Water Cycle Management Study

BlueScope Woods Residential Estate and BlueScope Employment Hub

8201911101

Prepared for

BlueScope Steel (AIS) Pty Ltd

30 June 2020

Cardno

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Table of Contents

Tables

Figures

1 Introduction

1.1 Overview

Cardno (NSW/ACT) Pty Ltd (Cardno) has been engaged by BlueScope Steel (AIS) Pty Ltd to prepare a Planning Proposal (PP) and a Neighbourhood Plan (NP) for the future urban development of five lots owned by BlueScope Steel (AIS) Pty Ltd (BSL) at Kembla Grange, and located within the West Dapto Urban Release Area (URA). The development is known as the BlueScope Woods Residential Estate and BlueScope Employment Hub.

The subject site is located within the Mullet Creek catchment in the Wollongong LGA. The majority of the site is located within the catchments of Dapto Creek and Sheaffes Creek, which are both tributaries of Mullet Creek. The confluence of these three watercourses is located some 500 m downstream of the site. As such, the site is subject to mainstream flooding and overland flow flooding.

As part of the Planning Proposal, Cardno has been engaged to undertake a Water Cycle Management Study (WCMS) to demonstrate that the proposal is in accordance with the environmental controls for floodplain management, stormwater management and water sensitive urban design as required by Wollongong City Council (WCC) The scope of works involved:

- Local refinement of the Mullet Creek Flood Model Update TUFLOW model using detailed topographic survey and the updated WCC Conduit Blockage Policy;
- Revision of pre-development flood extents, levels, velocities and hazards based on the refined model;
- Development of a post-development site layout, including areas of cut and fill, with a view to maximising the developable land whilst meeting WCC flood-related planning controls;
- Reviewing Wollongong City Council (WCC) planning policies and other documents, including
  - Wollongong Local Environmental Plan 2009, Clause 7.3;
  - Development Control Plan 2009 (WDCP 2009) Chapters E13, E14, E15, E23 and D16;
  - Draft West Dapto Vision Document (2018);
  - Riparian Corridor Management Strategy (DIPNR-2004); and
  - Pre-Lodgement Council Comments, received 11/6/2020, based on Pre-Lodgement Meeting (2/6/20);
- Preparation of Water Cycle Management Study report for inclusion in the Planning Proposal and Neighbourhood Plan submission.

1.2 Study Area

The site is located at West Dapto, within the suburb of Kembla Grange and to the north of the established suburb of Horsley. It is located approximately 2.5 km from the Dapto Town Centre and 10 km from the Wollongong City Centre, the site is shown in **Figure 1**-1 overleaf, and **Figure A1**. The topography is characterised by steep slopes northwest of the site with incised channels, and relatively flat land across the site itself, with broader flowpaths and overland flow. The five lots (collectively known as ‘the site’) consist of:

North of West Dapto Road, known as 84 Sheaffes Road, Kembla Grange:

- Lot 1 DP 588139
- Lot 2 DP 230137.

South of West Dapto Road, known as 261 West Dapto Road, Kembla Grange:

- Lot 1 DP 588140
- Lot 1002 DP 1192327.

1.2.1 North-western Precinct

The north-western precinct is bounded by Paynes Road to the west, Sheaffes Road to the south, West Dapto Road to the southeast; neighbouring rural lands to the north, the Illawarra Escarpment State Conservation Area to the east and existing industrial and rural lands to north east.

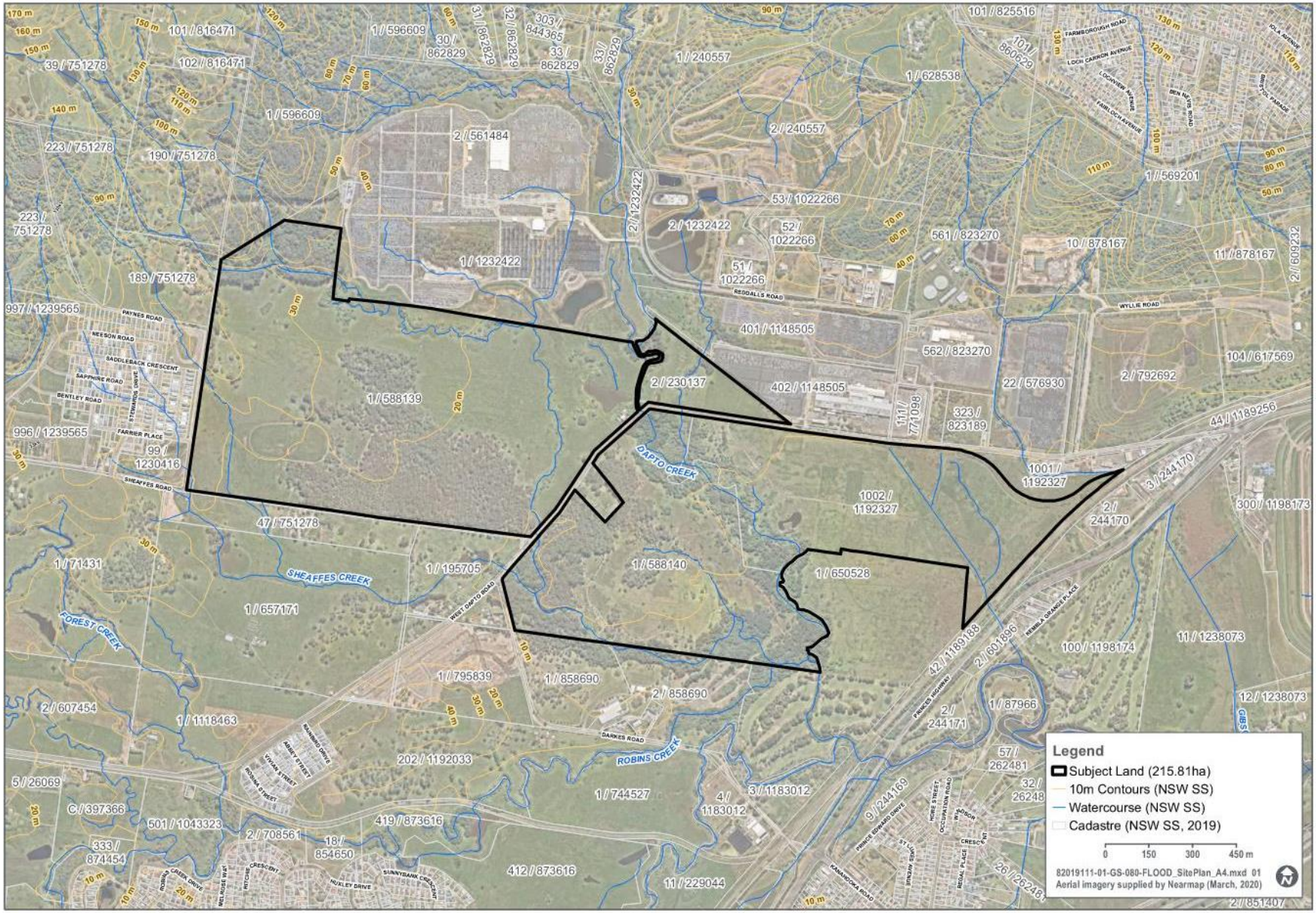

Figure 1-1 Site Layout

The site is largely undeveloped and has been used for livestock grazing with grassed areas in the central, north eastern and south eastern portions of the site. The south, middle and north west portions of the site are vegetated with a stand of remnant trees. A creek line (Sheaffes Creek) with areas of existing riparian vegetation runs along the northern boundary of the site and another in the south west corner.

The site broadly slopes towards West Dapto Road to the east. Surface water at the site is inferred to infiltrate or flow via surface runoff to the tributaries and creeks that generally flow from the north to the south and south east.

1.2.2 South-eastern Precinct

The south-eastern precinct is bounded to the north and northwest by West Dapto Road; to the southwest by Darkes Road; to the southeast by the South Coast Railway Line and Princes Highway. The Kembla Grange Golf Club is situated to the south-east beyond the existing railway line.

The site is largely undeveloped and has been used for livestock grazing and horse agistment within grassed areas in the north eastern portions of the site, and as informal recreation in the south-western portion utilised by Kembla Joggers. Three creek lines with riparian vegetation run across the site: Dapto Creek from the north-west to the south-east, Sheaffes Creek from the west to the east, and Robins Creek briefly within the site boundary at the south-east. All creeks are bounded by dense vegetation, mapped as a riparian corridor.

The south-eastern precinct broadly slopes towards the south-east. Surface water at the site is inferred to infiltrate or flow via surface runoff to the tributaries and creeks that generally flow from the north to the south and south east.

1.3 Study Objectives

Wollongong City Council (WCC) requires a proponent to demonstrate that the proposed development will not cause adverse flood impacts outside the site, and that the development itself will demonstrate compliance with Council's planning policies (including but not limited to the Wollongong LEP 2009 and Wollongong DCP 2009).

The objective of this Water Cycle Management Study is to undertake an assessment of flooding, on-site detention and water quality for the subject site and to provide advice for the proposed development. An overview of the assessment methodology is as follows:

- Define the pre-development and post-development design flood behaviour for the site in the 1% AEP and PMF events;
- Ensure that, in principle, the proposed development will be able to comply with Council's flood related planning controls;
- Develop an indicative on-site detention (OSD) strategy for the site; and
- Provide an overview of water quality and water sensitive urban design considerations for the proposed development.

2 Flood Assessment Methodology

2.1 Available Data

The flooding assessments were informed by the following data:

- Mullet Creek Flood Model Update (BMT WBM, 2018);
- Aerial Laser Scanning (ALS), collected by AAM 2005-2006, purchased from WCC;
- Detailed ground survey (Cardno, October 2019);
- Details of the WCC Conduit Blockage Policy (WCC DCP Ch. E13 & E14, Updated Mar 2020);
- Proposed site layout (Cardno, June 2020).

2.2 Hydraulic Modelling Approach

2.2.1 Pre-Development Conditions

The subject site is located within the study area for the 2018 Mullet Creek Flood Model Update (BMT WBM, 2018). The Mullet Creek Flood Model Update built on previous work undertaken by Bewsher Consulting in 2010 and 2011, and ensured that the modelling represented current catchment conditions.

The Flood Model Update used a WBNM hydrological model to generate design inflow hydrographs using IFD and storm burst temporal patterns from the 1987 version of Australian Rainfall and Runoff (ARR1987).

The adopted grid size for the TUFLOW hydraulic model was 5 m x 5 m.

The WBNM hydrological model, and TUFLOW hydraulic model developed by BMT WBM were used to establish benchmark pre-development conditions for this WCMS, allowing the flood assessment presented herein to be undertaken using the most recent information available.

Two key modifications were made to the adopted Mullet Creek Flood Model Update for use in this WCMS:

- The DEM was refined locally using detailed survey collected by Cardno in March 2019 and October 2019; and
- The blockage applied to bridges and culverts was updated to reflect the current WCC Conduit Blockage Policy (WCC DCP, March 2020).

The prescribed ‘Risk’ blockage factors were applied to the existing and proposed hydraulic structures within the site boundary. This blockage scenario was selected as a basis for undertaking the hydraulic analysis for this study.

2.2.2 Post-Development Conditions

A concept level post-development site layout was formulated that balances the objectives of maximising developable land for the establishment of residential areas and industrial areas, while managing flood risk both within and beyond the site boundary.

The post-development site layout is shown on **Figure A2**, and includes the land-forming features listed in **Table 2-1**.

It is noted that the below listed features will be further refined during the DA design development process.

Table 2-1 Key Land-forming Features for the Post-Development Scenario

Area ID	Proposed Land Use Type	Description of Key Land-forming Features
A	Residential	> Create a fill pad to elevate the south western corner of the site by approximately 1.2 m on average
	Industrial	> No earthworks are proposed
B	Industrial	> Fill the existing man-made dam on the eastern half of Area B (approx. 1.5 m depths to be filled) > create a fill pad, approximately 1.4 m above existing ground level on average; > Note that the western part of Area B is largely above the 1% AEP level, however some fill is required in the southwestern portion (to a level 1.2 m - 1.9 m above existing ground level; > An open channel is proposed along the northern boundary of Area B, approximately 30 m wide, and with depth ranging from 1 m below ground at the western (upstream) end, to 2 m at the eastern (downstream) end; and > Between area B and C, east of Dapto Creek, it is proposed to excavate an area of 0.9 ha to a depth of approximately 1.4 m, to create approximately 14,700 m^3 of flood storage. This additional floodplain storage is designed to offset the filling of the man-made dam in Area B, as well as the fill pad required for Area C (described below);
C	Industrial	> The existing flowpath through Area C will be formalised into a 30 m wide swale, grading from 1 m deep at the northern end to 2.5 m deep at the southern end; > Two fill pads are proposed to elevate Area C: – The western pad is to be filled by up to 1.2 m on average; – The eastern pad is to be filled by up to 0.5 m.
D	Industrial	> No land-forming is proposed, Area D is outside the floodplain (except for an incised channel at the south eastern corner. This is not proposed to be modified.
E	Residential	> Two fill pads are proposed to raise ground levels by 0.5 m
F	Industrial	> Two 30 m swales are proposed to run along the northern and southwestern/southern boundaries of Area F; > The northern swale ranges from 1.9 m to 2.4 m below existing ground levels; > The southern swale ranges from 1.5 m to 2.0 m below existing ground levels; > Area F is proposed to be raised by up to 1 m on average above existing ground levels; and > A basin is proposed at the eastern end of the site to both offset the fill over Area F and provide storage for flows entering from the two swales prior to discharging from the site. The basin will involve excavation to depths ranging from 0.7 m- 2 m to create a volume of approximately 107,365 m^3

2.3 Provisional Hazard

Criteria for provisional hazard are in accordance with the 2005 NSW Floodplain Development Manual (NSW Government, 2005). The Manual defines provisional hazard as one of three categories – low, transitional and high. The provisional hazard curves are shown in **Figure 2-1**.This hazard classification is used in the derivation of Flood Risk Precincts (see **Section 2.6**), which govern the flood-related development controls that apply to the proposed development (see **Section 4.2**).

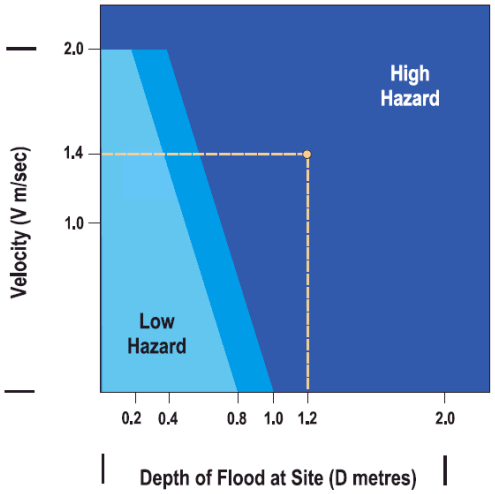

Figure 2-1 Provisional Hazard Curves (reproduced from the Floodplain Development Manual, 2005)

2.4 General Hazard

Further research into the relationship between the product of the velocity and depth of floodwaters has provided information on the potential vulnerability of people, vehicles and structures. Guidance from the Technical Flood Risk Management Guideline (Australian Emergency Management Institute, 2014) classifies hazard into six general categories from H1 (least hazard) to H6 (Highest Hazard). Book 6, Chapter 7 of the ARR 2019 guidelines support the use of these hazard curves for risk management. The general hazard curves are shown in **Figure 2-2**.

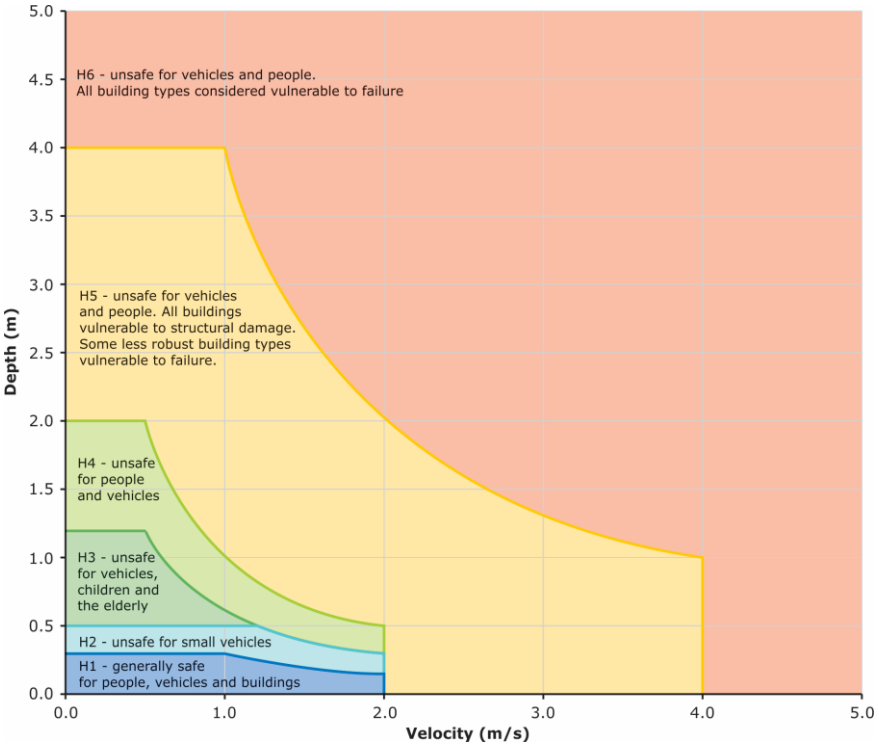

Figure 2-2 General Hazard Curves (reproduced from AIDR, 2017)

2.5 Hydraulic Categories

The hydraulic categories defined in the Floodplain Development Manual are:

- **Floodway** – Areas that convey a significant portion of the flow. These are areas that, even if partially blocked, would cause a significant increase in flood levels or a significant redistribution of flood flows, which may adversely affect other areas.
- **Flood Storage** – Areas that are important in the temporary storage of the floodwater during the passage of the flood. If the area is substantially removed by levees or fill it will result in elevated water levels and/or elevated discharges. Flood Storage areas, if completely blocked would cause peak flood levels to increase by 0.1m and/or would cause the peak discharge to increase by more than 10%.
- **Flood Fringe** – Remaining area of flood prone land, after Floodway and Flood Storage areas have been defined. Blockage or filling of this area will not have any significant effect on the flood pattern or flood levels.

For the purposes of this assessment, the definition of hydraulic categories has been adopted from the Mullet Creek Flood Model Update (BMT WBM, 2018). The definitions for each category are provided in **Table 2-2.**

Table 2-2 Hydraulic Categorisation (after Mullet Creek Flood Model Update, BMT WBM, 2018)

Category	Definition
Floodway	> Velocity x depth greater than 0.25 m^2/s and velocity greater than 0.25 m/s; or > Velocity greater than 1 m/s.
Flood Storage	> Areas which do not operate as floodways but where the depth of inundation exceeded 1 m.
Flood Fringe	> remaining area of land affected by flooding, after floodway and flood storage areas have been defined.

2.6 Flood Risk Precincts

Flood Risk Precincts are used by Councils to delineate the floodplain into areas with different levels of potential flood risk, and to determine areas where flood related development controls should be applied.

As described in Chapter E13 of Council's DCP (2009), flood prone land is divided into three flood risk precinct categories (refer to **Table 2-3**). A flood risk precinct (FRP) plan has been developed for both pre-development and post-development conditions across the site in accordance with the guidelines set out in Chapter E13 of Councils DCP (2009), and is presented in **Figure B11** and **Figure C13** respectively.

Table 2-3 Flood Risk Precinct (FRP) Categories

Risk Precinct	Definition
High	The High FRP is where high flood damages, potential risk to life and/or evacuation problems would be anticipated or where development would significantly or adversely alter flood behaviour. This area includes floodways. In this precinct, there would be a significant likelihood of flood damages and/or danger to life. The High FRP includes: i) Areas greater than H3 hazard conditions during a 1% AEP flood; ii) Land within 10m from the top of a watercourse bank; and iii) Floodways.
Medium	In this precinct there would be a significant likelihood of flood damage and/or danger to life, but these damages or danger to life can be minimised by the application of appropriate development controls.

	The Medium FRP includes: i) land below the 1% AEP level plus 0.5 m that is not within the High FRP area inundated in a 1% AEP plus freeboard and not classified as High FRP.
Low	This precinct is where the likelihood of damages is low for most land uses. The Low FRP includes: i) All areas within the floodplain (i.e. within the extent of the PMF) but not identified within either the High FRP or the Medium FRP; and ii) All areas within the 2100 Coastal Zone Inundation Extent not classified as a Medium Flood Risk or High Flood Risk Precinct.

3 Flood Assessment

3.1 Pre-development Conditions

The pre-development flood conditions were established using the Mullet Creek Flood Model Update TUFLOW model with the local revisions described in Section 2.2.1. Mapped results for the pre-development conditions are presented in **Appendix B** (and summarised in **Table 3-1**).

Table 3-1 Pre-Development Conditions Figure Index

Figure	Conditions	Title
B1	Pre-Development	1% AEP Depth and Water Levels
B2	Pre-Development	1% AEP Velocity
B3	Pre-Development	1% AEP Provisional Hazard
B4	Pre-Development	1% AEP General Hazard
B5	Pre-Development	1% AEP Hydraulic Categories
B6	Pre-Development	PMF Depth and Water Levels
B7	Pre-Development	PMF Velocity
B8	Pre-Development	PMF Provisional Hazard
B9	Pre-Development	PMF General Hazard
B10	Pre-Development	PMF Hydraulic Categories
B11	Pre-Development	Flood Risk Precincts

A description of the existing flood behaviour is as follows:

- At the western side of the site, overland flow draining in a south-easterly direction towards Sheaffes Creek affects the south western corner of proposed Residential Area ‘A’. The flow in this corner is less than 0.15 m deep in the 1% AEP event, is classified as Low Hazard (FDM, 2005) or H1 (AIDR, 2017), and is categorised as flood fringe;
- Moving east, an unnamed watercourse flows from north to south along the western edge of Area B. This is an incised channel categorised as a floodway bordered by flood fringe, with H5/ high hazard zones in the deepest part of the channel;
- Dapto Creek flows from the north of the site through to the south east. The channel and immediate overbank areas are classified as High hazard (H5), and is categorised as floodway;
- In the 1% AEP event, a secondary flowpath breaks out of Dapto Creek near the northern boundary of the site, and flows in an easterly direction towards the Princes Highway;
- This flowpath is categorised as a floodway, and is classified as experiencing H3-H5 hazard. Compared to Dapto Creek however, this flowpath is broader and shallower, and spans the northern portion of Area F;
- At the eastern boundary of the site, the Illawarra Railway embankment forms a significant hydraulic control, causing flow from this eastern flowpath, as well as a minor flowpath entering the site from the north and Dapto Creek itself to backwater behind the railway embankment.
- In the PMF, much site east of Dapto Creek is classified as H5/ High Hazard, as Dapto Creek and the eastern flowpath converge to cover most of Area F. This area is categorised as floodway in the PMF, with peak flood velocity ranging from 1 m/s - 2 m/s.

3.2 Post-development Conditions

Mapped results for the post-development conditions TUFLOW model are presented in **Appendix C** (summarised in **Table 3-2**).

Table 3-2 Post-Development Conditions Figure Index

Figure	Conditions	Title
C1	Post-Development	1% AEP Depth and Water Levels
C2	Post-Development	1% AEP Velocity
C3	Post-Development	1% AEP Provisional Hazard
C4	Post-Development	1% AEP General Hazard
C5	Post Less Pre-Development	1% AEP Water Level Difference
C6	Post-Development	PMF Depth and Water Levels
C7	Post-Development	PMF Velocity
C8	Post-Development	PMF Provisional Hazard
C9	Post-Development	PMF General Hazard
C10	Post Less Pre-Development	PMF Water Level Difference
C11	Post-Development	Flood Risk Precincts

A description of the post-development results is provided below:

- Area A is flood free in both the 1% AEP and PMF events;
- Area B is flood free in the 1% AEP, however is affected by shallow inundation in the PMF (less than 0.5 m);
- The western portion of Area C is subject to shallow inundation (less than 0.15 m in the 1% AEP), while the eastern portion is flood free in the same event. In the PMF event, the majority of Area C is subject to inundation with depths up to 0.5 m in the western portion, and up to 0.3 m in the eastern side;
- The flowpath that had previously crossed area F is bifurcated by the raised pad, and conveyed to the east in two swale drains. The drains discharge to a temporary flood storage area at the eastern end of the site. As a result, Area F is flood free in the 1% AEP event, and subject only to low hazard flood risk (H1-H3) in the PMF event.
- The two swales around area F are subject to high velocities, between 1 m/s - 2 m/s and are classified as high hazard (H5) in the 1% AEP flood, and velocities of up to 3 m/s in the PMF, in which they are classified as H6;
- The storage area to the East of Area F is also classified as High Hazard (H5) in the 1% AEP, however the classification is due to the greater depths of ponded water at this location (up to nearly 3 m in the 1% AEP event). In the PMF, the flood storage area is classified as H6;
- Aside from modifying the eastern flowpath (through Area F), the floodways defined under the pre-development conditions are retained, including Dapto Creek, the unnamed watercourse to the west of Dapto Creek, and Sheaffes Creek to the south of the site;
- The proposed works provide additional areas categorised as flood storage at the east of the site upstream of the Illawarra Railway embankment in both the 1% AEP and PMF event.

3.3 Flood Impact Assessment

The peak flood level results under post-development conditions were compared to the pre-development conditions to determine the effect of the proposed development on flood behaviour. The results of the flood impact assessment are shown on Figures C5 and C10 for the 1% AEP and PMF respectively.

Within the site, the following impacts are observed:

- Parts of Area A, B, C, E and F are no longer flooded in the 1% AEP event, due to having been filled to a level above the 1% AEP flood level;

- Area A is also flood free in the PMF event, however the Area B, C, E and F fill pads are overtopped and flooded to depths of less than 0.5 m;
- Peak flood levels on the western portion of Area C, and in the adjacent watercourse are increased by over 0.3 m as a result of the filling in Area C;
- Peak flood levels in the northern part of Dapto Creek are reduced by over 0.3 m as a result of the excavation between Dapto Creek and Area C, designed to increase floodplain storage and offset the loss of storage caused by filling the man-made dam at the eastern portion of Area B;
- Peak flood levels are notably reduced in the excavated channels that form the northern and south-western perimeters of Area F;
- At the eastern part of the site, flood levels are largely unchanged due to the influence of the Illawarra Railway embankment.

Outside the site boundary, the following impacts are observed:

- Peak flood levels at the southwestern corner of the site are increased by less than 0.05 m in the 1% AEP flood and up to 0.1 m in the PMF as a result of the filling across Area A. It is noted that these impacts are localised and do no directly affect any existing development;
- At the southern boundary, localised impacts are observed south of Area E where peak flood levels are increased by up to 0.05 m locally as a result of filling in Area E, and fill in Area B encroaching on the unnamed watercourse to the west of Dapto Creek; and
- Peak flood levels to the north of the site are locally reduced as a result of the excavation proposed to the east of Dapto Creek, and the channels along the northern boundary of Area F.

3.4 Post-Development Conditions: Flood Risk Precinct

The post-development flood behaviour was analysed to determine the Flood Risk Precinct classification across the site. The results are provided on **Figure C11** and are described in the context of each proposed development area in **Table 3-3**. It is noted that the Flood Risk Precinct definition is critical as it determines which development controls are applicable to the proposed development. These are summarised in **Section 4.2.**

Table 3-3 Post-Development Flood Risk Precincts

Area ID	Proposed Land Use Type	Flood Risk Precinct
A	Residential	> NA – Area A residential is outside the PMF flood extent under post-development conditions
	Industrial	> Low Flood Risk, with majority of the area outside the PMF extent.
B	Industrial	> Low Flood Risk, partially flood free.
C	Industrial	> Western portion: Medium Flood Risk Precinct > Eastern Portion: Low Flood Risk Precinct
D	Industrial	> Majority of this area is outside the PMF extent. A localised area of Low flood risk precinct is located in the eastern part of the site.
E	Residential	> Low Flood Risk, partially flood free.
F	Industrial	> Low Flood Risk

4 Flood Risk Management

This section sets out Wollongong City Council's flood related planning controls and requirements.

4.1 Floodplain Storage

Section 7 of WDCP, Chapter E13 Floodplain Management, pertains to filling in the floodplain. To demonstrate compliance with WCC's requirements, the following tasks have been undertaken as part of this WCMS:

- Demonstrating that the proposed development, which includes filling of some areas above the 1% AEP level, does not cause flood impacts in the PMF (refer to **Section 3.3**);
- Demonstrating that there is no net increase in fill in the floodplain, nor any decrease in floodplain storage (refer to **Table 4-1**).

Floodplain storage has been calculated using the ground level and peak flood level outputs from the TUFLOW hydraulic model for the site under both pre and post development conditions. A comparison of the volumes is provided in **Table 4-1**.

Table 4-1 Comparison of Pre and Post Development Floodplain Storage (m^3) (within site boundary)

Case	1% AEP Flood	PMF
Pre-Development (m^3)	760,540	1,421,960
Post-Developed (m^3)	807,460	1,434,990
Net Additional storage provided under Post-Development Conditions (m^3)	46,910	13,020

The results show that floodplain storage will not be decreased as a result of the proposed development. The comparison between pre-development and post-development floodplain storage volumes confirms that additional floodplain storage is provided within the site.

4.2 Flood Related Development Controls

The site is subject to flood related development controls set out in Wollongong DCP 2009, Chapter E13, Schedule 6: Prescriptive Controls – Mullet and Brooks Creek Floodplain. The DCP presents controls in a matrix, where the applicable controls are determined based on the land use type and the flood risk precinct.

The proposed development includes areas of residential land use and areas of industrial land use. As such, an assessment of the applicable controls to each land use type, according to the Flood Risk Precinct Classification, is provided below.

4.2.1 Residential Flood Related Development Controls (Low Flood Risk Precinct)

Cardno has reviewed the post-development flood results for the 1% AEP event and PMF, and has identified that the proposed residential developments (Area A) is proposed to be above the PMF level, while parts of Area E are filled to a level between the 1% AEP and PMF, and are therefore located within the Low Flood Risk Precinct (as per **Section 3.4**). The applicable flood related development controls are summarised below.

4.2.1.1 Floor Level

Not Applicable

4.2.1.2 Building Components

Not Applicable

4.2.1.3 *Structural Soundness*

Control 2. Applicant to demonstrate that any structure can withstand the forces of floodwater debris & buoyancy up to & including a 1% AEP flood plus freeboard, PMF plus freeboard if required to satisfy evacuation criteria.

Dwellings constructed within the parts of Area E below the PMF will be designed in accordance with the above control, including consideration of evacuation.

4.2.1.4 *Flood Affectation*

Not Applicable

4.2.1.5 *Evacuation and Safe Access*

Control 3. Reliable access for pedestrians or vehicles is required from the building, commencing at a minimum level equal to the lowest habitable floor level to an area of refuge above the PMF level, or a minimum of 20sqm of the dwelling to be above the PMF level.

Dwellings within the parts of Area E not already filled above the PMF level will be designed to ensure the above control can be achieved safely.

Control 4. The development is to be consistent with any relevant flood evacuation strategy or similar plan.

The subject site is located within the area covered by the NSW SES Illawarra Local Flood Plan (LFP). The NSW SES is the legislated combat agency for flood response in NSW, and is responsible for the management of flood evacuation activities. The proposed residential developments will be designed to be consisted with the objectives of the Illawarra LFP.

4.2.1.6 *Management and Design*

Not Applicable

4.2.2 Industrial Land Use Types

The proposed development includes industrial land uses in areas classified as Low or Medium Flood Risk Precincts, as described in **Table 3-3**. The applicable flood related development controls for each of the Low and Medium Flood Risk Precincts are summarised below.

4.2.2.1 *Floor Level*

Low Flood Risk Precinct: Not Applicable.

Medium Flood Risk Precinct:

Control 2. All Floor Levels to be equal to or greater than the 5% AEP flood level plus freeboard unless justified by site specific assessment. or

Control 5 Floor levels of shops to be as close to the flood planning level as practical. Where below the flood planning level, more than 30% of the floor area to be above the flood planning level or premises to be flood proofed below the flood planning level.

4.2.2.2 *Building Components*

Low Flood Risk Precinct: Not Relevant

Medium Flood Risk Precinct:

Control 1. All structures to have flood compatible building components below or at the 1% AEP flood level plus freeboard.

All structures proposed on industrially zoned land in Medium Flood Risk Precincts will be designed to comply with the above control.

4.2.2.3 Structural Soundness

Low Flood Risk Precinct: Not Applicable

Medium Flood Risk Precinct:

Control 2. Applicant to demonstrate that any structure can withstand the forces of floodwater, debris & buoyancy up to & including a 1% AEP flood plus freeboard, PMF plus freeboard if required to satisfy evacuation criteria (see below).

All structures proposed on industrially zoned land in Medium Flood Risk Precincts will be designed to comply with the above control.

4.2.2.4 Flood Affectation

Low Flood Risk Precinct:

Control 2. The impact of the development on flooding elsewhere to be considered, includes low density residential.

The impact of the proposed development on flooding is documented in **Section 3.3** of this WCMS. The flood impact assessment confirmed that the proposed development would not materially increase flood risk outside of the site boundary. Flood Impact maps showing the differences in the 100 year ARI and PMF levels are included in **Appendix C.**

Medium Flood Risk Precinct:

Control 1. Engineer's report required to certify that the development will not increase flood affectation elsewhere, includes medium & high-density residential proposals

The impact of the proposed development on flooding is documented in **Section 3.3** of this WCMS. The flood impact assessment confirmed that the proposed development would not materially increase flood risk outside of the site boundary. A Flood Impacts map showing the differences in the 100 year ARI and PMF levels are included in **Appendix C.**

4.2.2.5 Evacuation and Safe Access

Low Flood Risk Precinct:

Control 4. The development is to be consistent with any relevant flood evacuation strategy or similar plan.

The subject site is located within the area covered by the NSW SES Illawarra Local Flood Plan (LFP). The NSW SES is the legislated combat agency for flood response in NSW, and is responsible for the management of flood evacuation activities. The proposed residential developments will be designed to be consisted with the objectives of the Illawarra LFP.

Medium Flood Risk Precinct:

Control 1. Reliable access or refuge required during a 1% AEP flood.

Control 4. The development is to be consistent with any relevant flood evacuation strategy or similar plan.

The subject site is located within the area covered by the NSW SES Illawarra Local Flood Plan (LFP). The NSW SES is the legislated combat agency for flood response in NSW, and is responsible for the management of flood evacuation activities. The proposed residential developments will be designed to be consisted with the objectives of the Illawarra LFP.

4.2.2.6 Management and Design

Low Flood Risk Precinct: Not Applicable

Medium Flood Risk Precinct:

Control 2. Site Emergency Response Flood plan required (except for single dwelling-houses) where floor levels are below the flood planning level.

Control 3. Applicant to demonstrate that area is available to store goods above the 1% AEP flood level plus freeboard.

Control 5 No external storage of materials below the flood planning level which may cause pollution or be potentially hazardous during any flood.

All structures and facilities proposed on industrially zoned land in Medium Flood Risk Precincts will be designed to comply with the above control.

4.3 Evacuation Considerations

The subject site is located immediately adjacent to Darkes Road and the proposed Northcliffe Drive Extension traverses the western portion of the site, offering opportunity for the site to link directly to the Flood Reliable Road network developed by Wollongong City Council as part of the West Dapto Structure Plan (Chapter D16, Wollongong City Council DCP 2009).

A traffic impact assessment has been completed as part of the BlueScope Woods Residential Estate and BlueScope Employment Hub Planning Proposal and Neighbourhood Plan. Refer to this report for details of proposed access routes and internal road layout.

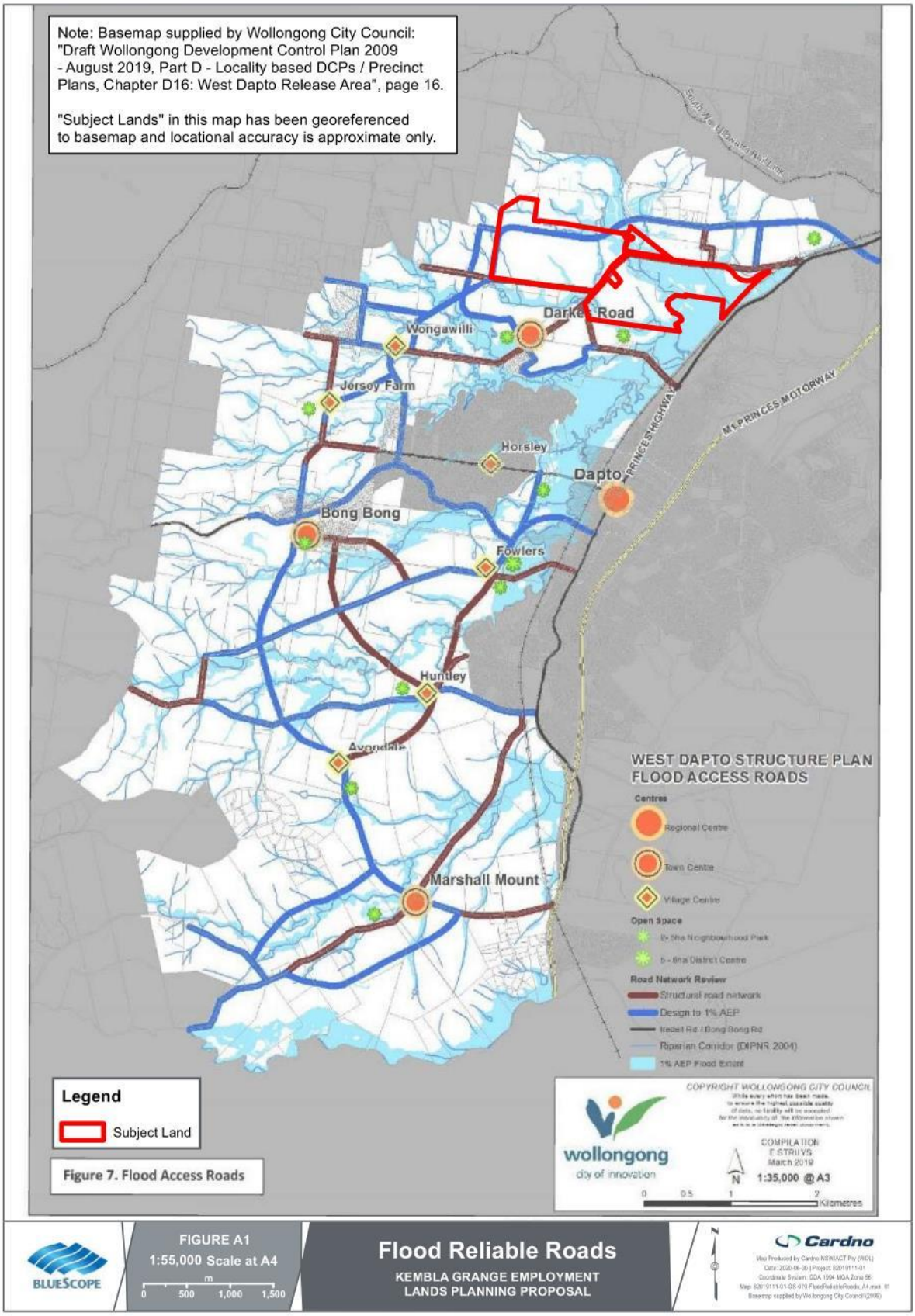

Figure 4-1 Flood Reliable Roads (WCC DCP 2009, D16)

5 Water Quantity Management

5.1 On-site Detention (OSD) Strategy

On-site detention (OSD) requirements generally apply to all types of development and redevelopment, on both flood prone and flood free sites. Requirements for OSD are set out in Wollongong City Council DCP 2009, Section E14, Chapter 10.

For the purposes of this WCMS, analysis has been undertaken to ensure that OSD requirements are incorporated in the overall site layout, to ensure a holistic and economic design. The desktop analysis involved the following steps:

- Delineation of the existing topography and proposed development into 7 sub-catchments;
- Identification of existing and proposed percentage imperviousness (based on Table 6, Section 10.2 WDCP2009);
- Estimation of Permissible Site Discharge (PSD) and Site Storage Requirement (SSR);
- Determination of basin capacities, nominal footprint sizes, and appropriate locations, noting that storage is to be located above the 5yr ARI flood level;
- It is noted that in accordance with WDCP 2009, for tributary areas exceeding 2 ha, the OSD must be designed using hydrologic and hydraulic analysis. A preliminary desktop analysis has been undertaken for the OSD design using the principles set out in Section 10.2.4 of WDCP 2009. It is proposed to confirm the outcome of this analysis at the DA stage using hydrologic and hydraulic modelling.

5.2 BlueScope Woods Residential Estate and BlueScope Employment Hub OSD Sub-catchments

The site is divided into seven (7) subcatchments, each requiring an OSD basin or tank to manage local runoff and ensure that peak discharges from each subcatchment are not increased as a result of the development. The subcatchments are indicated on **Figure D1** and listed in **Table 5-1.**

Table 5-1 Sub-catchment Properties under Developed Conditions

ID	Sub-catchment ID	Area (ha)	Proposed Land Use Type	Proposed Imperviousness
1	Res_North	6.5	Residential	60 %
2	Res_South	25.8	Residential	60 %
3	Ind_A	14.5	Industrial	100 %
4	Ind_B	9.1	Industrial	100 %
5	Ind_C	2.5	Industrial	100 %
6	Ind_D	24.6	Industrial	100 %
7	Res_E	1.2	Residential	60 %
8	Ind_F	15.7	Industrial	100 %

5.3 Preliminary Assessment

A preliminary desktop analysis has been undertaken for the OSD design using the principles set out in Section 10.2.4 of WDCP 2009. The PSD and SSR values were estimated as follows:

- PSD_5 and PSD_{100} were calculated using Equations 1.4.4.1 and 1.4.4.2 respectively from the Wollongong DCP 2009 Chapter 14 Stormwater Management Section 10 OSD;
- SSR_5 and SSR_{100} were calculated using Equations 1.4.4.3 and 1.4.4.4 respectively from the Wollongong DCP 2009 Chapter 14 Stormwater Management Section 10 OSD

The 1 hour 50 year ARI intensity (I_1^{50}) for each sub-catchments was determined from Appendix A2 Wollongong Rainfall Isohyets

The four factors (F1, F2, F3 and F4) in the equations were calculated as follows:

- F15 and F1100 = 1.0 because the existing condition of each sub-catchment was assessed as wholly undeveloped;
- F2 = A (ha) $^{-0.0872}$ which is an alternate relation fitted to the curve plotted in Appendix A4 F2 v Area;
- F3 = 0.145 and 0.190 for post-development imperviousness of 60% and 100% respectively
- F4 = A (ha) $^{0.2506}$ as given in Appendix A6 Factor F4 v Area

The basin or tank properties for each sub-catchment were calculated as follows:

- A base width and length for the basin or tank was adopted;
- The sides slope was assumed to be 1(V):4(H) for a basin and 1(V):0.1(H) for a tank respectively;
- A trial 5 yr ARI depth was adopted and the 5 yr ARI storage volume was calculated;
- The 5 yr ARI depth was adjusted until the storage volume was within 10% of the SSR5 value;
- A trial 100 yr ARI depth was adopted and the 100 yr ARI storage volume was calculated;
- The 100 yr ARI depth was adjusted until the storage volume matched the SSR_{100} value;
- For all basins and tanks the outflow was assumed to be controlled by a uniform width full vertical slot outlet;
- The width of the slot which gave a 100 yr ARI outflow which matched the PSD_{100} was determined
- The outflow under the estimated 5 yr ARI depth was calculated and compared to the PSD5 – the calculated outflow was typically 5% - 10% lower than the PSD5 value which indicated that the 5 yr ARI outflow would be less than permitted;
- The diagonal length of the slot out up to the 100 yr ARI depth was calculated and used to classify the outlet as Class 1, 2 or 3 for the purposes of blockage calculation;
- The appropriate blockage factor was then applied and the dimensions of an overflow spillway to limit the rise in the 100 yr ARI flood under the blocked outlet condition to no more than 0.15 m – 0.25 m was calculated;
- The water surface area under the blocked outlet condition was calculated;
- A further 2 m buffer was then added on all sides to give the area of land to be reserved for the basin or tank.

5.4 Results

The SSR and PSD values calculated using the approach outlined in Section 5.3 are summarised in **Table 5- 2**. The unit SSR and PSD values were also calculated to compare with SSR and PSD values adopted in other LGAs as a check on the indicative values given the application of Council's equations beyond the stated limit of application.

It was found that the unit SSR_{100} values increased with increasing sub-catchment size (rather than remaining constant) are within unit values which have been applied elsewhere in Sydney.

It was also noted that the unit PSD values decreased with increasing sub-catchment area.

This suggests that the preliminary sizing is conservative and that refinement of the OSD assessment during the DA stage may reduce the required size of a number of basins.

The indicative OSD basin/tank properties are summarised in **Table 5-3**.

Indicative basin sizing and locations are shown on **Figure D1**, and are proposed to be confirmed at the DA Stage. It is noted that there is sufficient space available in each development areas (A-E) to provide OSD outside of the PMF flood extent. The proposed OSD location for Area F will be confirmed at DA Stage pending finalisation of the site layout.

Table 5-2 Estimated PSD (L/s) and SSR (m3) and unit PSD (L/s/ha) and SSR (m3/ha) by Sub-catchment

Catchment	Area (ha)	PSD_5 (L/s)	PSD_{100} (L/s)	SSR_5 (m3)	SSR_{100} (m3)	PSD_5 (L/s/ha)	PSD_{100} (L/s/ha)	SSR_5 (m^3/ha)	SSR_{100} (m^3lha)
Res_North	6.5	1,487	2,601	913	1,596	229	401	141	246
Res_South	25.8	5,235	9,157	5,120	8,956	203	355	199	347
Ind_A	14.5	2,971	5,196	3,133	5,481	205	359	216	378
Ind_B	9.1	1,953	3,417	1,764	3,085	214	373	193	337
Ind_C	2.5	598	1,045	348	609	239	418	139	244
Ind_D	24.6	4,813	8,419	6,069	10,616	196	343	247	432
Res_E	1.2	313	548	110	192	254	445	89	156
Ind_F	15.7	3,205	5,606	3,477	6,081	204	356	221	386

Table 5-3 Indicative Properties of OSD Basins/ Tank

Catchment	Indicative Properties							
	Type	Land-take	5 yr ARI Depth	100 yr ARI Depth		Primary Outlet	Secondary Spillway	
		Rounded (m^2)	Unblocked (m)	Unblocked (m)	Blocked (m)	Slot Width (m)	Crest Length (m)	Crest Level (m)
Res_North	Basin	2,400	0.68	1.060	1.250	1.400	15	1.060
Res_South	Basin	8,200	0.96	1.470	1.720	3.000	36	1.470
Ind_A	Basin	6,900	0.67	1.030	1.220	2.920	30	1.030
Ind_B	Basin	4,260	0.66	1.000	1.210	2.000	18	1.000
Ind_C	Basin	1,200	0.62	0.940	1.103	0.675	9	0.940
Ind_D	Basin	10,000	0.9	1.420	1.683	2.920	30	1.420
Res_E	Tank	350	0.62	0.950	1.107	0.350	5	0.950
Ind_F	Basin	6,950	0.74	1.140	1.340	2.700	32	1.140

6 Water Quality Management

6.1 Potential WSUD Measures

The four main elements of Water Sensitive Urban Design (WSUD) are as follows:

- Stormwater management measures to minimise impacts of litter, sediments and nutrients on water quality;
- Water supply management to reduce potable water usage;
- Wastewater management to optimise opportunities for recycling; and
- Groundwater management.

WSUD promotes the integration of stormwater, water supply and wastewater management into new development. It requires the consideration of the urban water cycle at the early planning stage to ensure all possible opportunities for the application of best practice water cycle management solutions can be realised. The urban water cycle involves the cycling of water through the urban environment. The primary WSUD measures include:

- Rainwater tanks
- Gross pollutant traps / litter tanks
- Grassed and vegetated swales
- Bio-retention swales / basins
- Sedimentation basins
- Constructed wetlands
- Infiltration measures
- Aquifer storage / recovery
- Porous pavements.

6.2 Water Quality Treatment Targets

The intent of the WSUD treatment trains for the development is to achieve stormwater quality performance targets given in **Table 6-1.**

Table 6-1 Water Quality Treatment Targets

Performance Target reduction Loads	Residential	Industrial
Gross Pollutant	90%	90%
Total Suspended Solids	85%	80%
Total Phosphorus	60%	55%
Total Nitrogen	45%	40%

Source: Table 1, Chapter 15 water Sensitive Urban Design, Wollongong DCP 2009

6.3 Proposed WSUD Measures

WSUD measures have been considered as part of the WCC DCP (2009) requirements. The typical treatment train considered and the expected performance of the various components for the proposed site are described in **Table 6-2** below.

Modelling for WSUD treatment options would be prepared during the Development Application stage of the project and will consider the following treatment options in accordance with DCP:

- Primary treatment
- Secondary treatment
- Tertiary treatment.

Table 6-2 WSUD Measures Considered at BlueScope Woods Residential Estate and BlueScope Employment Hub

Treatment Measure	Primary and Secondary Purposes	Comment
Demand Management		Promote the use of water efficient showerheads and dishwashers and tap aerators. Provide native landscaping with a lower water demand than traditional urban planting regimes. These mechanisms will contribute to achieving BASIX targets.
Rainwater Tanks (RWT)	Reduction in potable water use through capture and re-use of roof runoff and associated pollutants	Typically included as one of a number of measures to ensure that new development meets or exceeds the BASIX requirements for reduction in potable water usage. Rainwater tanks can also form part of the treatment train in reducing runoff and pollutant exports due to the capture and re-use of roof runoff. It is noted that the quality of roof runoff is higher than the quality of surface runoff so additional measures are required to treat surface runoff.
Grass Lined Swales	Conveyance and capture of sediment and particulate-bound pollutants	Vegetated swales convey stormwater whilst also capturing of coarse and medium sediments. Swales are a secondary treatment and are often used as a pre-treatment for bio-retention systems.
Gross Pollutant Traps (GPTs)	Capture of coarse sediments and litter	Decrease loadings of coarse sediment and improve the amenity of downstream measures and/or the receiving environment.
Detention Basins	Control of runoff which can also lead to the removal of finer sediments	The primary purpose is the limit the adverse impacts of development on peak runoff and can be combined with other treatment measures to deliver dual benefits eg with a wetland or a biofilter located in the base of the basin.
Bio-retention Basin/ Wetlands	Sedimentation and removal of stormwater pollutants	End of line component of the WSUD treatment train to reduce TSS, TN & TP loads. Some of the proposed tertiary treatment systems will be constructed within the proposed OSD basins to achieve both water quantity and quality management outcomes.

6.4 Proposed Modelling Approach

The water quality software package MUSIC v6.2.0 (Model for Urban Stormwater Improvement Conceptualisation) will be used to optimise the configuration of the various WSUD measures identified above and to ensure water quality objectives are met at the DA stage.

MUSIC will be used to predict pollutant loads under the post-development conditions and estimate the reduction in pollution resulting from the proposed treatment train. This estimation is based on a range of project-specific input data including daily rainfall, monthly evapotranspiration rates, and sub-catchment characteristics. The following input data and parameters will be used in the Water Quality modelling assessment:

6.4.1 Rainfall and Evapotranspiration

Rainfall data is proposed to be obtained from the Bureau of Meteorology (BoM) for Albion Park. A 5 year rainfall dataset is proposed to be used from the period 1996-2006 by which a continuous 6 minute time-step simulation was run. Evapotranspiration data will similarly be sourced from BoM for the 5 year period ranging 2001-2006.

6.4.2 Catchment Land Use Characteristics

The impervious area for each sub-catchment is proposed to be assessed based on land use. Each sub-catchment will be divided into areas representing lots and road reserve, with consideration of existing undeveloped areas to be retained. Based on previous assessments, it is expected that the following characteristics will be applied:

- A total 60% impervious area adopted for residential areas (in accordance with WCC DCP, 2009);
- Division of residential areas into roof area and yard area;
- The roofs will be assigned a nominal area (e.g. 250 m^2) to be modelled as 100% impervious;
- The roof area was subtracted from the total residential urban area, with the remaining impervious area used to estimate the impervious cover of the yard area;
- The road impervious area was calculated directly from the civil design plans, providing an accurate value for use within the MUSIC model.

Table 6-3 Impervious Covers expected to be used in MUSIC Water Quality Model

Land Use (Music Node Type)	Imperviousness (%)
Urban Roof (Roof)	100%
Residential (Residential)	60%
Recreational Area (Rural residential)	25%
Sealed Road Reserve (Sealed road)	95%

6.4.3 Stochastically Generated Pollutant Concentrations

Pollutant concentrations are proposed to be stochastically generated in MUSIC modelling based on a review of urban catchments by Duncan (1999), which included a variety of different urban surfaces including roads, roofs, industrial and forest. Indicative parameters to stochastically generate pollutant concentrations in the MUSIC modelling are summarised in **Table 6-4**.

Table 6-4 Proposed Pollutant Model Parameters

Land Use	Flow Condition	TSS Mean (log mg/L)	TSS SD (log mg/L)	TP Mean (log mg/L)	TP SD (log mg/L)	TN Mean (log mg/L)	TN SD (log mg/L)
Residential	Base flow	1.20	0.17	-0.85	0.19	0.11	0.120
	Storm flow	2.15	0.32	-0.60	0.250	0.30	0.190
Roof	Base flow	N/A	N/A	N/A	N/A	N/A	N/A
	Storm	1.30	0.32	-0.89	0.25	0.30	0.19
Sealed Road	Base flow	1.20	0.17	-0.85	0.19	0.11	0.12
	Storm flow	2.43	0.32	-0.3	0.25	0.34	0.19
Rural Residential	Base flow	1.15	0.17	-1.22	0.19	-0.05	0.12
	Storm	1.95	0.32	-0.66	0.25	0.30	0.19

6.4.4 Runoff Generation

Infiltration and soil moisture storage parameters are required by MUSIC in the generation of runoff volumes from the various sub-catchments (and for water seepage losses in Wetlands and Swales due to infiltration of water through the base material). Guidance is given in the MUSIC software based on site soil conditions. In the absence of site-specific soil parameters, however, a conservative modelling approach will be applied by adopting an exfiltration rate of 0 mm/hr.

6.4.5 Rainwater Tanks

Considering the NSW Government BASIX requirements, a rainwater tank with a nominal diameter and capacity is proposed to be adopted for all allotments. Surface areas and volumes will then be collated into a single Rainwater Tank treatment node for each catchment as per the MUSIC modelling guidelines.

The roof areas will be separated into two nodes, one representing 75% area directed to the rainwater tank Treatment Nodes in the MUSIC model, the other representing the estimated 25% of roof area that would bypass the rainwater tanks. This approach accounts for residents disconnecting their rainwater tanks.

Reuse rates are proposed to be set to 300 L/day to represent water reuse for toilet flushing and outdoor use such as garden watering.

6.4.6 GPTs

GPTs are proposed to be modelled in MUSIC assuming a pollutant removal performance typical of the Ecosol RSF 4000 unit (or equivalent). The modelling input parameters for removal efficiencies of TSS, TP, TN and GP are expected to be adopted as 70%, 30%, 13% and 95%, respectively (to be confirmed at the assessment stage). These parameters are based on a comprehensive measurement of GPT nutrient capture in Australia as reported by Walker *et.al*. (1991), a document which has been referenced by the MUSIC development team in Appendix C3, CRC for Catchment Hydrology (revised February 2005 for MUSIC v2.1).

6.4.7 Bioretention Basins

The bioretention basins are proposed to be modelled using the ‘Bioretention’ treatment node in the MUSIC model, using footprint area and depth characteristics defined in the DA stage site layout. A saturated hydraulic conductivity of 180 mm/hr is proposed to be adopted for the sand filter, which is representative of sandy loam filter media.

7 Conclusion

This WCMS report concludes that:

- The pre-development and post-development flood conditions have been defined using the Mullet Creek Flood Model Update (BMT WBM, 2018), with local topographic refinements and updates to the applied blockage policy as required by WCC;
- The extents of flood risk precincts were determined in accordance with WCC DCP (2009) and indicated that the proposed development is, for the most part, outside the PMF extent or on land classified as Low Flood Risk Precinct. One portion of proposed industrial land (less than 2ha) is located within area classified as Medium Flood Risk Precinct.
- The Flood Impact Assessment has demonstrated that the proposed development would not materially increase flood risk outside of the site. Localised areas of increased peak flood levels beyond the site's southern border (less than 0.05 m in the 1% AEP event) are however noted, and it is expected that these could be resolved with further design and assessment;
- The proposed development does not reduce floodplain storage in either the 1% AEP event nor PMF, and in fact provides additional floodplain storage (Approximately 46,910 m^3 in the 1% AEP and 13,020 m^3 in the PMF event);
- The applicable flood-related development controls for each land use type and flood risk precinct have been documented and it is expected that with due consideration in the DA stage all requirements will be able to be complied with;
- Reliable road access is demonstrated to be achievable in the 1% AEP for all lots within the development owing to the proximity to Darkes Road and Northcliffe Drive, each forming part of the West Dapto Structure Plan. It is noted also that each area of residential is partly if not wholly above the PMF level;
- On-Site Detention (OSD) will be incorporated into the development. Preliminary sizing of basins and a tank has been undertaken to ensure that there is adequate provision for basins within the scheme. It was noted that the trends in SSR and PSD with increasing catchment size suggest that the preliminary sizing is conservative and that refinement of the OSD assessment during the DA stage may reduce the required size of a number of the basins; and
- An overview of the proposed WSUD measures and assessment process has been included for consideration, and will be undertaken in detail at the DA stage.

8 References

Australian Institute of Disaster Resilience (AIDR), 2017, Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia, Handbook 7, 3rd Edition

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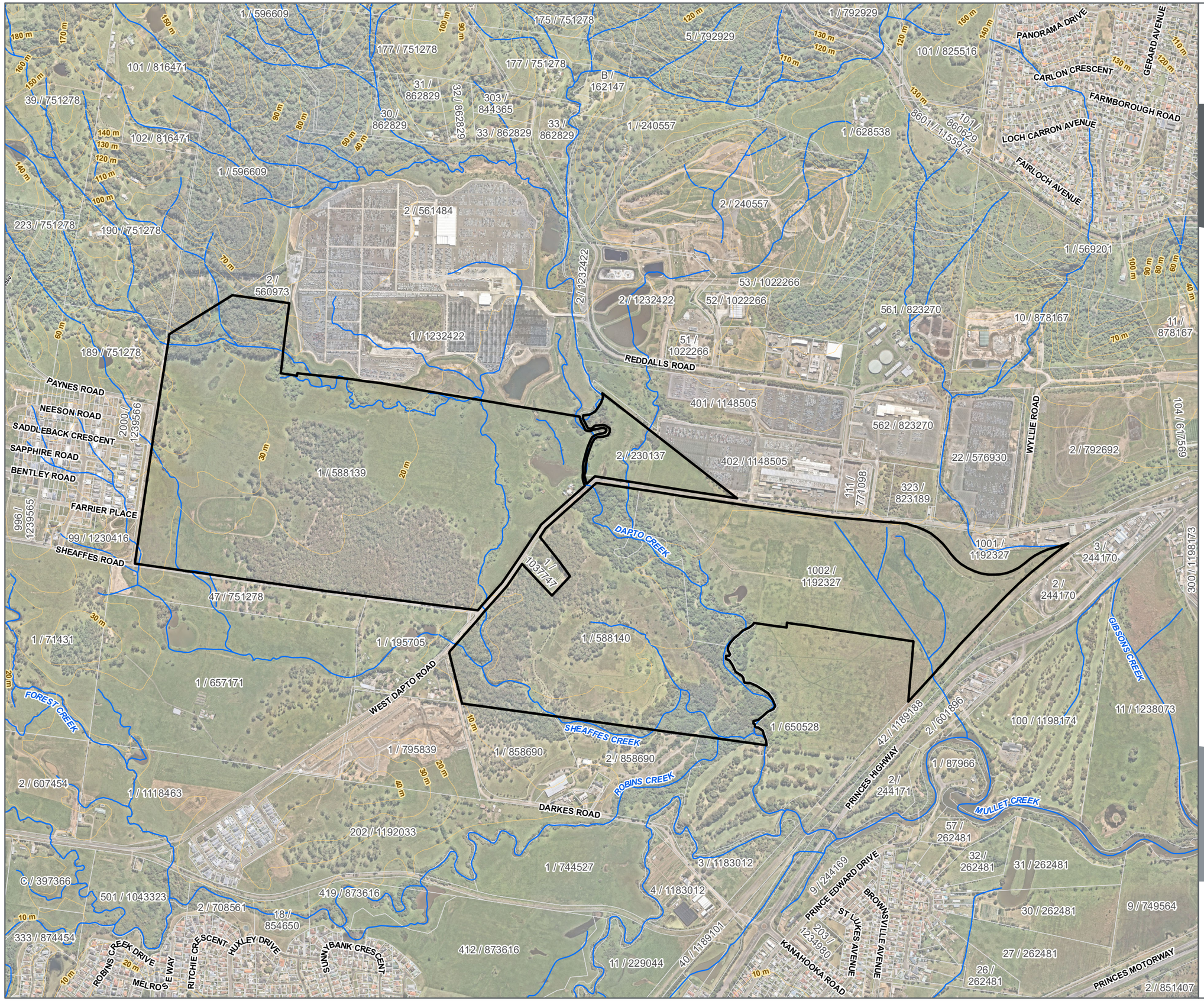
BlueScope Woods Residential Estate
and BlueScope Employment Hub

APPENDIX A

GENERAL SITE LAYOUT



Pre-Development Site Plan

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land (215.81ha)
- Watercourse (NSW SS)
- 10m Contours (NSW SS)
- Cadastre (NSW SS, 2019)

1:12,500 Scale at A3

m
0 100 200 300 400

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-29 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-053-FLOOD_PreDev_SitePlan.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

Post-Development Site Plan

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Area A Residential

Area A Industrial

Area B Industrial

Area C Industrial

Area D Industrial

Area E Residential

Area F Industrial

Legend

- Subject Land (215.81ha)
- Proposed Layout
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Proposed Landforming

- Channel
- Pipe
- Cut
- Fill

FIGURE A2

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-081-FLOOD_PostDev_SitePlan.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BlueScope Woods Residential Estate
and BlueScope Employment Hub

APPENDIX

B

PRE-DEVELOPMENT FLOOD FIGURES

BLUESCOPE

Pre-Development 1% AEP Depth and Water Levels

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- 2m Flood Height Contour
- Watercourse (NSW SS)
- Cadastre (NSW SS, 2019)

Depth and Water Level (m)

- 0 - 0.15
- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.5
- > 1.50

FIGURE B1

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-054-FLOOD_PreDev_AEP_Extent.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Pre-Development 1% AEP Flood Velocity

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Watercourse (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
GIBSONS CREEK
FOREST CREEK
WEST DAPTO ROAD
SHEAFFES CREEK
DARKES ROAD
PRINCES HIGHWAY
MULLET CREEK
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNNYBANK CRESCENT

FIGURE B2

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-055-FLOOD_PreDev_AEP_Velocity.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Pre-Development 1% AEP Provisional Hazard

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Watercourse (NSW SS)
- Cadastre (NSW SS, 2019)

Provisional Flood Hazard (FDM, 2005)

- Low
- Transitional
- High

FIGURE B3

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-056-FLOOD_PreDev_AEP_ProvHaz.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Pre-Development 1% AEP General Hazard

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Watercourse (NSW SS)
- Cadastre (NSW SS, 2019)

Flood General Hazard

- H1
- H2
- H3
- H4
- H5
- H6

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
GIBSONS CREEK
FOREST CREEK
WEST DAPTO ROAD
SHEAFFES CREEK
DARKES ROAD
PRINCES HIGHWAY
MULLET CREEK
ROBINS CREEK
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNKBANK CRESCENT

FIGURE B4

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-057-FLOOD_PreDev_AEP_GenHaz.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Pre-Development 1% AEP Hydraulic Categories

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Watercourse (NSW SS)
- Cadastre (NSW SS, 2019)

Hydraulic Category

- Floodway
- Flood Storage
- Flood Fringe

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
GIBSONS CREEK
FOREST CREEK
WEST DAPTO ROAD
SHEAFFES CREEK
DARKES ROAD
PRINCES HIGHWAY
MULLET CREEK
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNNYBANK CRESCENT
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY

FIGURE B5

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 82019111101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-058-FLOOD_PreDev_AEP_HydCat.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Pre-Development PMF Depth and Water Levels

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Watercourse (NSW SS)
- 2m Flood Height Contour
- Cadastre (NSW SS, 2019)

Depth and Water Level (m)

- 0 - 0.15
- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.5
- > 1.50

FIGURE B6

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-059-FLOOD_PreDev_PMF_Extent.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Pre-Development PMF Flood Velocity

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Watercourse (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
GIBSONS CREEK
FOREST CREEK
WEST DAPTO ROAD
SHEAFFES CREEK
DARKES ROAD
PRINCES HIGHWAY
MULLET CREEK
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNNYBANK CRESCENT

FIGURE B7

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 82019111101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-060-FLOOD_PreDev_PMF_Velocity.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Pre-Development PMF Provisional Hazard

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Watercourse (NSW SS)
- Cadastre (NSW SS, 2019)

Provisional Flood Hazard (FDM, 2005)

- Low
- Transitional
- High

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
GIBSONS CREEK
FOREST CREEK
WEST DAPTO ROAD
SHEAFFES CREEK
DARKES ROAD
PRINCES HIGHWAY
MULLET CREEK
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNNYBANK CRESCENT
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY

FIGURE B8

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-061-FLOOD_PreDev_PMF_ProvHaz.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Pre-Development PMF General Hazard

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Watercourse (NSW SS)
- Cadastre (NSW SS, 2019)

Flood General Hazard

- H1
- H2
- H3
- H4
- H5
- H6

FIGURE B9

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-062-FLOOD_PreDev_PMF_GenHaz.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Pre-Development PMF Hydraulic Categories

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Watercourse (NSW SS)
- Cadastre (NSW SS, 2019)

Hydraulic Category

- Floodway
- Flood Storage
- Flood Fringe

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
GIBSONS CREEK
FOREST CREEK
WEST DAPTO ROAD
SHEAFFES CREEK
DARKES ROAD
PRINCES HIGHWAY
MULLET CREEK
ROBINS CREEK
PRINCE EDWARD DRIVE
BROWNSVILLE AVENUE
ST LUKES AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNNYBANK CRESCENT

FIGURE B10

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 82019111101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-063-FLOOD_PreDev_PMF_HydCat.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Pre-Development Flood Risk Precincts

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Watercourse (NSW SS)
- Cadastre (NSW SS, 2019)

Flood Risk Precincts

- High
- Medium
- Low

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
SHEAFFES CREEK
WEST DAPTO ROAD
FOREST CREEK
GIBSONS CREEK
PRINCES HIGHWAY
DARKES ROAD
MULLET CREEK
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNNYBANK CRESCENT
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY

FIGURE B11

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-064-FLOOD_PreDev_FRP.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BlueScope Woods Residential Estate
and BlueScope Employment Hub

APPENDIX

C

POST-DEVELOPMENT FLOOD FIGURES

BLUESCOPE

Post-Development 1% AEP Depth and Water Levels

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Proposed Layout
- 2m Flood Height Contour
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Depth and Water Level (m)

- 0 - 0.15
- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.5
- > 1.50

FIGURE C1

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-065-FLOOD_PostDev_AEP_Extent.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

Post-Development 1% AEP Flood Velocity

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Area A Residential
Area A Industrial
Area B Industrial
Area C Industrial
Area D Industrial
Area E Residential
Area F Industrial

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
SHEAFFES CREEK
WEST DAPTO ROAD
FOREST CREEK
DARKES ROAD
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
WYLLIE ROAD
GIBSONS CREEK
PRINCES HIGHWAY
MULLET CREEK
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY

Legend

- Subject Land
- Proposed Layout
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

FIGURE C2

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-066-FLOOD_PostDev_AEP_Velocity.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Post-Development 1% AEP Provisional Hazard

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Area A Residential
Area A Industrial
Area B Industrial
Area C Industrial
Area D Industrial
Area E Residential
Area F Industrial

PANORAMA DRIVE
CARLON CRESCENT
GERARD AVENUE
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
SHEAFFES CREEK
WEST DAPTO ROAD
FOREST CREEK
DARKES ROAD
PRINCES HIGHWAY
GIBSONS CREEK
MULLET CREEK
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNNYBANK CRESCENT
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY

Legend

- Subject Land
- Proposed Layout
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Provisional Flood Hazard (FDM, 2005)

- Low
- Transitional
- High

FIGURE C3

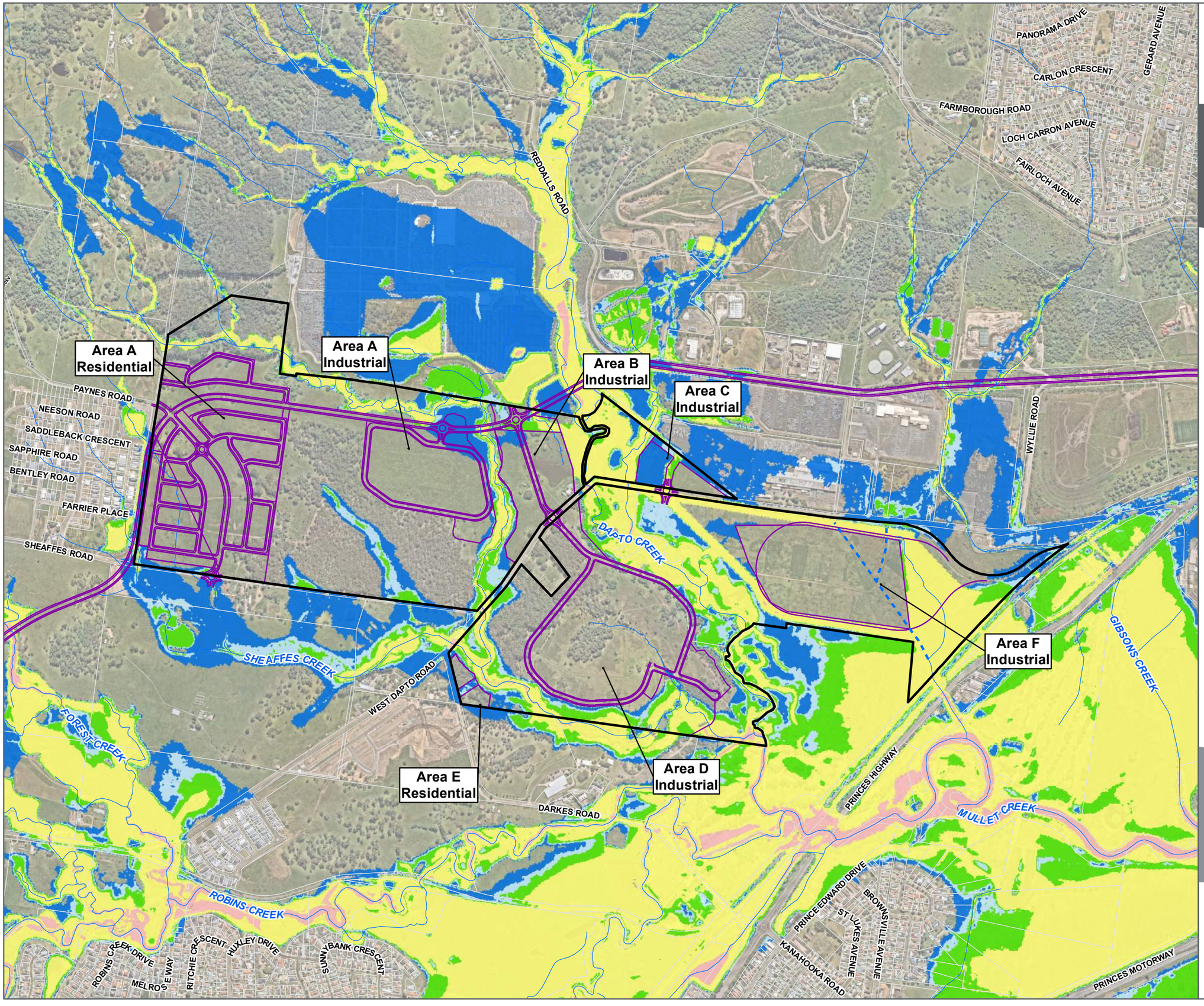
1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-067-FLOOD_PostDev_AEP_ProvHaz.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)



BLUESCOPE

Post-Development 1% AEP General Hazard

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Proposed Layout
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Flood General Hazard

- H1
- H2
- H3
- H4
- H5
- H6

FIGURE C4

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-068-FLOOD_PostDev_AEP_GenHaz .mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Post-Development 1% AEP Hydraulic Categories

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Proposed Layout
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Hydraulic Category

- Floodway
- Flood Storage
- Flood Fringe

Area A Residential
Area A Industrial
Area B Industrial
Area C Industrial
Area D Industrial
Area E Residential
Area F Industrial

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
SHEAFFES CREEK
WEST DAPTO ROAD
FOREST CREEK
DARKES ROAD
PRINCES HIGHWAY
GIBSONS CREEK
MULLET CREEK
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNNYBANK CRESCENT
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY

FIGURE C5

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-069-FLOOD_PostDev_AEP_HydCat.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

1% AEP Flood Impacts

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Proposed Layout
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Change in Flood Levels (m)

- Was Wet Now Dry
- < -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- > 0.1
- Was Dry Now Wet

FIGURE C6

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-070-FLOOD_AEP_Impacts.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

Area A Residential
Area A Industrial
Area B Industrial
Area C Industrial
Area D Industrial
Area E Residential
Area F Industrial

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
SHEAFFES CREEK
WEST DAPTO ROAD
FOREST CREEK
DARKES ROAD
PRINCES HIGHWAY
GIBSONS CREEK
MULLET CREEK
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNNYBANK CRESCENT
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY

BLUESCOPE

Post-Development PMF Depth and Water Levels

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Proposed Layout
- 2m Flood Height Contour
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Depth and Water Level (m)

- 0 - 0.15
- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.5
- > 1.50

Area A Residential

Area A Industrial

Area B Industrial

Area C Industrial

Area D Industrial

Area E Residential

Area F Industrial

PANORAMA DRIVE
CARLON CRESCENT
GERARD AVENUE
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
SHEAFFES CREEK
WEST DAPTO ROAD
FOREST CREEK
DARKES ROAD
PRINCES HIGHWAY
MULLET CREEK
GIBSONS CREEK
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNNYBANK CRESCENT
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY

FIGURE C7

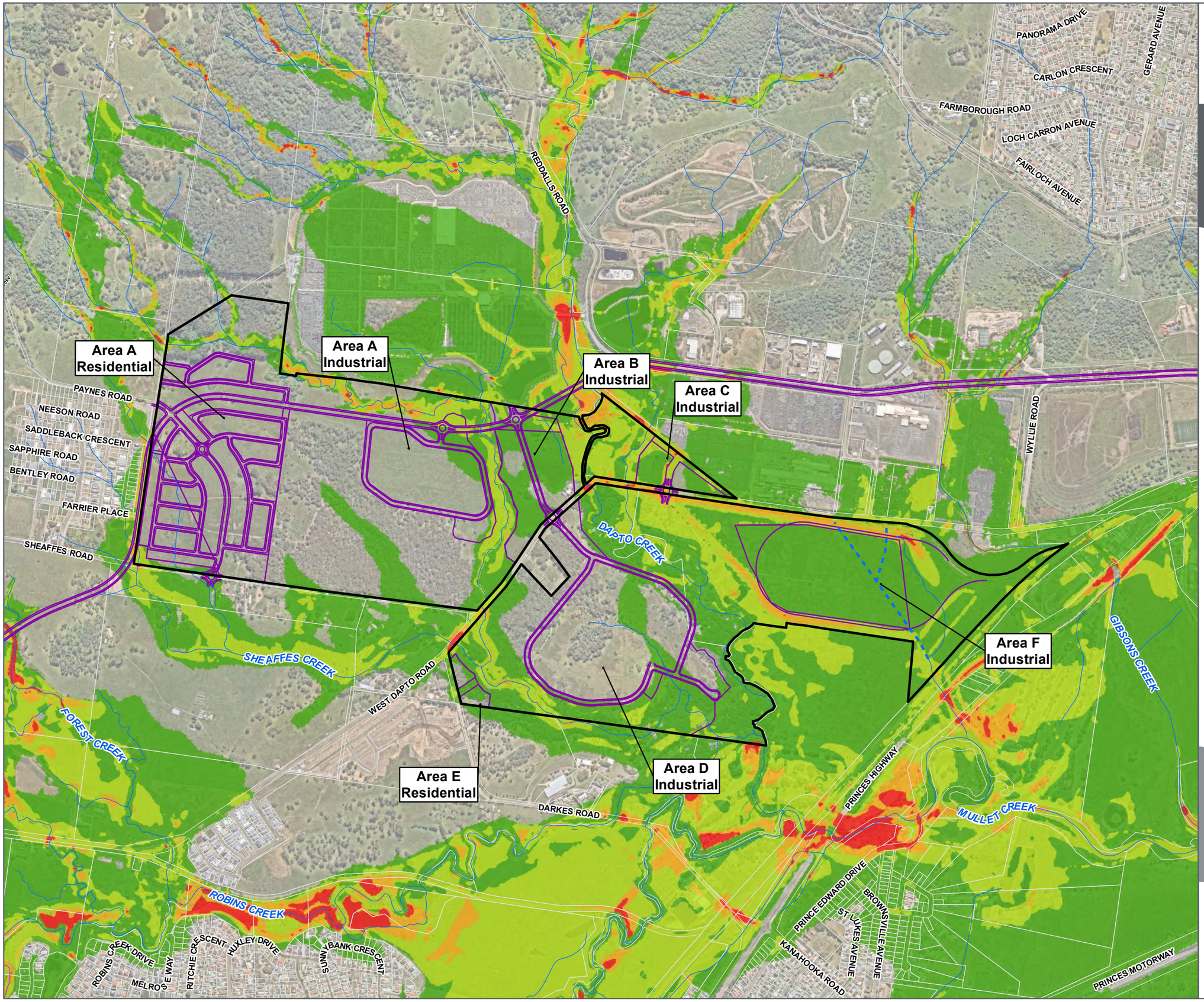
1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 82019111101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-071-FLOOD_PostDev_PMF_Extent.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)



BLUESCOPE

Post-Development PMF Flood Velocity

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Proposed Layout
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Flood Velocity (m/s)

- 0 - 1
- 1 - 2
- 2 - 3
- > 3

FIGURE C8

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-072-FLOOD_PostDev_PMF_Velocity.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Post-Development PMF Provisional Hazard

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Area A Residential

Area A Industrial

Area B Industrial

Area C Industrial

Area D Industrial

Area E Residential

Area F Industrial

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
SHEAFFES CREEK
WEST DAPTO ROAD
FOREST CREEK
DARKES ROAD
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNNYBANK CRESCENT
WYLLIE ROAD
GIBSONS CREEK
PRINCES HIGHWAY
MULLET CREEK
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY

Legend

- Subject Land
- Proposed Layout
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Provisional Flood Hazard (FDM, 2005)

- Low
- Transitional
- High

FIGURE C9

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-06-30 | Project: 8201911101
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-073-FLOOD_PostDev_PMF_ProvHaz.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)

BLUESCOPE

Post-Development PMF General Hazard

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Area A Residential
Area A Industrial
Area B Industrial
Area C Industrial
Area D Industrial
Area E Residential
Area F Industrial

PANORAMA DRIVE
CARLON CRESCENT
GERARD AVENUE
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
WYLLIE ROAD
SHEAFFES CREEK
WEST DAPTO ROAD
FOREST CREEK
DARKES ROAD
GIBSONS CREEK
PRINCES HIGHWAY
MULLET CREEK
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNBANK CRESCENT
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY

Legend

- Subject Land
- Proposed Layout
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Flood General Hazard

- H1
- H2
- H3
- H4
- H5
- H6

FIGURE C10

1:12,500 Scale at A3

m
0 100 200 300 400

N

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BLUESCOPE

Post-Development PMF Hydraulic Categories

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Proposed Layout
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Hydraulic Category

- Floodway
- Flood Storage
- Flood Fringe

Area A Residential
Area A Industrial
Area B Industrial
Area C Industrial
Area D Industrial
Area E Residential
Area F Industrial

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
SHEAFFES CREEK
WEST DAPTO ROAD
FOREST CREEK
DARKES ROAD
PRINCES HIGHWAY
GIBSONS CREEK
MULLET CREEK
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNNYBANK CRESCENT
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY

FIGURE C11

1:12,500 Scale at A3

m
0 100 200 300 400

N

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PMF
Flood Impacts

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Area A Residential
Area A Industrial
Area B Industrial
Area C Industrial
Area D Industrial
Area E Residential
Area F Industrial

PANORAMA DRIVE
GERARD AVENUE
CARLON CRESCENT
FARMBOROUGH ROAD
LOCH CARRON AVENUE
FAIRLOCH AVENUE
REDDALLS ROAD
WYLLIE ROAD
PAYNES ROAD
NEESON ROAD
SADDLEBACK CRESCENT
SAPPHIRE ROAD
BENTLEY ROAD
FARRIER PLACE
SHEAFFES ROAD
DAPTO CREEK
SHEAFFES CREEK
WEST DAPTO ROAD
FOREST CREEK
DARKES ROAD
PRINCES HIGHWAY
GIBSONS CREEK
MULLET CREEK
ROBINS CREEK
ROBINS CREEK DRIVE
MELROSE WAY
RITCHIE CRESCENT
HUXLEY DRIVE
SUNBANK CRESCENT
PRINCE EDWARD DRIVE
ST LUKES AVENUE
BROWNSVILLE AVENUE
KANAHOOKA ROAD
PRINCES MOTORWAY

Legend

- Subject Land
- Proposed Layout
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Change in Flood Levels (m)

- Was Wet Now Dry
- < -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- > 0.1
- Was Dry Now Wet

FIGURE C12

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

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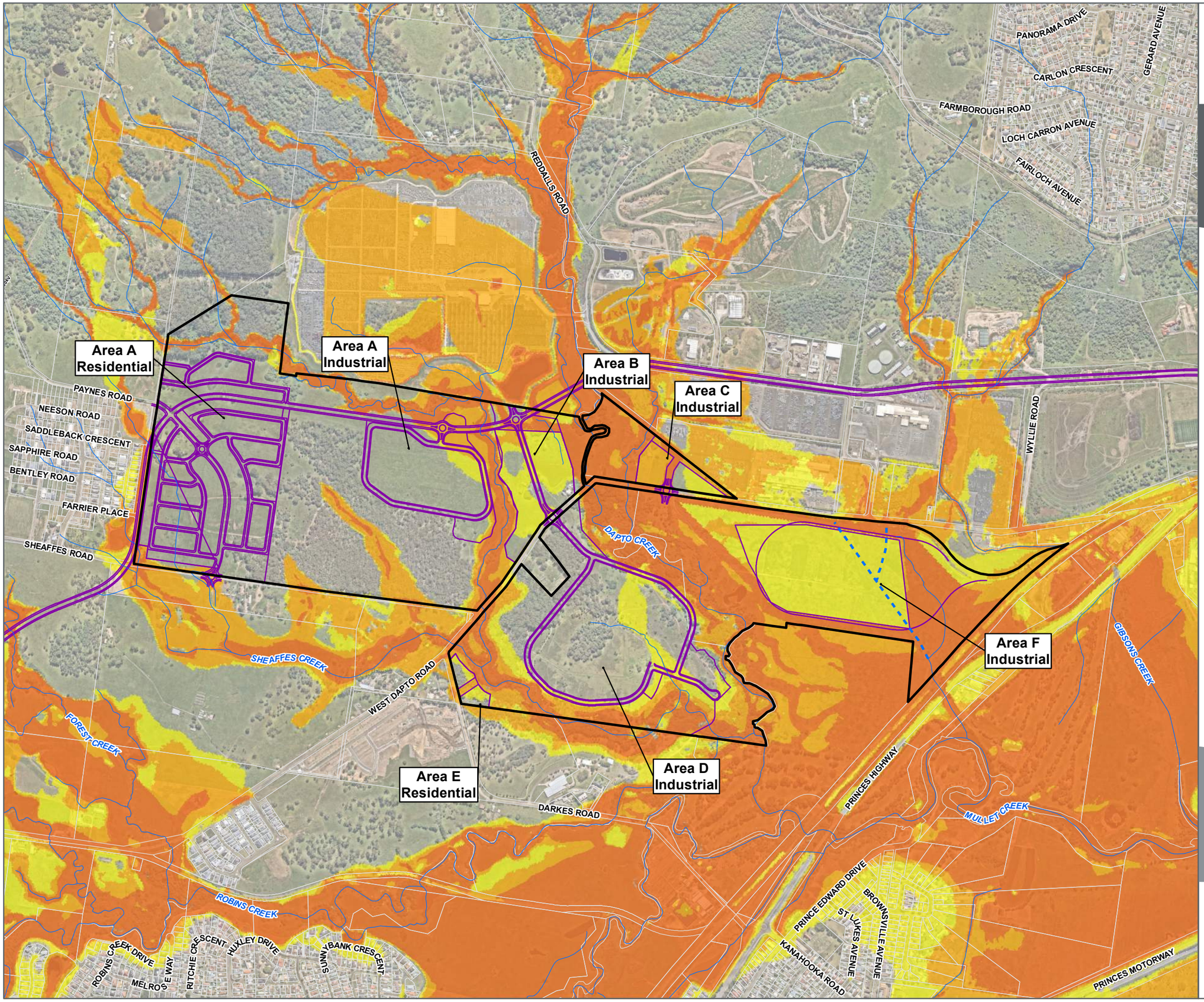
Coordinate System: GDA 1994 MGA Zone 56
Map: 82019111-01-GS-076-FLOOD_PostDev_PMF_Impacts.mxd 01
Aerial imagery supplied by Nearmap (March, 2020)



BLUESCOPE

Post-Development Flood Risk Precincts

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Proposed Layout
- Watercourse (NSW SS)
- Watercourse to be realigned
- Cadastre (NSW SS, 2019)

Flood Risk Precincts

- High
- Medium
- Low

FIGURE B11

1:12,500 Scale at A3

m
0 100 200 300 400

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
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Map: 82019111-01-GS-077-FLOOD_PostDev_FRP.mxd 01
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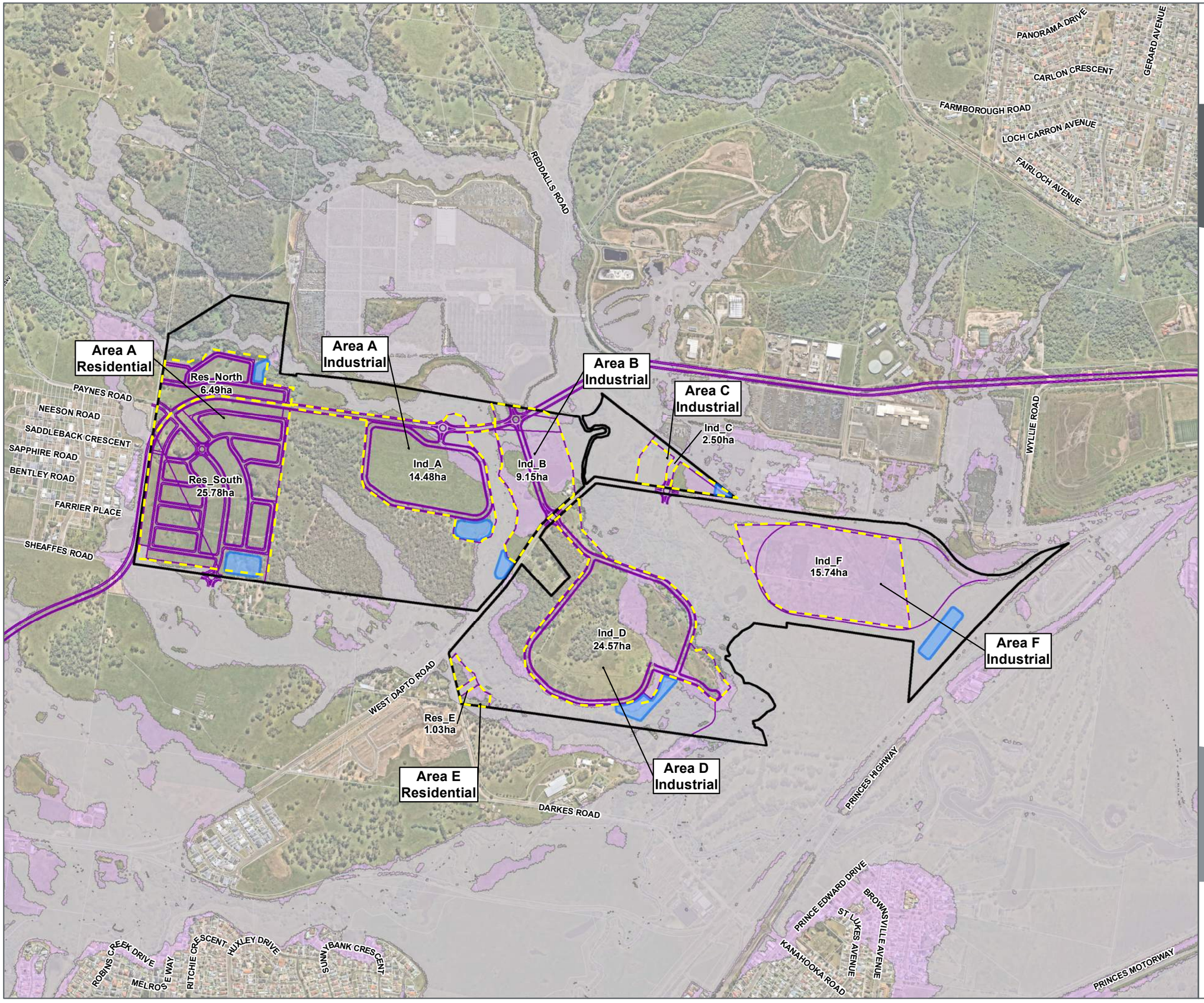
BlueScope Woods Residential Estate
and BlueScope Employment Hub

APPENDIX

D

ON-SITE DETENTION



OSD Location Plan

KEMBLA GRANGE EMPLOYMENT LANDS PLANNING PROPOSAL

Legend

- Subject Land
- Proposed Layout
- Cadastre (NSW SS, 2019)
- Indicative OSD Basin Footprint
- Indicative Subcatchment
- 1% AEP Flood
- PMF Flood Extent

Note:
1. OSD for Area E is proposed to be achieved with a tank, not a basin.

2. Basin sizes and locations are indicative only, and would be confirmed at DA stage.

FIGURE D1

1:12,500 Scale at A3

m
0 100 200 300 400

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