Proposed Residential Subdivision

Terragong Street, Tullimbar Stage 9 Ravenswood Estate
Development Application Stormwater Management &
Local Flood Study
Project No.1501 – January 2020

siteplus

planning . engineering . landscape . design . management

STORMWATER MANAGEMENT & LOCAL FLOOD STUDY

TERRAGONG STREET, TULLIMBAR STAGE 9 RAVENSWOOD ESTATE

PREPARED FOR

Balmoral Parade Pty Ltd.

PREPARED BY

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EXECUTIVE SUMMARY

Siteplus Pty Ltd has been commissioned by Balmoral Parade Pty Ltd. (BP) to undertake a Stormwater Management and Local Flood Study for Stage 9 of the proposed residential subdivision of Lot 414 DP1235168 and Lot 3 DP1214606 Noble Road, Tullimbar to support their Development Application. It assesses the Hydrological and Hydraulic characteristics of the site and demonstrates how the proposed stormwater infrastructure will meet the requirements of Councils Standards and downstream requirements of the existing approvals in place for the Tullimbar Village. BP is a subsidiary company of the Allam Property Group.

A DRAINS model was developed for the site and all contributing areas to Stage 9 as the one-dimensional model for analysis of Annual Exceedance Probability (AEP) up to and including the 1% AEP event. This will be the model for determining the suitability of the pit and pipe network and its ability to meet the requirements of SCC, Shellharbour Drainage Design Handbook, and Subdivision Design Requirements.

A two-dimensional analysis of the site was also developed using TUFLOW 2018. This was developed to model overland flow for the major storm events including the 100 year ARI Probable Maximum Flood (PMF). It demonstrates the management of floodwaters through the proposed site and their effect on the downstream Tullimbar Village. For this analysis a 1.0m cell size was used combined with the direct rainfall method for part of the catchment in the vicinity of the proposed development, with inflow hydrographs applied for the inflow of Hazelton and Cooback Creeks obtained from Shellharbour City Council.

For both models the analysis was performed using Australian Rainfall and Runoff (AR&R) 1987 rainfall values and methodology. The 1987 values were used as the study falls within the Catchment of Shellharbour City Council's adopted Macquarie Rivulet Flood Study undertaken by WMA water and this is the data used by this study.

All flow from the site drains into Hazelton Creek. Stage 9 is a separate drainage network to the northern development. The predominant flooding feature is a tributary of Hazelton Creek. Upstream diversion swales manage and direct flow into a large trunk drainage system which conveys flood flows under Road No.91 and through the development area.

It is shown that the proposed stormwater network can meet the requirements of Shellharbour City Council. The proposed stormwater network in Stage 9 adequately conveys stormwater through the stage with no inundation of private

land for all events up to and including the 1% as well as managing flow hazard within the stage to meet the requirements of SCC, Drainage Design Handbook, and Subdivision Design Requirements.

This Report demonstrates how the development of Stage 9 by BP will have no additional adverse flood effects on development within the catchment other than that considered in the report and that occurs in the existing situation.

1. INTRODUCTION

1.1. Preliminary

1.1.1. Siteplus Engagement

Site Plus Pty Ltd (Siteplus) has been engaged by Balmoral Parade Pty Ltd (BP) to prepare a Stormwater Management flood study for the Development Application for the construction of Stage 9 of the Ravenswood Estate as part of BP's residential development at Lot 414 DP1235168 and Lot 3 DP1214606 Noble Road, Tullimbar

1.1.2. Scope of Work

Siteplus determined the following investigations were required to complete a thorough flood study of the site:

- Construct a Hydrological model to determine the hyetographs for input into various models;
- Develop a DRAINS model for analysis of effectiveness of the stormwater network in meeting targets for minor flows;
- Develop a 2D TUFLOW model to calculate the 1% AEP and Probable Maximum Flood levels, velocities and hazard precincts for Stage 9 and ensure there are no adverse flood effects for existing downstream developments; and
- Prepare a report which summarises the findings of the analysis.

1.2. Subject Land

The subject site is located to the south of the existing Balmoral Parade and Ravenswood Estate that has recently been constructed. Stage 9 lies to the east of Hazelton Creek which is downslope to the site. The site is predominately cleared grazing pasture with existing vegetation around the existing overland flow path which runs east west to Hazelton Creek.

Up slope of the site to the south and east lies the Illawarra Lowland Grassy Woodland an Endangered Community which is to remain undeveloped in the future.

The site slopes towards Hazelton Creek at an average grade of approximately 15%.

The existing Tullimbar Village is located to the North West and downstream of the site. Located within the Village is the Hazelton Creek Wetlands, all water from the site drains to this wetland system and it has been sized to cater for all development within the subject site as outlined in the catchment plans by Forbes Rigby in Appendix C as well as the *Hazelton Creek Stormwater Strategy (Stage 2) Report 2002* by Forbes Rigby where the subject site is wholly located within Hazeltonn Creek Catchment (H8). Most water quality requirements for the site are managed within this wetland.

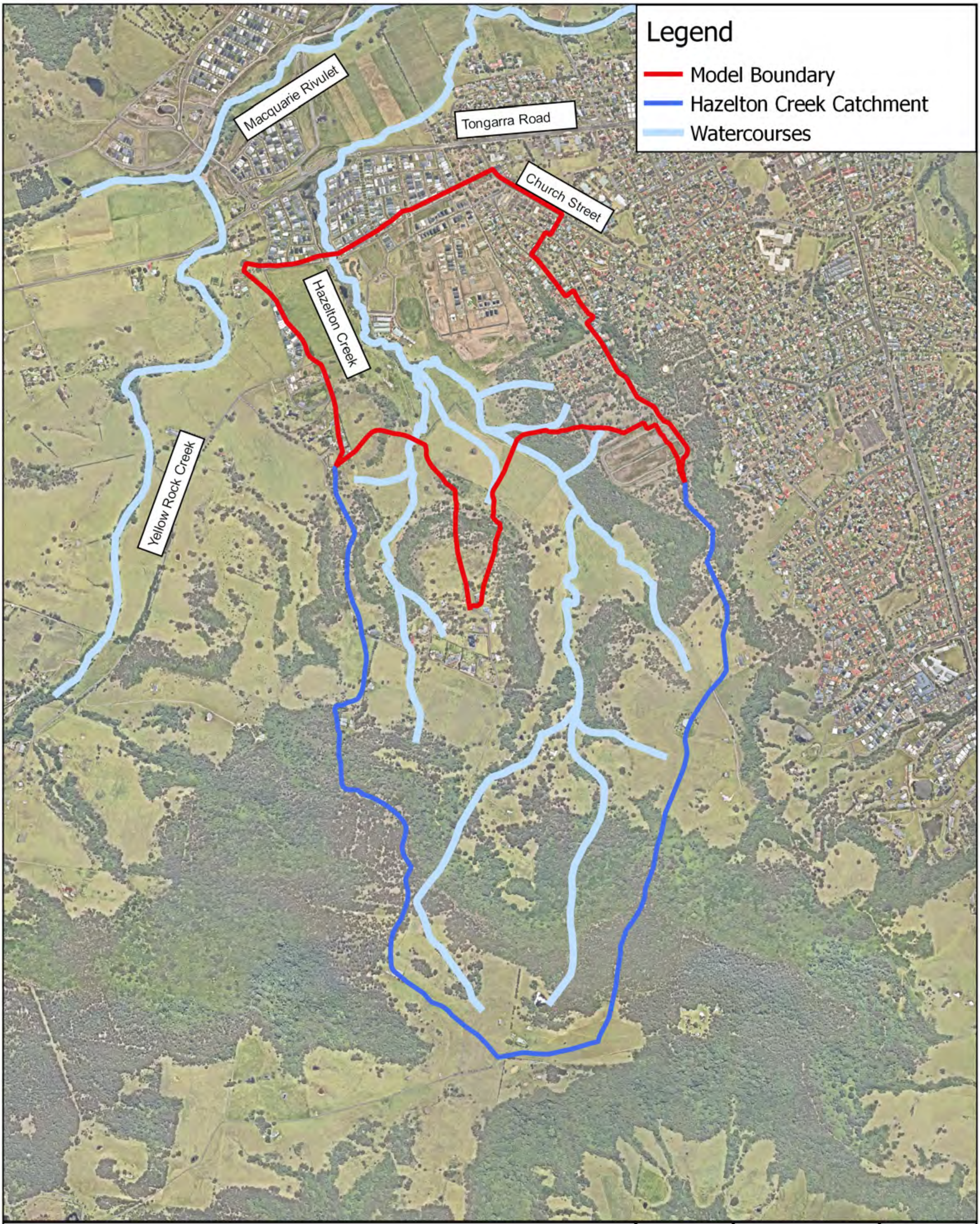
The exception to this is where the proposed discharges directly to Hazelton Creek at the intersection of Terragong Street and the Proposed Road 91. As outlined in the Hazelton Creek Wetland studies, a GPT is required and proposed wherever stormwater is discharged into Hazelton Creek. This GPT is to be sized at the construction Certificate Stage with the location of the GPT shown on the Civil Works plans prepared by Siteplus for Stage 9. Flows from the upslope diversion drain and Stage 9 development drain to this.

The subject site lies wholly within the Shellharbour City Council's Macquarie Rivulet Flood Study by WMA Water. Hazelton Creek is a tributary to Macquarie Rivulet and therefore has been modelled as part of this study. Figure 1-1 shows the location of the model within the Hazelton Creek Catchment

1.3. Existing Site Features

In the existing situation the site is affect by both sheet flow from the upstream catchment and a dry overland flow path which runs east west to Hazelton Creek.

The dry overland flow path has a small upstream catchment as the existing development off Crest Road east of the site falls to Digby Close with some overland flow in excess of the street drainage flowing towards the subject site.



Title:
Tullimbar Ravenswood Development - Stage 5 Flood Study
Location of Model within Hazelton Creek Catchment

Figure: 1.1

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1.4. Proposed Stormwater Network

The proposed stormwater network and site grading's have been designed to match the design assumptions of the Forbes Rigby Study and as such do not require any additional offsite works. Details of the Forbes Rigby Catchment Plan are included in Appendix C. As shown in the catchment plan on sheet 10 of the Siteplus Civil Plans 1501.DA7.C01-C14 revision A, the catchment for the stage is wholly within Hazelton Creek Catchment (H8) of the Forbes Rigby Major Flow Catchment Plan.

The proposed stormwater networks have been designed with a minimum 20% AEP minor design burst when in the road reserve with interallotment being designed with a 5% AEP minor design burst. Lines within the road reserve generally have a capacity above and beyond the requirements of the minor design burst to meet the requirements of SCC's DCP Table A10.5, *Depth x velocity as a measure of hazard.*

Overland flow will be managed through the site by the street network in all events up to and including the PMF. The grading of the site ensures that there are no trapped low points.

The proposed stormwater network and road geometry meet the requirements of the original Forbes Rigby Study under which the existing Village was constructed.

Catchments from the eastern diversion drain have been sized in the DRAINS model and discharges into Hazelton Creek. At the end of the line an off line GPT has been proposed as per the requirements of the Forbes Rigby Study which supported DA741/2002.

1.5. Existing Hazelton Creek Studies

Since the inception of the Tullimbar Village Development there have been various flood models produced for the Valley with various intents. There are three main existing studies that are relevant to the subject site. These are detailed in the following sections. All contain scenarios where the subject site is considered as developed.

1.5.1. Forbes Rigby Hazelton Creek Study

As part of the original approval for the Tullimbar Village, DA741/2002 a flood study was produced by Forbes Rigby mapping the 1% AEP and PMF extents of the Tullimbar Village using a combination of WBNM for the hydrology and HEC-RAS for the hydraulic analysis. This model is no longer adopted by Council for any current or future applications.

There are many limitations to the accuracy of this model given that it is a 1D analysis in a region where there are many interactions of flow paths and storage effects.

Some key features of this model include:

- The 1% AEP to be generally contained within the Hazelton and Cooback Creek riparian corridors with no inundation of private property
- PMF inundation of nearly the entire school site and the majority of roads and private property west of Balmoral Parade.
- There is no bypass down Balmoral Parade around the school site.

Whilst this Study and modelling will not be accepted by Council it is important to note that this was the report with which the downstream drainage network was constructed to and models the intentions of this design.

1.5.2. Cardno Forbes Rigby School Site Report Study

Cardno Forbes Rigby undertook some further modelling of the school site in 2006 when they undertook the design to make it flood free in all events up to and including the PMF event.

This study showed that the berm constructed around the school was constructed to make the school site flood free in the PMF whilst making parts of the Tullimbar Village flood free as well.

This study only shows the flood plain of the channelised Hazelton Creek and its major tributaries and did not consider how the PMF is conveyed to Hazelton Creek through the Tullimbar Village.

1.5.3. Shellharbour City Councils Macquarie Rivulet Study

Shellharbour City Council (Council) has an adopted Flood Study for the Macquarie Rivulet and its catchments that was completed by WMA Water in 2017. This study is a WBNM hydrograph input into the TUFLOW program with a 10.0m cell size.

The subject site for this study is wholly located within the Macquarie Rivulet Study. Because of this, inflow hydrographs and downstream water levels have been provided by Council and utilised within this model to ensure correlation between the two models. Loss rates and mapping outputs have also been adopted from this study.

Some key features of this model include:

- The study is carried out on a 10.0m cell size. Whilst appropriate for the Macquarie Rivulet study, this is too course for the smaller Hazelton Creek where the channel is narrower than 10.0m. This model's uses a 1.0m cell size has the potential to be more accurate due to the finer grid.
- The study is undertaken using LiDAR data captured in 2011 and then input to the model at the study site in a 5.0m grid. This is compared to the Hazelton Creek Survey obtained for this model and then input to the model on a 0.5m grid. The subject site specific data used in this Study will result in a more accurate study of Hazelton Creek.
- The 1% AEP results in this study show that Hazelton Creek flows are generally contained within the riparian corridor.
- In the PMF, flows breakout from the Hazelton Creek riparian corridor over the berm around the school and inundate the school site with flows that are generally H2-H4 Hazard Classification. The Village between the proposed oval and the Hazelton Creek corridor is totally inundated by the PMF. Flow within Exeter Place is the H5 Hazard Classification for the width of the carriageway. Other road reserves within the Village have patches of H5.

As a result of the flooding identified within the Village in this study, council has requested a detailed study of the way flow is conveyed from the BP site through the Tullimbar Village and its interaction with the Hazelton Creek flows. By using inputs from council's model but refining the hydraulic analysis within the subject site, the Siteplus model will produce a more accurate representation of the flows within the Tullimbar Village.

2. MODEL DEVELOPMENT

2.1. Introduction

Two Hydraulic models have been submitted to Shellharbour City Council as part of the Stage 9 Development Application.

The DRAINS model has been adopted as the 1D model to be used for the one-dimensional analysis of the Stormwater network to comply with Councils Drainage Design Handbook Requirements for storm events up to and including the 1% AEP event.

A TUFLOW model has also been developed as the 2D/1D hydrodynamic numerical model to simulate the flood effects as the major storm events flow through the site. An analysis will be provided as to Stage adequately meets the conditions of the consent.

2.2. DRAINS Model Development

A DRAINS model has been provided for all the catchment upstream of Stage 9 along with the proposed stormwater network within Stage 9.

IFD data was added to the program as shown below in Table 2-1 to produce the hyetographs. This was sourced from the Bureau of Meteorology Website for the catchment area with the coordinates 34.576066 S 150.758149 E.

Table 2-1 IFD Data

	2yr	50yr	
1 Hour Rainfall Intensity (mm/hr)	49.7	118	G = 0
12 Hour Rainfall Intensity (mm/hr)	11.3	27.1	F2 = 4.28
72 Hour Rainfall Intensity (mm/hr)	3.62	8.48	F50 = 15.79

An ILSAX model was the hydrological model chosen for the analysis at the direction of Council with the parameters in Table 2-2 below obtained from Councils Development Design Specification, Chapter D5, Subdivision Design Requirements.

Table 2-2 ILSAX parameters.

Parameter	Value
Impervious (Paved) Depression	1mm
Pervious (Grassed) Depression	5mm
Soil Type	3.0

Blockage has been applied as per council's blockage policy that is 20% blockage for on grade pits and 50% for Sag pits.

2.3. TUFLOW Model Development

This Siteplus study will analyse the development in two (2) unique development scenarios. These are outlined below

- An existing scenario – this will include all the development constructed or approved for construction at the time of undertaking the study including Balmoral Parade Stage 1 and Stage 2.
- An ultimate scenario – this will include the whole of BP's proposed Ravenswood development. This scenario also includes works filling of the Hazelton Creek flood plain by other developers.

These two development scenarios will enable the proposed development to be assessed completely for flood affectation and safe conveyance of stormwater in the fully developed scenario.

2.3.1. Data Collection

Topographic Data collated and used for this Study includes:

- Site survey provided by Project Surveyors;
- 1.0m DEM from the Foundation Spatial Data ELVIS program.
- Civil 3D Design Contours
- Work as Executed for Tullimbar Village Stage 1 by K.F.Williams & Associates Pty Ltd.
- Detailed Hazelton Creek Survey undertaken by K.F.Williams & Associates Pty Ltd.

The above sources have been ground proven through onsite delineation.

From this data a Digital Elevation Model (DEM) was developed. The DEM has been output in a 0.5m grid, which is considered appropriate for the level of detail required for the urban drainage network where the kerb and guttering is used to contain and channel flows.

Figures 2.1 and 2.2 show the final DEM used within the existing, proposed model. Within the catchment the elevation ranges from 17m AHD to 108m AHD.

Rainfall hyetographs were obtained via two methods. The hyetographs for the 1%AEP events were produced using the already developed and submitted to Council DRAINS model. PMF hyetographs were developed in the hydrological model WBNM.

IFD data was added to the program as shown earlier in Chapter 3.2 to produce the hyetographs. The input hyetographs are outlined in Appendix G.

Title:

Tullimbar Ravenswood Development - Stage 9 Study
Existing Model Topography

N

Scale 1:10,000 @ A3

0 120 240 360 480 m

Figure: **2.1**

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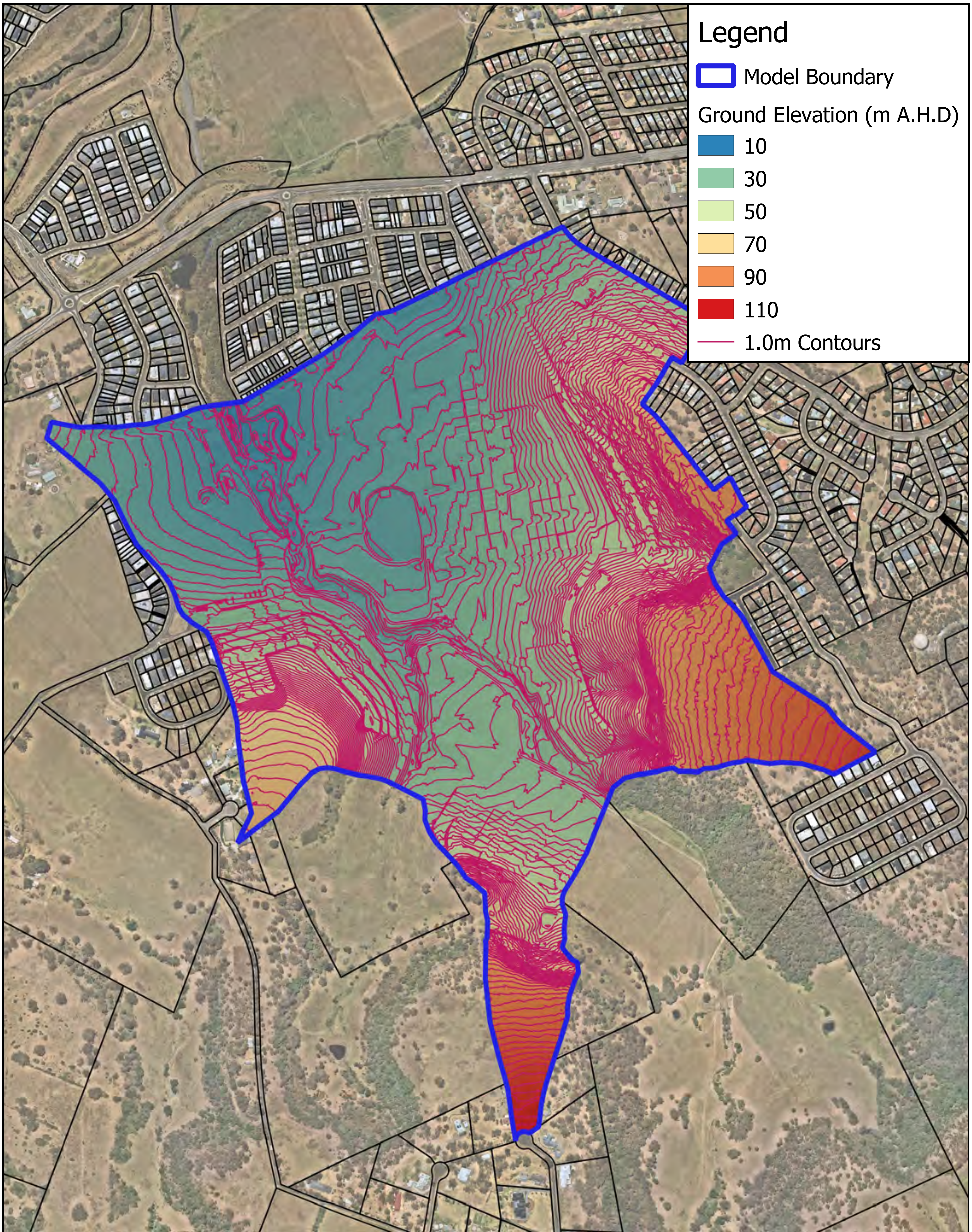

Title:
Tullimbar Ravenswood Development - Stage 9 Study
Proposed Model Topography

Figure: 2.2

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2.3.2. Modelling Technique

Siteplus has adopted a 2D/1D hydrodynamic numerical model as it is currently the most accurate, cost effective and efficient tools to predict flood behaviour.

For this Study TUFLOW was chosen for the modelling for the following reasons:

- Accurately representing overland flow paths especially at intersections where flows diverge;
- Dynamically linking the 1D (culverts) to any point within the 2D model;
- Apply rainfall directly to the modelled area;
- Produce high quality map outs; and
- Is widely accepted by councils as the preferred 2D model.

This Study utilises the TUFLOW 2018 release, which is the latest release at the time of the study.

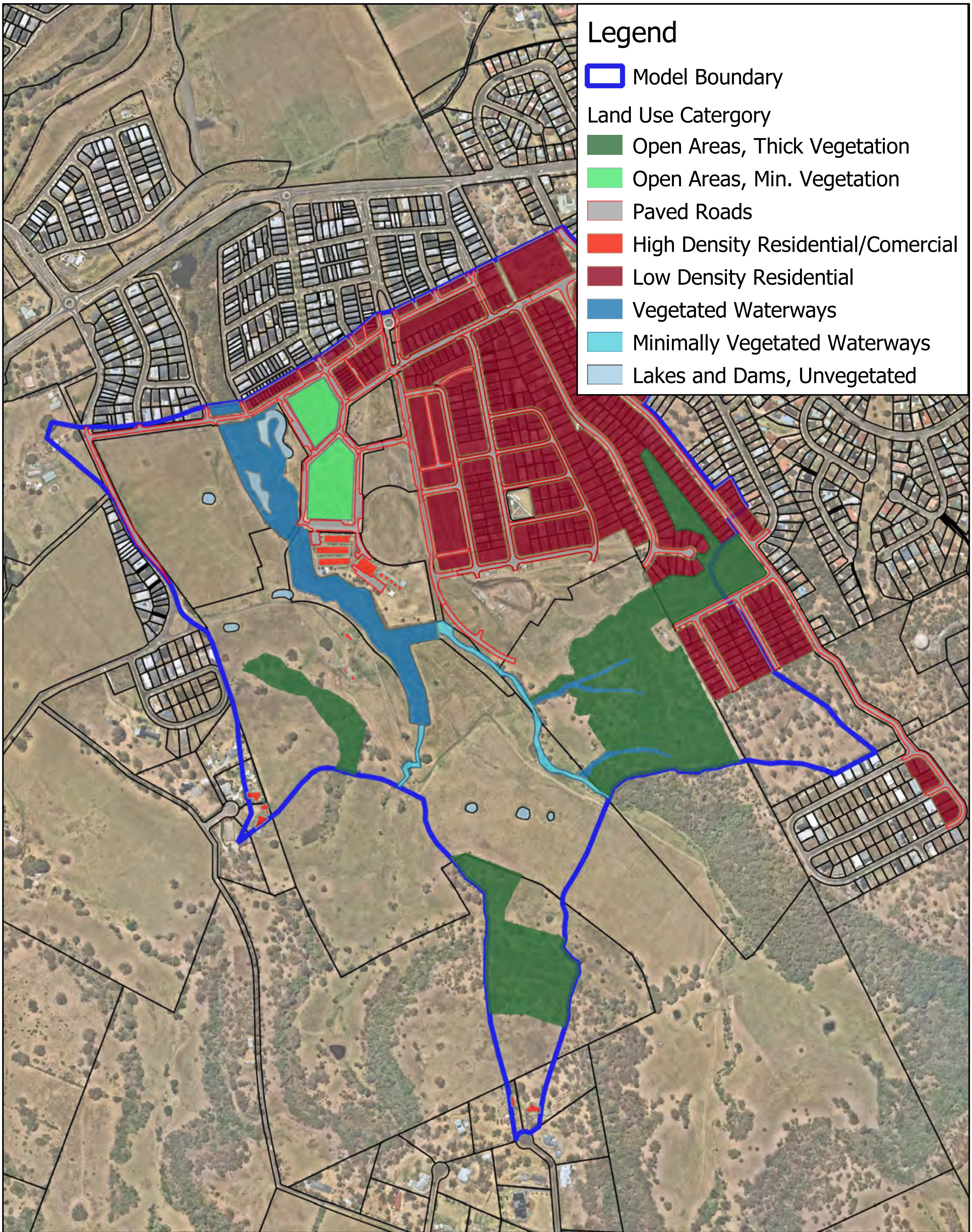
2.3.3. Hydraulic Roughness

Roughness coefficients represent the resistance to flood flows in channels and floodplains. The land use delineation for the model is based on aerial photography and the proposed lot layout. The land use delineation used in the TUFLOW model is presented in Figure 2-3 and Figure 2-4.

Manning's 'n' values were adopted in line ARR16 values. This is a simplistic approach and ensures that studies are utilising the same parameters and therefore may have similar flow rates. The adopted Manning's 'n' roughness coefficients for the land uses within the 2D hydraulic model extent are listed in Table 2-3

2.3.4. Design Rainfall Losses

Design loss values were applied to the various land uses discretised in the TUFLOW model, based on SCC Macquarie Rivulet Flood Study. The adopted initial and continuing rainfall losses are presented in Table 2-3.



Title:

Tullimbar Ravenswood Development - Stage 9 Study
Existing Land Use Delineation

Scale 1:10,000 @ A3

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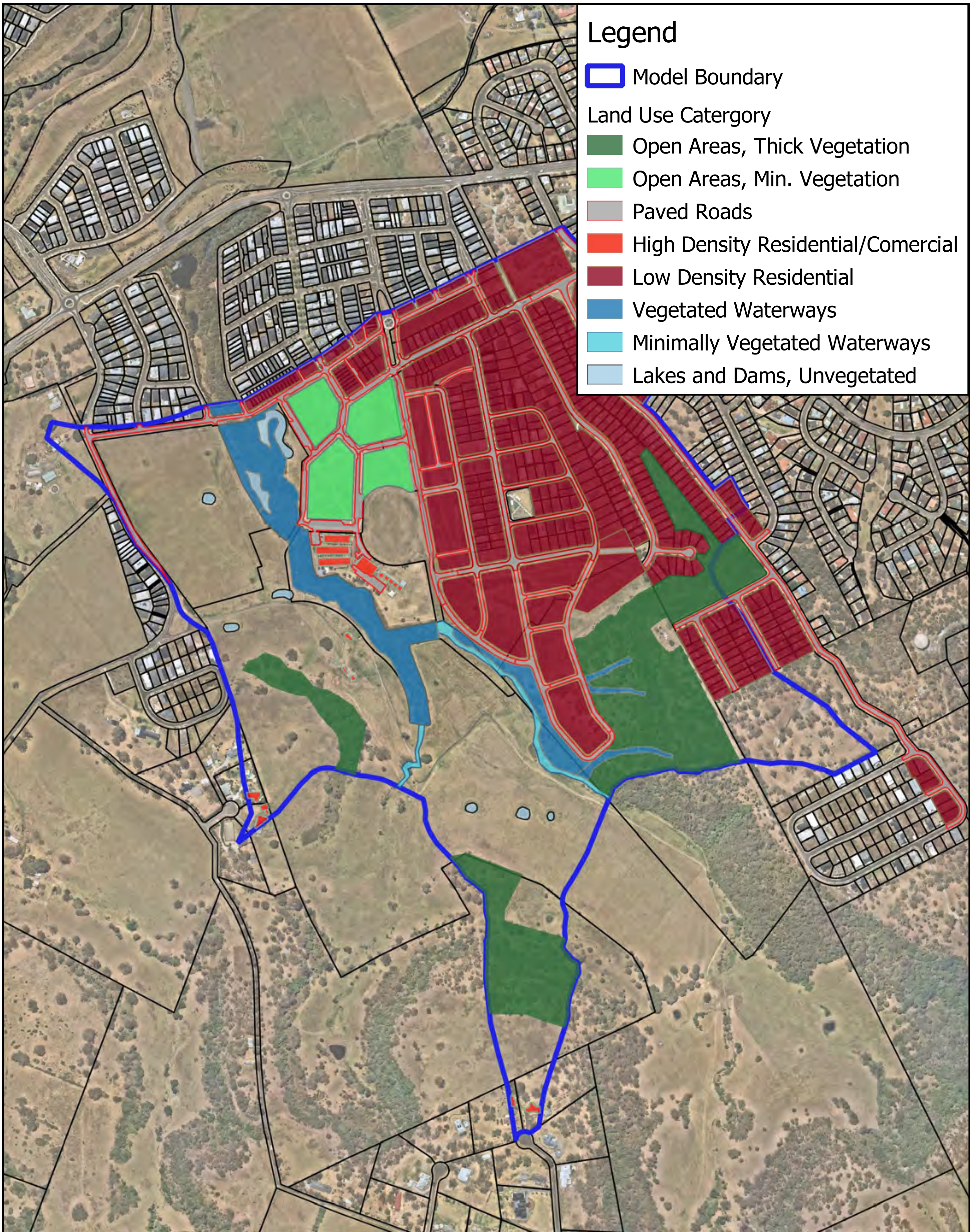

Title:

Tullimbar Ravenswood Development - Stage 9 Study
Proposed Land Use Delineation

N

Scale 1:10,000 @ A3

0 120 240 360 480 m

Figure: **2.4**

Rev: **A**

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Table 2-3 Land Use Table

ARR16 Land Use Type	Manning's 'n'	Initial Loss (mm)		Continuing Loss (mm)	
		1% AEP	PMF	1% AEP	PMF
Open Pervious Areas, thick vegetation	0.10	5.0	1.0	2.0	0.0
Open Pervious Areas, minimal vegetation	0.04	5.0	1.0	2.0	0.0
Paved Roads	0.025	1.5	1.5	0	0
Residential Areas – High Density	0.35	1.5	1.5	0	0
Residential Areas – Low Density	0.15	5.0	1.0	2.0	0
Waterways/channels – minimal vegetation	0.03	5.0	1.0	2.0	0
Waterways/channels – minimal vegetated	0.07	5.0	1.0	2.0	0
Lakes (no emergent vegetation)	0.02	1.5	1.5	0	0
Note: ▪ Uncoloured or unshaded areas in Figures 2.3 & 2-4 have been modelled as Open Pervious Areas with minimal Vegetation.					

2.3.5. Soil Losses

A standard soil loss parameter was applied using the Green-Ampt approach. This approach varies the rate of infiltration over time based on the soil's hydraulic conductivity, suction, porosity and initial moisture content.

The soil type chosen for the study was Clay based on geotechnical investigation carried out by Coffey for Lot 522 DP1168919 for BP dated 11 May 2015. This was chosen due to it being a conservative value for whole catchment area and suitable for the soil type of the subject site.

Variables applied by TUFLOW for the chosen soil type are listed below in Table 2-4.

Table 2-4 Soil Loss Table

Soil Type	Suction (mm)	Hydraulic Conductivity (mm/hr)	Porosity (Fraction)
Clay	316.3	0.3	0.385

For Paved Roads, Residential Areas Lakes and Waterways, no soil losses are applied.

2.3.6. Hydraulic Structures

Pit and pipe networks were added for all drainage structures within the catchment area upstream and downstream of the Stage 8B Development They were modelled as 1D networks within the model with automatic 2D connections.

Where survey wasn't available through Regal Heights, thorough onsite investigation was undertaken.

Pits were modelled as type Q connections where a depth discharge relationship is applied at the connection. In line with SCC Subdivision Drainage Design Guidelines, a 20% Blockage was applied to all on grade pits and a 50% blockage was applied to all Sag pits.

Blockage applied to open culvert inlets was in line with the Macquarie Rivulet Study and is outlined in Table 2-5 below.

Table 2-5 Blockage Hydraulic Structure

Hydraulic Structure Type	Percentage (%) Blocked
Diagonal Opening less than 1.0m.	100
Diagonal Opening greater than 1.0m and less than 6.0m.	50
Diagonal Opening greater than 1.0m.	0

Within the model there is currently a vehicular crossing of Hazelton Creek at Wongawilli Street in the form of a beam between precast concrete piers. Details of this bridge were obtained from LandTeam as part of their previous Works as Executed Study of the Village.

This bridge was modelled as a 2D layered constriction within TUFLOW to the details below in Table 2-6.It should be noted that in the SCC water surface levels provided to Site plus, the PMF level immediately downstream of the Bridge peaks at 17.57m AHD and therefore flood levels never reach the Deck Obvert.

Table 2-6 Wongawilli Bridge – Modelled Parameters

Parameter	Value
Deck Obvert	18.53m AHD
Below Deck Blockage	6%
Below Deck Loss Co-efficient	0.20
Deck Height	0.70m
Deck Blockage	100%
Deck Form Loss Co-efficient	0.50
Handrail Height	0.50m
Handrail Form Loss Co-efficient	0.13

The drainage network for both the existing, proposed and ultimate scenarios are shown in Figure 2-5, and Figure 2-6. The location of layered flow constriction for the Wongawilli Street Bridge are shown in Figure 2-8.

2.3.7. Boundary Conditions

The inflow and outflow boundary conditions are required for the TUFLOW model.

The TUFLOW model created for the subject site include four boundary conditions which are:

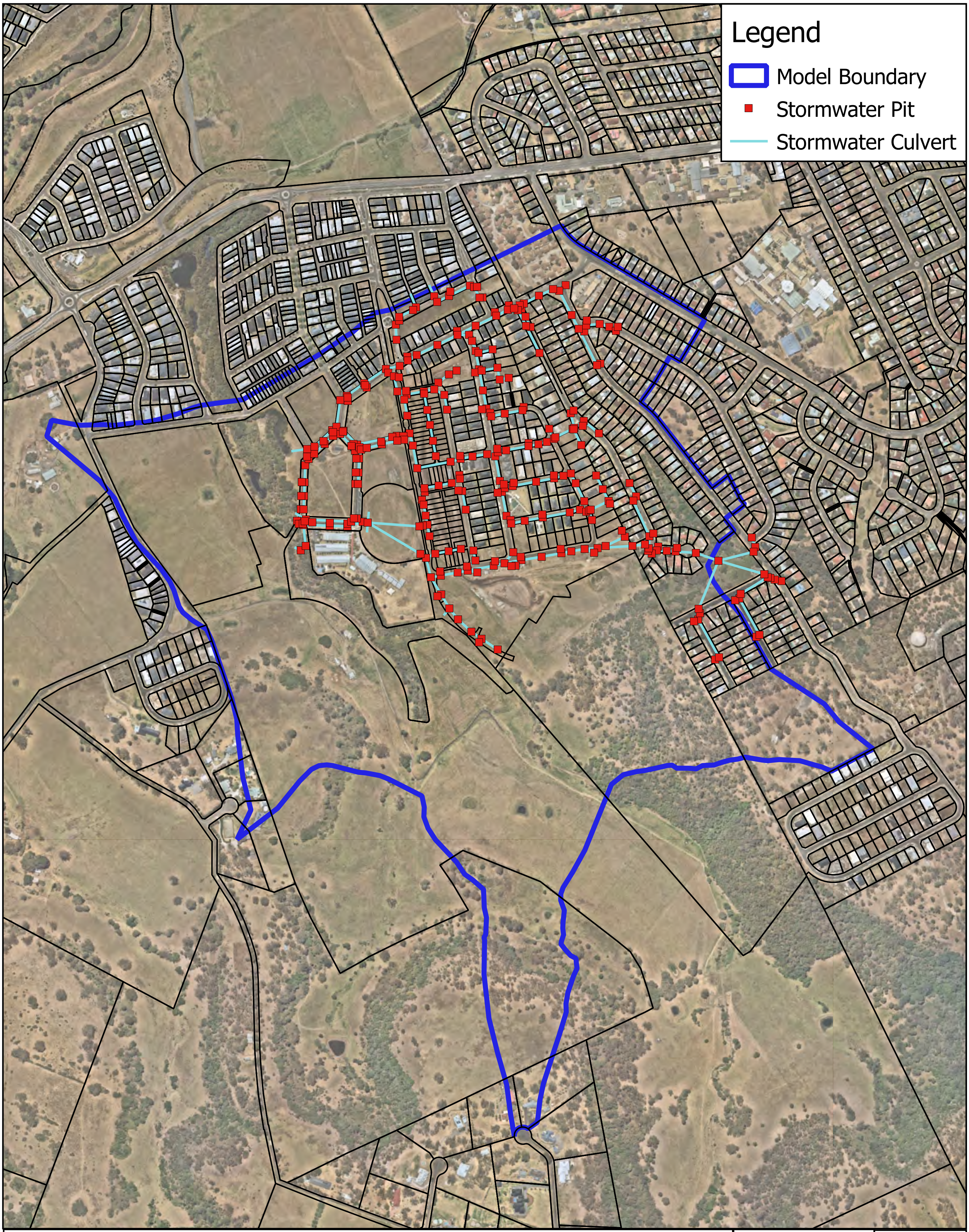
1. Application of direct rainfall
2. Flow vs Time Upstream Inflow Hydrographs;
3. Water level at the downstream boundaries; and
4. Water Level at the Pipe Outlets.

2.3.7.1 Rainfall Inflow Region

As the Stage 9 development is located upstream of an urban development the direct rainfall approach was applied for the catchment in the vicinity of the Ravenswood Development. This was done to remove any errors that may come about in assuming flows in a Hydrological Model which may occur in places such as intersections where a split in flow may occur. This is necessary when evaluating flooding as overland flow within a street before being contained by a riparian corridor.

The design rainfall hyetographs where derived from the raw data provided as described in section 2.2. All 100 year ARI hyetographs were extracted from the DRAINS program.

A PMF hyetograph was developed in the hydrological model WBNM. A Table for both hyetographs is located in Appendix F. For the PMF hyetographs the Bulletin 53 method was adopted and applied for the PMF direct rainfall.



Title:

Tullimbar Ravenswood Development - Stage 9 Study
Existing Stormwater Network

N

Scale 1:10,000 @ A3

0 120 240 360 480 m

Figure: **2.5**

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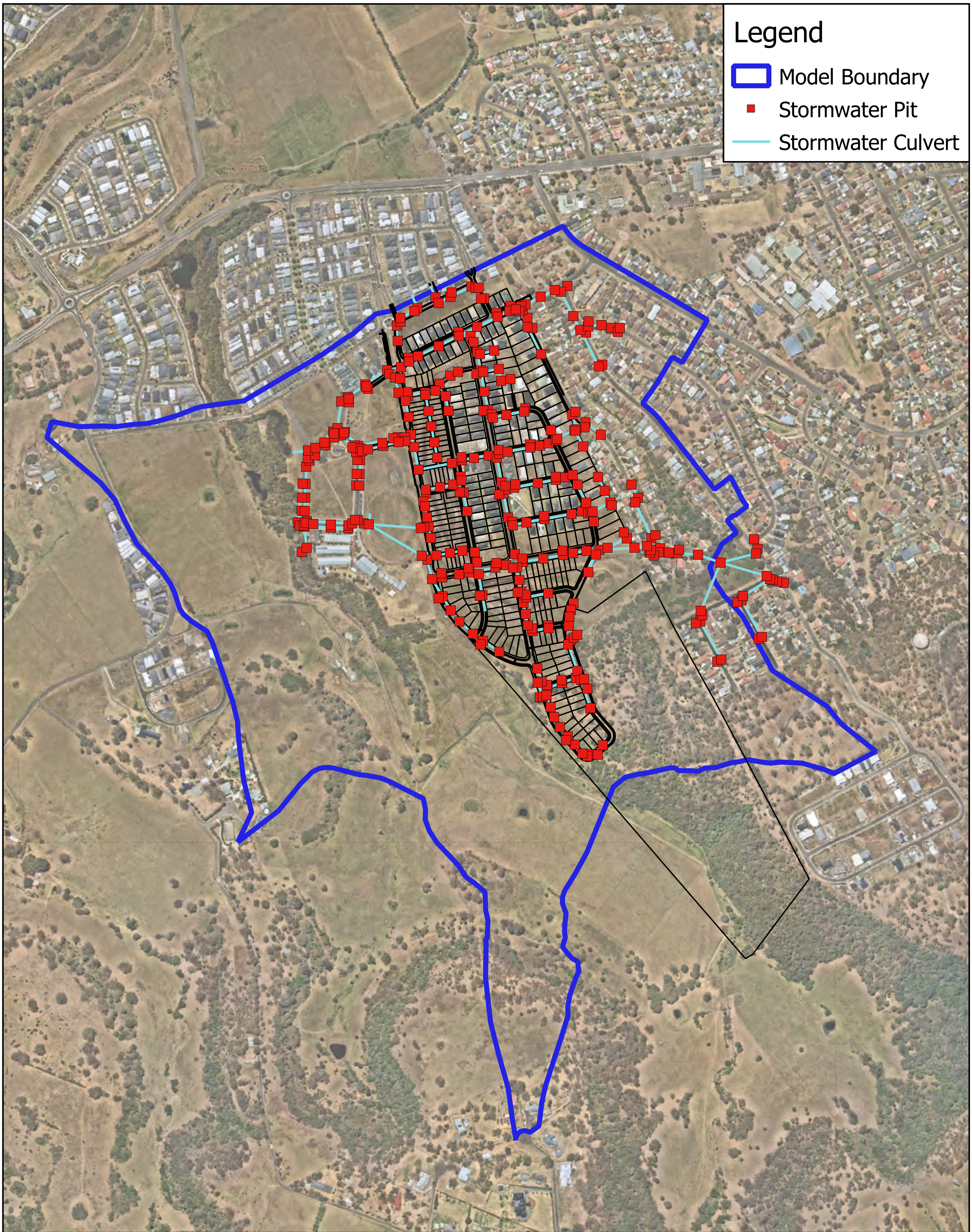

Title:
Tullimbar Ravenswood Development - Stage 9 Study
Proposed Stormwater Network

N

Scale 1:10,000 @ A3

0 120 240 360 480 m

Figure: 2.6

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2.3.7.2 Inflow Boundary Condition

Inflow hydrographs were obtained from Council from their Macquarie Rivulet Flood Study by WMA Water for both Hazelton and Cooback Creeks. These were obtained for the critical durations for the Village.

The location of these node locations within the Council model are shown in Appendix G. The nodes used in the model are shown as Hazelton3 and Cooback2 with a blue line on the image showing the location where this hydrograph was applied. Details of the 4 hydrographs are also shown in the appendix.

These hydrographs were applied to the model at the locations shown in Figure 2-7. These positions were chosen as it is a significant distance upstream of the site where the flow will still be channelised before breakout flow onto the flood plain.

2.3.7.3 Downstream Boundary Condition

The downstream boundary condition has been set within Hazelton Creek immediately downstream of the Wongawilli Street Bridge. This was chosen as the downstream boundary condition as the restriction of the bridge will be a controlling hydraulic structure and should ensure that the boundary condition has minimal effect on the model. The boundary condition in this location uses water level vs time (type HT) provided by Council from their Macquarie Rivulet Study for the corresponding critical durations to the inflow hydrographs.

These water level plots are shown in Appendix I. Multiple points of data along a line parallel to the bridge were provided by Council. These could be grouped into two groups, water levels within the main channel and those within the water quality structures on the western side of the corridor. As such, two sets of boundary conditions were produced from Council's data for both channels using an average of the points within each channel, excluding any outliers where the water level was equal to the surface level at that point and therefore not a true water level within the channel. The location of the points of data provided by Council are included in Appendix I.

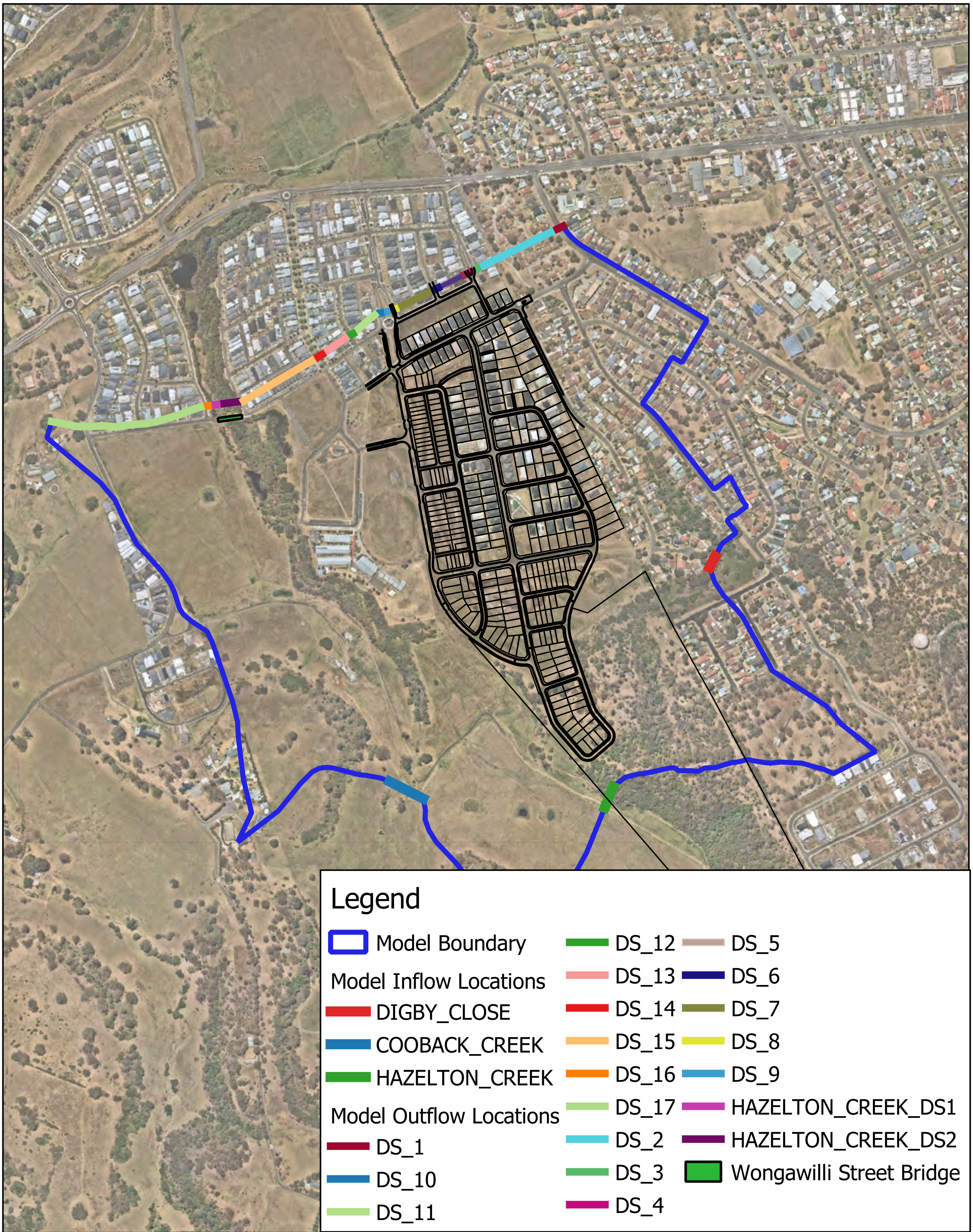
HT type boundary conditions were also used where sheet flow exited the model within lots. For these boundary conditions the water levels in the cells where set as a constant 10.0m AHD for the duration of the storm event. As the model boundary has been extended to a distance of at least 130m from the subject site, this is a suitable boundary condition that will not affect on the flooding within the subject site.

HQ type downstream boundary conditions were applied wherever flow was channelised when leaving the model, generally within the road reserve. This boundary condition automatically assumes a water level in the cell, taking into account the Manning's roughness and the slope defined in the attribute. Table 2-7 below, outlines the slopes given to the various boundary conditions throughout the model. This boundary condition type assumes normal flow, and as such will have minimal effect on the results in the cells immediately upstream. As it is assumed normal flow, water surface slope was taken as the slope of the surface below in the direction of the water travel. The boundary slope was determined from survey and the DEM used for the model, due to the distance from the subject site, any error in the slope causing a slight difference in water level at the boundary will have no effect on the subject site. Table 2-7 shows the slope attribute applied at each boundary condition.

Table 2-7 2D Downstream Boundary Conditions

Attribute ID	'b' Slope Attribute (m/m)	Water Level (m AHD) Time = 0hr	Water Level (m AHD) Time =100hr
DS_1	0.067		
DS_2		10.0	10
DS_3	0.020		
DS_4	0.067		
DS_5		10.0	10.0
DS_6	0.015		
DS_7		10.0	10.0
DS_8	0.012		
DS_9		10.0	10.0
DS_10	0.019		
DS_11		10.0	10.0
DS_12	0.025		
DS_13		10.0	10.0
DS_14	0.030		
DS_15	0.030		
DS_16	0.015		
DS_17		10	10

2D Downstream Boundary conditions are identical for all scenarios. The locations of these boundary condition are shown in Figure 2-7.



Title:

Tullimbar Ravenswood Development - Stage 9 Study
2D Boundary Conditions and Layered Flow Constrictions

N

Figure: **2.7**

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Scale 1:10,000 @ A3

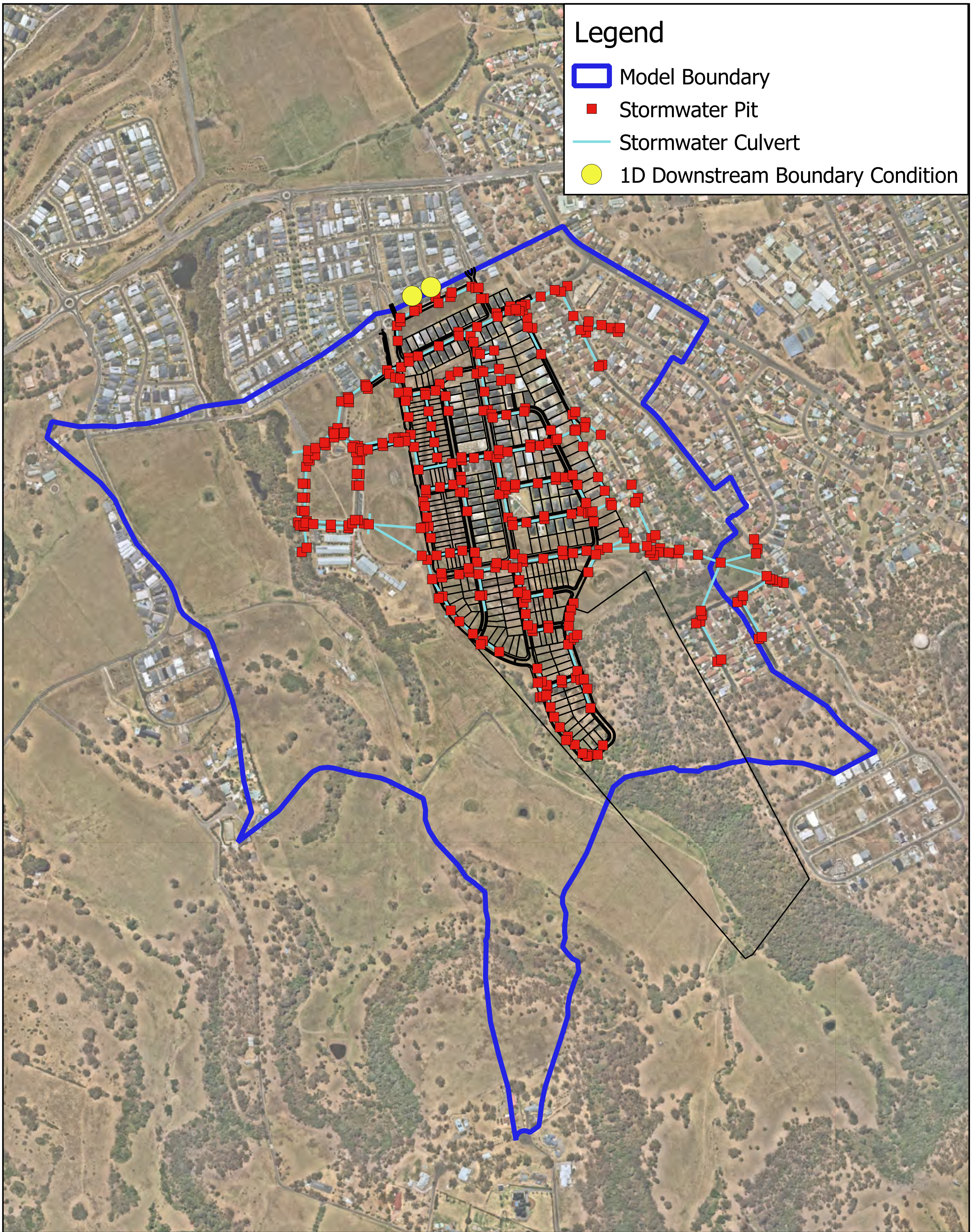
0 120 240 360 480 m

2.3.7.4 1D Downstream Boundary Conditions

Where a culvert or pipe passed through a downstream boundary, a 1D boundary conditions was applied as a water level over time condition. For this model a water level of the finished surface level above the corresponding pit. For kerb inlet pits, this level was taken as 200mm above the kerb invert. Table 2-8 below shows the boundary conditions applied to each culvert outlet. Locations of these outlets are shown in Figure 2.8.

Table 2-8 1D Downstream Boundary Conditions

Pit ID	Water Level (m AHD) Time = 0min	Water Level (m AHD) Time = 100min
G2	19.400	19.400
C2	19.330	19.330



Title:

Tullimbar Ravenswood Development - Stage 9 Study
1D Downstream Boundary Conditions

N

Scale 1:10,000 @ A3

0 120 240 360 480 m

Figure: 2.8

Rev: A

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