53A & 53B Warriewood Road

Civil Engineering Works Development Application

Prepared for Sekisui House

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Document Information

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Contents

List of Tables

List of Figures

List of Appendices

1 Introduction

Enspire Solutions (**Enspire**) have been engaged by **Sekisui House** to prepare the civil engineering and stormwater management design and documentation in support of a Development Application (**DA**) submission to Northern Beaches Council for the proposed construction of roads and stormwater drainage infrastructure associated with 53A & 53B Warriewood Road, Warriewood as depicted in **Figure 1**.

Works associated with this Development Application include:

- Sediment and erosion controls;
- Bulk earthworks;
- Construction of public and private roads, pavements, and stormwater drainage infrastructure, including two (2) On-Site Detention (OSD) and Water Quality (WQ) tanks;
- Construction of footpaths and shared paths;
- Construction of retaining walls; and
- Installation and commissioning of essential utility services.

Figure 1 – 53A & 53B Warriewood Road Site Plan

(Source: Nearmap)

2 Related Reports and Documents

This report is to be read in conjunction with the following reports and documents.

1) Development Application documentation prepared by Enspire Solutions

Table 1 - 53A & 53B Warriewood Road Drawing Reference

Drawing Number	Drawing Title
220122-00-DA-C01.01	COVER SHEET AND DRAWING SCHEDULE
220122-00-DA-C01.21	SPECIFICATION NOTES – SHEET 01
220122-00-DA-C01.41	GENERAL ARRANGEMENT PLAN
220122-00-DA-C02.01	DEMOLITION PLAN
220122-00-DA-C03.01	EROSION AND SEDIMENTATION CONTROL PLAN
220122-00-DA-C03.21	EROSION AND SEDIMENTATION CONTROL DETAILS
220122-00-DA-C04.01	BULK EARTHWORKS - CUT AND FILL PLAN
220122-00-DA-C04.21	BULK EARTHWORKS - CUT AND FILL SECTIONS
220122-00-DA-C05.01	SITEWORKS AND STORMWATER MANAGEMENT PLAN – SHEET 01
220122-00-DA-C05.02	SITEWORKS AND STORMWATER MANAGEMENT PLAN – SHEET 02
220122-00-DA-C05.11	NARRABEEN CREEK REHABILITATION WORKS
220122-00-DA-C06.01	ROAD TYPICAL CROSS SECTIONS
220122-00-DA-C07.01	ROAD LONGITUDINAL SECTIONS
220122-00-DA-C10.01	PAVEMENT, SIGNAGE AND LINEMARKING PLAN
220122-00-DA-C13.01	SITE SECTIONS
220122-00-DA-C14.01	SITEWORK DETAILS – SHEET 01
220122-00-DA-C20.01	PRE-DEVELOPMENT CATCHMENT PLAN
220122-00-DA-C21.01	POST-DEVELOPMENT CATCHMENT PLAN
220122-00-DA-C22.01	TURNING PATH PLAN – SHEET 01
220122-00-DA-C22.02	TURNING PATH PLAN – SHEET 02
220122-00-DA-C22.03	TURNING PATH PLAN – SHEET 03
220122-00-DA-C22.04	TURNING PATH PLAN – SHEET 04

2) Northern Beaches Council Water Management for Development Policy, version 2, dated February 2021.
3) Northern Beaches Councill Warriewood Valley Roads Masterplan, dated June 2018.
4) Northern Beaches Council Warriewood Valley Urban Land Release, water management specification, Revised Version, adopted by Pittwater Council on 12 February 2001.
5) Warriewood Valley Draft Planning Framework.
6) Warriewood Valley Landscape Masterplan and Design Guidelines (Public Domain), dated 2018.
7) Northern Beaches Engineering Design Code (AUSPEC 1).

8) Australian Rainfall and Runoff, Version 4.2 - Climate Change Chapter Update.
9) Pre-lodgement Meeting PLM2022/0235, dated 9 February 2023.
10) Flood Impact Assessment prepared by Catchment Simulation Solutions (CSS), dated March 2025.
11) Development Application engineering plans associated with 53C prepared by Jones Nicholson Consulting Engineers, dated November 2015.
12) Engineering plans associated (DA N0511/10), prepared by Proust and Gardner, dated July 2010 (neighbouring development to the north)
13) Development Application DA2019/0263 engineering plans associated with Lot 3, DP 1115877 and DP 942319, prepared by Craig & Rhodes, dated March 2019.

3 The Development

3.1 Proposed Development Works

The development site is located within the Northern beaches Local Government Area (LGA) and occupies a total area of approximately 1.65ha.

The development is generally bound by the following and reflected on **Figure 1**:

- Warriewood Road to the north;
- Pheasant Place to the east;
    - Pheasant place currently facilitates direct access to 7 lots as well as a proposed residential flat building to the west;
- Lorikeet Grove to the north and south.
    - The northern portion of Lorikeet Grove extends through to Brand Lane and Warriewood Road;
    - The southern portion of Lorikeet Grove is approximately 23m in length and has been constructed under neighbouring development works;
- Narrabeen Creek to the south.

The proposed development seeks consent for the five (5) lot Community Title Subdivision of the site, including the future public reserve, the extension of Lorikeet Grove, an internal road, stormwater works, associated landscaping and tree removal to facilitate the future residential development of the site. Three (3) super lots are proposed which will be further subdivided at a later date.

As part of the development, half-road construction of Warriewood Road is proposed to facilitate construction of a new bus bay and car parking bay as shown on the submitted plans. As part of the frontage works, adjustment of existing utilities and undergrounding of the overhead electrical main is also proposed, subject to approvals with the relevant authorities.

Augmentation of the existing DN600 trunk drainage main currently located on the southern boundary is also proposed and reflected on the engineering plans for assessment. Further details relating to the drainage strategy is discussed in Section 6 of the report.

The proposed development has been prepared in accordance with the relevant planning requirements and design specifications referenced in Section 2.

3.2 Existing Site Conditions

To facilitate development of 53A & 53B, levels across the site have been designed to replicate the existing topography. Levels vary from RL 14.0 at the northern corner of the site, to RL 3.0 at the southernmost corner adjacent to Narrabeen Creek.

Narrabeen Creek levels vary between RL 1.63 at the base to RL 3.89 taken at the top of bank. It is intended to retain existing levels within the creek bed. A select number of trees are also to be retained. Reference shall be made to **Appendix A** for the Detail Survey.

The proposed development is also largely constrained by the following boundary and site conditions:

- Neighbouring development to the south previously referred to as 53C Warriewood Road, Warriewood. Refer to **Appendix B** for details.

  - Pheasant Place was constructed under this development and provides direct access to seven (7) lots and a proposed residential flat building that is currently under construction. Levels throughout Pheasant Place are currently fixed and are to remain.
  - An existing retaining wall abuts the development site and varies in height.
  - An existing On-Site Detention (OSD) tank also abuts the site and forms part of the retaining wall structure.
  - A small section of Lorikeet Grove has been constructed as part of these works. The length of road is approximately 23m and currently services two (2) residential lots.
- Existing DN600 trunk drainage main located along the southern boundary.
  - The existing trunk drainage main is mis-aligned and is not located parallel to the southern boundary of the site.
  - An upstream catchment assessment has also been included to assess the capacity of the existing infrastructure. As a result of the assessment, it was determined the asset was to be re-aligned and located within a new 3m wide easement. Augmentation of the infrastructure is also proposed as demonstrated on the engineering set of plans.
- Existing DN1800 sewer carrier main traversing the site from North to South.
  - The existing asset is owned and operated by Sydney Water.
  - The asset is located within a 5m wide easement as depicted on the Detail Survey.
  - It is intended to retain existing infrastructure and protect all components during construction. All relevant approvals will be obtained prior to works commencing.
- Existing DN400 sewer main traversing the site from North to South. The sewer main is located in the downstream portion of the site and is to remain in its current alignment.
- Neighbouring development to the north previously referred to as 61 Warriewood Road, Warriewood. Refer DA N0511/10.
  - The development connects Ibis Place with Lorikeet Grove.
  - Levels throughout Lorikeet Grove are fixed at the northern boundary. It is intended to maintain levels along the northern boundary interface.
- The site is currently flood affected as reflected on Council's Online Mapping Portal.
  - Low, Medium and High-risk flood categories are illustrated in **Figure 2**.

Figure 2 - Existing Flood Conditions (NBC)

- The western portion of the site within Lot 1 is proposed to be 'cut' below existing levels to provide flood storage, matching that of existing conditions. The remainder of the site is typically filled above existing levels to provide immunity and freeboard to the relevant flooding events.
- Reference shall also be made to the site specific Flood Study prepared by CSS, provided in **Appendix D** for further details.

4 Erosion and Sediment Control

The objectives of the erosion and sediment control for the development site are to ensure:

- Adequate erosion and sediment control measures are applied prior to the commencement of construction and are maintained throughout construction; and
- Construction site runoff is appropriately treated in accordance with Northern Beaches Council requirements.

As part of the works, the erosion and sedimentation control will be constructed in accordance with Council requirements and the NSW Department of Housing Manual, “Managing Urban Stormwater Soil & Construction” 2004 (Blue Book) prior to any earthworks commencing on site.

4.1 Sediment Basin

As part of the works, the erosion and sedimentation control will be constructed in accordance with Council requirements and the NSW Department of Housing Manual, “Managing Urban Stormwater Soil & Construction” 2004 (Blue Book) prior to any earthworks commencing on site.

The sediment basin is proposed to be constructed prior to earthworks commencing and maintained throughout construction of the subdivision. The sediment basin will be designed to capture site runoff during construction.

As per Appendix C of the Blue Book, the expected soil texture group for the proposed development is Type D. The proposed sediment basin will be designed and sized during detailed design to represent this soil texture classification.

To ensure the sediment basin is working effectively it will be maintained throughout the construction works. Maintenance includes ensuring adequate settlement times or flocculation and pumping of clean water to reach the minimum storage volume at the lower level of the settling zone. The settling zone will be identified by pegs to clearly show the level at which design storage capacity is available.

The pumped water from the sediment basin can be reused for dust control during construction.

4.2 Sediment and Erosion Control Measures

Prior to any earthworks commencing on site, sediment and erosion control measure shall be implemented generally in accordance with the Development Application drawings and the “Blue Book”. The measures shown on the drawings are intended to be a minimum treatment only as the contractor will be required to modify and stage the erosion and sedimentation control measures to suit the construction program, sequencing and techniques. These measures will include:

- A temporary site security/safety fence is to be constructed around the site;
- Sediment fencing provided downstream of disturbed areas, including any stockpiles;
- Dust control measures including covering stockpiles, installing fence hessian and watering exposed areas;
- Placement of hay bales or mesh and gravel inlet filters around and along proposed catch drains and around stormwater inlets pits;
- Maintenance of the temporary sediment basin; and
- Stabilised site access at the construction vehicle entry/exits.

Any stockpiled material, including topsoil, shall be located as far away as possible from any associated natural watercourses or temporary overland flow paths. Sediment fences shall be installed to the downstream side of stockpiles and any embankment formation. All stockpiles and embankment formations shall be stabilised by hydroseeding or hydro mulching on formation.

5 Bulk Earthworks

5.1 Cut and Fill Operations

The proposed earthworks operations for the site will consist of cut to fill operations to facilitate construction of the public and private roads, residential allotments, retaining walls and public reserve.

The works associated with this Development Application details the following:

- Earthworks and operations to achieve required finished levels, road formations and flood storage requirements;
- Erosion and sediment controls;
- Retaining wall structures; and
- Interface works with the existing the road network around the site, specifically Warriewood Road, Pheasant Place, and Lorikeet Grove.

Due to the natural topography of the land, earthworks on the site will consist of cut and fill operations to achieve the desired levels.

Approximate cut to fill earthworks operations for the works subject to this development application are summarised within Enspire's engineering drawing package.

The cut and fill earthworks volumes provided are concept only and are subject to change pending final coordination and detailed civil design. It should be noted the cut and fill operations for this development are based on the following assumptions and parameters:

- No allowance for earthworks bulking factors;
- No allowance for spoil generated from utility service and stormwater drainage trenching;
- Allowance for topsoil stripping of the existing ground plane;
- A preliminary bulk earthworks surface has been adopted and is 400mm below the design surface; and
- No allowance for future house slabs.

Reference shall be made to Enspire's drawing package for further details.

6 Stormwater Management Strategy

6.1 Objectives and Controls

The stormwater strategy for the development has been developed in accordance with the proposed residential subdivision water management report prepared by C&R and Northern beaches council's Water Management for Development Policy.

The objectives of Council's Water Management for Development Policy are:

a) Improve the quality of water discharged to our natural areas to protect the ecological and recreational condition of our, beaches, waterways, riparian areas and bushland.
b) Minimise the risk to public health and safety.
c) Reduce the risk to life and property from any flooding and groundwater damage.
d) A sustainable and holistic catchment wide approach is taken to development, of both private land uses and public facilities, on flood prone land.
e) Climate change will inform decisions for future water infrastructure.
f) Water sensitive urban design measures will be integrated into the built form to maximise liveability and reduce the impacts of climate change e.g. urban heat island effect and intensified rainfall events.
g) Wherever possible, water courses are to be conserved or restored to their natural state.
h) Reduce the consumption of potable water by encouraging water efficiency, the reuse of water and use of alternative water sources.
i) Protect Council stormwater drainage assets during development works and to ensure Council's drainage rights are not compromised by development activities.

6.2 Proposed Stormwater Management Strategy

In accordance with Council's Water Management for Development Policy, the stormwater management strategy has been designed to ensure site stormwater runoff is managed in the following key areas:

- Existing and developed case catchments;
- Stormwater quantity;
- Stormwater quality; and
- Flooding.

The proposed civil engineering development package documents site levels, grading, minor and major stormwater drainage components and catchments for the site. The stormwater management strategy considered external upstream catchments as well as downstream conditions.

The lawful point of discharge for the site remains to be to Narrabeen Creek and is consistent with existing conditions.

6.3 Climate Change

The Stormwater Management strategy for the site has been developed in accordance with AR&R Version 4.2, Climate Change release.

The below 'Shared Socioeconomic Pathway' (SSP) and target period have been adopted as part of the assessment.

- SSP2-4.5: “Middle of the Road” [Intermediate emission’s]
- Target Year: 2050

Enspire’s hydraulic assessment considers the above Climate Change scenario. Rainfall multiplier has been applied as outlined in the sections following.

6.4 Flooding

A site-specific Flood Study assessment has been undertaken by CSS for the site and its surroundings. The peak water surface levels and flood extents for various storm events has been assessed for the site and results are reflected in the flood study. A summary of the results is outlined below.

Table 2 - Flood Levels (CSS)

Design Event (ARI)	Peak Flood level (m AHD) Pre-Development	Peak Flood Level (m AHD) Post-Development
1 in 2-year[1]	4.35	4.29
1 in 5-year[1]	4.44	4.38
1 in 20-year[1]	4.54	4.49
1 in 100-year[1]	4.71	4.66
Probable Maximum Flood (PMF)[1]	5.55	5.53

Inclusive of 30% Climate Change Impacts

The above flood levels are also reflected on Enspire’s engineering drawing package and in the proposed stormwater design for the development.

An overview of the 1 in 100 Yr + 30% Climate Change impacts is reflected in **Figure 3** below.

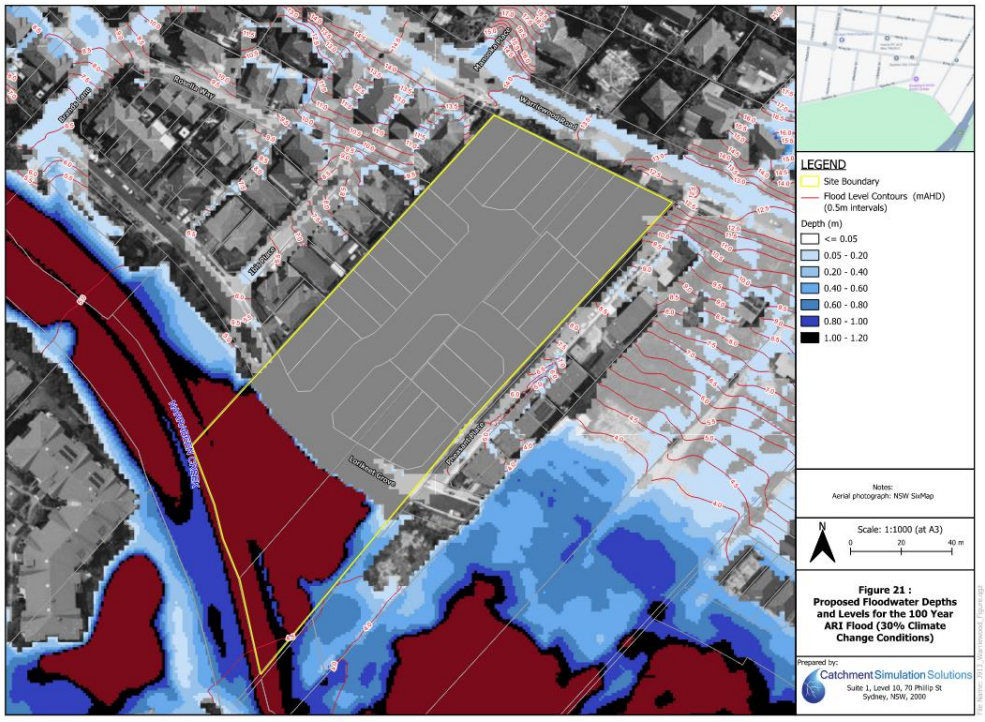

Figure 3 - 1 in 100 YR Flood Depths & Levels

Reference shall be made to **Appendix D** for further details.

6.5 External Conveyance

An upstream urban residential catchment of approximately 6.3 ha currently drains towards the site. As outlined in Section 3.2, an assessment was prepared to review the capacity of the existing DN600 trunk drainage main located on the southern boundary. The trunk drainage currently caters for a portion of the runoff resulting from the upstream catchment. As a result of the assessment, the existing trunk drainage main was determined to have:

- Be mis-aligned and not parallel to the southern boundary; and
- Have inadequate capacity and require augmentation as part of this Development Application.

Reference shall be made to the Upstream Catchment Assessment prepared by Enspire for further details.

6.6 Proposed Pit and Pipe Network

The proposed pit, pipe and overland flow network has been designed in accordance with Northern Beaches Council's Water Management for Development Policy and AR&R Version 4.2, Climate Change updates. The following key criteria as noted in **Table 3** will be considered and applied in the stormwater drainage design.

Table 3 - Stormwater Design Parameters

Design Condition	Design Criteria
General	Major Storm Event – 1% AEP Minor Storm Event – 20% AEP Inter-allotment drainage – 5% AEP
Impervious Percentage	Residential Lots – 75% Road Reserves – 95%
	Blockage factor • Sag pits 50% • On-grade pits 20%
Minor Storm Event	Maximum 150mm freeboard to grate level
	Flow width in roadway <2m or clear vehicle passage >3.5m
	Velocity x depth in roadway gutter < 0.4
Overland Flow	Reverse cross fall at road sag locations
Climate Change	Rainfall Multiplier of 1.2 applied in DRAINS.

6.7 Stormwater Quantity

The proposed stormwater management strategy has been developed in accordance with Council's Water Management for Development Policy and the Warriewood Valley Water Management Specification (WVWMS). As part of Council's policy, OSD is required to be implemented to ensure that the development does not increase stormwater discharge downstream and exceed that of the existing stormwater discharge conditions up to the 1% AEP storm event.

The development site is located within 'Region 1 – Northern Stormwater Region' as per Council's Water Management Policy, Section 9.3.1.

As presented in **Figure 4**, the development site is also located within 'Sector 4' of the Council's Warriewood Valley Urban Land Release, Water Management Specification. Certain Site Storage Requirements (SSR) and Permissible Site Discharge (PSD) requirements are set out under this specification in which have been addressed in the sections following.

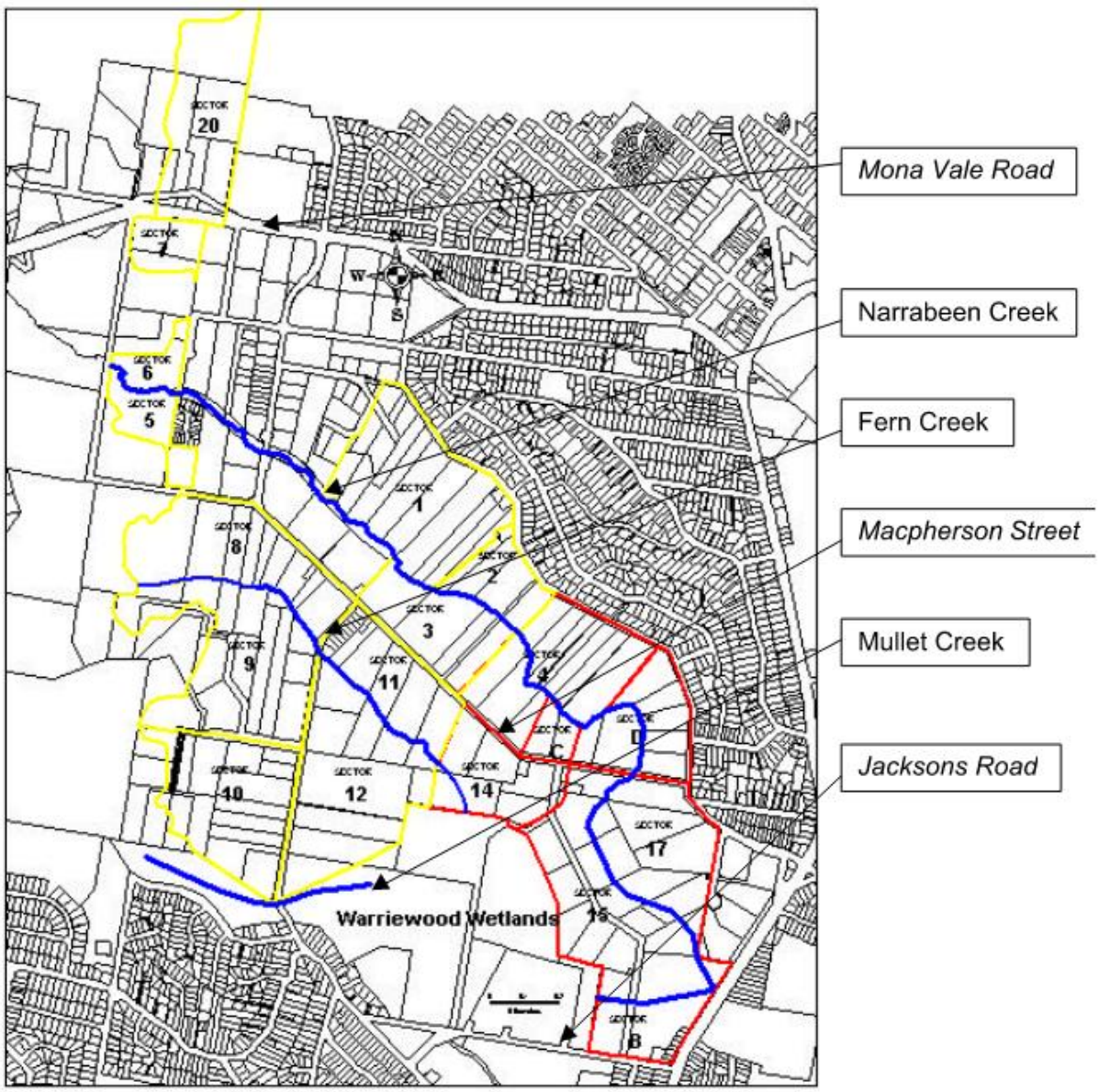

Figure 1 Sector Plan and Creeks of the Warriewood Valley - Existing Cadastre

Warriewood Valley Water Management Specification Page 1
J1887/R1817_v5

Figure 4 - WVWMS Extract (Sector 4)

In accordance with Table A.1 of Council's WVWMS, also presented in **Figure 5**, a SSR totalling 456m3 is recommended for the site.

Table A.1: Site Storage Requirements, SSR (m^3/ha) - Based on 1%AEP 1 Hour Critical Storm

Sectors	SSR (m^3/ha)
1,2,3,4,5,6,7,C,D	368
8,9	400
10	366
11,12	488
14	519
15	457

Note: Sectors 17 and B are unlikely to be further developed and have therefore been omitted.

Figure 5 – Sector 4 SSR

To ensure post-development runoff is retained to pre-development flow regimes, and in accordance with the SSR requirements for Sector 4, two (2) separate OSD tanks are proposed to restrict outflows to pre-developed conditions.

Enspire confirm the minimum SSR of 456m3 can be achieved and is reflected on the engineering plans.

6.7.1 Stormwater Quantity Modelling

The proposed subdivision will be drained by an in-ground pit and pipe network designed to convey the 20% AEP (minor) event, inclusive of Climate Change impacts. The surface drainage system (including roads) has been designed to convey flows in excess of the minor event up to and including the 1% AEP (major) storm event through overland flow.

Hydraulic modelling of the existing and proposed drainage scenarios was undertaken using DRAINS (ILSAX) modelling software. The model was prepared to represent the post-development flow regimes for the design, inclusive of Climate Change.

The ILSAX sub-areas adopted the following hydrological data and parameters:

- Post development impervious fraction (residential): 75%
- Depression storage:
    - 1mm for paved areas
    - 5mm for grassed areas
- Antecedence moisture condition: 3
- Time of concentration 5mins for impervious areas, 10mins for pervious areas.
- Climate Change rainfall multiplier: 1.2.

The climate change rainfall multiplier of 1.2 was adopted to align with the anticipated percentage increases for the selected scenario and time period (SSP2-4.5, 2050).

Further to this and as a sensitivity test, Enspire adopted Watercom's Climate Change Rainfall Modifier tool to determine the accuracy of the revised rainfall. The results are presented in **Figure 5**.

Burst Duration	Duration in Mins	Depth Factor	α %/°C	Total % Increase
≤1 hour	60	1.27	15.1%	27.0%
1.5 Hours	90	1.24	13.5%	24.0%
2 Hours	120	1.23	12.9%	23.0%
3 Hours	180	1.21	11.9%	21.0%
4.5 Hours	270	1.19	10.8%	19.0%
6 Hours	360	1.18	10.2%	18.0%
9 Hours	540	1.17	9.7%	17.0%
12 Hours	720	1.16	9.1%	16.0%
18 Hours	1080	1.15	8.6%	15.0%
≥24 Hours	1440	1.14	8.0%	14.0%

Figure 6 - Climate Change Percentage Increases

Watercom

An average rainfall modifier of 1.2 was adopted from the above, with values up to 1.27 tested for the reduced storm durations. Note rainfall data has been collected from the AR&R Data Hub and Bureau of Meteorology (BOM) websites. Reference is made to Enspire's DRAINS model for further details.

The pre-development case was assumed as 100% pervious (state of nature). The pre-development catchment plan is illustrated in **Figure 7.**

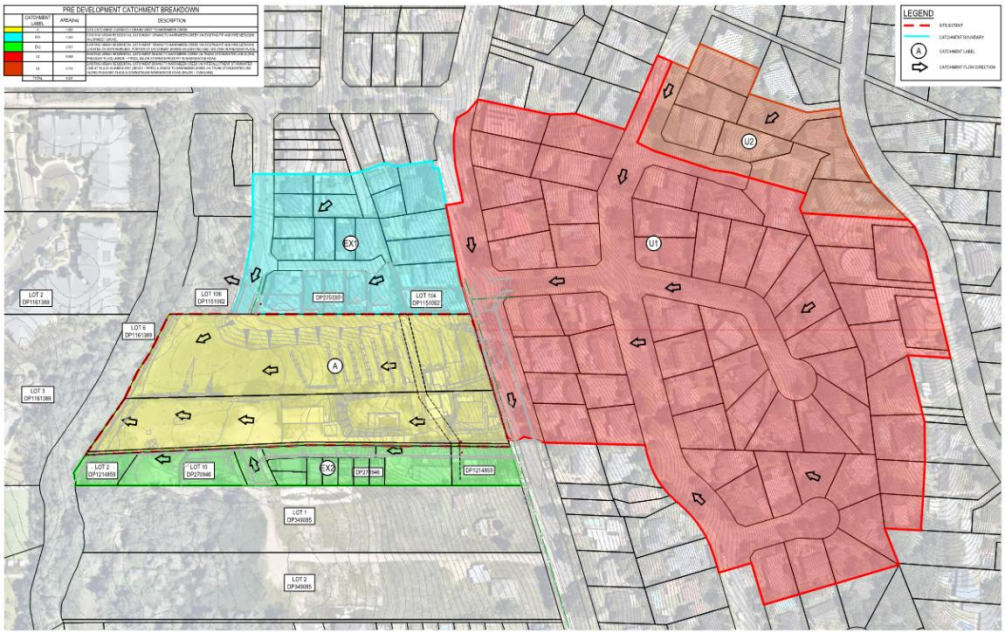

Figure 7 - Pre-Development Catchment Plan

The post-developed scenario was prepared, and the below fraction impervious parameters adopted.

- Roads: 95% Impervious, 5% pervious;
- Residential: 75% Impervious, 25% pervious; and
- Future public reserve: 100% pervious.

Both OSD tanks were incorporated into the DRAINS model to assess the performance of the overall system, including top water levels, freeboard, inflows, outflows and total storage requirements. The results are discussed in Section 6.6.2.

The proposed development catchment plan is illustrated in **Figure 8.**

Figure 8 - Post-Development Catchment Plan

6.7.2 Stormwater Quantity Results

A pre- to post-development flow assessment was undertaken for the site. The calculated Permissible Site Discharge (PSD) considers the subject site only and does not cater for any external catchments. All flows generated external and upstream of the site will not be conveyed via the pit and pipe network within the subdivision, but rather the trunk drainage and existing overland flow paths around the site.

The pre- to post-development flow assessment results are outlined below in **Table 4**. Results were taken at the lowest point of the site being Narrabeen Creek.

Table 4 – Pre-Post Flow Assessment

Storm Event	Pre-Development Flow (m^3/s)	Post-Development Flow (m^3/s)	Compliant
20% AEP	0.509	0.506	Yes
5% AEP	0.717	0.641	Yes
1% AEP	0.921	0.809	Yes

From the above, Enspire confirm with the provision of the OSD systems, post development flows are less than or equal to pre-development flows at the site discharge point.

6.8 Stormwater Quality

6.8.1 Stormwater Quality Objectives (Water Sensitive Urban Design)

The stormwater strategy for the development has been developed in accordance with the proposed residential subdivision water management report prepared by C&R and Northern beaches council's Water Management for Development Policy.

The objectives of Council's Water Management for Development Policy are:

a) Stormwater quality (temperature, salinity, chemical makeup and sediment beds) discharging from the development shall not impact the receiving waters. Reference shall be made to local data if available, including the Warringah Creek Management Study and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC), or other widely accepted guidelines. Stormwater and other drainage shall not be discharged into saltmarsh.
b) Disturbance to stream and wetland sediments is to be minimised by regulated discharge of stormwater and dissipation of flows at discharge locations. Runoff from the development must be retained at natural discharge rates and sediments controlled at the source.
c) Stormwater and groundwater flow is to mimic natural conditions and ensure a dispersed pattern of flow, avoiding centralised or concentrated discharge points into the wetland or waterway. Natural flow regimes must be retained. The reduction or increase in flows, alteration in seasonality of flows, changes to the frequency, duration, magnitude, timing, predictability and variability of flow events, altering surface and subsurface water levels and changing the rate of rise or fall of water levels must be avoided.

6.8.2 Stormwater Quality Management Strategy

A water quality analysis has been undertaken to assess the performance of the proposed WSUD strategy against the adopted stormwater quality targets. The stormwater quality analysis for this study was undertaken using the industry standard software model MUSIC (Model for Urban Stormwater Improvement Conceptualisation) Version 6.3.

MUSIC modelling was undertaken in accordance with the guidelines outlined in the NSW MUSIC Modelling Guidelines (BMT WBM 2015). The post-development catchments for the site have been separated into five unique land use nodes, specifically roof, road, impervious, pervious and driveways, with treatment nodes adopting parameters set out in the NSW MUSIC Modelling Guidelines and generally accepted industry parameters for proprietary products. Rainwater tanks have been included to the assessment.

The development will include two (2) permanent OSD and water quality tanks to attenuate and treat stormwater runoff. The overall treatment system will involve the use of proprietary cartridge filters within the tanks, pit basket inserts within road pits, rainwater tanks for future residential lots and an end of line vegetated swale as demonstrated on Enspire's engineering drawing package.

Refer to **Figure 9** for the proposed MUSIC Model strategy.

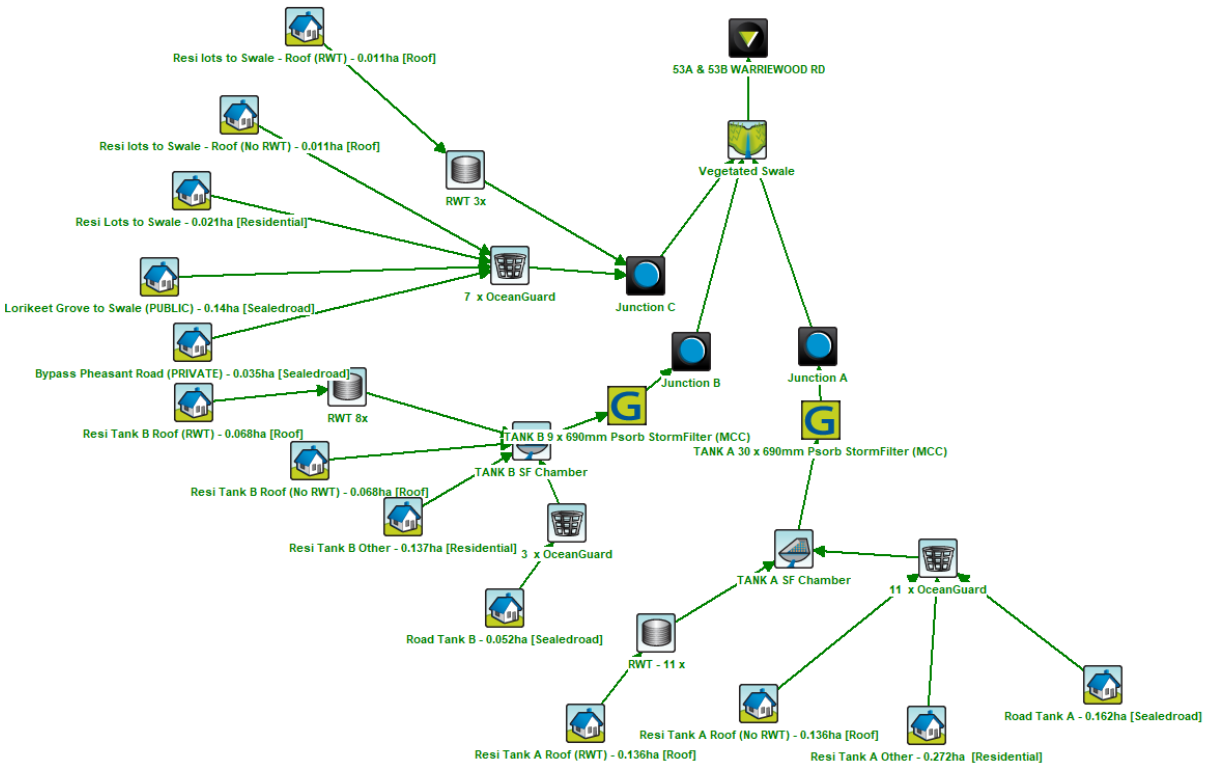

Figure 9 - MUSIC Model

6.8.3 MUSIC Model Results

The MUSIC model was run to estimate the annual pollutant loads generated by the proposed development, as well as the resultant pollutant loads discharging from the site after flows pass through the proposed treatment train.

Table 5 summarises the average annual pollutant loads and reductions.

Table 5 - Water Quality Targets

Pollutant	Performance Target	Performance Result	Compliant
Gross Pollutants	90% reduction in the post development mean annual load (for pollutants greater than 5mm in diameter)	100	Yes
Total Phosphorus	65% reduction in the post development mean annual load	65	Yes
Total Nitrogen	45% reduction in the post development mean annual load	49.2	Yes
Total Suspended Solids	85% reduction in the post development mean annual load	90	Yes

The results above demonstrate that the proposed stormwater quality strategy meet Council's target reductions for pollutant loads.

7 Siteworks

7.1 General

The proposed development works will involve construction of multiple new roadways. The road network will include the extension of Lorikeet Grove to the north and south and formation of two (2) new internal private roadways for the subdivision. A new permanent turning head arrangement is required to facilitate access to the future residential lots as shown on the engineering plans.

Pheasant Place will remain to be an existing access road to service existing residential lots to the south. It is proposed to connect into and locally widen the existing roadway to provide access to Road 02 and Lorikeet Grove as reflected on the engineering drawings.

Works are also proposed within Warriewood Road reserve and include half-road construction, formation of a new 3m wide bus bay, and a 2.1m wide car parking bay.

Figure 10 demonstrates the proposed road layout.

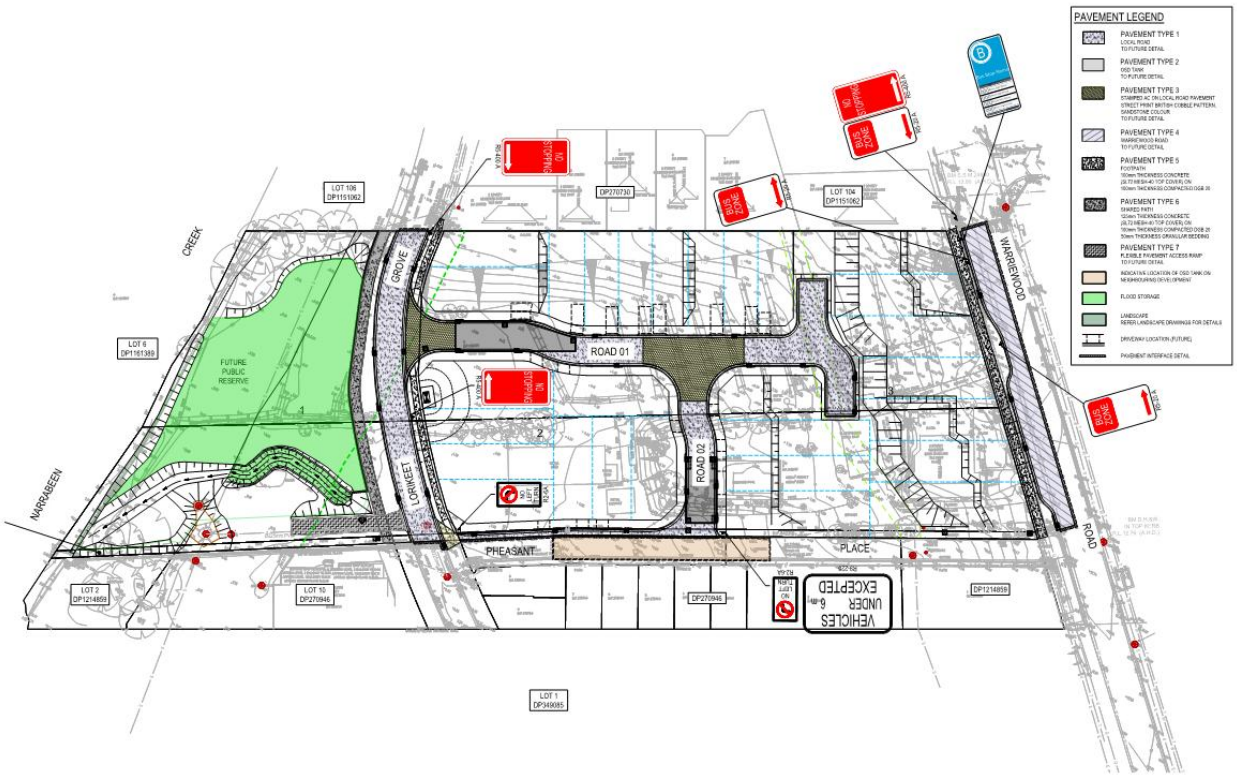

Figure 10 - Proposed Road Layout

7.2 Road Types

It is proposed that the following road hierarchy outlined in **Table 6** applies to the development.

Table 6 – Typical Road Sections

Road	Category	Typical Road Carriageway	Comments
Warriewood Road	Minor Collector	Existing road carriageway width varies ~ 9.4m	Half-road construction. Bus bay 3m wide. Parking bays 2.1m – On-street parking.
Lorikeet Grove	Local Access Road	7.5m 3.75m travel lanes	12.5m wide road reserve north of site.
Lorikeet Grove	Local Access Road	7.5m 3.75m travel lanes	16m wide road reserve south of site.
Pheasant Place	Private Access Road	7.6m 3.8m travel lanes	11.2m wide road reserve with-out on-street parking.
Road 01, 02	Private Access Road	7.5m 3.75m travel lanes	12.5m wide road reserve.

The proposed roadways are designed in accordance with normal engineering practice, Council's Engineering Design Code and relevant Austroad specifications.

7.3 Design and Posted Speed

Lorikeet Grove is intended to have a posted speed limit of 50km/h. The internal private roads are intended to be of a lower speed environment typical of 30km/h operating speeds.

- Lorikeet Grove (Local Access Road) – 50km/h
- Roads 01, 02 and Pheasant Place (Access Road) – 30km/h.

7.4 Parking and Signage

On-street parking is to be provided as outlined in **Table 6.**

Signage, line marking, and road pavement surface treatments will be provided for appropriate warning to vehicles, traffic calming at local road intersections and improve driver awareness in critical locations. Appropriate signage and linemarking provisions will be incorporated during detailed design phase of the development.

Reference is to be made to Enspire's engineering drawing package for details of proposed pavement, signage and line marking.

7.5 Vertical and Horizontal Geometry

The road geometry has been designed in accordance with Council's Engineering Design for Development guidelines and generally in accordance with AUSTROADS Guide to Road Design

Part 3. The vertical and horizontal geometry has considered sight distance in accordance with AUSTROADS Guide to Road Design Part 3.

Horizontal alignments, longitudinal gradients and vertical curves have been designed in accordance with Section 0041 – Geometric Road Design of AUSPEC 1.

7.6 Design Vehicles

Design vehicles for the development include a 5.2m passenger car (B99), and a 12.5m rigid truck as a checking vehicle. Swept path analysis has been completed for the proposed road network using AutoTURN software and in accordance with AUSTROADS (2006) and Council's Guidelines.

Reference is to be made to Enspire's engineering drawing package for swept path analysis.

7.7 Pavement Design

Pavements for the local road network will be designed as part of the detailed design phase generally in accordance with AUSTROADS Guide to the Design of New Pavements for light Traffic and Northern Beaches Engineering Design Code (AUSPEC 1).

The following design ESA traffic loadings have been adopted for each road category:

- 1×10^6 – Minor collector road (Warriewood Road).
- 4×10^4 – Local access (Lorikeet Grove, Internal Roads).

Indicative pavement designs for each type of pavement in the development based on an assumed subgrade CBR of 3% is as follows:

- Minor Collector – Flexible Pavement
    - 25mm AC10 deferred Wearing Course on
    - 25mm AC10 Wearing Course on
    - 10/7mm Double Coat Flush Seal on
    - 150mm DGB20 Basecourse on
    - 370mm DGS40 Sub-Base

- Local Access – Flexible Pavement
    - 25mm AC10 deferred Wearing Course on
    - 25mm AC10 Wearing Course on
    - 10/7mm Double Coat Flush Seal on
    - 150mm DGB20 Basecourse on
    - 210mm DGS40 Sub-Base

- Vehicular Crossings – To Council Standard Detail. Indicative profile as follows:
    - 125mm Concrete (SL62 mesh – 50 Top Cover) on
    - 25mm approved fine granular material, except where under the kerb and gutter line where this section is to be placed on
    - 150mm DGB20 Sub-Base

It is noted that the proposed AC layer is not considered as a structural layer of the pavement in accordance with Austroads Specifications.

Final pavement design is subject to future detail through the Subdivision Works Certificate phase of the development. Reference shall be made to Enspire's engineering plans for further details on proposed pavement treatments.

7.8 Retaining Walls

Retaining wall structures associated with the development are proposed to be constructed under this Development Application. Wall details and specifications will be provided during the detailed design phase of the development. Indicative sections are reflected on the submitted engineering plans to demonstrate feasibility.

The existing retaining wall located on the southern boundary currently supports Pheasant Place accessway. The wall also supports an existing OSD tank located within Pheasant Place as reflected in **Appendix B**.

The retaining wall is to remain in its current alignment, with sections of the wall filled against and buried to allow the new road connections. A structural engineering assessment of the existing structure is to be undertaken to confirm adequacy of the proposal.

An overview of the retaining wall locations is presented in **Figure 11**.

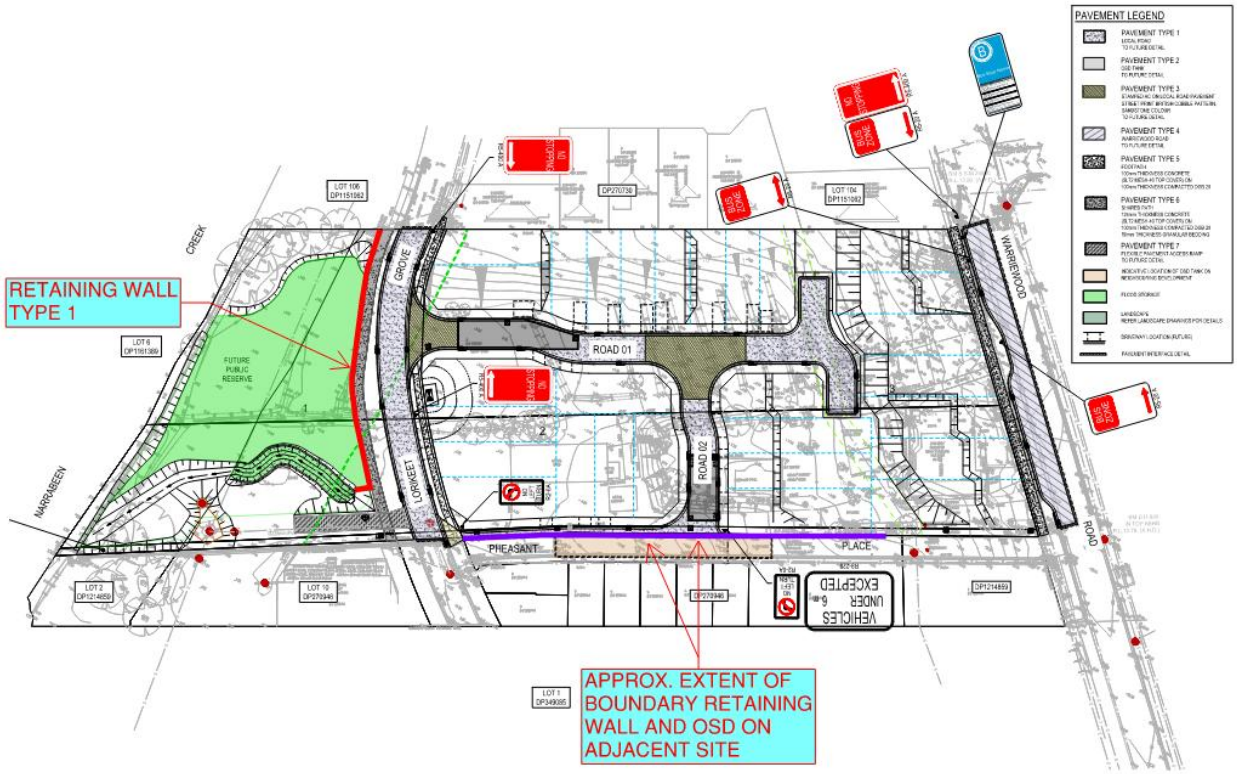

Figure 11 - Retaining Walls

8 Utilities

New utility infrastructure will be provided to service the proposed subdivision. These services will be placed in typical shared trench arrangements in accordance with the NSW Streets Opening Conference Guide to Codes and Practices for Streets Opening (2009) or equivalent alternative approved by the relevant authority.

The services to be provided within the development include:

1. Potable Water;
2. Sewer;
3. Telecommunications;
4. High and low voltage electrical services, including street lighting; and
5. Natural Gas.

The design of all utilities will be submitted as part of the construction certificate application and to each relevant authority.

8.1 Potable Water

The development at Warriewood Road will be serviced by extension of existing potable water main in Lorikeet Grove.

The development is intended to be serviced by Sydney Water. Potable water reticulation mains are located within Lorikeet Grove Warriewood Road. It is anticipated the potable water reticulation within the site will be serviced from the existing DN150 and DN100 mains located in Lorikeet Grove and Warriewood Road.

Refer **Figure 12** for the Sydney Water Hydra and existing potable water layout.

A Section 73 Certificate Application to Sydney Water will be required for assessment. Sydney Water will then issue a Notice of Requirements to outline the servicing requirements for the proposed development.

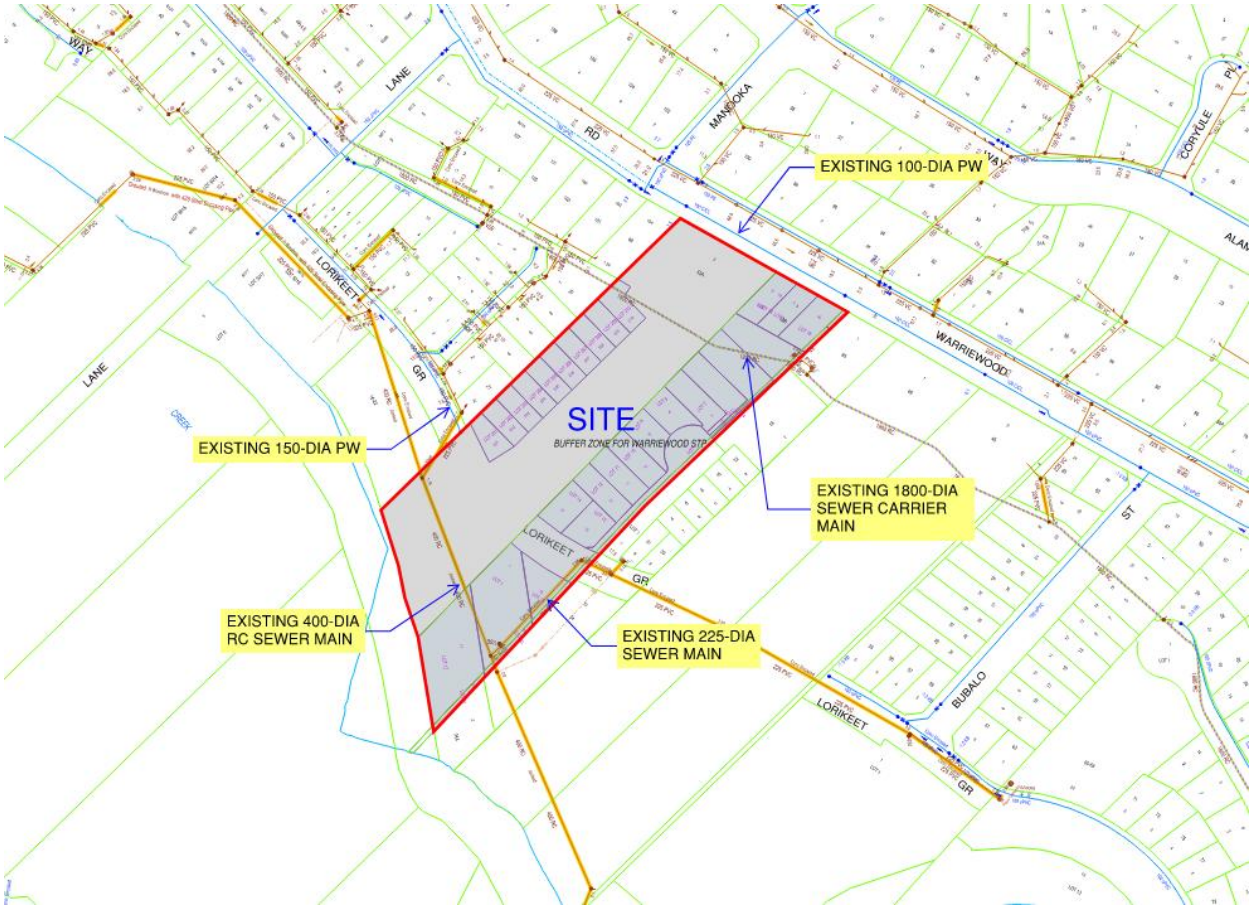

Figure 12 - Sydney Water Hydra

8.2 Sewer

Multiple existing sewer mains are located throughout the site as per the following:

- Existing 1800-dia RC sewer carrier main located within the northern portion of the site. The significant infrastructure is to be retained and protected throughout all proposed works. All works are subject to approvals with the authority;
- Existing 400-dia RC sewer main located within the southern portion of the site. The infrastructure is to be retained and protected throughout all proposed works. All works are subject to approvals with the authority; and
- Existing 225-dia PVC sewer main.

The main point for connection is to the Southern corner within Lorikeet Grove. It is proposed to connect to the existing 225-dia gravity sewer mains at this location. It is intended that internal reticulation will be through a new gravity sewer network within the development, subject to future design development.

A Section 73 Certificate application to Sydney Water will be required to be submitted for assessment. Sydney Water will then issue a Notice of Requirements to outline the servicing requirements for the proposed development.

Refer **Figure 11** for the Sydney Water Hydra and existing Sewer layout.

8.3 Telecommunications

Telecommunication services will be provided by NBN and will be provided to each future residential lot within the development site. NBN services are expected to be extended from Lorikeet Grove to the north and is subject to future design by others.

8.4 High and Low Voltage Electrical Services

Ausgrid is the existing service provider for the surrounding developments. It is proposed to service the development site by extending the electrical service conduits and cabling from Lorikeet Grove, subject to Ausgrid requirements and approvals. An electrical substation will be located within the development site and will be subject to authority requirements.

As part of the development, it is also proposed to underground the existing overhead electrical mains within Warriewood Road reserve. An application to Ausgrid will be required to be submitted for assessment. Ausgrid will then confirm the servicing requirements for the proposed development.

8.5 Natural Gas

It is anticipated that the natural gas supply will be extended from Lorikeet Grove to service the development, subject to Jemena requirements and approval. Gas reticulation is expected to follow a similar layout to the electrical reticulation. An application to Jemena for a gas connection is required.

9 Conclusion

This Civil Engineering report has been prepared to provide a summary of the road design assumptions and adopted design procedures, and a guide to the stormwater quantity and quality management techniques for the proposed development as depicted in **Figure 1**.

The overall stormwater management strategy has been prepared in conjunction with the Water Management Report previously prepared for the site. Reference shall be made to the supporting documents provided in the Appendix for further details.

Proposed horizontal and vertical road alignments will meet the requirements of Council's Engineering Design Code, and Austroads Guidelines.

Appendix A Detail Survey

Colliers

Appendix B 53C Warriewood Road

Stephen Bower Architects & Jones Nicholson

Appendix C 61 Warriewood Road DA N0511/10

Proust & Gardner & Alkira Homes

Appendix D Flood Impact Assessment

Catchment Simulation Solutions