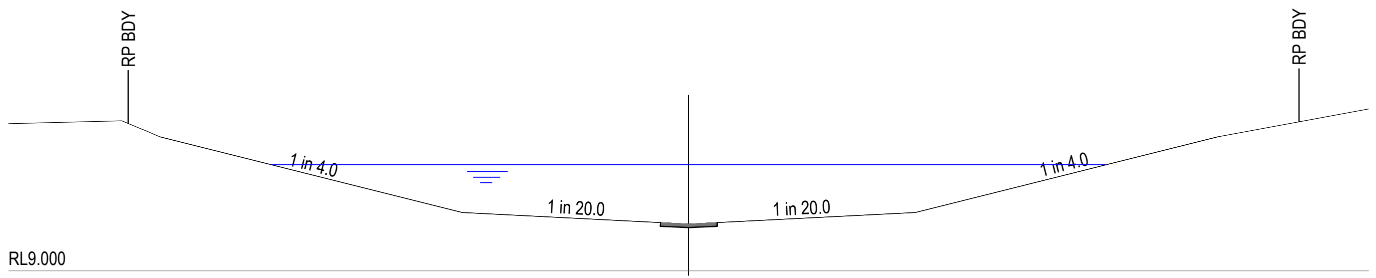
PROJECT No.	DRAWING No.	REVISION
21-000307	3058-SWMP01	A



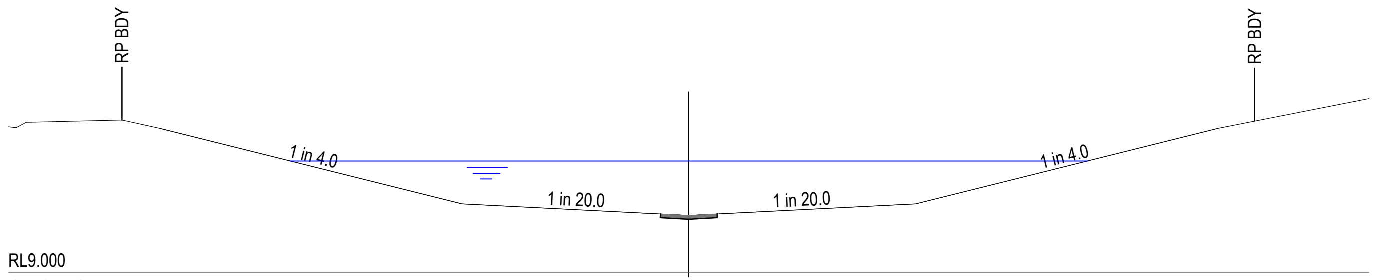
SECTION 5



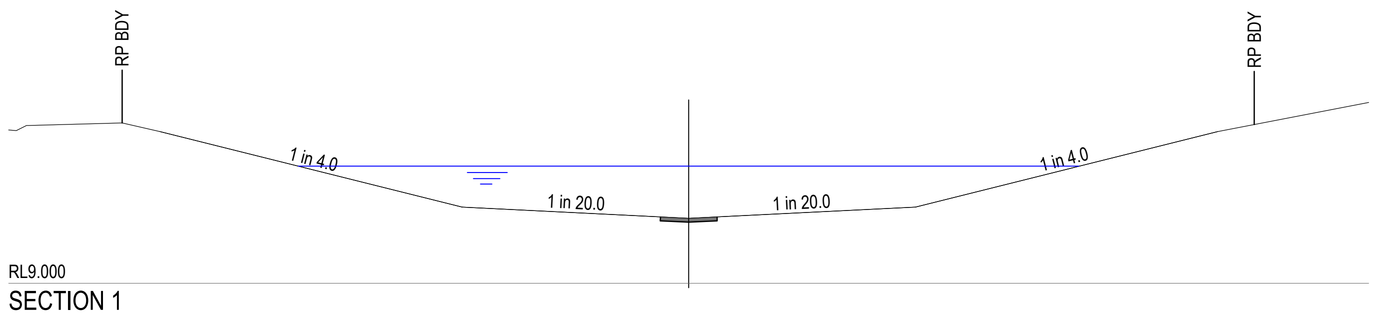
SECTION 4



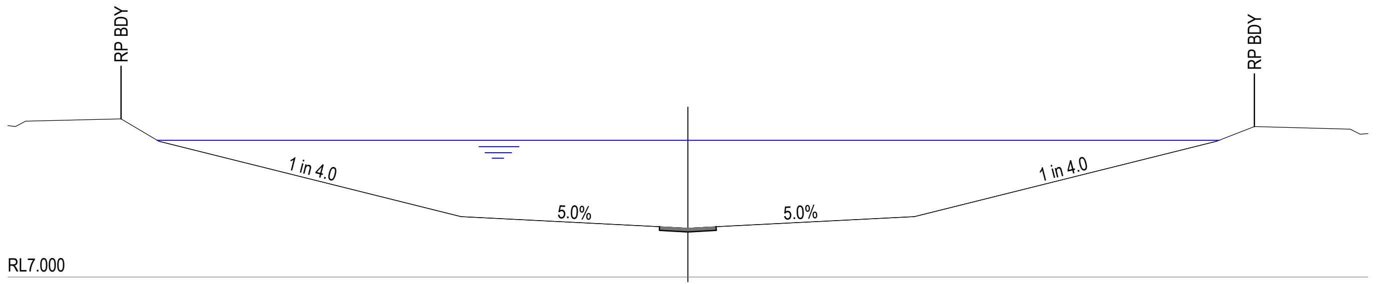
SECTION 3



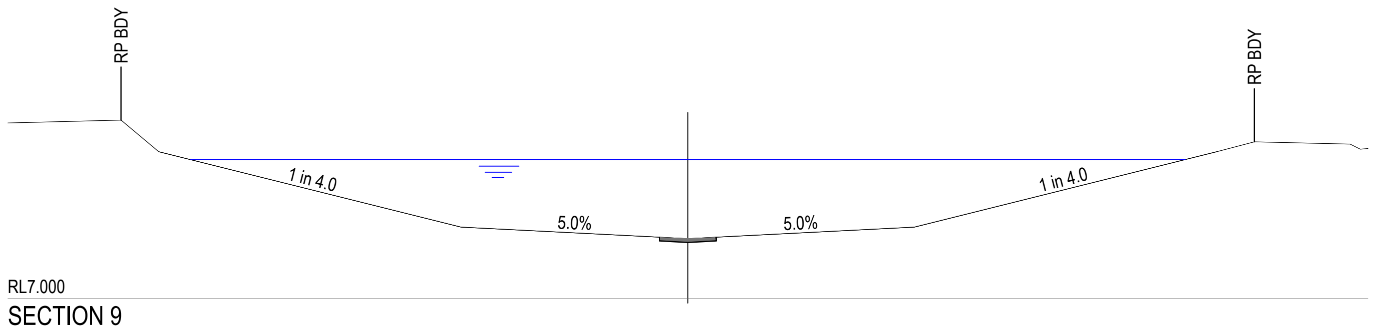
SECTION 2



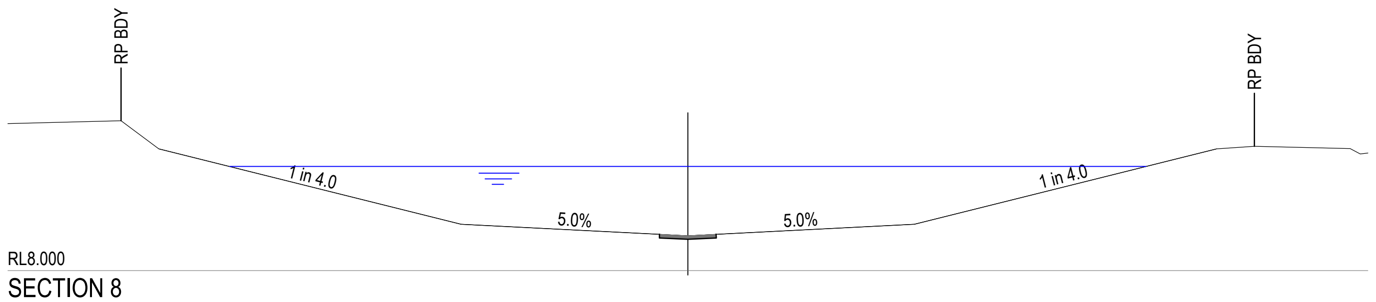
SECTION 1



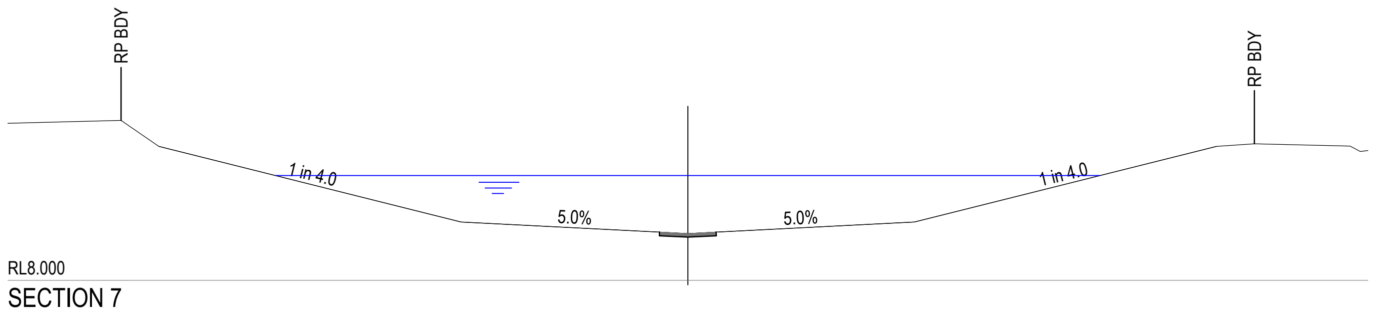
SECTION 10



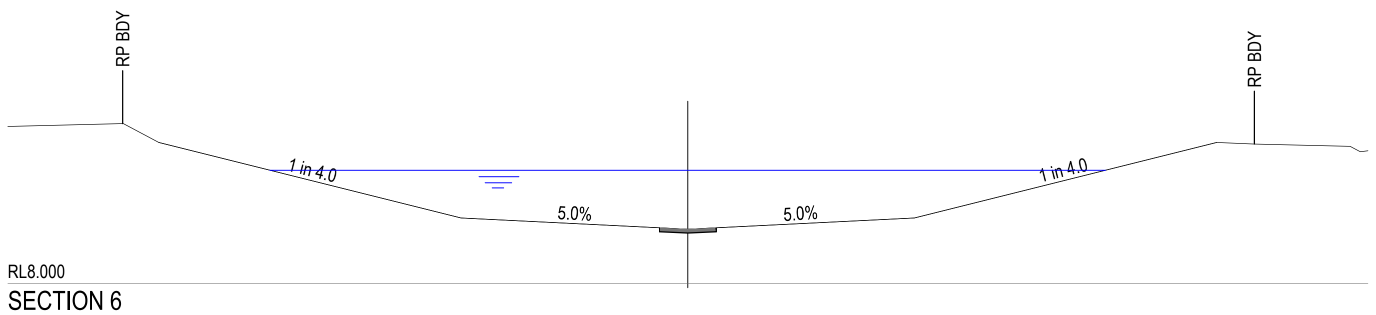
SECTION 9



SECTION 8



SECTION 7



SECTION 6

		DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE		BE	BE	BG		21.09.23	
AMENDMENTS	A	AT	NV	BG	BG	20.12.23	AMENDED TO SUIT RFI

STATUS

PRELIMINARY

APPROVED

BY: RPEQ NO:

SIGN: DATE:

SCALE

0 1 2 3 4 5 6 7 8

SCALE 1:100 (A1) SCALE 1:200 (A3)

egis

www.egis-group.com

CLIENT

STOCKLAND
DEVELOPMENTS PTY
LTD

Stockland AURA

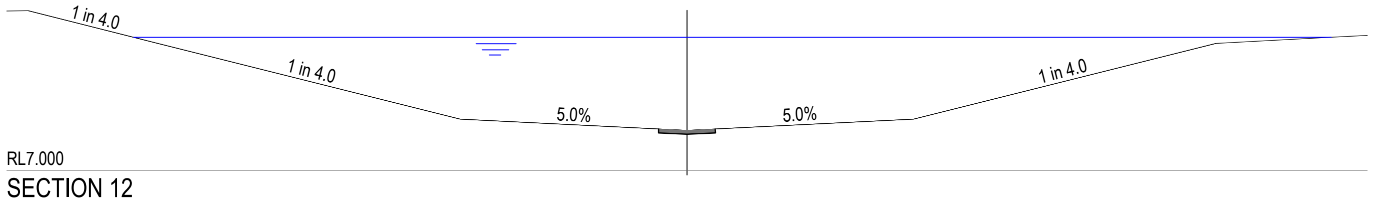
PROJECT

STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

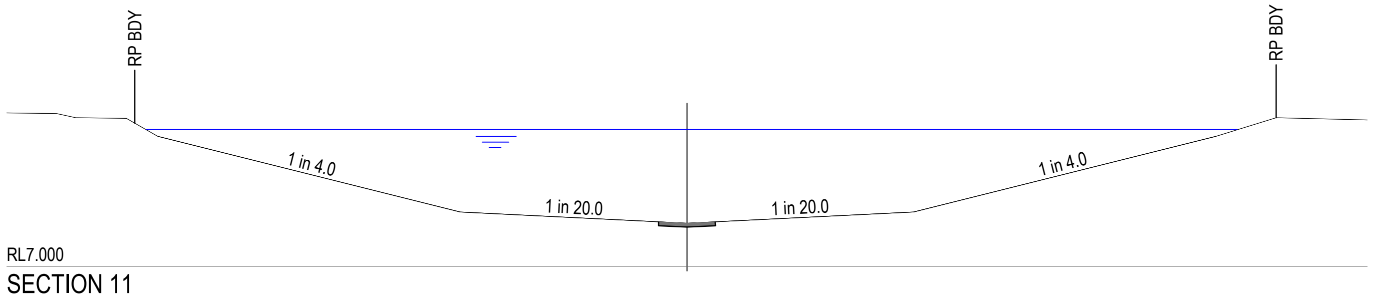
DRAWING TITLE

DRAINAGE CHANNEL SECTIONS
SHEET 1 OF 2

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-SWMP02	A



SECTION 12



SECTION 11

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	BE	BE	BG		21.09.23	
A	AT	NV	BG	BG	20.12.23	AMENDED TO SUIT RFI

AMENDMENTS

STATUS

PRELIMINARY

APPROVED

BY: RPEQ NO:

SIGN: DATE:

SCALE

0 1 2 3 4 5 6 7 8

SCALE 1:100 (A1) SCALE 1:200 (A3)

egis

www.egis-group.com

CLIENT

STOCKLAND
DEVELOPMENTS PTY
LTD

Stockland AURA

PROJECT

STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE

DRAINAGE CHANNEL SECTIONS
SHEET 1 OF 2

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-SWMP03	A

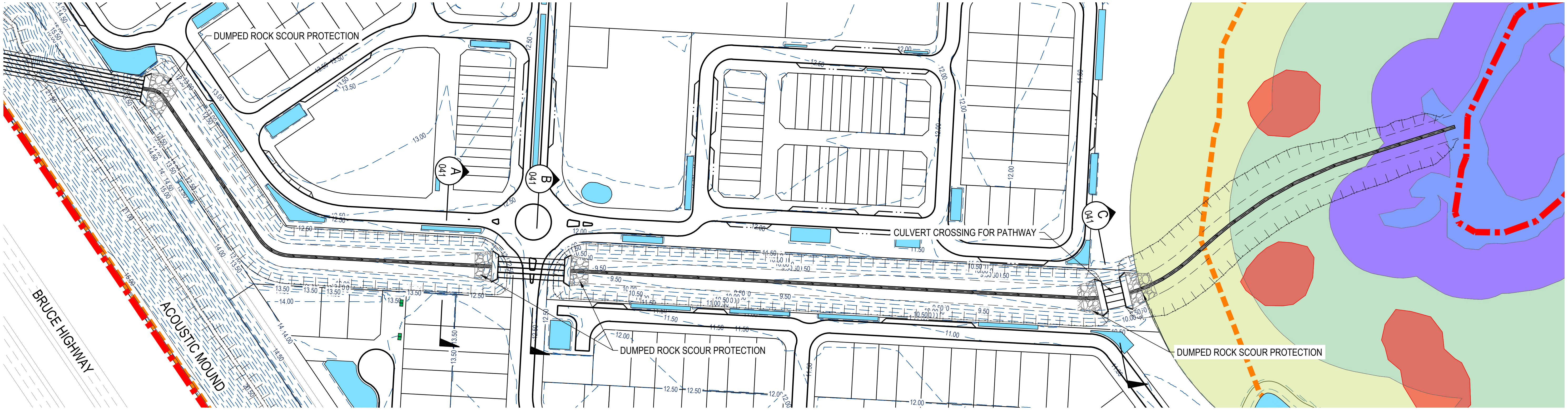
APPENDIX B: DRAINAGE LAYOUT PLANS

NOTE

1. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY & TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN.
2. REFER TO EGIS DRAINAGE LAYOUT PLAN 17-000934-3058-DA030.
3. REFER TO EGIS CATCHMENT LAYOUT PLAN 17-000934-3058-DA31.
4. REFER TO EGIS SMP FOR STORMWATER QUALITY MANAGEMENT DETAIL.
5. CONCEPT DESIGN FOR CAMCOS WORKS PRESENTED IS FUTURE (ULTIMATE) , BY OTHERS.

LEGEND

— — 14.00 — —	PROPOSED SURFACE CONTOURS
┬┬┬┬┬┬┬	PROPOSED BATTERS
🟦	WSUD INFRASTRUCTURE
🟩	WSUD STREET TREE



DRAINAGE SWALE LAYOUT

STORMWATER LINE X LAYOUT

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BE	BE	BG		30.08.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY:
RPEQ NO:
SIGN:
DATE:

SCALE
0 10 20 30 40 50 60 70 80
SCALE 1:1000 (A1)
SCALE 1:2000 (A3)

egis

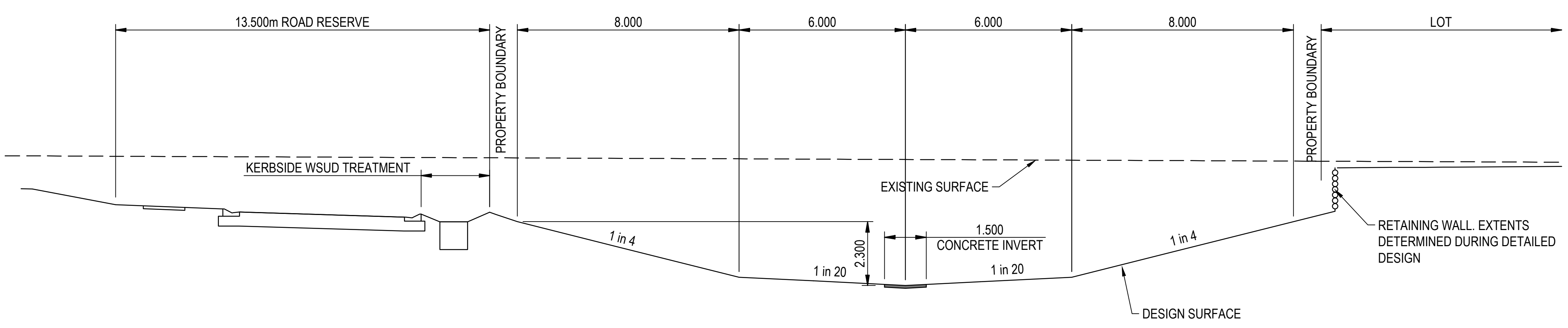
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

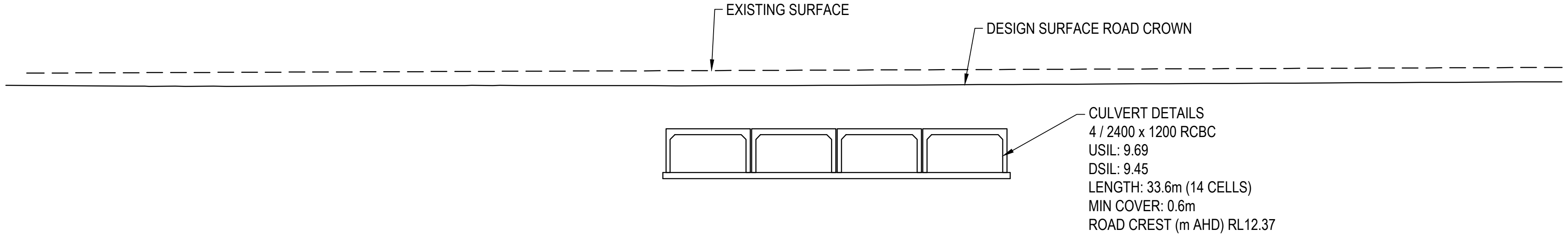
PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
DRAINAGE LAYOUT PLAN

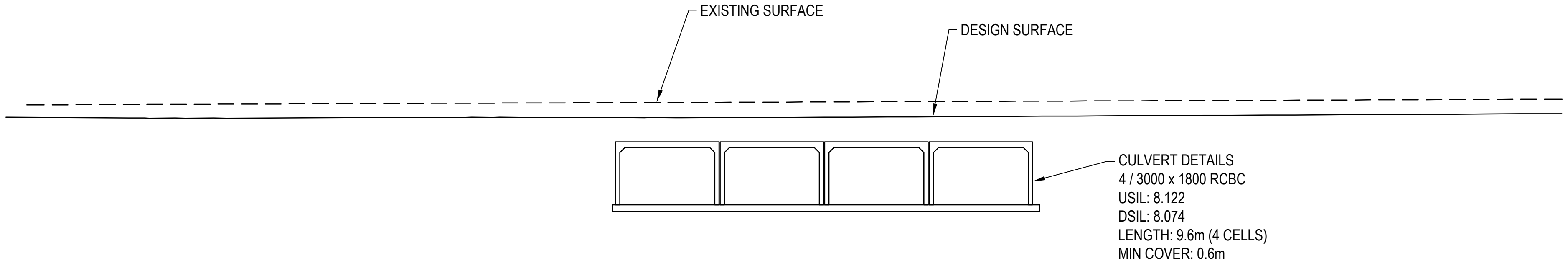
PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA040	A



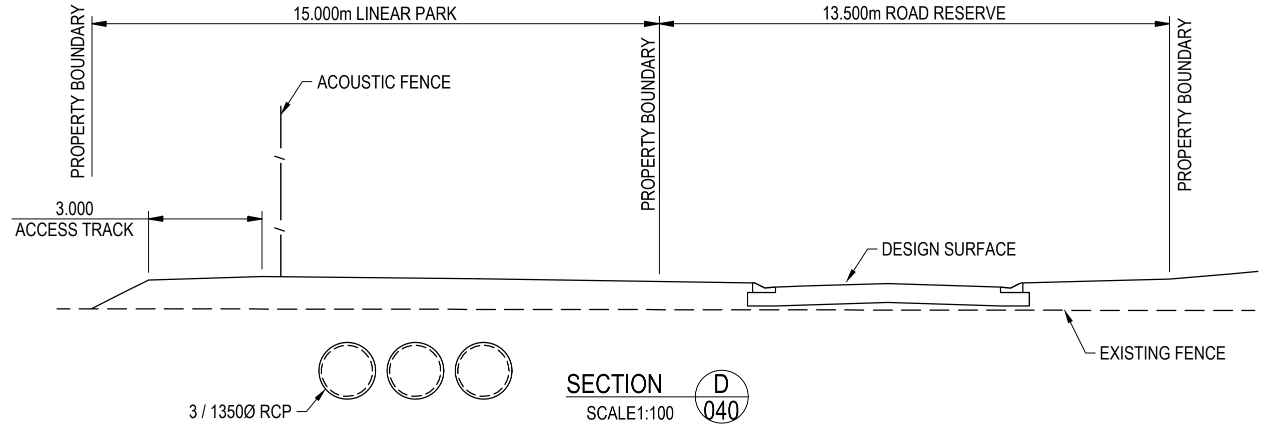
SECTION A 040
SCALE1:100



SECTION B 040
SCALE1:100



SECTION C 040
SCALE1:100



SECTION D 040
SCALE1:100

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	BE	BE	BG		30.08.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 10 20 30 40 50 60 70 80
SCALE 1:1000 (A1) SCALE 1:2000 (A3)

egis

www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
DRAINAGE CROSS SECTIONS

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA041	A

Egis Consulting Pty Ltd

www.egis-group.com

CONTACT US

Egis Consulting Pty Ltd

Level 4, Unit 402, 8 Market Lane, Maroochydore QLD 4558, Australia

Phone +61 7 3517 4190

APPENDIX D:
STORMWATER QUALITY MANAGEMENT PLAN BY EGIS

21-000307.11

STORMWATER QUALITY MANAGEMENT PLAN

AURA PRECINCT 15 WEST

Prepared for **Stockland Development Pty Ltd**

Document information

GENERAL INFORMATION

Author(s)	Matthew Starr
Version	D
Path/file name	21-000307.11.SWMP03D_01
Prepared by (authors)	Matthew Starr, Jingyi Chen, Sidd Unnikrishnan
Reviewed by	Ben Gear
Approved by	Matthew Starr
Security classification	Commercial-in-Confidence

HISTORY OF CHANGES

Version	Date	Checked by
A	28/09/2023	Ben Gear
B	20/12/2023	Ben Gear
C	03/05/2024	Ben Gear
D	17.06/2024	Ben Gear

Version	Date	Approved by
A	28/09/2023	Matthew Starr
B	20/12/2023	Matthew Starr
C	03/05/2024	Matthew Starr
D	17/06/2024	Matthew Starr

RPEQ 09485

egis

TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 Report Scope 1

1.2 Previous & Other Documentation 1

2 SITE DESCRIPTION 2

2.1 Location 2

2.2 Topography & Features 2

2.3 Discharge Location 2

3 STORMWATER QUALITY MANAGEMENT 3

3.1 Pollutants of Concern 3

3.2 Water Quality Objectives 3

3.3 Stormwater Quality Management Strategy 4

3.4 Stormwater Quality Improvement Devices 6

3.5 Stormwater Quality Improvement Device Design Approach 8

3.5.1 Rainwater Tanks 8

3.5.2 Bioretention Systems 9

3.5.3 Park Requirements 10

3.5.4 Frog Buffer Requirements 10

3.5.5 End of Line Concept Designs 10

4 STORMWATER QUALITY MODELLING 12

4.1 Modelling Methodology 12

4.1.1 Meteorological Data 12

4.1.2 Source Node Configuration 13

4.1.3 Drainage Link Configuration 15

4.1.4 Treatment Node Configuration 15

4.2 Modelling Results 18

5 CONSTRUCTION, OPERATIONAL MANAGEMENT & MAINTENANCE OF SQIDS ... 19

5.1 Construction & Establishment Phases 19

5.1.1 Gross Pollutant Traps 19

5.1.2 Bioretention Systems 19

5.2 Operational Phase 19

5.2.1 Rainwater Tanks 19

5.2.2 Gross Pollutant Traps 20

5.2.3 Bioretention Systems 20

5.3 General Requirements 22

5.3.1 Yearly Review of Maintenance Management Plan 22

5.3.2 Maintenance Personnel Safety (OH&S) 22

5.3.3 Public Safety.. 22

6 CONCLUSION.. 23

7 RECOMMENDATIONS.. 23

8 REFERENCES.. 24

TABLES

Table 3-1 Water Quality Objectives.. 3
Table 3-2 Summary of Stormwater Treatment Devices (Updated) 6
Table 3-3 Rainwater Tank Requirements.. 8
Table 3-4 Preliminary Minimum Rainwater Tank Size for Future Development........................ 9
Table 3-5 Preliminary Minimum Bioretention Filter Size for Future Development..................10
Table 4-1 MUSIC Source Node Areas (ha) 14
Table 4-2 Roof Area Assumptions..15
Table 4-3 Rainwater Tank Node Configuration 15
Table 4-4 Stormwater Catchment and Bioretention System Areas..16
Table 4-5 Bioretention Node Configuration 17
Table 4-6 Generic Treatment Node Configuration..18
Table 4-7 MUSIC Modelling Results (Updated) 18

FIGURES

Figure 2-1 Precinct 15 West Location.. 2
Figure 3-1 Precinct 15 West At-Source Stormwater Quality Management.................................. 5
Figure 3-2 Precinct 15 West End-Of-Line Stormwater Quality Management (Updated)................ 5
Figure 3-3 Stormwater Quality Improvement Device Layout (Updated)..................................... 6
Figure 4-1 MUSIC Model Layout (Updated)..12
Figure 4-2 MUSIC Source Node Catchments & Landuse 13

1 INTRODUCTION

Egis Consulting has been commissioned by Stockland Development Pty Ltd to prepare a Stormwater Quality Management Plan for Precinct 15 West of the Aura development, located within the on the north western side of Bells Creek South at the south western end of the overall Aura development. The proposed precinct is located within the Sunshine Coast Council local government area.

This report has been prepared to demonstrate that the Stormwater Quality Improvement Devices (SQIDs) proposed through the application area will achieve the required Water Quality Objectives (WQOs).

Report Version C was prepared in response to the Request for Further Information2 (RFI2) issued by Economic Development Queensland (EDQ) dated 13 March 2024.

> *This report (Version D) has been prepared to address Item 3a of the Further Issues EDQ Letter dated 11 June 2024, which requires the removal of Gross Pollutant Traps (GPT 1, 2 and 12) from the treatment train, or further justification for their inclusion. To address the item the specified GPT's have been removed.*
>
> *Changes made to the previous report to address Item 3a are identified as indented italicised text or are noted as updated in table and figure captions. The section of the report discussing the sensitivity of the MUSIC model results for part and full removal of GPT's from the treatment train (Section 4.3) has been removed from this version of the report.*

1.1 Report Scope

The scope of this report is to:

- Identify the WQOs for the proposed development.
- Provide details of the SQIDs proposed within the Precinct 15 West Stormwater Quality Management Strategy.
- Document the methodology and results of MUSIC modelling undertaken that demonstrates the proposed strategy will achieve the required WQOs.
- Provide management and maintenance details of the construction and operational phases of the proposed SQIDs.

1.2 Previous & Other Documentation

Precinct 15 of the Aura development has been the subject of the following flooding and stormwater management related investigations:

- *Aura Development Stormwater Quality Management Plan* (DesignFlow & BMT, 2019). Report that identified and defined the stormwater quality management objectives for the overall Aura development.
- *Aura Precinct 15 Stormwater Quality Management Plan – Version 3* (DesignFlow, September 2022). Report documenting the Stormwater Quality Management Plan for Aura Precinct 15. This report is referred to in the PDA Decision Notice.
- *Memorandum – Aura Development Acoustic Bund South* (Egis Consulting, August 2023). Technical Memorandum documenting the hydrologic and hydraulic investigation and analysis of the overland flow path and inlet structure associated with the acoustic bund located adjacent to the Aura Development.

2 SITE DESCRIPTION

2.1 Location

Precinct 15 West is in the western part of Aura. The site is bound by the Bruce Highway to the west, the Precinct 15 East and Lend Lease Community precinct to the east, future CAMCOS corridor to the North and Bells Creek South to the south. The West precinct forms part of the Caloundra South Priority Development Area (Aura). The Master Plan was approved by the (former) Urban Land Development Authority (ULDA reference No. DEV2011/200) now Economic Development Queensland (EDQ).

The location of Precinct 15 West is indicated in **Figure 2-1** below.

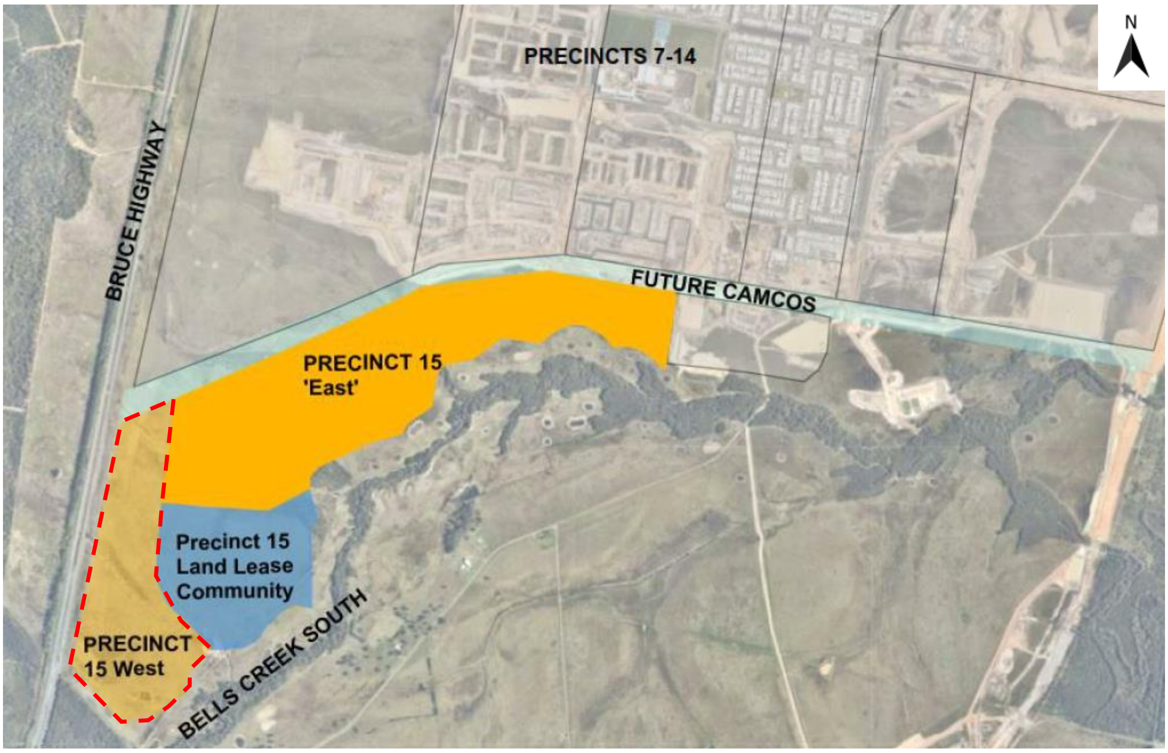


FIGURE 2-1 PRECINCT 15 WEST LOCATION

2.2 Topography & Features

The existing Precinct 15 West site is generally flat with less than 3m of fall across the 600m distance from the northern boundary of the site to the Bells Creek South.

2.3 Discharge Location

The existing and proposed runoff from the Precinct 15 West site discharges to Bells Creek South. It is noted that an overland flow path and inlet structure is proposed to be constructed within the site to convey runoff from external catchments (west of Bruce Highway) under an acoustic bund and through the site. For further details refer to the Egis Consulting *Memorandum – Aura Development Acoustic Bund South* (December 2023).

3 STORMWATER QUALITY MANAGEMENT

It is expected that the proposed development will increase the export of pollutants within stormwater runoff from the subject site. A stormwater management strategy employing suitable Stormwater Quality Improvement Devices (SQIDs) has been proposed to intercept and capture the pollutants so that the potential impacts on waterway downstream are mitigated.

This section discusses:

- The identification of key stormwater pollutants associated with the proposed development.
- The Water Quality Objectives (WQOs) identified for the catchment.
- Proposed measures to mitigate the increase in pollutant export; and
- Modelling of the proposed measures and comparison to the identified WQOs.

> *In response to the EDQ Further issues letter the stormwater management strategy and modelling has been updated.*

3.1 Pollutants of Concern

Typical key pollutants expected to be generated during the operational (post-construction) phase of the planned development are listed as follows, with those presented in capitals being the key pollutants to be targeted for treatment:

- LITTER
- SEDIMENT
- Oxygen demanding substances (possibly present)
- NUTRIENTS (N & P)
- Pathogens / Faecal coliforms
- Hydrocarbons
- HEAVY METALS (associated with fine sediments)
- Surfactants
- Organochlorines & organophosphates
- Thermal pollution
- pH altering substances

Only the key pollutants will be further addressed in this report; however, the treatment train developed will adequately mitigate the other pollutant loads. As heavy metals will predominately be associated with fine sediment, controls proposed to reduce total suspended solids will also adequately reduce loads of heavy metals.

3.2 Water Quality Objectives

As documented within the DesignFlow *Aura Precinct 15 Stormwater Quality Management Plan* (2022) the WQOs for Precinct 15 are based on the catchment and waterway modelling previously undertaken and documented within the DesignFlow & BMT *Aura Development Stormwater Quality Management Plan* (2019). These WQOs consider the High Ecological Value (HEV) of the receiving Pumicestone Passage waterway which has Ramsar wetland status.

The pollutant load reduction WQOs are stated in **Table 3-1** below.

TABLE 3-1 WATER QUALITY OBJECTIVES

POLLUTANT	TOTAL SUSPENDED SOLIDS (TSS)	TOTAL PHOSPHORUS (TP)	TOTAL NITROGEN (TN)	GROSS POLLUTANTS (GP)
Load Reduction	95%	89%	68%	90%

Source: DesignFlow

3.3 Stormwater Quality Management Strategy

The initial stormwater quality management strategy for Precinct 15 West deviated from the current "end of line' treatment strategy applied through Aura. In place of "end of line" devices Precinct 15 West incorporates an area of at-source bioretention systems to meet the prescribed water quality objectives.

In response to the initial EDQ RFI (dated 20 November 2023) the stormwater quality management strategy was updated to include "end of line" bioretention basins to capture and retain pollutant for part of the proposed development. This was documented within Version B.

RFI2 was received from EDQ following the submission of Version B. In response to RFI2 the following changes to the strategy were made:

- The at-source bioretention in Catchments 16, 17, and 24 have been removed. Instead, the runoff from these catchments now drains to the end-of-line bioretention CAT_12_BIO. This addresses Item 1a of RFI2.
- Allowance for treatment of the catchments for the future childcare centre, centres, community and multiple residential sites (Lot 8100 to 8103) have been included in the strategy. As the configuration of development on these lots is unknown at this time and will be subject to their own Development Approval, only preliminary sizing of rainwater tanks and bioretention systems for each lot (to meet State Planning Policy 2017 water quality objectives) have been identified. (Refer to Table 3-4 and Table 3-5.The adoption of SPP objectives for these lots will negate the need for a large bioretention footprints. Generic treatment nodes, configured to meet SPP water quality objectives, have been utilised in MUSIC to account for treatment that will be incorporated into each future development. This addresses Item 1b of RFI2.
- The bioretention tree pit in the Catchment 10 has been removed. CAT_GPT_10 remains to treat the stormwater from the Catchment 9, 10 and 11 before draining into the Bells Creek South. This addresses Item 1c of RFI2.
- A sensitivity analysis of different GPT configurations has been conducted to determine the impact of removing Gross Pollutant Traps (GPTs). This analysis is to assess the effectiveness of GPTs in pollutant reduction and evaluate their necessity in the overall stormwater quality management strategy. Refer to Section 4.3 for details. The undertaking of this sensitivity analysis addresses Item 1d of RFI2.
- The at-source bioretention pod treating runoff from just the linear park (CAT_37_BIO) has been removed and the runoff of this catchment (CAT_37) will bypass the treatment and drain into the Bells Creek South. This addresses Item 1e of RFI2.
- The at-source bioretention CAT_10_BIO, from CAT_12_BIO to CAT_24_BIO, CAT_30_BIO, CAT_37_BIO, CAT_40_BIO and CAT_41_BIO have been removed. An end-of-line bioretention basin (CAT_12_BIO) is now proposed in their place. requirements to meet the Water Quality Objectives. Refer to Figure 3-3 for further details. This addresses Items 1f and 1g of RFI2.

To address Item 3a of the EDQ Further Issues Letter the Gross Pollutant Trap (GPT;'s) 1, 2 and 12 have been removed from the strategy. Refer to ***Figure 3-3*** *for the updated layout of the proposed stormwater quality improvement devices.*

The strategy has influenced the urban design principles by:

- Limiting street leg lengths.
- Centrally located bioretention within road medians.
- 'Park fronted' terraces out letting directly to treatment devices.
- Consolidated at-source devices within the streetscape using a combination of smart urban design, locally widened road reserves and one-way cross fall roads; and
- Mandating mixed use, medium density, childcare, commercial sites etc. to have self-contained treatment.

To illustrate the proposed treatment strategies ***Figure 3-1*** *and* ***Figure 3-2*** *(updated) below are provided.*

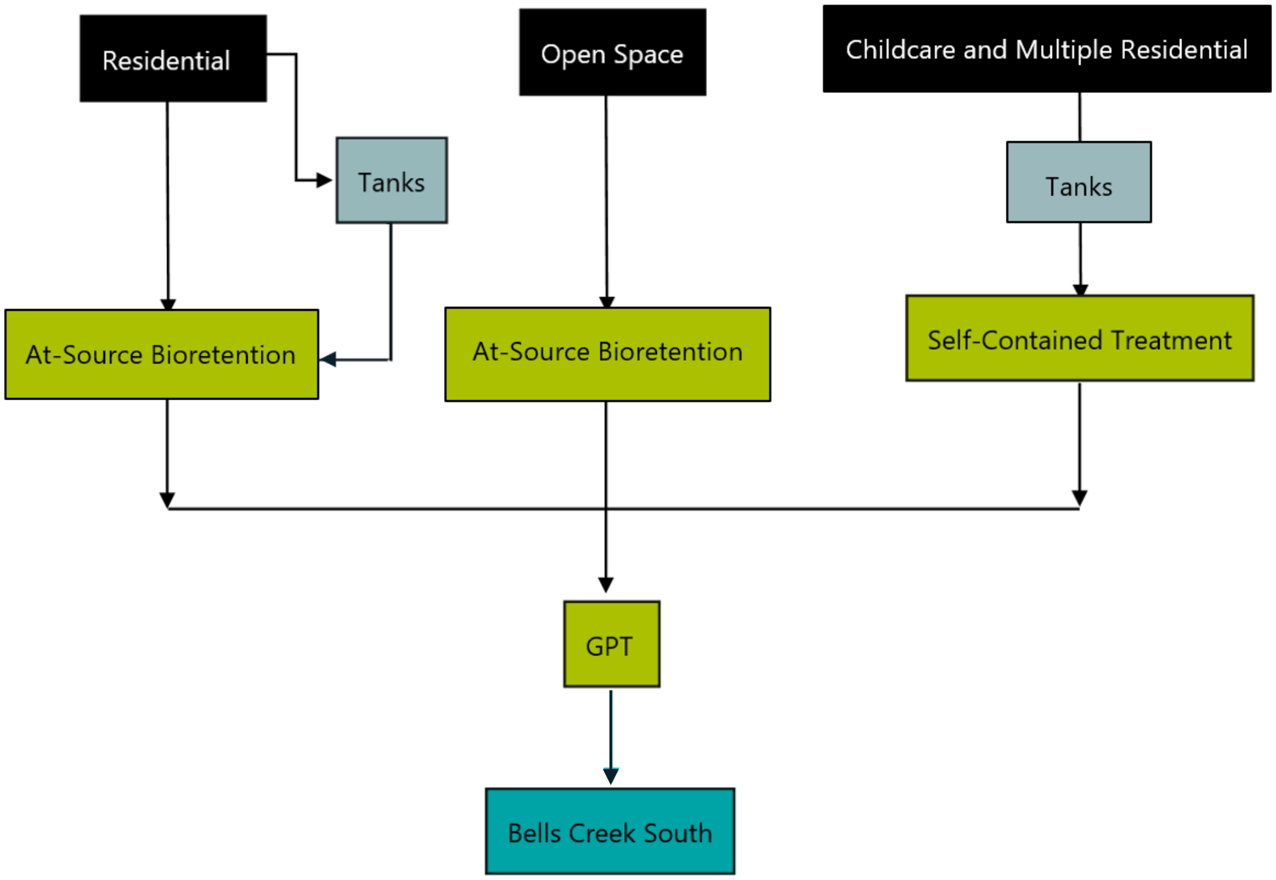


FIGURE 3-1 PRECINCT 15 WEST AT-SOURCE STORMWATER QUALITY MANAGEMENT

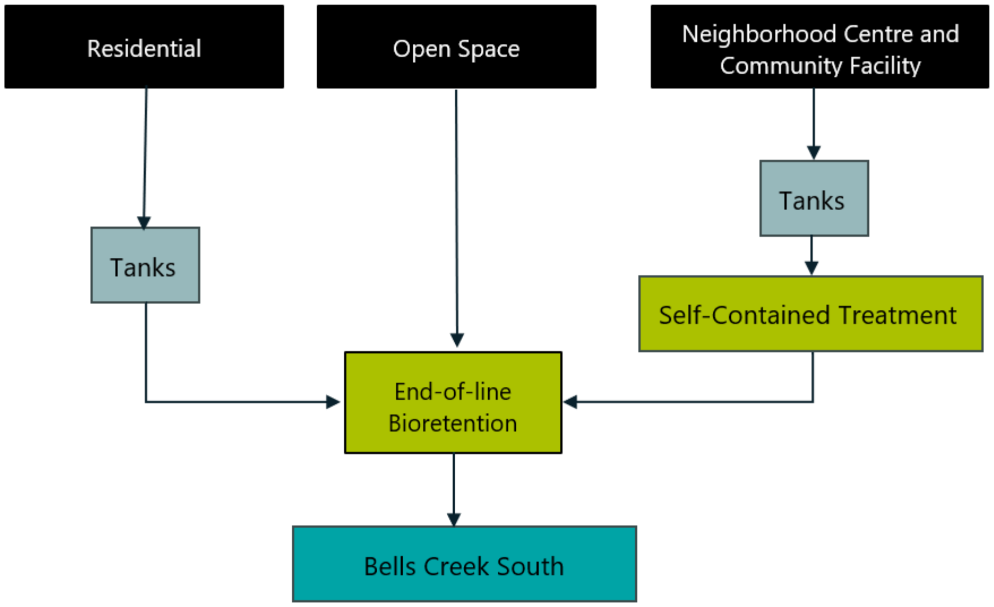


FIGURE 3-2 PRECINCT 15 WEST END-OF-LINE STORMWATER QUALITY MANAGEMENT (UPDATED)

Although the strategy differs from previous strategies across Aura, the same types of stormwater quality improvement devises are proposed to manage stormwater pollutants. **Section 3.4** discusses these devices in detail.

Figure 3-3 below provides an overview of the proposed stormwater quality improvement devices and land use characteristics.

Note the bioretention areas shown in **Figure 3-3** are the filter media area, they do not include batters etc. The integration of SQIDs into the development layout has been coordinated and considered from a bottom-up approach, with water quality driving urban design principals. Through the detailed design process amendments and refinements to SQID areas and catchment will be made as earthworks and final coordination occurs.

The lots indicated with the spotted hatch in ***Figure* 3-3** represent the future childcare centre, centres, community and multiple residential sites (Lot 8100 to 8103). The strategy proposes these lots are to incorporate their own stormwater quality treatment infrastructure to achieve the SPP water quality objectives only (not the higher objectives indicated in ***Table* 3-1**), thereby reducing the burden on developing these lots in the future.

FIGURE 3-3 STORMWATER QUALITY IMPROVEMENT DEVICE LAYOUT (UPDATED)

3.4 Stormwater Quality Improvement Devices

Table 3-2 below table summarises the proposed stormwater quality improvement devices proposed within Precinct 15 West.

TABLE 3-2 SUMMARY OF STORMWATER TREATMENT DEVICES (UPDATED)

DEVICE	DESCRIPTION
RAINWATER TANKS	To reduce the volume of stormwater runoff requiring treatment, rainwater tanks are proposed for residential land uses. As per Stockland's water conservation policy tanks are to be plumbed for toilet, cold laundry tap, outdoor uses and other non-potable demands. The integration of rainwater tanks is critical to ensure pollutant reductions targets are achieved, **Table 3-3** outlines the rainwater tank requirements for Precinct 15 West. Rainwater tanks will also be provided within the future childcare centre, centres, community and multiple residential sites (Lot 8100 to 8103).
GROSS POLLUTANT TRAPS	GPT's are to be located at the downstream extent of the stormwater drainage network. *GPT's upstream of Bioretention Basins have been removed from the strategy to address Item 3a of the EDQ Further Issues Letter.* GPT's are designed to remove gross pollutants, sediment, suspended particles, and some nutrients (bound to sediment and suspended solids) from the stormwater runoff. The application of these SQIDs immediately upstream of the proposed stormwater outlets will assist in removing floating litter, debris, and sediment from the stormwater discharging into Bells Creek South. The GPTs are to be owned and managed by Sunshine Coast Council.
BIORETENTION PODS	At-source bioretention systems (i.e. bioretention pods, bioretention basin) are proposed to capture stormwater runoff from residential, roads and open space land uses. The key constraints for at-source bioretention that need to be considered are: ■ The verge profile. ■ The location of footpaths. ■ The location of other services (crossings, lights, car parking bays, etc); and ■ The extended detention depth (level differences). Within Precinct 15 West where possible roads will incorporate one-way crossfall, this allows a single consolidated bioretention pods. This methodology allows for the footpath to be placed in the high-side verge, alleviating any potential conflicts. Bioretention systems utilise sandy loam soil based media to filter runoff. Sediment particles and suspended solids are trapped within vegetation and on the surface of the filter media while micro-organisms and vegetation remove dissolved nutrients (nitrogen and phosphorus) through biological uptake processes. Subsoil drainage provided below the filter media allows for the treated runoff to discharge from Bioretention systems where it is connected local stormwater drainage systems. The final design of the bioretention systems is to be in accordance with the Water by Design *Bioretention Technical Design Guidelines* (2014).
BIORETENTION BASINS	In response to the EDQ IRR at-source bioretention systems within the southern part of the Precinct (CAT_01 and CAT_02) have been replaced by two end of line bioretention basins, located between the southeastern esplanade road and Bells Creek. In response to the EDQ RFI2, bioretention tree pits were replaced by an additional end-of-line bioretention system, CAT_12_BIO, proposed in catchment CAT_12, located between the southeastern esplanade road and Bells Creek. This CAT_12_BIO aims to treat all the east-south catchment but exclude neighbourhood centre and the community facility area. These neighbourhood centre and the community facility area will have their own local stormwater treatment facility to meet SPP water quality objective during the future development approval stage. The final design of the bioretention systems is to be in accordance with the Water by Design *Bioretention Technical Design Guidelines* (2014).

3.5 Stormwater Quality Improvement Device Design Approach

3.5.1 Rainwater Tanks

Integration of rainwater tanks are critical to Stockland's water conservation and the stormwater quality strategy in Precinct 15 West and ensures pollutant reductions targets are achieved. **Table 3-3** below outlines the rainwater tank requirements for Precinct 15 West, the requirements are consistent with the rainwater tank specifications provided in *Aura Development Stormwater Quality Management Plan* (DesignFlow & BMT, 2019) and *Aura Precinct 15 Stormwater Quality Management Plan* (DesignFlow, 2022). To ensure compliance with this Stormwater Quality Management Plan these requirements have been written into the Plan of Development.

TABLE 3-3 RAINWATER TANK REQUIREMENTS

LANDUSE	ROOF AREA	TANK SIZE	CONNECTIONS
Residential Detached/attached dwellings (Lot >300m^2)	50% roof area drains to tank	5kL per dwelling	Tanks are to be connected to and supply to the following: ■ Toilets ■ Laundry cold ■ Outdoor taps
Residential Detached/attached dwellings (Lot = 225 – 300m^2)	50% roof area drains to tank	3kL per dwelling	Tanks are to be connected to and supply to the following: ■ Toilets ■ Laundry cold ■ Outdoor taps
Residential Detached/attached dwellings (Lot <225m^2)	No Tanks		
Residential Medium density dwellings	75% roof must connect / drain to tank. If multiple buildings then 50% of total roof area must connect / drain to tank	1KL per dwelling	Tanks are to be connected to and supply to the following: ■ Toilets ■ Laundry cold ■ Outdoor taps
All non-residential Uses including but not limited to: • Commercial • Retail • Industrial • School • Community	50% roof must connect / drain to tank. If multiple buildings then 50% of total roof area must connect / drain to tank	1KL per toilet or urinal or 25KL/ha Minimum 5KL size	Tanks are to be connected to and supply to the following: ■ Toilets ■ Laundry cold ■ Outdoor taps

To address Item 1b of the EDQ RFI2, preliminary sizing of rainwater tanks was undertaken for the future childcare centre, centres, community and multiple residential sites, based on the following:

- A volume of 25KL/ha for the future childcare centre, centres and community sites (Lots 8100, 8102 and 8103).
- For the multiple residential site (Lot 8101) a volume of 1KL per dwelling (with single toilet) and assuming a density of 40 dwellings per hectare.

The preliminary minimum rainwater tank sizes for the future childcare centre, centres, community and multiple residential sites are summarised in ***Table* 3-4** below.

TABLE 3-4 PRELIMINARY MINIMUM RAINWATER TANK SIZE FOR FUTURE DEVELOPMENT

SITE	LOT	LOT AREA (ha)	RAINWATER TANK SIZE (KL)
CHILDCARE CENTRE	8100	0.347	9
MULTIPLE RESIDENTIAL	8101	0.423	11
CENTRES	8102	0.691	18
COMMUNITY	8103	0.497	13

3.5.2 Bioretention Systems

At source bioretention systems (pods and small basins) are integrated into the Precinct 15 West urban layout to capture and treat stormwater flows generated by the development. The systems are to be located in consolidated locations to minimize the number of cells required, systems are generally positioned at side boundaries of lots, within open space or drainage lots. The following criteria are key design requirements:

- Roads are to incorporate one-way cross fall pavement.
- Street leg lengths have been limited to 120m to ensure stormwater flow depths are in accordance with the LGIA design requirements, meaning bioretention systems can be located at the end of streets (no mid-block systems).
- Lots at street ends orientated to front intersecting road, allowing the long side of the lot to provide area of bio within the road reserve, thus avoiding potential conflict with driveways.
- Road typologies that include central medians have been inverted with bioretention systems placed within the central median.
- Footpaths are located on the opposite side of the road reserve to bioretention systems.
- Services are to avoid bioretention systems but may pass underneath with appropriate protection as required by the service provider.
- Filter media is a minimum of 1m wide.
- Batters are maximum of 1 in 2.
- Filter media is set 1m minimum from invert of kerb; and
- Extended Detention Depth varies depending on location of systems, constrained roadside systems will have 200mm EDD and unconstrained systems will have 300mm EDD.

To address Item 1b of RFI2, preliminary sizing of bioretention systems was undertaken (using MUSIC) for the future childcare centre, centres, community and multiple residential sites (Lot 8100 to 8103). The size of the bioretention systems have been based on treating runoff from each future development to achieve SPP water quality objectives, rather than burden the future development with the higher WQOs in **Table 3-1**. The preliminary bioretention system sizes for the future childcare centre, centre, community and multiple dwelling sites are summarised in **Table 3-5**.

TABLE 3-5 PRELIMINARY MINIMUM BIORETENTION FILTER SIZE FOR FUTURE DEVELOPMENT

SITE	BIORETENTION AREA (m^2)
CHILDCARE CENTRE	43
MULTIPLE RESIDENTIAL	44
CENTRES	85
COMMUNITY	60

Contained within Appendix E of *Engineering Services Report Aura Precinct 15 'West'* (Egis, 2024) typical details of proposed bioretention systems are provided.

3.5.3 Park Requirements

To accommodate the required bioretention basin areas, stormwater quality improvement devices have been included within parks/open space. To ensure the open space remains creditable, criteria specified within the Caloundra South Local Government Infrastructure Agreement must been achieved. These criteria are:

- Max grade 1:4, 1:6 preferred for maintenance requirements.
- Land provided for stormwater treatment facilities for the park are to have a minimal impact on the park's functionality.
- Additional land provision for integrated stormwater treatment facilities for adjoining road areas can be co-located with park treatment facilities also to have no impact on park function.
- Max. 5% of total park area in one location.
- Where possible, stormwater treatment facilities are to be integrated with planting areas and form part of the overall vegetated area.

3.5.4 Frog Buffer Requirements

End of line bioretention basins are proposed to be located within the frog buffer along Bells Creek South. The following criteria is required to be met and is sourced from *Aura Precinct 15 Stormwater Quality Management Plan* (DesignFlow, 2022).

- No more than 40% of the frog buffer can be used for stormwater management devices, including drainage channels. Stormwater Management Devices must be placed uniformly along the length of the frog buffer to ensure no restriction to the overall connectivity of Wallum Sedgefrog Habitat within the Frog Zone and Frog Buffer.
- Where Stormwater management is located within the Frog Buffer, an average minimum setback of 20m is required between all edges of each stormwater management measure and the frog zone boundary. This set back distance does not apply to stormwater outlet drainage channels.
- The stormwater management measures must be set back 30m from the created Frog Ponds within the Frog Zone and Frog Buffer. Drainage channels and swales from the stormwater management measures to the creek can be closure than 30m.
- The final locations of the stormwater management devices will be determined during detailed design. The location will consider he proposed Wallum Sedgefrog Habitat ponds, foraging habitat and overall habitat connectivity to ensure compliance with Key Performance Criteria 5, listed in Table 6.2a with in the Wallum Sedgefrog Management Plan and Table 8.2a with the Acid Frog Management Plan.

3.5.5 End of Line Concept Designs

The proposed configurations of the end of line bioretention devices were developed with acknowledgement of the surrounding constraints, available area and contributing catchments. Survey of Bells Creek South has been undertaken to determine the standing water and associated bank levels to allow the concept designs to be developed. As illustrated on drawing 3058-DA038 contained within Appendix E of the *Precinct 15 West*

Engineering Services Report (Egis, 2023) the end of line bioretention basin filter media level is located ~1.8m above the standing water level is Bells Creek South.

Initial grading of batters, access tracks and bunds have been undertaken to ensure compliance with the requirements outlined in Section 3.5.5 and Section 3.5.6. The final size and location of the end of line systems will be determined through detailed design processes to ensure upstream catchments changes, stormwater network design and any other development constraints are captured.

In response to the EDQ RFI2, an additional end of-line Bioretention Basin CAT_12_BIO was proposed to capture and treat runoff from the east south part of the precinct (CAT_12) including the neighbourhood centre and community facility. This basin will incorporate the following key design attributes:

- Pre-treatment of inflows by a Gross Pollutant Trap.
- Filter Media depth of 500mm to reduce overall basin depth and better enable under-drainage to freely discharge to Bells Creek.
- Batters are maximum of 1 in 4, with provision of vehicular maintenance access into each basin; and
- Extended Detention Depth of 300mm.

4 STORMWATER QUALITY MODELLING

Stormwater quality modelling of the proposed Precinct 15 West development has been undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Version 6.3.0. MUSIC enables the user to conceptualise the transfer of pollutants through a stormwater drainage system and provides an aid in quantifying the effectiveness of the proposed stormwater quality management strategy. MUSIC only provides quantitative modelling for Total Suspended Solids (TSS), Total Phosphorous (TP), Total Nitrogen (TN) and Gross Pollutants (GP).

4.1 Modelling Methodology

The MUSIC model was setup generally in accordance with the Healthy Land and Water *MUSIC Modelling Guidelines* (2018) and utilising information sourced from the DesignFlow *Aura Precinct 15 Stormwater Quality Management Plan – Version 3* (2022). Subsequent sections discuss the model configuration adopted for the analysis.

*The updated layout of the MUSIC model is presented in **Figure 4-1** below.*

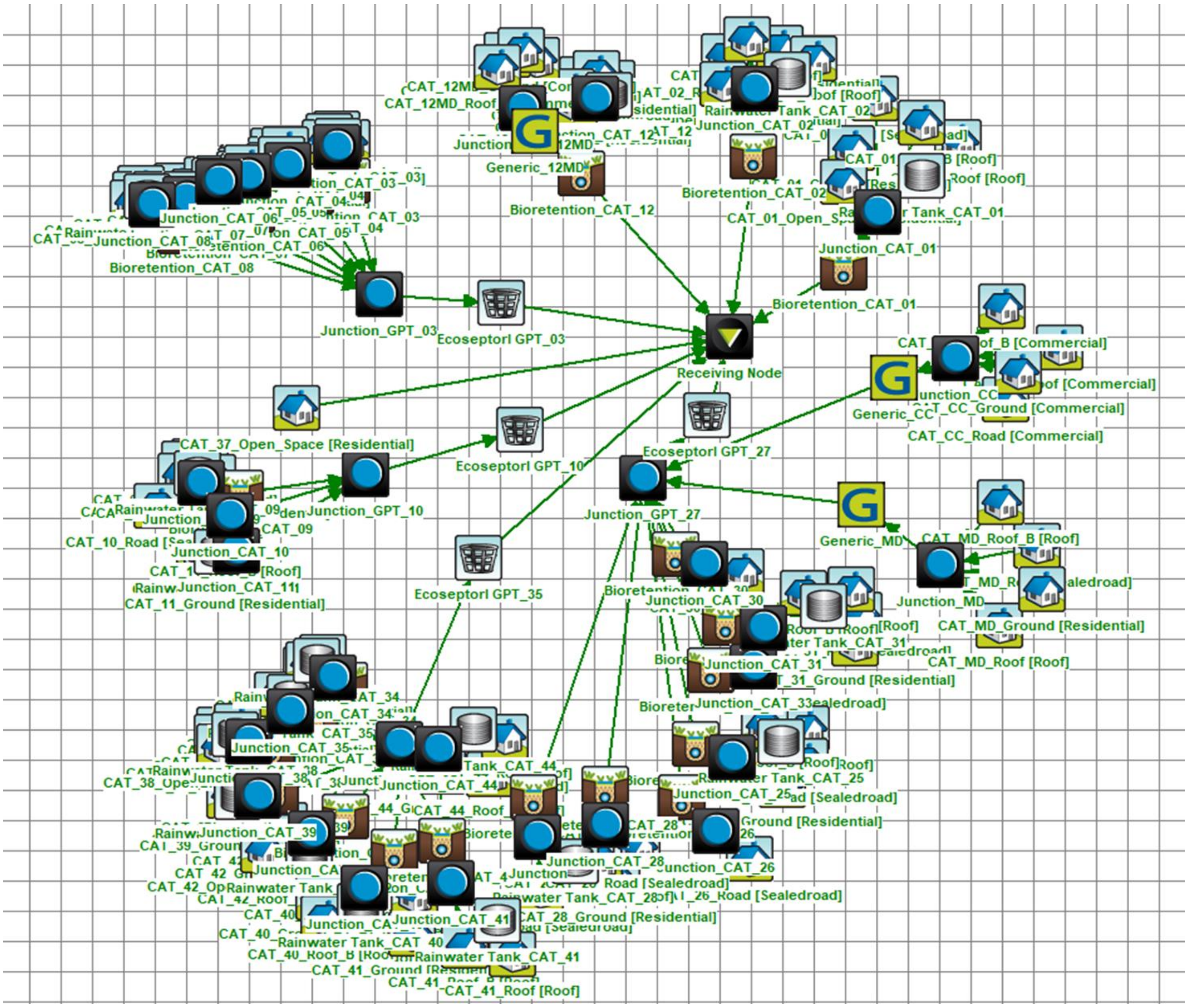


FIGURE 4-1 MUSIC MODEL LAYOUT (UPDATED)

4.1.1 Meteorological Data

Six minutes pluviographic data was sourced from the Bureau of Meteorology (BOM) for the Caloundra WTP Station (No. 40496).

The 13 year period from 1st January 1997 to 31st December 2009 has been adopted for the rainfall duration as per the *Aura Precinct 15 Stormwater Quality Management Plan* (2022). The mean annual rainfall for this period is 1,348mm. Monthly evapotranspiration data for the 13 year period was sourced from the *MUSIC Modelling Guidelines* (2018) and entered into the MUSIC Model. The annual evapotranspiration value adopted was 1,618mm.

4.1.2 Source Node Configuration

Within the MUSIC model source nodes represent the catchments of the proposed development. Runoff and pollutants (contained within the runoff) are generated by the source nodes.

The split catchment source node approach has been adopted in accordance with Section 3.3.2 of the *MUSIC Modelling Guidelines*, which divides each catchment into different surface types. Roof, Road and Ground source nodes have been utilised. Roof source nodes represent the dwelling roofs, road reserve source nodes represent road and road verge area, while ground nodes represent the ground area of each lot and open space areas (i.e. drainage reserve, acoustic bunded areas).

The MUSIC model catchment delineation and surface types that have been adopted for configuring source nodes are presented on **Figure 4-2** and in **Table 4-1**.

FIGURE 4-2 MUSIC SOURCE NODE CATCHMENTS & LANDUSE

TABLE 4-1 MUSIC SOURCE NODE AREAS (HA)

CATCHMENT NAME	ROOF TO RWT	ROOF BYPASSING RWT	ROAD	GROUND	OPEN SPACE
CAT_01	0.765	0.853	1.371	0.666	0.995
CAT_02	0.835	0.888	1.247	0.721	0.325
CAT_03	0.042	0.042	0.089	0.036	0.005
CAT_04	0.083	0.083	0.107	0.071	0.000
CAT_05	0.051	0.051	0.170	0.044	0.000
CAT_06	0.049	0.049	0.065	0.042	0.000
CAT_07	0.044	0.044	0.057	0.038	0.000
CAT_08	0.076	0.076	0.172	0.065	0.000
CAT_09	0.080	0.080	0.133	0.068	0.357
CAT_10	0.000	0.000	0.037	0.000	0.000
CAT_11	0.025	0.025	0.000	0.021	0.000
CAT_12	0.290	0.742	1.483	0.298	0.665
CAT_25	0.000	0.175	0.289	0.019	0.000
CAT_26	0.000	0.000	0.086	0.000	0.000
CAT_27	0.000	0.000	0.271	0.000	0.000
CAT_28	0.023	0.023	0.163	0.020	0.000
CAT_30	0.000	0.000	0.101	0.000	0.000
CAT_31	0.039	0.039	0.126	0.034	0.000
CAT_33	0.000	0.000	0.101	0.000	0.000
CAT_34	0.170	0.170	0.183	0.146	0.000
CAT_35	0.052	0.052	0.147	0.045	0.000
CAT_37	0.000	0.000	0.000	0.000	0.369
CAT_38	0.041	0.041	0.126	0.035	0.217
CAT_39	0.075	0.075	0.103	0.064	0.000
CAT_CC	0.087	0.087	0.104	0.069	0.000
CAT_MD	0.074	0.074	0.127	0.148	0.000
CAT_12MD	0.297	0.297	0.356	0.238	0.000
CAT_40	0.096	0.096	0.137	0.083	0.000
CAT_41	0.110	0.110	0.225	0.095	0.000
CAT_42	0.048	0.048	0.102	0.041	0.218
CAT_44	0.027	0.027	0.031	0.023	0.000

The development type of CAT_CC and CAT_12MD is commercial. The development type of CAT_MD is residential 40 dwellings/ha. The surface-type splits for road, roof and ground follow the Table 3.4 of MUSIC Guideline 2018.

The following is noted regarding the source node configuration:

- Area for road and open space nodes have been delineated for each catchment. Area of roofs has been calculated based on the proportion of allotment area as summarised in **Table 4-2** below. Remaining allotment area has been adopted as ground area.

TABLE 4-2 ROOF AREA ASSUMPTIONS

DWELLING TYPE	ROOF AREA
Detached/Attached Dwellings (Lot >300m^2)	70% of Allotment Area
Detached/Attached Dwellings (Lot = 225 - 300 m^2)	70% of Allotment Area
Detached/Attached Dwellings (Lot <225 m^2)	90% of Allotment Area

- Where bioretention systems are proposed within a catchment the source node area has been adjusted to account for the area of the bioretention system.
- Fraction impervious values have been adopted generally in accordance with Table 3.6 of the *MUSIC Modelling Guidelines*.
- Urban residential type rainfall runoff and split catchment pollutant export parameters as per Tables A1.2 and B1.3 of the MUSIC Modelling Guidelines have been adopted.

4.1.3 Drainage Link Configuration

No routing was adopted for drainage links within the MUSIC model. This assumes flows and associated pollutants from all parts of the catchment arrive at the treatment nodes at the same time. This is conservative as it means that MUSIC may overestimate the overflow volumes.

4.1.4 Treatment Node Configuration

Rainwater Tank, Gross Pollutant Trap, Bioretention and Generic treatment nodes have been configured generally in accordance with Section 4.2 of the *MUSIC Modelling Guidelines*. A summary of the configuration, including details of deviations where required, are provided in the following sections.

4.1.4.1 Rainwater Tank & Stormwater Harvesting Nodes

Table 4-3 below summarises the treatment node configuration adopted.

TABLE 4-3 RAINWATER TANK NODE CONFIGURATION

PARAMETER	ADOPTED VALUE	NOTES
High Flow Bypass	100 m^3/s	Default
Low Flow Bypass	0 m^3/s	Default
Volume Below Overflow Pipe	4 kL per detached dwelling allotment > 300m2 2.4 kL per detached dwelling allotment 225 m^2 to 300m^2	5,000 litre tanks with 80% utilisation specified for larger detached dwelling allotments. 3,000 litre tanks with 80% utilisation specified for smaller detached dwelling allotments.
Depth Above Overflow	200 mm	Default
Surface Area	2.5 m^2 per detached dwelling	Surface area based on tank height of 2m.
Overflow Pipe Diameter	90 mm per outlet	Standard uPVC pipe diameter adopted.
Annual Demand	384 mm per square metre	Calculated based on irrigation rate of 538 mm per year with 70% of ground area within lot irrigated on PET minus rain distribution.
Daily Demand	190 L per day per dwelling	Calculated based on detached dwellings having three bedrooms (2.8 EP) with rainwater used for toilet flushing and laundry, adopting half with full water saving fixtures and appliances and remaining adopting standard water saving fixtures and appliances.

Updates were made to the configuration of the Rainwater Tank treatment nodes in response to items raised in the EDQ RFI.

With regards to the changes please note:

- **Table 4-3** specifies how the rainwater tank treatment nodes have been configured in MUSIC, not the actual configuration of the treatment device. A condition can be included in the approval to state that rainwater tanks are to be installed with a suitable first flush device.
- Item 16(f) of EDQ RFI states that "*individual rainwater tanks for standard residential lots must incorporate a conservative factor to ensure the MUSIC model is modelled conservatively*" and "*at the end-of-life of the rainwater tank or water pump, some property owners may elect not to replace their rainwater tanks or pumps*". Therefore, the configuration of Rainwater Tank node volume has been updated to assume only 80% of residential lots have functioning rainwater tank, by reducing the size of each tank node volume by 20%.
- Annual irrigation demand has adopted 70% of ground area in accordance with the MUSIC modelling Guidelines (2018). Irrigation distribution has also been updated to account for no irrigation when rainfall occurs (i.e. PET minus rain now adopted).
- The depth above overflow value of 200mm has been adopted in accordance with the MUSIC Modelling Guidelines.
- Given the potential for property owners to not replace rainwater tanks or pumps (as stated in Item 16(f) of the EDQ RFI1) the potential for property owners to replace full water saving appliances and fixtures (when broken) with standard (less water conserving) appliances and fixtures would also be expected. Furthermore, the likelihood (and frequency) of water efficient appliances and fixtures being replaced by standard options would also be higher (say 50%). Therefore, the daily demand value has been updated to account for the potential for 50% of full water saving fixtures and appliances being replaced by standard appliances and fixtures over time.

4.1.4.2 Gross Pollutant Trap Nodes

The configuration of pollutant transfer functions for the Gross Pollutant Trap Node has been based on proprietary product information provided by Urban Asset Solutions for their Ecosol Gross Pollutant Trap system. Details of the Ecosol Gross Pollutant Trap and pollutant transfer function are provided in **Appendix A**.

It is noted that the Ecosol Gross Pollutant Trap has been adopted for this DA phase investigation for the purpose of demonstrating the WQOs can be achieved by the proposed stormwater quality management strategy. Alternate GPTs may be considered at a future phase of design, so long as the pollutant removal provided by the alternate GPT achieves that provided by the Ecosol unit.

Treatments nodes for GPT 1, 2 and 12 have been removed from the MUSIC model.

4.1.4.3 Bioretention Nodes

The breakdown of bioretention filter area and the coverage (i.e. filter area as a percentage of the catchment area treated) along with extended detention depth, is summarised in **Table 4-4** below.

TABLE 4-4 STORMWATER CATCHMENT AND BIORETENTION SYSTEM AREAS

CATCHMENT NAME	CATCHMENT AREA (m^2)	BIORETENTION AREA (m^2)	COVERAGE (%)	EXTENDED DETENTION DEPTH (mm)
CAT_01	46,494	1,814	3.90%	300
CAT_02	40,159	1,722	4.29%	300
CAT_03	2,133	85	3.99%	200
CAT_04	3,452	60	1.74%	200
CAT_05	3,166	60	1.90%	200
CAT_06	2,067	60	2.90%	200
CAT_07	1,826	60	3.29%	200
CAT_08	3,896	147	3.77%	200

CATCHMENT NAME	CATCHMENT AREA (m^2)	BIORETENTION AREA (m^2)	COVERAGE (%)	EXTENDED DETENTION DEPTH (mm)
CAT_09	7,174	359	5.00%	200
CAT_12	34,785	1,493	4.29%	300
CAT_25	4,833	199	4.12%	200
CAT_26	864	78	9.03%	200
CAT_27	2,705	60	2.22%	200
CAT_28	2,284	59	2.58%	200
CAT_30	1,013	145	14.32%	200
CAT_31	2,379	135	5.67%	200
CAT_33	1,007	15	1.49%	200
CAT_34	6,688	101	1.51%	200
CAT_35	2,959	57	1.93%	200
CAT_38	4,609	301	6.53%	200
CAT_39	3,177	108	3.40%	200
CAT_42	4,583	95	2.07%	200
CAT_40	4,122	110	2.67%	200
CAT_41	5,405	174	3.22%	200
Average Coverage			**3.791%**	

Other bioretention node configuration properties are presented below in **Table 4-5**.

TABLE 4-5 BIORETENTION NODE CONFIGURATION

Parameter	Adopted Value	Notes
High Flow Bypass	100 m^3/s	Default
Low Flow Bypass	0 m^3/s	Default
Extended Detention Depth	Variable	Refer to
Surface Area	Variable	Based on average of filter area and area at top of extended detention depth, assuming batters of 1 in 4 from filter surface to extended detention depth.
Filter Area	Variable	Refer to
Unlined Filter Media	0.1	Assumes filter is lined
Saturated Hydraulic Conductivity	200 mm/hr	As per MUSIC Modelling Guidelines
Filter Depth	500 mm	As per MUSIC Modelling Guidelines
TN Content of Filter Media	400 mg/kg	As per MUSIC Modelling Guidelines
Orthophosphate Content of Filter Media	30 mg/kg	As per MUSIC Modelling Guidelines
Exfiltration Rate	0 mm/hr	Assumes no exfiltration
Based Lined	Yes	Assumes no exfiltration
Vegetation Properties	Vegetated with Effective Nutrient Removal Plants	
Overflow Weir Width	Variable	Based on filter area divided by 10 as per MUSIC Modelling Guidelines

4.1.4.4 Generic Treatment Nodes

To enhance flexibility of the stormwater treatment facility in future childcare centre, centres, community and multiple residential sites (Lot 8100 to 8103), generic treatment nodes have been incorporated to align with the SPP water quality objectives. The configuration of these generic nodes is outlined in **Table 4-6** below. The specific stormwater treatment facility will be determined based on the development layout during the development application stage.

TABLE 4-6 GENERIC TREATMENT NODE CONFIGURATION

Pollutant	Concentration Based Capture Efficiency		Pollutant Reduction
	Input (mg/L)	Output (mg/L)	
Total Suspended Solids	1000	200	80%
Total Phosphorus	5	2	60%
Total Nitrogen	50	27.5	45%
Gross Pollutants	15	1.5	90%

4.2 Modelling Results

The results of the MUSIC model are summarised in **Table 4-7** below.

TABLE 4-7 MUSIC MODELLING RESULTS (UPDATED)

Pollutant	WQO (Load Reduction)	Source Load (kg/year)	Residual Load (kg/year)	Pollutant Reduction
Total Suspended Solids	95%	35,000	1,740	95.0%
Total Phosphorus	89%	71.6	6.0	91.6%
Total Nitrogen	68%	434	108	75.1%
Gross Pollutants	90%	4,520	12	99.7%

MUSIC model file AuraP15_WQ_Model_RFI2_Generic_240423.sqz \\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\21\000307.11 – Aura Precinct15 DA\6_Model\SF\P15_West_SWQMP_April2024\MUSIC\ AuraP15_WQ_Model_RFI2_240502_Sen2_No GPT_1&2&12.

The results confirm that the proposed stormwater quality management strategy achieves a reduction in pollutant export to meet the required WQOs.

5 CONSTRUCTION, OPERATIONAL MANAGEMENT & MAINTENANCE OF SQIDS

The following details management and maintenance requirements for the construction and operation phases of the SQIDs proposed.

5.1 Construction & Establishment Phases

Construction of the development and the following building works has the potential to mobilise large quantities of litter and sediment in runoff. Therefore a staged construction and establishment method for SQIDs is recommended.

5.1.1 Gross Pollutant Traps

Due to the large quantities of sediment and gross pollutants mobilised during construction activities it is recommended that the base components of the GPTs (chamber and fixed walls within) are initially installed.

Functional elements of GPTs (removable items) are to be installed after 80% of building phase is complete.

5.1.2 Bioretention Systems

Construction of the development and the building works has the potential to mobilise large quantities of sediment in runoff. For Bioretention Systems to perform as designed there is a need to protect filter media and pod vegetation during this phase of the development. Therefore, a staged construction and establishment method for construction of the Bioretention System will be followed.

It is proposed to follow an installation procedure for each Bioretention System generally in accordance with *Option 1 of the Staged Construction and Establishment Methodology* as outlined in *Table 3.6* and *Section 3.8.1* of the *Water by Design Construction and Establishment Guidelines* (2011). A summary of this methodology is presented below.

1. Civil Works (Functional Installation) – Initially the Bioretention System will be used for erosion and sediment control. Once most of the civil construction works are complete, earthworks and shaping to create the layout and functional elements of the Bioretention Systems will be undertaken. The installation of functional elements (e.g. inlets, outlets structures, subsoil drainage, transition layers and filter media) shall be undertaken as per the methodology detailed in *Section 3.9.1* in the *Water by Design Construction and Establishment Guidelines* (2011). Prior to the commencement of the Building Phase, sediment fences will be erected around the perimeter of the Bioretention System to avoid the entry of sediment. Laying a temporary filter cloth (or 25mm thick layer of coarse sand and 25mm of topsoil) over the Bioretention System shall protect the Bioretention Systems during both the Civil Works and the Building Phase.
2. Building Phase (Building Construction) – During this phase the Bioretention Systems shall continue to operate. Sediment fences shall remain around the perimeter of the Bioretention System (both around the filter media and the top of batter) to restrict sediment inflow. Clear indications of the restriction of traffic to the Bioretention systems shall also be displayed.
3. Landscape Establishment (Operational Establishment) – when the Building Phase is 80% complete, the temporary protective measures and accumulated sediments within the Bioretention System will be removed. The Bioretention System shall be planted with vegetation and landscaping as proposed. Sufficient watering and removal of weeds following planting shall be undertaken in accordance with *Section 3.9.3* of the *Water by Design Construction and Establishment Guidelines* (2011).

5.2 Operational Phase

5.2.1 Rainwater Tanks

The inspection and maintenance of Rainwater Tanks are to be undertaken by each separate property owner in accordance with relevant manufacturers guidelines. Sunshine Coast Council provide guidance for plumbing approval, installation and use of rainwater tanks.

Visit *https://www.sunshinecoast.qld.gov.au/development/building/rainwater-tanks* for further information.

5.2.2 Gross Pollutant Traps

During the first year of operation, under normal weather and operating conditions, GPTs should be checked every 3 months depending on quality and quantity of the inflow to the unit. It is recommended that initially monitoring is undertaken monthly or immediately after a major rain event. Once in operation for an extended period of time (say, 12 months) the monitoring schedule can be adjusted to reflect the actual operating conditions specific to the catchment. Under normal operating conditions the GPTs will normally require cleaning approximately every 12 months.

The maintenance plan for the GPT should be reviewed and refined in collaboration with Sunshine Coast Council's procedures and ensure optimal performance of the devices. As a general rule to ensure optimal performance, GPTs should be cleaned prior to 75% capacity.

Prior to cleaning a GPT unit, appropriate signage, barriers and traffic controls must be in place. The GPT can either be cleaned manually or by vacuum using an eductor truck. This vacuum method allows the suction truck to be positioned near the unit and the snorkel placed in the opened access cover. The captured pollutants are removed from the basket and the unity checked to ensure no obstructions prior to replacing the access cover.

For the Ecosol GPT it is recommended that maintenance is carried out in accordance with the Ecosol Maintenance Guide. Refer to **Appendix A** for details.

5.2.3 Bioretention Systems

The following sections outline the proposed procedures and methodology for the Operational Phase management as well as the maintenance of the Bioretention Systems proposed as part of the development. The following methodology will be followed through the operational phases of the Bioretention Systems. The information provided in this section will be incorporated into the detailed design. General requirements, health and safety and yearly reviews for the Bioretention Systems are also provided.

No monitoring of water quality is proposed. The level of operational management and the maintenance proposed is considered best practice and if followed will ensure SQIDs will operate to their design intent.

5.2.3.1 Inspection Requirements

During Operational Phase, regular inspections of the Bioretention Systems are required to ensure vegetation establishes and the properties of the filter media remain effective.

Checklists have been developed for the Bioretention Systems. The condition and maintenance carried out will be recorded on the checklist at the time the inspection and/or maintenance is undertaken. A copy of the checklist is presented in **Appendix B**.

Maintenance personnel should also be encouraged to report and document changes in vegetation type within the Bioretention Systems. Photographic documentation and mapping of vegetation types are to be recorded annually to determine changes in vegetation over time. Photographs of each device are to be taken at the same location annually.

Through these procedures a reliable maintenance database can be developed and used to determine if the maintenance undertaken is ensuring the SQID is functioning as intended.

Except for periods of extended wet weather, mosquitoes are unlikely to be an issue - as surface water within the Bioretention Systems is not expected to remain for more than two days.

5.2.3.2 Weed Removal

Maintenance personnel will need to identify species of both terrestrial and semi-aquatic weeds common to the area. As the Bioretention Systems are "dry" SQIDs, aquatic weed infestation is unlikely. When weeds have been identified they are to be removed by hand immediately or eradication methods scheduled before the infestation becomes larger and more difficult to control. It should be noted that herbicides should not be used in the removal of invasive weeds as this has negative impacts on downstream water quality.

5.2.3.3 Replanting

Replanting of vegetation is to be carried out to replace dead or damaged vegetation, vegetation that has been removed by scour or erosion, or vegetation that is being re-planted following tilling or the replacement of filter media. Removed vegetation should be replaced by plants of similar size and species, or as indicated on the appropriate Landscaping Plans.

5.2.3.4 Filter Inspection & Replacement

Fine sediment and silt may accumulate within the filter media of the Bioretention Systems over time. Removal of sediment and silt trapped within the filter media is expected to be the costliest maintenance requirement for Bioretention Systems.

It is recommended that a visual inspection of the infiltration properties be undertaken at least three times per year with more frequent inspections no greater than three months apart between October and May. This is to determine whether built-up fine sediment and silt has reached a point where the filter media has become clogged.

The infiltration properties of the filter media within the Bioretention Systems needs to be checked after a period of significant rainfall event, which is defined as a 24 hour period with rainfall greater than 100mm, or a shorter period with an average rainfall intensity greater than 50mm/hr. This is an ideal period to assess the infiltration properties as water should not pond for an extended period. Therefore inspections should occur 24 to 72 hours after an appropriate rainfall event.

In the event that isolated boggy patches occur within the Bioretention Systems then the subsoil drainage pipes could be blocked. If this is not the case and no other blockages have been observed, then surface of the media is to be tilled (raked and aerated) to a depth of 100 to 150mm. This will require temporarily removing and storing the surface vegetation prior to tilling the surface. Should the infiltration properties be improved then the removed vegetation and coarse aggregate layer can be replanted. Should tilling prove unsuccessful or if an infiltration check indicates filter media to be clogged, then the top portion of the filter media is to be replaced as follows:

1. Removal of surface vegetation and coarse aggregate layer and store for re-establishment.
2. Remove the top 150mm of filter media and dispose of in an approved manner.
3. Till the remaining filter media to a further depth of 300mm.
4. Place a new layer of appropriate filter media as per the specification (refer to **Appendix C**), free from organic matter, clay and silt; and
5. Replant the removed vegetation.

If blockages occur frequently, a filter media with a higher saturated hydraulic conductivity should be considered. Reassessing the species and planting density of vegetation is also an option. Unless changes to the filter media specification are made through a review of the SQID performance, the filter media to be used for the Bioretention Systems is to be a Sandy Loam as per the FAWB *Guidelines for Filter Media in Biofiltration Systems* (*Version 3.01*, 2009) presented in **Appendix C**.

5.2.3.5 Subsoil Drainage Inspection & Cleanout

The build-up of fine sediment and silt within the subsoil drainage pipes is unlikely as it will be trapped by the filter media. However, the subsoil drainage is to be checked annually for blockages that may be caused by foreign matter entering through cleanout inspection openings or by small fauna. This can be done by either:

- Observing the condition of the subsoil drain through the cleanout and inspection openings located towards the downstream end of a subsoil drainage pipe.
- Observing the amount of sediment and silt flushed into the downstream field inlet when water is pumped into the upstream end of the subsoil drainage line (through a cleanout and inspection opening).

If a considerable amount of sediment and silt is observed or carried into the downstream inlet, then each subsoil drainage line must be flushed out with high pressure water.

Water is to be pumped into each subsoil drainage pipe through the upstream cleanout inspection opening until all sediment has been ejected from the pipe. To collect the water and ejected sediment within the downstream pit a temporary barrier is to be placed over the downstream pipe opening (such as sand bags) and a pump used to draw the water, sediment and silt out of the pit and irrigated onto areas of open space away from each basin. This will ensure the sediment and silt does not enter the downstream waterway.

If frequent issues occur with the subsoil drainage system, CCTV checking could be undertaken to identify any damage subsoil drainage.

5.2.3.6 Monitoring

Visual monitoring of bioretention systems is proposed as part of the inspection and maintenance requirements for the Systems. Visual inspections will occur at least three times per year with more frequent inspections to occur no more than three months apart between October and May. Inspection should be made not less than 24 hours and not more than 72 hours after the cessation of rainfall if the total rainfall on any day exceeds 100mm.

5.3 General Requirements

5.3.1 Yearly Review of Maintenance Management Plan

Each year a review is to be carried out to determine if the programmed inspection and maintenance (including checklists) is ensuring SQIDs are functioning as intended. The review should include an assessment of the maintenance database to determine whether the programmed inspections and maintenance is effective. Information on the database should be assessed to determine whether any noticeable changes are evident in vegetation, presence of fauna and operational efficiency of any structures or features of the device. This will further provide indicators as to whether sufficient information is being recorded for management purposes.

5.3.2 Maintenance Personnel Safety (OH&S)

The *Workplace Safety Regulation* 2011 requires that all reasonably practicable steps be taken to protect an employee's health in a workplace. Organisations involved in the inspection and maintenance of the SQIDs should therefore:

- Have a documented occupational health and safety policy in place.
- Ensure all staff and maintenance personnel are aware of and abide by the policy; and
- The policy provides a mechanism for review and improvement.

As part of the policy personnel involved in the maintenance of the SQIDs are to have sufficient resources (such as personnel protective equipment, training etc.) to carry out the task in a safe manner.

5.3.3 Public Safety

The safety of the public in the area of the SQID being maintained also needs to be ensured. Notices to inform the staff and public accessing the site regarding the SQID maintenance needs to be circulated prior to the scheduled date. Temporary signage and safety barriers need to be erected around maintenance work areas prior to the works commencing and are not to be removed until all works have finished.

6 CONCLUSION

Egis Consulting has prepared this Stormwater Quality Management Plan for Precinct 15 West of the Aura development to support the proposed Development Application for Reconfiguration of a Lot over the western portion of the subject site known as Aura Precinct 15 'West'.

Version C was prepared in response to the Request for Further Information 2 (RFI2) issued by Economic Development Queensland (EDQ) dated 13 March 2024.

> *This report (Version D) has been prepared to address Item 3a of the Further Issues EDQ Letter dated 11 June 2024, which requires the removal of Gross Pollutant Traps (GPT 1, 2 and 12) from the treatment train, or further justification for their inclusion. To address the item GPT's 1, 2 and 12 have been removed.*

This report has therefore:

- Identified the pollutants of concern and pollutant load reduction Water Quality Objectives to be achieved.
- Proposed an updated stormwater quality management strategy utilising the following stormwater quality improvement devices:
  - Allotment scale Rainwater Harvesting and reuse.
  - Gross Pollutant Traps.
  - Bioretention systems, being bioretention pods and basins.

  Preliminary sizing of rainwater tanks and bioretention systems have been identified for the future childcare centre, centres, community and multiple residential sites (Lot 8100 to 8103), which will be required to achieve State Planning Policy (2017) Water Quality Objectives as part of future separate Development Applications. As discussed in Version B, litter baskets and stormwater harvesting have been removed from the strategy.
- Presented MUSIC modelling methodology and results, now including the future childcare centre, centres, community and multiple residential sites (Lot 8100 to 8103), demonstrating the proposed strategy will achieve a reduction in pollutant export to achieve the identified water quality objectives.
  - *Incorporated removal of GPT's 1, 2, and 12 from the MUSIC model, the results of which do not significantly impact the pollutant reductions (i.e. Water Quality Objectives are still achieved).*
- Identified the operational management and maintenance requirements for SQIDs during both construction and operational phases of the development.

> *The report (Version D) therefore addresses Item 3a of the EDQ Further Issues Letter.*

7 RECOMMENDATIONS

The following is recommended:

- The stormwater quality management plan proposed within this report is approved and adopted for detailed design phase of the development.
- The future childcare centre, centres, community and multiple residential sites (Lot 8100 to 8103) are to employ stormwater quality management strategies to achieve the post construction phase pollutant export reductions for South East Queensland as identified in Table B Appendix 2 of the *State Planning Policy* (2017).

8 REFERENCES

DesignFlow & BMT (2019), *Aura Development Stormwater Quality Management Plan*.

DesignFlow (2022), *Aura Precinct 15 Stormwater Quality Management Plan – Version 3*.

Egis Consulting (2023), *Memorandum – Aura Development Acoustic Bund South*.

Egis Consulting (2023), *Engineering Services Report Aura Precinct 15 'West'*.

Queensland Department of Infrastructure, Local Government and Planning (2017), *State Planning Policy*.

Healthy Land and Water (2018), *MUSIC Modelling Guidelines*.

Water by Design (2011), *Construction and Establishment Guidelines*.

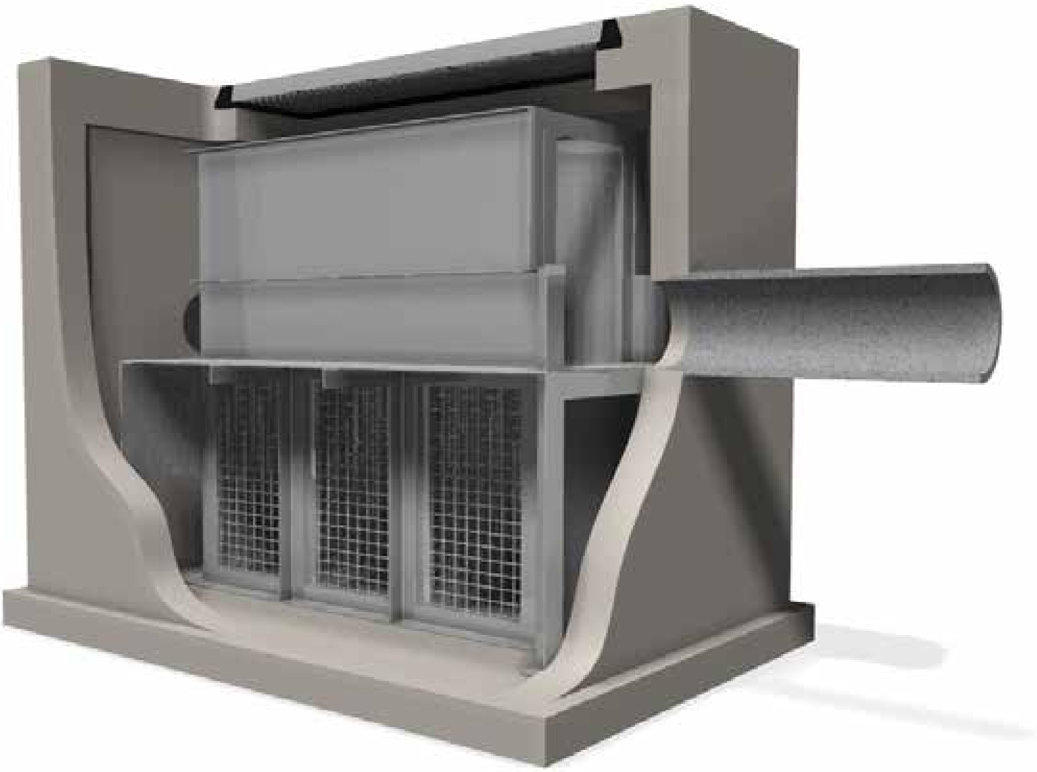
FAWB (2009), *Guidelines for Filter Media in Biofiltration Systems (Version 3.01)*.

Urban Asset Solutions (2023), *Ecosol Gross Pollutant Trap Technical Specification*.

Urban Asset Solutions (2023), *Ecosol GPT Maintenance Guide*.

APPENDIX A:
ECOSOL GROSS POLLUTANT TRAP TECHNICAL SPECIFICATION & MAINTENANCE GUIDE

Ecosol™ Gross PollutantTrap
Technical Specification



environmentally engineered
for a better future

URBAN®
ASSET SOLUTIONS

Contents

1.0 Introduction
  1.1 How and Why the **Ecosol™ GPT** Works

2.0 Ecosol™ GPT Credentials and Case Studies

3.0 Warranty and Life Expectancy

4.0 Safety Considerations

5.0 Key Features and Benefits

6.0 Key Dimensions

7.0 Capture Efficiencies

8.0 MUSIC Modelling Guidelines
  8.1 Creating the Node

9.0 Design Guidelines

10.0 Hydraulic Specification
  10.1 By-Pass Capacity and Headloss

11.0 Cleaning and Maintenance

12.0 Monitoring

13.0 Cleaning and Maintenance Services

14.0 Applications and Configurations

15.0 Turnkey Service

16.0 Accreditation

17.0 Supplier Technical Product Contact Details

Appendix 1 - Ecosol™ GPT Essential Information Form

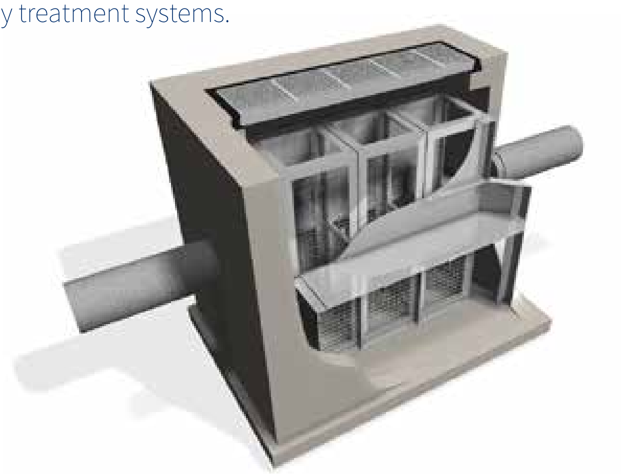
Appendix 2 - References

URBAN®
ASSET SOLUTIONS

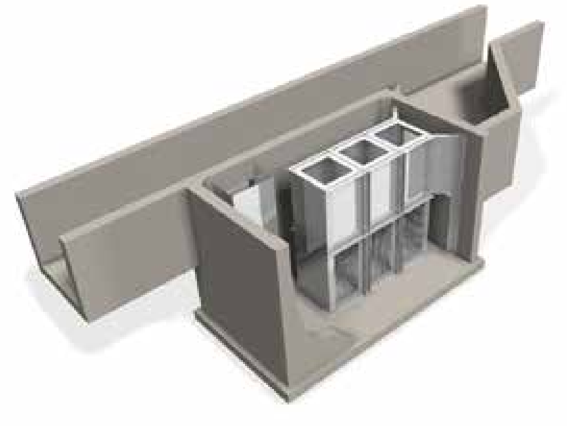
1.0 Introduction

Increasingly stringent environmental best management practice requires planners and developers to apply a fit-for-purpose treatment train approach to stormwater treatment to achieve today's water quality objectives (WQOs). An integral element to any good WSUD is primary treatment or pre-screening of stormwater flows to remove coarse sediment and gross pollutants prior to downstream secondary or tertiary treatment systems such as wetlands.

The **Ecosol™ Gross Pollutant Trap** provides effective primary treatment of stormwater flows thereby significantly enhancing the operational life of downstream secondary and tertiary treatment systems.



Typical In-Line Ecosol™ GPT configuration



Typical Off-Line Ecosol™ GPT configuration

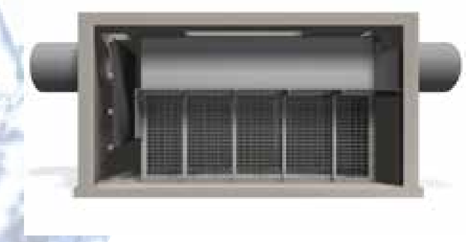
The system has been designed to provide a robust and durable cost effective primary treatment system that captures and retains solid pollutants conveyed in stormwater conduits.

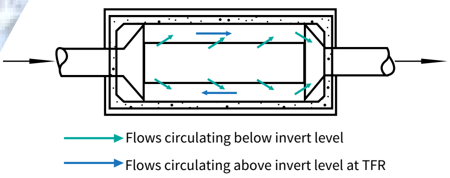
In developing this innovative stormwater treatment system careful consideration has been given to durability, longevity, cost and maintainability. Key commercial technical features include:

- low visual impact and energy footprint;
- designed hydraulics with proven performance and longevity;
- scalable design; and
- cost effective maintenance regime.

This technical manual describes the operation and performance characteristics of the system.

1.1 How and Why the Ecosol™ GPT Works





The objective of stormwater treatment is to achieve a real, visible, and sustainable improvement in water quality. Pollution control measures, including Gross Pollutant Traps (GPT's), such as the Ecosol™ GPT, litter baskets, sediment basins, grass swales, infiltration systems and sand filters all reduce the level and concentration of a variety of pollutants, thereby enhancing water quality.

The Ecosol™ GPT is a non-blocking, wet sump, tangential filtration system that has been specifically designed to filter stormwater pollutants conveyed in stormwater conduits by capturing and retaining all contaminants larger than 2mm up to a designed treatable flow rate (TFR). It can play and integral role in reducing pollution in urbanised catchments and help reduce the footprint of a total stormwater treatment train by providing essential prescreening.

Developed in 1996 and tested by the University of South Australia and also EngTest the commercial consulting division of the Adelaide University it remains today one of the most widely recognised and used stormwater primary treatment systems. Today as part of our continual product improvement program the modern Ecosol™ GPT is designed to provide high pollutant retention rates with little hydraulic impact on the drainage infrastructure.

2.0 Ecosol™ GPT Credentials and Case Studies

The Ecosol™ GPT is designed specifically to provide essential primary treatment of stormwater runoff. It is a compact, efficient and cost-effective solution to the ever-increasing problem of gross pollutants present in stormwater flows. Key to its success is the robust, engineered design and tangential screens housed in a pre-cast concrete pit that provides a significantly greater screening area than that of traditional direct screening trash rack designs. Further its large detention chamber enables gravitational separation to occur retaining fine particulate matter conveyed in stormwater.

Urban Water Resources Centre – University of South Australia
Product Performance Testing.

In 1997 and 1998 the University of South Australia (UniSA), was commissioned to undertake a series of tests on the widely-used Ecosol™ GPT (formerly known as the RSF 4000) to confirm the product's performance. The tests measured the capture efficiency of the system under varying flow conditions and gradients and also the hydraulic headloss of the system under varying flows and gradients.

EngTest Department of Civil and Environmental Engineering –
University of Adelaide – Product Performance Testing

In October 1998 after further product development Ecosol commissioned Engtest the Department of Civil and Environmental Engineering at the University of Adelaide to undertake further testing on the system to confirm hydraulic head loss and capture efficiencies.

2.0 Ecosol™ GPT Credentials and Case Studies Continued

Avocet Consulting - CFD modelling to determine pollutant trapping performance and fluid hydraulic characteristics under varying flow conditions.

In early 2000 to mid-2001 as part of the companys continuous product improvement program Ecosol engaged the services of Avocet Consulting to assess the Ecosol™ GPTs hydraulic performance, structural integrity, capture efficiency, treatable flow rates relevant to product sizing and scaling. Additional laboratory testing was also completed to monitor its performance as it filled and also to review the non-blocking, tangential filtration longevity of the system under varying flow conditions and percentage of fill.

EngTest Department of Civil and Environmental Engineering – University of Adelaide – Performance Review

In June 2013 the University of Adelaide (EngTest) completed a series of additional product tests to further verify product performance and concurrently reviewed all past laboratory and field testing on the performance of the product to comprehensively determine its performance for current industry applications.

3.0 Warranty and Life Expectancy

The Ecosol™ GPT has a one-year warranty covering all components and workmanship. Urban Asset Solutions Pty Ltd will rectify any defects that fall within the warranty period. The warranty does not cover damage caused by vandalism and may be invalidated by inappropriate cleaning procedures or where the unit is not cleaned within the recommended frequency. The Ecosol™ GPT is designed to meet strict engineering guidelines and manufacturers guarantees and is one of the most durable stormwater treatment systems available. The stainless steel components have a life expectancy of 15 years while the pre-cast concrete pit has a life expectancy of 50 years providing appropriate maintenance practices are employed.

4.0 Safety Considerations

The simple, yet effective design of the Ecosol™ GPT reduces OH&S risks as most of the work is undertaken in a controlled factory environment. The unit arrives to site complete and ready for installation reducing significantly on-site time, an important factor given the costs associated with delays that can be caused by inclement weather.

5.0 Key Features and Benefits

The Ecosol™ GPT captures and retains more than 98% of pollutants larger than 2000μm and whilst designed as a primary treatment solution, can capture and retain attached particulate Suspended Solids, Phosphorous and Nitrogen at its design Treatable Flow Rate (TFR).

Its efficiency is largely dependant on the chemical composition of the particles and the bonding of these chemical constituents to the surface of particles and the body of pollutants forming a media within the device.

Easily installed, the pre-cast modular Ecosol™ GPT can be fitted to conduits of almost any size and shape, either within the drainage network or off-line adjacent to creeks or open channels. Its range of applications include industrial and commercial sites, such as car parks, shopping centres and wash-bays, residential developments, airports, freeways, civil construction projects and wetlands.

Key Features	Benefits
Hydraulics	• Low headloss (k) factor • Designed and managed hydraulics eliminates blockage risk • Patented hydraulically-driven barrier reduces premature by-pass • Non-blocking tangential filtration screening
Pollutant Capture and Retention	• Captures and retains more than 98% of solid pollutants > 2000μm • Captures and retains up to 99% free oils and grease in spill situations • No remobilisation of captured settled Gross Pollutants
Design and Construction	• Can be sized to suit a wide range of flows, gradients and pipe sizes • Up to a GPT 4900 unit comes complete to site making installation easy and safe • Shallow depth below invert reduces water table problems • Product is made in-house thereby reducing lead times significantly
Cleaning and Maintenance	• Cost-effective vacuum cleaning so no need for the pollutants to be handled • Large pollutant storage capacity • Baffle design for emergency spill storage
Environmental Impact	• Effective pre-screening as part of a treatment train to achieve water quality objectives • Positive effect on natural ecosystem by improving water quality • Unit is housed in its own pit with little effect on the site aesthetics
Tried and Tested	• Independently laboratory field tested • Meets industry standards and guidelines

Table 1 - Ecosol™ GPT key features and benefits.

6.0 Key Dimensions

The table below shows the approximate dimensions and holding capacities for, the Ecosol™ GPT. Their capacity to retain large quantities of captured pollutants ensures that its specified capture efficiency is maintained between scheduled cleaning events.

Ecosol GPT Product Code	Maximum Inlet/Outlet Pipe Diameter	Treatable Flow Rate (L/s)	Approximate External Dimensions (L x W x D from inlet invert level) (mm)	Pollution Holding Capacities		
				Solid Pollutants >2mm	Free Oils and Grease	Water
				m^3	Litres	Litres
GPT 4200	Up to 300mm	Up to 51	2200 x 900 x 750	0.23	268	667
GPT 4300	Up to 525mm	Up to 120	2700 x 1350 x 750	0.32	469	1,181
GPT 4450	Up to 600mm	Up to 260	3600 x 1650 x 1050	1.03	1,347	3,348
GPT 4600	Up to 900mm	Up to 470	4500 x 1950 x 1350	2.43	2,994	7,211
GPT 4750	Up to 1050mm	Up to 730	5600 x 2300 x 1650	4.83	5,711	13,608
GPT 4900	Up to 1350mm	Up to 1,050	6500 x 2600 x 1975	8.30	9,576	22,768
GPT 41050	Up to 1500mm	Up to 1,430	7450 x 2950 x 2300	13.11	14,850	35,262
GPT 41200	Up to 1800mm	Up to 1,870	8630 x 3300 x 2625	19.52	22,793	51,698
GPT 41350	Up to 1950mm	Up to 2,370	9700 x 3700 x 2950	27.70	30,578	72,495
GPT 41500	Up to 2100mm	Up to 2,930	10680 x 4000 x 3250	37.94	41,491	98,317
GPT 41800	Up to 2400mm	Up to 4,210	12730 x 4700 x 3900	65.33	70,452	166,836

Table 2 - Key product dimensions

Notes:
1. The unit can be sized to suit almost any type of pipe or box culvert.
2. Unit dimensions can vary depending on the vehicle load requirements and the wall thickness.

The Ecosol™ GPT is available in four configurations:
- In-line/End of Line;
- Off-Line;
- Fixed tangential screens for vacuum truck cleaning;
- Removable basket configuration for cleaning by crane truck.

Unit Design Loading

The range of Ecosol™ GPT's are designed for Class B, D and up to Class G loadings suitable for underground installations in highways, airport and wharf applications.

7.0 Capture Efficiencies

In order to determine a meaningful characterisation of the products collection efficiency, an extensive verification phase was undertaken by Avocet Consulting Pty Ltd, Ecosol and EngTest (The University of Adelaide). Tables 3 and 4 summarise these results.

Particulate Size (Micron)	Capture Efficiency
20 - 60	23%
60 - 200	67%
200 - 600	94%
600 - 2000	98%

Table 3 – Typical PSD results

ECOSOL GPT CAPTURE EFFICIENCY PERFORMANCE SUMMARY

Pollutants	Capture Efficiency	Details
Gross Pollutants (GP)	98%	Particulate >2000 micron
Total Suspended Solids (TSS)	61%	Particulate 20-2000 micron (mean averages)
Total Phosphorous (TP)	29%	Particulate and dissolved mean average efficiency less standard deviation
Total Nitrogen (TN)	1%	Particulate and dissolved mean average efficiency less standard deviation
Total Petroleum/Hydrocarbon (TPH)	99%	In dry weather emergency oil spill solutions
	23%	In a high flow event

Table 4 – Mean average pollutant percentage reductions

Figures quoted are mean collection efficiency statistics based on available product testing data. It is important to note that the water quality CE values are indicative of potential field CEs given that the product is designed as a primary treatment solution providing physical screening and the removal of chemical constituents is largely dependent on the chemical composition of the particles and the bonding of these chemical constituents to the surface of particles. Further, finer and attached particle filtration performance of the product is also dependent on the body of pollutants forming a media already captured by the filter. Quoted CE values are intended as a general guide, please consult with your Urban Asset Solutions Pty Ltd representative for site specific product sizing and modelling.

8.0 MUSIC Modelling Guidelines

These guidelines provide instruction to the creation and application of a treatment node for the Ecosol™ GPT for the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). The Ecosol™ GPT can be modelled in MUSIC using the Gross Pollutant Trap Treatment node to represent the results derived from independent laboratory testing and field testing by the University of South Australia and the University of Adelaide (Engtest The school of Civil, Environmental and Mining Engineering). The guidelines apply to the creation of the treatment node within MUSIC V6.1.0.

8.1 Creating the Node

Insert a GPT treatment node into your model by selecting “GPT” under the treatment nodes menu. When the node is created the node properties dialog is displayed. There are several changes that need to be made in this dialog.

- Adjust the text in the location box to read "Ecosol GPT" plus any other relevant information (4200, 4300 etc.).
- Adjust the low flow bypass to reflect any flow (m^3/ sec) diverted away from the unit before treatment (usually zero)
- Adjust the high flow bypass to reflect the treatable flow rate (TFR values are detailed in table 2) (m^3/sec) any higher flows will bypass treatment.

NOTES: Can be used to describe assumptions or location of reduction values for authority approvals.

Adjust the transfer function for each pollutant selecting the pollutant and editing (right click on the function point) the input and output values on the graph below to reflect capture efficiencies (CE) of the treatment device. Table 5 provides the input and output values for the Ecosol™ GPT based on High Flows. Table 5 provides input and output nodes for the Ecosol™ based on Low Flows.

Pollutant	Removal Rate (%)	Entered Input Value	Entered Output Value
Total Suspended Solids (20 - 2000µm)	61	1000	390
Total Phosphorus	29	1000	710
Total Nitrogen	1	1000	990
Gross Pollutants (>2000µm)	98	1000	20

Table 5 - Ecosol™ Gross Pollutant Trap – input and output values

9.0 Design Guidelines

To ensure your system is appropriately designed for its intended application and meets local water quality objectives it is essential that the following minimum information is provided.

- Confirm the required treatable flow rate – this is the minimum stormwater run-off volume that must be treated. Typically this is the 1 in 3 month to 1 in 1 year ARI.
- Confirm the maximum design flow capacity of the drainage line. This is important as it allows us to appropriately design and model the system to cater for these peak flows at minimal head-loss.
- Confirm the proposed number and locations of Ecosol™ GPT's to be installed. Where possible please provide clearly marked drainage plans indicating the proposed locations.
- Confirm local water quality objectives - Recent state governmental planning policies have established clear stormwater quality bench mark objectives for local and regional councils. Accordingly local and regional council water sensitive urban design objectives have been amended to meet these stormwater pollution reduction targets. It is important we are provided this information specific to your site and local council regulations so that we can clearly advise you of the products removal efficiency relevant to these WQO's.

For further assistance in sizing or specifying a system for your next project please complete the form in Appendix 1 and forward to your local Urban Asset Solutions Pty Ltd representative.

Urban Asset Solutions Pty Ltd engineering team is able to provide a comprehensive design proposal for almost any project where the Ecosol™ GPT is proposed either individually or in conjunction with any other filtration systems working together in a treatment-train approach. Services offered include preliminary hydraulic, structural, and total concept designs, as well as consideration to access and hardstand designs for cleaning and maintenance. This includes MUSIC (Model for Urban Stormwater Improvement Conceptualisation) modelling, CAD drawings and product specifications together with maintenance schedules and associated costs.

Further, Urban Asset Solutions Pty Ltd can also undertake all civil and structural installation works, and our complete turnkey service also includes full maintenance of the proposed stormwater treatment systems and reporting.

URBAN®
ASSET SOLUTIONS

10.0 Hydraulic Specification

Gross Pollutant Traps (GPT's), such as the Ecosol™ GPT, are primarily designed to remove gross pollutants (>2mm) from stormwater at high treatable flow rates (TFR) and can play an integral role in reducing pollution in heavily-urbanised catchments that discharge into our waterways.

The Treatable Flow Rate (TFR) is the minimum flow that a GPT must treat, without by-pass, to achieve the desired pollutant capture criteria for a particular development. It varies dependent on that catchment size and percentage of impervious area thereby determining the pipe size and gradient. Typically, the Ecosol™ GPT is designed to treat the 1-in-3 month Annual Rainfall Intensity (ARI) discharges, with greater flows by-passing the unit.

Ecosol GPT Product Code	maximum Inlet/Outlet Pipe Diameter	Treatable Flow Rate (L/s)	Approximate External Dimensions (L x W x D from inlet invert level) (mm)
GPT 4200	Up to 300mm	Up to 51	2200 x 900 x 750
GPT 4300	Up to 525mm	Up to 120	2700 x 1350 x 750
GPT 4450	Up to 600mm	Up to 260	3600 x 1650 x 1050
GPT 4600	Up to 900mm	Up to 470	4500 x 1950 x 1350
GPT 4750	Up to 1050mm	Up to 730	5600 x 2300 x 1650
GPT 4900	Up to 1350mm	Up to 1,050	6500 x 2600 x 1975
GPT 41050	Up to 1500mm	Up to 1,430	7450 x 2950 x 2300
GPT 41200	Up to 1800mm	Up to 1,870	8630 x 3300 x 2625
GPT 41350	Up to 1950mm	Up to 2,370	9700 x 3700 x 2950
GPT 41500	Up to 2100mm	Up to 2,930	10680 x 4000 x 3250
GPT 41800	Up to 2400mm	Up to 4,210	12730 x 4700 x 3900

Table 6 - Ecosol GPT indicative product Treatable Flow Rates

10.1 By-Pass Capacity and Head-Loss

The range of Ecosol™ GPT's has been designed to cater for maximum flow by-pass at minimal head-loss. The placement of any structure into a stormwater line will induce headloss. The extent of this head-loss is a function of the velocity in the outlet pipe and the k factor adopted. The k factor must be representative of the type of structure and its operation during full-flow conditions as distinct from the TFR.

The Ecosol™ GPT has one of the lowest k factors of any GPT currently available. Extensive independent testing has been carried out to confirm the unit's k factor for a range of pipe and unit sizes based on full flow, worst case scenarios. These tests show that the k factor can vary between 0.6 and 1.5 depending on the pipe configuration and the relative unit size, as shown below.

Gradient	*k* Factor
1%	0.6
2%	1.0
3%	1.5

Table 7 – Measured maximum k factor for the Ecosol™ GPT at the suggested treatable flow rate for non surcharged flows.

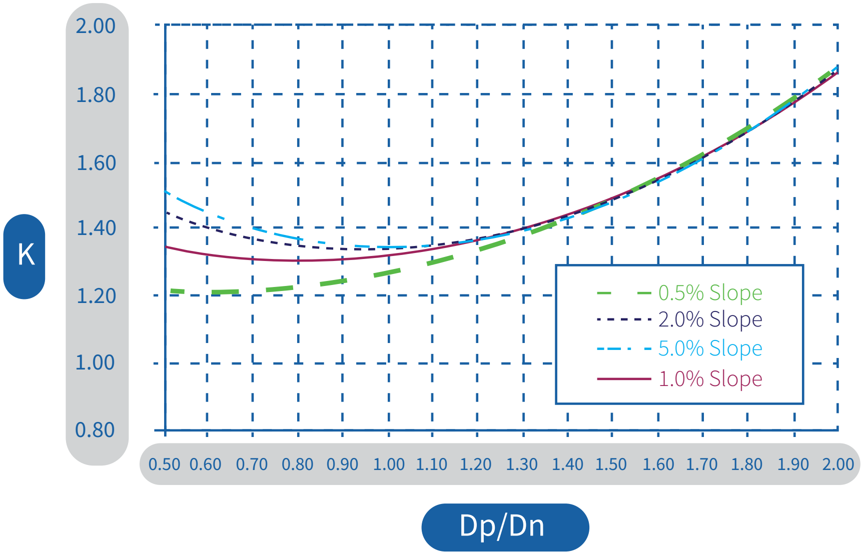


Figure 1 Measured maximum k factors for the Ecosol™ GPT at its designed maximum by-pass flow rate (designed discharge rates) in a surcharged environment.

11.0 Cleaning and Maintenance

The cleaning frequency and the cost, depends heavily on the catchment size and type, the unit's proximity to a waste facility and the quality and quantity of stormwater runoff

Cleaning frequencies are based on typical pollution loads of 0.280m^3 /ha/year for gross pollutants and 0.380m^3 /ha/year for sediment generated on typical fully developed fully developed urban catchment. For larger catchments or during extended dry weather periods additional system cleaning may be required.

Urban Asset Solutions Pty Ltd specialises in the cleaning and maintenance of all Stormwater Treatment Devices including vegetated solutions and would be pleased to assist you with your ongoing asset maintenance.

Ecosol GPT Product Code	Pollution Holding Capacities			Optimal Catchment Area (Ha)	Recommended Cleaning Frequency
	Solid Pollutants >2mm	Free Oils and Grease	Water		
	m^3	Litres	Litres	Ha	Per Annum
GPT 4200	0.23	268	667	0.35	1
GPT 4300	0.32	469	1,181	0.50	1
GPT 4450	1.03	1,347	3,348	1.50	1
GPT 4600	2.43	2,994	7,211	3.60	1
GPT 4750	4.83	5,711	13,608	7.30	1
GPT 4900	8.30	9,567	22,768	12.50	1
GPT 41050	13.11	14,850	35,262	19.80	1
GPT 41200	19.52	22,793	51,698	29.50	1
GPT 41350	27.70	30,578	72,495	41.90	1
GPT 41500	37.94	41,491	98,317	57.40	1
GPT 41800	65.33	70,452	166,836	98.90	1

Table 8 - Ecosol™ GPT Recommended Cleaning Frequencies

12.0 Monitoring

Under normal weather and operating conditions, your Ecosol™ GPT should be checked, minimum every 3 months depending on quality and quantity of the inflow to the unit. Initially, Urban Asset Solutions Pty Ltd recommends that monitoring is undertaken monthly or immediately after a major rain event. Once the unit has been in operation for an extended period of time (say, 12 months) then the monitoring schedule can be adjusted to reflect the actual operating conditions specific to the catchment.

Under normal operating conditions the unit would normally require cleaning approximately every 12 months.

13.0 Monitoring, Cleaning and Maintenance Service

An essential element of any good stormwater management program includes regular inspections, cleaning, and maintenance of installed Stormwater Quality Improvement Devices (SQIDS) to ensure that they continue to capture and retain pollutants to their designed specifications without premature by-pass and without any adverse impact on the drainage capacity of the stormwater conduit that it is installed on.

Cleaning frequencies, methodologies and even they equipment used to maintain these systems will vary depending on the type of device installed the catchment type, size and rainfall patterns.

At Urban Asset Solutions Pty Ltd we offer:

- a competitive cleaning and maintenance service;
- a long-standing record in safe work practices, supported by Quality Assured processes;
- in-depth knowledge and experience with all popular types and brands of GPTs;
- a complete understanding of pollution removal and disposal regulations and processes that ensures your unit is cleaned effectively and efficiently without risk of damage and;
- useful, easy-to-read reports, allowing you to track performance and pollution loading.

14.0 Applications and Configurations Continued

The Ecosol™ GPT is usually installed In-Line/end-of-line on stormwater pipes or box culverts ranging in size from 200mm to 1800mm, although is suitable for larger pipes and box culverts. The product can be easily integrated into most drainage designs for residential, commercial or industrial applications .

Commercial Precincts

Car Parks

Residential Developments

The unit is also suitable for installation off-line adjacent to large open channels or drains.

The Ecoso™ GPT is able to be custom designed specific to you application. We can vary the loading class, pit depth and accommodate varying pipe types and sizes.

15.0 Turnkey Services

Urban Asset Solutions Pty Ltd design and estimating staff provide a dedicated management approach towards your project. In addition all staff are capable of liaising with the client, the consulting engineer, the contractor, and all other interested third parties to achieve a successful outcome.

16.0 Accreditation

Urban Asset Solutions Pty Ltd is accredited to ISO 14001 (Environment) and AS/NZS 9001 (Quality). Our commitment to continuously improving our products and services is demonstrated by our ongoing accreditation for Quality and Environmental Management. Urban Asset Solutions Pty Ltd is also committed to a safe environment for its employees. We are fully third-party accredited to AS/NZS 4801and OHSAS 18001.

ATLAS CERTIFICATION OHSAS 18001
ATLAS CERTIFICATION AS/NZS 4801
ATLAS CERTIFICATION ISO 9001
ATLAS CERTIFICATION ISO 14001

17.0 Suppiler and Technical Product Contact Details

For any maintenance or technical product enquiries please contact:
Urban Asset Solutions Pty Ltd
Tel: 1300 706 624
Fax: 1300 706 634
Email: info@urbanassetsolutions.com.au

URBAN® ASSET SOLUTIONS

Appendix 1

Ecosol™ GPT Essential Information Form

To ensure your system is appropriately designed for its intended application and meets local water quality objectives it is essential that the following minimum information is provided:

Customer Details

Contact Person:

Company Name:

Phone:

Fax:

Email:

Project and Site Information

Project Name:

Project Address:

Type of Development/Catchment Type:

Pollutant Removal Targets (%):
Site Water Quality Objectives (WQO's)

Gross Pollutants (>2000µm)

Total Suspended Solids (20 – 2000µm)

Total Phosphorus

Total Nitrogen

Heavy Metals

Total Petroleum/ Hydrocarbon

Other

Local Authority:

Device Location:

Designed Discharge (Peak ARI Flow Rate) L/s:

Treatable Flow Rate (L/s):

Tidal or submerged (inundated) system:

Inlet Pipe Diameter/Size

Depth to Inlet pipe invert level

Preferred access cover type and loading
(Grated or solid top) (Class A, B or D)

Other essential design or site relevant information:

Please forward the above information for your next project to your local Urban Asset Solutions Pty Ltd representative. On receipt Urban Asset Solutions Pty Ltd will model and design the most appropriately sized system to suit your application to assist you achieve the project Water Sensitive Urban design objectives.
Email: info@urbanassetsolutions.com.au - Fax: 1300 706 634.

URBAN®
ASSET SOLUTIONS

Appendix 2

References

Please note that the Ecosol™ GPT was originally known as the Ecosol RSF 4000.

Mr J Pisaniello & Assoc. Porf. J Argue (1998) Testing of the Ecosol RSF 4000 (commonoly known as the Ecosol™ GPT) for Hydraulic Headloss – Urban Water Resources Centre University of South Australia.

Mr I Charlton (1998) RSF 4000 (commonoly known as the Ecosol™ GPT) Field Testing Report Playford City Council – Ecosol

Mr A Wundke & Dr. M. Lambert (1998) Hydraulic Headloss and Capture Efficiency Testing of the Ecosol RSF 4000 and RSF 6000 Filtration Unit – EngTest - The Department of Civil & Environmental Engineering – The University of Adelaide

Dr. A Wallace (2000) Technical Report – Ecosol RSF 4000 Fluid Mechanics - Avocet Consulting Pty Ltd

Dr. A Wallace (2000) Technical Report – Review of Bypass Capacity of RSF 4000 - Avocet Consulting Pty Ltd

Dr. A Wallace (2000) Technical Report – Ecosol RSF 4000 Fluid Mechanics, Measurements of Headloss at peak flow in units with and without secondary lids - Avocet Consulting Pty Ltd

Mr J Wiltshire (2000) Eurobodalla Shire Council Stormwater Quality Management and Monitoring Report 1998 – 2000, Ecosol Gross Pollutant Traps and Litter Baskets Batemans Bay Industrial Area – Ecosol

Dr. A Wallace (2001) Technical Report – Head Loss and Treatable Flow Rate measurements - Avocet Consulting Pty Ltd

Appendix 2 Continued

References

Dr. A Wallace (2001) Technical Report – RSF 4000 Performance Testing (Capture Efficiency Versus fill of silo) - Avocet Consulting Pty Ltd

Dr. A Wallace (2001) Technical Report – RSF 4000 Performance Testing (Capture Efficiency Versus fill of silo with impermeable material) - Avocet Consulting Pty Ltd

Dr. A Wallace (2001) Technical Report – RSF 4000 Hydraulic Modelling (Modelling TFR with a range of pipe diameters) - Avocet Consulting Pty Ltd

Dr M Lambert (2001) RSF 4000 Stormwater Filter Performance Testing – EngTest, The Department of Civil and Environmental Engineering – The Adelaide University.

Dr. A Wallace (2002) Technical Report – Oil collection efficiency measurements on Ecosol 4100 Gross Pollutant Trap - Avocet Consulting Pty Ltd

Dr. A Wallace (2002) Technical Report – Sediment Collection Efficiency measurements on the Ecosol 4000 Gross Pollutant Trap - Avocet Consulting Pty Ltd

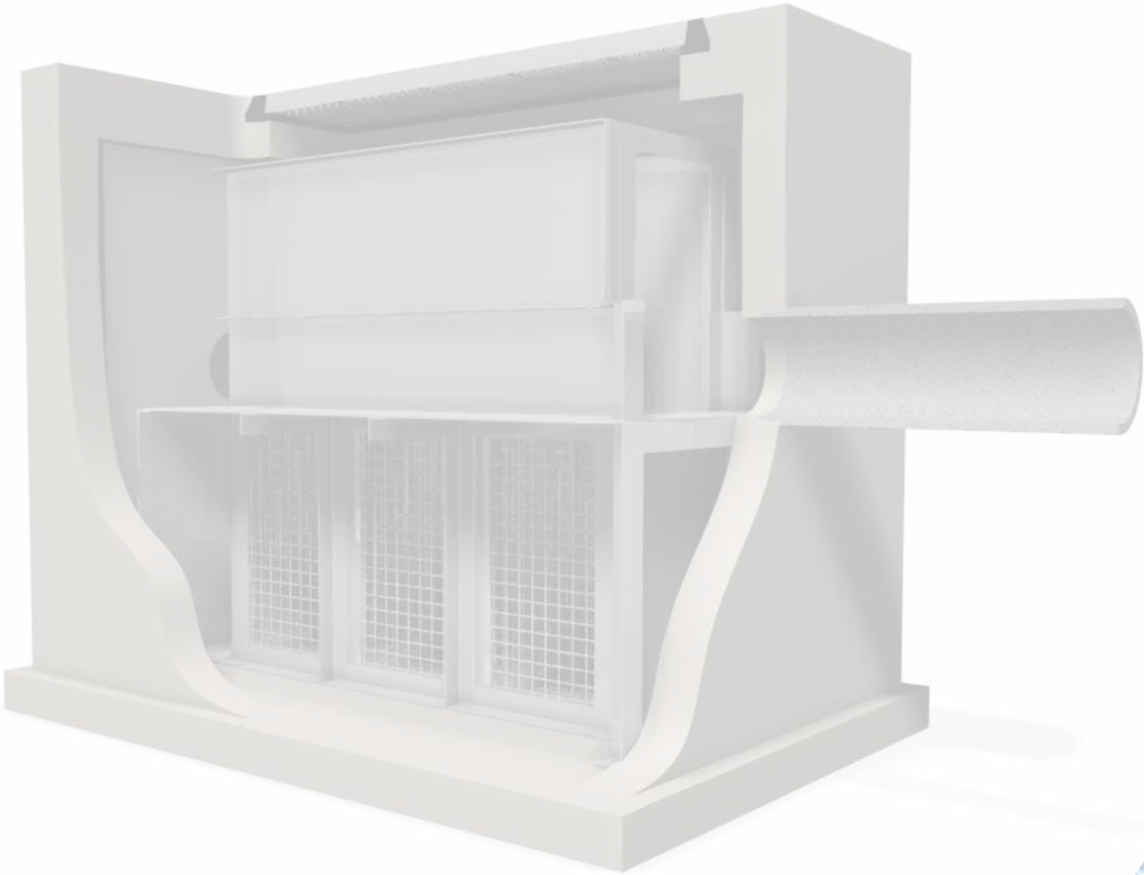
Dr. A Wallace (2002) Technical Report – Study on the performance of an Ecosol RSF 4000 Gross Pollutant Trap subjected to heavy loadings of grass clippings in the input stream - Avocet Consulting Pty Ltd

Manly Hydraulics Laboratory (2004) (NSW Department of Commerce) – SQIRTS Assessment at Solander Park Erskineville

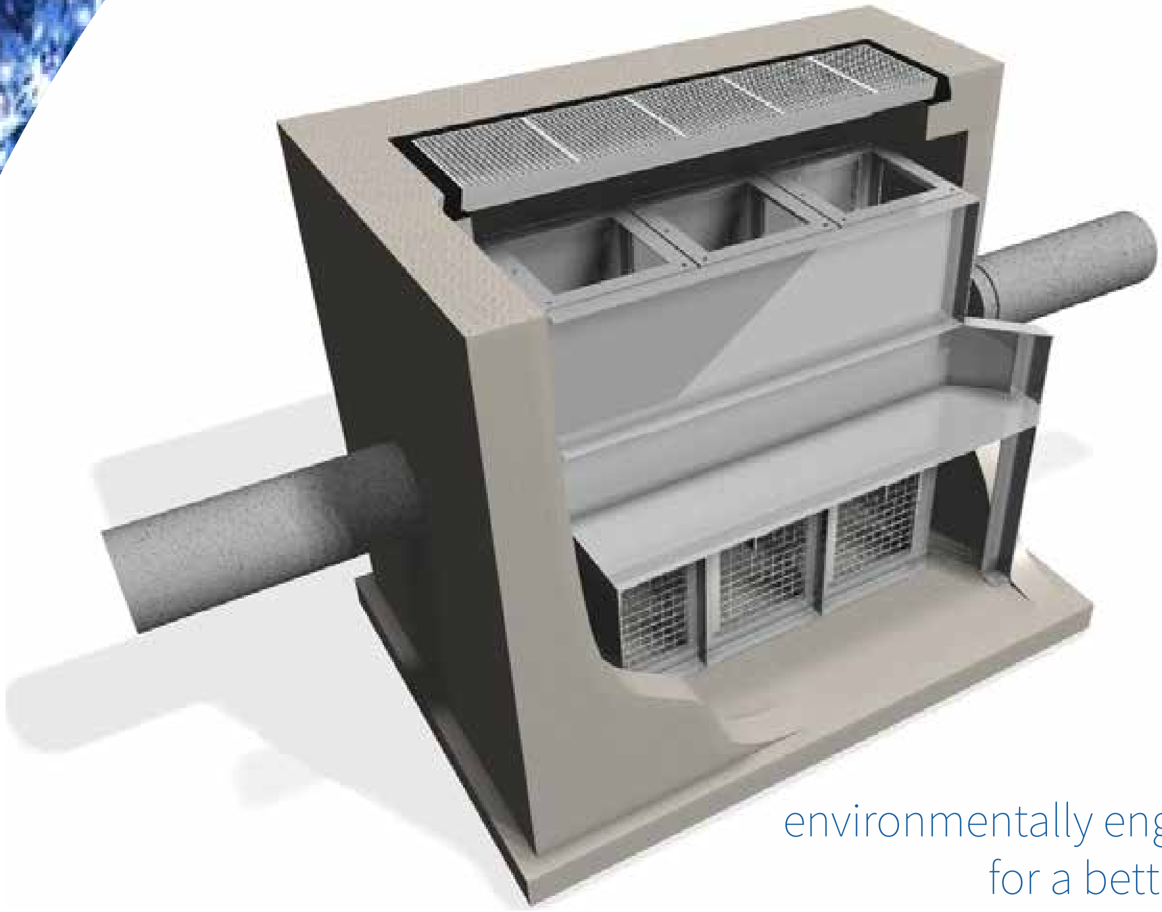
Prof. M Lambert, Dr. A Zecchin (2013) Experimental determination of collection efficiency of Ecosol In-Line GPT Solid Pollutant Filter – EngTest , The Department of Civil and Environmental Engineering – The Adelaide University.

Prof. M Lambert, Dr. A Zecchin (2013) Performance Review of the Ecosol GPT Stormwater Pollutant Filter – EngTest , The Department of Civil and Environmental Engineering – The Adelaide University.

Urban Asset Solutions Pty Ltd
ABN 73 627 354 830
Telephone: 1300 706 624
Fax: 1300 706 634
Website: www.urbanassetsolutions.com.au



Ecosol™ GPT
Maintenance Guide



environmentally engineered
for a better future

URBAN®
ASSET SOLUTIONS

Contents

1.0 Introduction

2.0 Key Dimensions

3.0 Monitoring

4.0 Cleaning and Maintenance Procedures

5.0 Cleaning and Maintenance Services

6.0 Catchment Sizes and Recommended Cleaning Frequencies

7.0 Reporting

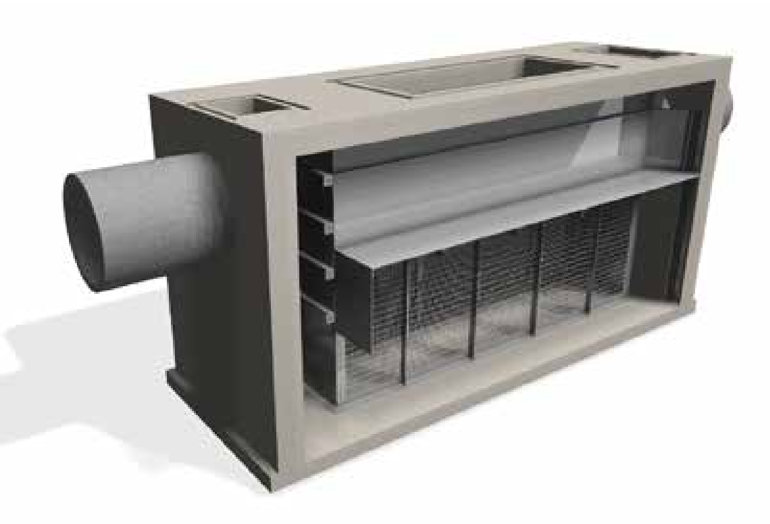
8.0 Life Expectancy

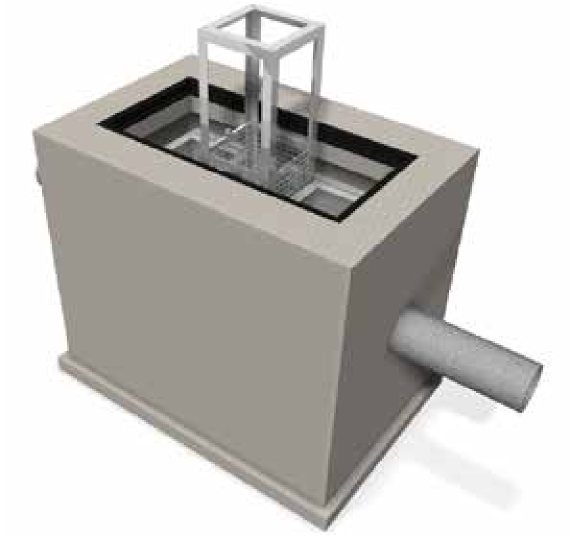
9.0 Warranty

10.0 Supplier and Technical Contact Details

11.0 Ecosol GPT Cleaning and Maintenance Inspection Form

The Ecosol™ GPT has been designed specifically for easy on site cleaning and maintenance using a licensed waste contractor equipped with either a vacuum truck or crane truck for removable basket configurations.





1.0 Introduction

The Ecosol™ GPT (in-line/end-of-line stormwater treatment solution) is a non-blocking tangential filtration system.

The range of Ecosol™ GPT's are designed specifically to provide essential primary treatment of gross pollutants conveyed in stormwater at high velocities. Typically this system has been designed to capture and retain more than 98% of pollutants larger than 2mm.

2.0 Key Dimensions

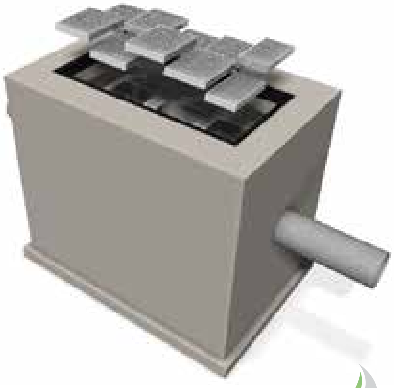
The Ecosol™ GPT is able to be custom designed to suit most applications. The below table provides a general guide on typical unit configurations for cylindrical and box culvert pipe applications and typical pollutant holding capacities.

Ecosol GPT Product Code	Maximum Inlet/Outlet Pipe Diameter	Treatable Flow Rate (L/s)	Approximate External Dimensions (L x W x D from inlet invert level) (mm)	Pollution Holding Capacities		
				Solid Pollutants >2mm	Free Oils and Grease	Water
				m^3	Litres	Litres
GPT 4200	Up to 300mm	Up to 51	2200 x 900 x 750	0.23	268	667
GPT 4300	Up to 525mm	Up to 120	2700 x 1350 x 750	0.32	469	1,181
GPT 4450	Up to 600mm	Up to 260	3600 x 1650 x 1050	1.03	1,347	3,348
GPT 4600	Up to 900mm	Up to 470	4500 x 1950 x 1350	2.43	2,994	7,211
GPT 4750	Up to 1050mm	Up to 730	5600 x 2300 x 1650	4.83	5,711	13,608
GPT 4900	Up to 1350mm	Up to 1,050	6500 x 2600 x 1975	8.30	9,576	22,768
GPT 41050	Up to 1500mm	Up to 1,430	7450 x 2950 x 2300	13.11	14,850	35,262
GPT 41200	Up to 1800mm	Up to 1,870	8630 x 3300 x 2625	19.52	22,793	51,698
GPT 41350	Up to 1950mm	Up to 2,370	9700 x 3700 x 2950	**27.70**	**30,578**	72,495
GPT 41500	Up to 2100mm	Up to 2,930	10680 x 4000 x 3250	37.94	41,491	98,317
GPT 41800	Up to 2400mm	Up to 4,210	12730 x 4700 x 3900	65.33	70,452	166,836

Table 1 Ecosol GPT Configurations

3.0 Monitoring

Under normal weather and operating conditions, your Ecosol™ GPT should be checked a minimum of every three months depending on the quality and quantity of the inflow to the unit. Initially, Urban asset Solutions Pty Ltd recommends that monitoring is undertaken monthly. Once the unit has been in operation for an extended period of time (say, 12 months) then the monitoring schedule can be adjusted to reflect the actual operating conditions specific to the catchment. It is also recommended that the unit is inspected after every major storm event.



4.0 Cleaning and Maintenance Procedures

The steps to be followed for cleaning your Ecosol™GPT are as follows:

Prior to cleaning day:

- Advise all concerned parties of the proposed date and time the clean is to take place
- Obtain approvals from the appropriate authorities
- Check weather conditions
- Prepare all necessary Safe Work Method Statements
- Ensure all necessary plant and equipment is loaded and safe for operation

Site establishment:

- Complete and sign off all relevant Safe Work Method Statements
- Ensure that all access points are exposed and accessible
- Ensure barricades are provided at all working areas and that signs are in place to prevent injuries to public or staff
- Ensure all working areas are safe and all equipment, including hoses and machinery, are in place and ready for operation

Removal of floating pollutants:

- Open surface access lids
- Lower the vacuum hose into the central capture silo chamber and position over retained floating debris
- Commence removal of floating materials, including hydrocarbons, by moving the vacuum hose over the floating material at water level
- Once all visible floating debris and hydrocarbons (free floating oils and grease) have been removed stop the vacuum

De-watering process (for large GPT systems only):

- Commence de-watering the system by pumping all water from the clean chamber (outlet end access point) to the nearest sewer manhole (relevant sewage utility approval must be obtained prior to de-watering to sewage)
- Set up the de-watering pump adjacent to the clean chamber access point
- Connect all hoses and lower one end into the clean chamber. It is important that the hose lowered into the clean chamber sits above the base of the unit to avoid sucking and disturbing any sediment settled at the base of the unit. When lowering the hose into position ensure the operator is tethered to prevent risk of falling
- Position hoses from the pump downstream of the unit into an approved sewer for de-watering

4.0 Cleaning and Maintenance Procedures Continued

De-watering process (for large GPT systems only cont):

- Turn on the pump and commence de-watering the unit
- When the water level of the unit has subsided to a point where settled sediment is visible in the clean chamber or when the water being discharged becomes very dark with sediment, stop de-watering
- Remove all positioned hoses and pack away
- Position heavy duty mesh over the clean chamber opening to prevent risk of falling

Removal of settled pollutants:

The steps required to successfully remove all capture and retained pollutants from the Ecosol™ GPT are:

- Start the vacuum truck and position the vacuum hose over the capture silo access openings
- The vacuum truck hose operator is to wear a safety harness and must be tethered to reduce risk of falling prior to commencing with the removal of pollutants
- Lower the vacuum hose into GPT and position over pollutants
- Commence moving the vacuum hose over the material to commence removal of pollutants

- If entry to the unit is necessary to loosen captured pollutants and remove large debris then only confined space trained personnel with all equipment available and in place can enter the unit. This Includes using the established 4 to 1 access and recovery tripod and harness system
- Ensure the worker lowered in to the GPT is always connected to the rope recovery system and is wearing steel capped gum boots, protective clothing and hard hat. When lifting material from the GPT manually, ensure the worker below stands clear during this operation
- Once all visible pollutants have been removed from the capture silo chamber, lift the vacuum hose from the GPT
- Lower the vacuum hose into the clean chamber and remove any fine sediment from the base of this chamber.
- Again, ensure the operator is tethered to prevent risk of falling.

4.0 Cleaning and Maintenance Procedures Continued

Final clean out process:

To avoid the potential build-up of fine sediment behind the filtration screens, it is important at the conclusion of each clean that the screens are cleaned with a high pressure water hose. Most combination vacuum trucks have this facility.

- Start the vacuum and position the vacuum hose into the bottom of the clean chamber to remove any fine sediment as it is flushed from behind the screens (again ensure the operator is wearing a safety harness and is tethered prior to commencing with the removal of pollutants)
- From the surface, hose down all of the filtration screens using a high pressure hose
- Whilst this is occurring, continue to remove sediment flushed out by vacuum hose
- On completion, remove the vacuum hose and pack up equipment

Site demobilisation:

- Complete cleaning report accordingly
- Using long handle access cover lifters, lift all access covers back into position
- Using an 8mm Allen key reinstall all access cover lock down bolts.
- Reinstall all bolt protective caps
- Note it is recommended that all access covers, frames and bolts should be greased at least once per annum.
- The vacuum truck must be packed up and leave site to dispose of all captured pollutants at an approved waste facility
- If required under local regulations, ensure the transporter of the stormwater waste is licensed. Record all details of the disposal location and volume of waste disposed.
- Load all other plant equipment and tools ensuring the site is restored to its original condition.

5.0 Monitoring Cleaning and Maintenance Service

Urban Asset Solutions Pty Ltd has a very competitive cleaning service for the removal of all captured pollutants. After each clean we provide a full report detailing the volume and type of pollutants removed. We believe that it is in your best interests for Urban Asset Solutions Pty Ltd staff to clean and maintain the unit, not only because we are specialists, but also because proper monitoring and maintenance enhances the unit life significantly.

6.0 Catchment Size and Recommended Cleaning Frequency

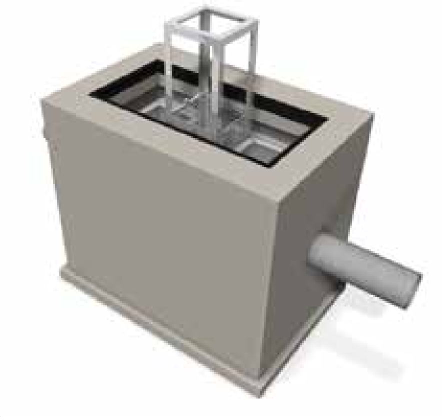
The tables below provide a broad guideline about the catchment size and number of cleans required annually.

Ecosol GPT Product Code	Pollution Holding Capacities			Optimal Catchment Area (Ha)	Recommended Cleaning Frequency
	Solid Pollutants >2mm	Free Oils and Grease	Water		
	m^3	Litres	Litres	Ha	Per Annum
GPT 4200	0.23	268	667	0.35	1
GPT 4300	0.32	469	1,181	0.50	1
GPT 4450	1.03	1,347	3,348	1.50	1
GPT 4600	2.43	2,994	7,211	3.60	1
GPT 4750	4.83	5,711	13,608	7.30	1
GPT 4900	8.30	9,567	22,768	12.50	1
GPT 41050	13.11	14,850	35,262	19.80	1
GPT 41200	19.52	22,793	51,698	29.50	1
GPT 41350	27.70	30,578	72,495	41.90	1
GPT 41500	37.94	41,491	98,317	57.40	1
GPT 41800	65.33	70,452	166,836	98.90	1

Table 2 - Optimal catchment sizes and cleaning frequencies

Cleaning frequencies are based on typical pollution loads of 0.280m^3 /ha/year for gross pollutants and 0.380m^3 /ha/year for sediment generated on typical fully developed fully developed urban catchment. For larger catchments or during extended dry weather periods, additional system cleaning may be required.

Urban Asset Solutions Pty Ltd specialises in the cleaning and maintenance of all Stormwater Treatment Devices including vegetated solutions and would be pleased to assist you with your ongoing asset maintenance.



7.0 Reporting

After each clean it is important that all cleaning data is recorded for use in ongoing asset management activities. A cleaning report should be prepared that details, as a minimum, the following information:

- Site location;
- Date and time of the clean;.
- Duration of the clean;
- Volume or weight of material removed;
- Composition of the captured material e.g sediment, vegetation, litter, etc; and
- Details of any remedial work undertaken or required at a later stage.

Reporting of the above information is included in the cost of any clean undertaken by Urban Asset Solutions Pty Ltd. Please refer to the next section for more details.

8.0 Life Expectancy

The Ecosol™ GPT is designed to meet strict engineering guidelines and manufacturers guarantees. The stainless steel components have a life expectancy of 15 years while the pre-cast concrete pit has a life expectancy of 50 years, providing appropriate maintenance practices are employed.

9.0 Warranty

All Ecosol™ GPT's are covered by a twelve-month warranty, provided the unit is maintained and cleaned with the frequency and using the method recommended in our technical specification.

10.0 Supplier and Technical Product Contact Details

For any maintenance or technical product enquiries please contact:
Urban Asset Solutions Pty Ltd
Tel: 1300 706 624
Fax: 1300 706 634
Email: info@urbanassetsolutions.com.au

11.0 Ecosol™ GPT Cleaning and Maintenance Inspection Form

Asset Owner:

Asset ID:

Unit Location :

UAS Ref:

Date:

Time:

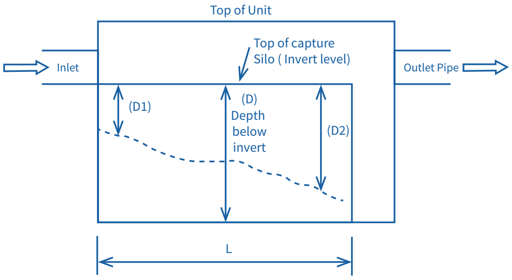
Product Code: Ecosol™ GPT

Inspected By:

Visual Inspection

Item	Good	Fair	Damaged	Remarks
Access covers				
Access cover surrounds				
Surrounding surfaces				
Internal components				
Other				
Floatables visible				

Extent of Captured Material



Capture Silo Dimensions

Unit Size	Depth (D) (m)	Length (L) (m)	Width (W) (m)	Silo Vol (m^3)
GPT 4200	0.600	1.310	0.250	0.23
GPT 4300	0.600	1.500	0.300	0.32
GPT 4450	0.900	2.250	0.450	1.03
GPT 4600	1.200	3.000	0.600	2.43
GPT 4750	1.500	3.750	0.750	4.83
GPT 4900	1.800	4.500	0.900	8.30
GPT 41050	2.100	5.250	1.050	13.11
GPT 41200	2.400	6.000	1.200	19.52
GPT 41350	2.700	6.750	1.350	27.70
GPT 41500	3.000	7.500	1.500	37.94
GPT 41800	3.600	9.000	1.800	65.33

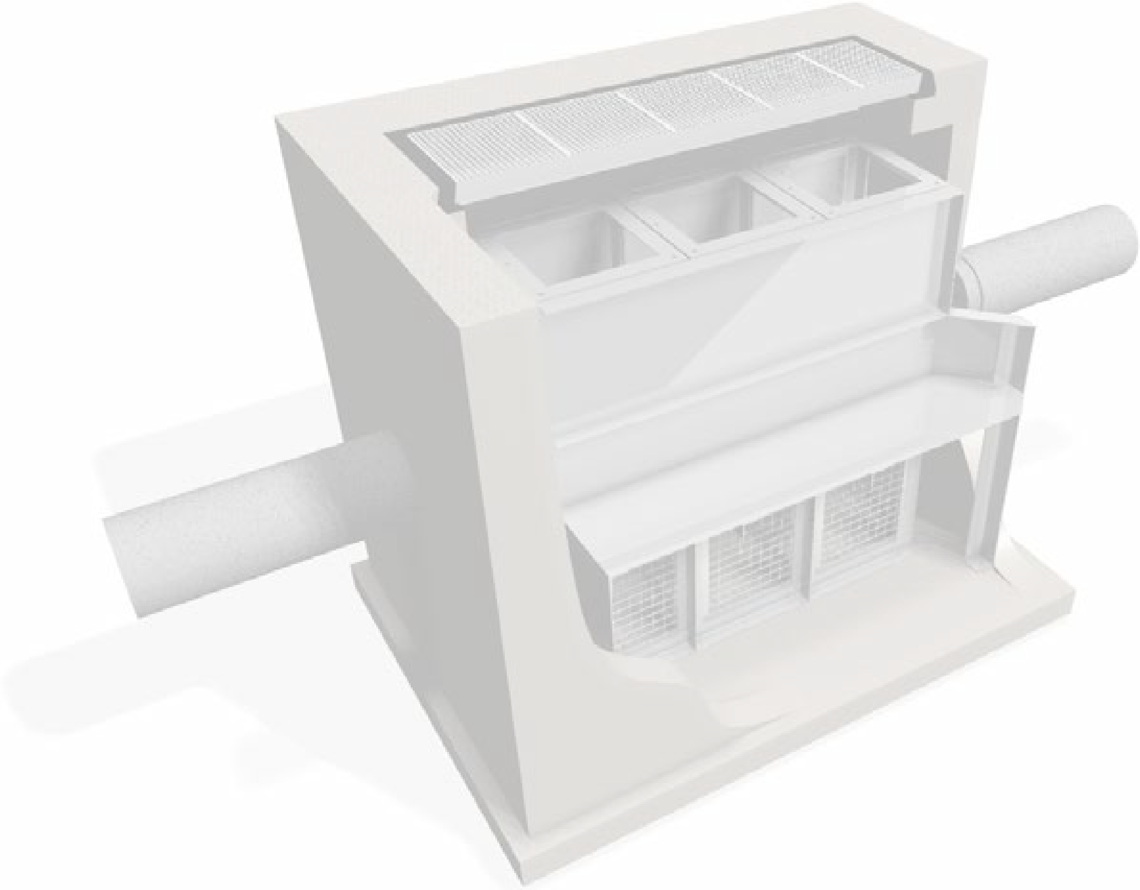
Evolution of Captured Material

D = m	D1 = m	D2 = m	Dav. = (D1 + D2)/ 2 = m
L= m	W = m	Vol = (D - Dav.) x L x W = m^3	

- Note: Cleaning to be scheduled when the capture silo is approximately 70% full

Comments :

Urban Asset Solutions Pty Ltd
ABN 73 627 354 830
Telephone: 1300 706 624
Fax: 1300 706 634
Website: www.urbanassetsolutions.com.au



URBAN®
ASSET SOLUTIONS

APPENDIX B: CHECKLIST

Bioretention Basin Inspection & Maintenance Requirements

Treatment Device / Property	Inspection	Inspection Frequency	Maintenance
Bioretention Basin			
Litter & Weeds	Visually check for litter, weeds and debris within the Bioretention Basin.	Quarterly for first year then every six months after establishment. Also after significant storm events.*	Remove litter, weeds and debris from the basin and dispose of at approved waste disposal facility.
Inlet and Outlet	Visually check for blockages within the upstream and downstream inlet pits. Check for locked weep holes within the upstream pit.		Remove any blockages or debris within inlet pits or blockages to weep holes.
Sedimentation	Visually check surface of Bioretention Basin for accumulation of sediment.		If sediment build-up is observed, remove accumulated sediment where it is smothering vegetation.
Scour, Erosion and Vehicle Damage	Visually check Bioretention Basin surface for scouring and areas of erosion or vehicle damage.		Repair damage to Bioretention Basin surface and filter media if exposed. Undertake replanting if necessary and maintain watering of area until vegetation has established.
Vegetation	Visually check for any planted vegetation that has died.	Quarterly for first year then every six months after establishment.	Remove dead vegetation and replace with stock of equivalent size and species as detailed in plant schedule. Maintain watering until new vegetation has established.
Filter Media	Check surface of Bioretention Basin for any isolated "boggy" areas.	Every six months.	Increase infiltration rate by tilling the surface of the filter media.
	Visually check and determine time of ponding within basin after a storm event.*	During wetter periods.	If duration of ponding exceeds 48 hours, trial tilling of the surface of the filter media. If no improvement occurs then dispose and replace the top 100 to 150mm layer of filter media (below is the detailed procedure): i. Remove vegetation and store for replanting. ii. Remove top 150mm of filter media and dispose of in an approved manner. iii. Till the remaining filter media to a further depth of 300mm. iv. Place a new layer of appropriate filter media; v. Replant removed vegetation
Subsoil Drainage	Check subsoil drainage for blockages. This is subject to earlier stages of inspection. To discover blockage, flush subsoil drain from the upstream inspection opening. If there is no evidence of a blockage, no further action is required.	Subject to earlier stage of inspection.	If blockage is discovered remove by flushing out the subsoil drainage pipe. Below is an outline of the procedure i. Set up a pump and an appropriate collection device (i.e. a sandbag) at the downstream pipe. ii. Draw outflow through pipe, not allowing any sediment/silt to enter the downstream stormwater drainage system. iii. Collect and dispose flushed material appropriately.

* Significant Rain Event defined as a 24 hour period with rainfall greater than 200mm, or shorter period with an average rainfall intensity greater than 20mm/hour.

BIORETENTION BASIN INSPECTION & MAINTENANCE CHECKLIST

SQID:

Location:

Date:

Time:

Inspector:

Weather Conditions

	Condition Acceptable			
Maintenance Item	**Yes**	**No**	**N/A**	**Comments**
1. Basin Surface				
Clear of sediment build-up				
Check for erosion, scour, vehicle & other damage				
Check for dead or damaged vegetation				
2. Filter Media				
Check for erosion, scour, vehicle & other damage				
Check for isolated boggy patches				
3. Subsoil Drainage				
Visually check subsoil drainage through cleanout inspection openings for build-up of sediment				
Check for blockages to subsoil drainage using other methods (eg. CCTV or flush-out)				

Additional Comments

Actions to be taken

APPENDIX C:
BIORETENTION SPECIFICATION

GUIDELINES FOR FILTER MEDIA IN BIOFILTRATION SYSTEMS (Version 3.01)
June 2009

The following guidelines for filter media in biofiltration systems have been prepared on behalf of the Facility for Advancing Water Biofiltration (FAWB) to assist in the development of biofiltration systems, including the planning, design, construction and operation of those systems.

NOTE: This is a revision of the previous FAWB guideline specifications (published in 2006 (Version 1.01), 2008 (Version 2.01)). It attempts to provide a simpler and more robust guideline for both soil-based and engineered filter media. FAWB acknowledges the contribution of EDAW Inc., Melbourne Water Corporation, Dr Nicholas Somes (Ecodynamics), Alan Hoban (South East Queensland Healthy Waterways Partnership), Shaun Leinster (DesignFlow) and STORM Consulting to the preparation of the revised guidelines.

Disclaimer

The Guidelines for Soil Filter Media in Biofiltration Systems are made available and distributed solely on an "as is" basis without express or implied warranty. The entire risk as to the quality, adaptability and performance is assumed by the user.

It is the responsibility of the user to make an assessment of the suitability of the guidelines for its own purposes and the guidelines are supplied on the understanding that the user will not hold EDAW Inc., Monash University, or parties to the Facility for Advancing Water Biofiltration (FAWB) ("the Licensor") liable for any loss or damage resulting from their use.

To the extent permitted by the laws of Australia, the Licensor disclaims all warranties with regard to this information, including all implied warranties of merchantability and fitness. In no event shall the Licensor be liable for any special, direct or consequential damages or any damages whatsoever resulting from loss or use, whether in action of contract, negligence or other tortious action, arising out of the use of, or performance of this information.

1 GENERAL DESCRIPTION

The biofiltration filter media guidelines require three layers of media: the filter media itself (400-600 mm deep or as specified in the engineering design), a transition layer (100 mm deep), and a drainage layer (50 mm minimum cover over underdrainage pipe). The biofiltration system will operate so that water will infiltrate into the filter media and move vertically down through the profile.

The filter media is required to support a range of vegetation types (from groundcovers to trees) that are adapted to freely draining soils with occasional wetting. The material should be based on **natural or amended natural soils** or it can be **entirely engineered**; in either case, it can be of siliceous or calcareous origin. In general, the media should have an appropriately high permeability under compaction and should be free of rubbish, deleterious material, toxicants, declared plants and local weeds (as listed in local guidelines/Acts), and should not be hydrophobic. The filter media should contain some organic matter for increased water holding capacity but be low in nutrient content. In the case of natural or amended natural soils, the media should be a **loamy sand**.

Maintaining an adequate infiltration capacity is crucial in ensuring the long-term treatment efficiency of the system. The ability of a biofiltration system to detain and infiltrate incoming stormwater is a function of the filter surface area, extended detention (ponding) depth, and the hydraulic conductivity of the filter media (Figure 1). Most importantly, design of a biofiltration system should optimize the combination of these three design elements.

For a biofiltration system in a temperate climate with an extended detention depth of 100 – 300 mm and whose surface area is approximately 2% of the connected impervious area of the contributing catchment, the prescribed hydraulic conductivity will generally be between 100 – 300 mm/hr in order to meet best practice targets (Figure 2). This configuration supports plant growth without requiring too much land space. In warm, humid (sub- and dry- tropical) regions the hydraulic conductivity may need to be higher in order to achieve the required treatment performance using the same land space (i.e., ensuring that the proportion of water treated through the media meets requirements).

Where one of these design elements falls outside the recommended range, the infiltration capacity can still be maintained by offsetting another of the design elements. For example, a filter media with a lower hydraulic conductivity may be used, but the surface area or the extended detention depth would need to be increased in order to maintain the treatment capacity. Similarly, if the available land were the limiting design element, the system could still treat the same size storm if a filter media with a higher hydraulic conductivity were installed. Where a hydraulic conductivity greater than 300 mm/hr is prescribed, potential issues such as higher watering requirements during the establishment should be considered. Biofiltration systems with a hydraulic conductivity greater than 600 mm/hr are unlikely to support plant growth due to poor water retention, and may also result in leaching of pollutants. However plant survival might be possible if the outlet pipe were raised to create a permanently submerged zone.

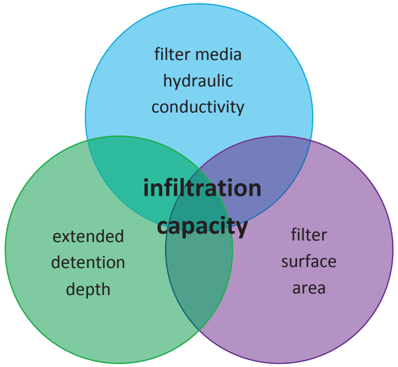


Figure 1. Design elements that influence infiltration capacity.

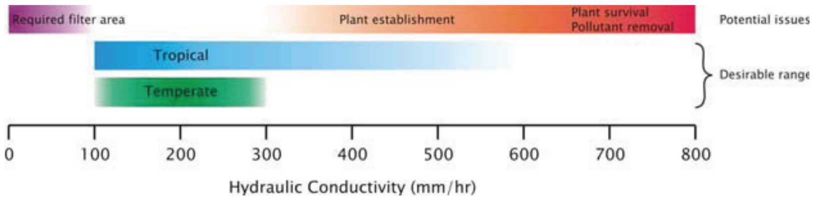


Figure 2. Recommended filter media hydraulic conductivity range and potential issues

The infiltration capacity of the biofiltration system will initially decline during the establishment phase as the filter media settles and compacts, but this will level out and then start to increase as the plant community establishes itself and the rooting depth increases (see Appendix A). In order to ensure that the system functions adequately at its eventual (minimum) hydraulic conductivity, a safety co-efficient of 2 should be used: i.e., **designs should be modelled using half the prescribed hydraulic conductivity**. If a system does not perform adequately with this hydraulic conductivity, then the area and/or ponding depth should be increased. It may also be desirable to report sensitivity to infiltration rate, rather than simply having expected rate. This is important when assessing compliance of constructed systems as systems should ideally meet best practice across a range of infiltration rates.

2 TESTING REQUIREMENTS

2.1 Determination of Hydraulic Conductivity

The hydraulic conductivity of potential filter media should be measured using the ASTM F1815-06 method. This test method uses a compaction method that best represents field conditions and so provides a more realistic assessment of hydraulic conductivity than other test methods.

Note: if a hydraulic conductivity lower than 100 mm/hr is prescribed, the level of compaction associated with this test method may be too severe and so underestimate the actual hydraulic conductivity of the filter media under field conditions. However, FAWB considers this to be an appropriately conservative test, and recommends its use even for low conductivity media.

2.2 Particle Size Distribution

Particle size distribution (PSD) is of secondary importance compared with hydraulic conductivity. A material whose PSD falls within the following recommended range does not preclude the need for hydraulic conductivity testing i.e., it does not guarantee that the material will have a suitable hydraulic conductivity. However, the following composition range (percentage w/w) provides a useful guide for selecting an appropriate material:

Clay & Silt	<3%	(<0.05 mm)
Very Fine Sand	5-30%	(0.05-0.15 mm)
Fine Sand	10-30%	(0.15-0.25 mm)
Medium to Coarse Sand	40-60%	(0.25-1.0 mm)
Coarse Sand	7-10%	(1.0-2.0 mm)
Fine Gravel	<3%	(2.0-3.4 mm)

Clay and silt are important for water retention and sorption of dissolved pollutants, however they substantially reduce the hydraulic conductivity of the filter media. This size fraction also influences the structural stability of the material (through migration of particles to block small pores and/or slump). It is essential that the total clay and silt mix is **less than 3% (w/w)** to reduce the likelihood of structural collapse of such soils.

The filter media should be well-graded i.e., it should have all particle size ranges present from the 0.075 mm to the 4.75 mm sieve (as defined by AS1289.3.6.1 - 1995). There should be no gap in the particle size grading, and the composition should not be dominated by a small particle size range. This is important for preventing structural collapse due to particle migration.

2.3 Soil-Based Filter Media: Properties

The following specifications are based on results of extensive treatment performance testing conducted by FAWB as well as recommendations made by AS4419 – 2003 (Soils for Landscaping and Garden Use). Filter media must be tested for the following; media that do not meet these specifications should be rejected or amended:

i. Total Nitrogen (TN) Content – <1000 mg/kg.

ii. Orthophosphate (PO_4^{3-}) Content – <80 mg/kg. Soils with total phosphorus concentrations >100 mg/kg should be tested for potential leaching. Where plants with moderate phosphorus sensitivity are to be used, total phosphorus concentrations should be <20 mg/kg.

iii. Organic Matter Content – at least 3% (w/w). An organic content lower than 3% is likely to have too low a water holding capacity to support healthy plant growth. In order to comply with both this and the TN and PO_4^{3-} content requirements, a low nutrient organic matter will be required.

iv. pH – as specified for 'natural soils and soil blends' 5.5 – 7.5 (pH 1:5 in water).

v. Electrical Conductivity (EC) – as specified for 'natural soils and soil blends' <1.2 dS/m.

Optional testing:

vi. Dispersibility – this should be carried out where it is suspected that the soil may be susceptible to structural collapse. If in doubt, then this testing should be undertaken.

Potential filter media should generally be assessed by a horticulturalist to ensure that they are capable of supporting a healthy vegetation community. This assessment should take into consideration delivery of nutrients to the system by stormwater. Any component or soil found to contain high levels of salt (as determined by EC measurements), high levels of clay or silt particles (exceeding the particle size limits set above), or any other extremes which may be considered retardant to plant growth should be rejected.

3 ENGINEERED FILTER MEDIA

Where there is not a locally available soil-based material that complies with the properties outlined in Sections 2.1 - 2.3, it is possible to construct an appropriate filter medium. A washed, well-graded sand with an appropriate hydraulic conductivity should be used as the filter medium. Suitable materials include those used for the construction of turf profiles (e.g. golf greens); these materials are processed by washing to remove clay and silt fractions. In large quantities (>20 m^3), they can be obtained directly from sand suppliers, while smaller quantities can be purchased from local garden yards. The **top 100 mm of the filter medium** should then be ameliorated with appropriate organic matter, fertiliser and trace elements (Table 1). This amelioration is required to aid plant establishment and is designed to last four weeks; the rationale being that, beyond this point, the plants receive adequate nutrients via incoming stormwater.

Table 1. Recipe for ameliorating the top 100 mm of sand filter media

Constituent	Quantity (kg/100 m^2 filter area)
Granulated poultry manure fines	50
Superphosphate	2
Magnesium sulphate	3
Potassium sulphate	2
Trace Element Mix	1
Fertilizer NPK (16.4.14)	4
Lime	20

Laboratory testing has shown that biofilters that contain an engineered filter medium will achieve essentially the same hydraulic and treatment performance as those containing a soil-based filter medium (Bratieres *et al.*, 2009). However, it is recommended that a submerged zone be included in biofiltration systems that utilise such a free draining filter medium to provide a water source for vegetation between rainfall events.

4 TRANSITION LAYER

The transition layer prevents filter media from washing into the drainage layer. Transition layer material shall be a clean, well-graded sand material containing <2% fines. To avoid migration of the filter media into the transition layer, the particle size distribution of the sand should be assessed to ensure it meets 'bridging criteria', that is, the smallest 15% of the sand particles bridge with the largest 15% of the filter media particles (Water by Design, 2009; VicRoads, 2004):

D_{15} (transition layer) ≤ 5 x D_{85} (filter media)

where: D_{15} (transition layer) is the 15th percentile particle size in the transition layer material (i.e., 15% of the sand is smaller than D_{15} mm), and
D_{85} (filter media) is the 85th percentile particle size in the filter media.

A dual-transition layer, where a fine sand overlays a medium-coarse sand, is also possible. While it is acknowledged that this can increase the complexity of the construction process, testing indicates that a dual-transition layer produces consistently lower levels of turbidity and concentrations of suspended solids in treated outflows than a single transition layer. Therefore, it is recommended that this design be specified for stormwater harvesting applications (to enable effective post-treatment disinfection) and where minimising the risk of washout during the establishment period is of particular importance.

The transition layer can be omitted from a biofiltration system provided the filter media and drainage layer meet the following criteria as defined by the Victorian Roads *Drainage of Subsurface Water from Roads - Technical Bulletin No 32* (VicRoads, 2004):

D_{15} (drainage layer) ≤ 5 x D_{85} (filter media)
D_{15} (drainage layer) = 5 to 20 x D_{15} (filter media)
D_{50} (drainage layer < 25 x D_{50} (filter media)
D_{60} (drainage layer) < 20 x D_{10} (drainage layer)

These comparisons are best made by plotting the particle size distributions for the filter media and gravel on the same soil grading graphs and extracting the relevant diameters (Water by Design, 2009).

5 DRAINAGE LAYER

The drainage layer collects treated water at the bottom of the system and converys it to the underdrain pipes. Drainage layer material is to be clean, fine gravel, such as a 2 – 5 mm washed screenings. Bridging criteria should be applied to avoid migration of the transition layer into the drainage layer (Water by Design, 2009; VicRoads, 2004):

D_{15} (drainage layer) ≤ 5 x D_{85} (transition layer)

where: D_{15} (drainage layer) is the 15th percentile particle size in the drainage layer material (i.e., 15% of the gravel is smaller than D_{15} mm), and
D_{85} (transition layer) is the 85th percentile particle size in the transition layer material.

Note: The perforations in the underdrain pipes should be small enough that the drainage layer cannot fall into the pipes. A useful guide is to check to that the D_{85} (drainage layer) is greater than the pipe perforation diameter.

Geotextile fabrics are **not recommended** for use in biofiltration systems due to the risk of clogging. An open-weave shade cloth can be placed between the transition layer and the drainage layer to help reduce the downward migration of smaller particles if required, however this should only be adopted where there is insufficient depth for transition and drainage layers.

6 INSTALLATION

It is recommended that filter media be lightly compacted during installation to prevent migration of fine particles. In small systems, a single pass with a vibrating plate should be used to compact the filter media, while in large systems, a single pass with roller machinery (e.g. a drum lawn roller) should be performed. Under no circumstance should heavy compaction or multiple-passes be made. Filter media should be installed in two lifts unless the depth is less than 500 mm.

Egis Consulting Pty Ltd

www.egis-group.com

CONTACT US

Egis Consulting Pty Ltd
Choose office

Choose phone

egis

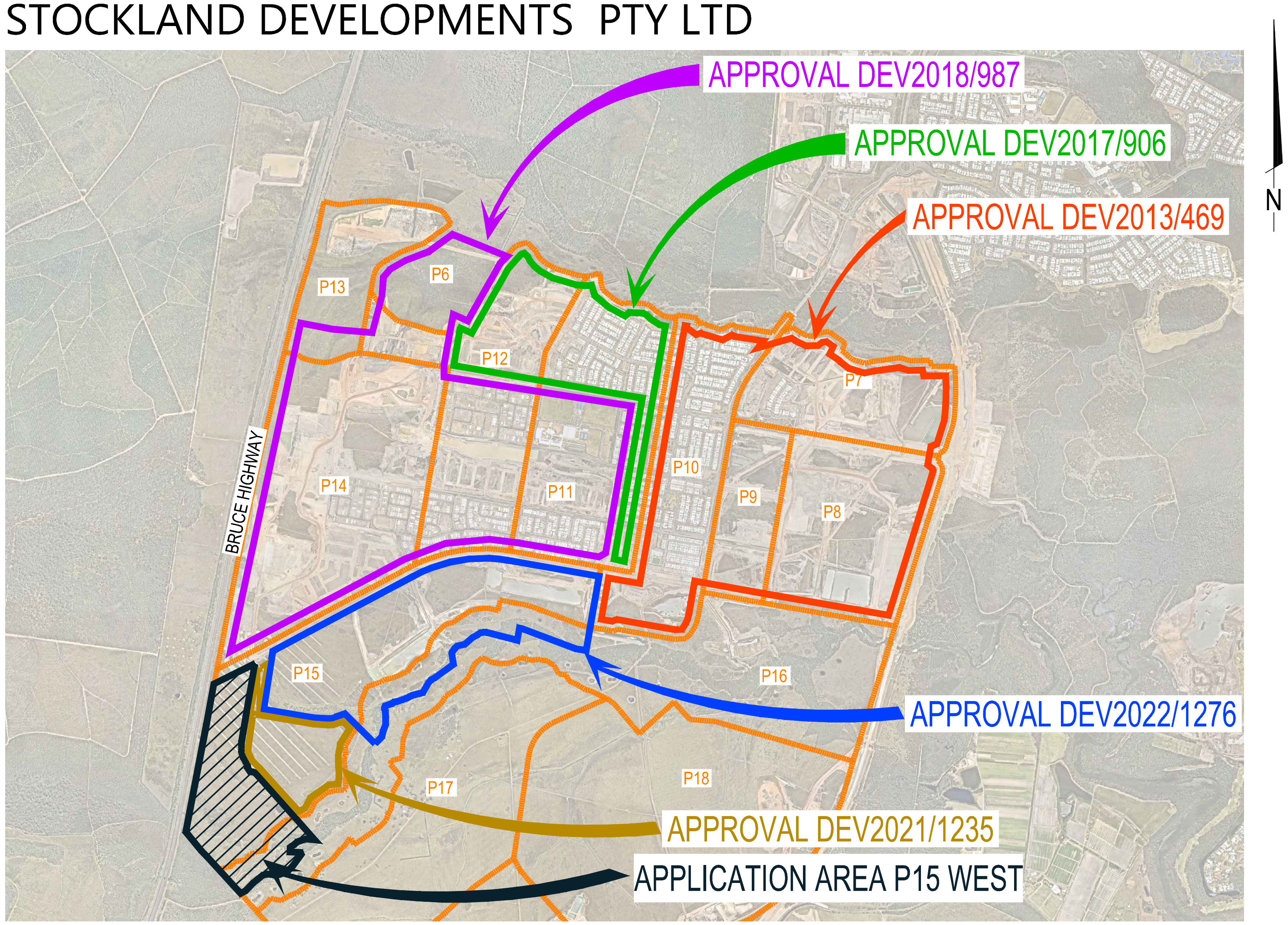
APPENDIX E:
ENGINEERING DRAWINGS BY EGIS

STOCKLAND - AURA

PRECINCT 15 WEST

RECONFIGURATION OF A LOT

STOCKLAND DEVELOPMENTS PTY LTD



Stockland

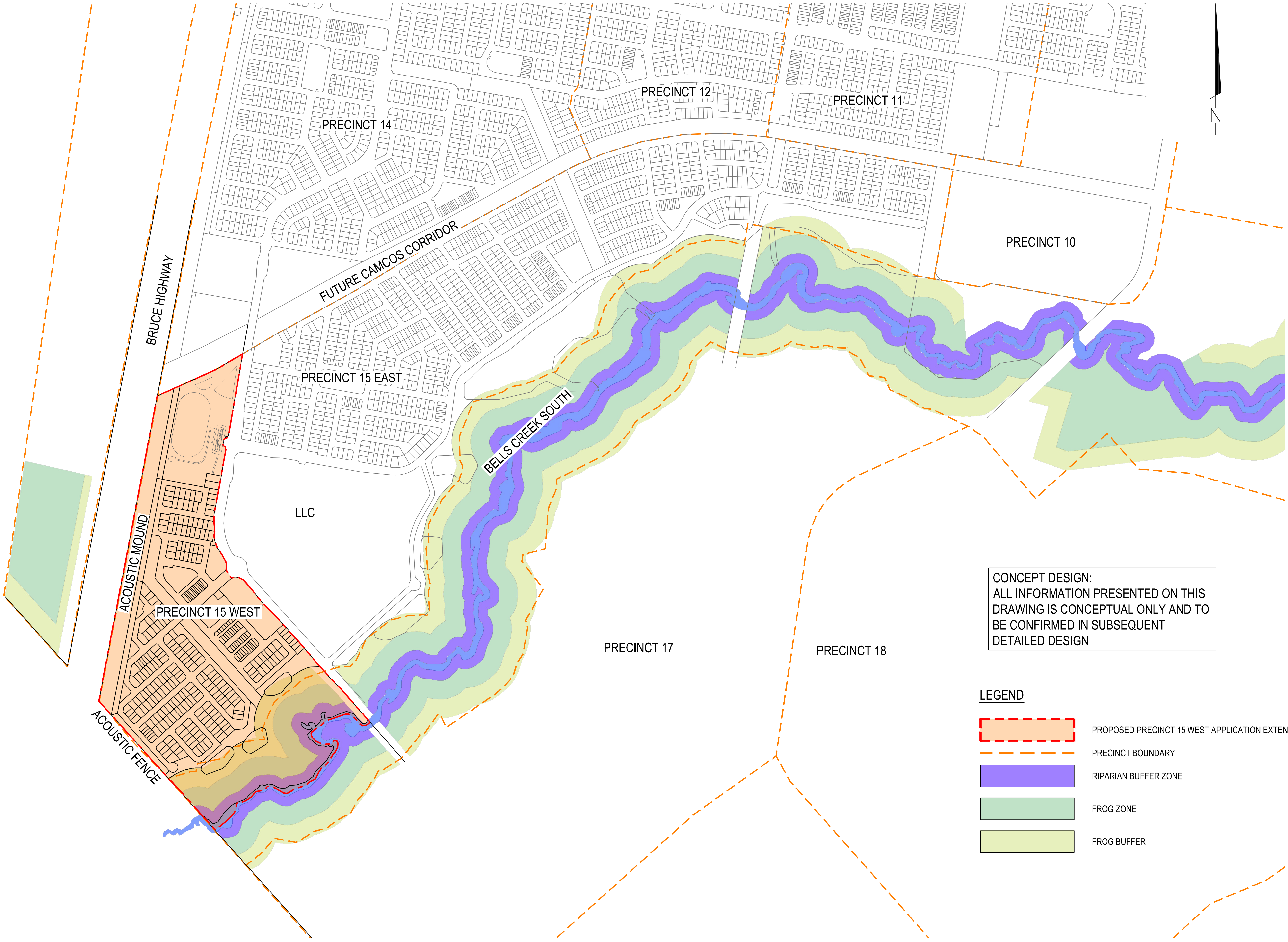
AURA

DRG NO	DRAWING TITLE
GENERAL	
3058-DA000	TITLESHEET AND LOCALITY PLAN
3058-DA010	OVERALL LAYOUT & KEY PLAN
3058-DA020	BULK EARTHWORKS CUT AND FILL DEPTH RANGES
3058-DA021	BULK EARTHWORKS DETAIL PLAN SHEET 1 OF 2
3058-DA022	BULK EARTHWORKS DETAIL PLAN SHEET 2 OF 2
DRAINAGE	
3058-DA030	SCHEMATIC STORMWATER DRAINAGE LAYOUT PLAN
3058-DA031	DRAINAGE CATCHMENT PLAN
3058-DA032	STORMWATER LAYOUT PLAN SHEET 1 OF 2
3058-DA033	STORMWATER LAYOUT PLAN SHEET 1 OF 3
3058-DA034	TYPICAL BIOPOD DETAILS SHEET 1 OF 2
3058-DA035	TYPICAL BIOPOD DETAILS SHEET 2 OF 2
3058-DA037	TYPICAL INVERTED NEIGHBORHOOD CONNECTOR ROAD K CROSS SECTION
3058-DA038	END OF LINE BASIN CONCEPT DESIGN
3058-DA040	DRAINAGE LAYOUT PLAN
3058-DA041	DRAINAGE CROSS SECTIONS
INTERSECTIONS	
3058-DA050	INTERSECTION FUNCTIONAL LAYOUT OVERALL PLAN
3058-DA051	INTERSECTION FUNCTIONAL LAYOUT PLAN
3058-DA055	SWEPT PATH OVERALL LAYOUT
3058-DA056	SWEPT PATH ANALYSIS SHEET 1 OF 2
3058-DA057	SWEPT PATH ANALYSIS SHEET 2 OF 2
EMERGENCY ACCESS	
3058-DA058	EMERGENCY ACCESS LAYOUT PLAN
3058-DA059	EMERGENCY ACCESS SECTIONS
WATER RETICULATION	
3058-DA060	CONCEPTUAL WATER RETICULATION PLAN
SEWER RETICULATION	
3058-DA070	CONCEPTUAL SEWER RETICULATION PLAN

egis

IMAGINE. CREATE. ACHIEVE.
a sustainable future

Project No.:	Milestone:	Revision Date.:	Drawing No.:	Revision:
21-000307	PRELIMINARY	17.06.24	3058-DA000	C



CONCEPT DESIGN:
ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN

LEGEND

🟧	PROPOSED PRECINCT 15 WEST APPLICATION EXTENTS
- - -	PRECINCT BOUNDARY
🟪	RIPARIAN BUFFER ZONE
🟩	FROG ZONE
🟨	FROG BUFFER

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BE	BE	BG		21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI
B	BG	BG	BG	BG	09.05.24	AMENDED TO SUIT FURTHER ISSUES

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 50 100 150 200 250 300 350 400
SCALE 1:5000 (A1) SCALE 1:10000 (A3)

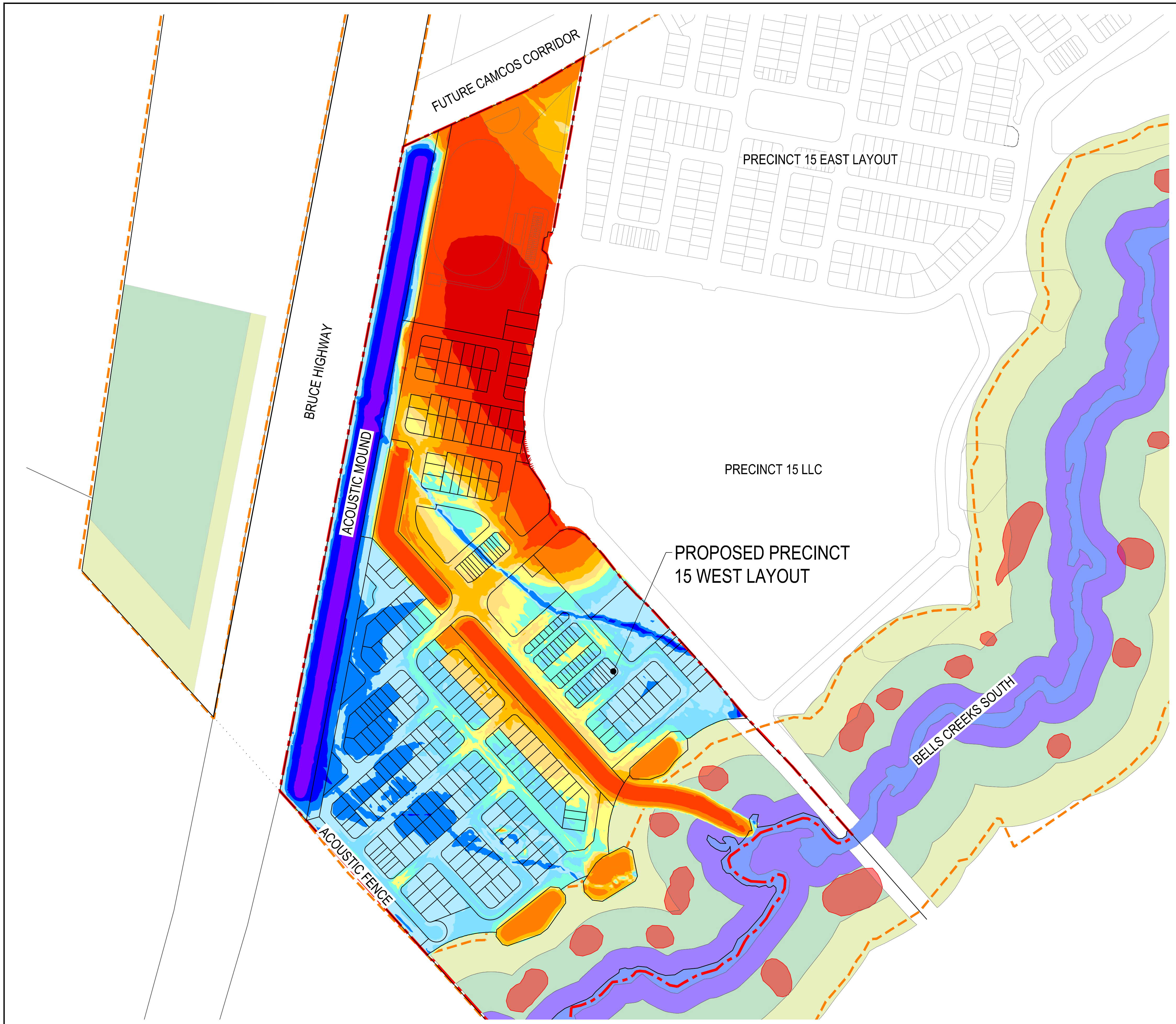
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
OVERALL LAYOUT & KEY PLAN

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA010	B



NOTE:
NO WORKS TO BE UNDERTAKEN IN CAMCOS CORRIDOR.

N

ROL AREA VOLUMES

CUT: 274,635m³
FILL: 241,519m³
BALANCE: 41,566m³

CONCEPT DESIGN:

1. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN. THROUGHOUT DETAILED DESIGN, BULK EARTHWORKS TO BE DEVELOPED TO BEST MATCH REQUIREMENTS OF THE OTHER PRECINCTS.
2. INDIVIDUAL LOT BENCHING TO BE CONFIRMED DURING DETAIL DESIGN. ALL LOTS TO FALL TO ADJACENT ROADWAY.

LEGEND

🟥	OVER 2.0m OF CUT
🟥	2.0m - 1.5m OF CUT
🟧	1.5m - 1.0m OF CUT
🟧	1.0m - 0.5m OF CUT
🟨	0.5m - 0.25m OF CUT
🟨	0.25m - 0.00m OF CUT
🟩	0.00m - 0.25m OF FILL
🟦	0.25m - 0.50m OF FILL
🟦	0.50m - 1.0m OF FILL
🟦	1.0m - 1.5m OF FILL
🟦	1.5m - 2.0m OF FILL
🟪	OVER 2m OF FILL
— —	PRECINCT BOUNDARY
— · —	APPLICATION EXTENT P15 EAST

INITIAL ISSUE		DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
		BE	BE	BG		21.09.23	
AMENDMENTS	A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

STATUS
PRELIMINARY

APPROVED
BY:
RPEQ NO:
SIGN:
DATE:

SCALE
0 25 50 75 100 125 150 175 200
SCALE 1:2500 (A1)
SCALE 1:5000 (A3)

egis

www.egis-group.com

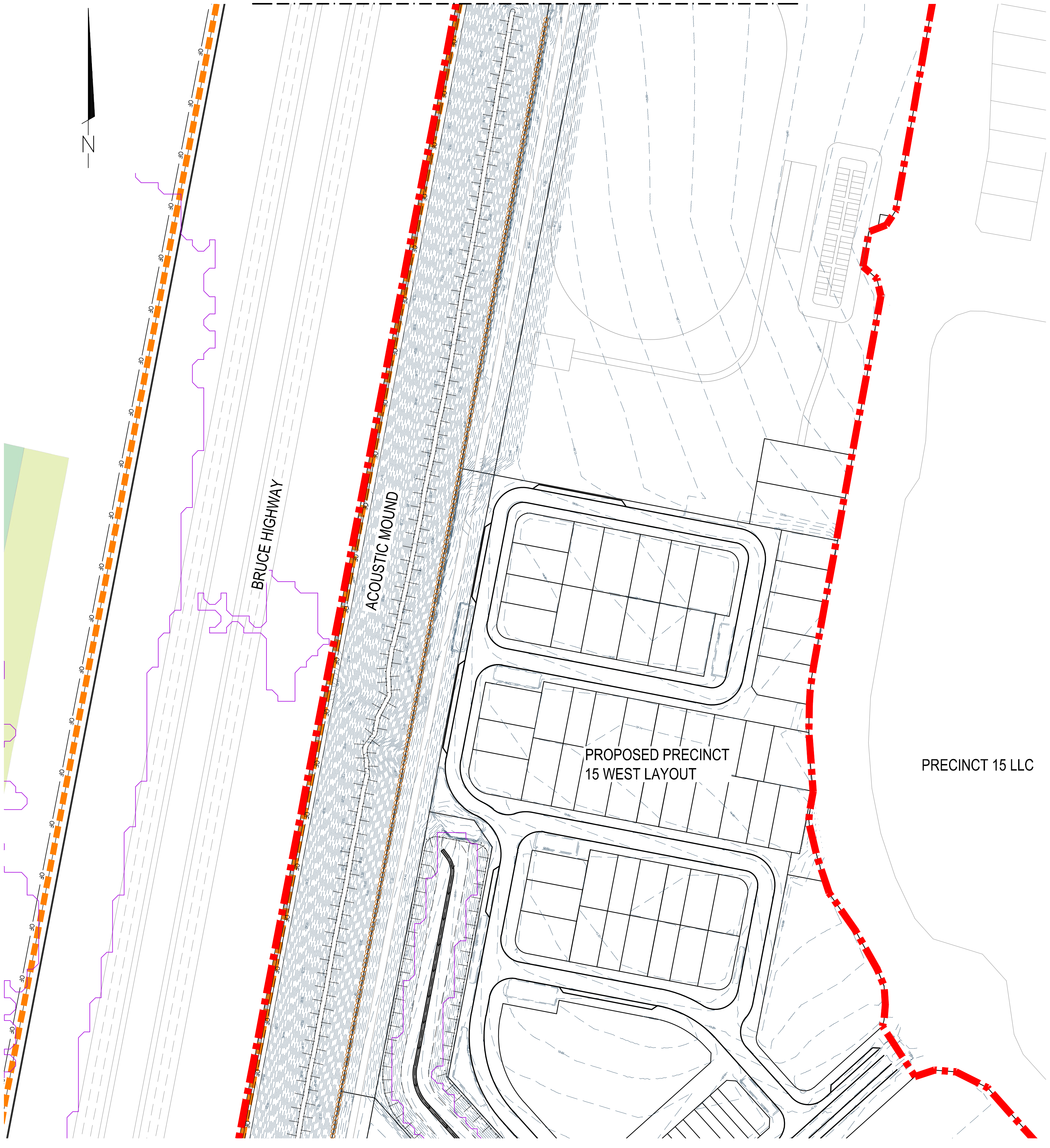
CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

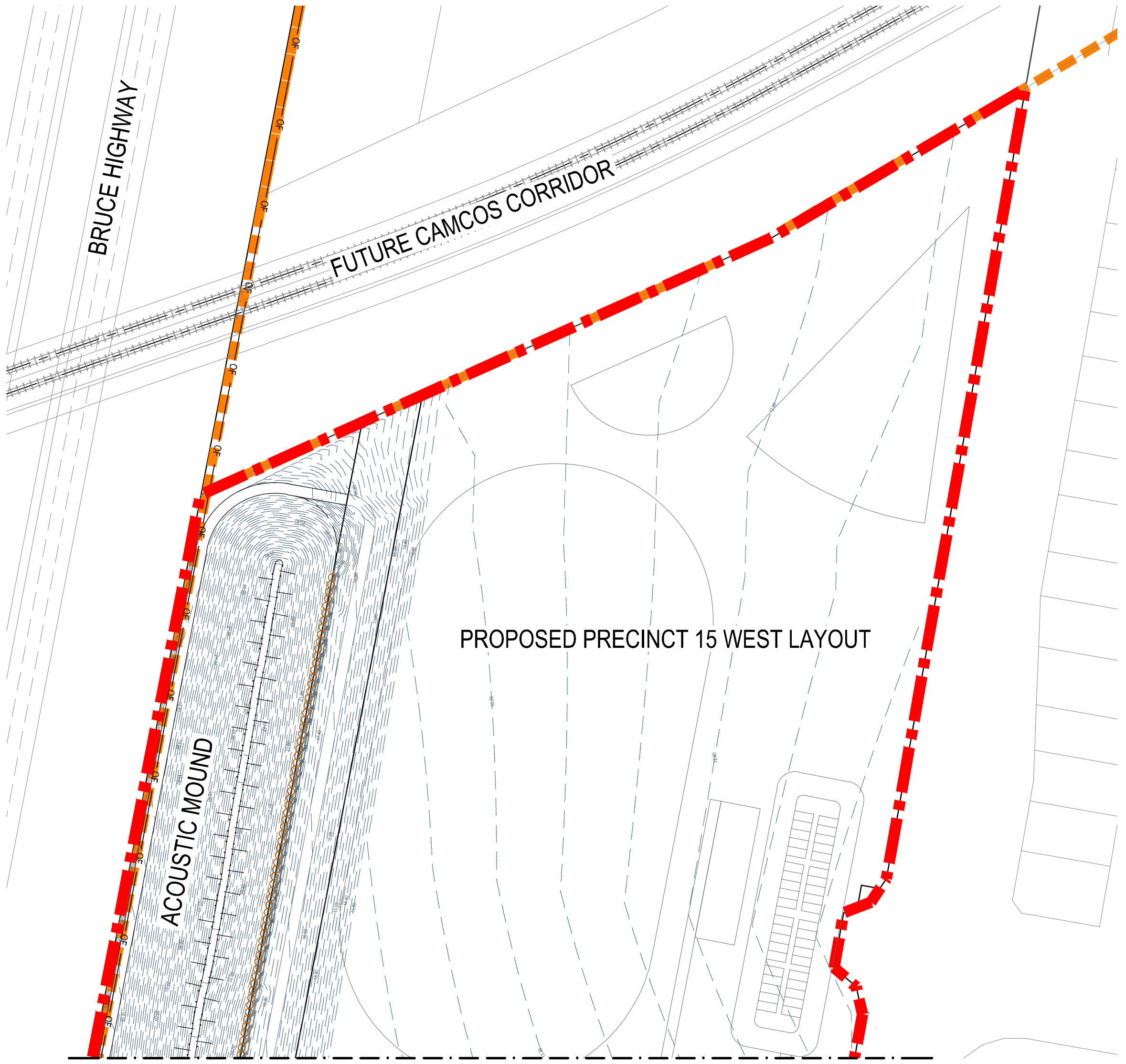
DRAWING TITLE
BULK EARTHWORKS
CUT AND FILL DEPTH
RANGES

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA020	A

FOR CONTINUATION REFER RIGHT



FOR CONTINUATION REFER SHEET 2



FOR CONTINUATION REFER LEFT

CONCEPT DESIGN:

1. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN. THROUGHOUT DETAILED DESIGN, BULK EARTHWORKS TO BE DEVELOPED TO BEST MATCH REQUIREMENTS OF THE OTHER PRECINCTS.
2. INDIVIDUAL LOT BENCHING TO BE CONFIRMED DURING DETAIL DESIGN. ALL LOTS TO FALL TO ADJACENT ROADWAY.

LEGEND

🟪	RIPARIAN BUFFER ZONE
🟩	FROG ZONE
🟨	FROG BUFFER
▬ ▪ ▬	APPLICATION EXTENT P15 EAST
— —	PROPOSED PRECINCT BOUNDARY
oooooooooooo	PROPOSED RETAINING WALL
⎍	PROPOSED 100yr AR1 2100 FLOOD EXTENTS. EXTENTS BASED ON BMT FLOOD MODELLING AND MODIFIED FOR SITE FILLING

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BE	BE	BG		21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI
B	BG	BG	BG	BG	29.04.24	AMENDED TO SUIT FURTHER ISSUES

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY:
RPEQ NO:
SIGN:
DATE:

SCALE
0 10 20 30 40 50 60 70 80
SCALE 1:1000 (A1)
SCALE 1:2000 (A3)

egis

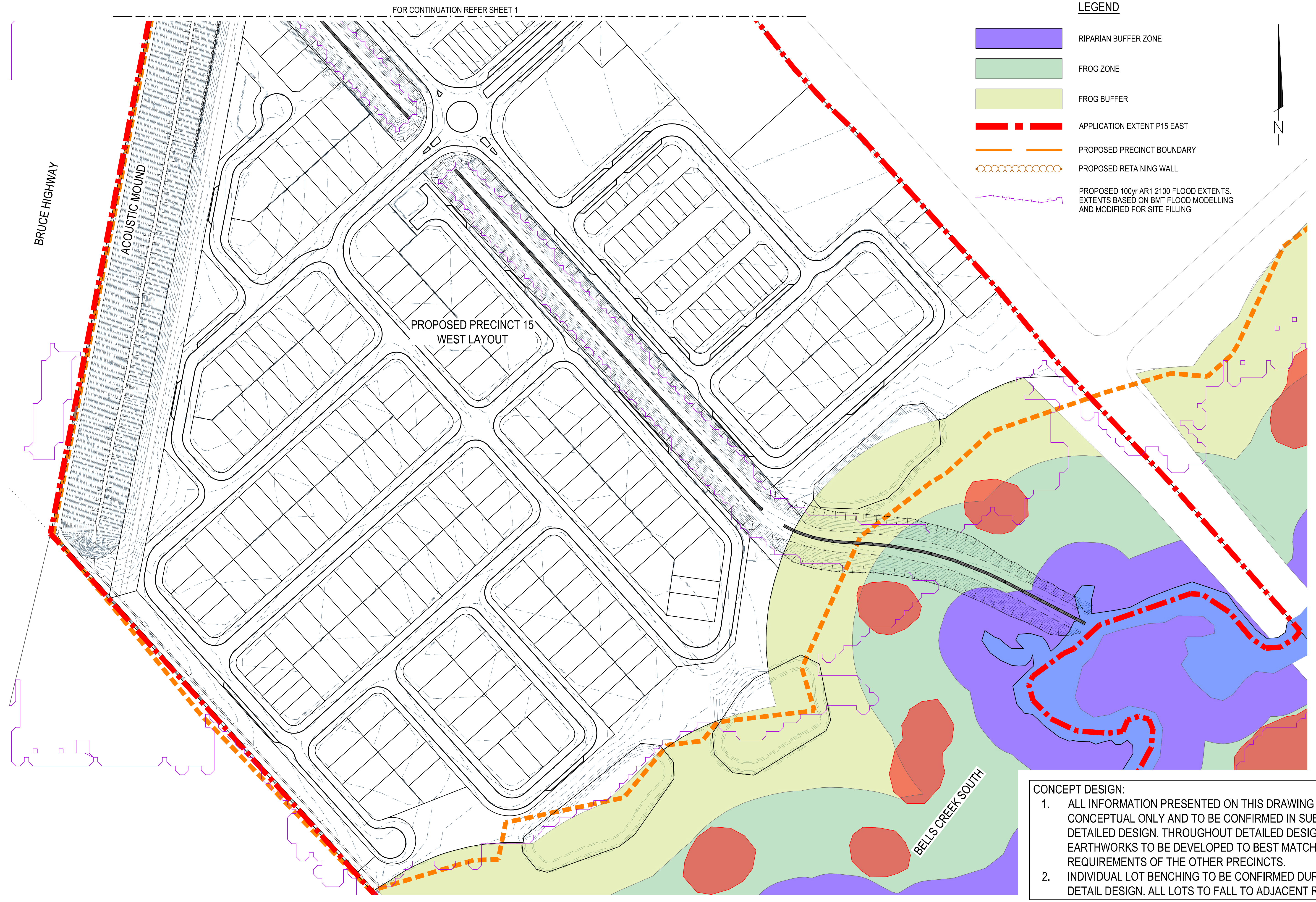
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
BULK EARTHWORKS
DETAIL PLAN
SHEET 1 OF 2

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA021	B



LEGEND

🟪	RIPARIAN BUFFER ZONE
🟩	FROG ZONE
🟨	FROG BUFFER
▬ · ▬	APPLICATION EXTENT P15 EAST
— —	PROPOSED PRECINCT BOUNDARY
○○○○○○○○○○	PROPOSED RETAINING WALL
∼	PROPOSED 100yr AR1 2100 FLOOD EXTENTS. EXTENTS BASED ON BMT FLOOD MODELLING AND MODIFIED FOR SITE FILLING

CONCEPT DESIGN:

1. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN. THROUGHOUT DETAILED DESIGN, BULK EARTHWORKS TO BE DEVELOPED TO BEST MATCH REQUIREMENTS OF THE OTHER PRECINCTS.
2. INDIVIDUAL LOT BENCHING TO BE CONFIRMED DURING DETAIL DESIGN. ALL LOTS TO FALL TO ADJACENT ROADWAY.

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BE	BE	BG		21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY:
RPEQ NO:
SIGN:
DATE:

SCALE
0 10 20 30 40 50 60 70 80
SCALE 1:1000 (A1) SCALE 1:2000 (A3)

egis

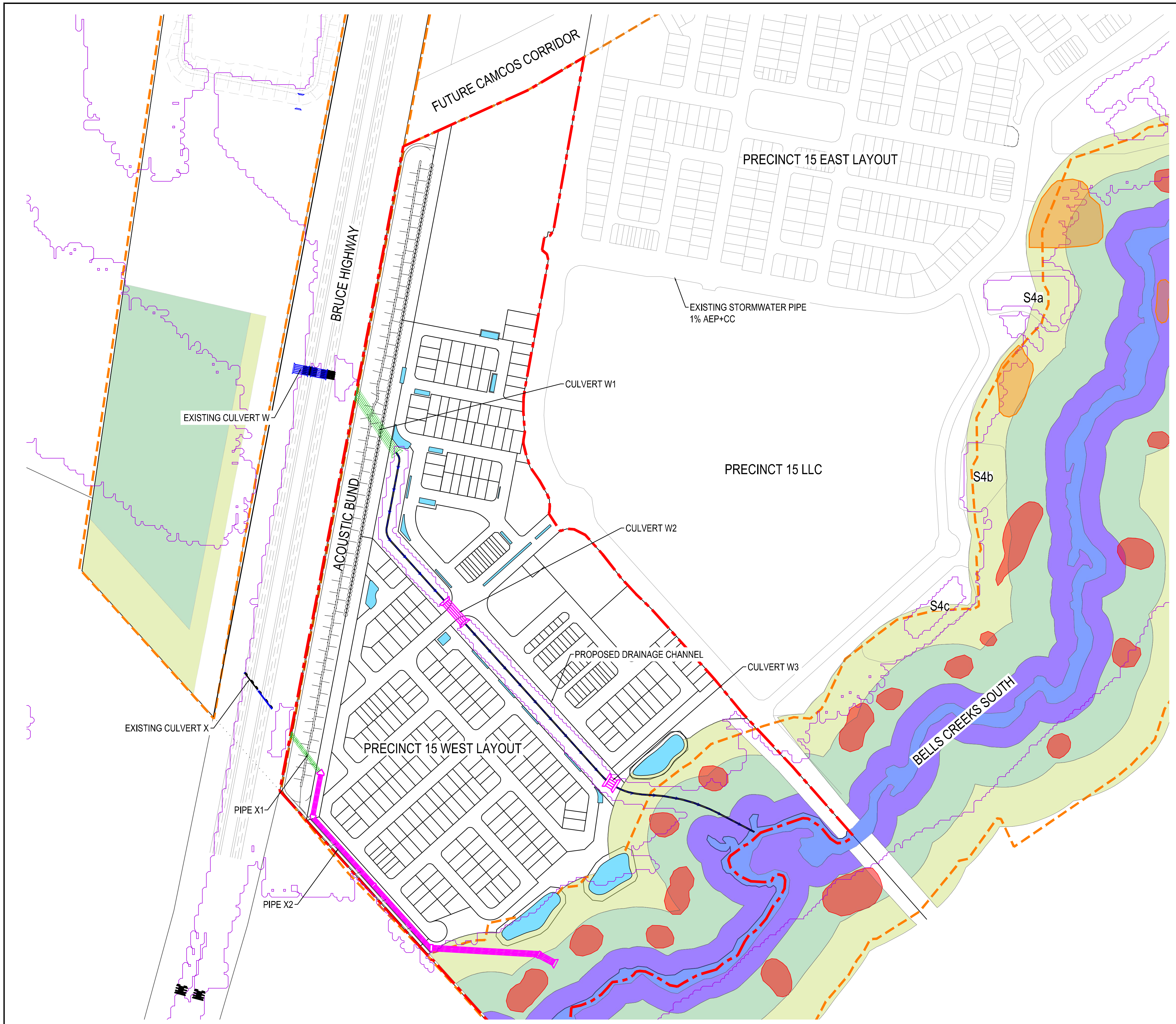
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
BULK EARTHWORKS
DETAIL PLAN
SHEET 2 OF 2

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA022	A



N

NOTE

1. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY & TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN.
2. INTERNAL PRECINCT 15 WEST STORMWATER PIPE NETWORK TO CONVEY 2yr & 10yr ARI FLOWS FOR MINOR & MAJOR ROADS, RESPECTIVELY.
3. THIS DRAWING FOCUSES ON CONVEYANCE OF EXTERNAL CATCHMENT FLOWS THROUGH PRECINCT 15 WEST TO BELLS CREEK SOUTH.
4. REFER TO EGIS CATCHMENT PLAN 17-000934-3058-DA024.
5. REFER TO STORMWATER QUALITY MANAGEMENT DETAIL.
6. PIPE DESIGN CRITERIA IS PRESENTED ON THIS PLAN. THIS IS THE MINIMUM PIPE CAPACITY FOR EACH REACH. REFER TO EGIS CONSULTING STORMWATER MANAGEMENT REPORT - PRECINCT 15 (REFERENCE 17-000394-3058-SWMP01.LM) FOR RECOMMENDED SIZES AND MODELLING CAPACITIES

LEGEND

🟩	BRUCE HIGHWAY CULVERT FLOWS
▬	1% AEP+CC STORMWATER PIPE NETWORK EXTERNAL CATCHMENT FLOWS
▬	100yr ARI: STORMWATER NETWORK P15 LOCAL FLOWS + EXTERNAL CATCHMENT FLOWS
〰	PROPOSED 100yr AR1 2100 FLOOD EXTENTS. EXTENTS BASED ON BMT FLOOD MODELLING AND MODIFIED FOR SITE FILLING
●	PROPOSED STORMWATER PIT
☒	1% AEP + CC CAPACITY INLET PIT
○	SURCHARGE PIT
- - -	PRECINCT BOUNDARY
—·—	APPLICATION EXTENT P15 WEST
🟥	FROG POND BOUNDARY
🟧	FROG HABITAT BOUNDARY
🟦	WSUD INFRASTRUCTURE

INITIAL ISSUE		DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
		BE	BE	BG		21.09.23	
AMENDMENTS	A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 25 50 75 100 125 150 175 200
SCALE 1:2500 (A1) SCALE 1:5000 (A3)

egis

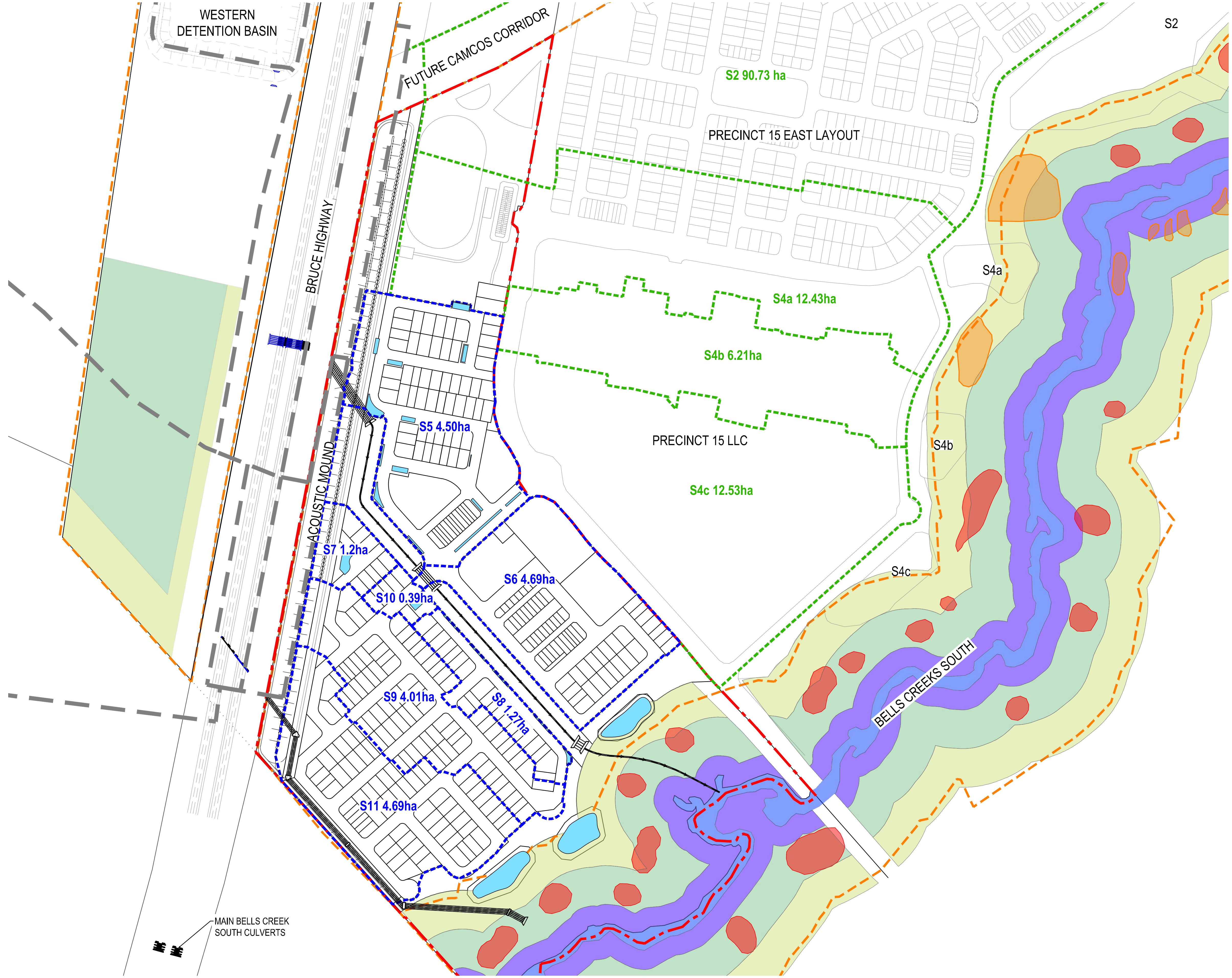
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
SCHEMATIC STORMWATER DRAINAGE LAYOUT PLAN

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA030	A



N

NOTE

1. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY & TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN.
2. REFER TO EGIS SWMP FOR STORMWATER QUALITY MANAGEMENT DETAIL.

LEGEND

— — 10.00 — —	DESIGN CONTOURS
- - - - -	PRECINCT BOUNDARY
—·—·—	APPLICATION EXTENT P15 WEST
- - - - -	EXTERNAL CATCHMENTS (TO P15 WEST)
- - - - -	PROPOSED CATCHMENT BOUNDARY
- - - - -	P15 EAST CATCHMENT BOUNDARY
Sx xx.xx ha	PROPOSED CATCHMENT LABEL & AREA
🟥	FROG POND BOUNDARY
🟧	FROG HABITAT BOUNDARY
🟦	WSUD INFRASTRUCTURE
🟩	WSUD STREET TREE

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	BE	BE	BG		21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 25 50 75 100 125 150 175 200
SCALE 1:2500 (A1) SCALE 1:5000 (A3)

egis

www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
DRAINAGE CATCHMENT PLAN

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA031	A

FOR CONTINUATION REFER SHEET 2

NOTE

1. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY & TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN.
2. REFER TO EGIS DRAINAGE LAYOUT PLAN 17-000934-3058-DA030.
3. REFER TO EGIS CATCHMENT LAYOUT PLAN 17-000934-3058-DA031.
4. REFER TO EGIS FOR STORMWATER QUALITY MANAGEMENT DETAIL.
5. PIPE DESIGN CRITERIA IS PRESENTED ON THIS PLAN. THIS IS THE MINIMUM PIPE CAPACITY FOR EACH REACH. REFER TO EGIS STORMWATER MANAGEMENT REPORT - PRECINCT 15 (REFERENCE 21-000307.11.LF01A) FOR RECOMMENDED SIZES AND MODELLING CAPACITIES

LEGEND

— — 10.00 — —	DESIGN CONTOURS
━━━	1% AEP+CC STORMWATER PIPE NETWORK EXTERNAL CATCHMENT FLOWS
●	PROPOSED STORMWATER PIT
—>—>—	CRITICAL INTERNAL P15 PIPELINE ROUTE
- - - -	PROPOSED CATCHMENT BOUNDARY
- - - -	PROPOSED SUB-CATCHMENT BOUNDARY
➤	OVERLAND FLOW PATH DIRECTION
🟥	FROG POND BOUNDARY
🟧	FROG HABITAT BOUNDARY
🟦	WSUD INFRASTRUCTURE
🟪	RIPARIAN BUFFER ZONE
🟩	FROG ZONE
🟨	FROG BUFFER
━ ▪ ━ ▪	APPLICATION EXTENT P15 EAST
— — —	PROPOSED PRECINCT BOUNDARY

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BE	BE	BG		21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 10 20 30 40 50 60 70 80
SCALE 1:1000 (A1) SCALE 1:2000 (A3)

egis

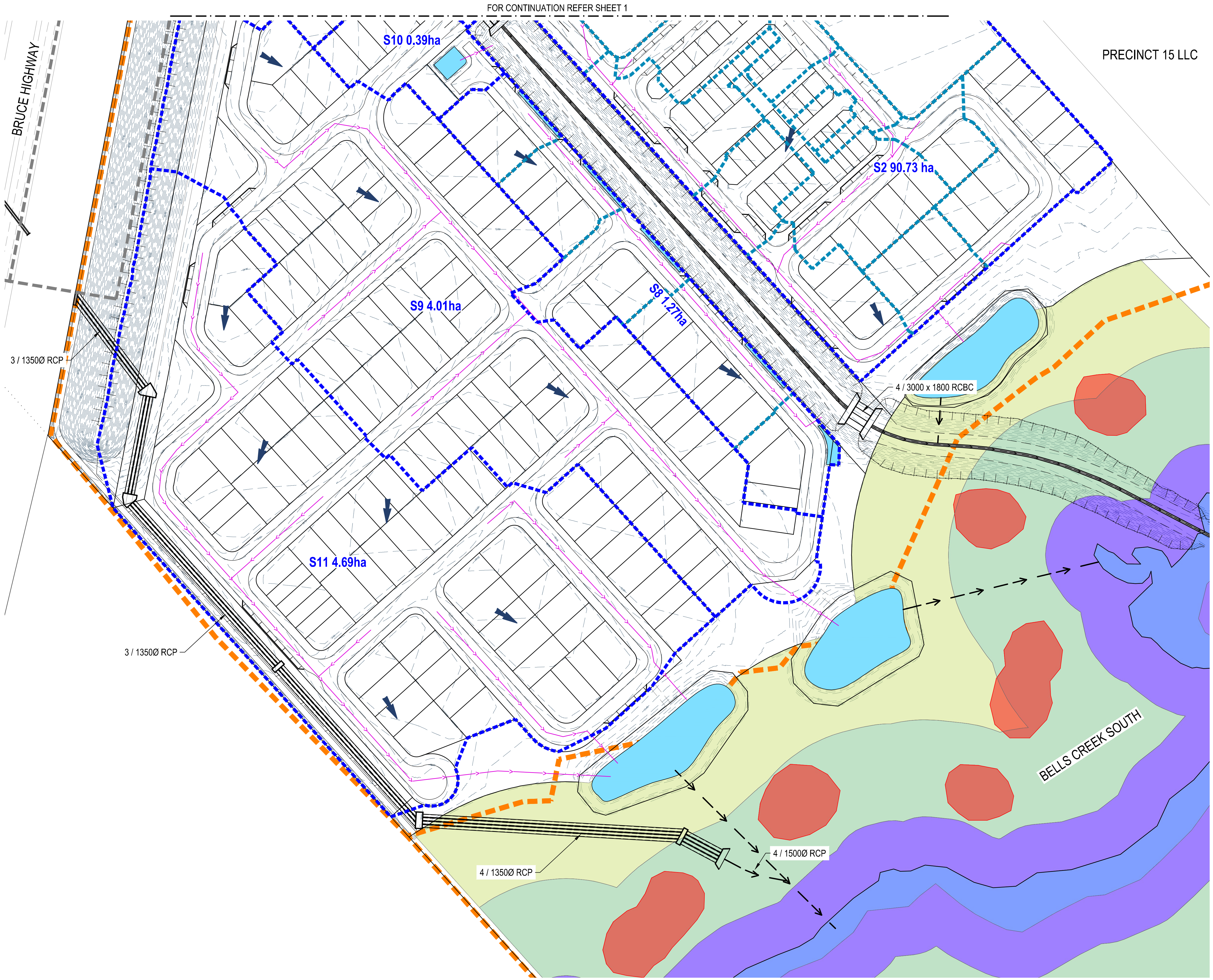
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
STORMWATER LAYOUT PLAN
SHEET 1 OF 2

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA032	A



NOTE

1. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY & TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN.
2. REFER TO EGIS DRAINAGE LAYOUT PLAN 17-000934-3058-DA030.
3. REFER TO EGIS CATCHMENT LAYOUT PLAN 17-000934-3058-DA031.
4. REFER TO EGIS SMP FOR STORMWATER QUALITY MANAGEMENT DETAIL.
5. PIPE DESIGN CRITERIA IS PRESENTED ON THIS PLAN. THIS IS THE MINIMUM PIPE CAPACITY FOR EACH REACH. REFER TO EGIS STORMWATER MANAGEMENT REPORT - PRECINCT 15 (REFERENCE 21-000307.11.LF01A) FOR RECOMMENDED SIZES AND MODELLING CAPACITIES

LEGEND

- DESIGN CONTOURS
- 1% AEP+CC STORMWATER PIPE NETWORK EXTERNAL CATCHMENT FLOWS
- ● PROPOSED STORMWATER PIT
- CRITICAL INTERNAL P15 PIPELINE ROUTE
- PROPOSED CATCHMENT BOUNDARY
- PROPOSED SUB-CATCHMENT BOUNDARY
- ➔ OVERLAND FLOW PATH DIRECTION
- 🟥 FROG POND BOUNDARY
- 🟧 FROG HABITAT BOUNDARY
- 🟦 WSUD INFRASTRUCTURE
- 🟪 RIPARIAN BUFFER ZONE
- 🟩 FROG ZONE
- 🟨 FROG BUFFER
- APPLICATION EXTENT P15 EAST
- PROPOSED PRECINCT BOUNDARY

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	BE	BE	BG		21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 10 20 30 40 50 60 70 80
SCALE 1:1000 (A1) SCALE 1:2000 (A3)

egis

www.egis-group.com

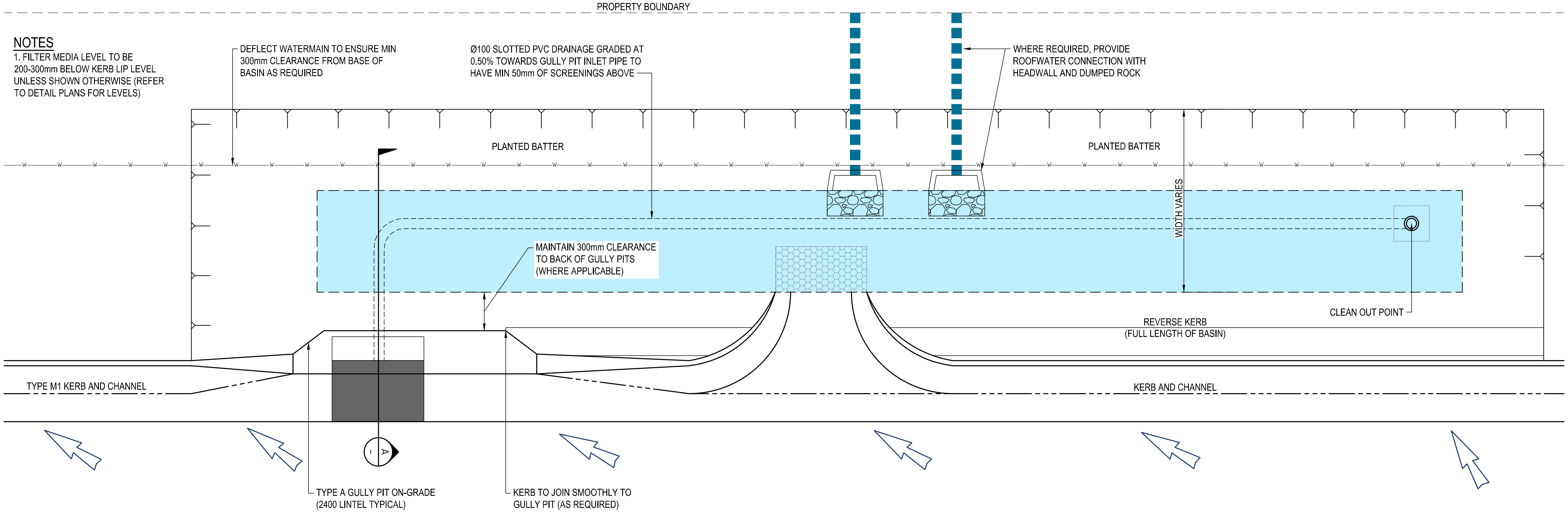
CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

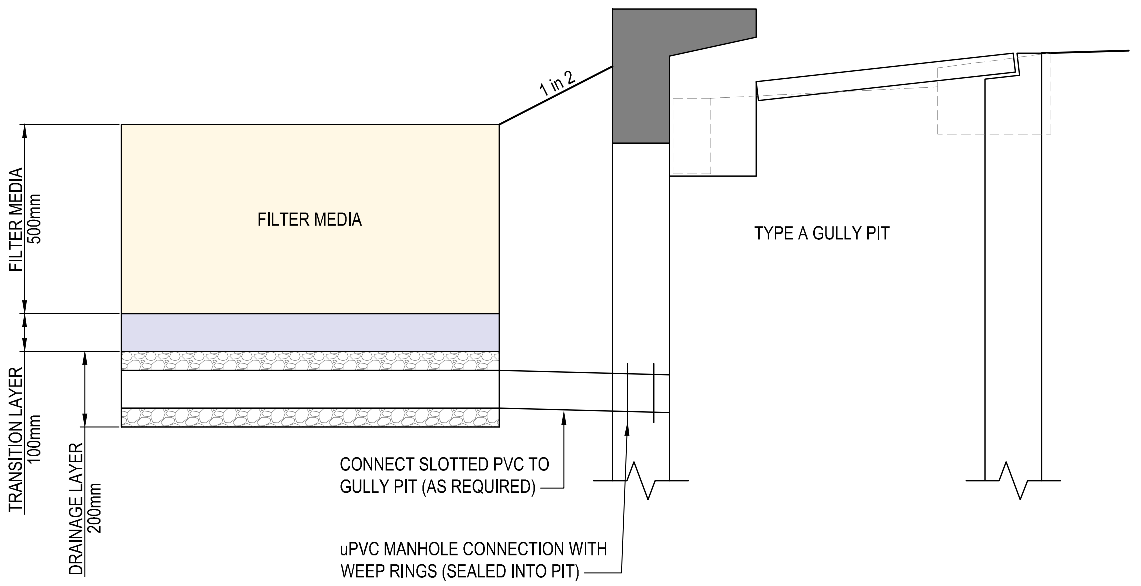
DRAWING TITLE
STORMWATER LAYOUT PLAN
SHEET 2 OF 2

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA033	A

NOTES
1. FILTER MEDIA LEVEL TO BE 200-300mm BELOW KERB LIP LEVEL UNLESS SHOWN OTHERWISE (REFER TO DETAIL PLANS FOR LEVELS)



TYPICAL BIO-POD ARRANGEMENT WITH GULLY PIT
1:20 @ A1 | 1:40 @ A3



SECTION A -
SCALE (A1): 1:10
SCALE (A3): 1:20

NOTE:
THIS DRAWING TO BE READ IN CONJUCTION WITH IPWEA STD DRG WSUD-005 & WSUD-007

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	BE	BE	BG		30.08.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 10 20 30 40 50 60 70 80
SCALE 1:1000 (A1) SCALE 1:2000 (A3)

egis

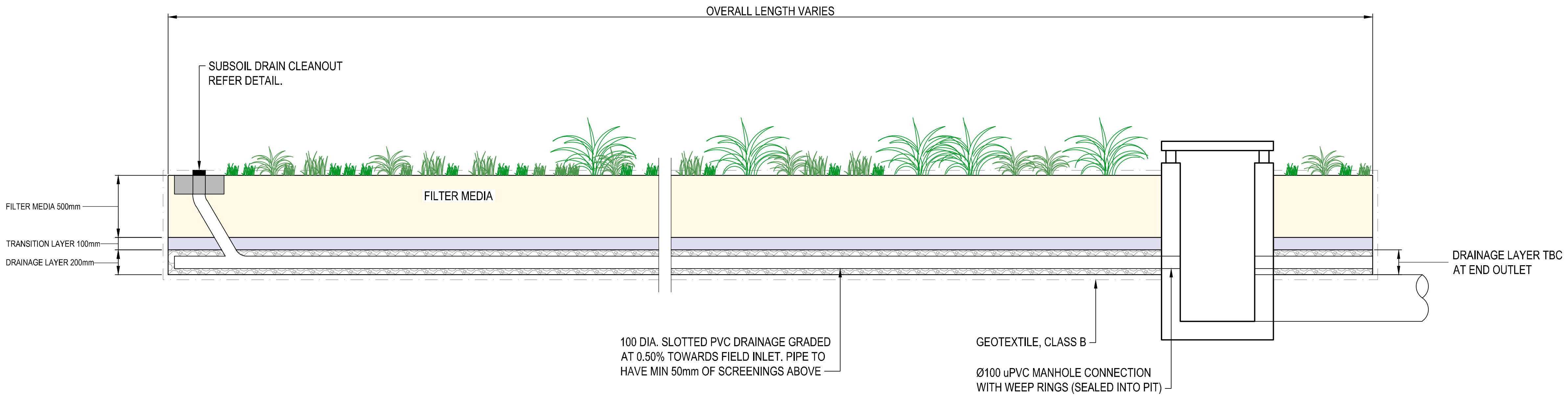
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

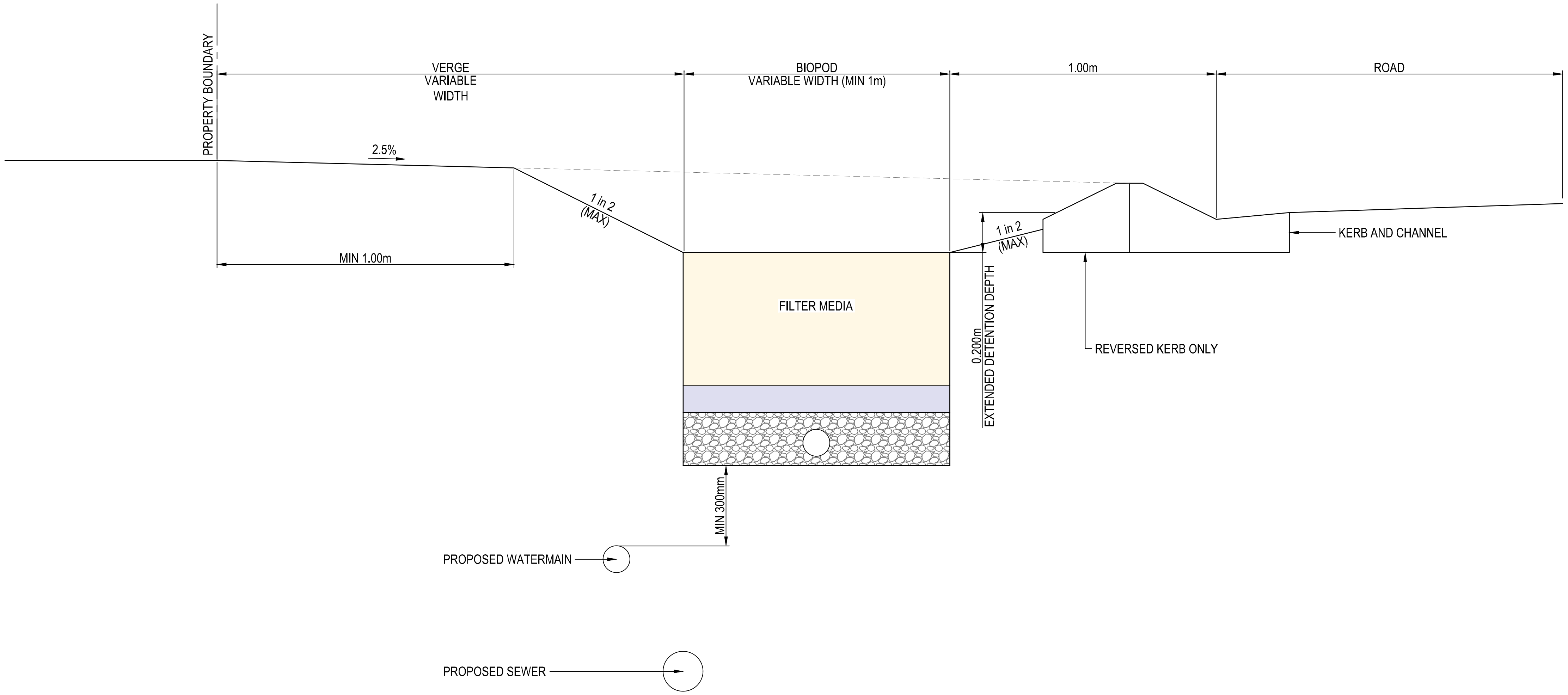
DRAWING TITLE
TYPICAL BIOPOD DETAILS
SHEET 1 OF 2

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA034	A



TYPICAL BIOPOD WITH FIELD INLET PIT

1:20 @ A1 | 1:40 @ A3



TYPICAL BIO-RETENTION ROAD INTERFACE

1:10 @ A1 | 1:20 @ A3

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BE	BE	BG		30.08.23	
AMENDMENTS A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

STATUS

PRELIMINARY

APPROVED

BY: RPEQ NO:

SIGN: DATE:

SCALE

0 10 20 30 40 50 60 70 80

SCALE 1:1000 (A1) SCALE 1:2000 (A3)

egis

www.egis-group.com

CLIENT

STOCKLAND
DEVELOPMENTS PTY
LTD

Stockland AURA

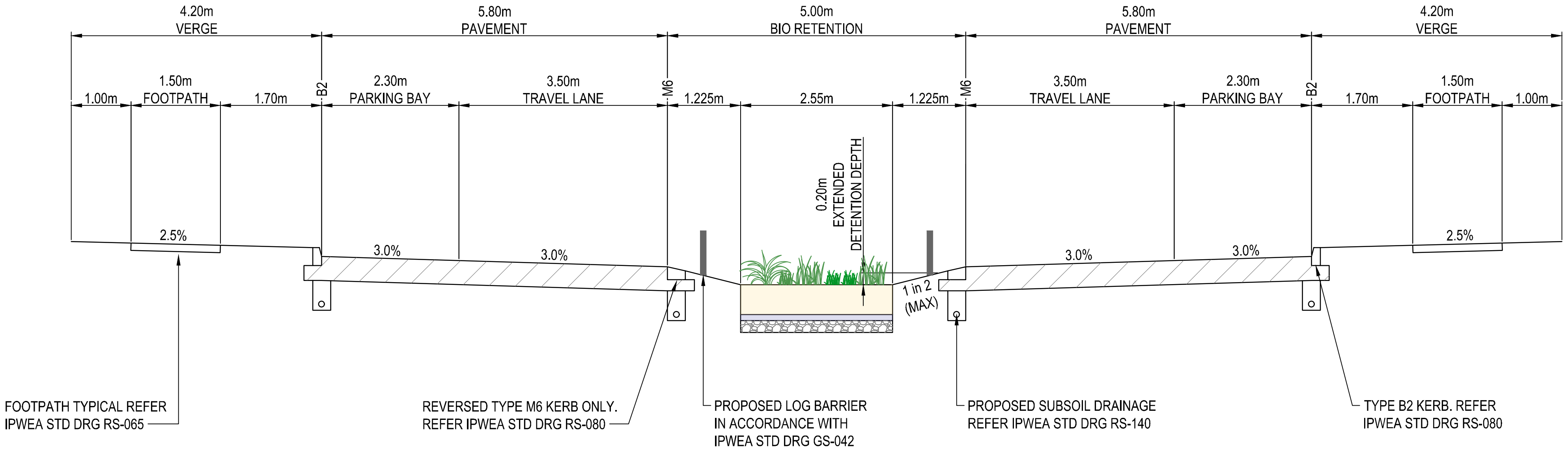
PROJECT

STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE

TYPICAL BIOPOD DETAILS
SHEET 2 OF 2

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA035	A



TYPICAL INVERTED NEIGHBORHOOD CONNECTOR ROAD K
CROSS SECTION

SCALE 1:50 @ A1 | 1:100 @ A3

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	BE	BE	BG		21.12.23	
AMENDMENTS						

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
SCALE 1:50 (A1) SCALE 1:100 (A3)

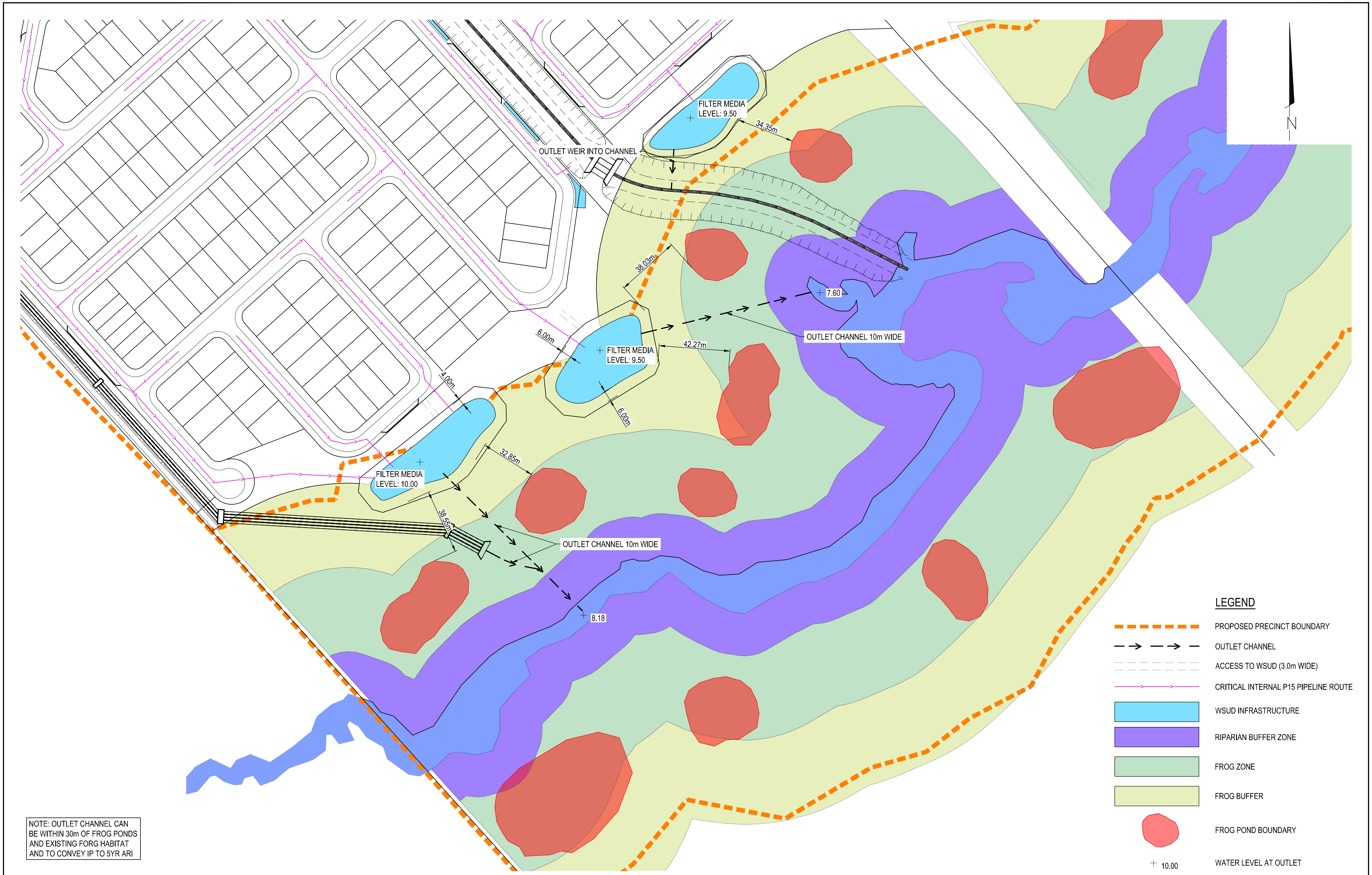
www.egis-group.com

CLIENT
STOCKLAND
DEVELOPMENTS PTY
LTD

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
TYPICAL INVERTED
NEIGHBORHOOD CONNECTOR ROAD K
CROSS SECTION

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA037	-



NOTE: OUTLET CHANNEL CAN
BE WITHIN 30m OF FROG PONDS
AND EXISTING FORG HABITAT
AND TO CONVEY IP TO 5YR ARI

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	BE	BE	BG		21.12.23	
AMENDMENTS						

STATUS

PRELIMINARY

APPROVED

BY: RPEQ NO:

SIGN: DATE:

SCALE

0 10 20 30 40 50 60 70 80

SCALE 1:1000 (A1) SCALE 1:2000 (A3)

www.egis-group.com

CLIENT

STOCKLAND DEVELOPMENTS PTY LTD

PROJECT

STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE

END OF LINE BASIN
CONCEPT DESIGN

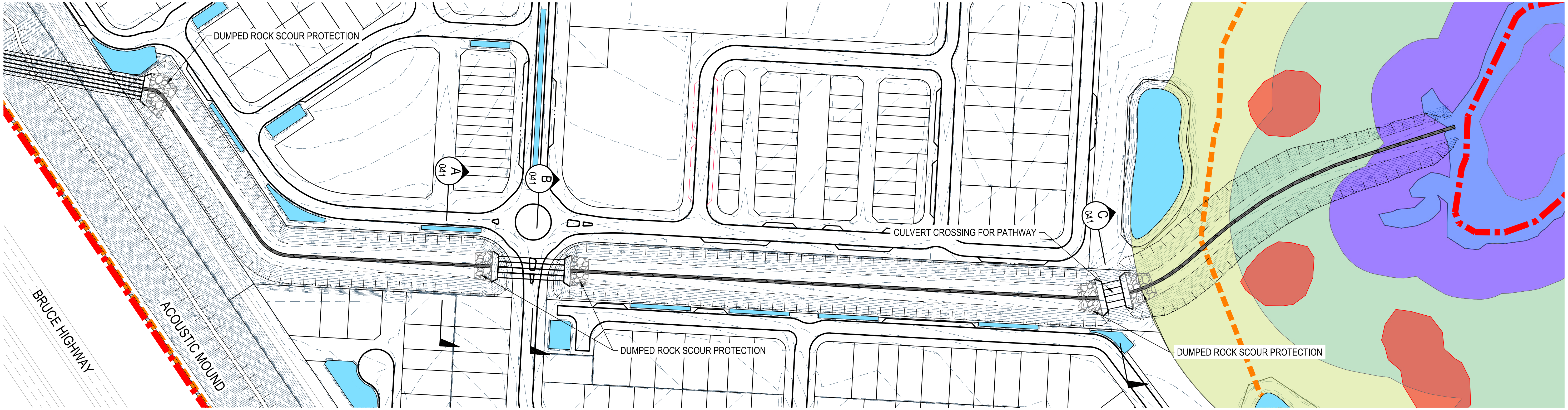
PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA038	-

NOTE

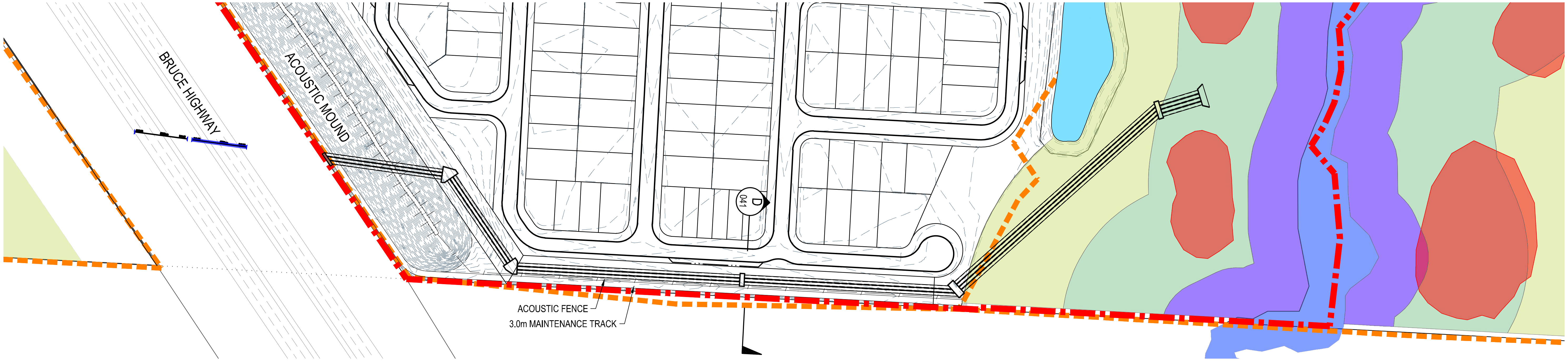
1. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY & TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN.
2. REFER TO EGIS DRAINAGE LAYOUT PLAN 17-000934-3058-DA030.
3. REFER TO EGIS CATCHMENT LAYOUT PLAN 17-000934-3058-DA31.
4. REFER TO EGIS SMP FOR STORMWATER QUALITY MANAGEMENT DETAIL.
5. CONCEPT DESIGN FOR CAMCOS WORKS PRESENTED IS FUTURE (ULTIMATE) , BY OTHERS.

LEGEND

— — 14.00 — —	PROPOSED SURFACE CONTOURS
┬┬┬┬┬┬	PROPOSED BATTERS
🟦	WSUD INFRASTRUCTURE



DRAINAGE SWALE LAYOUT



STORMWATER LINE X LAYOUT

INITIAL ISSUE		DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
		BE	BE	BG		30.08.23	
AMENDMENTS	A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 10 20 30 40 50 60 70 80
SCALE 1:1000 (A1) SCALE 1:2000 (A3)

egis

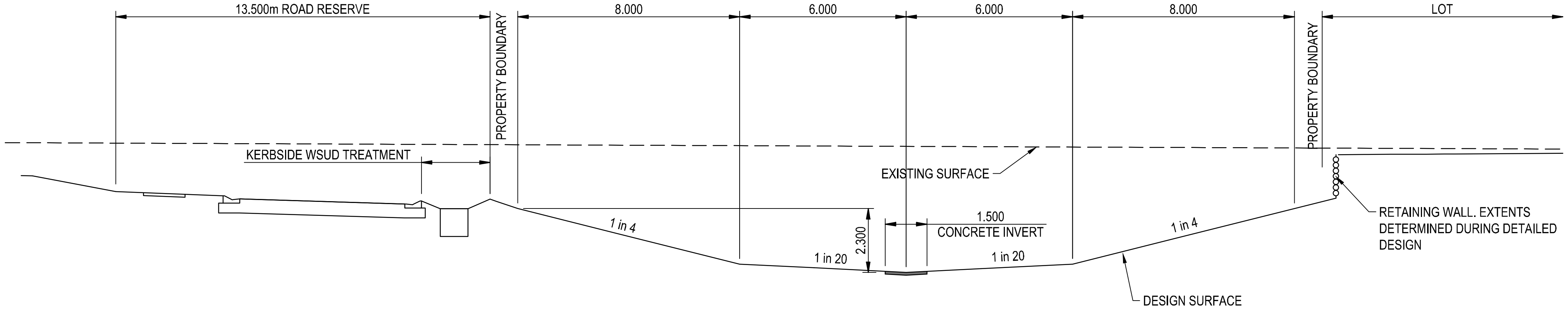
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

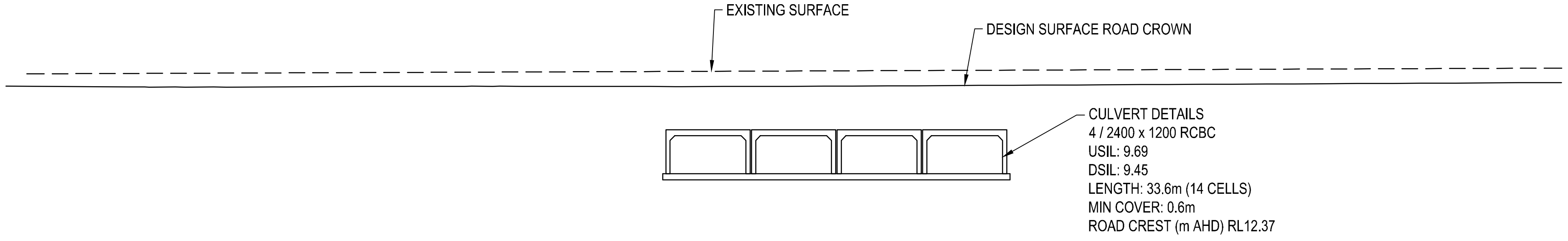
PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
DRAINAGE LAYOUT PLAN

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA040	A

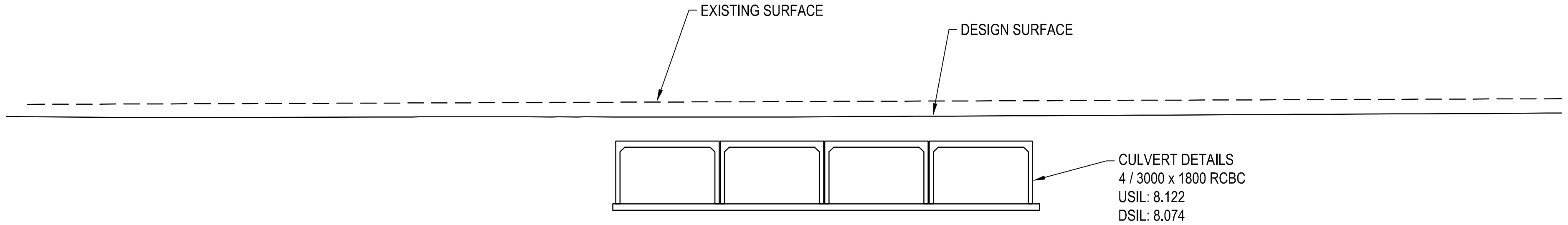


SECTION A/040
SCALE1:100



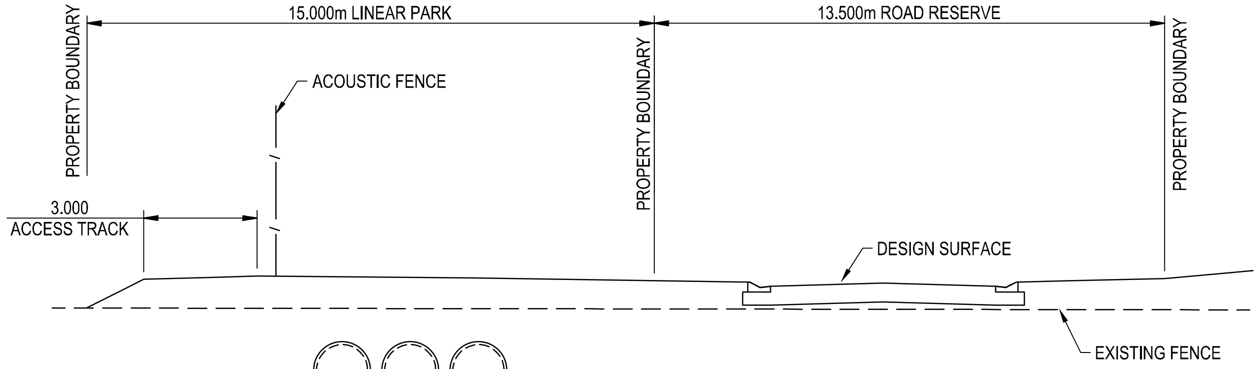
CULVERT DETAILS
4 / 2400 x 1200 RCBC
USIL: 9.69
DSIL: 9.45
LENGTH: 33.6m (14 CELLS)
MIN COVER: 0.6m
ROAD CREST (m AHD) RL12.37

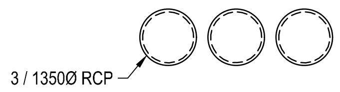
SECTION B/040
SCALE1:100



CULVERT DETAILS
4 / 3000 x 1800 RCBC
USIL: 8.122
DSIL: 8.074
LENGTH: 9.6m (4 CELLS)
MIN COVER: 0.6m
PATH LEVEL (m AHD) RL10.389

SECTION C/040
SCALE1:100





SECTION D/040
SCALE1:100

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	BE	BE	BG		30.08.23	
AMENDMENTS A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

STATUS
PRELIMINARY

APPROVED
BY:
RPEQ NO:
SIGN:
DATE:

SCALE
0 10 20 30 40 50 60 70 80
SCALE 1:1000 (A1)
SCALE 1:2000 (A3)

egis
© 2023 Egis Consulting Pty Ltd
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
DRAINAGE CROSS SECTIONS

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA041	A

KEY INTERSECTION LAYOUT PLAN

SCALE: 1:2500 (A1)
SCALE: 1:5000 (A3)

CONCEPT DESIGN:
1. ALL INFORMATION ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN.
2. REFER TO URBIS MOVEMENT NETWORK PLAN FOR PRECINCT 15 TO CONFIRM FOOTPATH CONFIGURATION.
3. THIS PLAN HAS BEEN SUBMITTED FOR APPROVAL WITH THE RECONFIGURATION OF A LOT - PRECINCT 15 WEST APPLICATION, FOR INFORMATION PURPOSES ONLY.

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BE	BE	BG		21.09.23	
AMENDMENTS						

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 25 50 75 100 125 150 175 200
SCALE 1:2500 (A1) SCALE 1:5000 (A3)

egis

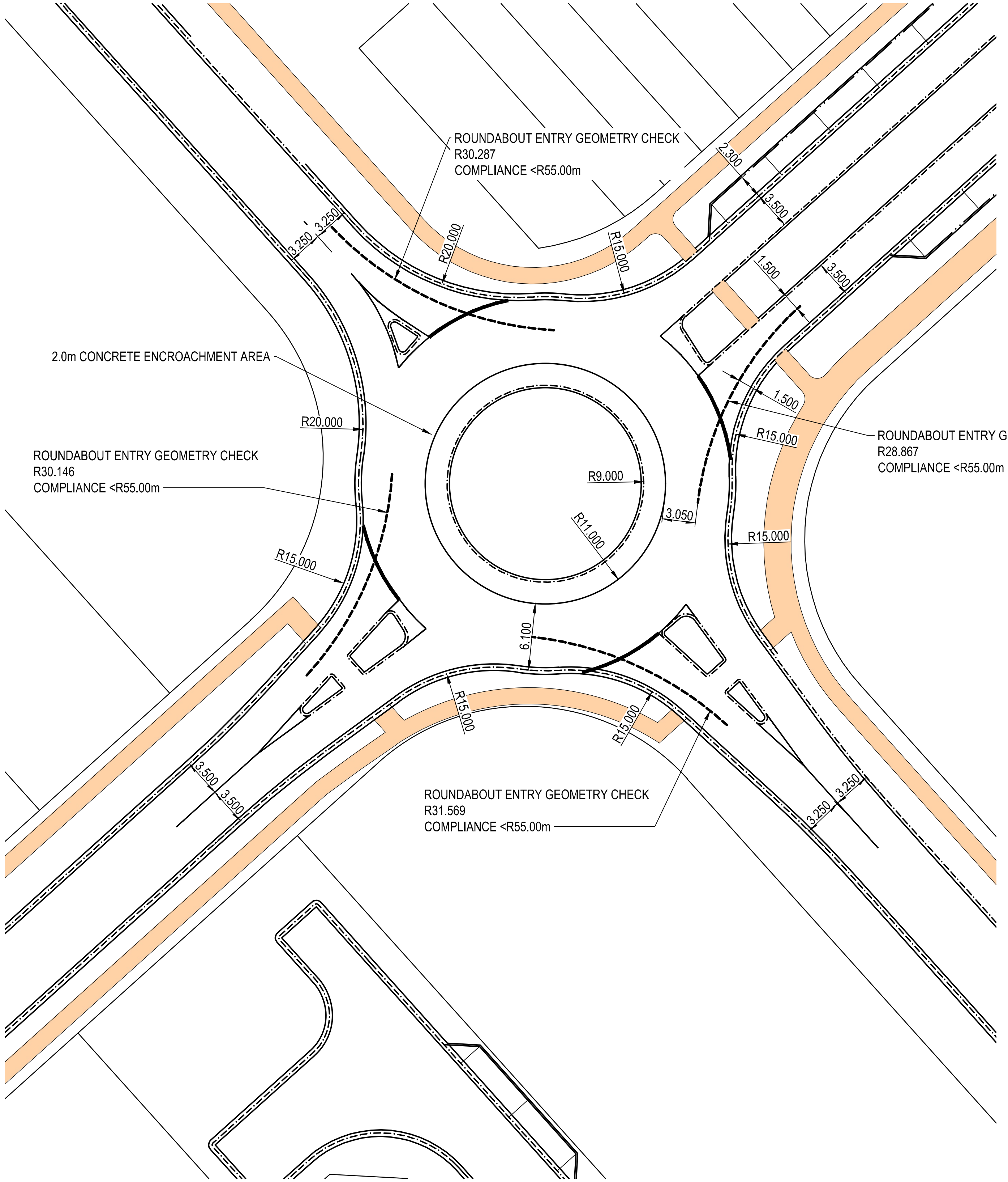
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
INTERSECTION FUNCTIONAL LAYOUT OVERALL PLAN

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA050	-



INTERSECTION 1551 LAYOUT PLAN

SCALE: 1:250 (A1)
SCALE: 1:500 (A3)

N

LEGEND

— — —	PRECINCT BOUNDARY
═══	PROPOSED KERB AND/OR CHANNEL. TYPE TO BE DETERMINED IN DETAILED DESIGN
▭	PROPOSED FOOTPATH

CONCEPT DESIGN:

1. ALL INFORMATION ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN.
2. REFER TO URBIS MOVEMENT NETWORK PLAN FOR PRECINCT 15 TO CONFIRM FOOTPATH CONFIGURATION.
3. THIS PLAN HAS BEEN SUBMITTED FOR APPROVAL WITH THE RECONFIGURATION OF A LOT - PRECINCT 15 WEST APPLICATION, FOR INFORMATION PURPOSES ONLY.

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BE	BE	BG		21.09.23	
AMENDMENTS						

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 2.5 5 7.5 10 12.5 15 17.5 20
SCALE 1:250 (A1) SCALE 1:500 (A3)

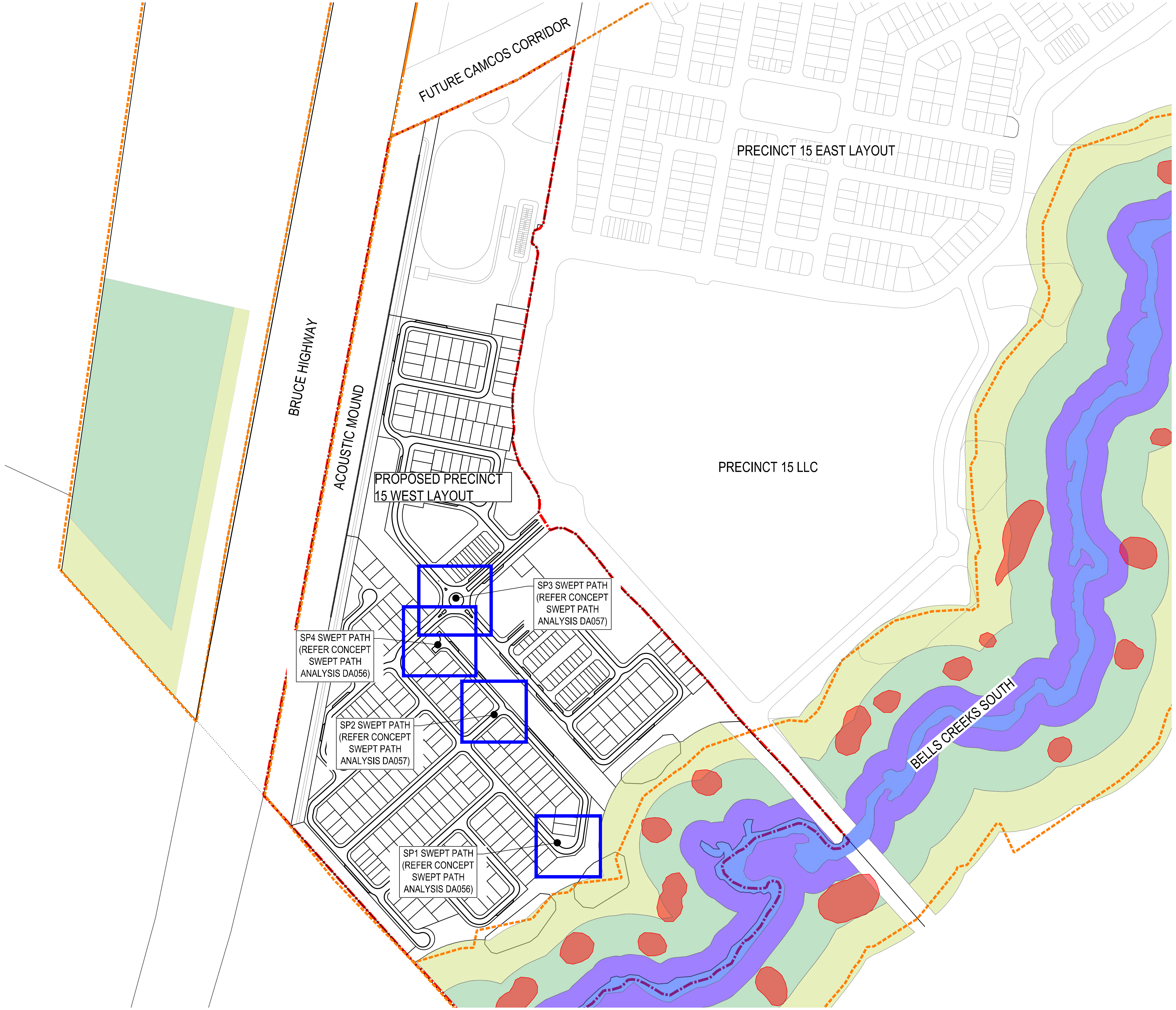
egis
© 2023 Egis Consulting Pty Ltd
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA PRECINCT 15 WEST RECONFIGURATION OF A LOT

DRAWING TITLE
INTERSECTION FUNCTIONAL LAYOUT PLAN

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA051	-



KEY INTERSECTION LAYOUT PLAN

SCALE: 1:5000 (A1)
SCALE: 1:10000 (A3)

CONCEPT DESIGN:

1. ALL INFORMATION ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN
2. WIDENING OF THE LANEWAY CARRIAGEWAY MAY BE REQUIRED AT SOME SIGNIFICANT BENDS IN THE REAR ACCESS LANES, SUBJECT TO DETAILED DESIGN.
3. SOME VEHICULAR CROSSOVERS FROM THE ADJACENT ROAD NETWORK MAY NEED TO BE WIDENED, SUBJECT TO DETAILED DESIGN.

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BE	BE	BG		21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI
B	BG	BG	BG	BG	29.04.24	AMENDED TO SUIT FURTHER ISSUES

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY:
RPEQ NO:
SIGN:
DATE:

SCALE
0 25 50 75 100 125 150 175 200
SCALE 1:2500 (A1) SCALE 1:5000 (A3)

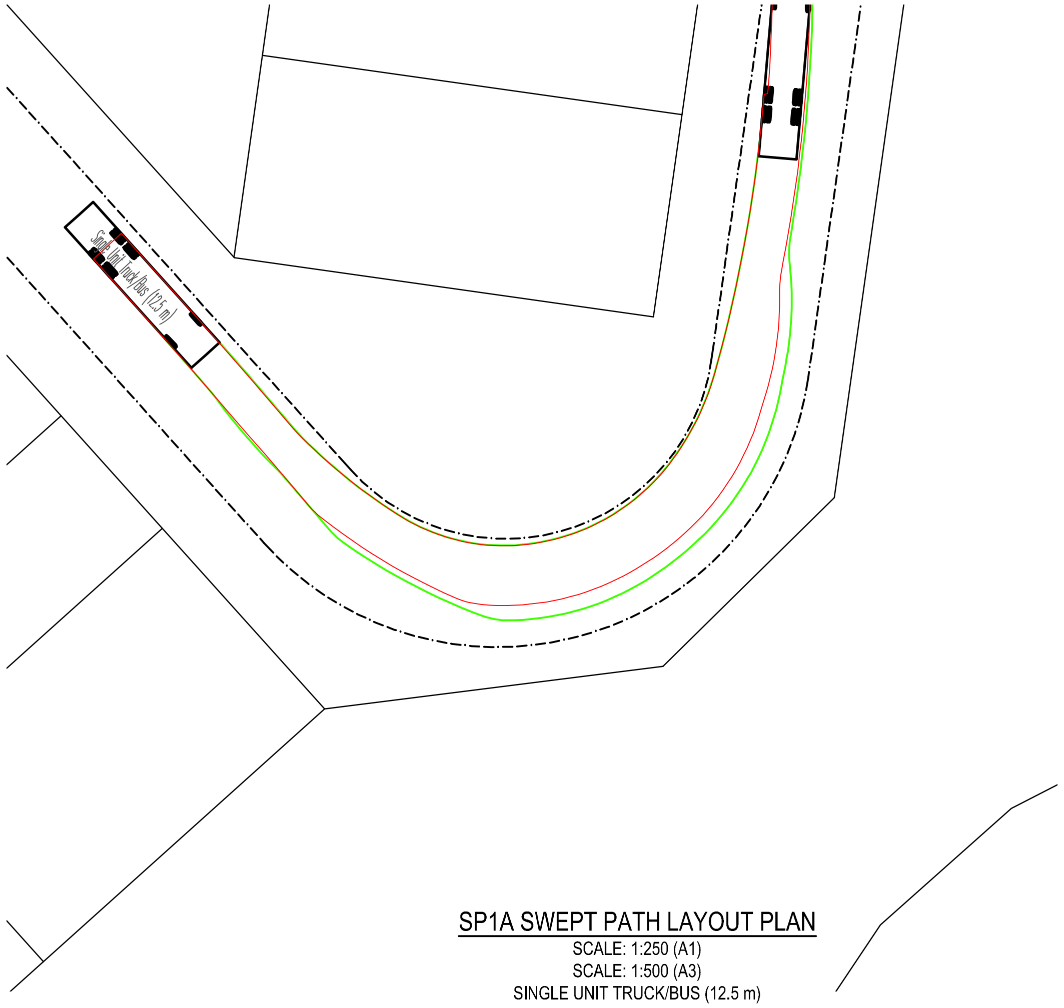
egis
© 2023 Egis Consulting Pty Ltd
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

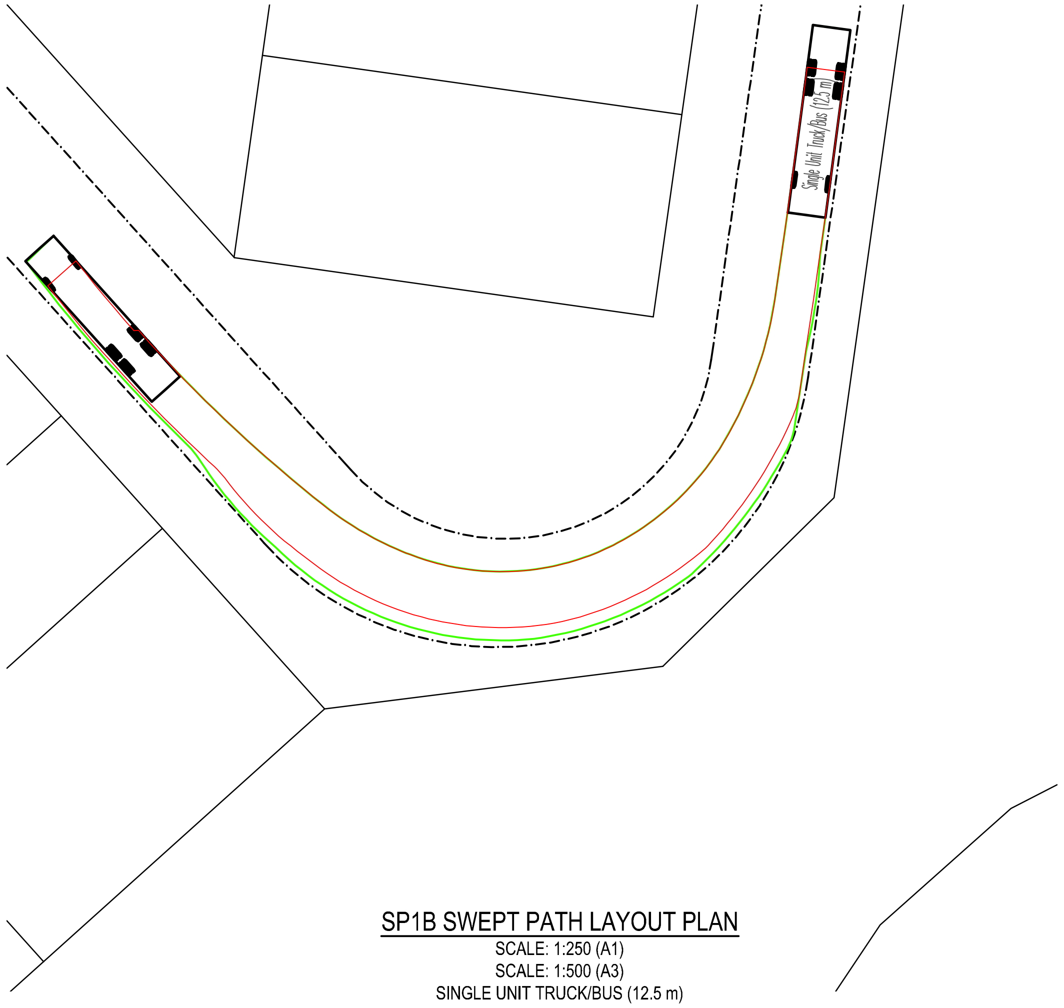
DRAWING TITLE
SWEPT PATH OVERALL LAYOUT

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA055	B



SP1A SWEPT PATH LAYOUT PLAN

SCALE: 1:250 (A1)
SCALE: 1:500 (A3)
SINGLE UNIT TRUCK/BUS (12.5 m)

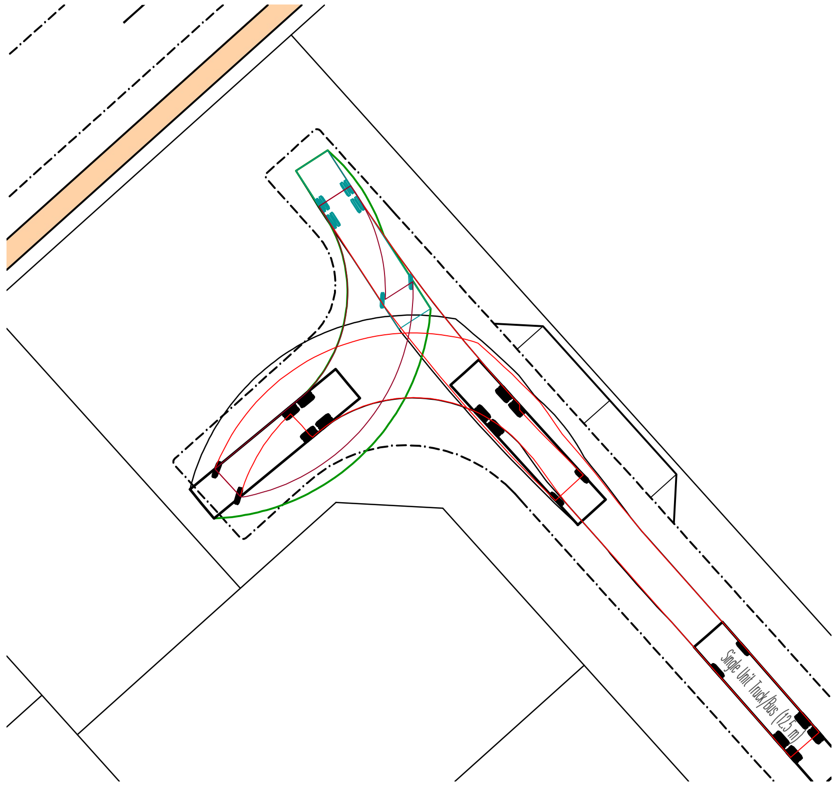


SP1B SWEPT PATH LAYOUT PLAN

SCALE: 1:250 (A1)
SCALE: 1:500 (A3)
SINGLE UNIT TRUCK/BUS (12.5 m)

LEGEND

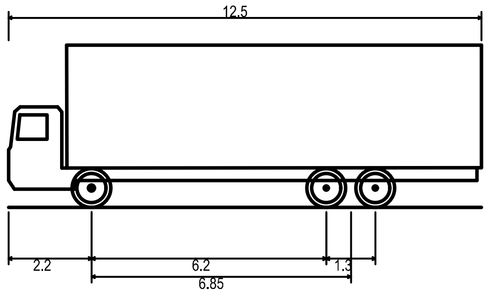
— — —	PRECINCT BOUNDARY
— - — - —	PROPOSED KERB AND/OR CHANNEL. TYPE TO BE DETERMINED IN DETAILED DESIGN



SP4 SWEPT PATH LAYOUT PLAN

SCALE: 1:250 (A1)
SCALE: 1:500 (A3)
SINGLE UNIT TRUCK/BUS (12.5 m)

CONCEPTUAL DESIGN ONLY REFER TO
3058-DA055 FOR KEY PLAN & NOTES.



Single Unit Truck/Bus (12.5 m)	
Overall Length	12.500m
Overall Width	2.500m
Overall Body Height	4.300m
Min Body Ground Clearance	0.490m
Track Width	2.500m
Lock to lock time	6.00s
Kerb to Kerb Turning Radius	12.500m

INITIAL ISSUE		DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
		BE	BE	BG		21.09.23	
AMENDMENTS	A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI
	B	BG	BG	BG	BG	29.04.24	AMENDED TO SUIT FURTHER ISSUES

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 2.5 5 7.5 10 12.5 15 17.5 20
SCALE 1:250 (A1) SCALE 1:500 (A3)

egis

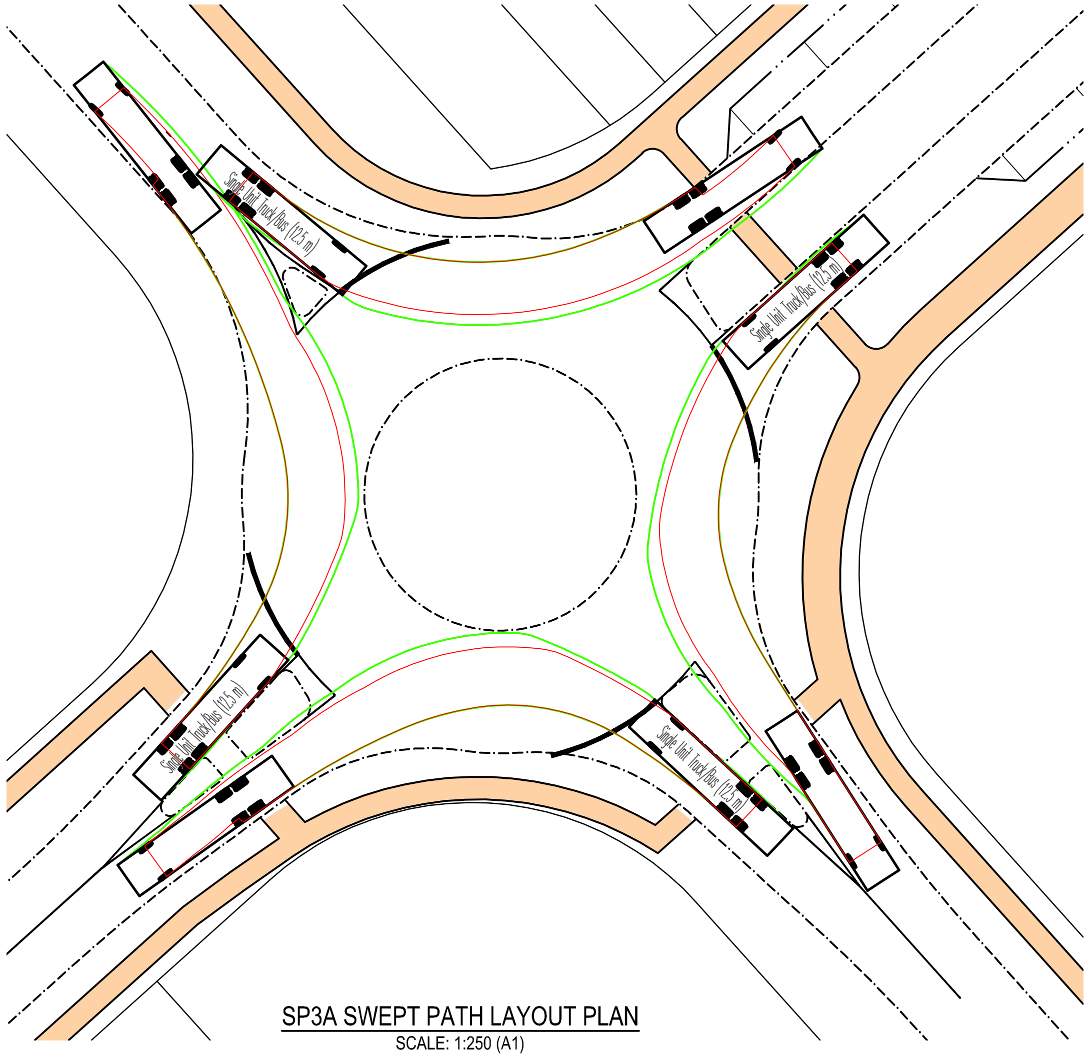
www.egis-group.com

CLIENT
STOCKLAND
DEVELOPMENTS PTY
LTD
Stockland AURA

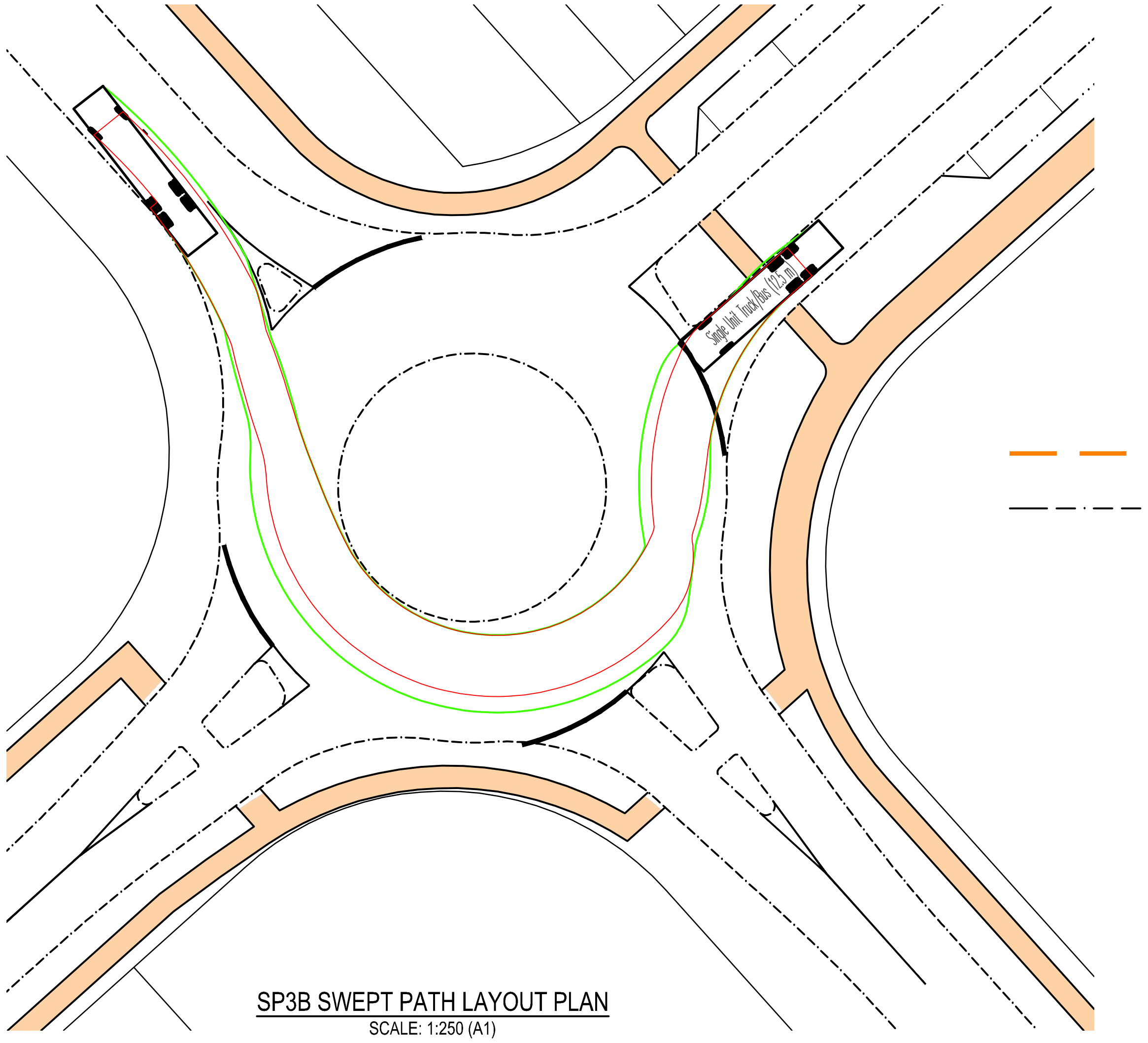
PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
SWEPT PATH ANALYSIS
SHEET 1 OF 2

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA056	B



SP3A SWEPT PATH LAYOUT PLAN
SCALE: 1:250 (A1)
SCALE: 1:500 (A3)
SINGLE UNIT TRUCK/BUS (12.5 m)

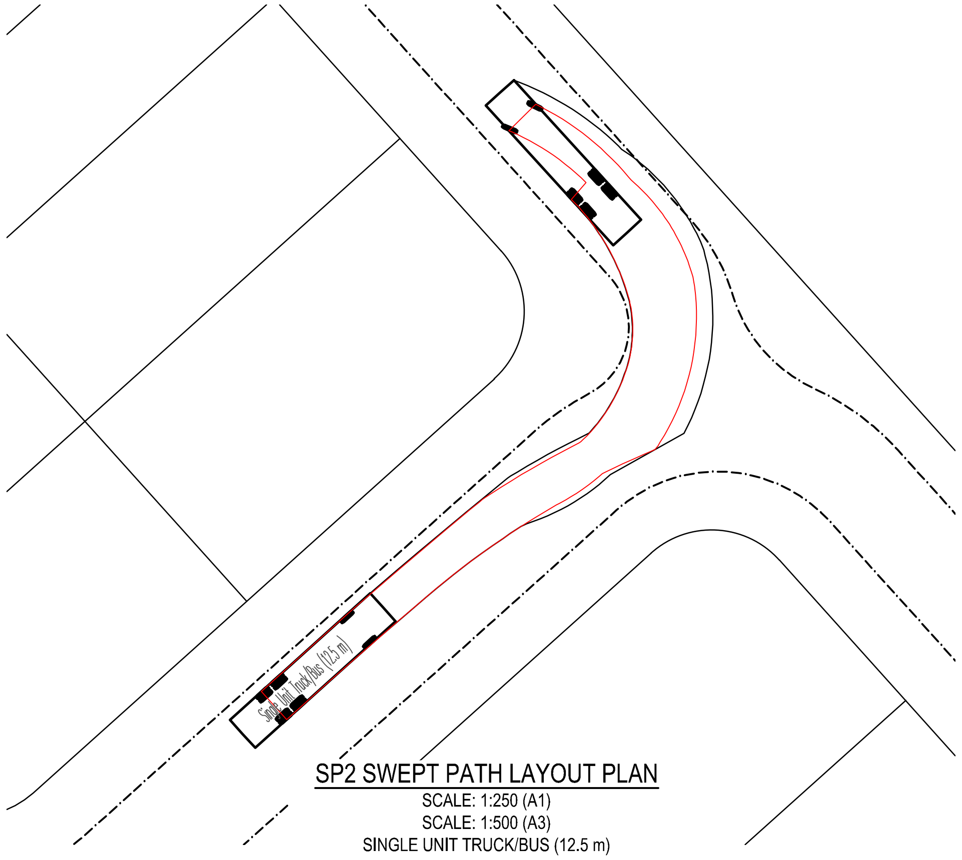


SP3B SWEPT PATH LAYOUT PLAN
SCALE: 1:250 (A1)
SCALE: 1:500 (A3)
SINGLE UNIT TRUCK/BUS (12.5 m)

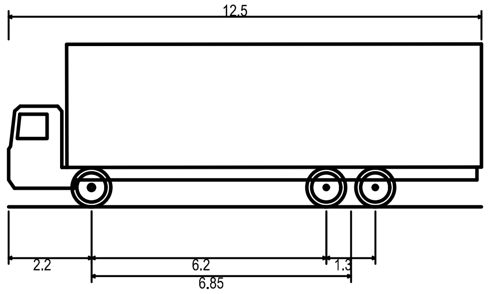
CONCEPTUAL DESIGN ONLY REFER TO 3058-DA055 FOR KEY PLAN & NOTES.

LEGEND

— — —	PRECINCT BOUNDARY
— — · — — ·	PROPOSED KERB AND/OR CHANNEL. TYPE TO BE DETERMINED IN DETAILED DESIGN



SP2 SWEPT PATH LAYOUT PLAN
SCALE: 1:250 (A1)
SCALE: 1:500 (A3)
SINGLE UNIT TRUCK/BUS (12.5 m)



Single Unit Truck/Bus (12.5 m)

Overall Length	12.500m
Overall Width	2.500m
Overall Body Height	4.300m
Min Body Ground Clearance	0.490m
Track Width	2.500m
Lock to lock time	6.00s
Kerb to Kerb Turning Radius	12.500m

		DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE		BE	BE	BG		21.09.23	
AMENDMENTS	A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI
	B	BG	BG	BG	BG	29.04.24	AMENDED TO SUIT FURTHER ISSUES

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 2.5 5 7.5 10 12.5 15 17.5 20
SCALE 1:250 (A1) SCALE 1:500 (A3)

egis

www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
SWEPT PATH ANALYSIS
SHEET 2 OF 2

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA057	B

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	AT	AT	BG		19.12.23	

AMENDMENTS

STATUS

PRELIMINARY

APPROVED

BY: RPEQ NO:

SIGN: DATE:

SCALE

0 10 20 30 40 50 60 70 80

SCALE 1:1000 (A1) SCALE 1:2000 (A3)

egis

www.egis-group.com

CLIENT

STOCKLAND DEVELOPMENTS PTY LTD

Stockland AURA

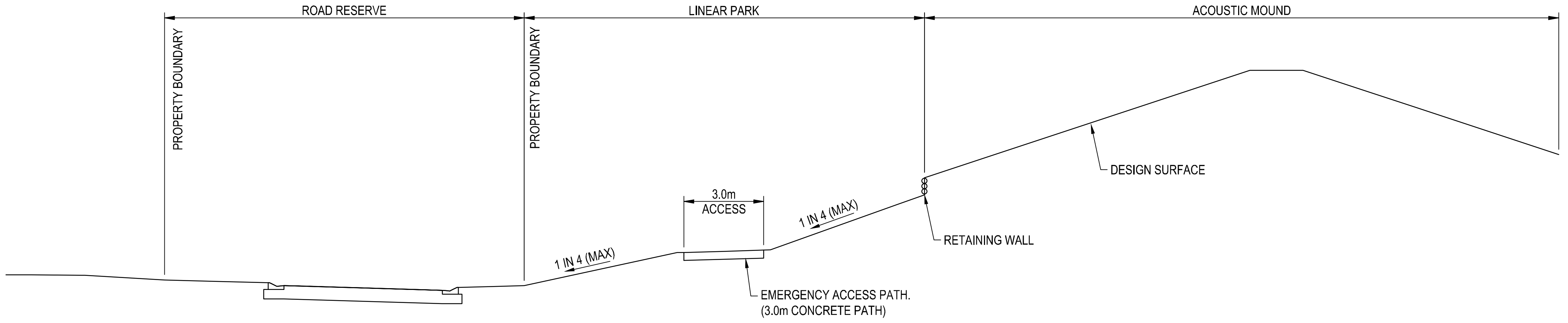
PROJECT

STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

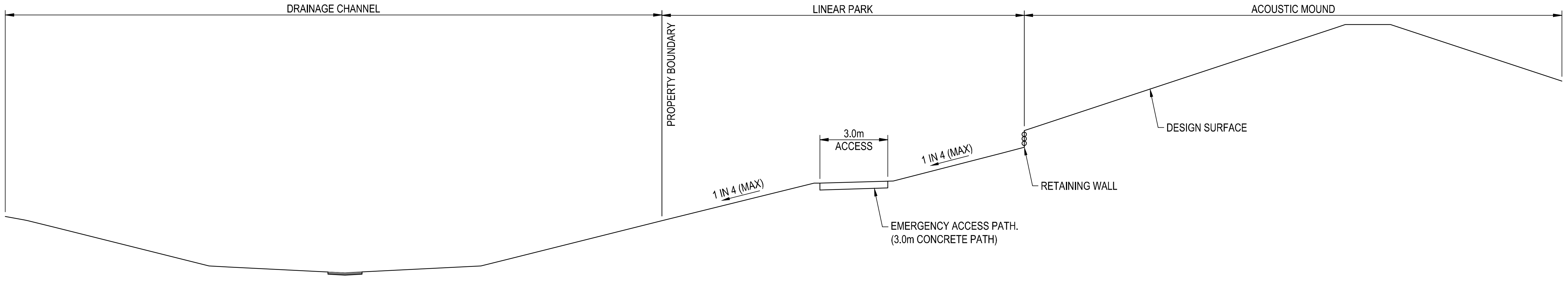
DRAWING TITLE

EMERGENCY ACCESS LAYOUT PLAN

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA058	-



SECTION A/058
SCALE1:100



SECTION B/058
SCALE1:100

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	AT	AT	BG		19.12.23	
AMENDMENTS						

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE

www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
EMERGENCY ACCESS SECTIONS

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA059	-

KEY INTERSECTION LAYOUT PLAN

SCALE: 1:5000 (A1)
SCALE: 1:10000 (A3)

NOTE

1. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY & INTENDED FOR DISCUSSION PURPOSES. WASTEWATER & WATER RETICULATION ALIGNMENTS ARE TO BE CONFIRMED WITH UNITYWATER THROUGH A PRECINCT NETWORK PLAN APPROVAL.
2. SIZING OF RETICULATION WATERMAIN IS TO BE VERIFIED THROUGH NETWORK MODELING AND TO BE APPROVED BY UNITYWATER THROUGH A PRECINCT NETWORK PLAN APPROVAL.

LEGEND

– – –	PRECINCT BOUNDARY
— · —	APPLICATION EXTENT P15 EAST
—W—W—	WATER RETICULATION
—WT—WT—	TRUNK WATER
🟦	WSUD INFRASTRUCTURE
🟪	RIPARIAN BUFFER ZONE
🟩	FROG ZONE
🟨	FROG BUFFER

		DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE		BE	BE	BG		21.09.23	
AMENDMENTS	A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 25 50 75 100 125 150 175 200
SCALE 1:2500 (A1) SCALE 1:5000 (A3)

egis

www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
CONCEPTUAL WATER RETICULATION PLAN

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA060	A

NOTE

1. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY & INTENDED FOR DISCUSSION PURPOSES. WASTEWATER & WATER RETICULATION ALIGNMENTS ARE TO BE CONFIRMED WITH UNITYWATER THROUGH A PRECINCT NETWORK PLAN APPROVAL.
2. SIZING OF RETICULATION WASTEWATER IS TO BE VERIFIED THROUGH NETWORK MODELING AND TO BE APPROVED BY UNITYWATER THROUGH A PRECINCT NETWORK PLAN APPROVAL.

LEGEND

- - -	PRECINCT BOUNDARY
-·-·-	APPLICATION EXTENT P15 EAST
—	SEWER DN160 RETICULATION
—ST—ST—	EXISTING TRUNK WATER
■	WSUD INFRASTRUCTURE
■	RIPARIAN BUFFER ZONE
🟩	FROG ZONE
■	FROG BUFFER

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	BE	BE	BG		21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY:
RPEQ NO:
SIGN:
DATE:

SCALE
0 25 50 75 100 125 150 175 200
SCALE 1:2500 (A1)
SCALE 1:5000 (A3)

egis

www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland
AURA

PROJECT
STOCKLAND - AURA
PRECINCT 15 WEST
RECONFIGURATION OF A LOT

DRAWING TITLE
CONCEPTUAL SEWER RETICULATION PLAN

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-DA070	A

APPENDIX F:
STATE CONTROLLED INFRASTRUCTURE INTERFACE REPORT FOR PRECINCT 15 WEST BY EGIS

21-000307.3058

STATE CONTROLLED INFRASTRUCTURE INTERFACE REPORT

AURA PRECINCT 15 'WEST'

Prepared for **Stockland Development Pty Ltd**

Document information

GENERAL INFORMATION

Author(s)	Ben Gear
Version	2
Path/file name	\\sunnas01\H:\17\000934 - Aura P7 - 10\000934 AURA\3000 Other Works\3058 - Precinct 15\2_Docs\Reports\Engineering Services Report\P15 West\21-000307.3058.STIR01
Prepared by (author)	Ben Gear
Reviewed by	Stockland
Approved by	Ben Gear
Security classification	Commercial-in-Confidence

HISTORY OF CHANGES

Version	Date	Checked by
0	30/08/2023	Stockland
1	21/12/2023	Ben Gear
2	23/07/2024	Ben Gear

Version	Date	Approved by
0	25/09/2023	Ben Gear
1	21/12/2023	Ben Gear
2	23/07/2024	Ben Gear

TABLE OF CONTENTS

1 INTRODUCTION 4

1.1 Existing Planning and Approvals 4

1.2 Amendments to Engineering Services Report – Revision 1.....................4

1.3 Amendments to Engineering Services Report – Revision 2.....................5

2 THE BRUCE HIGHWAY INTERFACE 6

2.1 Bruce Highway Noise Attenuation...6

3 BRUCE HIGHWAY STORMWATER MANAGEMENT 8

3.1 Existing Conditions...8

3.2 Post Development 9

4 CAMCOS RAIL CORRIDOR...10

4.1 CAMCOS Details...10

APPENDIX A: ENGINEERING DRAWINGS BY EGIS 11

APPENDIX B: STORMWATER MANAGEMENT PLAN BY EGIS 12

TABLE OF FIGURES

Figure 1: Extract from the State Transport Infrastructure Agreement September (STIA – 2015) 6

Figure 2: Pre-development catchment areas 9

1 INTRODUCTION

Egis has prepared this State Controlled Infrastructure Interface Report to accompany the submission of a PDA Development Application for Reconfiguring a Lot, Material Change of Use and Operational Works (Advertising Devices) over a portion of the greater Aura site known as Aura Precinct 15 'West'.

The application proposes to subdivide the site (approximately 33ha) into various land uses as defined in the proposed development layout. Refer to Attachment A for the proposed application extents and lot layout.

Egis have prepared the concept civil engineering design for the Subdivision. Civil Engineering Aspects focussed on Bulk earthworks, Road Design, Servicing (Water and Wastewater) and Stormwater Drainage. The civil engineering design has many interfaces with the State Controlled Infrastructure. Urban Design, Land uses, Regional Flooding and Acoustic Reporting are covered by other consultants.

Egis's concept design has been developed in accordance with a number of Approvals, Planning Documents, Investigations and Studies, for further details refer to Egis Engineering Services Report 21-000307.3058.ESR02, dated August 2023. Critical to the interface with the State Controlled infrastructure is the Caloundra South Priority Development Area Infrastructure Agreement – State Transport Infrastructure (STIA, 2015).

1.1 Existing Planning and Approvals

Egis's concept design has been developed in accordance with a number of Approvals, Planning Documents, Investigations and Studies.

These documents include but are not limited to:

- Caloundra South Priority Development Area Infrastructure Agreement – State Transport Infrastructure (STIA, 2015);
- Caloundra South Development: Flood Risk Management Strategy (BMT WBM, 2015);
- Caloundra South Water Quality Management Plan (BMT, May 2017);
- Environmental Management Plan (BMT, August 2017);
- Ultimate Caloundra South Traffic Model (MWH, 2015);
- Construction Environment Management Plan (Egis, Oct 2017);
- Wallum Sedge Frog Management Plan (Stockland, 2017);
- Operational work for Waterway barrier works Preliminary Approval and Development Permit (partial only), subject to conditions (SARA, 2018);
- Additional Geotechnical Investigation, Aura Precincts 6-16 (Douglas Partners, August 2017);
- State Controlled Infrastructure Interface Report for Aura Precincts 11 (Part), 12 (Part), 13 (Part) and 14 (reference 17-000934.3015TMRR01.AM.Rl (Egis Consulting, July 2020); and
- Aura Precinct 15 'East' Engineering Services Report (Egis Consulting, March 2022).

1.2 Amendments to Engineering Services Report – Revision 1

Amendments have been made to the State Controlled Infrastructure Interface Report, Revision 1, in response to the Further Issues Letter dated 20 November in relation to Development Approval DEV2023/1445.

Changes to the report are summarised below:

- Figures updated and Appendices to reflect revised layout.

1.3 Amendments to Engineering Services Report – Revision 2

Amendments have been made to the State Controlled Infrastructure Interface Report, Revision 2, following the revised acoustic modelling undertaken by Trinity Consulting.

Changes to the report are summarised below:

- Appendices amended to reflect revised acoustic modelling requirements.

2 THE BRUCE HIGHWAY INTERFACE

The development presents an approximate 900m interface along the State Controlled Road - Bruce Highway. The indicative State Controlled Road (SRC) Chainages along the proposed Bruce Highway interface are detailed in Calibre State Controlled Infrastructure Interface Report, Reference 17-000934.3015TMRR01.AMP.RI dated July 2020, drawing 17000934.3015-SK101 and as follows in Table below:

TABLE 1: DEVELOPMENT ATTRIBUTE LOCATION VS SCR CHAINAGE

SCR CHAINAGE (INDICATIVE) – BRUCE HIGHWAY	DEVELOPMENT ATTRIBUTE
50,960	Existing Interchange at Roys Road. (External to the forthcoming Development Application area)
52310	Aura Precinct 15 (Southern Development Application Boundary)
53,160	CAMCOS Corridor Centreline intersecting with the Bruce Highway. (Northern Development Application Boundary)

The typical cross section detailing the proposed duplication (additional north and south bound lanes) of the Bruce Highway has been extracted (below) from the State Transport Infrastructure Agreement. TMR's proposed intention for duplication of the highway is acknowledged with the interface strategies described below.

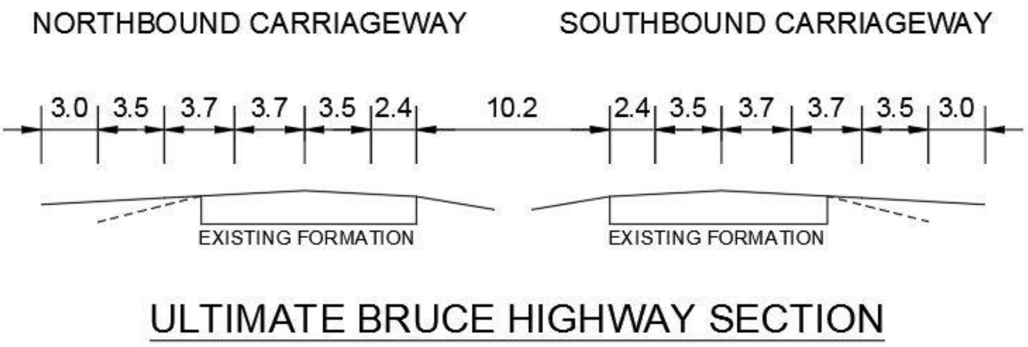


FIGURE 1: EXTRACT FROM THE STATE TRANSPORT INFRASTRUCTURE AGREEMENT SEPTEMBER (STIA – 2015)

At this stage the detailed design of the Bruce Highway Duplication has not occurred. However, during the design process for Aura Precinct 11 – 14 TMR have provided design stings for the duplication. Sections of the Bruce Highway interface are indicated on attached drawings 21-000307.3058-STI-DA04 and 21-000307.3058-STI-DA05.

2.1 Bruce Highway Noise Attenuation

The existing master planning approval for Aura calls for the integration of acoustic attenuation along the development's common boundary with the Bruce Highway. Detail of the proposed acoustic treatment along the State Controlled Road common boundary has been developed with reference to the Bruce Highway Buffer Assessment – Noise and Vibration Impact Assessment (ASK Nov 2013) and Aura Development – Precinct 15 (West) Road Traffic Noise Assessment (Trinity, 2023) The proposed acoustic earth mound extends along the common boundary before transitioning into a Acoustic Fence along the boundary between Stockland and Forestry property.

The attenuation is detailed in the attached drawings 21-000307.3058-STI-DA02 to 21-000307.3058-STI-DA05 in Appendix A. This development application proposes to satisfy this requirement for acoustic attenuation with the following strategy:

TABLE 2: ACOUSTIC TREATMENT EXTENTS

SCR Chainage – Bruce Highway	Acoustic Treatment
52,160	Southern end of proposed acoustic fence
52,350	Transition from acoustic fence to acoustic earth mound
53,160	Northern end of proposed acoustic earth mound.

The proposed longitudinal acoustic earth mound section will range to be between 4m – 6m above the Bruce Highway carriageway along Aura's western boundary to achieve required noise attenuation. The earth mound has been designed to fit within the 40m land contribution corridor specified by the STIA and Master Plan. The earth mound is also adjacent to a planned linear park that will adopt surface grades in accordance with the LGIA. It is intended that a combination of earth mound and dense landscape buffer will be constructed to best integrate with the natural topography and provide a vegetation strip to soften the view and provide screening from the highway.

The section of proposed acoustic fence will range to be between 6m – 4m above the existing ground level to achieve the required noise attenuation. The acoustic fence is proposed to sit within a planned linear park, dense landscaping will be constructed to best integrate with to the surrounding development.

3 BRUCE HIGHWAY STORMWATER MANAGEMENT

3.1 Existing Conditions

Aura's total development footprint is located over an area which was formally used as a pine forest plantation that has since been cleared and is currently used for cattle grazing. The area is gently undulating with the ground surface overall falling from west to east. Due to former forestry plantation use, the existing surface contains localised deep rutting with a number of tracks and rough formed roads. The area is covered with grasses, small shrubbery and, in isolated areas, mature pine trees.

Drawing 21-000307.3058-STI-DA01, accompanying this report, provides details of the existing stormwater discharge points across the site.

Adjacent to Precinct 15, subject to the PDA Development Application, there are two (2) existing culvert structures under the highway. These 2 culvert structures will be reported on in the subsequent section of this report to demonstrate no adverse flood impact (no worsening) on the Bruce Highway Infrastructure due to the works associated with Precinct 15 PDA Development Application.

Adjacent to Precinct 11 – 14 , but not within the Application Extent is another four (4) culvert crossing of the highway. These 4 culvert structures are reported on in the approved Technical Memorandum titled *"Aura Western Detention Basin (South) and Acoustic Bund Drainage Diversion Technical Memorandum"* prepared by Calibre dated 26 October 2022.

The two catchments that impact the development application extent (refer Figure 2), total 415ha and discharge through to Bells Creek South. The overall stormwater strategy will be indicated for works in Precinct 15, but no specific details will be presented and are external to this report. Further south of the Stockland Property there is another drainage crossing at Bells Creek South. Refer to 21-000307.3058-STI-DA01 regarding the culvert locations. For details of regional flooding at Bells Creek South refer to BMT flood report 2020.

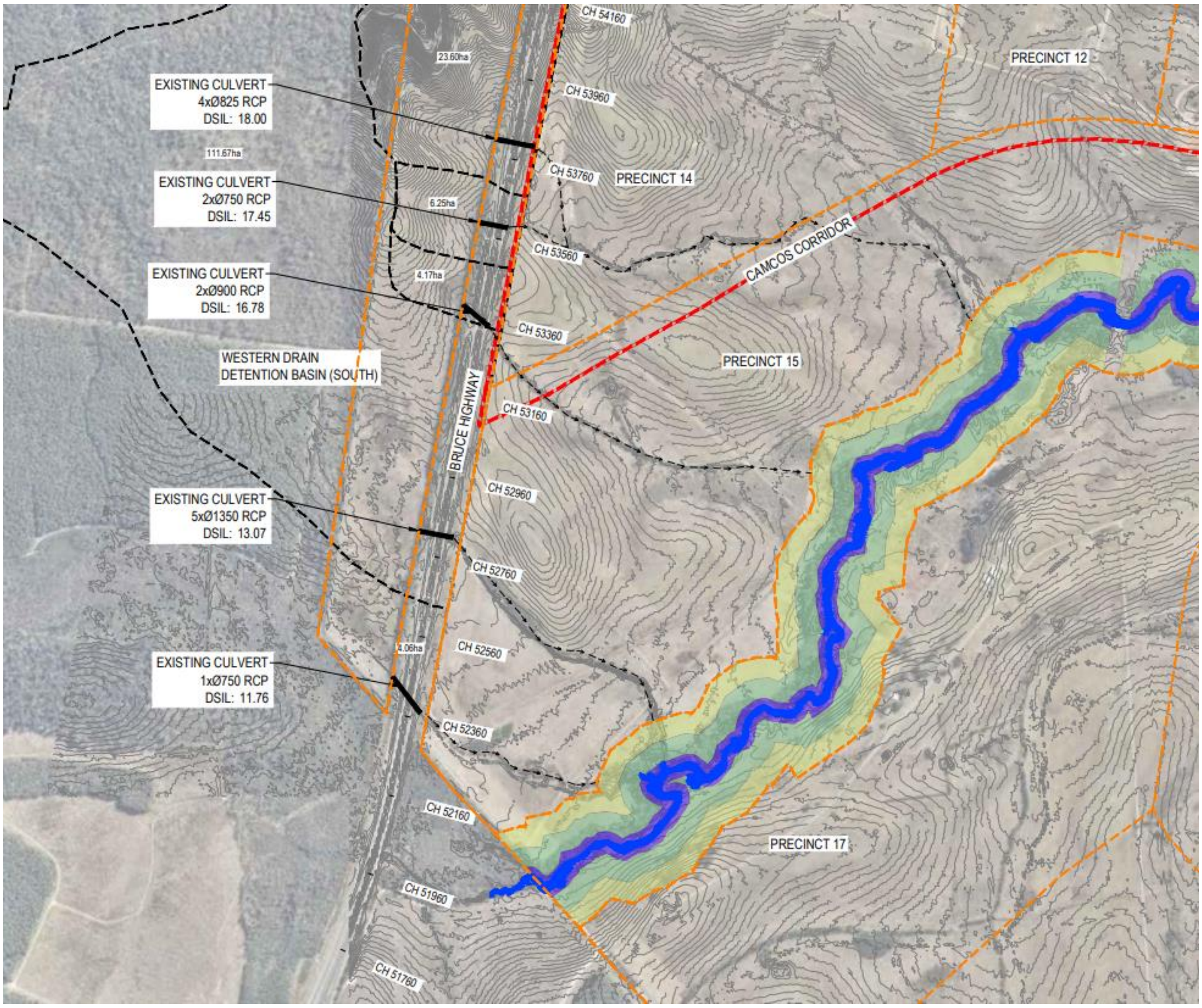


FIGURE 2: PRE-DEVELOPMENT CATCHMENT AREAS

3.2 Post Development

3.2.1 Completed Development Works

Development works within Precinct 11 – 14 are currently under construction, the mitigation measures required to ensure a non-worsening on the State Controlled Infrastructure was initial documented with the approved report titled "*State Controlled Infrastructure Interface Report – Aura Precinct 11 (Part), 12 (Part), 13 (Part) and 14*" prepared by Calibre dated 23 July 2020 and then further expanded as part of the Operational Works Approval process with Sunshine Coast Council and DTMR as a referral agency undertaken during 2022 and 2023. The operational works approved documents are listed below:

- Engineering Design Drawings 3049-SK100 to 3049-SK118 (OPW21/0738 Sunshine Coast Council)
- Aura Western Detention Basin (South) and Acoustic Bund Drainage Diversion Technical Memorandum" prepared by Calibre dated 14 March 2022 (2201/26769 SRA)

These works documented and approved above have been constructed excluding from all reporting. For information the western detention basin (south) is designed to safely capture and detain flows from the proposed diversion channel and subsequently discharge to a fourth TMR road culvert located at Bruce Highway Chainage 52,760. The southern detention basin has been sized to mitigate the increases in peak flows reporting to this TMR culvert for all standard AEP design storms up to and including the 1% AEP 2100CC event.

3.2.2 Development Works

The stormwater management strategy to ensure non-worsening conditions on State Controlled Infrastructure for works is documented in Aura Precinct 15 West Acoustic Bund (South) Drainage Design prepared by Egis dated September 2023 and contained within Appendix B.

The existing overland flow paths currently conveying the flow from the two TMR culverts W and X, will be captured by an inlet pit and conveyed under the acoustic mound via a pipe network. The systems are inlet controlled and as such have been designed to ensure non-worsening conditions are achieved for all standard AEP design storms up to and including the 1% AEP 2100CC event.

4 CAMCOS RAIL CORRIDOR

Calibre prepared an CAMCOS Corridor Alignment Study in 2015 (Reference 15-002608CER01C) that investigated the proposed Caboolture to Maroochydore railway line (CAMCOS) against adjacent land uses and transport and planning principles.

The study was commissioned to review the proposed design with consideration to the planning and environment requirements and refine the alignment for effective integration with Aura. The identified horizontal and vertical alignments from the study were designed to maximise potential patronage, respect topography and reduce environmental impact.

Ultimately Queensland Rail will construct and deliver the CAMCOS rail line, however it is integral to the development application that the proposed planning for rail geometry and vehicle/pedestrian underpasses be considered in full to ensure a best practice master planned outcome.

The proposed preliminary design of the CAMCOS rail alignment is specifically in accordance with the 2015 report. The typical rail cross section and embankment grades have been applied in accordance with Calibre's previous 2015 report. Appropriate acoustic treatment will be constructed within the CAMCOS corridor in accordance with acoustic modelling and Queensland Rail standards, by others.

4.1 CAMCOS Details

4.1.1 Concept Design – Ultimate Scenario

The northern edge of the development application bounds the southern boundary of the CAMCOS, earthworks grading has been undertaken to ensure complaint grades are achieved. Egis has prepared a concept design based on the 2015 alignment study. Egis Plan 21-000307.3058-STI-DA06 indicates the concept design of the CAMCOS corridor.

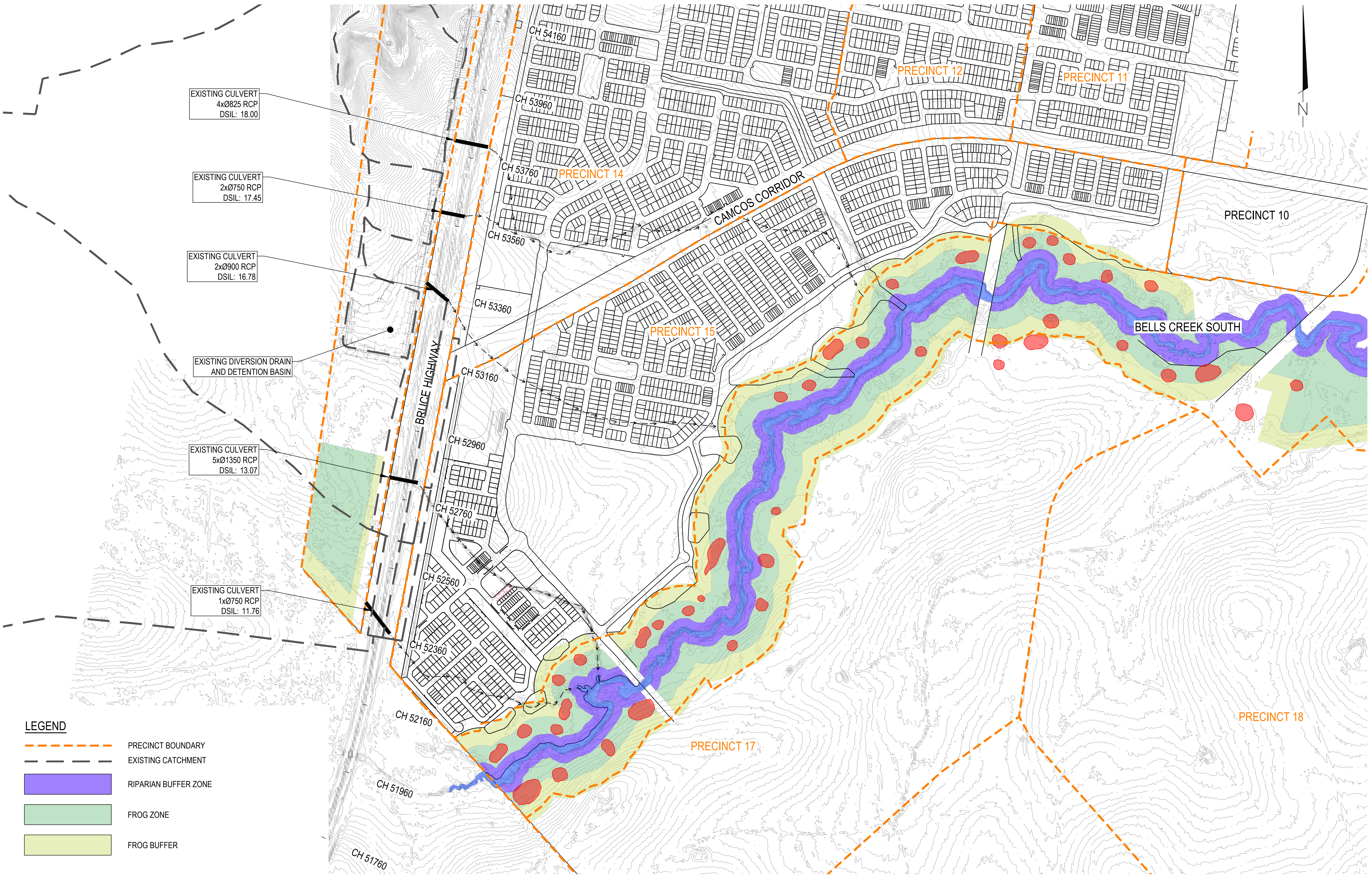
As noted on the Sketch Plans:

- All information presented on this drawing is conceptual only and to be confirmed in subsequent detailed design.
- Concept design presented is future (ultimate) CAMCOS works, by others.
- Interim works cover below rail bulk earthworks only.
- Any acoustic barriers for treatment of noise impacts from the CAMCOS corridor must be located wholly within the CAMCOS corridor and be the responsibility of DTMR.

The CAMCOS corridor is typically 40m wide, however the section adjust the development application has been widened for the railway overpass of the Bruce Highway and the roadway underpass C2.

Further details external the development application extent regarding the CAMCOS are documented with the approved report titled "*State Controlled Infrastructure Interface Report – Aura Precinct 11 (Part), 12 (Part), 13 (Part) and 14*" prepared by Calibre dated 23 July 2020.

APPENDIX A:
ENGINEERING DRAWINGS BY EGIS



LEGEND

PRECINCT BOUNDARY

EXISTING CATCHMENT

🟪 RIPARIAN BUFFER ZONE

🟩 FROG ZONE

🟨 FROG BUFFER

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	BG	BG	BG	BG	21.09.23	
AMENDMENTS						

STATUS

PRELIMINARY

APPROVED

BY: RPEQ NO:

SIGN: DATE:

SCALE

0 50 100 150 200 250 300 350 400

SCALE 1:5000 (A1) SCALE 1:10000 (A3)

egis

www.egis-group.com

CLIENT

STOCKLAND
DEVELOPMENTS PTY LTD

Stockland AURA

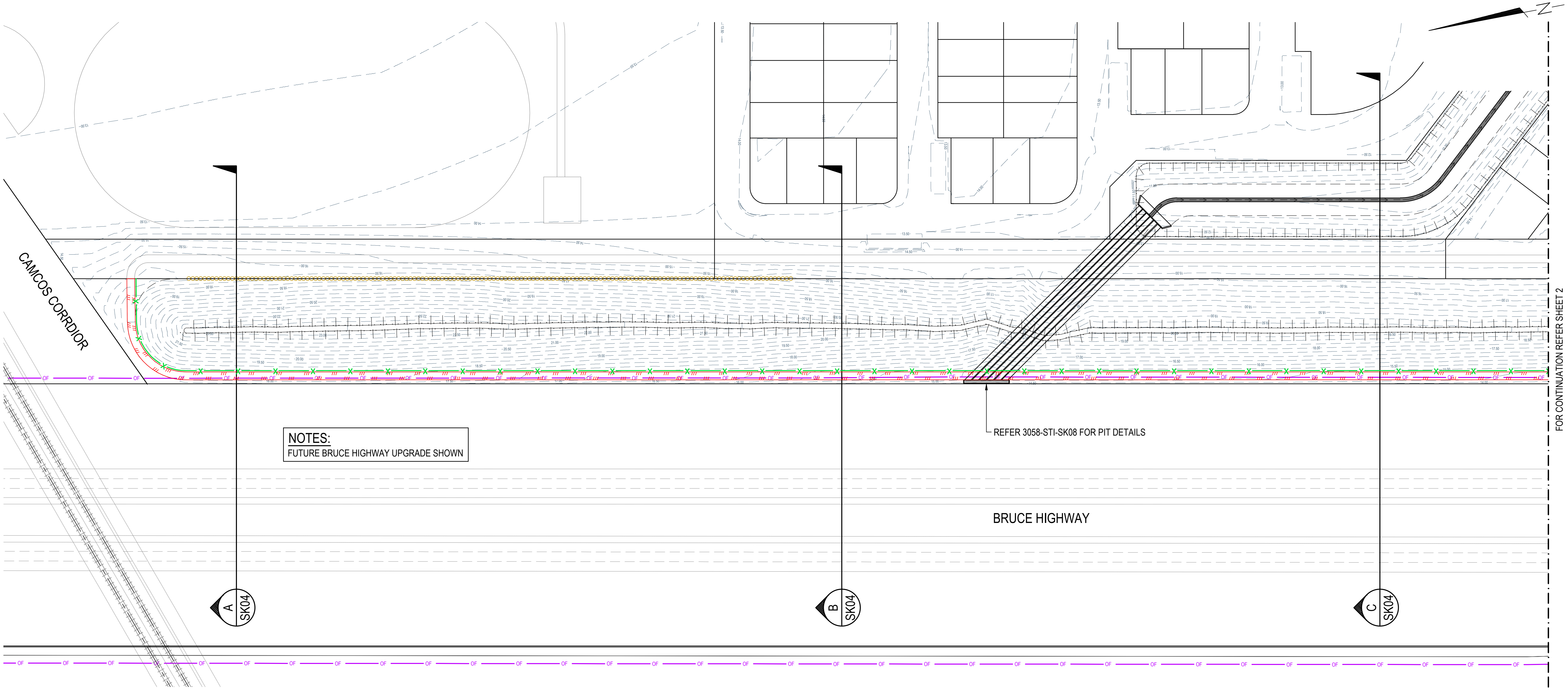
PROJECT

PRECINCT 15 WEST
STATE CONTROLLED
INFRASTRUCTURE INTERFACE

DRAWING TITLE

PRE DEVELOPMENT PLAN

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-STI-SK01	-



CONCEPT DESIGN:
ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN

NOTES:

1. ULTIMATE BRUCE HIGHWAY UPGRADE SHOWN (PENDING DETAILED DESIGN).
2. ACOUSTIC MOUND AND FENCE LEVELS IN ACCORDANCE WITH TRINITY REPORTING.
3. LGIA INDICATES DISTRICT LINER PARK MAXIMUM CROSSFALL 1 IN 4 HOWEVER, DURING DETAILED DESIGN FURTHER RETAINING WALLS COULD BE INCORPORATED FOR LANDSCAPE AND AESTHETIC ENHANCEMENT.

LEGEND

- PROPOSED CONTOURS
- TOP OF BATTER
- BOTTOM OF BATTER
- SANDSTONE RETAINING WALL
- ACCESS TRACK
- OPTIC FIBRE
- FAUNA FENCE

AMENDMENTS	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BG	BG	BG	BG	21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI
B	BG	NV	BG	BG	24.07.24	ACOUSTIC MOUND AMENDED

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 7.5 15 22.5 30 37.5 45 52.5 60
SCALE 1:750 (A1) SCALE 1:1500 (A3)

egis

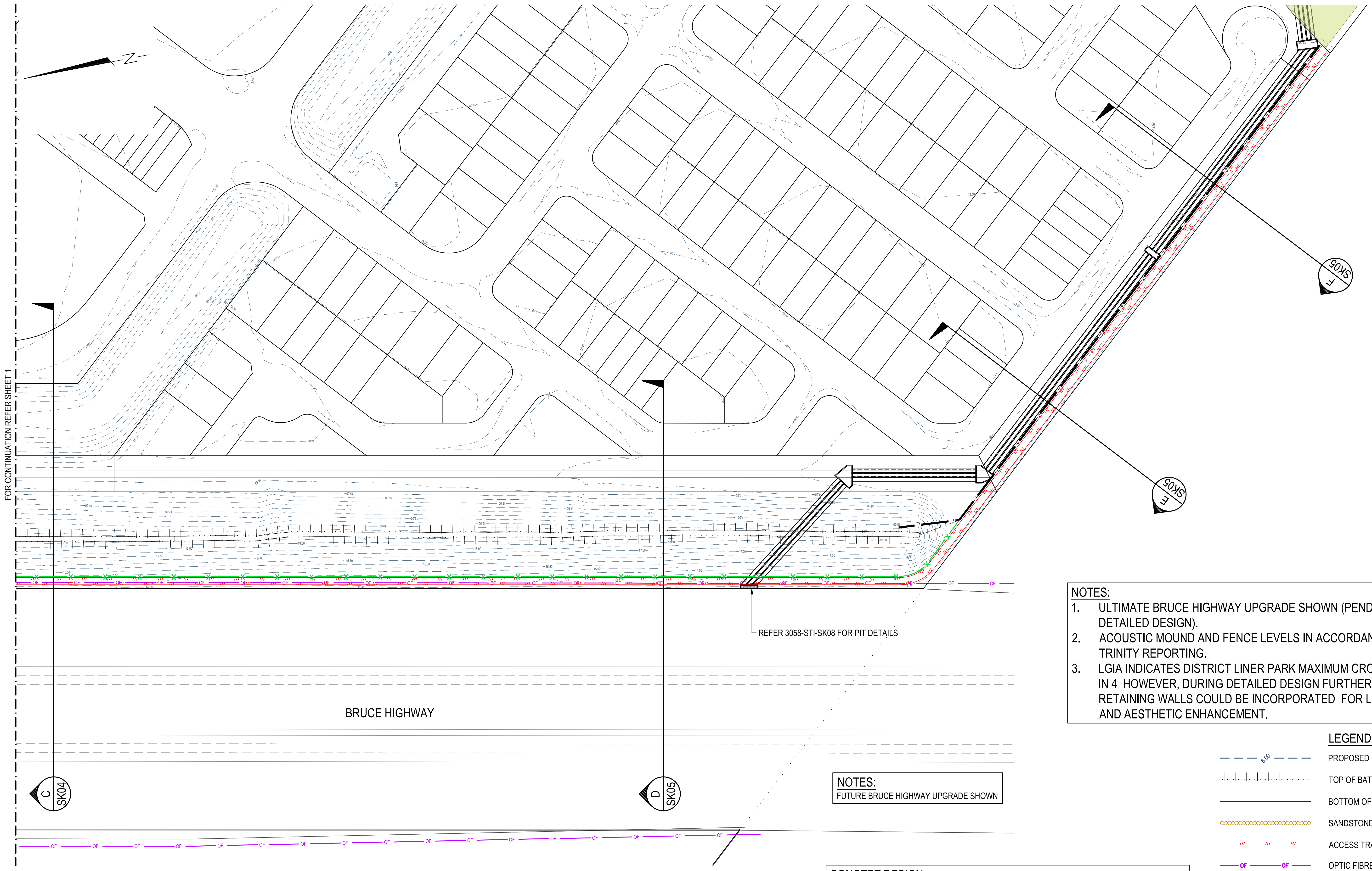
www.egis-group.com

CLIENT
STOCKLAND
DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
PRECINCT 15 WEST
STATE CONTROLLED
INFRASTRUCTURE INTERFACE

DRAWING TITLE
ACOUSTIC ATTENUATION
LAYOUT PLAN
SHEET 1 OF 2

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-STI-SK02	B



NOTES:
1. ULTIMATE BRUCE HIGHWAY UPGRADE SHOWN (PENDING DETAILED DESIGN).
2. ACOUSTIC MOUND AND FENCE LEVELS IN ACCORDANCE WITH TRINITY REPORTING.
3. LGIA INDICATES DISTRICT LINER PARK MAXIMUM CROSSFALL 1 IN 4 HOWEVER, DURING DETAILED DESIGN FURTHER RETAINING WALLS COULD BE INCORPORATED FOR LANDSCAPE AND AESTHETIC ENHANCEMENT.

NOTES:
FUTURE BRUCE HIGHWAY UPGRADE SHOWN

CONCEPT DESIGN:
ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN

LEGEND

— — 8.00 — —	PROPOSED CONTOURS
┴┴┴┴┴┴┴┴	TOP OF BATTER
———	BOTTOM OF BATTER
∘∘∘∘∘∘∘∘∘∘	SANDSTONE RETAINING WALL
—///—///—	ACCESS TRACK
—OF—OF—	OPTIC FIBRE
—X—X—	FAUNA FENCE
—/—/—	ACCOUTIC FENCE

AMENDMENTS	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BG	BG	BG	BG	21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI
B	BG	NV	BG	BG	24.07.24	ACOUSTIC MOUND AMENDED

STATUS
PRELIMINARY

APPROVED
BY:
RPEQ NO:
SIGN:
DATE:

SCALE
0 7.5 15 22.5 30 37.5 45 52.5 60
SCALE 1:750 (A1) SCALE 1:1500 (A3)

egis

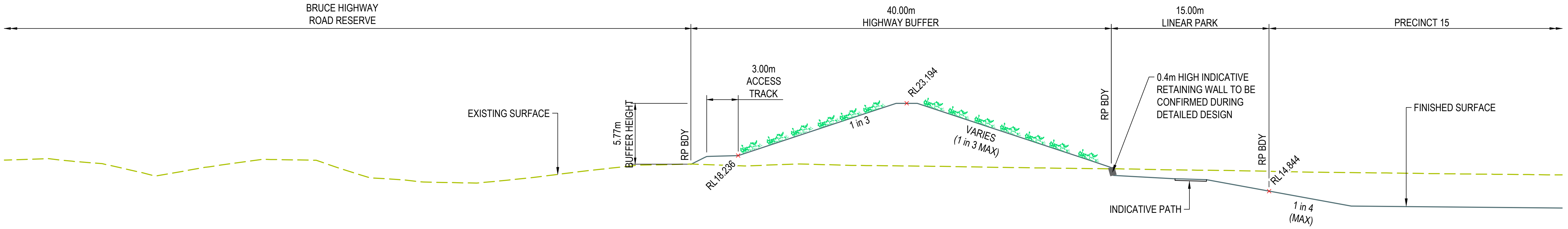
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

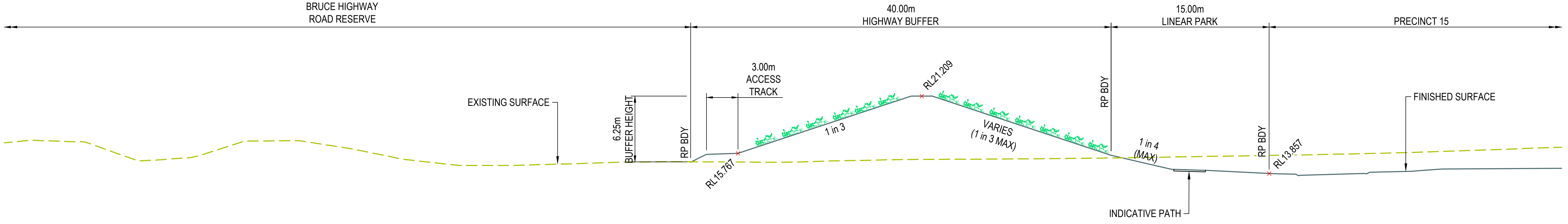
PROJECT
PRECINCT 15 WEST
STATE CONTROLLED
INFRASTRUCTURE INTERFACE

DRAWING TITLE
ACOUSTIC ATTENUATION
LAYOUT PLAN
SHEET 2 OF 2

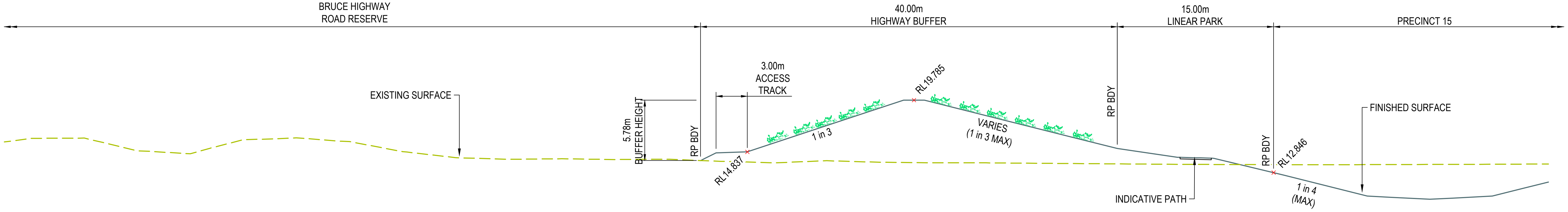
PROJECT No.	DRAWING No.	REVISION
21-000307	3058-STI-SK03	B



SECTION A SK02
SCALE (A1): 1:200
SCALE (A3): 1:400



SECTION B SK02
SCALE (A1): 1:200
SCALE (A3): 1:400



SECTION C SK02
SCALE (A1): 1:200
SCALE (A3): 1:400

NOTES:

1. ULTIMATE BRUCE HIGHWAY UPGRADE SHOWN (PENDING DETAILED DESIGN).
2. TOP OF BUND LEVEL DERIVED FROM INFORMATION PROVIDED BY TMR FOR FUTURE BRUCE HIGHWAY UPGRADE LEVELS AND ASK CONSULTING ACOUSTIC REPORTING DATED JULY 2020 MINIMUM ACOUSTIC MOUND HEIGHT.
3. LGIP INDICATES DISTRICT LINER PARK MAXIMUM CROSSFALL 1 IN 4 (DESIRED 1 IN 6) HOWEVER, DURING DETAILED DESIGN MINOR RETAINING WALLS COULD BE INCORPORATED FOR LANDSCAPE AND AESTHETIC ENHANCEMENT.

CONCEPT DESIGN:

ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BG	BG	BG	BG	21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI
B	BG	NV	BG	BG	24.07.24	ACOUSTIC MOUND AMENDED

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
0 150 300 450 600 750 900 1050 1200
SCALE 1:1500 (A1) SCALE 1:3000 (A3)

egis

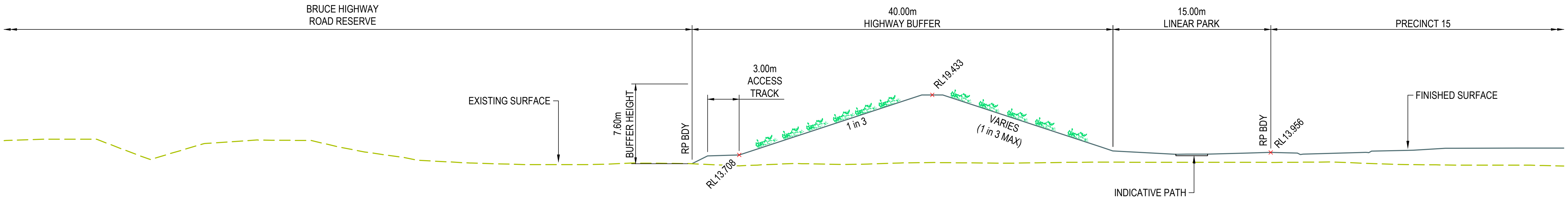
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

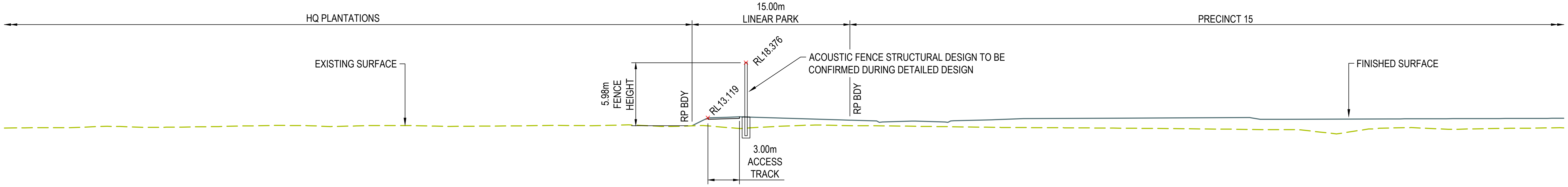
PROJECT
PRECINCT 15 WEST
STATE CONTROLLED
INFRASTRUCTURE INTERFACE

DRAWING TITLE
ACOUSTIC ATTENUATION
CROSS SECTIONS
SHEET 1 OF 2

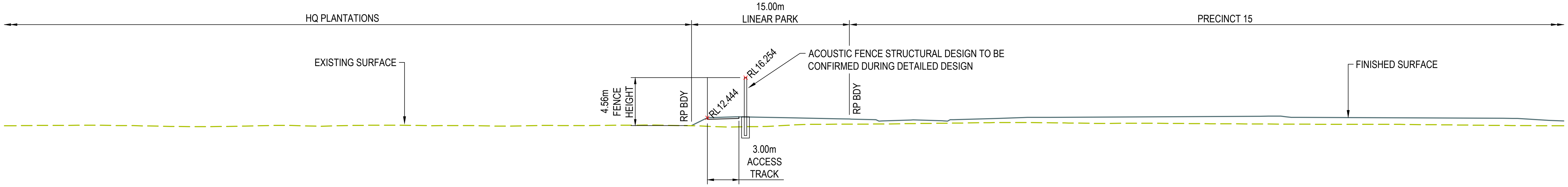
PROJECT No.	DRAWING No.	REVISION
21-000307	3058-STI-SK04	B



SECTION D
SK02
SCALE (A1): 1:200
SCALE (A3): 1:400



SECTION E
SK02
SCALE (A1): 1:200
SCALE (A3): 1:400



SECTION F
SK02
SCALE (A1): 1:200
SCALE (A3): 1:400

NOTES:

1. ULTIMATE BRUCE HIGHWAY UPGRADE SHOWN (PENDING DETAILED DESIGN).
2. TOP OF BUND LEVEL DERIVED FROM INFORMATION PROVIDED BY TMR FOR FUTURE BRUCE HIGHWAY UPGRADE LEVELS AND ASK CONSULTING ACOUSTIC REPORTING DATED JULY 2020 MINIMUM ACOUSTIC MOUND HEIGHT.
3. LGIP INDICATES DISTRICT LINER PARK MAXIMUM CROSSFALL 1 IN 4 (DESIRED 1 IN 6) HOWEVER, DURING DETAILED DESIGN MINOR RETAINING WALLS COULD BE INCORPORATED FOR LANDSCAPE AND AESTHETIC ENHANCEMENT.

CONCEPT DESIGN:

ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BG	BG	BG	BG	21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI
B	BG	NV	BG	BG	24.07.24	ACOUSTIC MOUND AMENDED

STATUS
PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE

egis

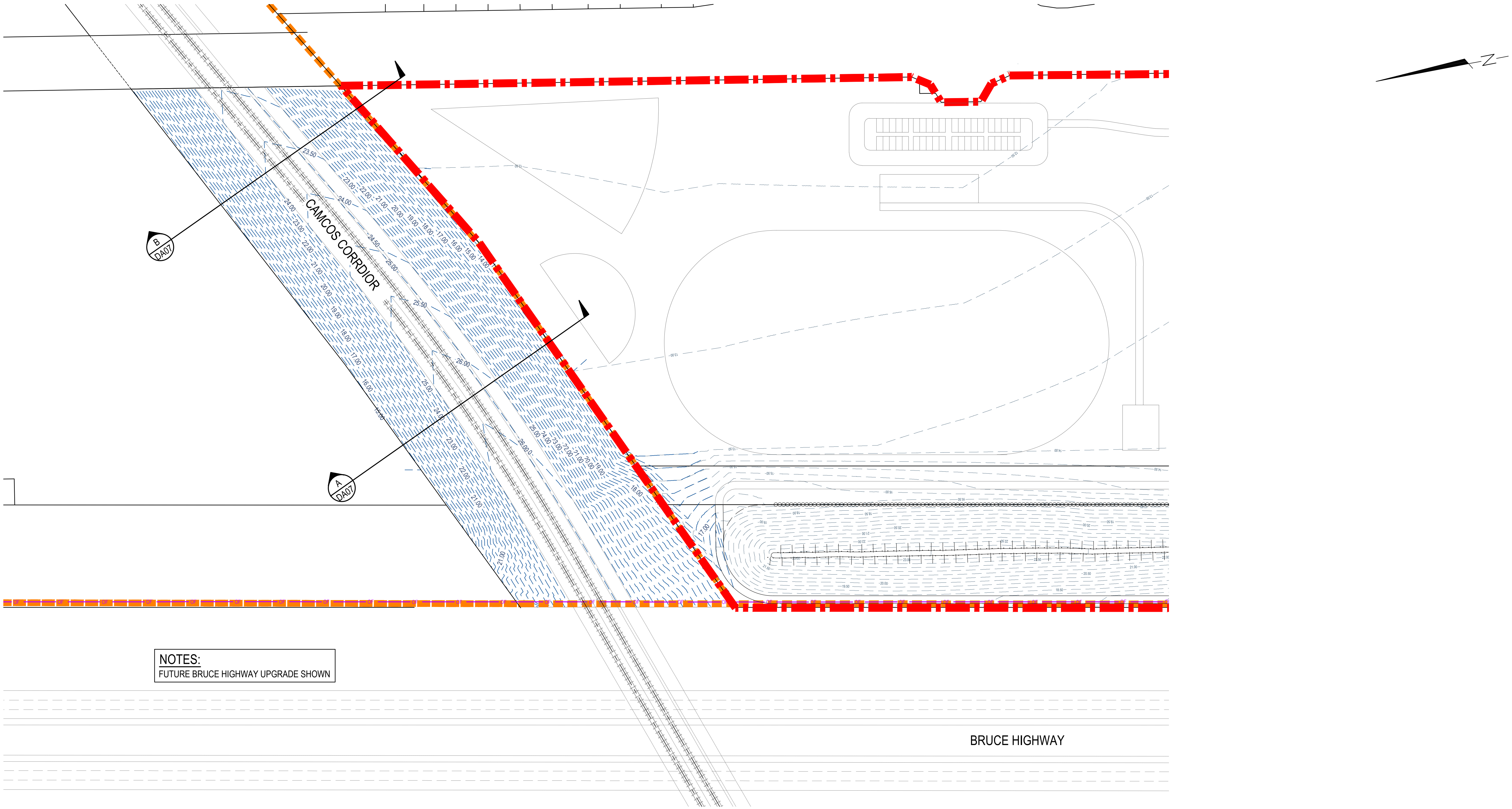
www.egis-group.com

CLIENT
STOCKLAND
DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
PRECINCT 15 WEST
STATE CONTROLLED
INFRASTRUCTURE INTERFACE

DRAWING TITLE
ACOUSTIC ATTENUATION
CROSS SECTIONS
SHEET 2 OF 2

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-STI-SK05	B



NOTES:
FUTURE BRUCE HIGHWAY UPGRADE SHOWN

CONCEPT DESIGN:
ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN

LEGEND

— — 8.00 — —	PROPOSED CONTOURS
┴┴┴┴┴┴┴	TOP OF BATTER
———	BOTTOM OF BATTER
—OF—OF—	OPTIC FIBRE

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BG	BG	BG	BG	21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI
B	BG	NV	BG	BG	24.07.24	ACOUSTIC MOUND AMENDED

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY:
RPEQ NO:
SIGN:
DATE:

SCALE
0 7.5 15 22.5 30 37.5 45 52.5 60
SCALE 1:750 (A1)
SCALE 1:1500 (A3)

egis

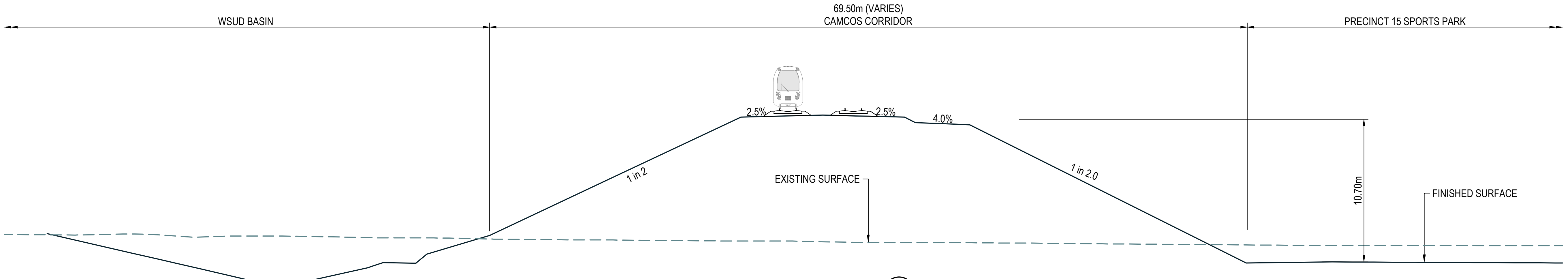
www.egis-group.com

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

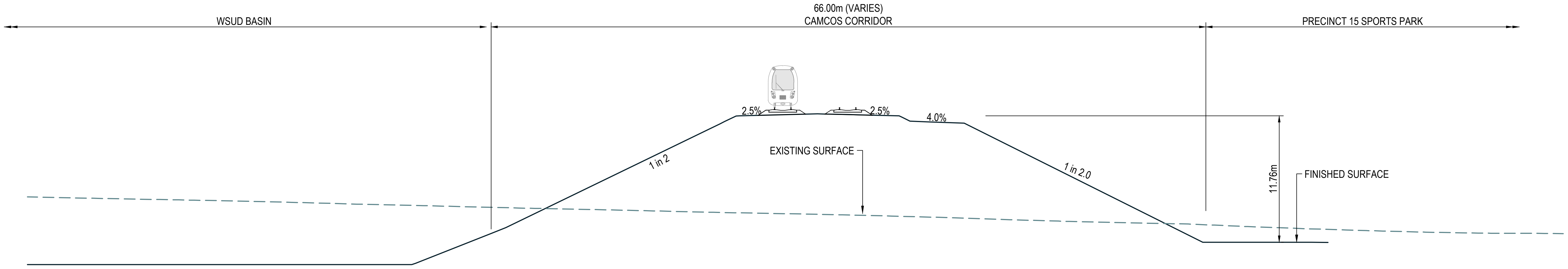
PROJECT
PRECINCT 15 WEST
STATE CONTROLLED INFRASTRUCTURE INTERFACE

DRAWING TITLE
CAMCOS CORRIDOR LAYOUT PLAN

PROJECT No.: 21-000307
DRAWING No.: 3058-STI-SK06
REVISION: B



SECTION A SK06
SCALE (A1): 1:200
SCALE (A3): 1:400



SECTION B SK06
SCALE (A1): 1:200
SCALE (A3): 1:400

CONCEPT DESIGN:
ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPTUAL ONLY AND TO BE CONFIRMED IN SUBSEQUENT DETAILED DESIGN

	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	BG	BG	BG	BG	21.09.23	
A	AT	NV	BG	BG	21.12.23	AMENDED TO SUIT RFI

AMENDMENTS

STATUS
PRELIMINARY

APPROVED
BY:
RPEQ NO:
SIGN:
DATE:

SCALE
0 150 300 450 600 750 900 1050 1200
SCALE 1:1500 (A1) SCALE 1:3000 (A3)

egis

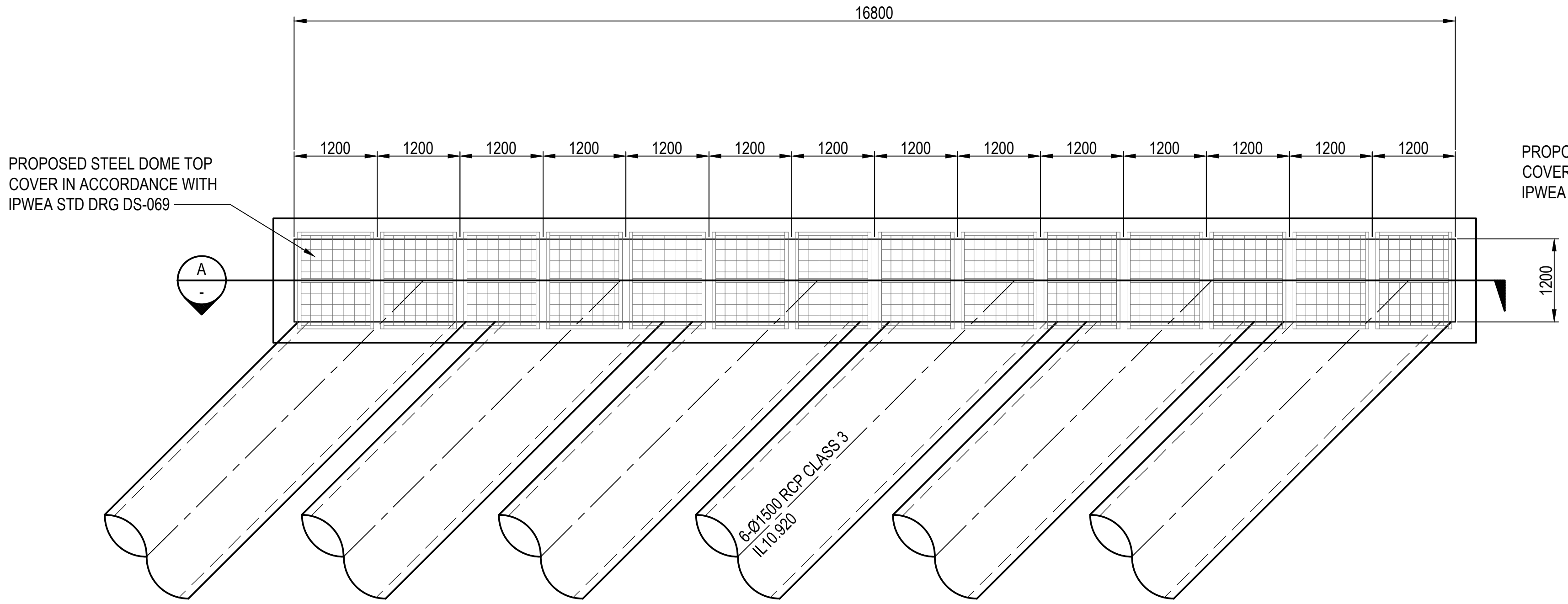
www.egis-group.com

CLIENT
STOCKLAND
DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
PRECINCT 15 WEST
STATE CONTROLLED
INFRASTRUCTURE INTERFACE

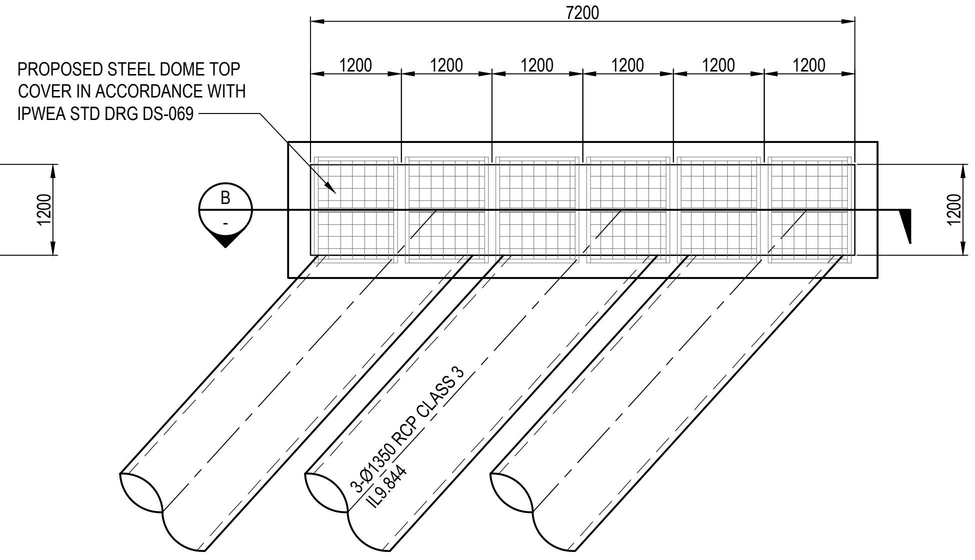
DRAWING TITLE
CAMCOS CORRIDOR
CROSS SECTIONS

PROJECT No.	DRAWING No.	REVISION
21-000307	3058-STI-SK07	A



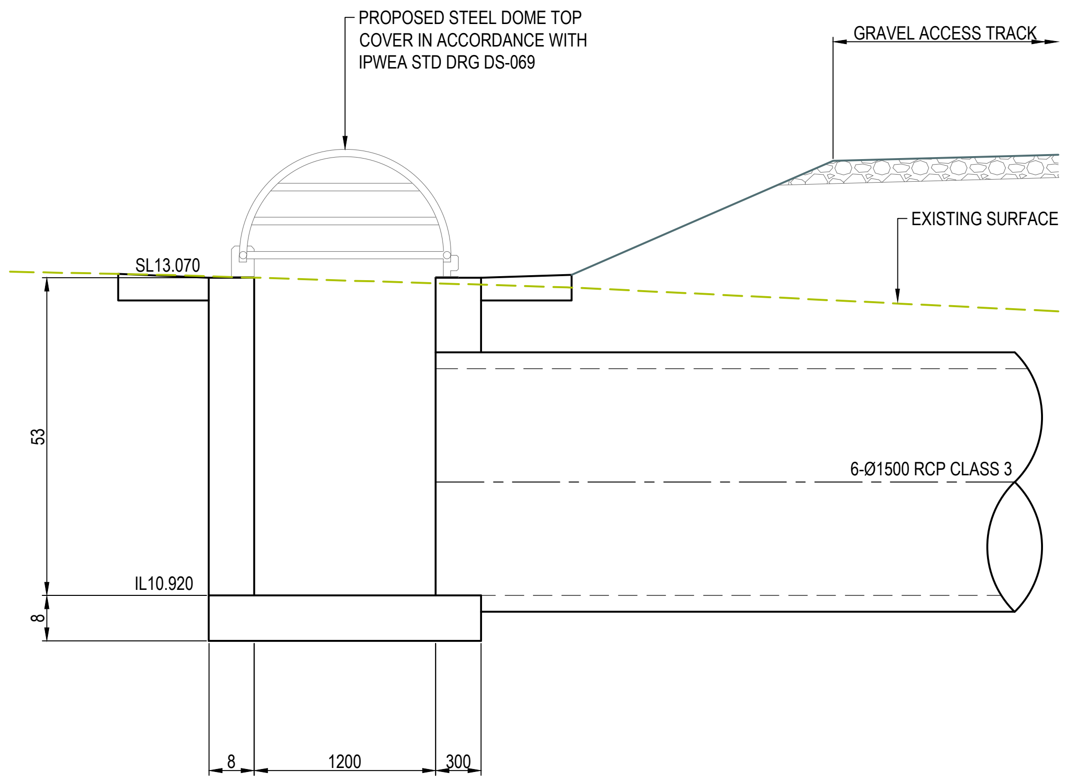
CULVERT W1: 6-1500 RCP

SCALE: 1:50 @ A1 | 1:100 @ A3



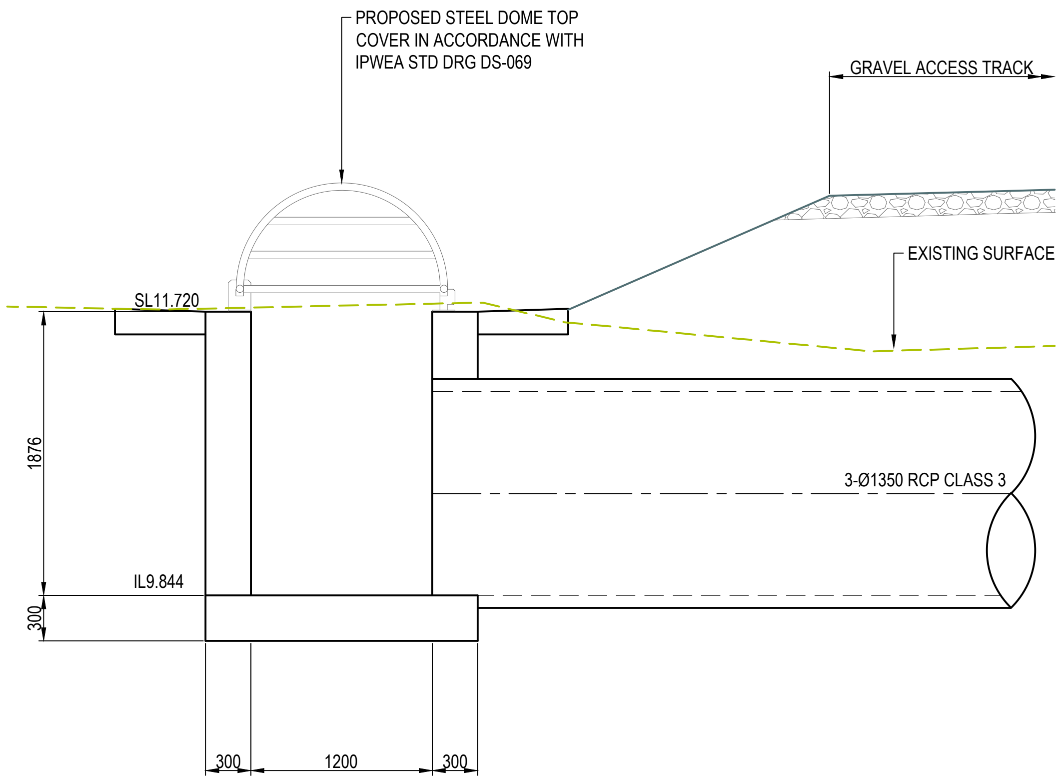
CULVERT X1: 3-1350 RCP

SCALE: 1:50 @ A1 | 1:100 @ A3



SECTION A -

SCALE (A1): 1:25
SCALE (A3): 1:50



SECTION B -

SCALE (A1): 1:25
SCALE (A3): 1:50

INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	BG	BG	BG	BG	21.12.23	
AMENDMENTS						

STATUS
PRELIMINARY

APPROVED
BY:
RPEQ NO:
SIGN:
DATE:

SCALE

egis

www.egis-group.com

CLIENT
STOCKLAND
DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT
PRECINCT 15 WEST
STATE CONTROLLED
INFRASTRUCTURE INTERFACE

DRAWING TITLE
ACOUSTIC MOUND
CULVERT W & X
DETAILS

PROJECT No. 21-000307
DRAWING No. 3058-STI-SK08
REVISION -

APPENDIX B:
STORMWATER MANAGEMENT PLAN BY EGIS

MEMORANDUM

AURA PRECINCT 15 WEST: ACOUSTIC BUND DRAINAGE DESIGN

08 December 2023

Author(s)	Kyle Vaughan
Reviewer/Approver	Daniel Yates
Entity	Water Resources QLD
Version	B
Reference	21-000307.11.WRE.TM01B.DY.kv.docx

1 INTRODUCTION

The following Technical Memorandum details the changes to catchment configurations and overland flow paths to facilitate the construction of an acoustic bund adjacent to Precinct 15 of the Aura Development without causing adverse drainage impacts to the adjacent state-controlled road (Bruce Highway). The purpose of this memorandum is to provide details of the proposed acoustic bund drainage infrastructure required to achieve this non-worsening requirement.

1.1 Background

The location of the acoustic bund and interaction with the Bruce Highway is depicted in Figure 1-1. The acoustic bund is located east of the Bruce Highway's southbound carriageway bordering the western boundary of Aura Precinct 15 West. If unmitigated the acoustic bund will impede existing overland flow paths immediately downstream of two Department of Transport and Main Roads (TMR) cross drainage culverts. These culverts have nominally been referred to as Culvert W and Culvert X herein. The corresponding acoustic bund drainage structures immediately downstream of these TMR culverts have nominally been referred to as Culvert W1 and Pipe X1 herein.

The post-development scenario modelling described herein relies on associated drainage works to the west of the Bruce Highway corridor adjacent to Aura Precinct 14, namely the western diversion drain (south) and the western detention basin (south). No change to the configurations of those previously approved drainage works are proposed. As such, the flood modelling and analysis presented in this document builds on the flood modelling detailed in Calibre's Technical Memorandum titled *Aura Western Detention Basin (South) and Acoustic Bund (South) Drainage Diversions* (Calibre Ref: *18-000340-TM05E_AURA_WDB.DOCX*), dated 26 October 2022.

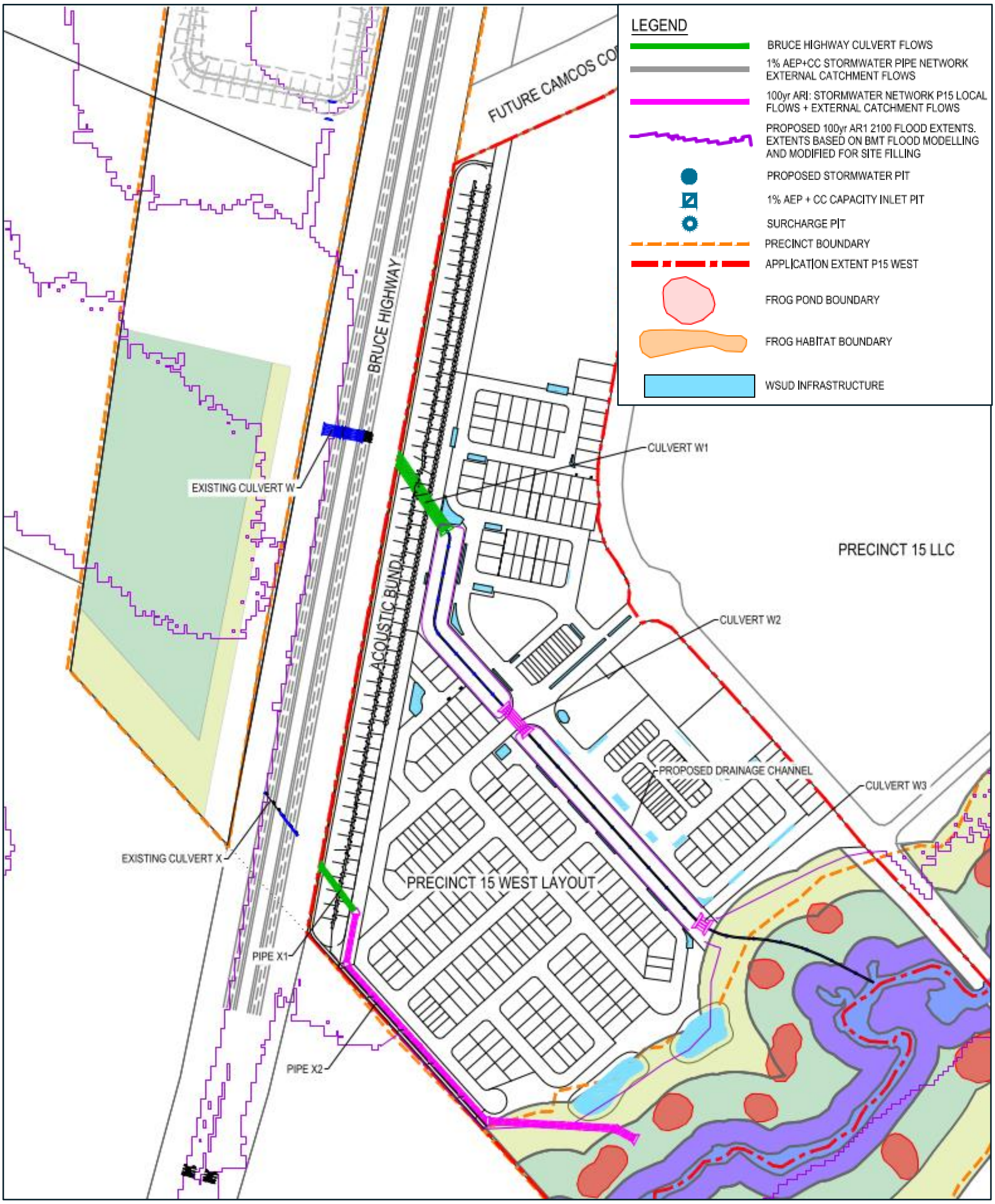


FIGURE 1-1 SITE LOCATION

1.2 Design Constraints

The constraints that have guided the development of acoustic bund drainage design are as follows:

- There is an existing optic fibre conduit which runs along the western side of the Aura development boundary that coincides with the proposed location of the acoustic bund. The levels of the optic fibre conduit have been potholed to determine the existing depth.

- No works are to occur within the TMR road corridor. Hence, any structures must be constructed within the Aura development property boundary.
- No adverse flooding impacts are allowed within the TMR corridor.

2 METHODOLOGY

The drainage design methodology for the acoustic bund drainage Culvert W1 and Pipe X1, downstream of TMR Culvert W and Culvert X are similar in approach. This methodology adopts the following assumptions:

- Custom field inlet structures are to be located at the upstream ends of Culvert W1 and Pipe X1 at the toe of the acoustic bund.
- The field inlets will be constructed within the footprint of the earth bund within the Aura development boundary. Sizing of these filed inlets to achieve the required capture flow has adopted multiple standard 1200 x 1200 dome screen field inlets using a combination of weir and orifice flow capture.
- The inlet structures are to be located on the eastern side of the Optic Fiber line running parallel to the Bruce Highway.
- Both custom inlets are connected to multiple barrel pipe arrangements that have been sized to allow the inlet structure to hydraulically control the flow leaving the TMR corridor. With the inlet performing as the hydraulic control, the design water levels within the TMR corridor will be unaffected by any subsequent changes to the drainage configuration within the downstream Aura Development during the Defined Flood Event (DFE) under design blockage conditions.

3 MODELLING

The flood modelling and analysis presented herein is consistent with (and builds upon) the flood modelling and analysis presented in Calibre's Technical Memorandum *18-000340-TM05E_AURA_WDB.DOCX*, dated 26 October 2022. This modelling was undertaken using the XP-Solutions Stormwater & Wastewater Management Model (XP-SWMM) software. XP-SWMM is a comprehensive modelling package that is suitable for the dynamic modelling of engineered and natural drainage systems. The software integrates hydrological and hydraulic processes in a one-dimensional (1D) model that is ideal for the analysis of urban drainage (i.e. catchments, pits and pipes).

3.1 Model Verification

The XP-SWMM model verification is detailed in Technical Memorandum TM05, whereby Rational Method calculations in accordance with QUDM were undertaken for a range of existing scenario sub-catchments with varying size and flow path length. As detailed in TM05C, satisfactory correlation was achieved between the XPSWMM model Runoff Mode calculations and those calculated using the Rational Method, and the XP-SWMM model was therefore adopted and further developed for this analysis.

3.2 Model Scenarios

The following models were adopted as part of the analysis. These models both utilise the 1% AEP climate change rainfall event with the 1% AEP regional event tailwater level.

Existing Scenario Model – The existing scenario hydrological and hydraulic modelling was adopted from that presented in Calibre's Technical Memorandum *18-000340-TM05E_AURA_WDB.DOCX*, dated 26 October 2022. The modelling includes the existing site conditions encompassing all catchments flowing through the TMR corridor and the pre-developed Aura site. The XP-SWMM model was verified with Rational Method calculations in accordance with QUDM for a range of existing scenario sub-catchments.

Developed Scenario Models – A hydrological and hydraulic model was developed to represent the site in developed conditions. This model has been used to determine the changes in peak flow and water surface level (WSL) upstream, within and downstream of the TMR corridor as a result of the total site development and inlet design.

3.3 Pit Inlet Design

The pit inlet has been designed through an iterative process to optimise the size respective to the culvert headwater and tailwater levels. A spreadsheet was used to derive the flow capture curves for multiple 1200x1200 field inlet pits placed side-by-side along the toe of the acoustic bund embankment adopting 50% inlet blockage factor in accordance with the design values specified in QUDM (2016 Ed.), Section 7.5.2, Table 7.5.1 *Provision for blockage* adopting a dome screen field inlet type. The spreadsheet adopts Equations 7.4 and 7.5 (and associated assumptions) as per QUDM (2016 Edition) Section 7.5.4(a) *Inflow Capacity*. The iterative modelling process involved increasing the number of standard 1200x1200 field inlet pits at Culvert W1 and Pipe X1 until the developed 1% AEP+CC water surface levels within the TMR corridor were at or below existing (pre-development) levels at each location, respectively.

The inlet curve diagram for the proposed inlet pits at the upstream ends of Culvert W1 and Pipe X1 are shown in **Figure 4-1** and **Figure 4-2**, respectively. To achieve the reported pit capture at Culvert W1 with 50% blockage shown in **Figure 4-1**, 8 x 1200x1200 field inlets are required. To achieve the reported pit capture at Pipe X1 with 50% blockage shown in **Figure 4-2**, 2 x 1200x1200 field inlets are required.

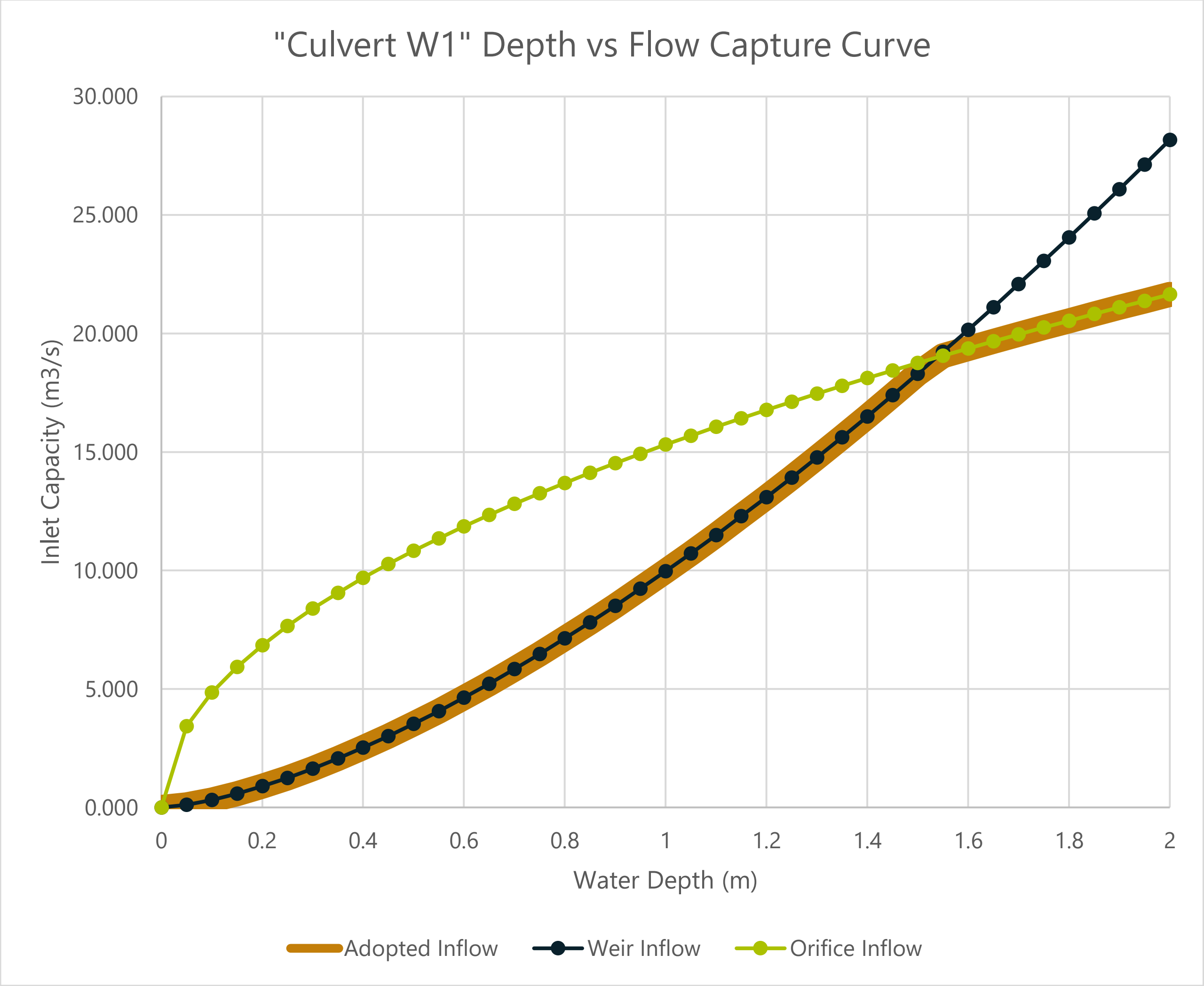


FIGURE 3-1 PIT INLET CURVE AT CULVERT W1

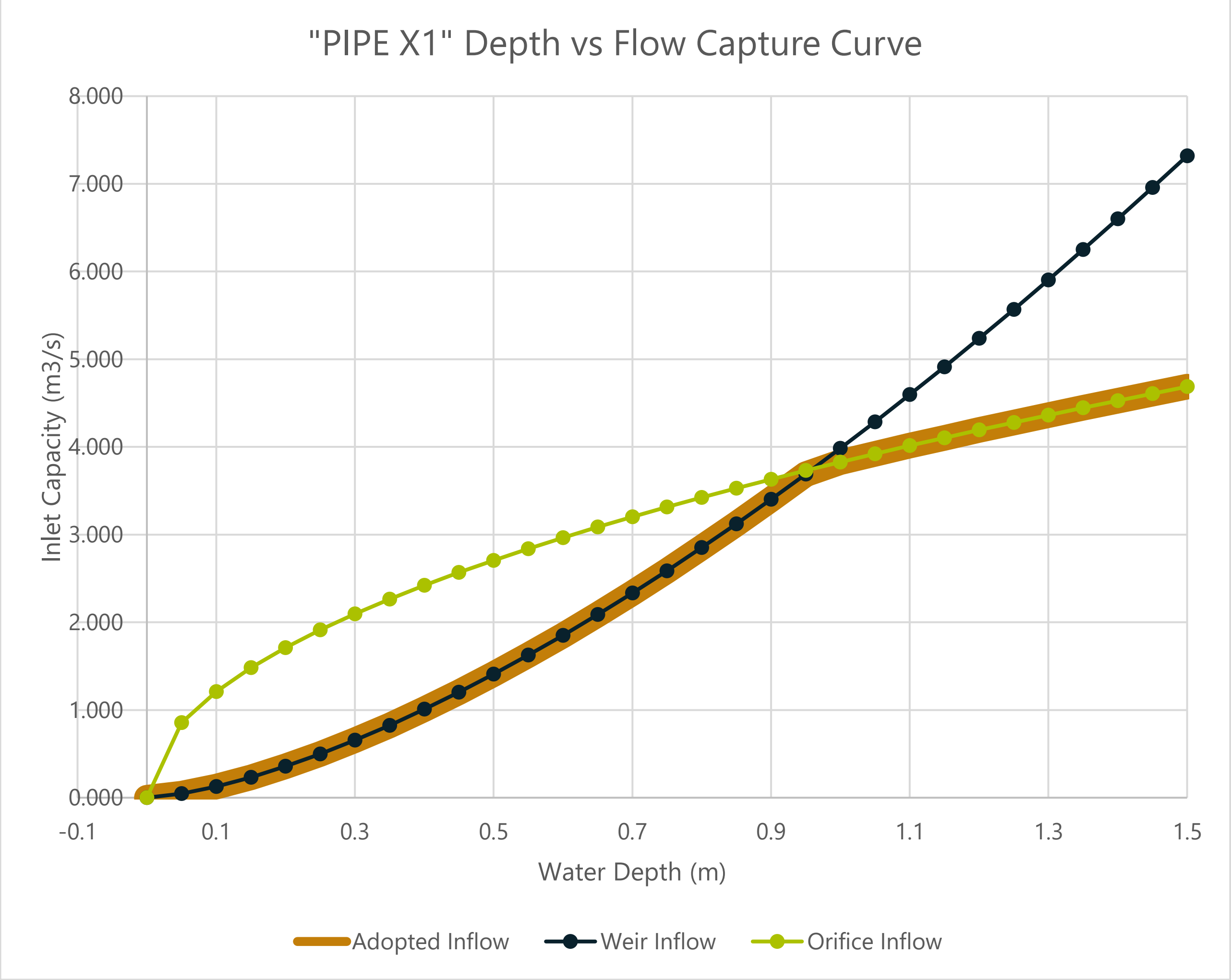


FIGURE 3-2 PIT INLET CURVE AT PIPE X1

4 RESULTS

The results of the XP-SWMM modelling for the existing and ultimate development conditions are presented on **Figure 4-1** and **Figure 4-2** below, which depict the existing (pre-development) and developed 1% AEP+CC water surface levels on longitudinal sections at TMR Culvert W and Culvert X, respectively.

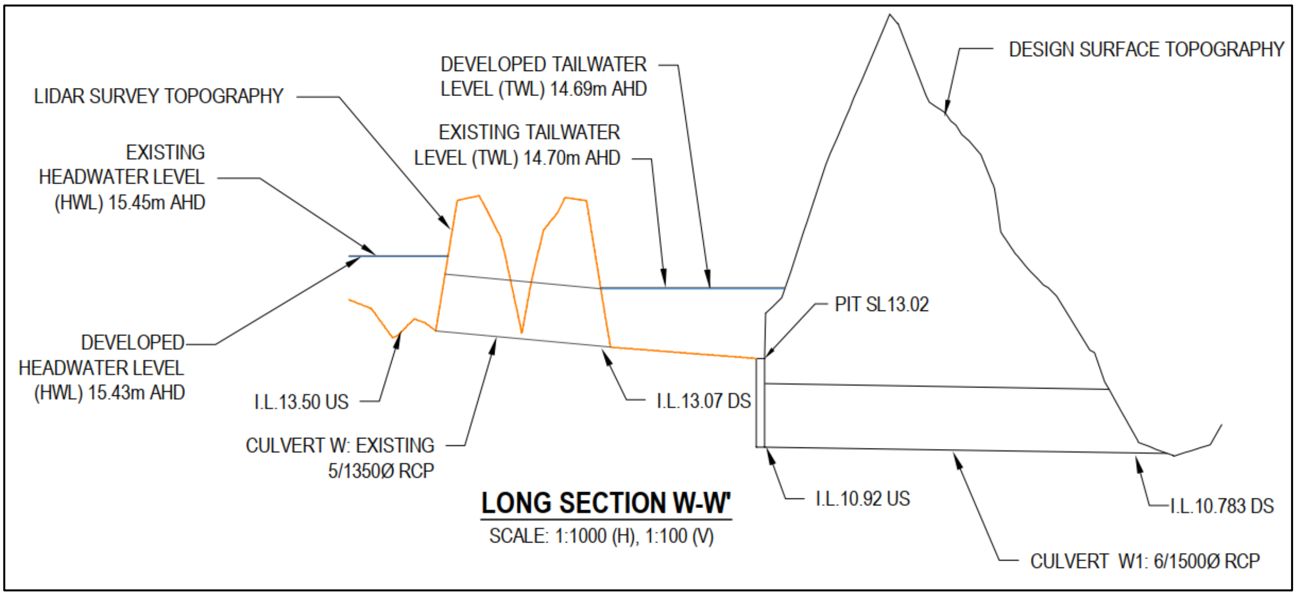


FIGURE 4-1 CULVERT W AND W1 LONGITUDINAL SECTION

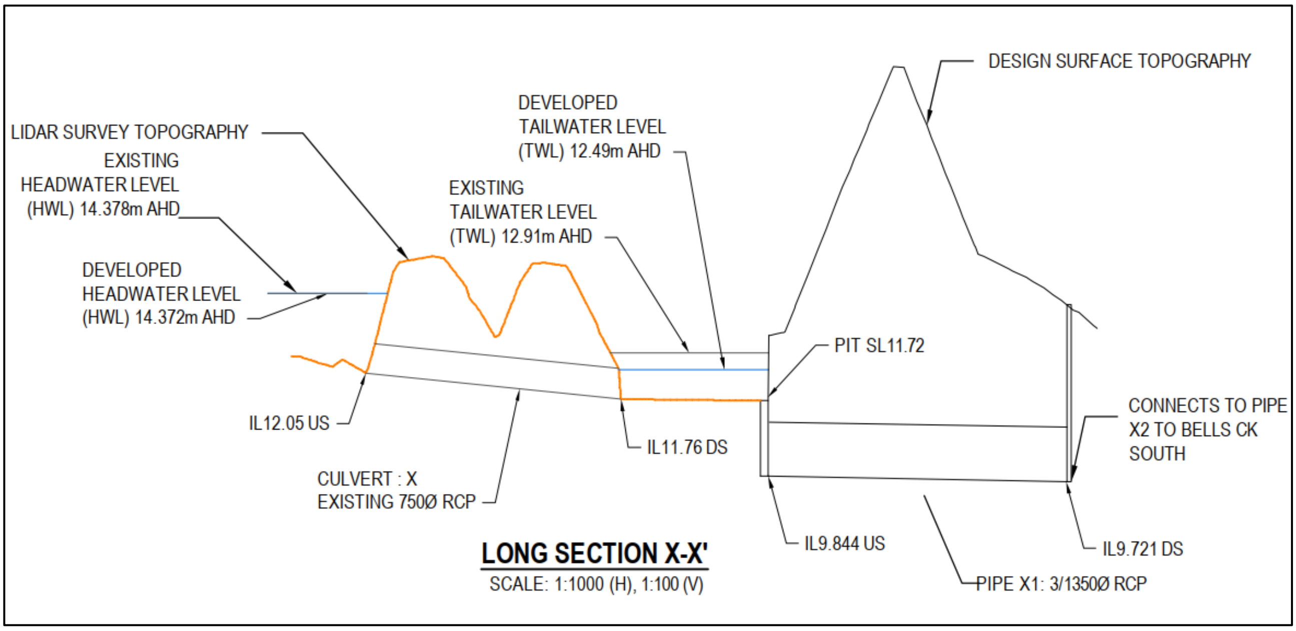


FIGURE 4-2 CULVERT X AND PIPE X1 LONGITUDINAL SECTION

Tabulated results of the XP-SWMM modelling for the existing and ultimate development conditions are presented in **Table 1 and Table 2**.

TABLE 1 XP-SWMM MODEL WSL RESULTS

CULVERT ID	CULVERT HEADWATER & TAILWATER LEVELS (m AHD) FOR 1% AEP+CC					
	EXISTING CONDITIONS		ULTIMATE DEVELOPMENT CONDITIONS		CHANGE (M)	
	HWL	TWL	HWL	TWL	HWL	TWL
Culvert W	15.450	14.700	15.430	14.698	-0.020	-0.002
Culvert X	14.378	12.910	14.372	12.494	-0.006	-0.416

As shown above, the ultimate development scenario 1% AEP+CC headwater and tailwater levels for both TMR Culvert W and Culvert X have been kept at or below the existing scenario 1% AEP+CC levels as a result of the proposed Acoustic Bund drainage works in the adjacent Aura P15 West development.

TABLE 2 – XP-SWWM MODEL PEAK FLOW AND VELOCITY RESULTS

CULVERT ID	CULVERT PEAK FLOWS (m^3/s) & VELOCITIES (m/s) FOR 1%+CC					
	EXISTING CONDITIONS		ULTIMATE DEVELOPMENT CONDITIONS		CHANGE (M)	
	PEAK FLOW	VELOCITY	PEAK FLOW	VELOCITY	PEAK FLOW	VELOCITY
Culvert W	18.95	2.63	18.74	2.60	- 0.08	- 0.03
Culvert X	1.62	3.74	1.67	3.77	+0.05 (+3%)	+0.03 (+0.8%)

The Sunshine Coast Planning Scheme 2014 - Version 26 (23 October 2023) - Schedule 6, Appendix SC6.9A states "Numerical inaccuracies in the modelling process are accepted to 10mm (depth) and 0.5% (velocity)." A less than 1% increase in peak flow velocity during the in 1% AEP + CC event is deemed to result in a negligible impact to the TMR corridor. Regarding the 3% increase in 1% AEP+CC peak flows at Culvert X, the modelling has demonstrated that this peak flow increase does not result in a corresponding increase in water levels within the TMR corridor and will therefore have no actionable impact within the corridor. As such, the above table demonstrates nil or negligible worsening due to the proposed downstream acoustic bund drainage arrangement comprised of custom field inlet pits at Culvert W1 and Pipe X1, respectively.

5 CONCLUSION

In summary, this memorandum provides the necessary acoustic bund drainage configurations adjacent to Aura Precinct 15. The proposed acoustic bund drainage infrastructure, including Culvert W1 and Pipe X1 and associated custom inlet pits effectively mitigate adverse flood impacts within the TMR road corridor. The results indicate that the acoustic bund drainage design will keep ultimate development scenario 1% AEP+CC headwater and tailwater levels at or below the existing scenario 1% AEP+CC levels for both TMR Culvert W and Culvert X. Thus, the proposed drainage configuration under the Aura P15 acoustic bund will ensure non-worsening drainage conditions prevail for ultimate development conditions for all flood events up to and including the 1% AEP+CC event.

Egis Consulting Pty Ltd

www.egis-group.com

CONTACT US

Egis Consulting Pty Ltd
Level 4, Unit 402, 8 Market Lane, Maroochydore QLD 4558, Australia

+61 7 3517 4186