Stormwater Management Strategy

For

Modification 21

For

Huntlee Stage 1 Urban Release Area

for Huntlee Pty Ltd

Report Document Control

Project: Modification 21 – Stormwater Management Strategy

Project Ref: NL151661

Document Ref: E18

File Name: NL151661_E18_Mod21_SWMP_Report_[B].docx

Client: Huntlee Pty Ltd

Title: Stormwater Management Strategy

Revision History:

Revision	Report Status	Issue Date	Prepared	Reviewed	Admin
A	Approval	1/08/2022	NM	LG	LC
B	Approval	07/03/2023	DN	LG	CB

Prepared:

Laurence Gitzel
Associate | Flood Engineer
BEng(Env) MProfEng(Env) MIEAust CPEng NER(Civil)

Reviewed:

Ben Clark
Principal | Civil Engineer
BEng (Civil) MIEAust CPEng NER RPEQ

Limitation statement

Northrop Consulting Engineers Pty Ltd (Northrop) has been retained to prepare this report based on specific instructions, scope of work and purpose pursuant to a contract with its client. It has been prepared in accordance with the usual care and thoroughness of the consulting profession for the use by Huntlee Pty Ltd. The report is based on generally accepted practices and standards applicable to the scope of work at the time it was prepared. No other warranty, express or implied, is made as to the professional advice included in this report.

Except where expressly permitted in writing or required by law, no third party may use or rely on this report unless otherwise agreed in writing by Northrop.

Where this report indicates that information has been provided to Northrop by third parties, Northrop has made no independent verification of this information except as expressly stated in the report. Northrop is not liable for any inaccuracies in or omissions to that information.

The report was prepared on the dates shown and is based on the conditions and information received at the time of preparation. This report should be read in full, with reference made to all sources. No responsibility is accepted for use of any part of this report in any other context or for any other purpose. Northrop does not purport to give legal advice or financial advice. Appropriate specialist advice should be obtained where required.

To the extent permitted by law, Northrop expressly excludes any liability for any loss, damage, cost or expenses suffered by any third party relating to or resulting from the use of, or reliance on, any information contained in this report.

Level 1, 215 Pacific Highway
Charlestown NSW 2290
02 4943 1777
newcastle@northrop.com.au
ABN 81 094 433 100

Contents

1. Introduction

Northrop Consulting Engineers have been engaged by Huntlee Pty Ltd to prepare a Concept Stormwater Management Strategy for the proposed Modification 21 subdivision located to the west of the existing Huntlee Town Centre and Wine Country Drive (WCD). Positioned across Lot 240, DP 110559 and Lot 158, DP 1259859, the subdivision is proposed to become part of the Stage 1 Project Area.

This report has been prepared to support the Modification Application for Stage 1 and convey the concept stormwater management philosophy adopted for the revised subdivision layout.

1.1 Project Background

1.1.1 Huntlee Urban Release Area

The Huntlee Project is a major URA in the Hunter region which will provide housing for approximately 20,000 people accommodated within up to 7,300 dwellings. The project will deliver a new town comprising of a commercial centre, residential precincts, open spaces, recreation areas, conservation reserves and supporting employment lands.

In 2013 the Huntlee Development Control Plan (DCP) was adopted by the Director-General of the Department of Planning and Infrastructure pursuant to the provisions of Section 74C of the Environmental Planning and Assessment Act, 1979 (the Act). The DCP applies to all development on the land in Zone R1 General Residential, Zone R2 Low Density Residential and Zone B4 Mixed Use within the Huntlee site and is to be used to assess all development applications.

Figure 1 below shows an extract from the DCP illustrating the extent of the Huntlee Project Area and respective LGA's.

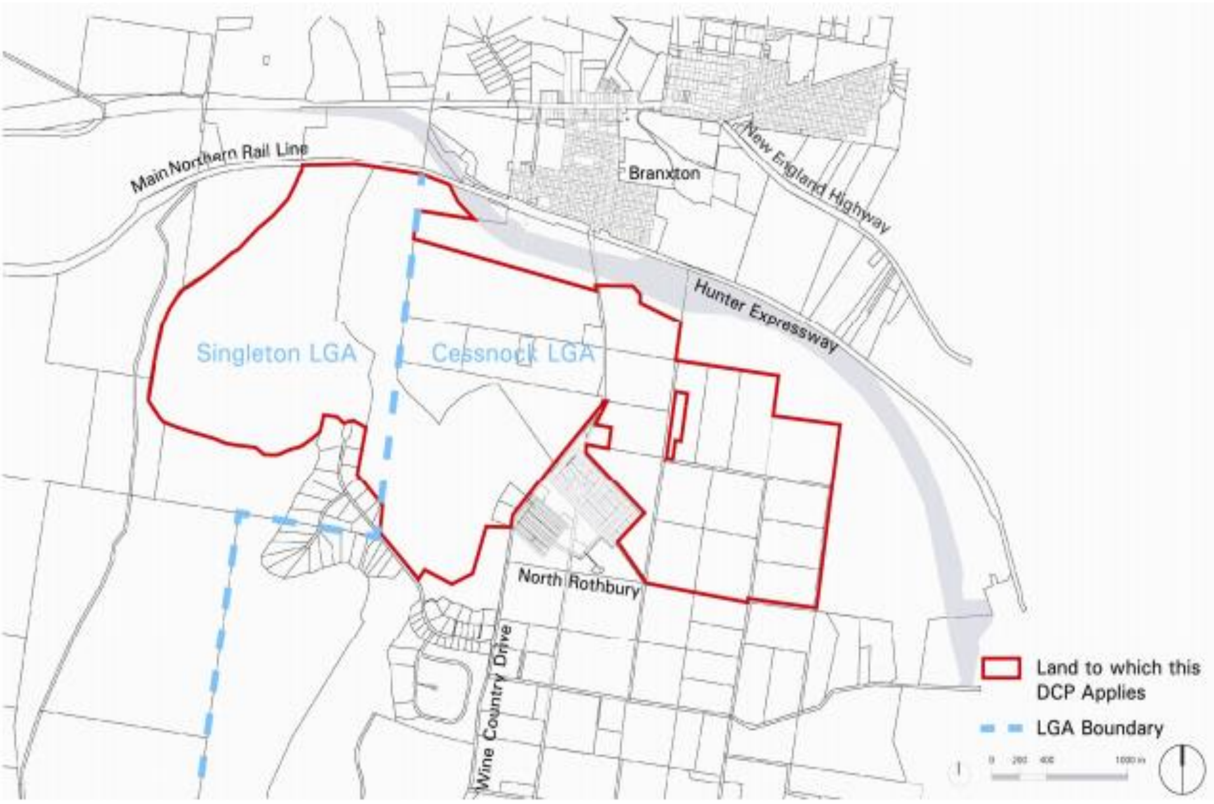


Figure 1 – Extract from Huntlee DCP 2013

1.1.2 Stage 1 Project Area

The Stage 1 Project Area was granted approval in 2013 and covers approximately 360ha of the Huntlee URA, much of which is now well into the construction phase. The Stage 1 Project Area in context of the overall Huntlee development framework is shown below in **Figure 2**.

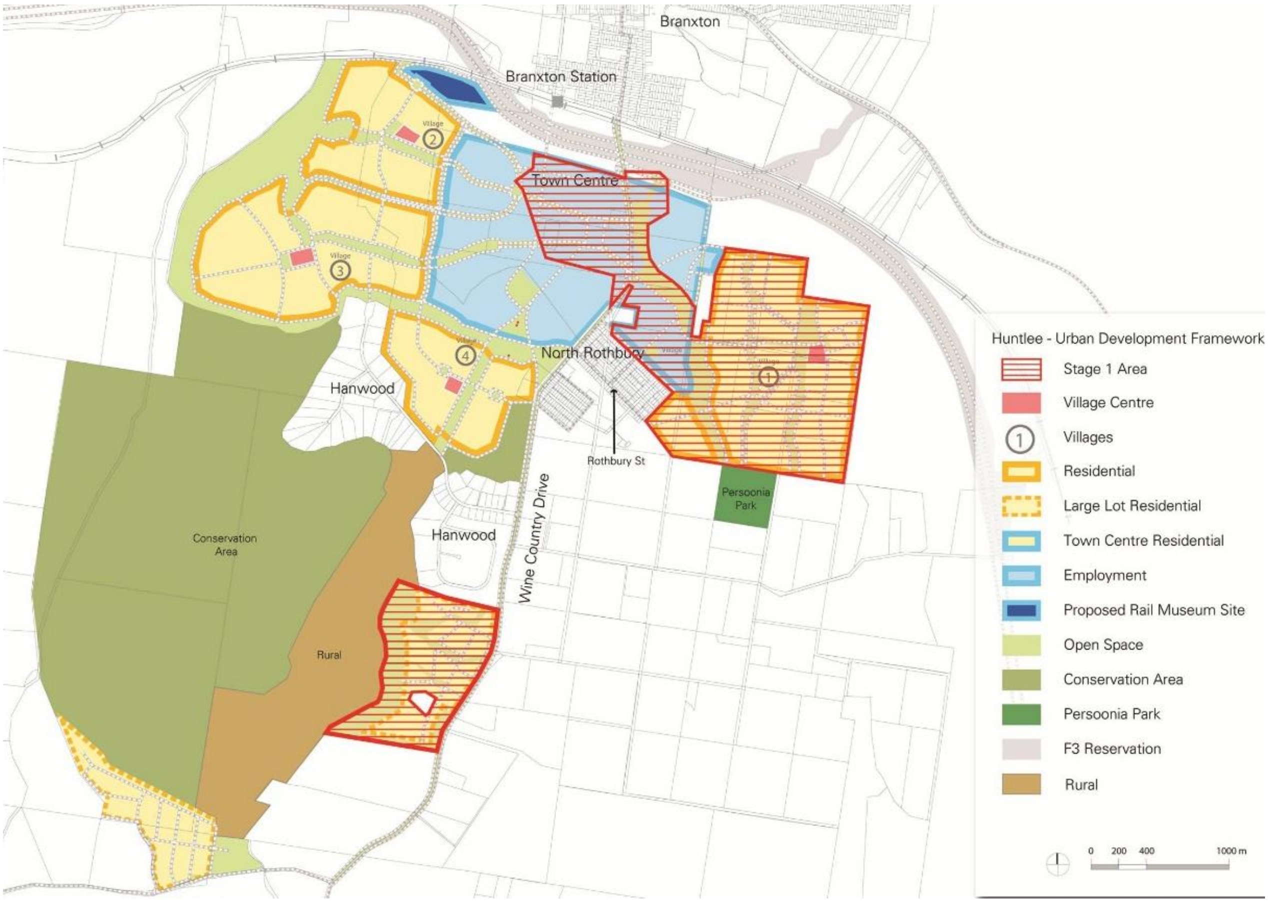


Figure 2 – Stage 1 Project Area within Overall Huntlee Development Framework

The Stage 1 Project Area includes the first residential village extending north-east of the existing North Rothbury township, approximately 50ha of the Town Centre and approximately 80ha of large residential lots located off WCD to the south of the Town Centre within the suburb of Rothbury.

1.2 Proposed Development and Current Approval Modification

Modification 21 (or MOD 21) is proposed to deliver a mixed-use development to the west of the Town Centre with lot sizes ranging from approximately 180m^2 up to over 7,800m^2. Road reserves and densities across the site will be in keeping with the surrounding developments and properties. Two public parks are located in the subject site with the majority of the remaining vegetated areas attributed to managing floodwaters and riparian extents.

This modification is seeking approval to amend the extent of the Stage 1 boundary to include the proposed MOD 21 development footprint. Specifically, under the modification this report is intended to build upon the current approved stormwater strategy titled: *Trunk Stormwater and Flooding Assessment* - Stage *1 Project Application* prepared by WorleyParsons in 2012 to include MOD 21.

2. Stormwater Management

2.1 Stormwater Management Objectives

Urbanised development often results in significant modification to soils, topography, impervious percentages and vegetation. Surface water runoff volumes and pollutant concentrations from urban catchments are typically above pre-developed states, and without management have the potential to convey increased runoff volumes and pollutant loads to downstream receiving waters. Unmanaged these increases can have detrimental impacts on stream stability, environmental ecology and flooding.

To mitigate the potentially detrimental effects of urbanisation upon the catchment a Stormwater Management Plan will be implemented across the site. The principles of the proposed stormwater management strategy have been derived from the riparian, flood and water cycle controls identified under Section 3 of the 2013 Huntlee DCP. The DCP states that development is to incorporate the principles of Water Sensitive Urban Design (WSUD).

To deliver a Stormwater Management Plan which achieves the principles of WSUD the following objectives have been set:

- Identify the riparian corridors within the site through categorisation of the tributaries in accordance with DPI Water's 'Guideline for Riparian Corridors on Waterfront Land' requirements.
- Determine the 1% AEP flood inundation extents along the identified tributaries within the site boundary to inform flood planning for the development.
- Minimise the potential impact of local and downstream flooding by ensuring no net increase in peak flows during events up to the 1% AEP storm in receiving waterways.
- Mitigate the impacts of urban development on stormwater quality through integrated management of land and water resources incorporating best practice stormwater management, to reach the nominated pollutant load reduction targets.

2.2 Proposed Stormwater Management Strategy

The Stormwater Strategy approved under the Stage 1 Development Application was based on the *Trunk Stormwater and Flooding Assessment* - Stage *1 Project Application* prepared by WorleyParsons in 2012 herein referred to as the Original Report (WorleyParsons, 2012).

It is noted that the subject site is located outside the extent of the catchment considered in the Original Report (WorleyParsons, 2012) however, as previously mentioned, the strategy presented herein remains consistent with the approved strategy whereby:

- The quantity of stormwater runoff from the proposed development is to be managed through stormwater detention devices.
- The quality of stormwater runoff from the proposed development is to be managed through Water Sensitive Urban Design (WSUD) elements including Gross Pollutant Traps (GPTs) and bio-retention basins.

The report sections below aim to identify the Site's existing riparian and onsite flooding constraints, review the sites requirement for onsite detention and outline the proposed stormwater mitigation measures to be adopted under the revised management strategy.

3 Site Characteristics

3.1 Existing Site Description

The Site is located approximately 0.6km north-west of the existing North Rothbury township and 0.3km south of the Hunter Expressway. Covering a total area of approximately 78.2ha the Site is bordered to the west, south and north by bushland, and the Huntlee Town Centre to the east. The boundary between Singleton Shire Council and Cessnock City Council is located along the western boundary of the subject site.

The Site is predominately bushland, with two creeks traversing through the northern and southern portions. Average surface slopes across the Site are approximately 4% with only small areas of minor localised regrading.

The site falls in a westerly direction, away from the Town Centre and towards Black Creek. Black Creek is a significant feature of the Cessnock LGA, with a large proportion of the City's population living within its catchment. An aerial of the site in its current state is provided overleaf in **Figure 3.**

The Site is located to the west of existing stages of the Huntlee Town Centre subdivision including a detention basin that discharges through the subject site via the southern tributary.

3.2 Available Topographic Data

Due to the size of the Site, detailed survey has not been undertaken at this stage of the development. It is understood that detailed survey of the development area will be undertaken on a stage-by-stage basis during the detailed design phase. For this reason, Light Detection and Ranging (LiDAR) aerial survey has been used for the purpose of this assessment.

It is noted that the accuracy of the ground information obtained from LiDAR survey can be adversely affected by the nature and density of vegetation, the presence of steeply varying terrain, the vicinity of buildings and/ or the presence of water. The accuracy is typically, plus or minus 0.15 m for clear terrain. As this assessment has been undertaken to inform the concept planning of the proposal the level of accuracy provided by the LiDAR data has been considered reasonable. It is however, recommended that detailed survey be used to undertake future detailed designs.

Legend

- Subject Site
- Proposed Developed Layout
- Cadastre

0 100 200 Metres

1:6,000

Figure 3

Site Locality

Huntlee Mod 21
NL151661

NORTHROP

30/7/2022 Y:\YEAR 2015 Jobs\NL151661\G - Design\XPRafts\STAGE 2\220524\Stage 2 QGIS Project MUSIC_220706.qgz

3.3 Existing Catchment

3.3.1 Black Creek

The subject site is not expected to be impacted by flood water derived from Black Creek which is located west of the site. Flood levels extracted from the Black Creek Flood Study (WMA Water, 2015) suggest at its closest location downstream of the Site, Black Creek reaches a maximum flood elevation of approximately 40m AHD, which is approximately 4 meters below the minimum levels observed using LiDAR at the Site.

3.3.2 Local Site Creeks

The subject site is located in the upper reaches of the catchment and drains via two un-named tributaries to Black Creek. These tributaries convey runoff from the upstream Town Centre and the subject site. Each of these creeks have been classified in accordance with the Strahler method. The classifications have been summarised in **Table 1.**

Table 1 – Entering Watercourse Classification

Water Course	Sub-Catchment Area (ha)	Strahler Order
Northern Tributary	36.66	2nd
Southern Tributary	40.44	1st

Designated riparian corridors are to be established along each of the identified watercourses to determine development offsets in accordance with the Original Report (WorleyParsons, 2012). Riparian corridors play a vital ecological role providing a transition zone between the terrestrial environment on land and the aquatic environment within a waterbody.

In accordance with the NSW Department of Planning, Industry and Environment (DPIE) Water requirements, riparian corridors are to be established based on watercourse order to determine the 'Vegetated Riparian Zone' and average channel width. The following **Table 2** summarises the adopted total riparian corridor widths for each water course order.

Table 2 – Adopted Riparian Corridor Widths

Watercourse Order	Vegetated Riparian Zone Width Each Side of Watercourse (m)	Average Channel Width (m)	Total Riparian Corridor Width (m)
1st	10	0-5	20-25
2nd	20	5	45
3rd	30	5-10	65-70
4th	40	10	90

4 Stormwater Quantity

The stormwater quantity assessment has sought to investigate the pre and post developed runoff flow rates to assess the requirement for stormwater detention generally in accordance with the Original Report (WorleyParsons, 2012).

To understand the flooding constraints across the catchment containing the MOD 21 Site area analysis and modelling has been undertaken. A site-specific flood model has also been developed to determine the flood extents generated in the previously discussed local tributaries.

4.1 Methodology

The following methodology has been undertaken for the assessment:

- Review of available information including the proposed development layout, LiDAR elevation data, Aerial Imagery and Cadastre.
- Construction of a one-dimensional XP-RAFTS model to estimate peak flows derived by the existing catchment.
- Modification of the one-dimensional XP-RAFTS model to include the proposed development and performance of stormwater detention, involving the outlet configuration for each tributary.
- Comparison of the peak flow derived by the pre and post developed catchments during the 0.5EY, and the 20%, 10%, 5% and 1% AEP design storm events.
- Construction of a two-dimensional TUFLOW model to review the flood extents through the subject site during both the 1% AEP and PMF design storm events for both the existing and developed case scenarios.
- A summary of the stormwater detention requirements and flood behaviour for the subject site is presented herein.

4.2 Hydrological Model Parameters

The hydrological model was developed in XP-RAFTS using Laurenson Hydrology. As per the latest Australian Rainfall and Runoff Guidelines (ARR 2019); initial loss, continuing loss and pre-burst rainfall portions of the design storm events have been considered as part of this study as shown in the below **Figure 4.**

The input data for the Laurenson Hydrological model used in this study includes sub-catchment data, design rainfall, temporal patterns, pre-burst rainfall and the initial and continuing losses, each of which have been summarised in the report sections below.

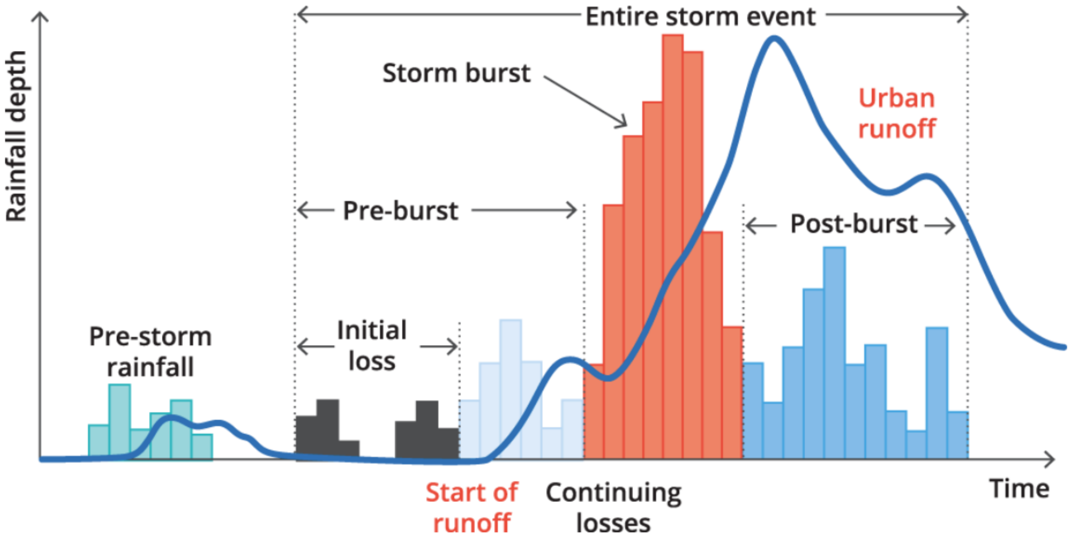


Figure 4 – Conceptual Design Storm Pattern (ARR 2019 Figure 9.6.4)

4.2.1 Sub-Catchment Properties

The study area was split into a number of sub-catchments which were digitised using a combination of LiDAR, Aerial imagery and Cadastral data. Appendix A - **Figure A1** presents the sub-catchments determined for the existing case while, the below **Table 3** presents the catchment properties.

Catchment slope has been determined individually for each sub-catchment, while impervious percentages for have been estimated from review of aerial imagery and design drawings.

Hydrological roughness was based on a review of aerial imagery and the values used in the Original Report (WorleyParsons, 2012). It is important to note that hydrological roughness is an average roughness over the full extent of each sub-catchment which includes both the creeks and bushland.

Table 3 – Modelled Existing Case Sub-Catchment Properties

Catchment Reference	Area (ha)	Impervious (%)	Slope (%)	Roughness (Manning's)
E01	13.02	0	6.89	Pervious =0.09
E02	1.66	0	1.00	Pervious =0.09
E03	25.76	0	3.10	Pervious = 0.09
E04	36.66	0	3.90	Pervious = 0.09

The developed case catchments were updated with an increased impervious percentage over the proposed developed areas. Impervious fractions for the developed areas are generally summarised as below while, a summary of the updated developed case catchments is presented in **Table 4.**

As the land use of the development is classified as mixed use, a typical 85% impervious fraction has been adopted over the majority of developed areas. This excludes catchment D01, which has modelled with a combined impervious fraction of 74.6% which is generally consistent with the existing adjacent subdivision.

Table 4 – Modified Developed Case Sub-Catchment Properties

Catchment Reference	Area (ha)	Impervious (%)	Slope (%)	Roughness (Manning's)
D01	14.56	74.6	6.2	Pervious = 0.035 Impervious = 0.015
D02	1.08	0.0	5.9	Pervious = 0.060
D03	1.02	0.0	3.8	Pervious = 0.060
D04	3.13	0.0	3.0	Pervious = 0.060
D05	11.86	85.0	2.7	Pervious = 0.035 Impervious = 0.015
D06	13.42	85.0	5.7	Pervious = 0.035 Impervious = 0.015
D07	32.23	85.0	5.2	Pervious = 0.035 Impervious = 0.015
D08	4.79	29.1	4.5	Pervious = 0.090 Impervious = 0.015
D09	3.81	0.0	5.1	Pervious = 0.060

4.2.2 Catchment Lag

Lag times between sub-catchments was estimated based on the average flow path grades and the guidance of QUDM 4th Edition, in particular **Table 4.6.6**. Adopted catchment link lag times are summarised in the below **Table 5**.

Table 5 – Catchment Link Lag Times (Existing - Left, Developed - Right)

Link (Refer to Figure A1)	Lag Time (mins)
E01 - E02	0.5
E02 - E03	6.5

Link (Refer to Figure A2)	Lag Time (mins)
D01 – D02	0.5
D02 – D03	3.0
D03 – D04	3.5
D05 – D04	0.5
D06 – D04	0.5
D07 – D09	0.5
D08 – D09	4.5

4.2.3 Burst Rainfall

The latest AR&R 2019 Intensity-Frequency-Duration (IFD) rainfall depths have been obtained from the Bureau of Meteorology (BOM) for a location over the study area. For this investigation, storm durations ranging from the 10-minute to 12-hour were considered to determine the critical storm duration.

The latest AR&R 2019 temporal patterns for the “East-Coast South” region was applied to the 0.5EY, 20%, 10%, 5%, 1%, 1 in 200 and 1 in 500 AEP design storm depths. Areal Reduction Factors have not been considered as part of this study.

The Generalised Short Duration Method (GSDM) and procedures outlined in the Publication *“The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method”* (BOM, 2003) were used to develop design storm depths and patterns for the Probable Maximum Flood (PMF). Storm durations ranging from 15 minutes to 12 hours were modelled to determine the critical event for the Probable Maximum Flood (PMF).

A summary of the rainfall depths used for this assessment are provided in the following **Table 6.**

Table 6 – Rainfall Intensity-Frequency-Duration (BOM, 2020)

Duration (mins)	0.5 EY (mm)	20% AEP (mm)	10% AEP (mm)	5% AEP (mm)	1% AEP (mm)	1 in 200 AEP (mm)	1 in 500 AEP (mm)	PMF (mm)
10	12.7	15.9	19.3	22.7	31.9	35.7	41.8	N/A
15	15.9	19.9	24.1	28.5	40.1	44.9	52.5	180
20	18.2	22.9	27.7	32.7	45.8	51.4	60.2	N/A
25	20.1	25.2	30.5	35.9	50.2	56.3	66	N/A
30	21.7	27.1	32.7	38.6	53.7	60.3	70.7	250
45	25.2	31.4	37.7	44.4	61.2	68.8	80.8	320
60 (1hr)	27.7	34.5	41.4	48.5	66.6	74.9	87.8	370
90 (1.5hr)	31.5	39.1	46.8	54.7	74.6	83.8	98.2	450
120 (2hr)	34.5	42.6	51	59.6	81	90.9	107	520
150 (2.5hr)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	570
180 (3hr)	39.2	48.4	57.8	67.6	91.9	103	120	610
240 (4hr)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	690
270 (4.5hr)	44.8	55.4	66.2	77.4	106	118	138	750

Duration (mins)	0.5 EY (mm)	20% AEP (mm)	10% AEP (mm)	5% AEP (mm)	1% AEP (mm)	1 in 200 AEP (mm)	1 in 500 AEP (mm)	PMF (mm)
360 (6hr)	49.4	61.3	73.4	85.9	118	132	154	790
540 (9hr)	57.1	71.2	85.7	101	140	155	182	N/A
720 (12hr)	63.4	79.7	96.2	113	158	176	206	860

4.2.4 Storm Losses

Recently, the NSW Office of Environment and Heritage (OEH) commissioned a review of the nationally derived losses and pre-burst for catchments over NSW. As a result, a new hierarchical approach has been developed, presenting five different methodologies for applying storm losses and pre-burst rainfall.

For this study, the calibration losses presented in the Black Creek Flood Study – Stage 2 (Nulkaba to Branxton) (WMA Water, 2015) have been used in combination with the NSW Specific Transformational pre-burst rainfall depths. The calibration losses used for rural catchments in this study are presented in **Table 18** of the Black Creek Flood Study (WMA Water, 2015).

With the intended land-use for the proposed developed to be largely mixed use and residential, the pervious initial losses have been reduced to 60% of the calibrated rural losses which is generally in accordance with the latest AR&R 2019 recommendations.

A summary of the losses used for this study is presented in the below **Table 7.** The latest ARR 2019 Data Hub storm losses, obtained over the subject site have also been provided in **Table 7** for comparison purposes.

Table 7 – Modelled Hydrologic Losses and Roughness Parameters

Land-use	Initial Loss (mm)	Continuing Loss (mm/hr)
Rural Pervious (ARR Data Hub)	25	2.1
Black Creek Stage 2 (WMA Water, 2015) Calibration Losses	30.0	2.0
Modelled Pervious (Rural Areas)	30.0	2.0
Modelled Pervious (Urban Areas)	18.0	2.0
Modelled Impervious	1.5	0.0
Sensitivity Testing – Initial Losses (Pervious Catchments)	0	2.0

4.2.5 Pre-Burst Rainfall

As mentioned above, the NSW Specific Transformational pre-burst depths have been used for this study. Pre-burst rainfall was added to the design rainfall events and distributed evenly over six timesteps prior to the burst of the design storm events.

As recommended by the latest ARR 2019 guidelines, the 60min pre-burst ratios have been used for storm durations that are less than 60 minutes. A summary of these pre-burst depths is presented in presented **Table 8** below.

Table 8 – NSW-Specific Transformational Pre-Burst Rainfall (AR&R Data Hub)

Duration (mins)	20% AEP (mm)	10% AEP (mm)	5% AEP (mm)	1% AEP (mm)
60 (1hr)	13.4	13.7	12.8	17.6
90 (1.5hr)	14.9	14.7	12.9	15.6
120 (2hr)	12.3	13.8	14	18.2
180 (3hr)	13.3	14.5	14.9	19.5
360 (6hr)	14	14.2	15.6	20.3
720 (12hr)	13.5	13.9	14.9	20.3

The NSW-Specific Transformational pre-burst rainfall has been added to each storm event over several timesteps prior to the burst. The resultant burst rainfall loss for each event is then determined by the difference between the NSW-Specific Transformational pre-burst rainfall and the Calibration Storm Losses presented in **Table 7** above. This calculation is summarised below. Through this methodology, the latest hierarchical approach for storm losses and pre-burst rainfall has been adopted as part of this study.

Burst Initial Loss = Calibration Initial Loss (Table 7) - NSW Specific Transformational Pre-burst Rainfall (*Table 8*)

4.3 Hydraulic Model Parameters

The hydraulic model for this study was developed using the TUFLOW two-dimensional hydrodynamic modelling software and the HPC GPU solver. The existing and developed case TUFLOW model setup is presented in **Figures A3** and **A4** of Appendix A respectively.

4.3.1 Terrain Data

The terrain data used for the two-dimensional model is 2011 LiDAR elevation data obtained from ELVIS – Elevation and Depth – Foundation Spatial Data website and made available for use by the NSW Government. Additional detailed survey was also incorporated into the model to provide a more recent representation of the topography.

For the developed case scenario, the design surface containing the proposed detentions, biofiltration basins, embankments and the roads was added while the proposed lots were blocked out.

A manual modification to the terrain was included in the existing and developed case scenarios to represent the removal of the existing rail corridor embankment, located along the western edge of the southern tributary. This is primarily outside the model extent however, to remove potential impacts on the model, this feature has been included.

It is anticipated that future road and stormwater design will occur at detailed design stage. The results presented herein assume the majority of these works will remain on-grade with limited changes to the terrain.

4.3.2 Grid Extent, Size and Timestep

Figures A3 and **A4** of Appendix A present the two-dimensional model extent with the grid extending approximately 650m west of Wine Country Drive, east of Black Creek, approximately 300m south of the Hunter Express Way and 650m north-west of North Rothbury. The western extent of the model is bounded by the Cessnock City Council LGA Boundary.

A two-metre cell size has been used which was considered a suitable size for the purposes of this study. An adaptive timestep has been used which enables more efficient model run times while, still maintaining a high degree of accuracy.

4.3.3 Catchment Roughness

Catchment roughness was based on review of hydraulic literature and aerial imagery. **Figures A3** and **A4** present the extent of the existing and developed case land use while, the below **Table 9** presents the adopted hydraulic roughness for each.

A sensitivity test on the adopted manning's roughness for the model was conducted to determine the sensitivity of the modelled flood behaviour. These are included in the table below, and the results are presented in Figures F3 and F4.

Table 9 – Modelled Hydraulic Roughness Parameters

Land use Type	Roughness (Manning's)		
	(-)20%	Adopted	(+)20%
Bushland	0.072	0.09	0.108
Grass	0.036	0.045	0.054
Drainage Channel	0.048	0.06	0.072
Biofiltration Basin	0.08	0.10	0.12
Road Reserves	0.02	0.025	0.03
Water Bodies	0.016	0.02	0.024

4.3.4 Boundary Conditions

Inflow hydrographs produced by the XP-RAFTS model were applied directly to the two-dimensional grid via a series of inflow boundaries as shown in **Figures A3** and **A4** of Appendix A. The inflows for each of the tributaries have been extracted from the one-dimensional XP-RAFTS model and added to the TUFLOW model at various locations through the creek to represent the contributing catchments.

Two outlet head boundaries with elevations of 40.0m AHD for the northern tributary and 43.0m AHD for the southern tributary have been entered downstream of the subject site for each of the events modelled. These have been applied to the one-dimensional and two-dimensional grid to account for flows through the stormwater outlet and across the embankment, in extreme events. This represents a free-outfall tail-water condition for flows continuing downstream of the subject site.

4.3.5 Hydraulic Structures

Figure A4 presents the developed case stormwater infrastructure across the subject site. The modelled stormwater network was based on design drawings from the existing subdivision, aerial imagery and LiDAR elevation data.

As the site is located in the upper reaches of the catchment stormwater detention is expected to be required. The strategy presented herein includes the introduction of two detention basins at the site outlet for both the northern and southern tributaries. In addition to the proposed detention basins, the existing detention basin developed as part of the adjacent Town Centre stages on the southern tributary has also been included in the developed case scenario.

A 0% blockage factor has been used for both the existing and developed case detention basins. It is expected a debris rack or similar will be installed at the outlets to reduce the potential for blockage within the basins. A sensitivity analysis for blockage is also presented in the results section below.

The embankments for the northern and southern basins are not currently proposed to be trafficable, however there is the potential that they may be used for vehicles as future stages of the subdivision are designed. As such, both basins have been designed with a minimum of 600mm freeboard to the crest of each embankment.

Table 10 provides a summary of the modelled developed case stormwater infrastructure, and is presented in **Figure A4** of Attachment A.

Table 10 – Developed Case Infrastructure

Reference (Refer to Figures A4)	Description	Size/Type	Number of
EX01	Low Flow Culvert from Existing Detention Basin	600mm RCP	1
EX02	High Flow Weir from Existing Detention Basin	7.5m @ RL. 55.40m AHD	1
DEV_1	Low Flow Outlet for Northern Tributary Basin	375mm RCP (Low Flow)	2
DEV_2	High Flow Outlet for Northern Tributary Basin	600mm RCP (High Flow)	2
DEV_3	Low Flow Outlet for Southern Tributary Basin	525mm RCP (Low flow)	1
DEV_4	High Flow Outlet for Southern Tributary Basin	750mm RCP (High Flow)	3

4.4 Results

4.4.1 Critical Duration

The critical duration was determined in XP-RAFTS with storm durations ranging from 10-minutes to the 12-hours considered for the 20%, 10%, 5% and 1% AEP design storm events.

During the 1% AEP, critical durations observed in XP-RAFTS at various locations across subject site were passed into the two-dimensional model. All ten temporal patterns for each duration were passed to the two-dimensional TUFLOW model. The median pattern for each storm duration was calculated with the duration producing the highest median value classified as the critical event as recommended in the latest ARR 2019 guidelines.

The below **Table 11** presents the critical duration ensembles passed into the two-dimensional TUFLOW model for each return interval for both the existing and developed case models. These durations were also used in the 1 in 200 AEP and 1 in 500 AEP flood events, used as proxies for climate change.

Table 11 – Two-dimensional model duration ensembles (Existing and Developed)

Case	Design Storm Event	Duration One	Duration Two	Duration Three
Existing	1% AEP	60min	90min	120min
Developed	1% AEP	60min	60min	120min

During PMF, all durations ranging from the 15-minute to the 12-hour design storm duration were passed to the two-dimensional model. The duration that produced the maximum flood level for the PMF was considered the critical event. Generally, the 15- and 45-minute durations were critical for the southern tributary while, the 30-minute duration was critical for the northern tributary.

4.4.2 Detention

The XP-RAFTS model has been used to review the pre-developed and post-developed peak flow rates for the subject site. The post-development scenario contained the northern and southern basins, with the low and high flow outlets included.

The following two site discharge points have been identified (refer to Appendix A – **Figure A1** and **A2** for locations):

- Discharge Point I: Northern Outlet
- Discharge Point II: Southern Outlet

The pre-developed and post developed critical duration and peak flow results for the main discharge points are presented in the below **Table 12** and **Table 13**.

Table 12 – Pre to Post Comparison Discharge Point I (Northern Tributary)

Storm Event	Pre-Developed Critical Event	Pre-Developed Flow (m^3/s)	Post-Developed Critical Event	Post-Developed Flow (m^3/s)	Difference (m^3/s)
0.5 EY	6hour TP8	0.73	90min TP6	0.70	-0.03
20% AEP	180min TP7	1.10	90min TP1	0.92	-0.18
10% AEP	180min TP6	1.64	120min TP2	1.39	-0.28
5% AEP	180min TP6	2.14	120min TP7	2.08	-0.06
1% AEP	120min TP2	3.47	120min TP6	2.93	-0.54

Table 13 – Pre to Post Comparison Discharge Point II (Southern Tributary)

Storm Event	Pre-Developed Critical Event	Pre-Developed Flow (m^3/s)	Post-Developed Critical Event	Post-Developed Flow (m^3/s)	Difference (m^3/s)
0.5 EY	6hour TP5	0.82	90min TP4	0.71	-0.11
20% AEP	180min TP7	1.28	90min TP5	0.96	-0.32
10% AEP	180min TP6	1.90	360min TP4	1.45	-0.45
5% AEP	180min TP6	2.42	360min TP8	2.31	-0.11
1% AEP	90min TP10	3.94	120min TP6	3.56	-0.38

The results presented in the above **Table 12** and **Table 13** suggest post developed peak flow rates are successfully reduced to equal to or less than the pre-developed rates for both of the tributaries within the subject site.

4.4.3 Existing Case Flooding

Figures C1 to **C2** of Appendix A present the existing case flood depth and elevation through the subject site for both the 1% AEP and PMF design storm events. Across the subject site, flows through both tributaries are observed running in a westerly direction before terminating at the model extent downstream of the subject site.

4.4.4 Developed Case Flooding

Figures D1, D2, D4 and D5 of Appendix A present the developed case flood depth, elevation contours and hazard through the subject site for both the 1% AEP and PMF design storm events. Additionally, **Figure D3** presents the 1% AEP flood velocity.

Flow behaviour during the developed case is similar to that of the existing case with the exception of the upstream Town Centre detention basin and the proposed northern and southern tributary detention basins.

Runoff generated by the upstream urban and forested catchments enter each tributary and continues in a westerly direction before ponding within the proposed basins. Runoff within the basins pass through the high and low flow outlets and continue downstream, towards Black Creek. The developed case flood depths, levels and storage volume are summarised in the following **Table 14.**

Table 14 – Summary of Flood Depth, Levels and Volume (2D Results)

Detention Basin	Depth (m)		Elevation (m AHD)		Volume (ML)
	1% AEP	PMF	1% AEP	PMF	1% AEP
Northern	3.80	4.85	47.92	48.98	25.7
Southern	3.18	5.29	49.20	51.31	23.2

The results presented in **Figure D1** of Appendix A shows flows are contained within the watercourses with all proposed lots flood free during the 1% AEP design storm event. During the PMF, flows are observed over the detention basin embankments as well as a portion of the region adjacent to the southern side of the southern tributary.

Flood hazard during the 1% AEP and PMF design storm events is presented in **Figures D2** and **D5** of Appendix A respectively. Flood hazard has been based on the latest AR&R hazard categories as summarised in **Figure 5** below.

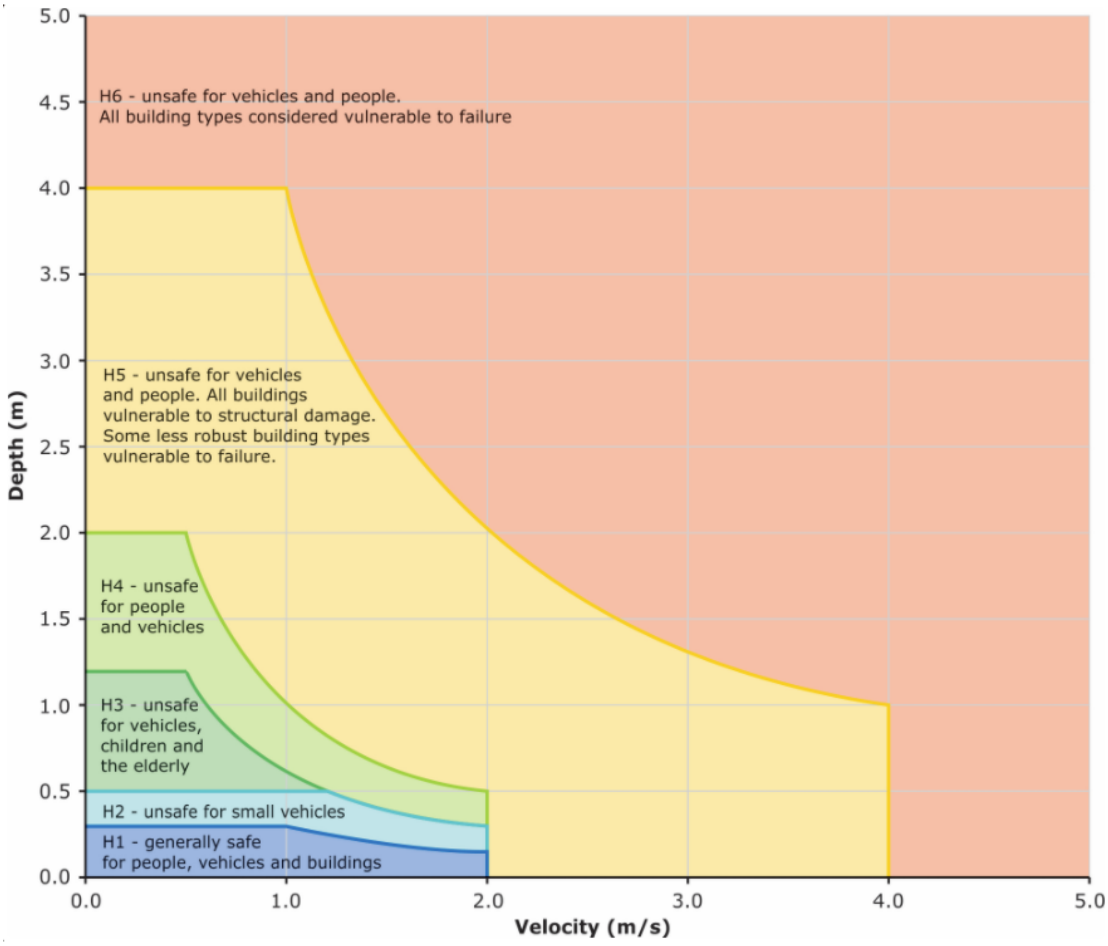


Figure 5 – Flood Hazard Categories (AR&R 2019)

Figure D2 of Appendix A shows flood hazard conditions in the existing and proposed detention basins of up to H5. Furthermore, all proposed roads are shown to be flood free during the regional flood event.

During the PMF event, **Figure D5** of Appendix A shows flood hazard of up to H6 observed in the proposed northern and southern detention basins. In addition, flood hazard ranging from H1 to H4 is also observed across the proposed road network on the southern side of the southern tributary.

4.4.5 Proposed Culvert Crossings

The Cessnock City Council's Engineering Guidelines recommend trafficable culvert crossings be designed with minimal adverse headwater inundation (afflux) when unblocked, and a minimum 600mm freeboard to the road surface.

Whilst the two basins have been designed with embankments along the western edge opposed to roads, both basins have been designed assuming future vehicular access is available, allowing leverage for modifications to future works. As a result, both are required to maintain a minimum of 600mm freeboard using the 1% AEP flood event. As the crossings are to be used for a secondary purpose as stormwater detention, afflux is required and is therefore not considered a design requirement.

An assessment of the necessary freeboard for the proposed crossing has been made as shown in **Table 15** overleaf**.**

Table 15 – Summary of Culvert Design Results

Variable	Structure / Scenario					
Culvert Configuration	Northern Tributary			Southern Tributary		
Blockage (%)	Existing	0	50	Existing	0	50
Embankment Level (m AHD)	-	48.52		-	50.75	
US Invert Level (m AHD)	-	44.1		-	46.0	
Cover (m)	-	0.8		-	0.6	
US Water Level (m AHD)	46.3	47.9	48.2	44.3	49.2	49.5
DS Invert Level (m AHD)	-	43.70		-	45.55	
Freeboard Depth (m)	-	0.6	0.3	-	1.5	1.2

The above **Table 15** shows the necessary freeboard of 600mm is achieved for both (proposed and likely future) road crossings. It is noted that the basin sizes and road crossings are approximate only at this stage to inform spatial requirements across the site. Basin sizes and road crossings will need to be confirmed at detailed design stage once site grading has been finalised.

4.4.6 Sensitivity Analysis

Climate Change

The 1 in 200 AEP and 1 in 500 AEP design storm events provides a proxy for increased rainfall depths due to climate change. A comparison between each event with the 1% AEP suggests increases in flood depths within each of the proposed detention basins. A summary of the expected increases is shown in **Table 16**. **Figures E1** and **E2** illustrate the impacts of climate change for the subject site for the 1 in 200 and 1 in 500 AEP flood events.

Table 16 – Climate Change Sensitivity

Detention Basin	1% AEP	1 in 200 AEP	1 in 500 AEP
Northern Tributary	47.92	48.16	48.52
Southern Tributary	49.20	49.37	49.74

Losses Sensitivity

A sensitivity test has been performed to review the effect initial losses have on the developed case peak flow and flood levels across the subject site. The XP-RAFTS model, prepared as part of this assessment has been updated with a reduced initial loss from 30mm to 0mm for the pervious catchments. The following **Table 17** presents a comparison between the peak flows from the design flood event and the sensitivity test with reduced initial losses.

Table 17 – Initial Loss Peak Flow Sensitivity Test

Discharge Point (Refer to Figure A1)	Critical Event	Post Developed Peak Flow (m3/s)	Sensitivity Test Peak Flow (m3/s)	Difference (m3/s)	Difference (%)
Northern Tributary	120min TP6	2.93	3.17	+0.24	+8.2
Southern Tributary	120min TP6	3.56	3.71	+0.15	+4.2

The results presented in the above **Table 17** demonstrate a relatively minor increase in peak flow as a result of the removal of the initial losses.

To review the impact this has on flood levels across the site, the updated hydrology was reviewed using the two-dimensional TUFLOW model. A comparison between the design scenario results presented in **Figure D1** and the sensitivity test are presented in **Figure E3** of Appendix A.

The results presented in **Figure E3** of Appendix A suggest an increase in the proposed basins of up to 120mm and 51mm for the northern and southern tributaries, respectively. As freeboard to the top of the basins remain during this scenario, the proposed basins are not considered sensitive to changes in the assumed losses.

Blockage Assessment

A blockage sensitivity assessment was conducted using the latest ARR 2019 Blockage Design Criteria. Using the method outlined in Book 6 Chapter 6, a 50% blockage was assigned to each of the outlet pipes. This is presented in **Figure E4.**

The results suggest an increase of up to approximately 300mm is expected. As highlighted by **Table 15** a minimum of 300mm freeboard is still expected to be available within the basins during a blocked scenario.

As freeboard in the basins remain under the blocked scenario, the proposed basins are not considered sensitive to blockage. It is also noted that debris screens are still proposed as part of the development and as such the risk of blockage is expected to be low.

Manning's Roughness

An assessment was conducted on the surface roughness adopted in the model. Through executing the two-dimensional TUFLOW model with +/- 20% roughness value, the sensitivity of the catchment surface and the impact of this on the peak flow could be assessed. Roughness values adopted for the sensitivity are presented in the above **Table 9.**

The results of the sensitivity assessment are presented in **Figure E5** and **Figure E6**. A change of up to approximately 25mm was determined by the sensitivity test. This suggests the catchment is not expected to be sensitive to the assumed surface roughness.

4.4.7 Flood Planning Area

The Flood Planning Area has been determined based on the 1% AEP + 500mm. The results are presented in F1 overleaf. The results presented in **Figure 6** demonstrate all proposed lots and roads are located outside the extent of the Flood Planning Area, therefore are also located above the Flood Planning Level of the 1% AEP + 500mm.

Legend

- Model Extent
- Subject Site
- Cadastre
- Layout
- Flood Planning Area

Flood Depth (m)

- 0.0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.8
- 0.8 - 1.2
- 1.2 - 2.0
- 2.0 - 2.5
- >2.5

0 100 200 Metres

1:6,000

Figure 6 [B]

Developed Case
1% AEP Flood Depth
and Flood Planning Area

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)

7/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

5 Erosion Protection and Energy Dissipation

Management of streamflow velocities is vital to mitigate the impact of urban development on channel bed and bank erosion. High streamflow velocities can lead to increased scour, erosion and downstream sedimentation resulting in negative impacts on riparian flora and fauna. Detailed design of all works within the project area, instream, offline and adjacent to watercourses, is to be undertaken to implement appropriate control measures to dissipate energy and reduce velocities.

Piped stormwater networks are to be designed to minimise velocities at headwall outlets through appropriate alignment, sub-catchment size and longitudinal grade. High flow bypass structures are to be designed to divert major event runoff around any proposed stormwater water quality treatment devices. Basin and creek line embankments are to be designed to promote the establishment of vegetation for increased stabilisation and reduce the potential for scour.

Rip-rap erosion protection is to be provided at all proposed discharge points including piped inlets/outlets, inline culvert embankments and dam spillways to prevent scour. The energy dissipation devices are to be designed in accordance with the requirements outlaid in Catchments and Creeks 2014 guidelines for Single Pipe and Culvert Outlets and Dam Spillways. Rip-rap sizing is to be provided at the Detailed Design stage of each sub catchment with appropriate consideration given to the outlet flow rate, velocity, pipe diameter and/or spillway width and depth. Where necessary concrete control structures such as apron slabs may be required however naturalised materials such as site won rock will be preferred.

Figure D3, provided in Appendix A, illustrates the anticipated instream velocities during a 1% AEP storm event in the post developed scenario. As depicted flow velocities on both tributaries is expected to be relatively low with only minor areas near basin outlet control structures at approximately 2m/s, the anticipated threshold for grass surfaces. As such, provision of rock scour erosion protection and riparian vegetation is anticipated to sufficiently mitigate impact of streamflow velocities.

6 Stormwater Quality

In order to minimise any adverse impacts upon the ecology and health of the downstream watercourses, stormwater treatment devices have been incorporated into the design of the development.

6.1 Methodology

The performance of the proposed stormwater management strategy has been assessed using the conceptual computer software MUSIC (Version 6.3). MUSIC serves as a planning and decision support system that is used to estimate the efficiency of Stormwater Quality Improvement Devices (SQIDs) at capturing common stormwater pollutants including Total Suspended Solids, Total Nitrogen, Total Phosphorous and Gross Pollutants from stormwater runoff. Modelling involves the use of historical or synthesized long-term rainfall data and algorithms that can simulate the performance of stormwater treatment measures to determine stormwater pollution control.

6.2 Stormwater Quality Philosophy and Targets

Stormwater quality is proposed to be managed through a treatment train approach to meet pollutant removal efficiency targets outlined in the Huntlee DCP 2013. These targets have been reproduced in **Table 18** below.

Table 18 – Pollutant Removal Efficiency Targets

Pollutant	Treatment Efficiency Target
Total Suspended Solids (TSS)	85% reduction in pollutant loads
Total Nitrogen (TN)	45% retention of average annual load.
Total Phosphorous (TP)	45% retention of average annual load.

6.3 Treatment Train Assessment

6.3.1 Catchments

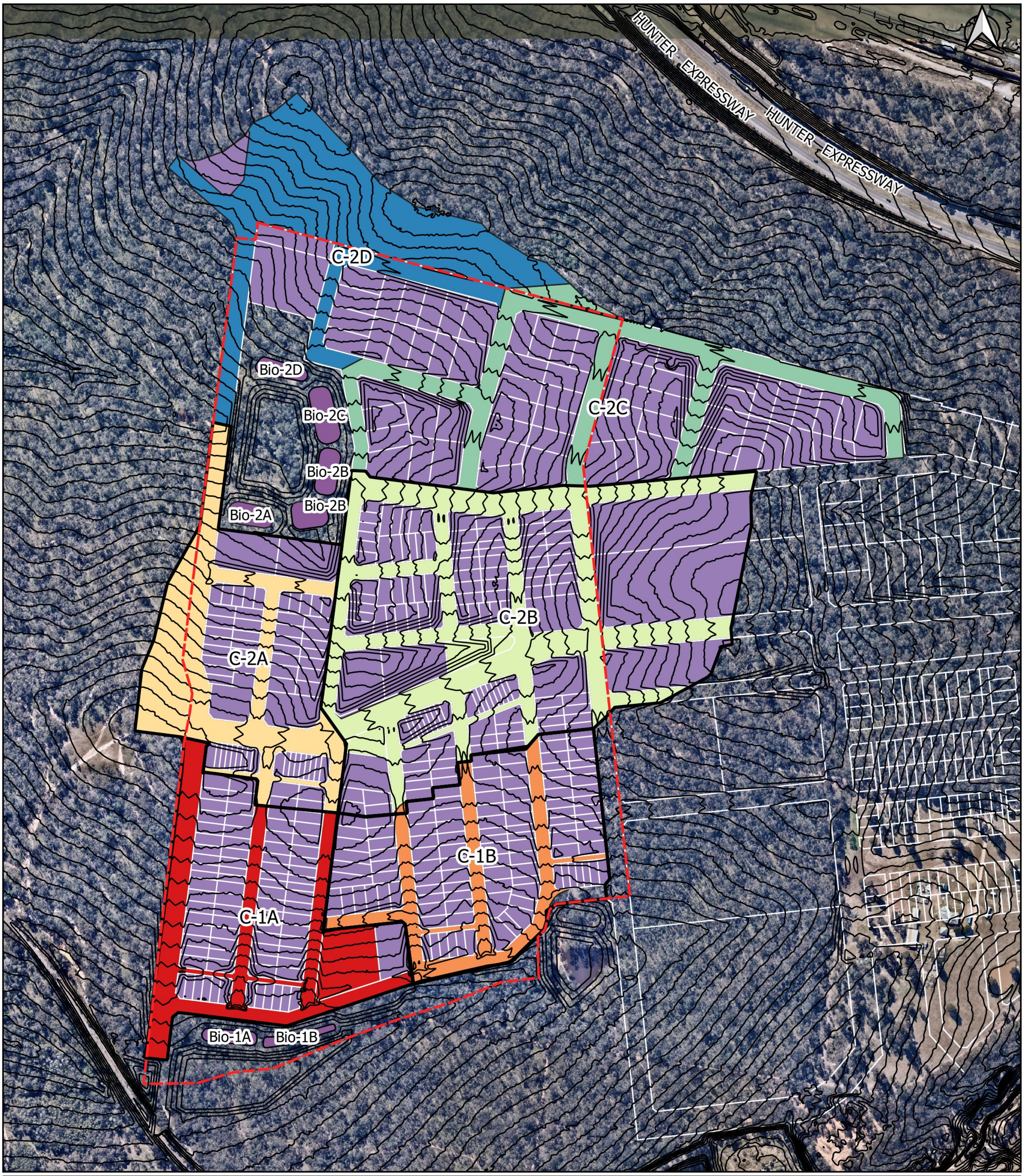
A total impervious percentage of 85% was adopted for residential areas, commercial areas and the road reserve. The upstream bushland catchment was modelled with an impervious percentage of 0% and the parkland areas were modelled with an impervious percentage of 10%.

To reflect this the catchment was split into five primary land use categories being 'Residential', 'Road Reserve', 'Park", 'Bushland' and "Commercial'. It is noted that the routing the upstream bushland area through the treatment facilities is considered conservative for the purposes of this investigation as pollutant runoff from this area is not expected to be significantly altered as a result of the proposed development.

The below **Table 19** and **Figure 7**present the MUSIC catchments used for this study.

Table 19 – Water Quality Catchments

Catchment	Total Area (ha)	Residential (ha)	Road Reserve (ha)	Park (ha)	Bushland (ha)	Commercial (ha)
Basin 1A	6.30	3.569	2.054	0.493	-	0.213
Basin 1B	5.70	4.104	1.61	-	-	-
Basin 2A	6.07	2.483	2.5075	-	-	1.075
Basin 2B	13.60	4.078	4.572	0.32	-	4.63
Basin 2C	10.15	-	3.02	-	0.15	6.98
Basin 2D	7.70	-	2.073	-	2.97	2.657



Legend

- Subject Site
- Bioretention Basins
- Terrain (1m Contours)
- Lots
- Layout
- Subcatchment Extents

Subcatchments

- C-1A
- C-1B
- C-2A
- C-2B
- C-2C
- C-2D

Figure 7

Developed Case - MUSIC Catchments

Huntlee Mod 21
NL151661

NORTHROP

3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\XPRafts\STAGE 2\220524\Stage 2 QGIS Project MUSIC_220706.qgz

6.3.2 Model Parameters

In order to establish a MUSIC model, rainfall and evaporation records in the vicinity of the Huntlee site were sought. To develop a model that could comprehensively assess the performance of the proposed stormwater management plan and to be consistent with the Original Report (WorleyParsons, 2012), 6-minute pluviograph data from the BoM station 061174, located in Millfield, was used. As per the Original Report (WorleyParsons, 2012), rainfall between 1969 and 1973 was used for all MUSIC water quality simulations. This period is reported to represent '5 consecutive years of approximate average rainfall'.

Monthly areal potential evapotranspiration (PET) rates for the site were established from PET data provided by the Climate Atlas of Australia (BoM). The monthly average PET adopted by the MUSIC model are shown in **Table 20.**

Table 20 – Average Evaporation and Potential Evapotranspiration at Huntlee

Month	Average Monthly Evaporation^ (mm/month)	Areal Potential Evapotranspiration (mm/month)
January	180	170
February	175	140
March	125	130
April	100	90
May	90	65
June	80	60
July	75	50
August	90	70
September	120	90
October	140	120
November	180	150
December	200	165

^ Evaporation from Class evaporation pan

The source nodes adopted to represent the development were Urban Residential, Urban Sealed Road, Urban Commercial and Urban Revegetated Land (for parkland areas and upstream bushland catchments).

The Base and Storm Flow concentration parameters for the different land uses have been adopted from the NSW MUSIC Modelling Guidelines, 2015. Parameters for the source node inputs used are summarised in **Table 21** to **Table 24**.

Table 21 – Concentration Parameters for TSS (Tables 5-6 and 5-7 NSW MUSIC Modelling Guidelines)

Total Suspended Solids	Concentration Parameter	Residential	Sealed Road	Parkland/ Bushland	Commercial
Base Flow	Mean (log mg/L)	1.200	1.200	1.150	1.200
	Std Dev (log mg/L)	0.170	0.170	0.170	0.170
Storm Flow	Mean (log mg/L)	2.150	2.430	1.950	2.150
	Std Dev (log mg/L)	0.320	0.320	0.320	0.320

Table 22 – Concentration Parameters for TP (Tables 5-6 and 5-7 NSW MUSIC Modelling Guidelines)

Total Phosphorus	Concentration Parameter	Residential	Sealed Road	Parkland/ Bushland	Commercial
Base Flow	Mean (log mg/L)	-0.850	-0.850	-1.220	-0.850
	Std Dev (log mg/L)	0.190	0.190	0.190	0.190
Storm Flow	Mean (log mg/L)	-0.600	-0.300	-0.660	-0.600
	Std Dev (log mg/L)	0.250	0.250	0.250	0.250

Table 23 – Concentration parameters for TN (Tables 5-6 and 5-7 NSW MUSIC Modelling Guidelines)

Total Nitrogen	Concentration Parameter	Residential	Sealed Road	Parkland/ Bushland	Commercial
Base Flow	Mean (log mg/L)	0.110	0.110	-0.050	0.110
	Std Dev (log mg/L)	0.120	0.120	0.120	0.120
Storm Flow	Mean (log mg/L)	0.300	0.340	0.300	0.300
	Std Dev (log mg/L)	0.190	0.190	0.190	0.190

Table 24 – Rainfall-Runoff Parameters (Table 5-5 NSW MUSIC Modelling Guidelines)

Property	Rainfall-Runoff Parameter	Residential/ Seal Road/ Parkland/ Bushland/Commercial	Road Reserve
Impervious Areas	Rainfall Threshold (mm/day)	1	1.5
Pervious Areas	Soil Storage Capacity (mm)	88	88
	Initial Storage (% of Capacity)	25	25
	Field Capacity (mm)	70	70
	Infiltration Capacity Coefficient –a	180	180
	Infiltration Capacity Exponent –b	3	3
Ground Water	Initial Depth (mm)	10	10
	Daily Recharge Rate (%)	25	25
	Daily Baseflow Rate (%)	25	25
	Daily Deep Seepage Rate (%)	0	0

6.3.3 Adopted Treatment Train

The site was divided into six stormwater catchments which considered the existing topography, as well as the proposed site layout and grading. The treatment train for each catchment consists of primary measures in the form of a Gross Pollutant Traps (GPTs) followed by tertiary treatment in offline bio-filtration basins.

In conjunction with the practical constraints of the proposed development layout and riparian corridors, device positions were governed by the provision of access for maintenance.

- Gross Pollutant Traps (GPT):
  - The published removal treatment efficiencies for the proprietary inline GPTs have been utilised within the MUSIC model to simulate the removal of coarse sediment and litter at the GPT locations.
  - A proprietary GPT device will be required upstream of each bio-retention basin inlet to treat approximately the 3-monthly ARI (Annual Recurrence Interval) peak flow rate approaching each unit.
  - The modelling utilises the GPT treatment node inputs from the NSW MUSIC Modelling Guidelines (August 2015) with the following reduction efficiency:
    - Total Suspended Soiled = 65%
    - Total Phosphorus = 25%
    - Total Nitrogen = 14%
    - Gross Pollutants = 90%
  - Research presented in Australian Runoff Quality (Engineers Australia 2006) suggests that roughly 1m^3/ hectare/ year of gross pollutants and sediment could be expected from a typical residential catchment. It is expected that with full development the GPTs will need

maintenance on average twice per year. Should a dry weather hydrocarbon spill or any other spill occur, additional maintenance should be carried out to ensure the device operates as intended.

- Bio-filtration Basins:
  - Biofiltration systems are designed with the primary intent of removing suspended pollutants from stormwater before the water is discharged to the local waterway. The stormwater temporarily ponds on the surface within the extended detention zone before slowly filtering through the soil media. The soil media controls the flow rate of water through the system as well as providing a growing media for the plants. Pollutants are retained through fine filtration, absorption and biological uptake. Treated stormwater is collected at the base of the system via a network of perforated pipes located within the gravel drainage layer to be discharged to the outlet pits. Stormwater will enter these basins via a riprap-lined weir designed to dissipate energy.
  - A high flow bypass has been modelled as 50% of the 1EY flows to prevent scour damage in higher intensity rainfall events.
  - The bio-filtration basins have been modelled with a filter depth of 0.5m and an extended detention depth of 0.2m.
  - **Table 25** shows the filter area and surface area for the proposed biofiltration basins for each catchment. Parameters for the bioretention basin were adopted in accordance with the “NSW MUSIC Modelling Guidelines” (BMT WBM, 2015). The proposed location and approximate sizing of these biofiltration basins has been depicted in **Figure 7.**

Table 25 – Biofiltration basin areas

Catchment	Filter Area (m^2)	Surface Area (m^2)
1A	630	790
1B	570	715
2A	610	760
2B	1360	1700
2C	1015	1270
2D	770	965

It is noted that the basin sizes presented in **Table 25** are approximate only provided at this stage to inform spatial requirements across the site. Basin filtration sizes will need to be confirmed at detailed design stage once site grading has been finalised. The following **Figure 8**, shown overleaf presents the nodal representation of the modelled treatment train in MUSIC.

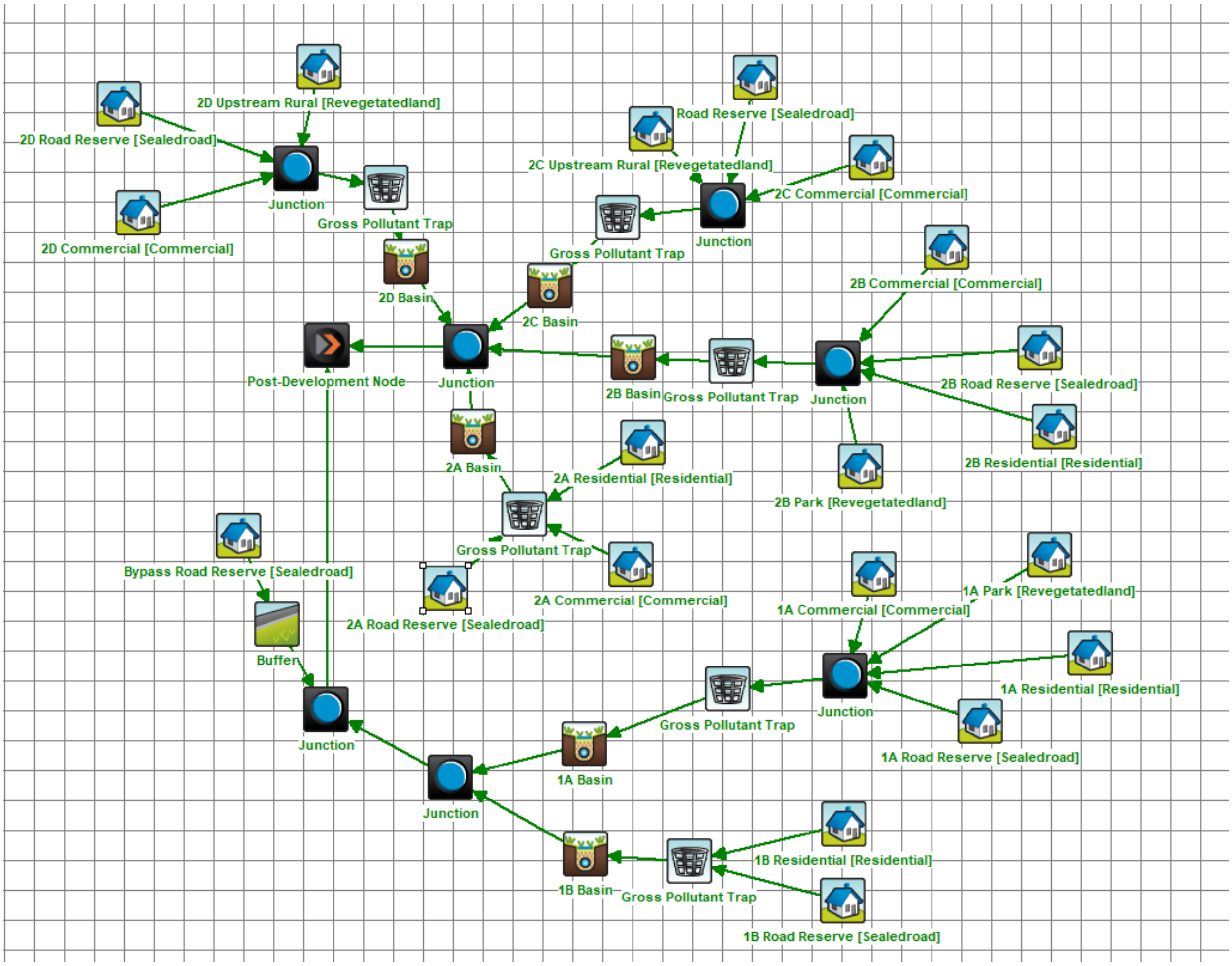


Figure 8: Schematic of MUSIC model

6.3.4 MUSIC Model Results

The results calculated by the MUSIC model for both the Northern and Southern tributaries are shown below in **Table 26** and **Table 27** respectively. The tables show pollutant load and removal efficiencies for the proposed developed exceed the required targets outlined in the Huntlee DCP 2013 (refer to **Table 18**).

Table 26 – Pollutant Removal Efficiency Results (Northern Tributary)

Parameter	Source Load	Residual Load	% Reduction
TSS (kg/yr)	47200	5630	88.1
TP (kg/yr)	77.4	24.1	68.8
TN (kg/yr)	450	212	52.9
GP (kg/yr)	6120	102	98.3

Table 27 – Pollutant Removal Efficiency Results (Southern Tributary)

Parameter	Source Load	Residual Load	% Reduction
TSS (kg/yr)	16200	2290	85.9
TP (kg/yr)	27.1	9.18	66.1
TN (kg/yr)	156	75.8	51.5
GP (kg/yr)	2150	83.5	96.1

7 Conclusion

The proposed development has been assessed with respect to the necessary stormwater quantity and quality requirements.

The following recommendations and conclusions are made:

- Riparian corridors are to be established over the proposed natural watercourses which exist across the Site to ensure development buffers are adopted by future on lot development.
- Flood inundation extents for the 1% AEP and PMF across the Site have been provided to inform flood planning of future development.
- All proposed lots are positioned at or above the Flood Planning Level (i.e. the 1% AEP + 500mm).
- Assessment of the pre and post developed flow regimes has been undertaken, concluding that onsite detention will be required to mitigate runoff from the future development, to ensure no significant adverse impact on the existing flood behaviour during the regional flood event.
- The impact of the urban development on stormwater quality is to be mitigated through the incorporation of source and end-of-line treatment controls to reach the nominated pollutant load reduction targets.

We trust this meets your requirements, however, should you require anything further, please do not hesitate to contact the undersigned.

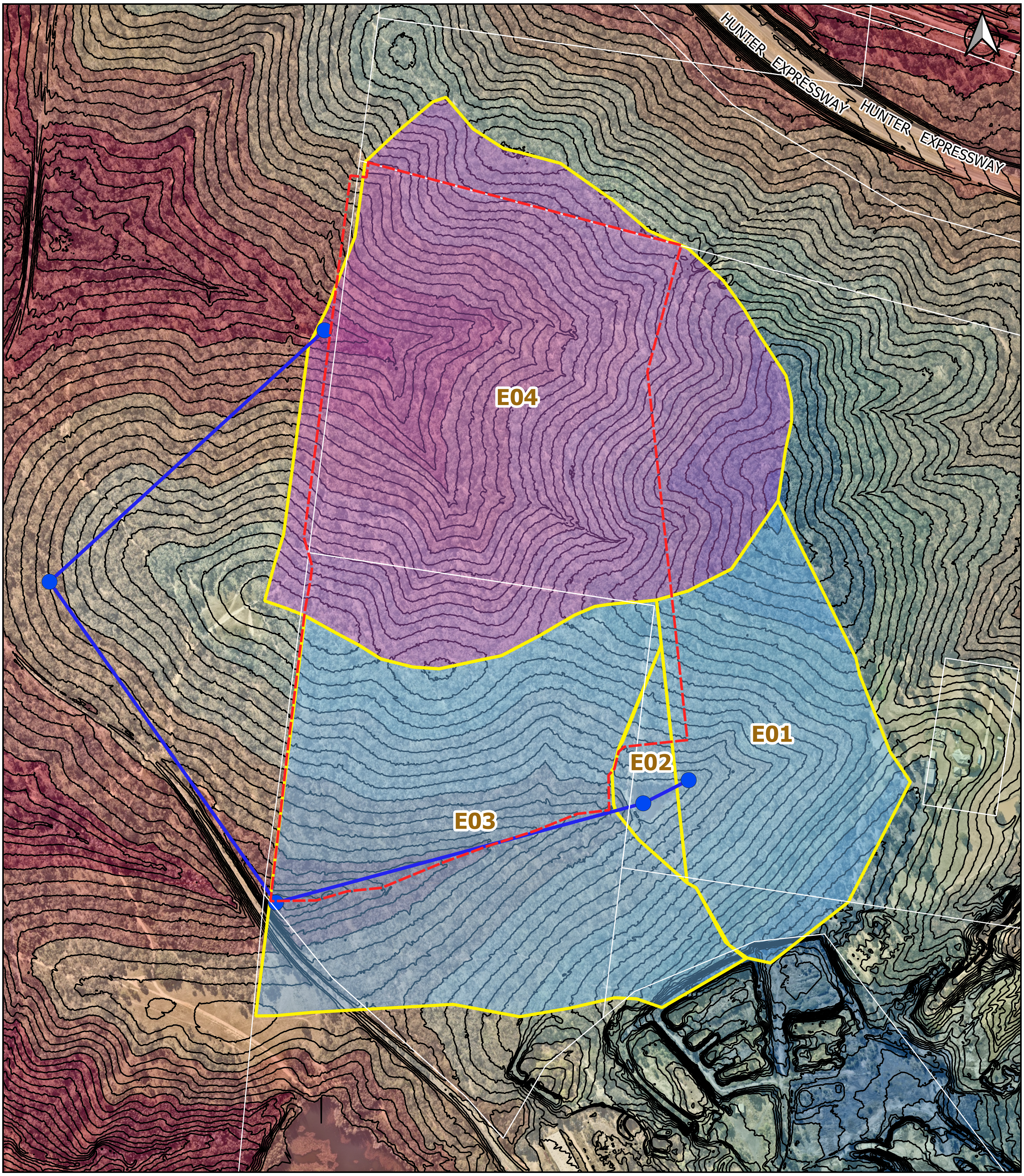
Prepared by:

Laurence Gitzel
Associate | Flood Engineer
BEng(Env) MProfEng(Env) MIEAust CPEng NER(Civil)

Reviewed:

Ben Clark
Principal | Civil Engineer
BEng (Civil) MIEAust CPEng NER RPEQ

Appendix A - Flood Study Figures



Legend

- Northern Tributary
- Southern Tributary
- Catchment Boundaries
- Subject Site
- Cadastre
- Minor Contours (1m)
- Major Contours (5m)
- Links
- Nodes

Terrain (m AHD)

- <= 45.0
- 45.0 - 50.0
- 50.0 - 55.0
- 55.0 - 60.0
- 60.0 - 65.0
- 65.0 - 70.0
- 70.0 - 75.0
- > 75.0

0 100 200 Metres
1:7,000

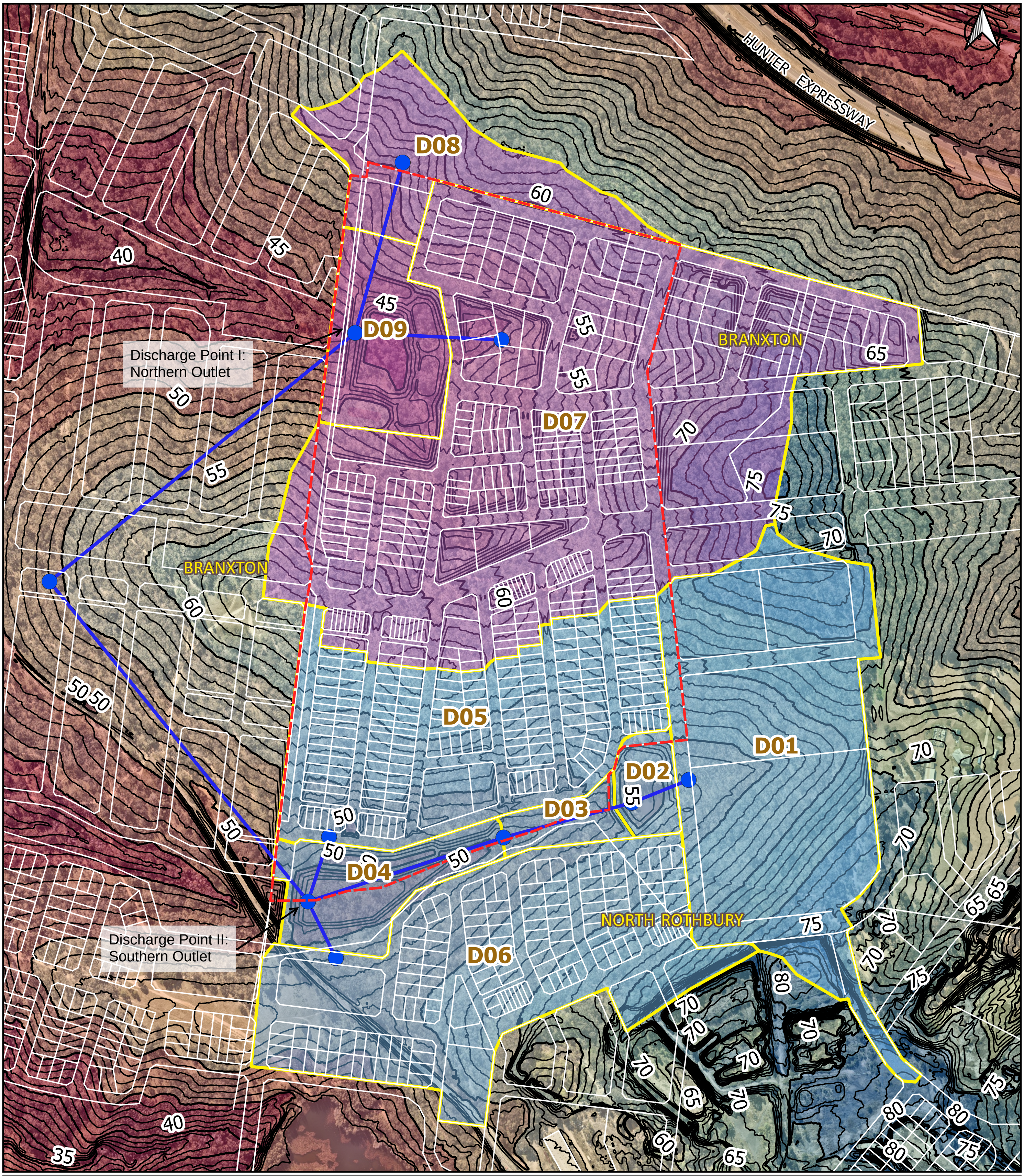
Figure A1 [B]

Existing Case
Hydrological Model Catchments

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz



Legend

- Northern Tributary
- Southern Tributary
- Catchment Boundaries
- Subject Site
- Cadastre
- Minor Contours (1m)
- Major Contours (5m)
- Links
- Nodes

Terrain (m AHD)

- <= 45.0
- 45.0 - 50.0
- 50.0 - 55.0
- 55.0 - 60.0
- 60.0 - 65.0
- 65.0 - 70.0
- 70.0 - 75.0
- > 75.0

0 100 200 Metres
1:7,000

Figure A2 [B]

Developed Case
Hydrological Model Catchments

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Legend

- Model Extent
- Subject Site
- Cadastre
- Inflows
- Outfall

Roughness (Manning's)

- Drainage Channel (0.060)
- Bushland (0.090)
- Water Bodies (0.020)

0 100 200 Metres

1:5,000

Figure A3 [B]

Existing Case
Roughness and Model Setup

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)

3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Legend

- Model Extent
- Subject Site
- Cadastre
- Inflows
- Lots (Blocked Out)
- Outfall
- Stormwater Pipe Network
- Stormwater Pit Network

Roughness (Manning's)

- Drainage Channel (0.060)
- Bushland (0.090)
- Grass (0.045)
- Road Reserve (0.025)
- Biofiltration Basins (0.100)

0 100 200 Metres
1:5,000

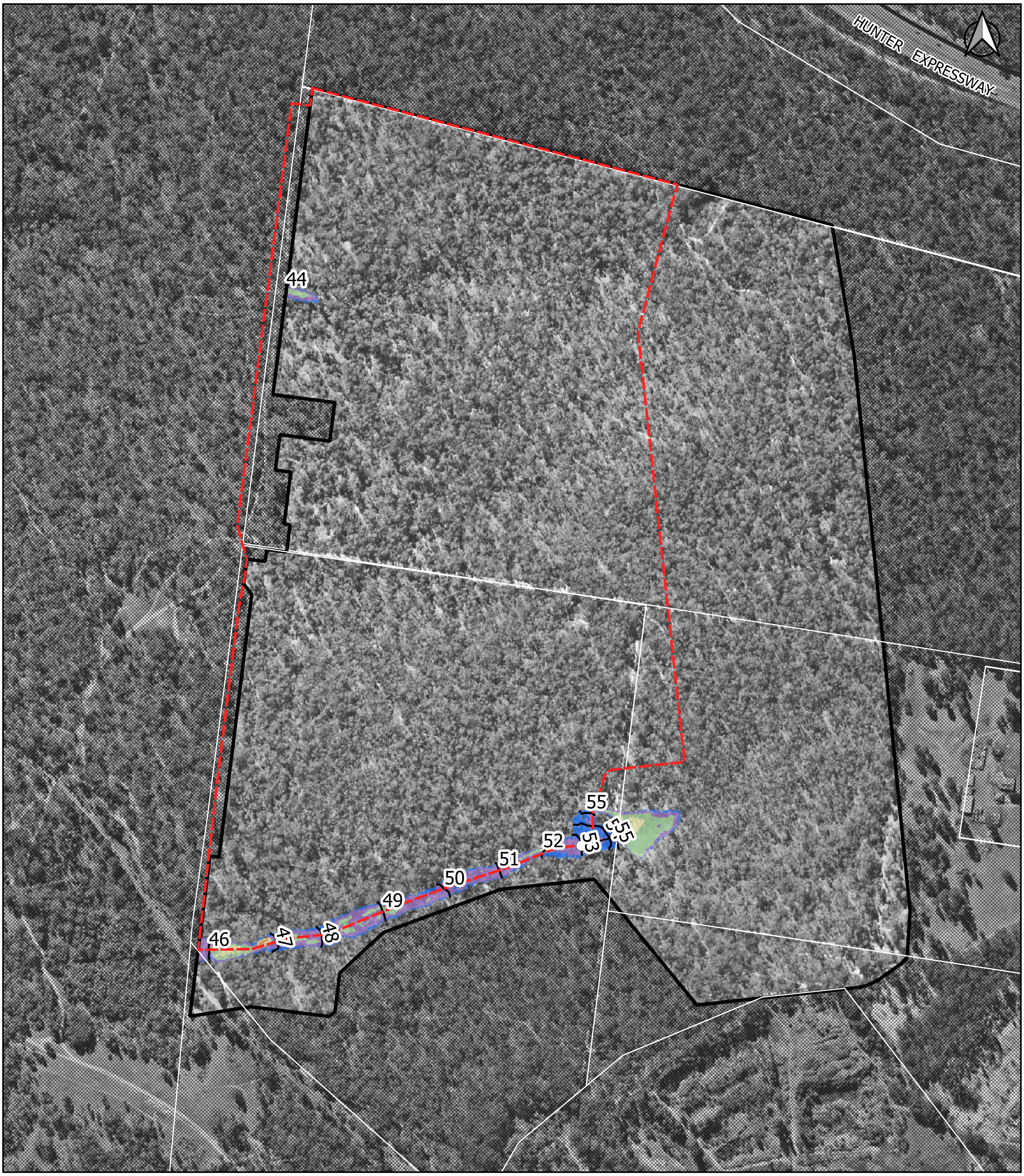
Figure A4 [B]

Developed Case
Roughness and Model Setup

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz



Legend

- Model Extent
- Subject Site
- Cadastre
- Flood Elevation (m AHD)

Flood Depth (m)

- 0.0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.8
- 0.8 - 1.2
- 1.2 - 2.0
- 2.0 - 2.5
- >2.5

0 100 200 Metres

1:6,000

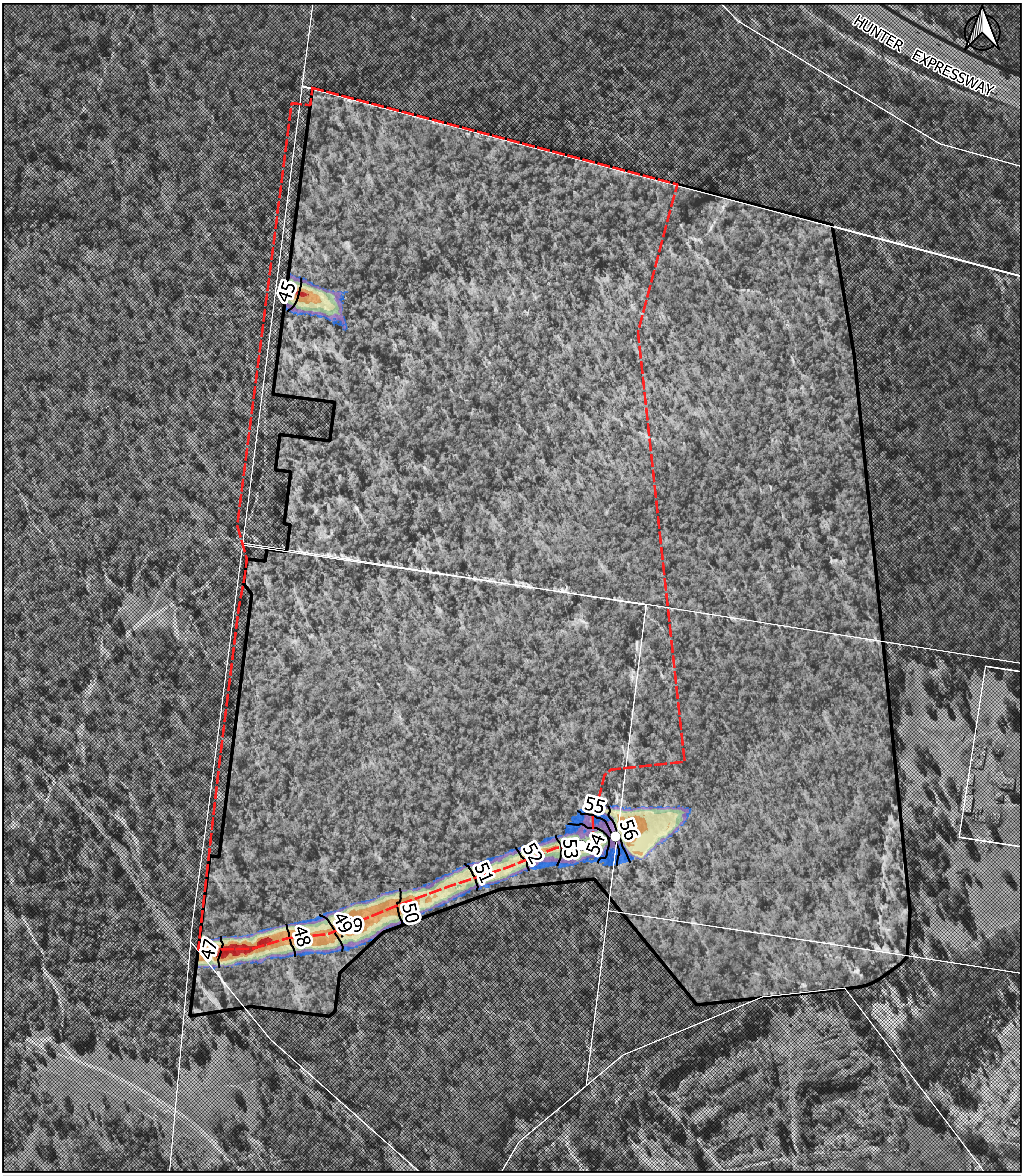
Figure C1 [B]

Existing Case
1% AEP Flood Depth and Elevation

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz



Legend

- Model Extent
- Subject Site
- Cadastre
- Flood Elevation (m AHD)

Flood Depth (m)

- 0.0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.8
- 0.8 - 1.2
- 1.2 - 2.0
- 2.0 - 2.5
- >2.5

0 100 200 Metres

1:6,000

Figure C2 [B]

Existing Case

PMF Flood Depth and Elevation

Huntlee Mod 21

NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)

3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Legend

- Model Extent
- Subject Site
- Cadastre
- Layout
- Stormwater Pipe Network
- Stormwater Pit Network
- Flood Elevation (m AHD)

Flood Depth (m)

- 0.0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.8
- 0.8 - 1.2
- 1.2 - 2.0
- 2.0 - 2.5
- >2.5

0 100 200 Metres

1:6,000

Figure D1 [B]

Developed Case

1% AEP Flood Depth and Elevation

Huntlee Mod 21

NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)

3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Legend

- Model Extent
- Subject Site
- Cadastre
- Layout

Hydraulic Hazard (ARR2019)

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

0 100 200 Metres

1:6,000

Figure D2 [B]

Developed Case
1% AEP Flood Hazard

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Legend

- Model Extent
- Subject Site
- Cadastre
- Layout
- Velocity Vectors

Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 100 200 Metres

1:6,000

Figure D3 [B]

Developed Case
1% AEP Flood Hazard

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)

3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Legend

- Model Extent
- Subject Site
- Cadastre
- Layout
- Stormwater Pipe Network
- Stormwater Pit Network
- Flood Elevation (m AHD)

Flood Depth (m)

- 0.0 - 0.1
- 0.1 - 0.3
- 0.3 - 0.5
- 0.5 - 0.8
- 0.8 - 1.2
- 1.2 - 2.0
- 2.0 - 2.5
- >2.5

0 100 200 Metres

1:6,000

Figure D4 [B]

Developed Case

PMF Flood Depth and Elevation

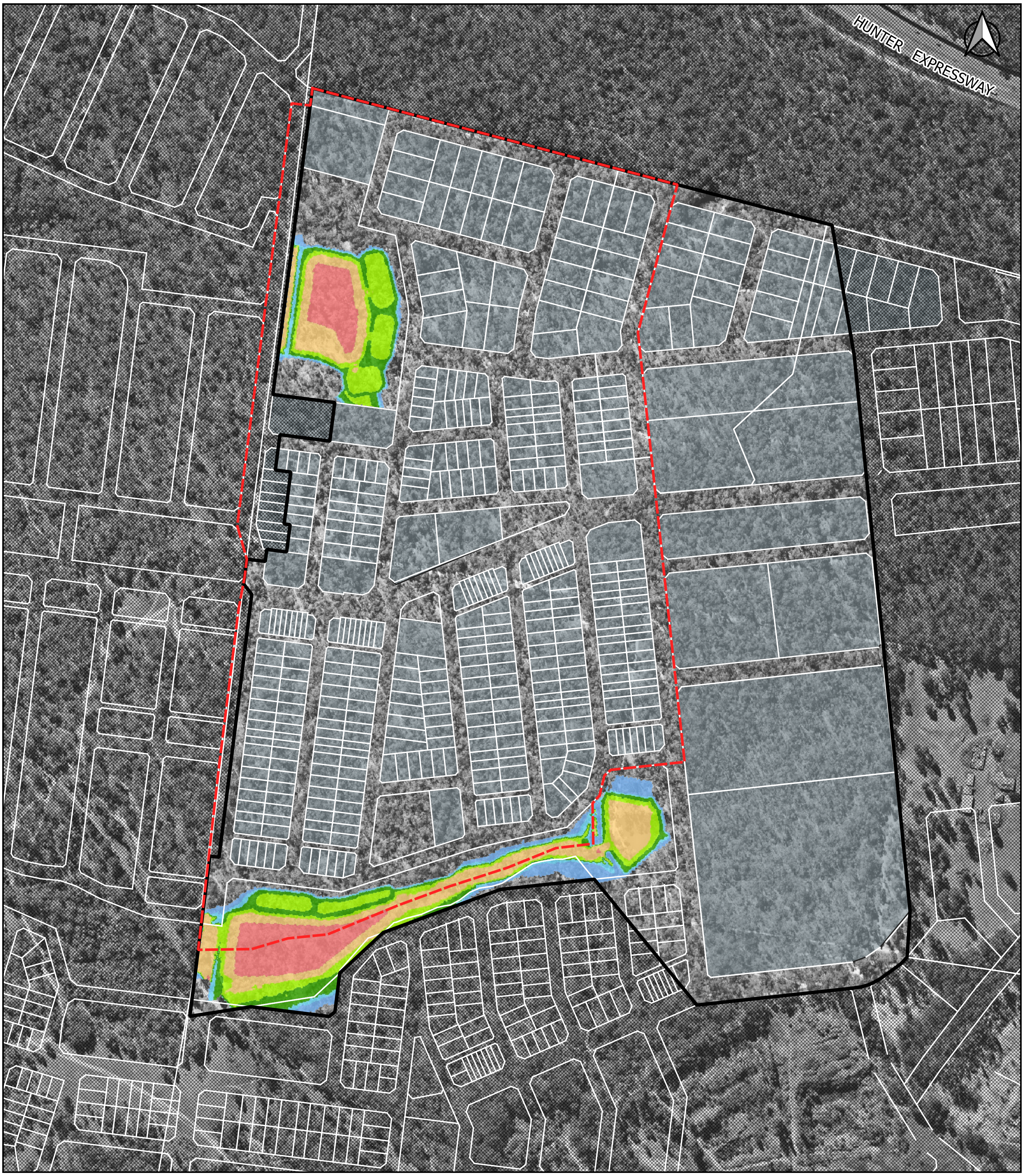
Huntlee Mod 21

NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)

3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz



Legend

- Model Extent
- Subject Site
- Cadastre
- Layout

Hydraulic Hazard (ARR2019)

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

0 100 200 Metres

1:6,000

Figure D5 [B]

Developed Case
PMF Flood Hazard

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Legend

Study Extent
Subject Site
Cadastre

Elevation Difference (m)

<= -0.500
-0.500 - -0.250
-0.250 - -0.100
-0.100 - -0.050
-0.050 - -0.010
-0.010 - 0.010
0.010 - 0.050
0.050 - 0.100
0.100 - 0.250
0.250 - 0.500
> 0.500

0 100 200 Metres
1:6,000

Figure E1 [B]

Developed Case
Climate Change Sensitivity
1 in 200 AEP minus 1% AEP Flood Event

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Legend

Study Extent
Subject Site
Cadastre

Elevation Difference (m)

<= -0.500
-0.500 - -0.250
-0.250 - -0.100
-0.100 - -0.050
-0.050 - -0.010
-0.010 - 0.010
0.010 - 0.050
0.050 - 0.100
0.100 - 0.250
0.250 - 0.500
> 0.500

0 100 200 Metres
1:6,000

Figure E2 [B]

Developed Case
Climate Change Sensitivity
1 in 500 AEP minus 1% AEP Flood Event

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Legend

- Study Extent
- Subject Site
- Cadastre

Elevation Difference (m)

- <= -0.300
- -0.300 - -0.200
- -0.200 - -0.100
- -0.100 - -0.050
- -0.050 - -0.025
- -0.025 - -0.010
- -0.010 - -0.005
- -0.005 - 0.005
- 0.005 - 0.010
- 0.010 - 0.025
- 0.025 - 0.050
- 0.050 - 0.100
- 0.100 - 0.200
- 0.200 - 0.300

0 100 200 Metres
1:6,000

Figure E3 [B]

Developed Case
Initial Losses Sensitivity
1% AEP Flood Event

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Legend

Study Extent
Subject Site
Cadastre

Elevation Difference (m)

<= -0.300	-0.025 - -0.010
-0.300 - -0.200	-0.010 - -0.005
-0.200 - -0.100	-0.005 - 0.005
-0.100 - -0.050	0.005 - 0.010
-0.050 - -0.025	0.010 - 0.025
	0.025 - 0.050
	0.050 - 0.100
	0.100 - 0.200
	0.200 - 0.300

0 100 200 Metres
1:6,000

Figure E4 [B]

Developed Case
Blockage Sensitivity
1% AEP Flood Event

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Legend

- Study Extent
- Subject Site
- Cadastre

Elevation Difference (m)

- <= -0.300
- -0.300 - -0.200
- -0.200 - -0.100
- -0.100 - -0.050
- -0.050 - -0.025
- -0.025 - -0.010
- -0.010 - -0.005
- -0.005 - 0.005
- 0.005 - 0.010
- 0.010 - 0.025
- 0.025 - 0.050
- 0.050 - 0.100
- 0.100 - 0.200
- 0.200 - 0.300

0 100 200 Metres

1:6,000

Figure E5 [B]

Developed Case
Manning's Roughness Sensitivity (-20%)
1% AEP Flood Event

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)

3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Legend

- Study Extent
- Subject Site
- Cadastre

Elevation Difference (m)

- <= -0.300
- -0.300 - -0.200
- -0.200 - -0.100
- -0.100 - -0.050
- -0.050 - -0.025
- -0.025 - -0.010
- -0.010 - -0.005
- -0.005 - 0.005
- 0.005 - 0.010
- 0.010 - 0.025
- 0.025 - 0.050
- 0.050 - 0.100
- 0.100 - 0.200
- 0.200 - 0.300

0 100 200 Metres

1:6,000

Figure E6 [B]

Developed Case
Manning's Roughness Sensitivity (+20%)
1% AEP Flood Event

Huntlee Mod 21
NL151661

NORTHROP

Data Source: Aerial (SIX Maps), Cadastre (NSW LPI)
3/3/2023 Y:\YEAR 2015 Jobs\NL151661\G - Design\GIS\Figures\220708 - Mod21 Figures\230221_Modification21_QGISProject.qgz

Appendix B – ARR Data Hub Data

Results - ARR Data Hub

[STARTTXT]

Input Data Information

[INPUTDATA]

Latitude,-32.668000

Longitude,151.340000

[END_INPUTDATA]

River Region

[RIVREG]

Division,South East Coast (NSW)

River Number,10

River Name,Hunter River

[RIVREG_META]

Time Accessed,02 December 2021 11:07AM

Version,2016_v1

[END_RIVREG]

ARF Parameters

[LONGARF]

Zone,SE Coast

a,0.06

b,0.361

c,0.0

d,0.317

e,8.11e-05

f,0.651

g,0.0

h,0.0

i,0.0

[LONGARF_META]

Time Accessed,02 December 2021 11:07AM

Version,2016_v1

[END_LONGARF]

Storm Losses

[LOSSES]

ID,14303.0

Storm Initial Losses (mm),25.0

Storm Continuing Losses (mm/h),2.1

[LOSSES_META]

Time Accessed,02 December 2021 11:07AM

Version,2016_v1

[END_LOSSES]

Temporal Patterns

[TP]

code,ECsouth

Label,East Coast South

[TP_META]

Time Accessed,02 December 2021 11:07AM

Version,2016_v2

[END_TP]

Areal Temporal Patterns

[ATP]

code,ECsouth

arealabel,East Coast South

[ATP_META]

Time Accessed,02 December 2021 11:07AM

Version,2016_v2

[END_ATP]

Median Preburst Depths and Ratios

[PREBURST]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.5 (0.020),0.7 (0.022),0.9 (0.022),1.1 (0.022),1.6 (0.028),2.1 (0.031)

90 (1.5),2.8 (0.098),1.9 (0.050),1.4 (0.030),0.9 (0.016),0.8 (0.012),0.7 (0.010)

120 (2.0),0.0 (0.001),0.7 (0.016),1.1 (0.022),1.5 (0.025),1.5 (0.021),1.5 (0.019)

180 (3.0),0.4 (0.013),1.3 (0.028),1.9 (0.033),2.5 (0.037),2.0 (0.025),1.7 (0.018)

360 (6.0),2.2 (0.049),4.2 (0.069),5.6 (0.076),6.9 (0.080),9.2 (0.088),10.9 (0.092)

720 (12.0),3.7 (0.066),7.7 (0.097),10.4 (0.108),12.9 (0.114),14.4 (0.104),15.6 (0.098)

1080 (18.0),0.5 (0.007),6.5 (0.069),10.4 (0.092),14.2 (0.106),15.1 (0.092),15.8 (0.084)

1440 (24.0),0.0 (0.000),4.6 (0.044),7.7 (0.060),10.6 (0.070),12.1 (0.065),13.3 (0.062)

2160 (36.0),0.0 (0.000),1.2 (0.010),1.9 (0.013),2.7 (0.015),5.7 (0.026),8.0 (0.032)

2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.2 (0.001),0.3 (0.001)

4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

[PREBURST_META]

Time Accessed,02 December 2021 11:07AM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST]From preburst class

10% Preburst Depths

[PREBURST10]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

[PREBURST10_META]

Time Accessed,02 December 2021 11:07AM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST10]From preburst class

25% Preburst Depths

[PREBURST25]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

1080 (18.0),0.0 (0.000),0.1 (0.001),0.1 (0.001),0.1 (0.001),0.1 (0.000),0.0 (0.000)

1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)

[PREBURST25_META]

Time Accessed,02 December 2021 11:07AM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST25]From preburst class

75% Preburst Depths

[PREBURST75]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),14.0 (0.559),12.3 (0.357),11.2 (0.270),10.1 (0.209),14.3 (0.244),17.3 (0.261)

90 (1.5),30.1 (1.060),21.3 (0.546),15.5 (0.331),9.9 (0.181),10.3 (0.157),10.6 (0.143)

120 (2.0),7.3 (0.233),12.8 (0.300),16.5 (0.323),20.0 (0.336),23.8 (0.334),26.7 (0.330)

180 (3.0),12.3 (0.348),23.8 (0.492),31.4 (0.544),38.8 (0.574),35.3 (0.436),32.7 (0.356)

360 (6.0),18.4 (0.413),31.7 (0.518),40.6 (0.553),49.0 (0.571),54.3 (0.524),58.3 (0.493)

720 (12.0),19.0 (0.332),32.4 (0.407),41.4 (0.430),49.9 (0.441),49.1 (0.356),48.5 (0.306)

1080 (18.0),14.0 (0.211),29.4 (0.315),39.7 (0.349),49.5 (0.368),53.3 (0.324),56.2 (0.296)

1440 (24.0),6.7 (0.090),19.2 (0.184),27.5 (0.216),35.5 (0.234),43.8 (0.235),50.1 (0.233)

2160 (36.0),3.4 (0.040),9.2 (0.076),13.1 (0.088),16.8 (0.094),29.3 (0.134),38.6 (0.153)

2880 (48.0),1.2 (0.012),4.0 (0.030),5.9 (0.036),7.7 (0.039),15.5 (0.064),21.3 (0.076)

4320 (72.0),0.0 (0.000),0.7 (0.004),1.1 (0.006),1.6 (0.007),5.5 (0.020),8.5 (0.027)

[PREBURST75_META]

Time Accessed,02 December 2021 11:07AM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST75]From preburst class

90% Preburst Depths

[PREBURST90]

min (h)\AEP(%),50,20,10,5,2,1

60 (1.0),39.4 (1.576),36.2 (1.051),34.1 (0.825),32.1 (0.662),59.0 (1.009),79.1 (1.189)

90 (1.5),66.4 (2.338),60.9 (1.559),57.2 (1.224),53.7 (0.981),64.5 (0.982),72.6 (0.974)

120 (2.0),26.0 (0.836),51.2 (1.201),67.9 (1.331),83.9 (1.408),86.0 (1.204),87.6 (1.082)

180 (3.0),38.2 (1.081),55.9 (1.156),67.7 (1.170),79.0 (1.169),92.6 (1.144),102.9 (1.120)

360 (6.0),55.7 (1.253),68.6 (1.120),77.1 (1.051),85.3 (0.993),105.8 (1.020),121.1 (1.025)

720 (12.0),46.8 (0.819),69.6 (0.874),84.7 (0.881),99.2 (0.875),93.0 (0.674),88.4 (0.558)

1080 (18.0),37.1 (0.558),66.6 (0.712),86.1 (0.759),104.9 (0.780),106.3 (0.646),107.4 (0.567)

1440 (24.0),31.1 (0.420),52.5 (0.501),66.7 (0.523),80.3 (0.530),99.6 (0.535),114.1 (0.531)

2160 (36.0),11.3 (0.133),29.0 (0.238),40.6 (0.272),51.8 (0.291),72.4 (0.331),87.9 (0.348)

2880 (48.0),13.3 (0.143),25.0 (0.186),32.7 (0.199),40.2 (0.204),57.5 (0.238),70.5 (0.253)

4320 (72.0),13.7 (0.131),15.0 (0.099),15.8 (0.085),16.5 (0.075),27.2 (0.100),35.2 (0.113)

[PREBURST90_META]

Time Accessed,02 December 2021 11:07AM

Version,2018_v1

Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

[END_PREBURST90]From preburst class

Interim Climate Change Factors

[CCF]

,RCP 4.5,RCP6,RCP 8.5

2030,0.869 (4.3%),0.783 (3.9%),0.983 (4.9%)

2040,1.057 (5.3%),1.014 (5.1%),1.349 (6.8%)

2050,1.272 (6.4%),1.236 (6.2%),1.773 (9.0%)

2060,1.488 (7.5%),1.458 (7.4%),2.237 (11.5%)

2070,1.676 (8.5%),1.691 (8.6%),2.722 (14.2%)

2080,1.810 (9.2%),1.944 (9.9%),3.209 (16.9%)

2090,1.862 (9.5%),2.227 (11.5%),3.679 (19.7%)

[CCF_META]

Time Accessed,02 December 2021 11:07AM

Version,2019_v1

Note,ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website.

[END_CCF]

Probability Neutral Burst Initial Loss

[BURSTIL]

min (h)\AEP(%),50.0,20.0,10.0,5.0,2.0,1.0

60 (1.0),16.6,11.1,10.8,11.7,10.4,6.9

90 (1.5),12.9,9.6,9.8,11.6,11.0,8.9

120 (2.0),18.2,12.2,10.7,10.5,9.5,6.3

180 (3.0),16.1,11.2,10.0,9.6,9.4,5.0

360 (6.0),14.7,10.5,10.3,8.9,8.5,4.2

720 (12.0),15.1,11.0,10.6,9.6,10.3,4.2

1080 (18.0),17.1,12.2,11.6,9.5,11.6,3.2

1440 (24.0),19.4,14.3,13.4,11.9,12.1,4.7

2160 (36.0),23.1,18.1,17.5,17.6,15.6,6.9

2880 (48.0),23.7,20.1,19.7,22.3,17.1,8.9

4320 (72.0),24.3,21.8,22.3,24.9,20.1,15.1

[BURSTIL_META]

Time Accessed,02 December 2021 11:07AM

Version,2018_v1

Note,As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. Probability neutral burst initial loss values for NSW are to be used in place of the standard initial loss and pre-burst as per the losses hierarchy.

[END_BURSTIL]

Transformational Pre-burst Rainfall

[PREBURST_TRANS]

min (h)\AEP(%),50.0,20.0,10.0,5.0,2.0,1.0

60 (1.0),7.9,13.4,13.7,12.8,14.1,17.6

90 (1.5),11.6,14.9,14.7,12.9,13.5,15.6

120 (2.0),6.3,12.3,13.8,14.0,15.0,18.2

180 (3.0),8.4,13.3,14.5,14.9,15.1,19.5

360 (6.0),9.8,14.0,14.2,15.6,16.0,20.3

720 (12.0),9.4,13.5,13.9,14.9,14.2,20.3

1080 (18.0),7.4,12.3,12.9,15.0,12.9,21.3

1440 (24.0),5.1,10.2,11.1,12.6,12.4,19.8

2160 (36.0),1.4,6.4,7.0,6.9,8.9,17.6

2880 (48.0),0.8,4.4,4.8,2.2,7.4,15.6

4320 (72.0),0.2,2.7,2.2,0.0,4.4,9.4

[PREBURST_TRANS_META]

The tranformational pre-burst is intended for software suppliers in the NSW area and is simply the Initial Loss - Burst Initial Loss. It is not appropriate to use these values if considering a calibrated initial loss.

[END_PREBURST_TRANS