APPENDIX G

Flood Impact Assessment and Stormwater Quality Management Plan

Reference.: R.B21415.022.00.N3A3B_FIA_SQMP, Revision O

Prepared by BMT

dated 18 October 2019

Flinders Precinct 1, Neighbourhoods 3A & 3B, Flood Impact Assessment and Stormwater Quality Management Plan

Reference: R.B21415.022.00.N3A3B_FIA_SQMP
Date: October 2019
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Synopsis: This report presents a flood impact assessment and conceptual stormwater quality management plan to support a reconfiguration of a lot application for Flinders Neighbourhoods 3A and 3B.

REVISION/CHECKING HISTORY

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1 Introduction

1.1 Background

The Flinders Master Planned Community (hereafter referred to as Flinders) is a 4,000 hectare landholding located in Undullah, south west of Logan City being developed by Pacifiq.

Flinders includes an approximately 1,000 hectare area known as Precinct 1, which is located within the Greater Flagstone Priority Development Area (GFPDA). Precinct 1 is proposed to ultimately accommodate approximately 18,000 residents in 7,280 dwellings. Neighbourhoods 3a and 3b are located on the eastern boundary of Precinct 1 (refer to Figure 1-1) and proposed to accommodate 509 dwellings. The proposed development consists of residential development and parkland.

Pacifiq requires both a Stormwater Management Plan (SMP), including both a Flood Impact Assessment (FIA) and Stormwater Quality Management Plan (SQMP), to be prepared in support of the development approval (DA) application with Economic Development Queensland (EDQ) for Neighbourhoods 3a and 3b within Precinct 1.

BMT has previously provided flooding and stormwater quality related advice in the area in support of the Whole of Site Material Change of Use (MCU) application, including the following relevant reports:

- Flinders Precinct 1: Flood Impact Assessment (BMT, 2017)
- Flinders Precinct 1: Stormwater Quality Management Plan (BMT, 2017)
- Flinders Precinct 1: Lake Infrastructure Master Plan (BMT, 2019).

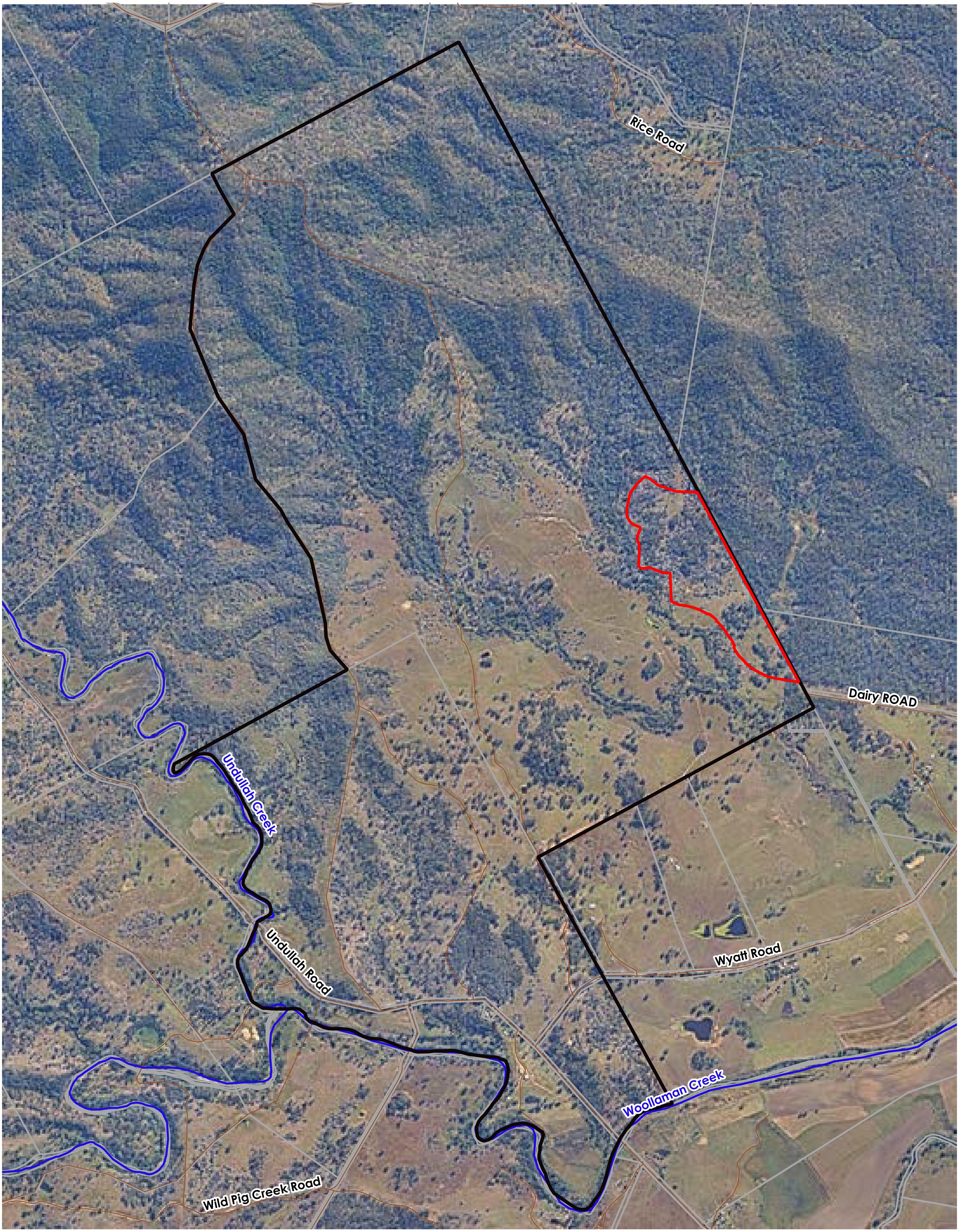
1.2 Scope

BMT was commissioned to provide a Stormwater Management Plan (SMP) in support of the proposed development. The investigation included the following elements:

Flood Impact Assessment, including the following two components:

- *Hydrologic Assessment:* A WBNM hydrologic model of the local catchment was created to provide inflow hydrographs to the hydraulic model.
- *Hydraulic Assessment:* A two-dimensional model of the local catchment was established to demonstrate that the proposed development does not lead to any unacceptable adverse off-site impacts with respect to flooding.

Stormwater Quality Management Plan: provides a conceptual water quality assessment of the proposed development and predicts how the estimated stormwater pollutant loads from the developed site will compare to the given stormwater quality management objectives.



LEGEND

- Neighbourhood 3A and 3B Boundary
- Precinct 1 Boundary
- Watercourses
- Roads
- Cadastral Boundaries

Title: **Site Location**

Drawing: **1-1**

Rev: **A**

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Filepath: I:\B21415_I_JLB Flinders Project NC\QGIS\Figure_Generator\N3A3B__Report Figures\Fig 1-1 Site Location N3A3B.qgz

2 Site Description

2.1 Location

Neighbourhood 3a and 3b is a 35-hectare site located over part of Lot 3 on S311896 at Undullah within the Logan City Council area. The site is currently a mix of agricultural and forested land use.

A recent aerial photograph of the site is presented in Figure 2-1.

2.2 Topography and Drainage

Ground elevations vary between 79.9 m AHD on the northern boundary of the site, to 37.1 m AHD on the southern boundary.

Two overland flow paths exist within the site. A 14-hectare catchment drains in a south westerly direction though the middle of the site. An 86-hectare catchment drains through the southern portion of the site. The two flow paths join just outside the site boundary where they enter a tributary of Teviot Brook which then flows into the Logan River approximately 2.5 kilometres downstream.

The topography of the site and surrounding areas is presented in Figure 2-2.

2.3 Proposed Development

A layout plan of the proposed development and associated land uses is presented in Figure 2-3. This has been adopted from information provided by Mortons Urban Solutions and provided in Appendix A.

The topography of the proposed development has also been supplied by Mortons Urban Solutions. This topography is presented in Figure 2-4.

LEGEND

Neighbourhood 3A and 3B Boundary

Roads

Cadastral Boundaries

Title:

Recent Site Aerial Photograph

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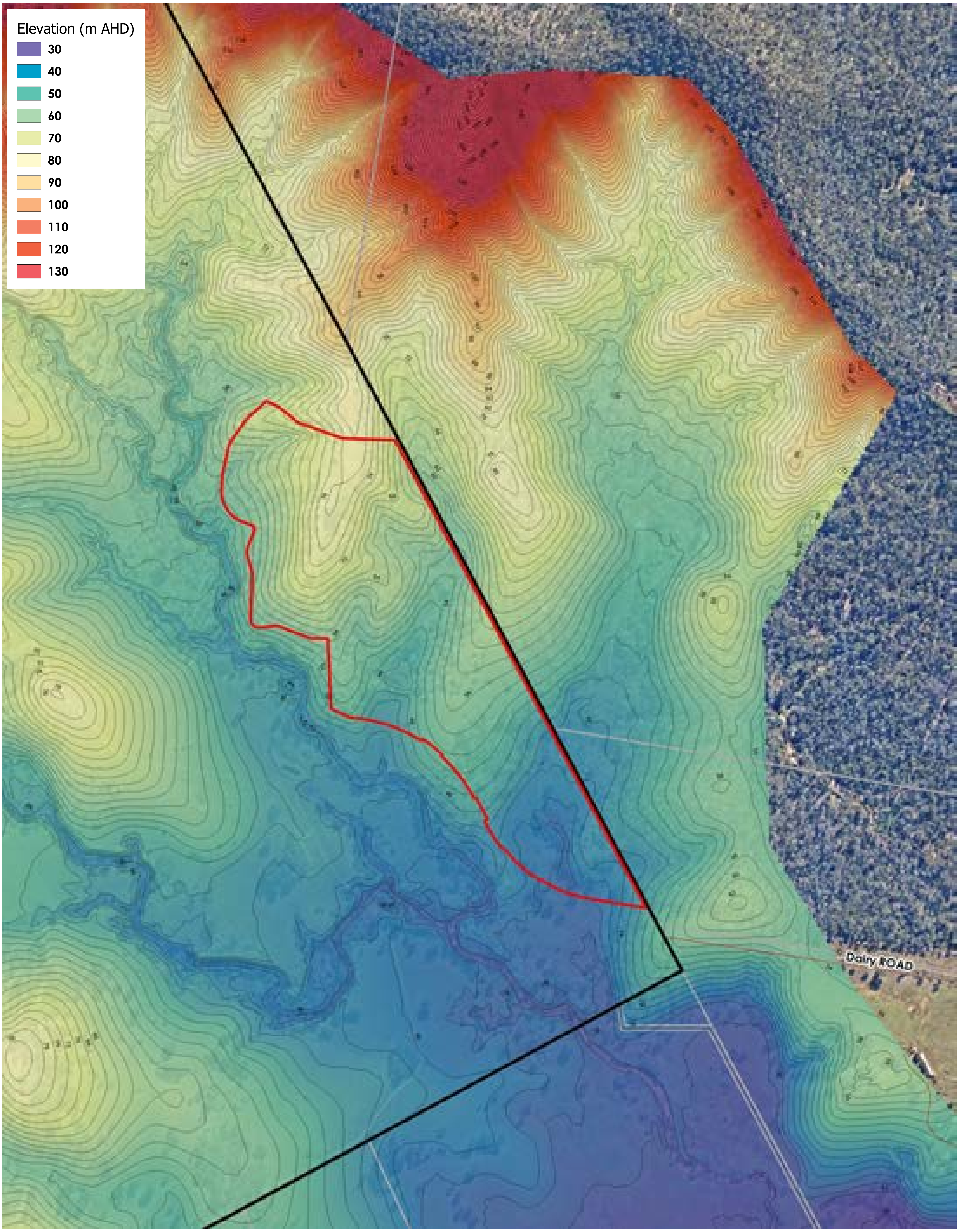

LEGEND

- Neighbourhood 3A and 3B Boundary
- Contours
- Precinct 1 Boundary
- Watercourses
- Roads

Title:

Existing Site Topography

Drawing: 2-2

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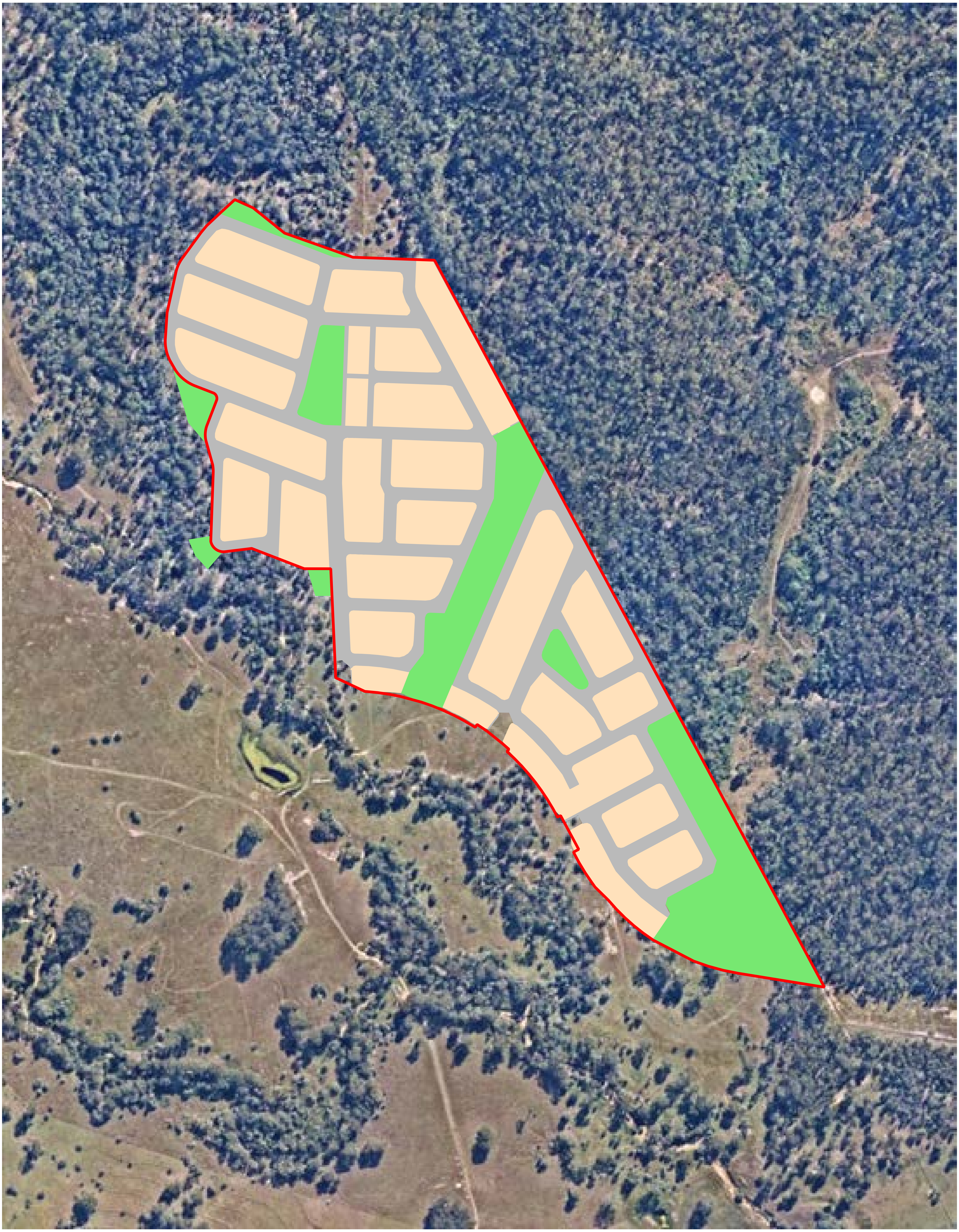

LEGEND

- Neighbourhood 3A and 3B Boundary
- Roads
- Residential
- Open Space

Title:

Plan of Proposed Development

Drawing: 2-3

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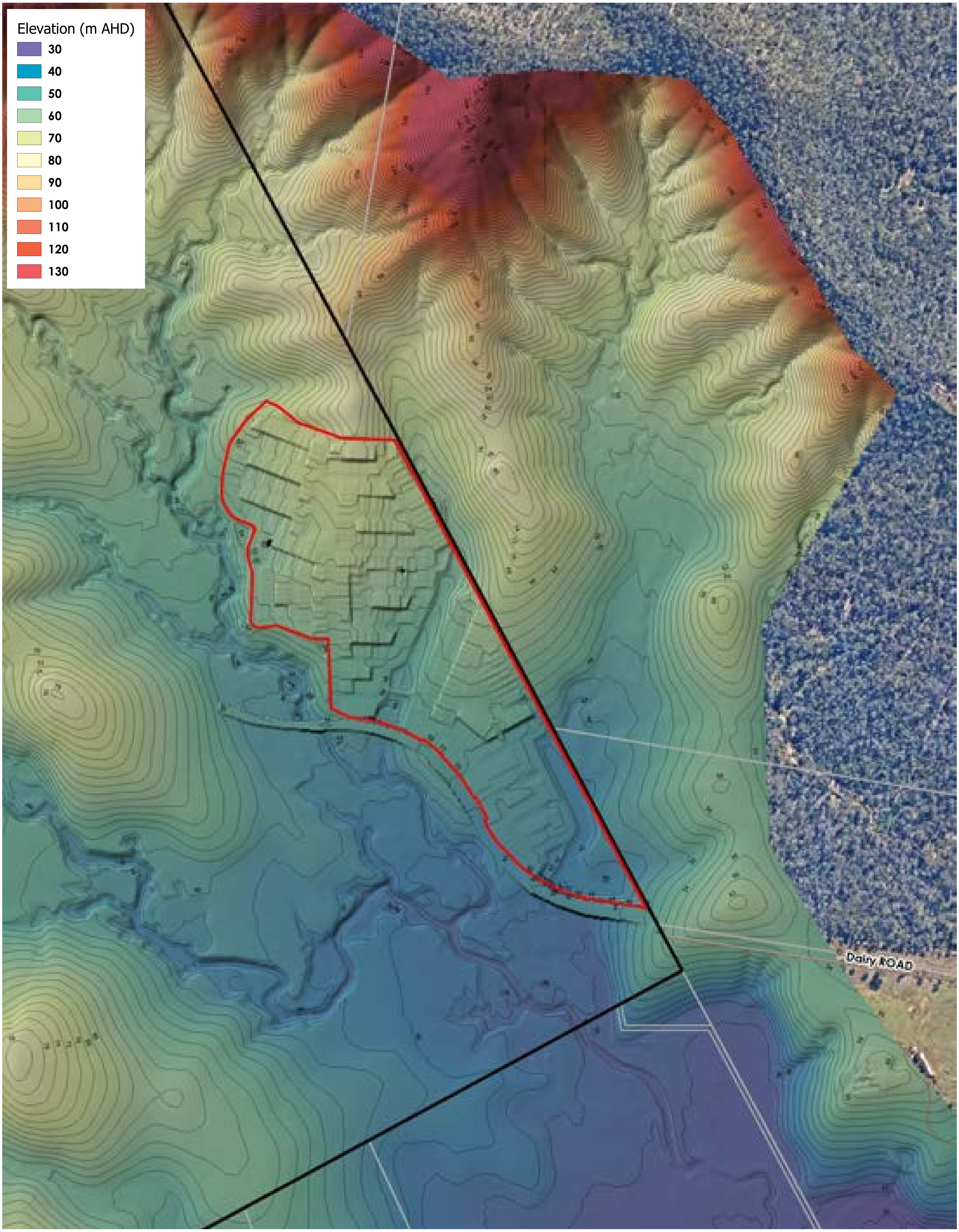

LEGEND

- Neighbourhood 3A and 3B Boundary
- Precinct 1 Boundary
- Roads
- Cadastral Boundaries

Title:

Developed Site Topography

Drawing: 2-4

Rev: A

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3 Hydrologic Model

3.1 Overview

Hydrologic models were constructed for both the existing site, and the site including the proposed development. The non-linear runoff routing WBNM software package (WBNM2003 v1.03) was used to create the models. Runoff hydrographs calculated by the models were input to the hydraulic model of the site (refer Section 4).

For the existing case hydrology, it was assumed that the area to the east of the Precinct 1 boundary is un-developed and that appropriate measures will be put in place in accordance with Common Law requirements to ensure that development of the area does not result in an increase in discharge into the Flinders development area.

3.2 Existing Case Hydrologic Model Setup

3.2.1 Catchment

To represent the hydrologic behaviour of the catchment, 38 sub-catchments were created using CatchmentSIM software for use in the hydrologic models. The sub-catchment layout is presented in Figure 3-1.

3.2.2 Land Use Fraction Impervious

Catchment land use was determined for the existing site based on aerial photography and site inspection. Appropriate fraction impervious areas were then defined for each use based on Table 4.5.1 of the *Queensland Urban Drainage Manual* (QUDM, 2013). The fraction impervious values adopted for each landuse are listed in Table 3-1.

Table 3-1 Land Use Impervious Area

Landuse	Impervious %
Urban Residential	75%
Commercial and Community Centres	90%
Dense Vegetation	0%
Light Vegetation	0%
Open Space / Grass	0%
Standing Waterbodies	100%
Roads – Pavement	90%
Exposed Creek Channel Bed	0%
Rock for Scour Protection	100%

3.2.3 Rainfall Parameters

The rainfall parameters used in the WBNM model were extracted from *Australian Rainfall and Runoff* (Institution of Engineers Australia, 1987) for the Undullah area. The adopted parameters are presented in Table 3-2.

Table 3-2 Rainfall Parameters

Parameter	Value
ARR Zone	3
2 Year ARI 1 hour	44.02
2 Year ARI 12 hour	6.76
2 Year ARI 72 hour	1.87
50 Year ARI 1 hour	81.41
50 Year ARI 12 hour	12.23
50 Year ARI 72 hour	3.86
Skew Coefficient	0.19
Geographical Factor F2	4.39
Geographical Factor F50	17.08

3.2.4 Hydrologic Parameters

The hydrologic parameters adopted in the WBNM model are presented in Table 3-3. These parameters are based on the previous flood modelling undertaken for the site by Gilbert and Sutherland, as presented in Table 3.1.1 of the G&S 2012 report). For the G&S 2012 report a lag parameter value of 1.6 was adopted based on the recommended values for WBNM models (refer Section 4.1 of the G&S 2012 model). Based on a review of the peak flow rates obtained using this value (refer Section 3.2.6), the lag parameter was considered to be reasonable.

It can be noted that an initial loss of 15 mm was adopted for pervious areas for all events in accordance with the recommendation of the SKM review of the previous G&S flood report, as documented in the G&S letter dated 4 February 2012.

Table 3-3 Sub-Catchment Hydrologic Parameters

Parameter	Design Storm ARI						
	1	2	5	10	20	50	100
Initial Loss (Pervious) (mm)	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Initial Loss (Impervious) (mm)	0.5						
Continuing Loss (Pervious) (mm)	1.5						
Lag Parameter C	1.6						
Impervious Lag Factor	0.1						

3.2.5 Rational Method Verification

Due to the absence of a stream gauge on the watercourses that drain through the study area, it was not possible to calibrate the hydrologic models to historic flood events.

In lieu of calibration data, recourse was made to the Rational Method to confirm that the peak flows calculated by the hydrologic model were reasonable. For the catchment draining into the development area of neighbourhood 3A and 3B (subcatchments 13-a, 13-b, 13-c and 2-i2) the

Rational Method assessment was completed in accordance with the procedures nominated in Section 4 of QUDM. The parameters adopted for the assessment are presented in Table 3-4.

Table 3-4 Rational Method Parameters

Parameter	Existing Catchment	Notes
Catchment Area (ha)	111.45	Subcatchments: 13-a, 13-b, 13-c, 2-i2
Fraction Impervious (%)	0%	
Channel Length (m)	2.01 km	
Equal Area Slope	2%	
Travel Velocity	0.5 m/s	QUDM Table 4.6.6, Flat country
Time of Concentration (min)	1.12 hr	
Runoff Coefficient (C_{10})	0.44	QUDM Table 4.5.4: Light bushland, high soil permeability

A comparison of the peak flow predicted using the Rational Method and that calculated by the WBNM model is presented in Table 3-5.

Table 3-5 Rational Method Comparison

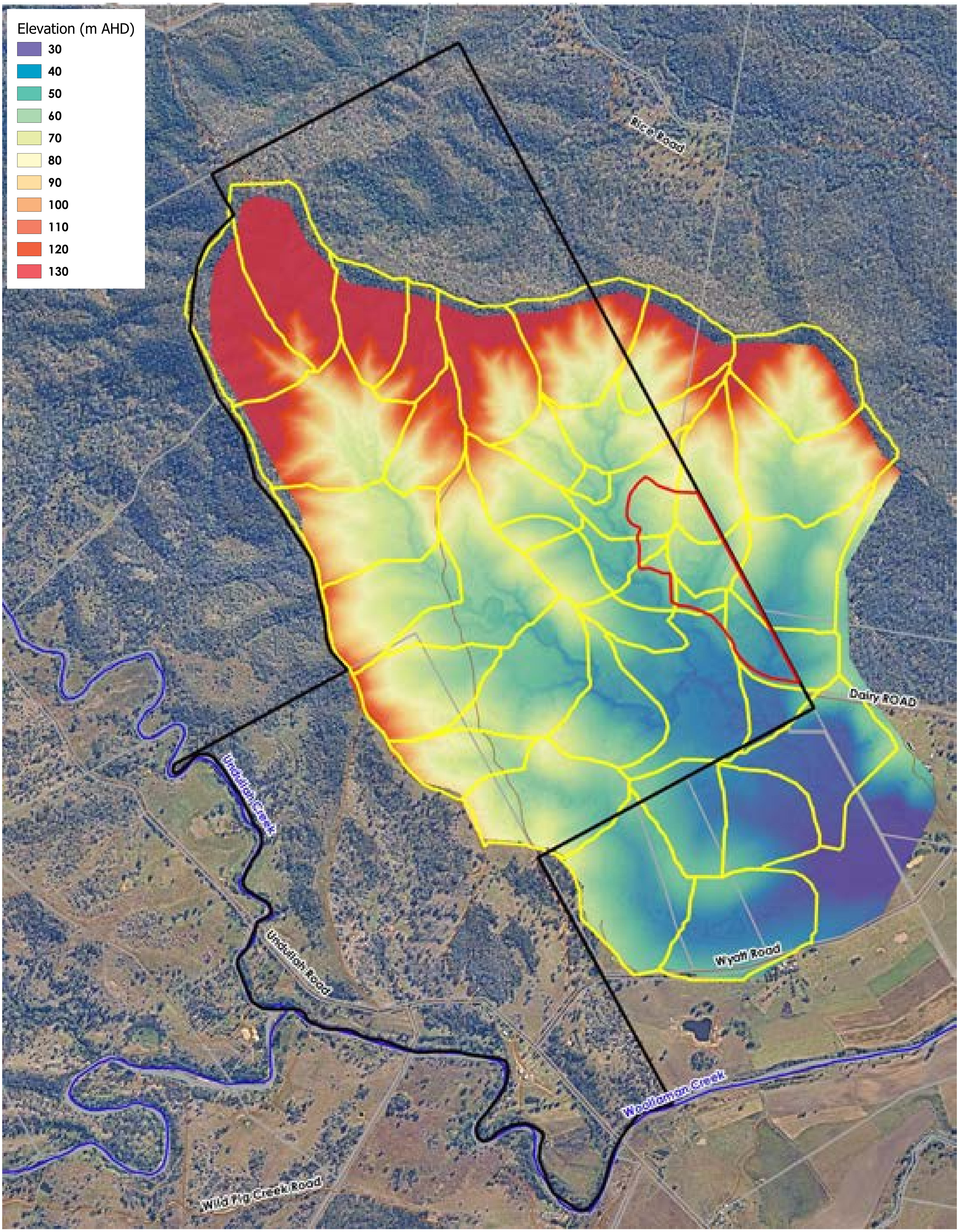
ARI (Years)	Rational Method	WBNM	% Difference
1	3.4	2.6	-24%
2	4.6	4.3	-8%
5	6.6	6.6	1%
10	7.8	8.2	5%
20	9.5	10.4	10%
50	12.2	13.3	9%
100	14.2	15.8	11%

Based on the results presented in Table 3-5 above, it is considered that a reasonable correlation exists between the WBNM model and the Rational Method and that therefore the model can be used with confidence to define runoff hydrographs for use in the hydraulic model.

3.3 Developed Case Hydrologic Model Setup

The existing case model was revised to reflect the increased impervious area associated with the development (i.e. increased roof and pavement area).

The developed case model was then used to determine the increase in discharge associated with the development of the site and appropriately modified runoff hydrographs were applied to the hydraulic model.



LEGEND
- Site Boundary
- Precinct 1 Boundary
- Sub-Catchments
- Watercourses
- Roads
- Cadastral Boundaries

Title: **Existing Site Sub-Catchments**

Drawing: 3-1

Rev: A

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4 Hydraulic Model

4.1 Overview

To confirm that the development will not cause an unacceptable impact on adjacent properties, detailed flood modelling of the local catchment was undertaken.

For the analysis, a TUFLOW two-dimensional model of the local catchment was established. The model included a detailed representation of the surface drainage network via a two-dimensional grid, linked with one-dimensional elements representing the underground (pipe) drainage network under Lakeside Drive.

This section provides a description of the assessment undertaken and the results obtained from the simulation.

4.2 Existing Case Model Setup

4.2.1 Model Extent and Topography

The TUFLOW model created for this assessment covers the area from the top of the local catchment to 1km downstream of the Precinct 1 boundary. The downstream extent of the model was chosen to ensure that conditions at the downstream end of the model do not affect results at the site.

Ground level data for the model was obtained from 2009 LIDAR survey data provided by DNRM.

To provide a high level of detail, a hydraulic model with a 5 metre grid cell size was used in the 2D domain.

4.2.2 Roughness

A roughness map representing the Manning 'n' roughness coefficients was adopted based on previous flood studies for the site (G&S 2012 report) which in turn had been derived from a review of aerial photography and site inspections. As part of the current investigation, the adopted roughness values were reviewed and found to be consistent with ARR Project 15, *Two Dimensional Modelling of Urban and Rural Floodplains* (AR&R, 2012).

Given this, the adopted roughness values presented in Table 4-1 were considered appropriate for use.

Table 4-1 Roughness Values

Landuse	Manning's Roughness
Urban Residential	0.20
Commercial and Community Centres	0.20
Dense Vegetation	0.08
Light Vegetation	0.06
Open Space / Grass	0.05
Standing Waterbodies	0.02
Roads – Pavement	0.02
Exposed Creek Channel Bed	0.035
Rock for Scour Protection	0.022

4.2.3 Boundary Conditions

The tailwater level adopted for the hydraulic model was based on the previous flood study for the development (G&S, 2012). The G&S 2012 report used a tailwater condition of 33.02m AHD to represent the combined influence of regional flooding from the Teviot Brook and the Logan River catchments (refer Section 5.2.2 of G&S 2012 report).

4.3 Developed Case Model Setup

4.3.1 Model Extent and Topography

To assess the proposed redevelopment of the site, the existing case model 2D domain, as described above, was updated to reflect the proposed terrain and land usage changes associated with the development.

4.3.2 Roughness

The roughness values adopted for the existing case were adjusted to reflect the development layout as outlined in Figure 2-3.

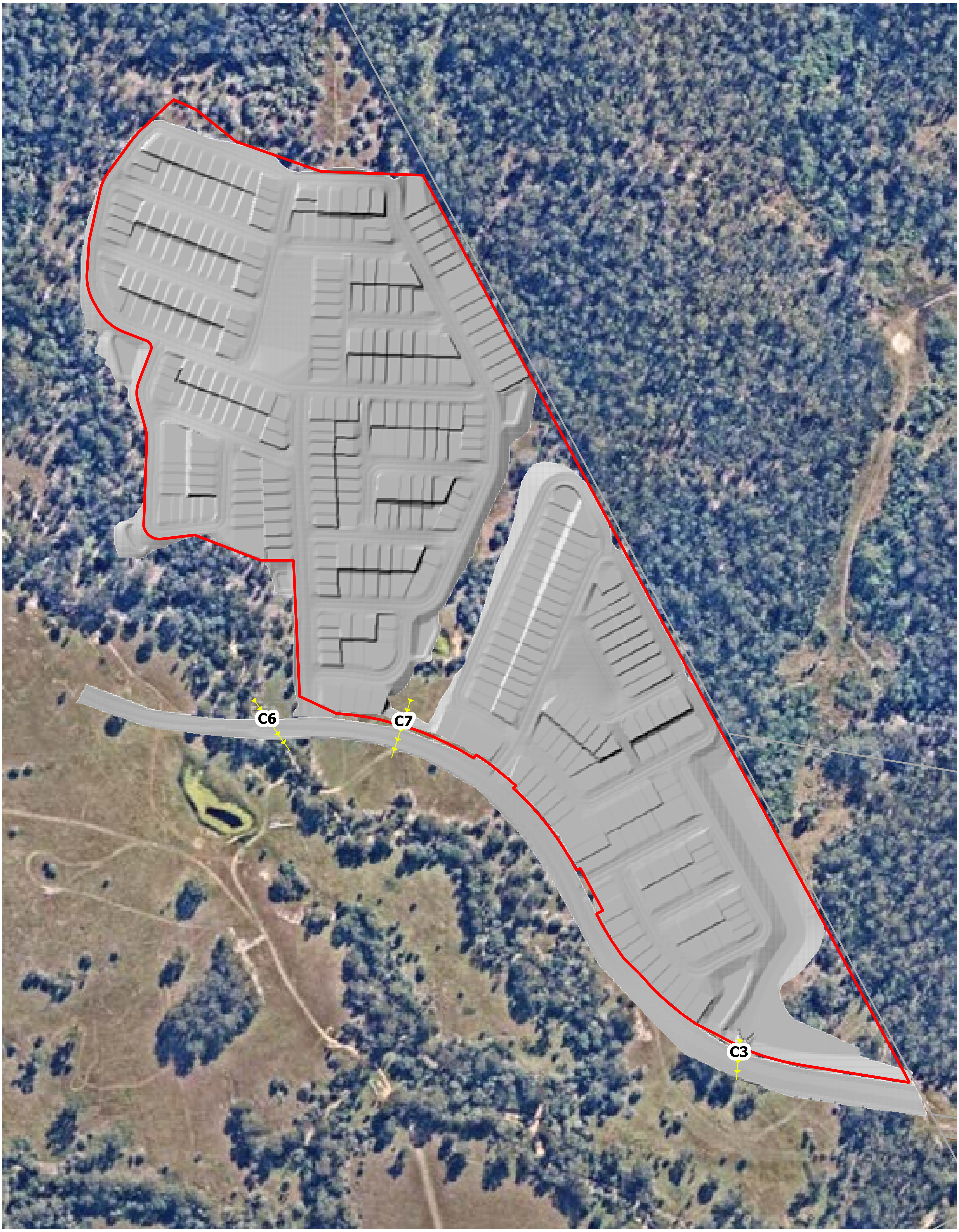
4.3.3 Culvert Network

A 1D domain was used to represent the culvert network within the 3A and 3B proposed development. Two sets of culverts are to be located under Lakeside Drive in order to convey flows up to and including the 100-year ARI event under Lakeside Drive. Additionally, the culverts are to provide sufficient detention to mitigate the increases run-off associated with the proposed development.

The proposed culvert sizes used in the hydraulic model are presented in Table 4-2. The indicative culvert locations are presented in Figure 4-1.

Table 4-2 Proposed Culverts

Culvert ID	Quantity	Size (mm)	Type
C3	3	1800x2100	RCBC
C6	3	2400x1800	RCBC
C7	2	1500x1500	RCBC



LEGEND

- Site Boundary
- Cadastral Boundaries
- Neighbourhood 3A and 3B Culverts

Title:

Proposed Culvert Locations

Drawing: 4-1

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5 Hydraulic Model Results

The hydraulic model was used to calculate flood levels for both the pre-developed and developed cases for a range of storm events and durations.

The mapped resultant pre and post-development case peak flood levels for the 100 year ARI storm event are presented in Figure 5-1 and Figure 5-2 respectively.

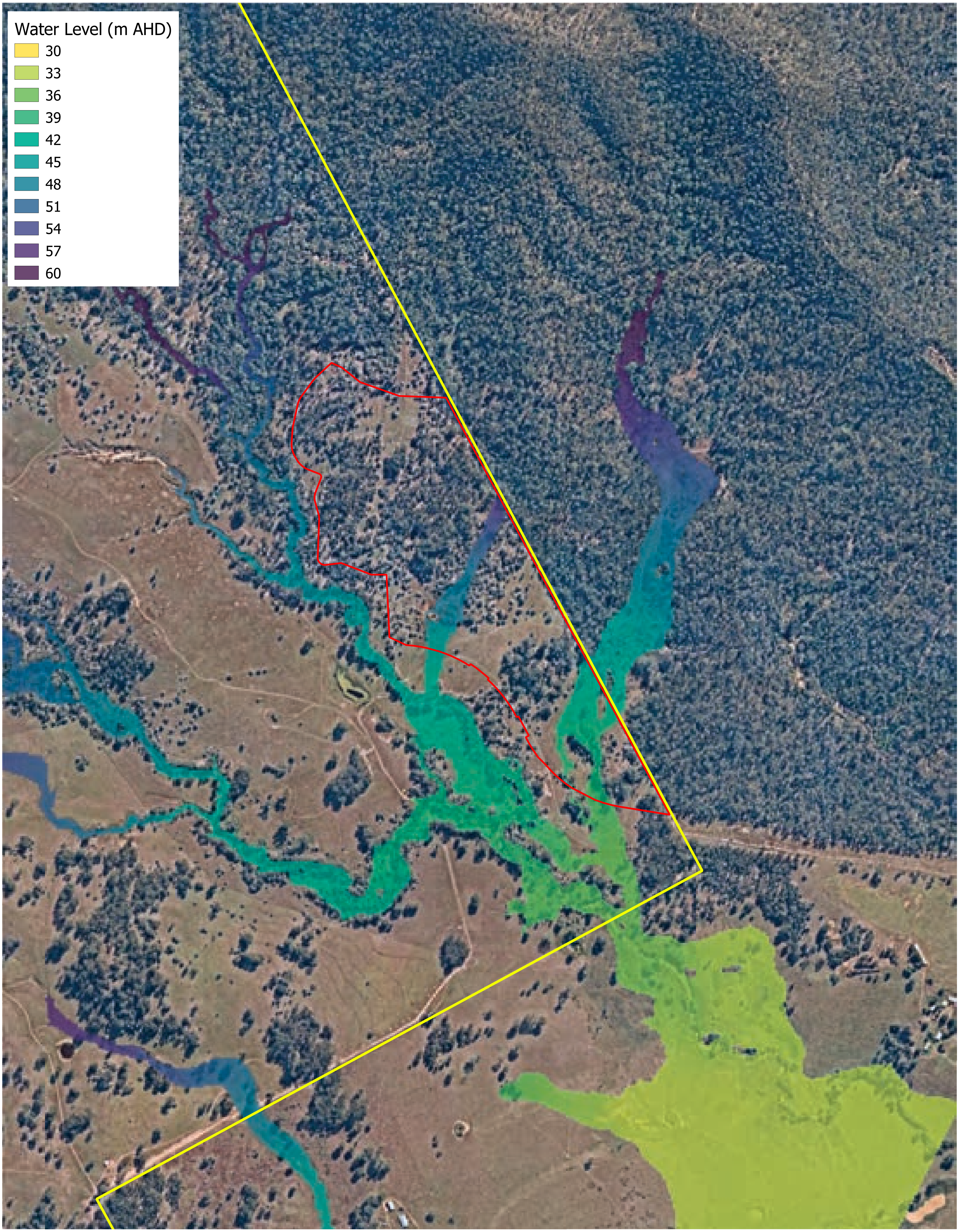
Mapped resultant pre and post-development case peak flood levels for the 2, 5, 10, 20 and 50 year ARI storm events are presented in Appendix B in the following figures.

- Figure B-1 1 Year ARI Peak Flood Level – Existing Case
- Figure B-2 2 Year ARI Peak Flood Level – Existing Case
- Figure B-3 5 Year ARI Peak Flood Level – Existing Case
- Figure B-4 10 Year ARI Peak Flood Level – Existing Case
- Figure B-5 20 Year ARI Peak Flood Level – Existing Case
- Figure B-6 50 Year ARI Peak Flood Level – Existing Case
- Figure B-7 1 Year ARI Peak Flood Level – Developed Case
- Figure B-8 2 Year ARI Peak Flood Level – Developed Case
- Figure B-9 5 Year ARI Peak Flood Level – Developed Case
- Figure B-10 10 Year ARI Peak Flood Level – Developed Case
- Figure B-11 20 Year ARI Peak Flood Level – Developed Case
- Figure B-12 50 Year ARI Peak Flood Level – Developed Case

Afflux plots for the 100 year ARI storm event are presented in Figure 5-3. The plot shows no unacceptable increase in water level external to the site.

Afflux plots for the 2, 5, 10, 20 and 50 year ARI storm events are presented in Appendix B in the following figures.

- Figure B-13 1 Year ARI Peak Flood Afflux
- Figure B-14 2 Year ARI Peak Flood Afflux
- Figure B-15 5 Year ARI Peak Flood Afflux
- Figure B-16 10 Year ARI Peak Flood Afflux
- Figure B-17 20 Year ARI Peak Flood Afflux
- Figure B-18 50 Year ARI Peak Flood Afflux



Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

100 Year ARI Peak Water Level

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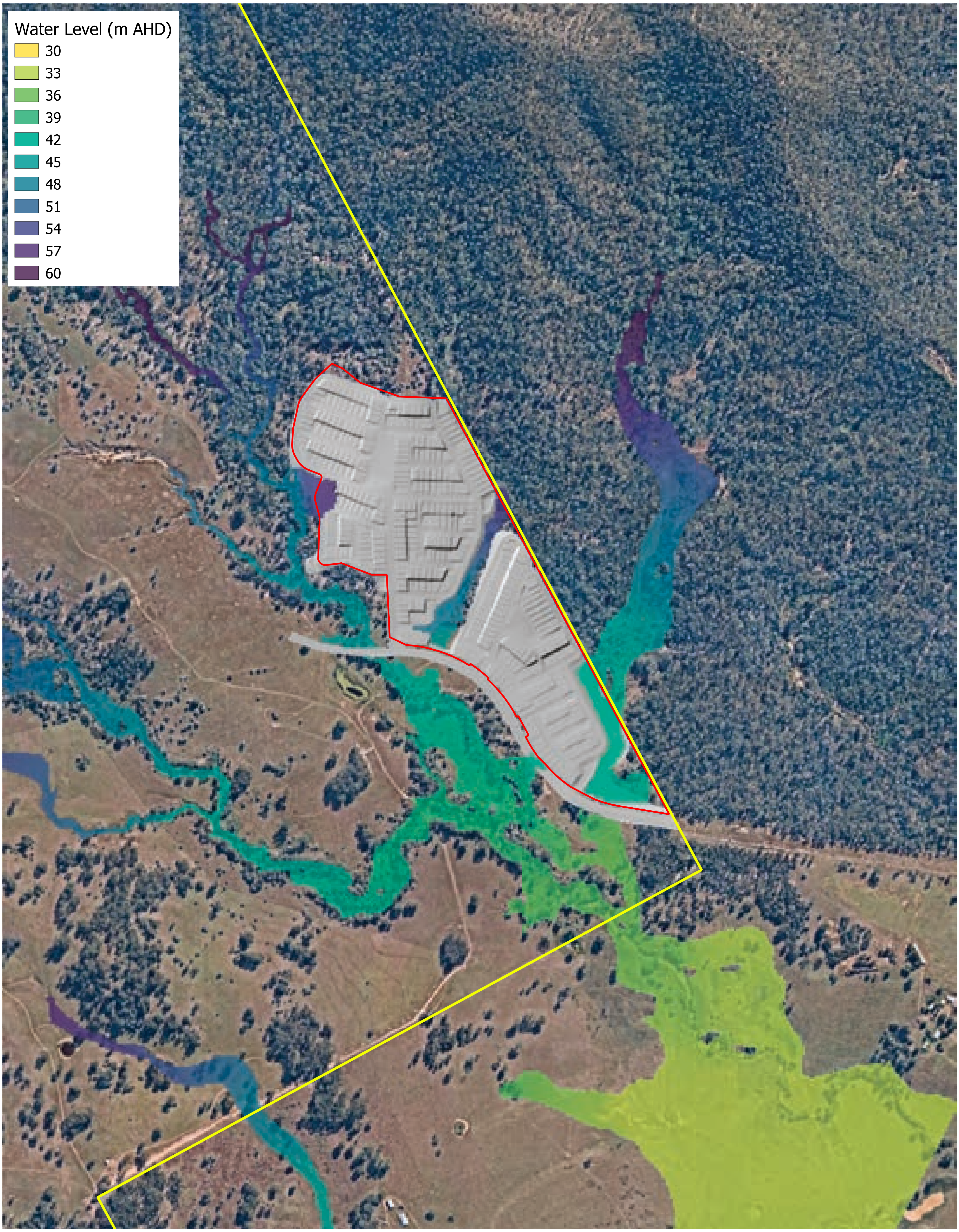

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- Flinders Precinct 1 Boundary
- Neighbourhood 3A and 3B Boundary

Title:

100 Year ARI Peak Water Level

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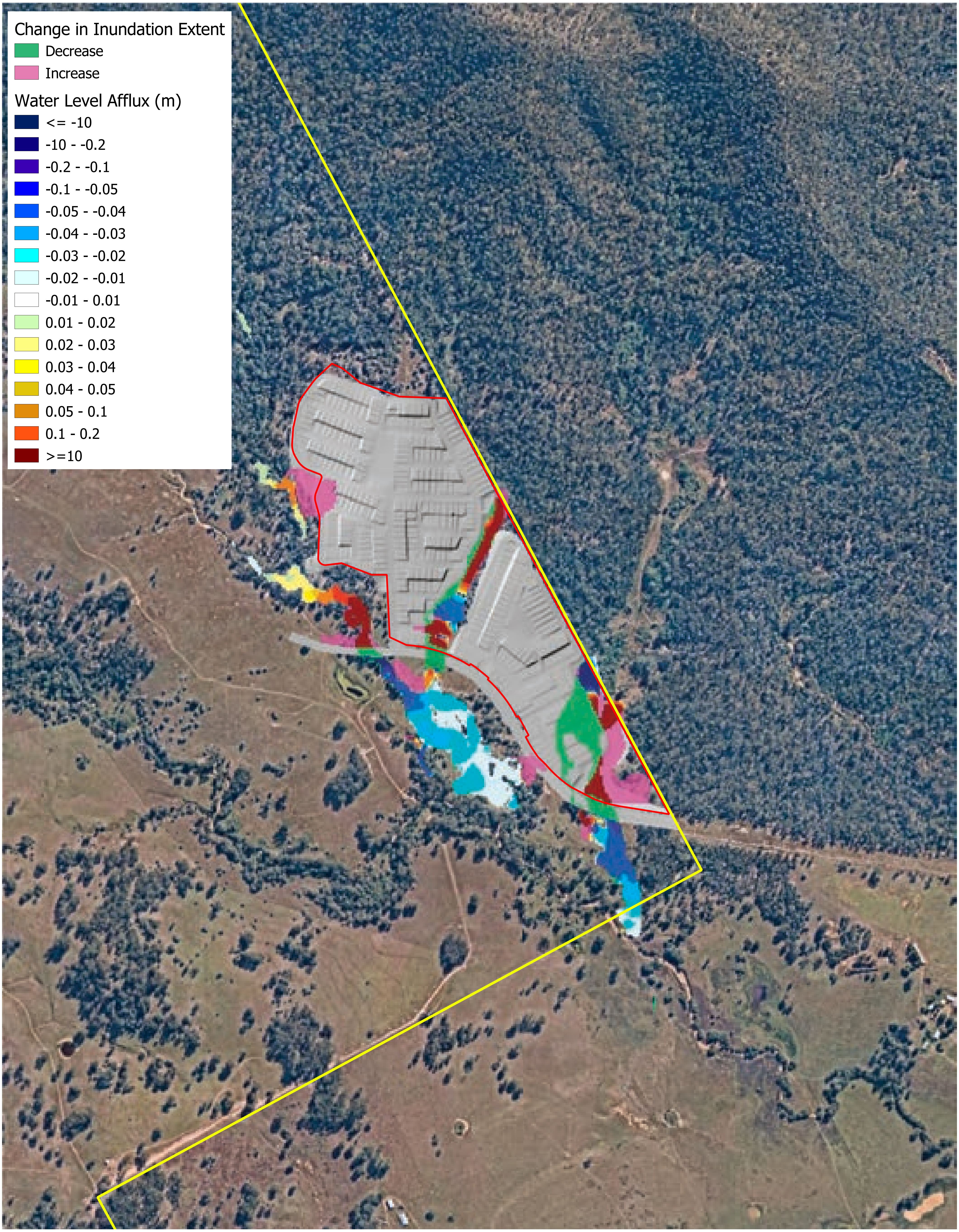

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Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

100 Year Peak Water Level Afflux

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6 Stormwater Quality Management Strategy

6.1 Preamble

This section provides a conceptual stormwater quality assessment of the proposed development. This has been prepared to determine the size, location and performance characteristics of the proposed stormwater management strategy. This section explains how predicted stormwater pollutant loads from the development will compare to the given stormwater quality management objectives.

6.2 Stormwater Quality Management Objectives

Stormwater quality management objectives apply to both the construction and operational phases of the development. These management objectives are described in subsequent Section 6.2.1 and Section 6.2.2.

6.2.1 Construction Phase

Performance criteria for the construction phase of the development have been adopted directly from the *State planning policy* (DILGP 2017). These criteria are given in Table 6-1.

Table 6-1 Construction Phase Performance Criteria

Issue	Construction Phase Performance Criteria
Drainage control	1. Manage stormwater flows around or through areas of exposed soil to avoid contamination. 2. Manage sheet flows in order to avoid or minimise the generation of rill or gully erosion. 3. Provide stable concentrated flow paths to achieve the construction phase stormwater management design objectives for temporary drainage works as follows: • Design life and minimum design storm event of temporary drainage structures: – Design life: <12 months— 39% AEP. – Design life: 12-24 months— 18% AEP. – Design life: > 24 months— 10% AEP. • Where temporary drainage works are located immediately up-slope of an occupied property that would be adversely affected by the failure or overtopping of the structure—minimum 10% AEP hydraulic capacity. • Temporary culvert crossing—minimum 63% AEP hydraulic capacity 4. Provide emergency spillways for sediment basins to achieve the construction phase stormwater management design objectives for emergency spillways on temporary sediment basins as follows: • Design life <3 months— 10% AEP. • Design life 3-12 months— 5% AEP. • Design life > 12 months— 2% AEP.
Erosion control	1. Stage clearing and construction works to minimise the area of exposed soil at any one time.

Issue	Construction Phase Performance Criteria
	2. Effectively cover or stabilise exposed soils prior to predicted rainfall. 3. Prior to completion of works for the development, and prior to removal of sediment controls, all site surfaces must be effectively stabilised13 using methods which will achieve effective short-term stabilisation.
Sediment control	1. Direct runoff from exposed site soils to sediment controls that are appropriate to the extent of disturbance and level of erosion risk. 2. All exposed areas greater than 2500 m^2 must be provided with sediment controls which are designed, implemented and maintained to a standard which would achieve at least 80% of the average annual runoff volume of the contributing catchment treated (i.e. 80% hydrological effectiveness) to 50mg/L Total Suspended Solids (TSS) or less, and pH in the range (6.5–8.5).
Litter, hydrocarbon and other contaminants	1. Remove gross pollutants and litter. 2. Avoid the release of oil or visible sheen to released waters. 3. Dispose of waste containing contaminants at authorised facilities.
Waterway stability and flood flow management	1. Where measures are required to meet post-construction waterway stability objectives, these are either installed prior to land disturbance and are integrated with erosion and sediment controls, or equivalent alternative measures are implemented during construction. 2. Earthworks and the implementation of erosion and sediment controls are undertaken in ways which ensure flooding characteristics (including stormwater quantity characteristics) external to the development site are not worsened during construction for all events up to and including the 1 in 100 year ARI (1% AEP).

The management strategy for achieving these criteria will be described as part of a detailed erosion and sediment control (ESC) plan. Details of the ESC plan have not been provided as part of this report.

6.2.2 Operational Phase

The site is located within a water resource catchment and water supply buffer area as identified in the *State Planning Policy Interactive Mapping System* (DSDMIP 2018), therefore performance criteria for the operational phase of the development shall be in accordance with the *Seqwater Development Guidelines* (Seqwater 2017). These criteria are provided in Table 6-2.

The water quality criteria nominated in the Seqwater guidelines are more onerous than those nominated in the *State Planning Policy* (2017).

Table 6-2 Operational Phase Performance Criteria

Pollutant	Criteria
Total suspended solids	85 % reduction in load
Total phosphorus	65% reduction in load
Total nitrogen	45% reduction in load
Gross pollutants (5 mm or larger)	95% reduction in load

6.2.3 Waterway Stability

In addition to the performance criteria listed above, the *State Planning Policy* (DILGP 2017) includes a waterway stability management criterion. The intent of this criterion is to reduce the impact of urban development on channel bed and bank erosion by limiting the post-development 63% annual exceedance probability (AEP) event discharge within the receiving waterways to the pre-development peak. As the development will discharge to the lake there will be no impacts on the downstream bed and banks. Any impacts on the environment immediately downstream of the development will be mitigated by the proposed stormwater quality management measures.

6.3 MUSIC Modelling

Version 6.3 of the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software has been used to assess the generation, transportation and management/ treatment of flows and pollutant loads from the development. MUSIC modelling was undertaken for the following scenarios:

- Developed site without the proposed stormwater management strategy in place
- Developed site with the proposed stormwater management strategy in place.

Appendix C provides a detailed description of the MUSIC modelling methodology applied.

6.4 Proposed Strategy

The proposed treatment strategy consists of education and bioretention basins to manage stormwater quality for the site. It is proposed that bioretention basins will be integrated into open space areas immediately downstream of areas proposed for development.

Bioretention basins have been adopted as the proposed stormwater management measure (SMM) for the following reasons:

- These SMMs generally provide the greatest treatment per unit area compared to other best practice treatment measures.
- Bioretention basins are expected to be the most cost-effective solution (i.e. lowest cost per unit of stormwater pollutant removed relative to other typical SMMs).
- Bioretention basins can be readily integrated with other uses in parks and drainage corridors.

This proposed strategy is schematically illustrated in Figure 6-1. Details of the stormwater management measures proposed for use on the site are presented in Section C.4.

Table 6-3 provides a summary of the proposed stormwater management strategies for the site.

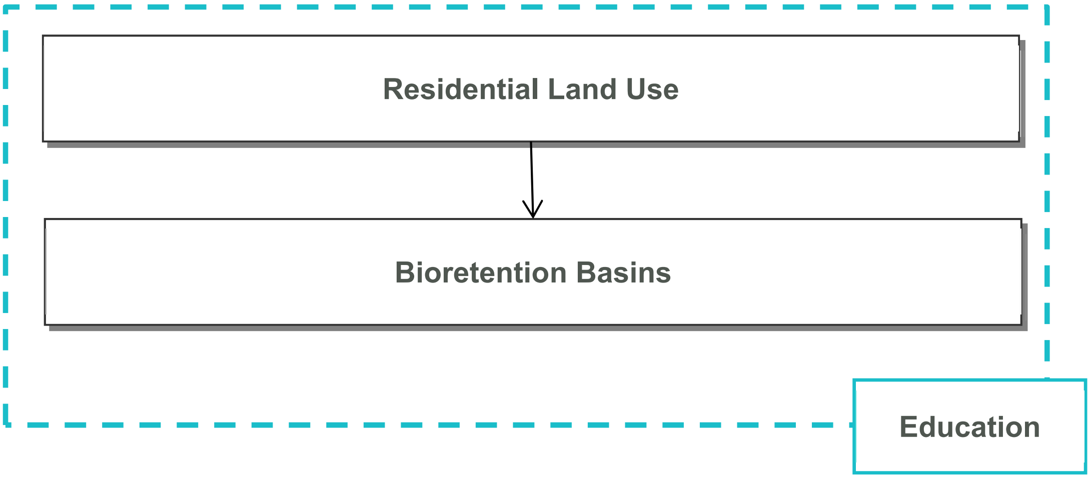


Figure 6-1 Stormwater Treatment Train

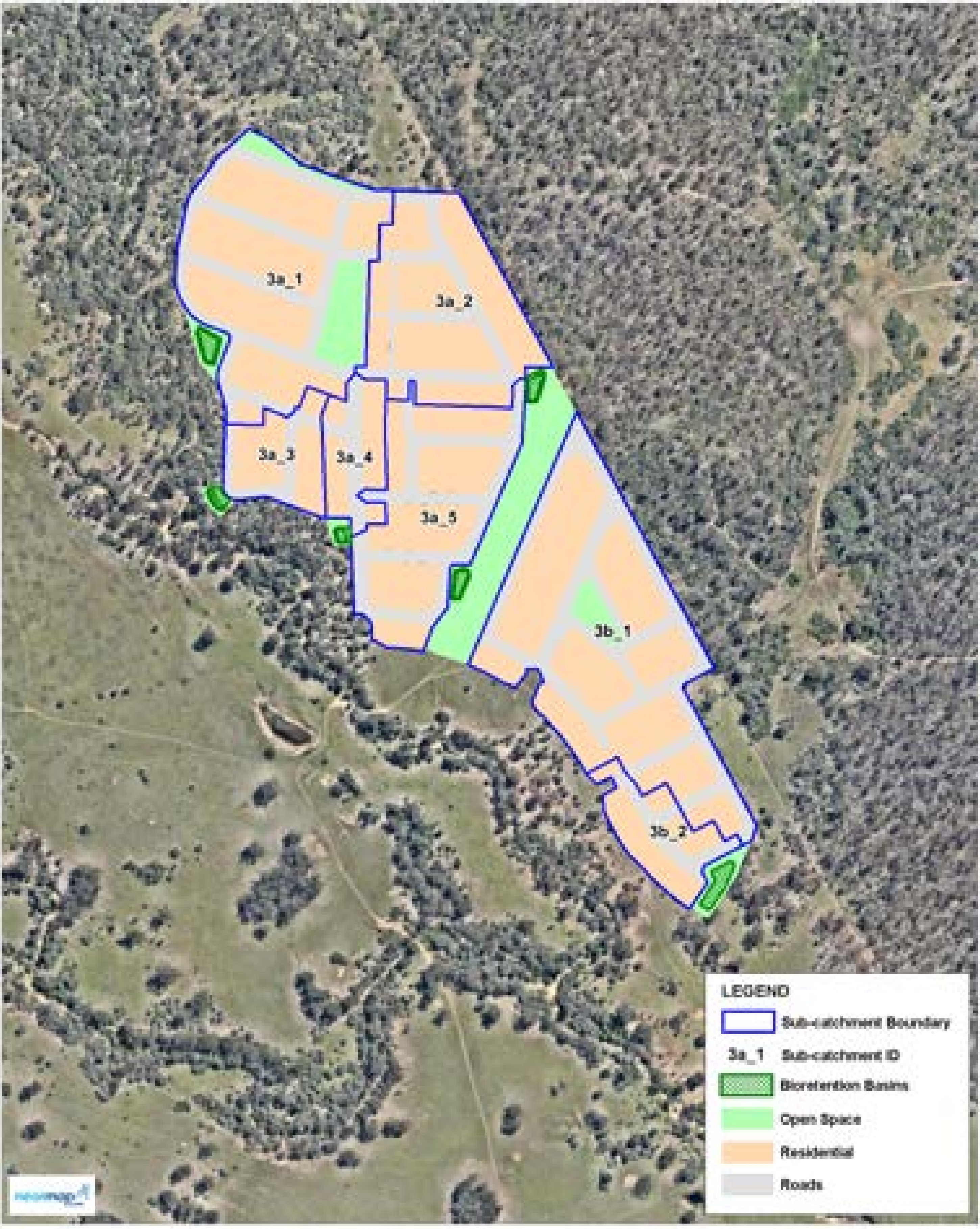
Table 6-3 Summary of Proposed Stormwater Treatment Strategy

Component	Description
Education	Signage installed at appropriate locations (e.g. near bioretention basins). No pollutant removal capacity has been assumed in modelling or assessment.
Bioretention Basins	Bioretention basins located in open spaces and near road reserves. Each sub-catchment (identified in Figure 6-2) below has been analysed and modelled in MUSIC with flow treated through bioretention systems. Each system has been assumed to have the following properties: • storage depth of 0.3 m • filter depth of 0.5 m • sandy loam filter media (saturated hydraulic conductivity 300 mm/hr, total nitrogen content 400 mg/kg, orthophosphate content 30 mg/kg) – As identified by Healthy Land and Water (2018) • vegetated with effective nutrient removal plants • zero exfiltration.

Table 6-4 Required Bioretention Filter Media Area

Sub-catchment	Required Bioretention Filter Media Area (m^2)*
3a_1	595
3a_2	390
3a_3	125
3a_4	115
3a_5	380
3b_1 & 3b_2	845

**It should be noted that the above table includes the filter media area only and the total footprint area can be up to double that of the filter media area (to account for the addition of internal and external batters, maintenance access, etc.)*



Title:

Proposed Sub-catchment Layout with Bioretention Basins

Figure: 6-2

Rev: A

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0 125 250

Approx Scale

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6.5 Model Results

The proposed management plan has been modelled using the MUSIC software, and results have been obtained, as described below.

Table 6-5 Predicted Average Annual Flows & Pollutant Loads (1968 to 1977)

Parameter	Unmitigated Development	Developed Site with Treatment	% Removal	% Removal Target
Flow (ML/year)	152	146	3.7	-
TSS (kg/ year)	26,500	5,020	81	85
TP (kg/ year)	56.4	15.5	72.5	65
TN (kg/ year)	317	166	47.8	45
Gross Pollutants (kg/ year)	4310	0	100	95

The results identified in the above table show that the proposed stormwater management strategy is predicted to achieve the operational pollutant load reduction targets for TP, TN and gross pollutants. Based on the modelled results, the load reduction target for TSS will not be met. It should be noted that the removal target is higher than the usual value of 80% removal for south east Queensland as the site is located within a water resource catchment and water supply buffer area as outlined in Section 6.2.2. The proposed treatment system is predicted to remove 21,480 kg/yr of TSS. To achieve an 85% reduction of TSS an additional 1,045 kg/yr of sediment would need to be removed, however to achieve this additional removal, a 29% increase in the bioretention area would be required.

However, such an increase in area is not considered to be warranted in this case. As part of the development of the full site, a lake will be constructed which will receive runoff from Neighbourhoods 3A and 3B. The residence time afforded by the lake will provide for the settlement of additional sediment, allowing the water quality objective to be satisfied with respect to sediment.

In the interim, sediment basins provided as part of the construction phases and swales within the site downstream of the basins (which will ultimately be removed by the lake) will provide the additional required sediment removal.

6.6 Construction and Establishment

The bioretention basins will need to be constructed and established in accordance with the guideline *Construction and establishment guidelines: swales, bioretention systems and wetlands* (Water by Design 2010a).

The appropriate construction and establishment of the bioretention systems will be critical to maximising their ability to protect waterway and waterbody health and minimise operational issues (and maintenance requirements).

6.7 Maintenance

Maintenance of the bioretention systems should be undertaken in accordance with the guideline *Maintaining vegetated stormwater assets* (Water by Design 2012a).

6.8 Asset Hand-over

It is anticipated that ownership and maintenance requirements of the proposed bioretention basins within the site will be 'handed over' to Logan City Council. Handover of the bioretention systems should be undertaken in accordance with the guideline *Transferring ownership of vegetated stormwater assets* (Water by Design 2012b).

7 Conclusion

A detailed flood impact assessment has been undertaken with respect to Neighbourhood 3A and 3B within Precinct 1 of the proposed Flinders Master Planned Community. The investigation has been limited to the development of 3A and 3B and the portion of Lakeside Drive associated with this section of Precinct 1.

The flood impact assessment has determined that the detention afforded by the construction of Lakeside Drive and its associated culverts, will be sufficient to ameliorate the impact of development on runoff external to the Precinct 1 boundary.

The conceptual Stormwater Quality Management Strategy presented in this plan broadly outlines the planning, management and maintenance issues for the selected stormwater treatment measures.

An assessment of the strategy demonstrated that adequate treatment of stormwater at this site is readily achievable. Sufficient consideration of stormwater controls has been made at this conceptual design stage of the development to demonstrate compliance with the *Seqwater Development Guidelines* (Seqwater 2017). (Refer to Table 6-2).

Modelling results indicate that the option proposed results in a significant decrease in stormwater pollutant loads, with removal targets being achieved for total suspended solids, total phosphorus, total nitrogen and gross pollutants.

8 References

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DSDMIP – see Department of State Development, Manufacturing, Infrastructure and Planning.

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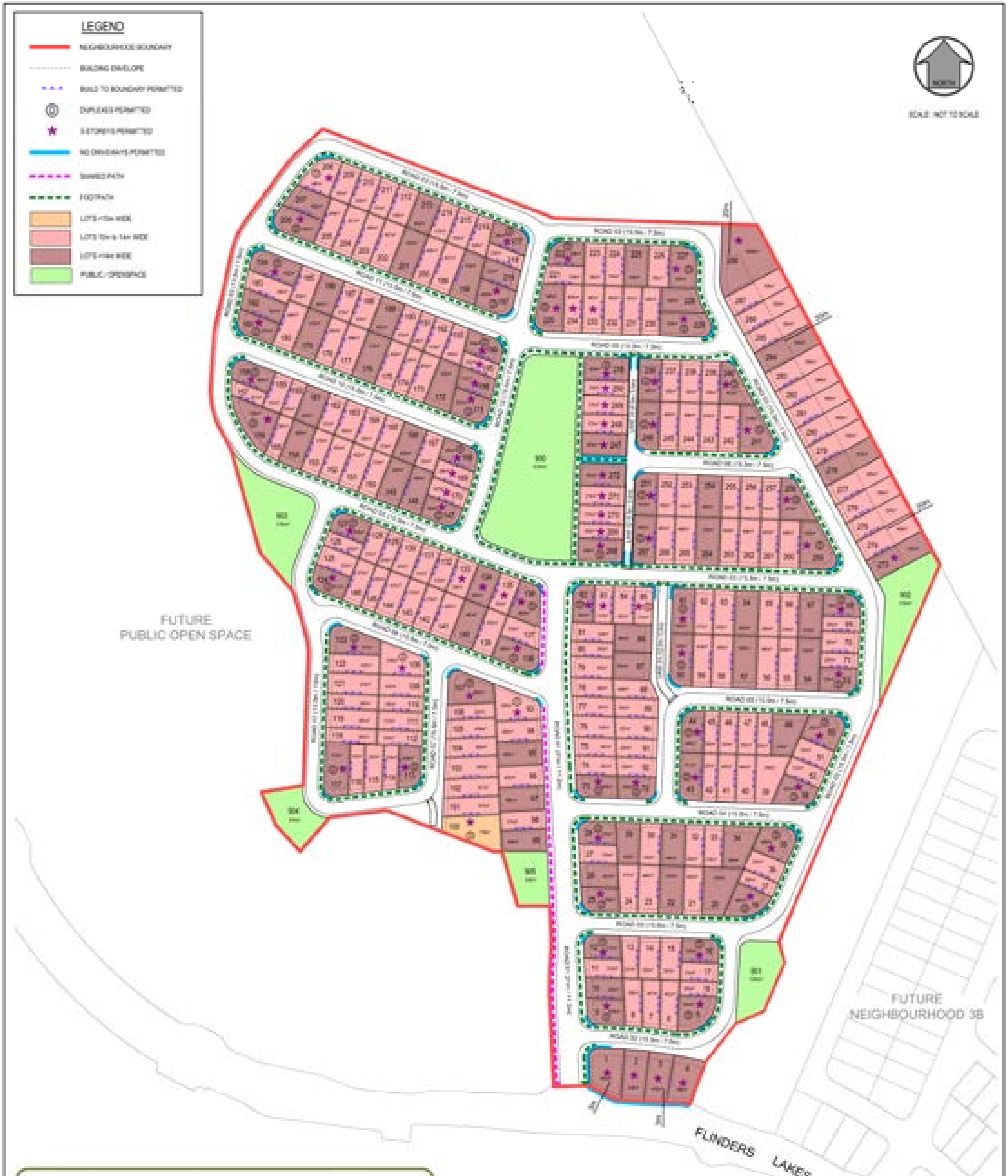
Water by Design 2012b, *Transferring ownership of vegetated stormwater assets*, Healthy Waterways, Brisbane.

Appendix A Site Development Plans



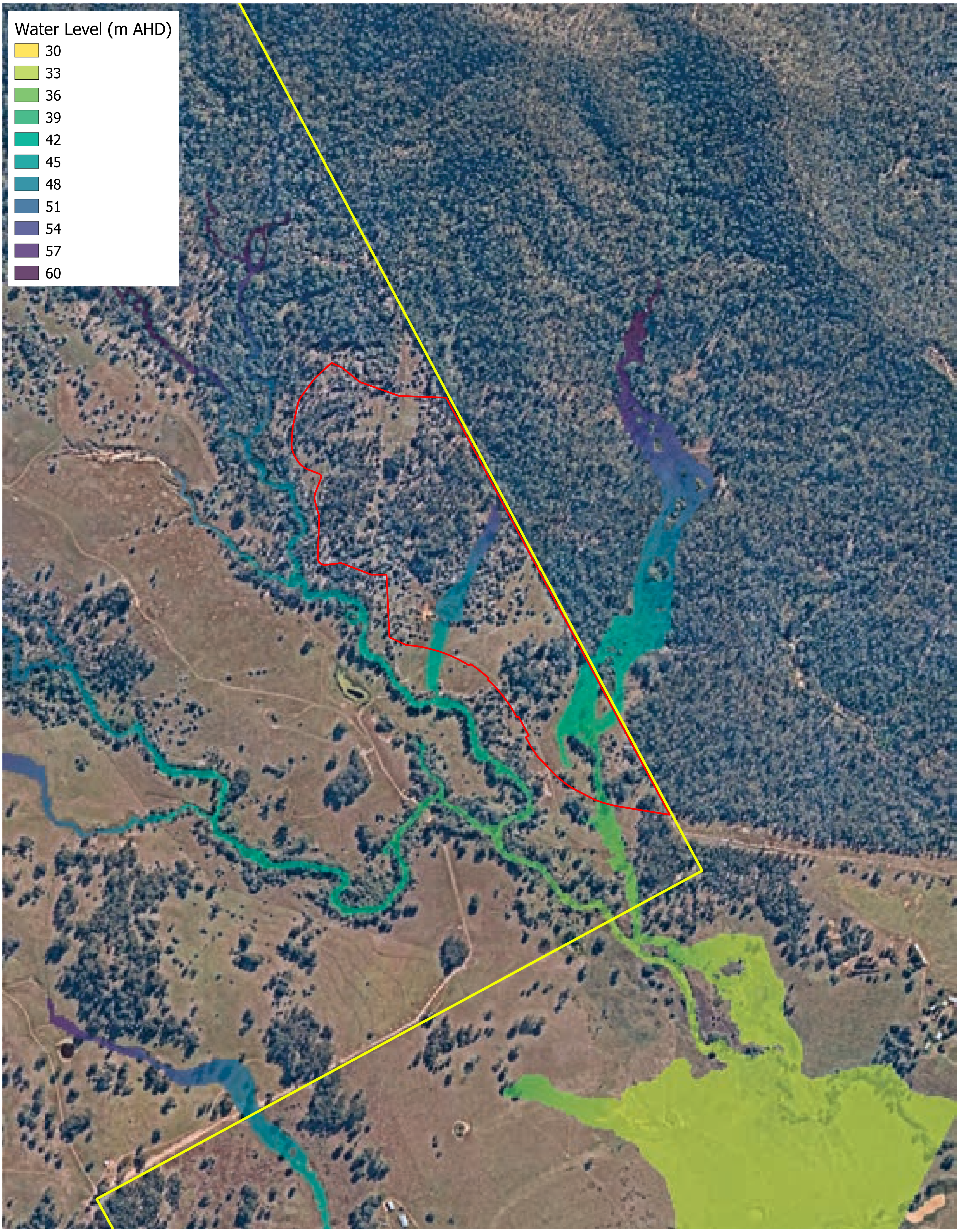
This Plan of Development shall be read in conjunction with the endorsed
FLINDERS PRECINCT ONE | LAND USE & DEVELOPMENT CODE
Particularly, dwellings shall be designed in accordance with Section 2.0 – Parts C, D and E

PROJECT NAME	CLIENT	ASSOCIATED CONSULTANTS		DRAWING TITLE
FLINDERS LAKES NEIGHBOURHOOD 3A	PACIFIQ RP DESCRIPTION LOT 24 ON SP142997 AND LOT 1 ON RP49298	HDG, robertsday, BMT WBM, Cardno	MORTONS urbansolutions Urban & Regional Planning Civil Engineering Project Coordination	PLAN OF DEVELOPMENT 23301-NH3A-POD001 B

This Plan of Development shall be read in conjunction with the endorsed
FLINDERS PRECINCT ONE | LAND USE & DEVELOPMENT CODE
Particularly, dwellings shall be designed in accordance with Section 2.0 – Parts C, D and E

PROJECT NAME	CLIENT	ASSOCIATED CONSULTANTS		DRAWING TITLE
FLINDERS LAKES NEIGHBOURHOOD 3B	PACIFIQ RP DESCRIPTION LOT 24 ON SP142997 AND LOT 1 ON RP49296	HDG robertsday BMT WBM Cardno	MORTONS urbansolutions Urban & Regional Planning Civil Engineering Project Coordination	PLAN OF DEVELOPMENT 23301-NH3B-POD001

Appendix B Hydraulic Model Results



Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

1 Year ARI Peak Water Level

Drawing: **B-1**

Rev: **A**

0 200 400 m

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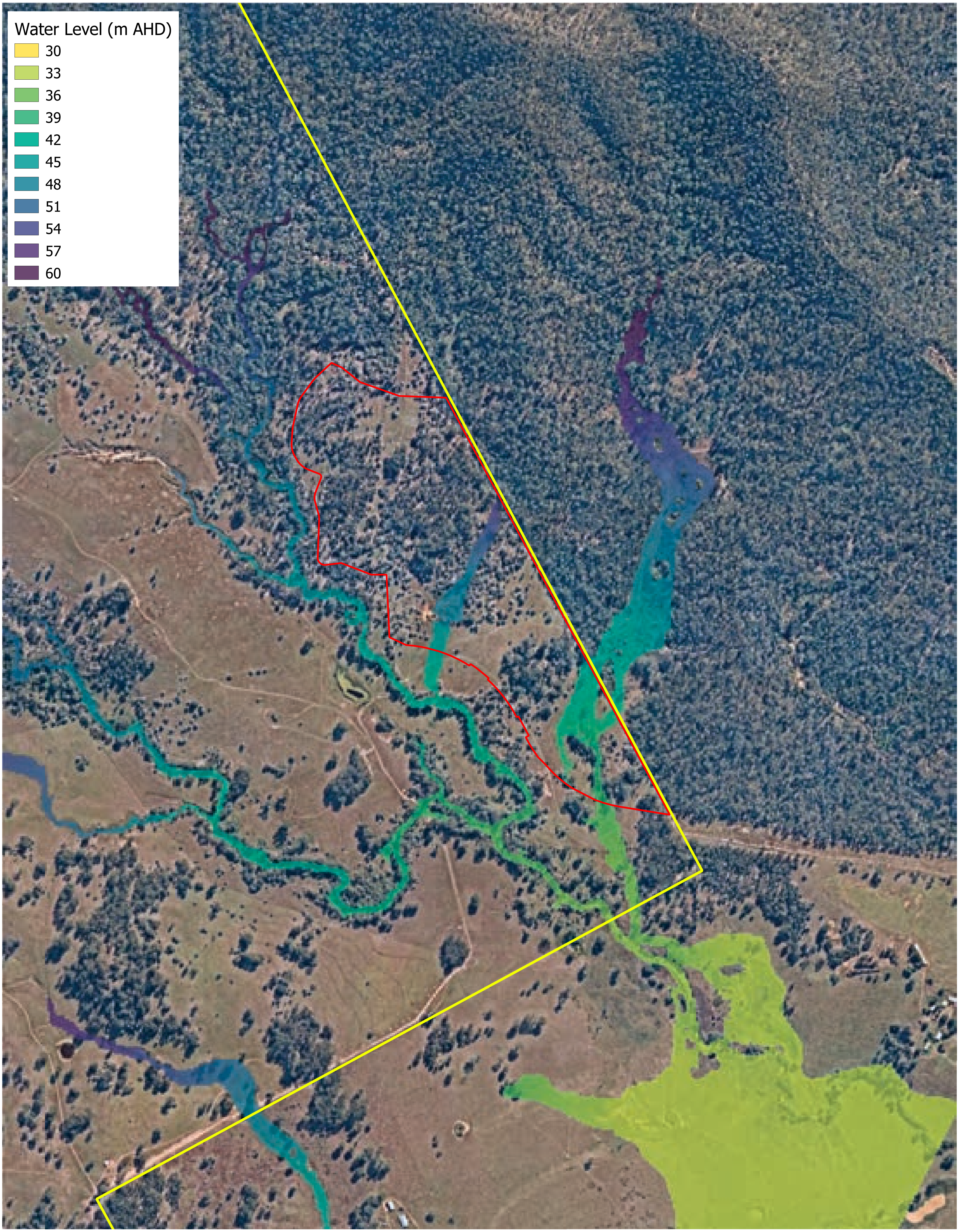

Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

2 Year ARI Peak Water Level

Drawing: **B-2**

Rev: **A**

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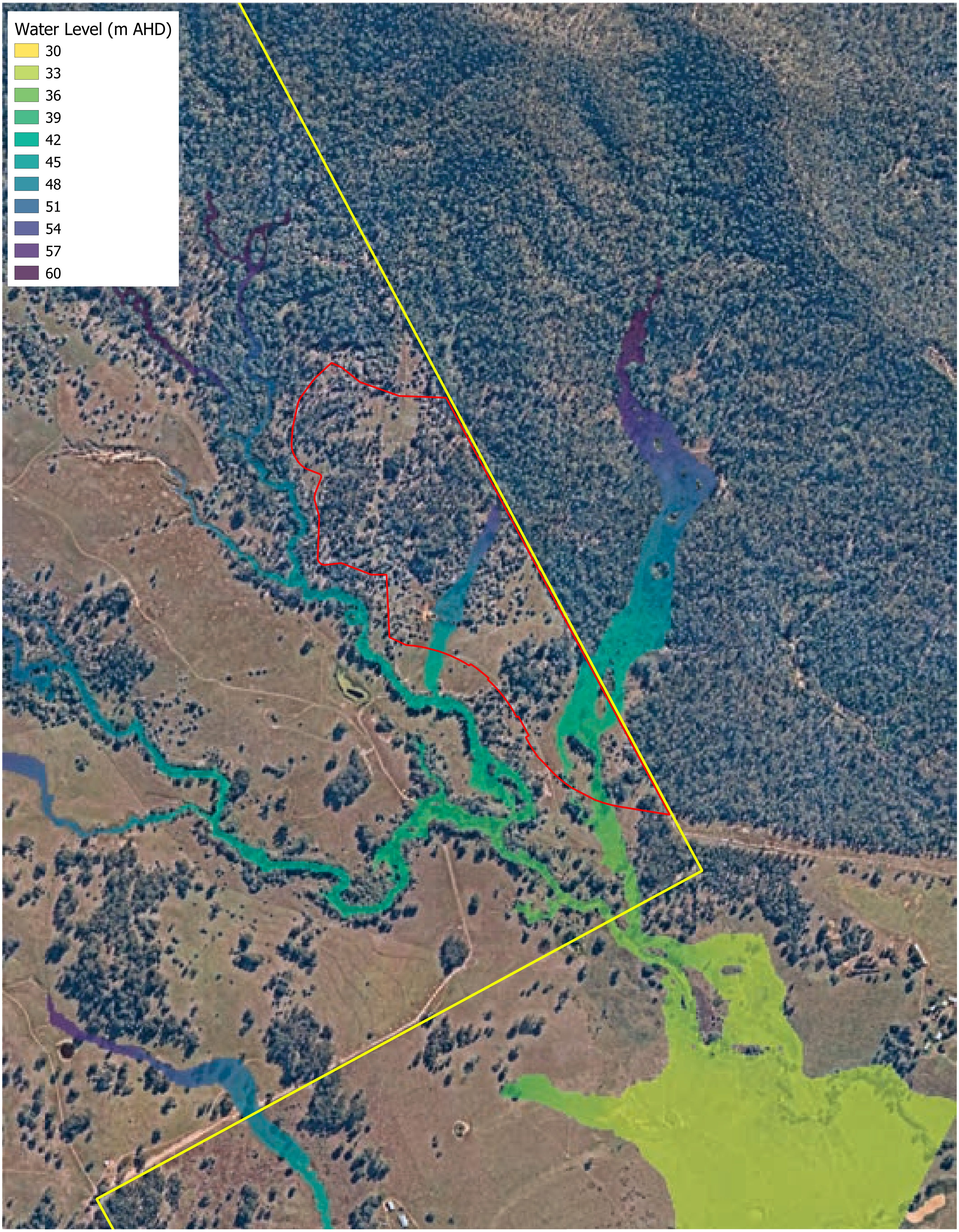

Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

5 Year ARI Peak Water Level

Drawing: B-3

Rev: A

0 200 400 m

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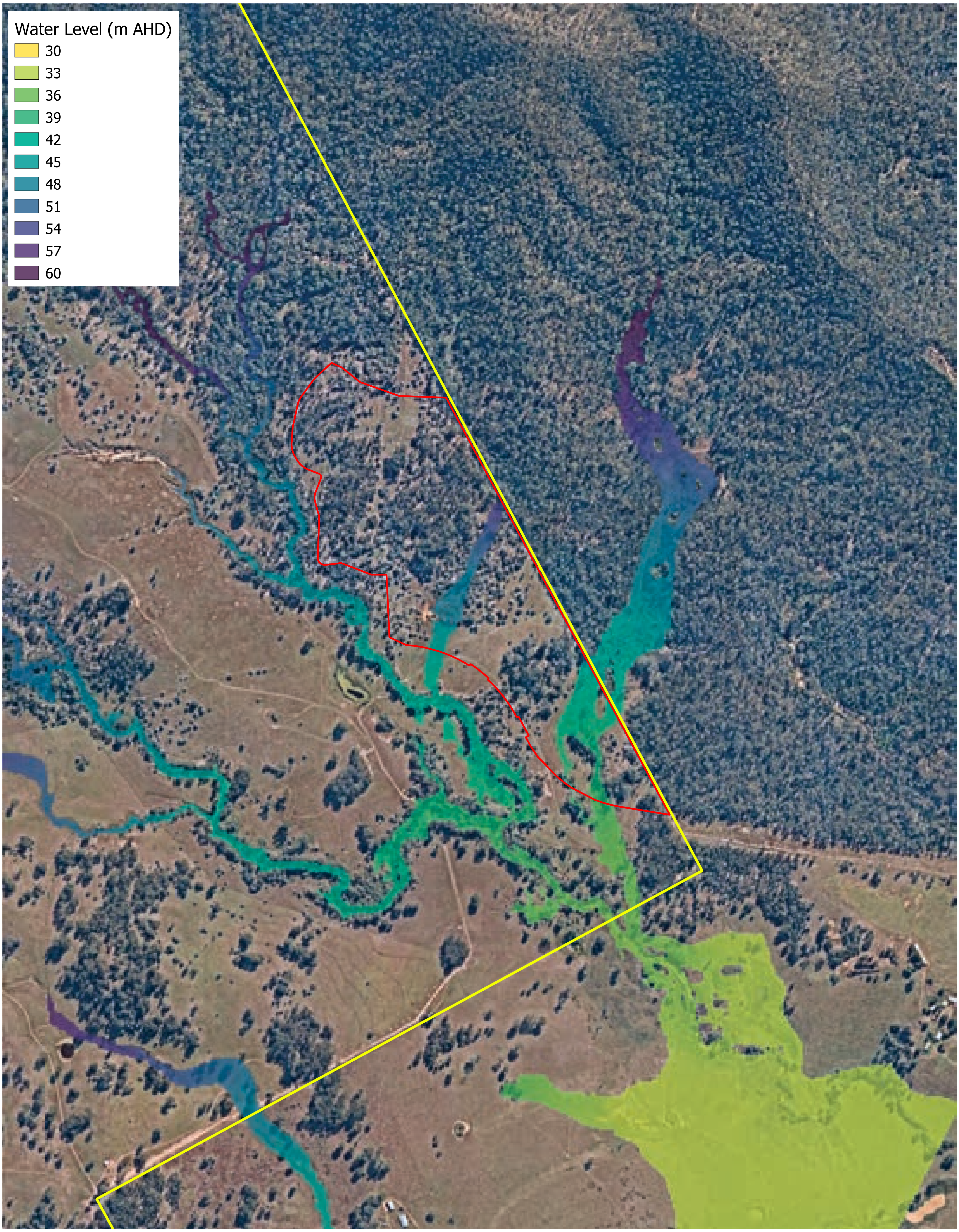

Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

10 Year ARI Peak Water Level

Drawing:

B-4

Rev:

A

0 200 400 m

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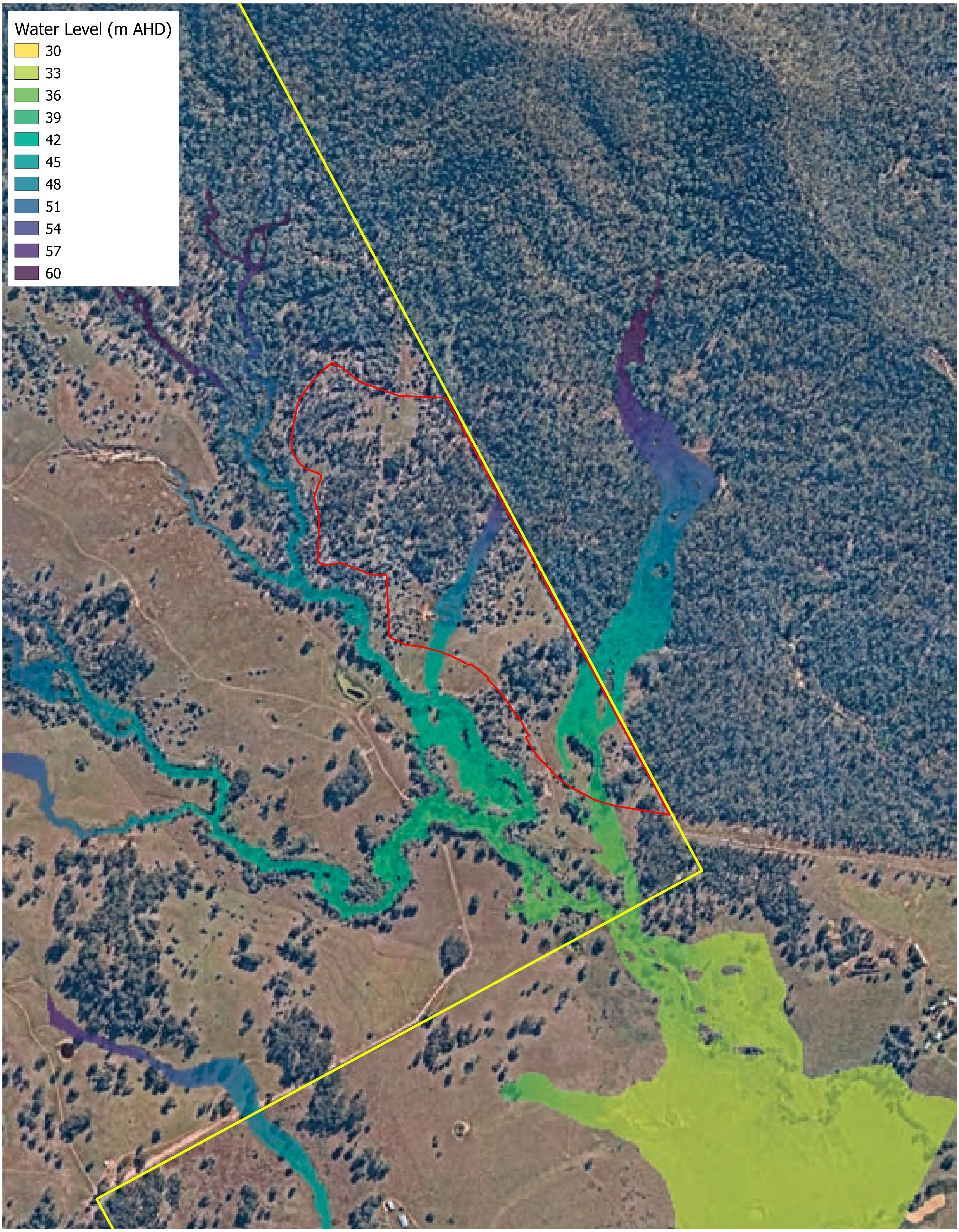

Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title: **20 Year ARI Peak Water Level**

Drawing: **B-5**

Rev: **A**

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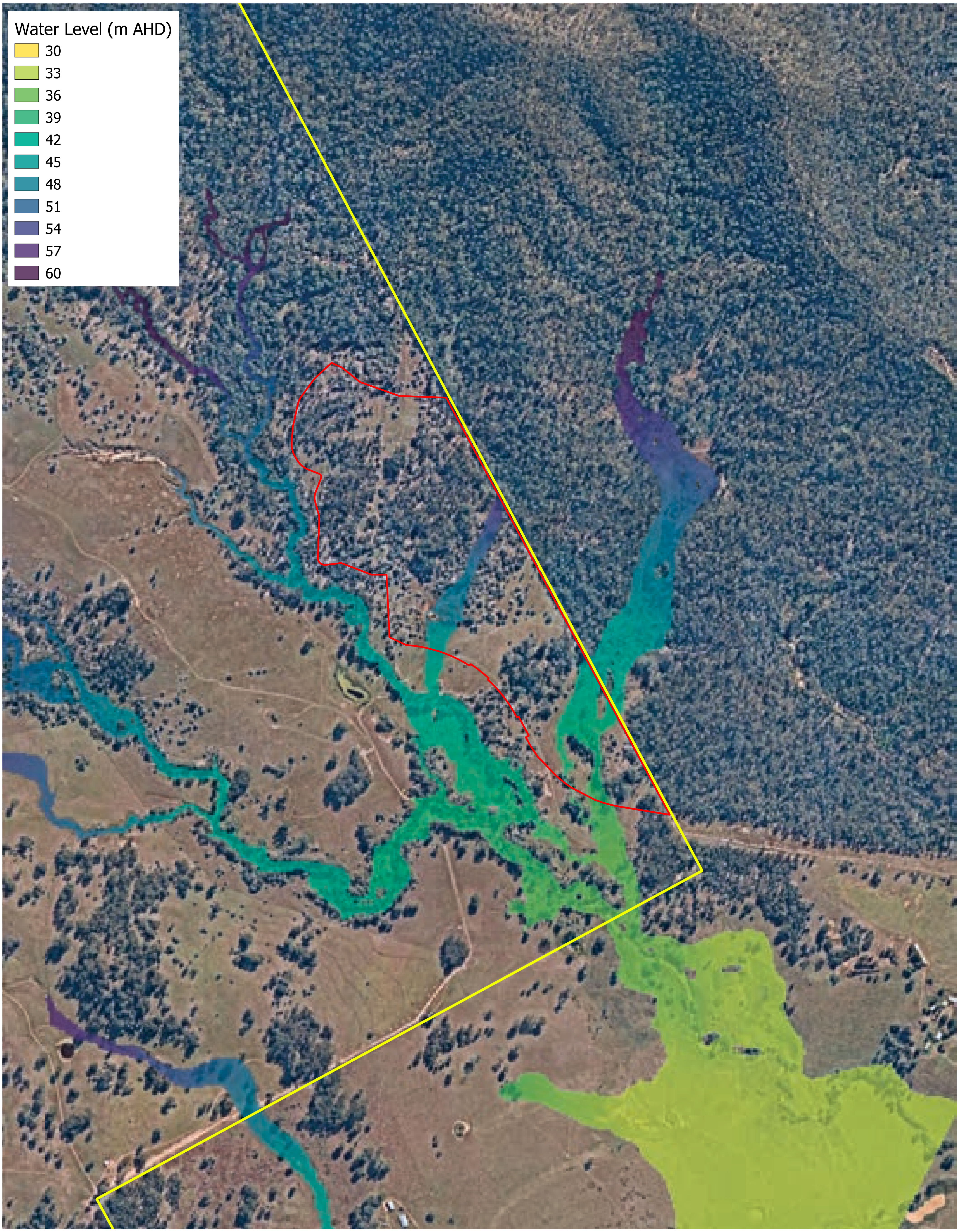

Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

50 Year ARI Peak Water Level

Drawing: **B-6**

Rev: **A**

0 200 400 m

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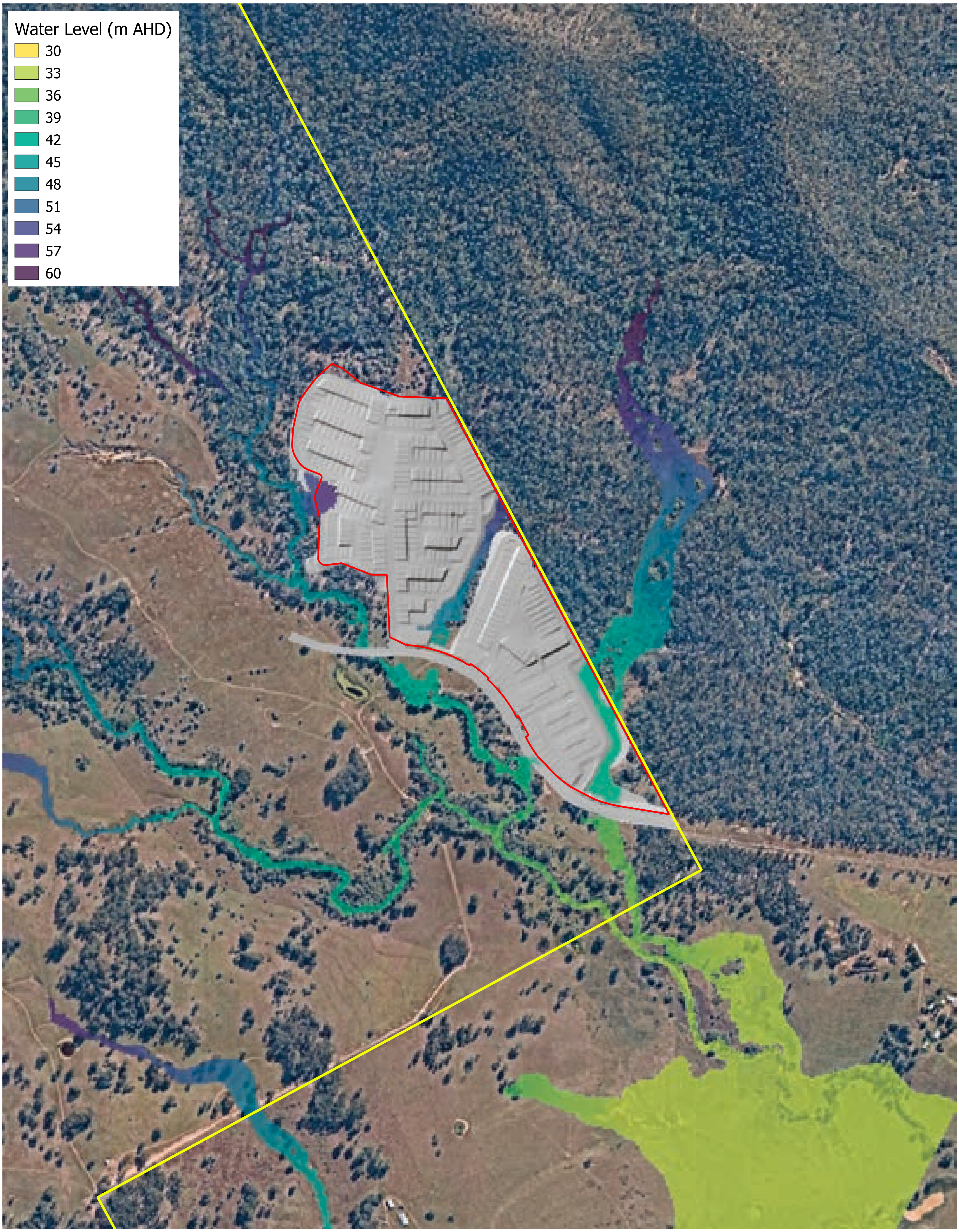

Legend

Flinders Precinct 1 Boundary
Neighbourhood 3A and 3B Boundary

Title:

1 Year ARI Peak Water Level

Drawing: B-7

Rev: A

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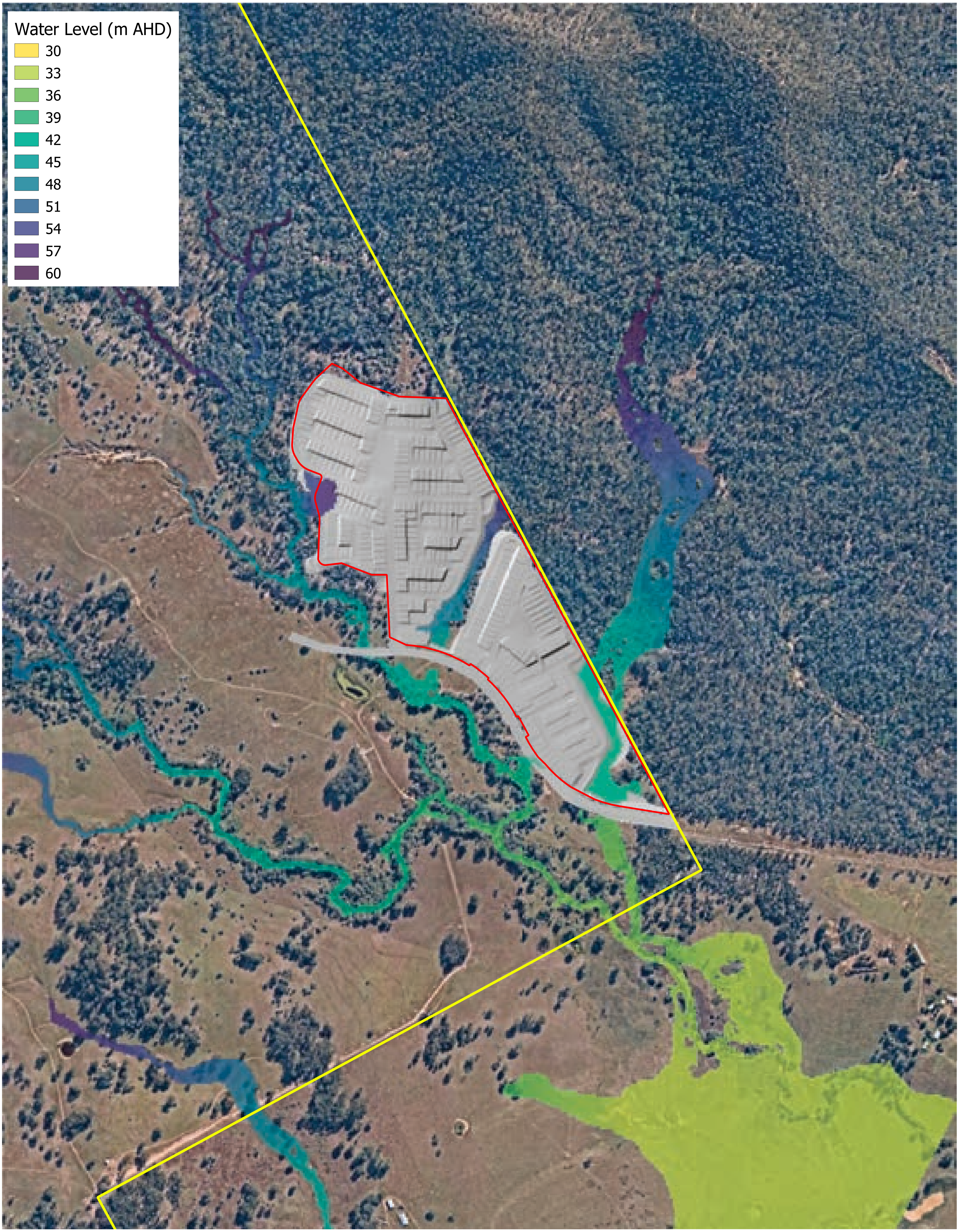

Legend

Flinders Precinct 1 Boundary
Neighbourhood 3A and 3B Boundary

Title:
2 Year ARI Peak Water Level

Drawing: **B-8**

Rev: **A**

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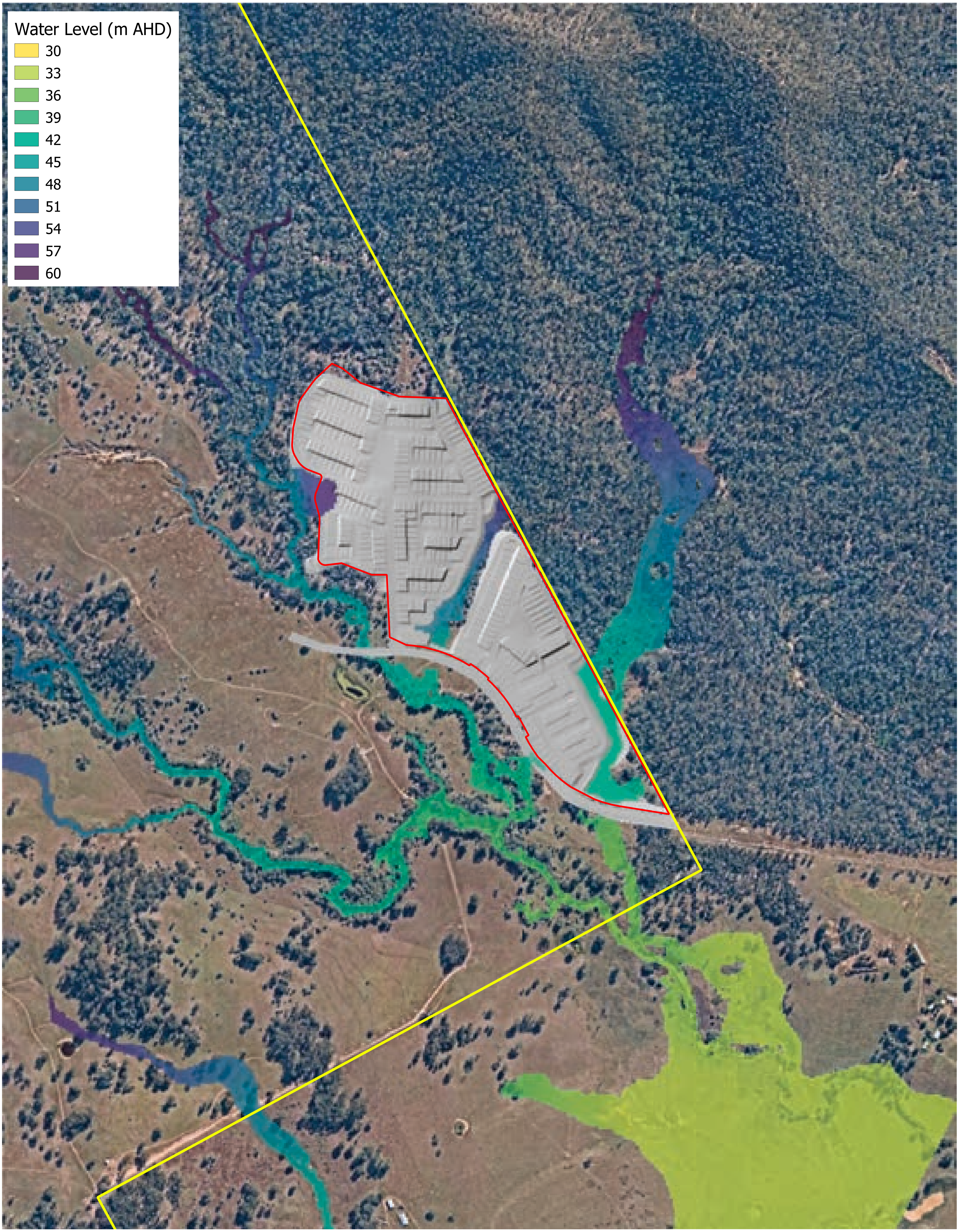

Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

5 Year ARI Peak Water Level

Drawing:

B-9

Rev:

A

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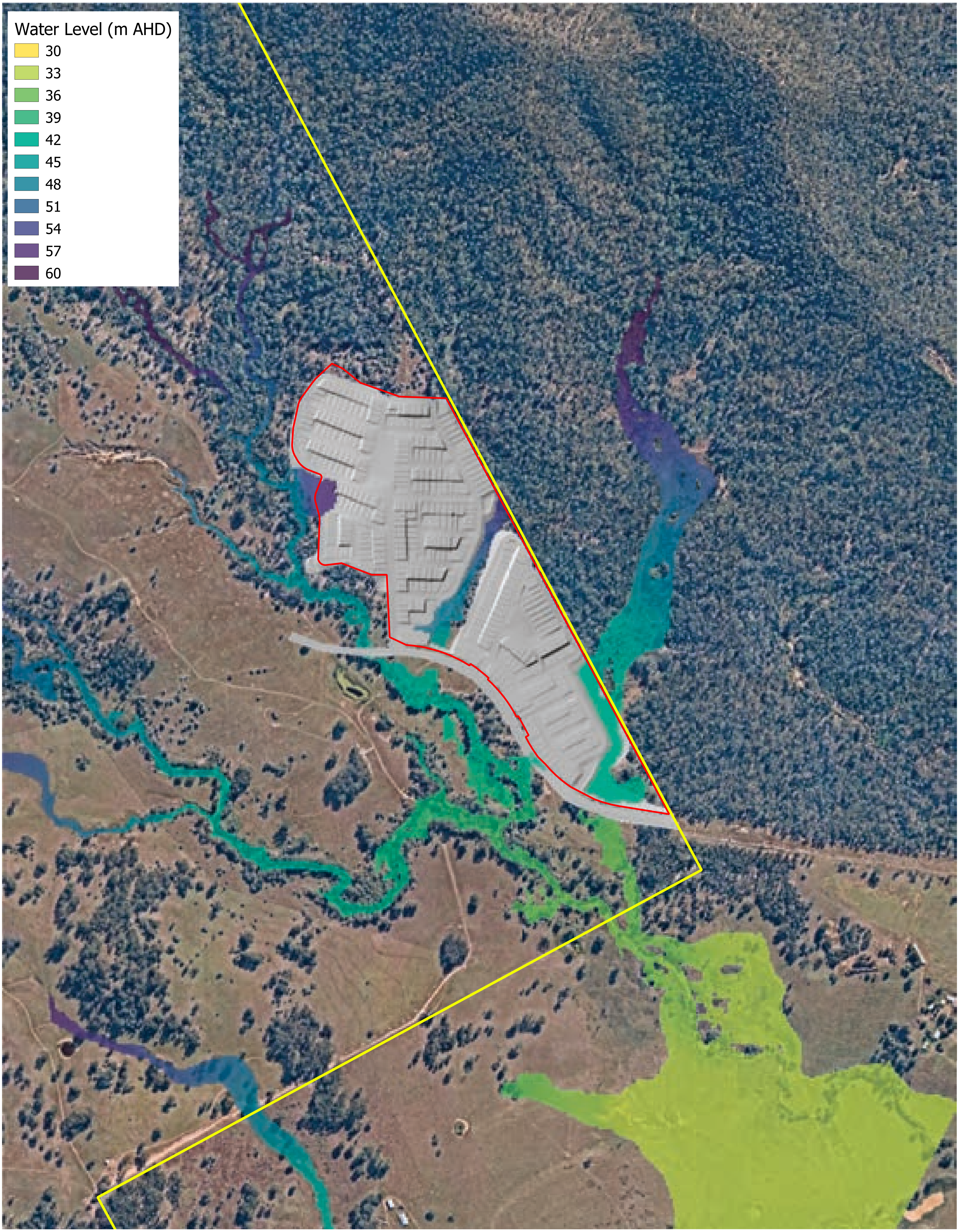

Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

10 Year ARI Peak Water Level

Drawing:

B-10

Rev:

A

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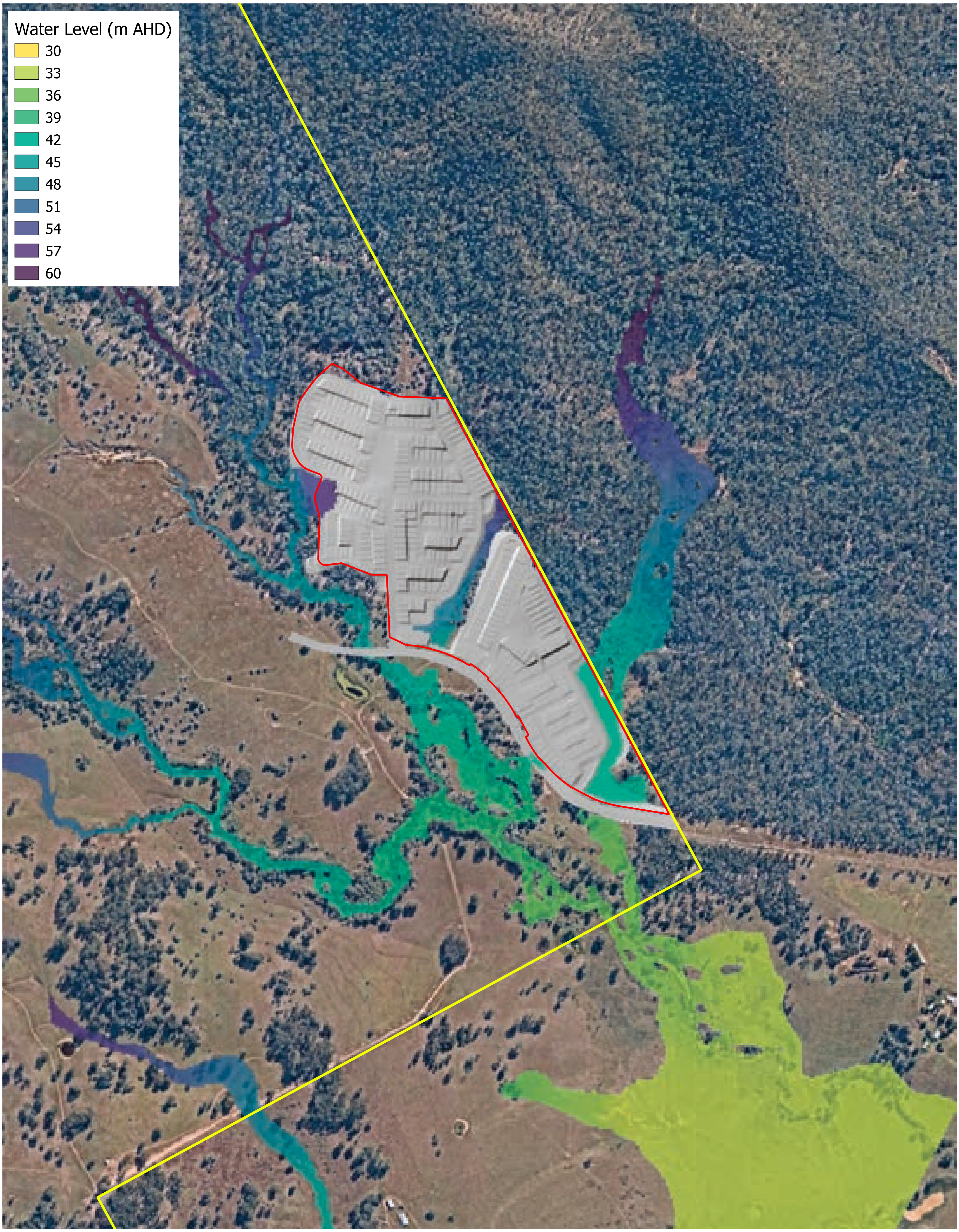

Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

20 Year ARI Peak Water Level

Drawing: B-11

Rev: A

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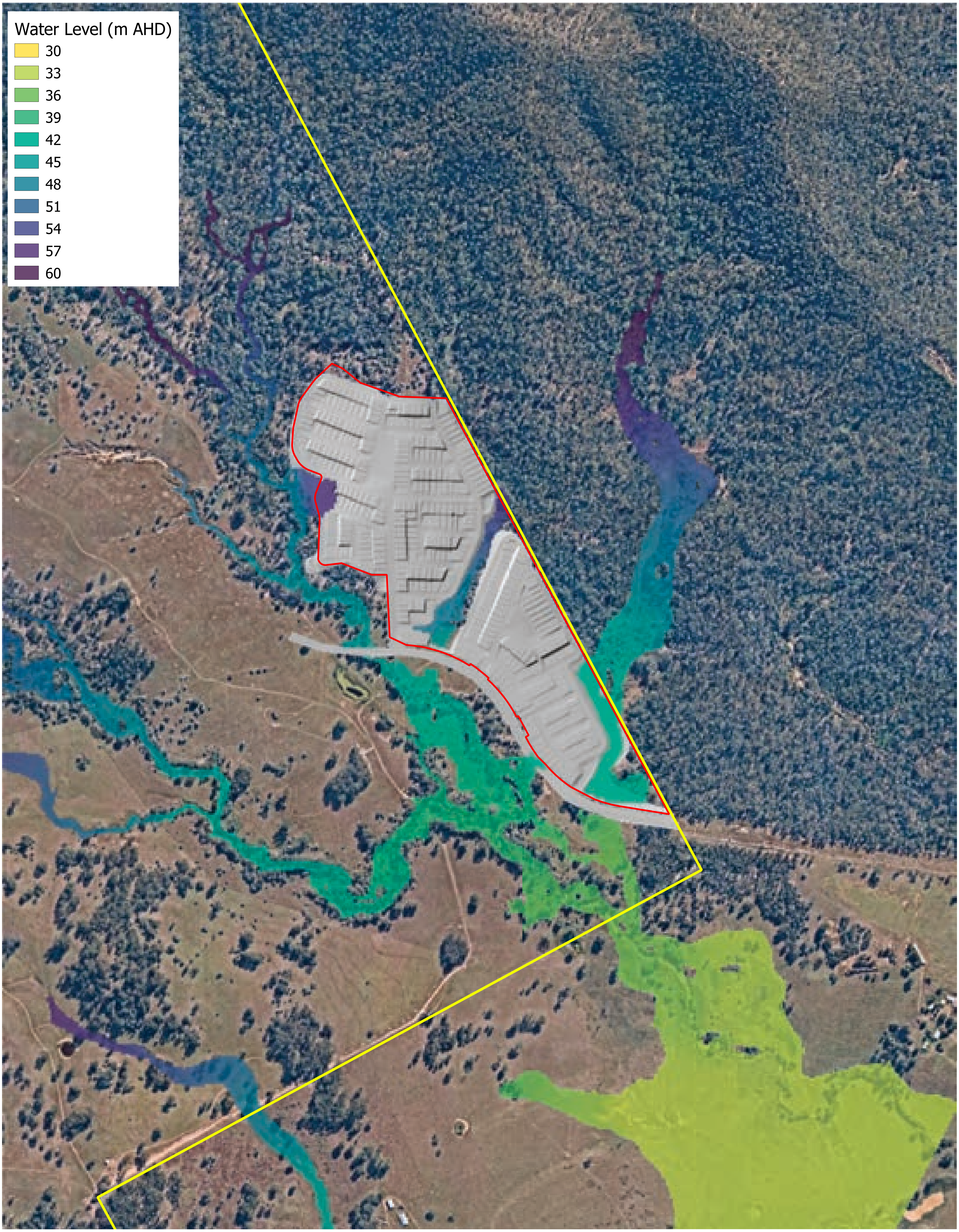

Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

50 Year ARI Peak Water Level

Drawing:

B-12

Rev:

A

0 200 400 m

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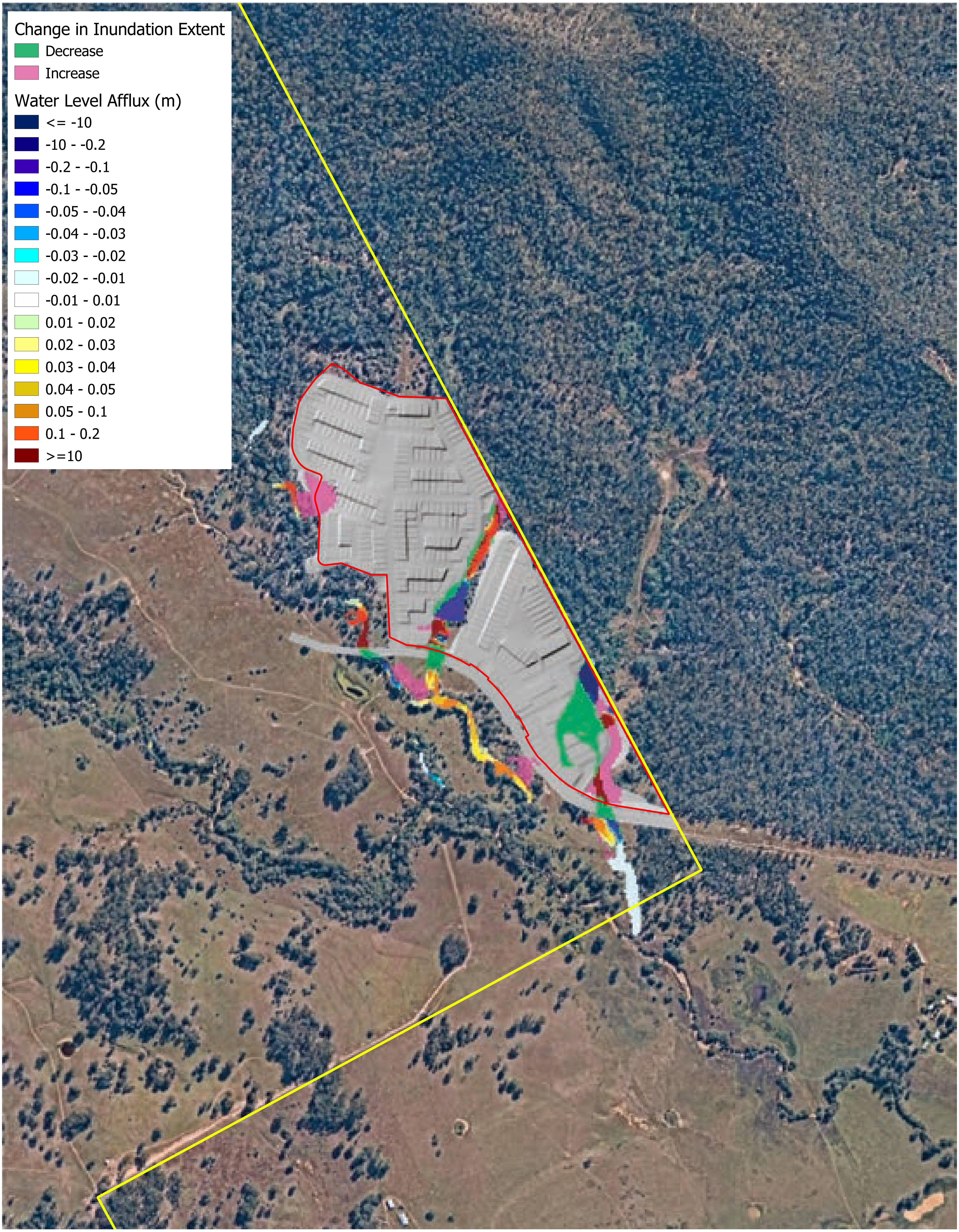

Legend

- Flinders Precinct 1 Boundary
- Neighbourhood 3A and 3B Boundary

Title: **1 Year Peak Water Level Afflux**

Drawing: **B-13**

Rev: **A**

0 200 400 m

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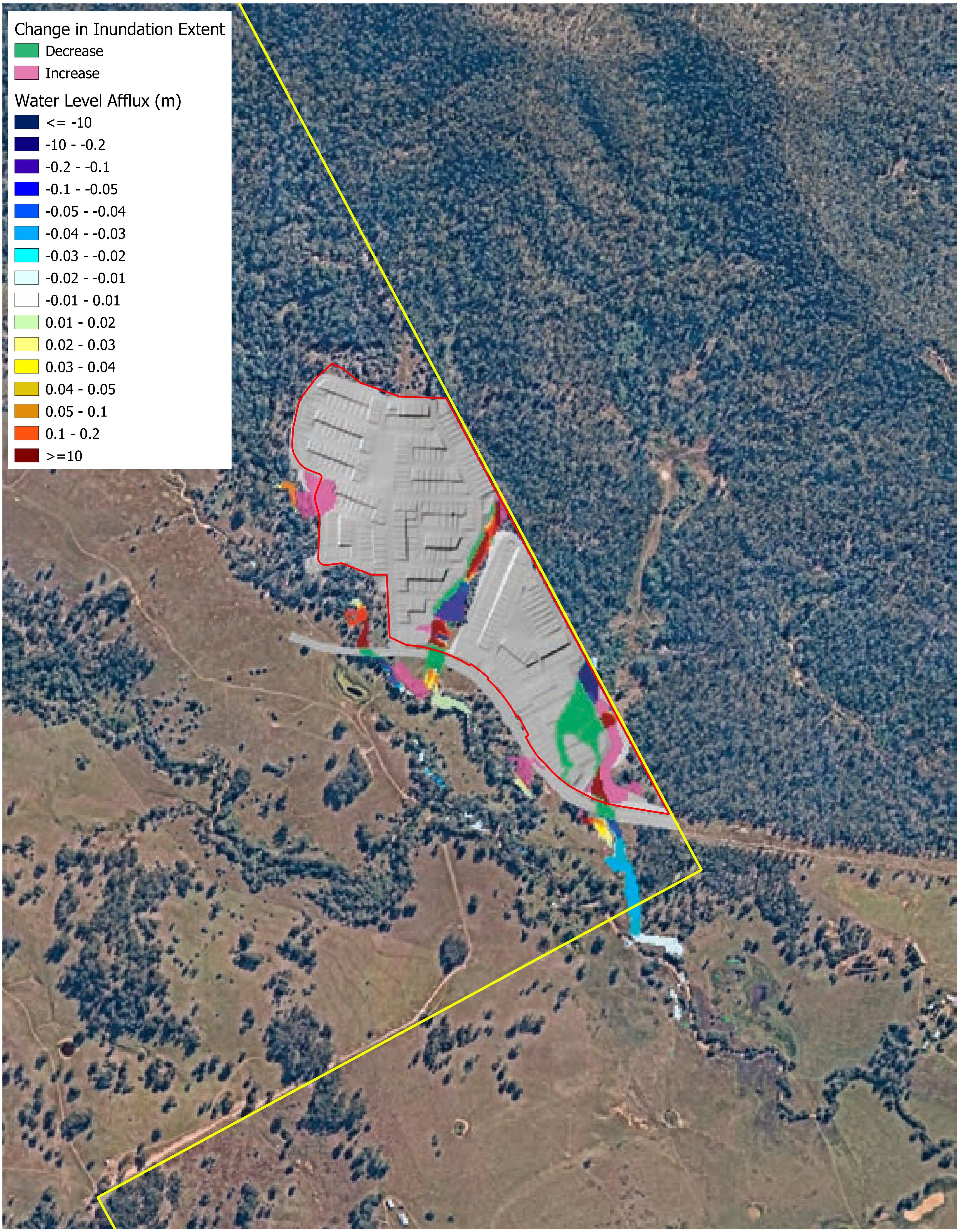

Legend

- Flinders Precinct 1 Boundary
- Neighbourhood 3A and 3B Boundary

Title:	Drawing:	Rev:
2 Year Peak Water Level Afflux	**B-14**	**A**

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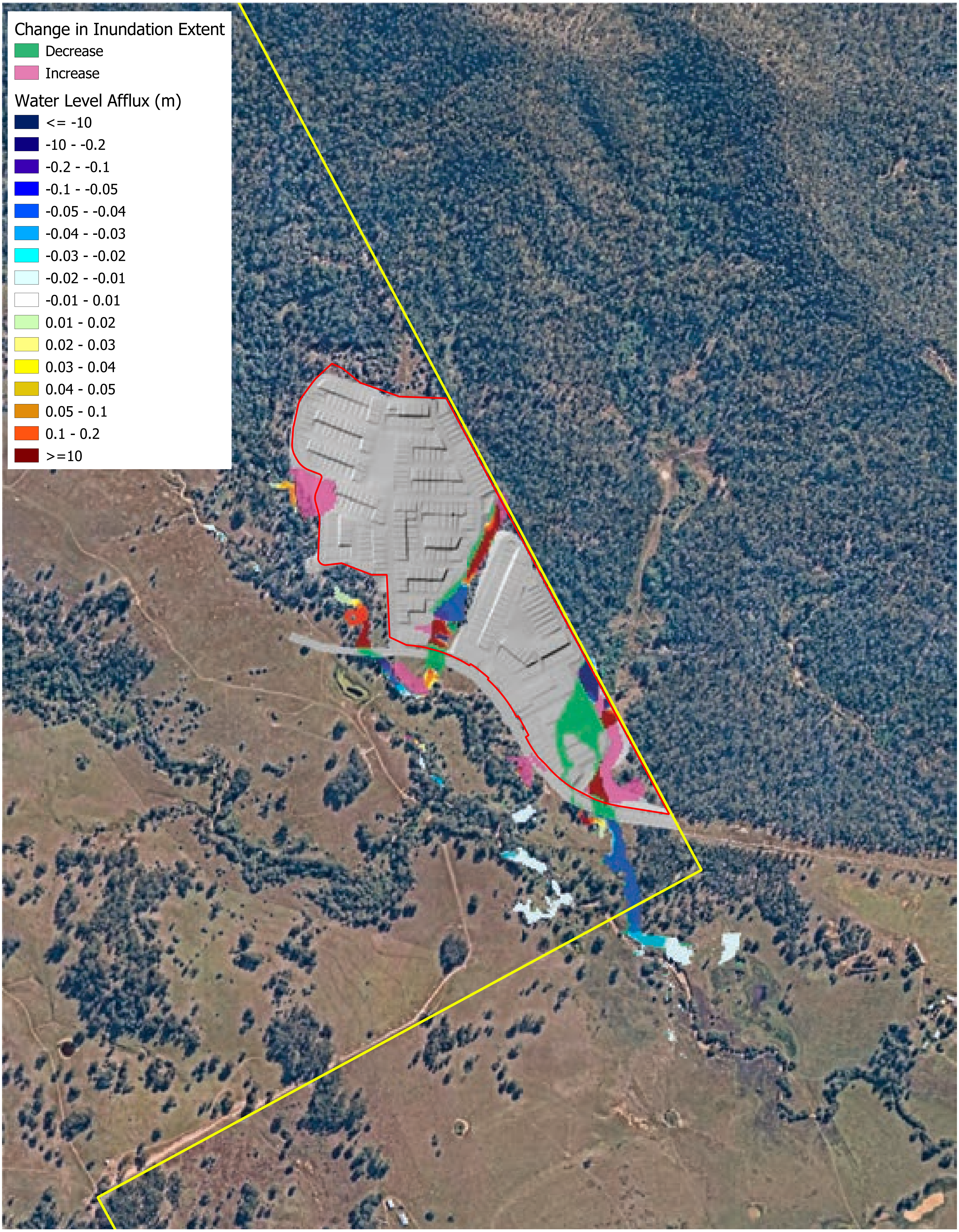

Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title: **5 Year Peak Water Level Afflux**

Drawing: **B-15**

Rev: **A**

0 200 400 m

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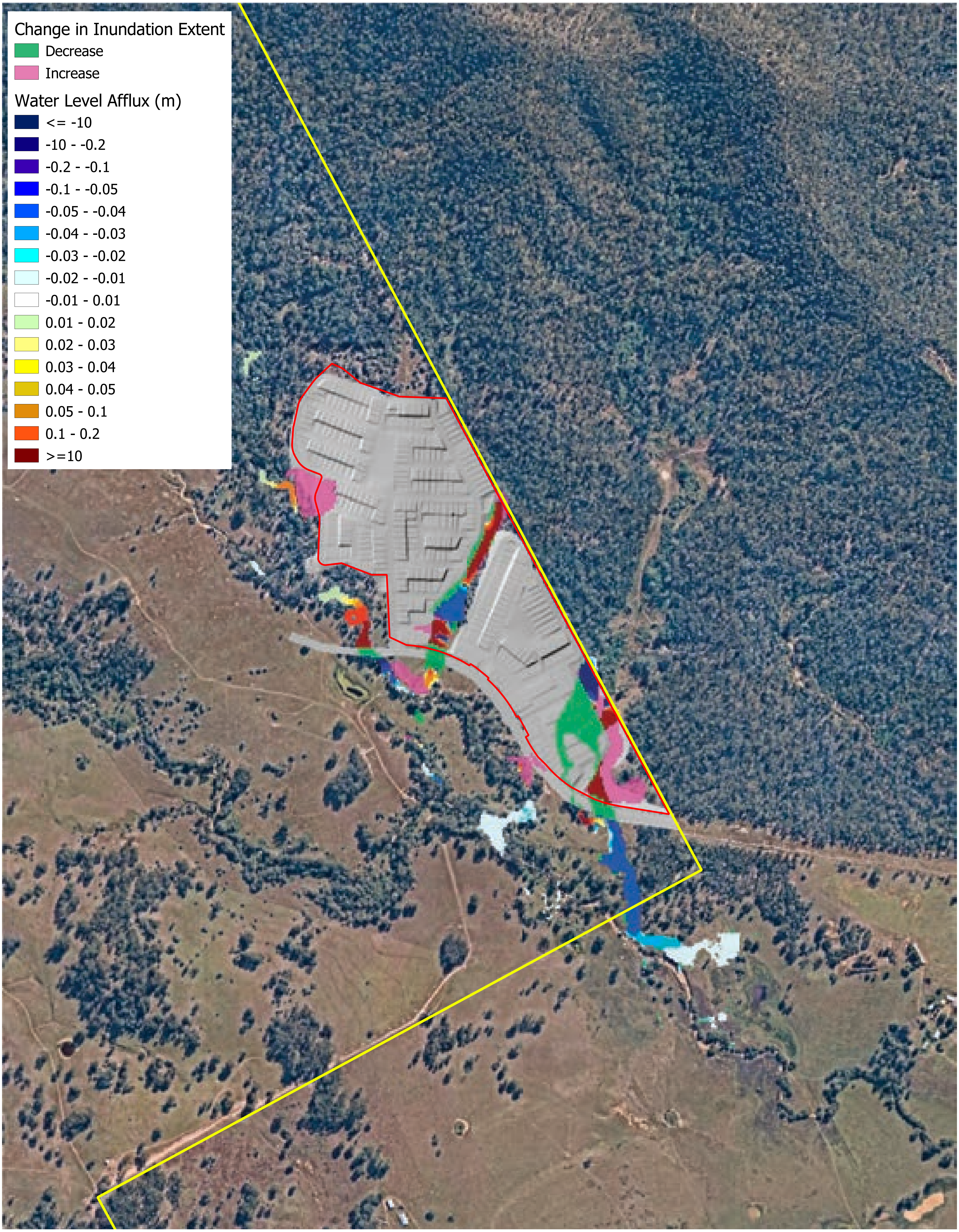

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Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

10 Year Peak Water Level Afflux

Drawing: **B-16**

Rev: **A**

0 200 400 m

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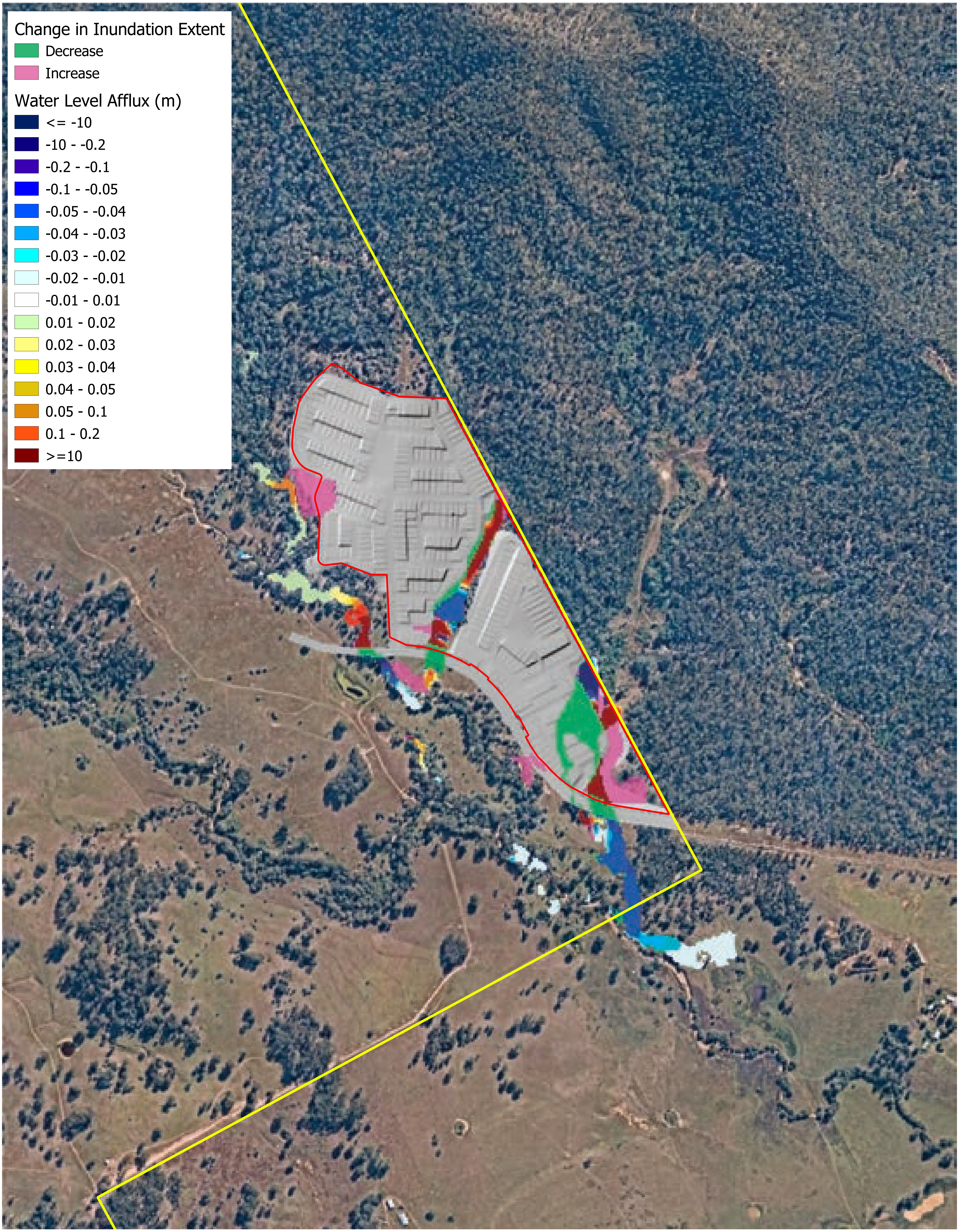

Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title:

20 Year Peak Water Level Afflux

Drawing: **B-17**

Rev: **A**

0 200 400 m

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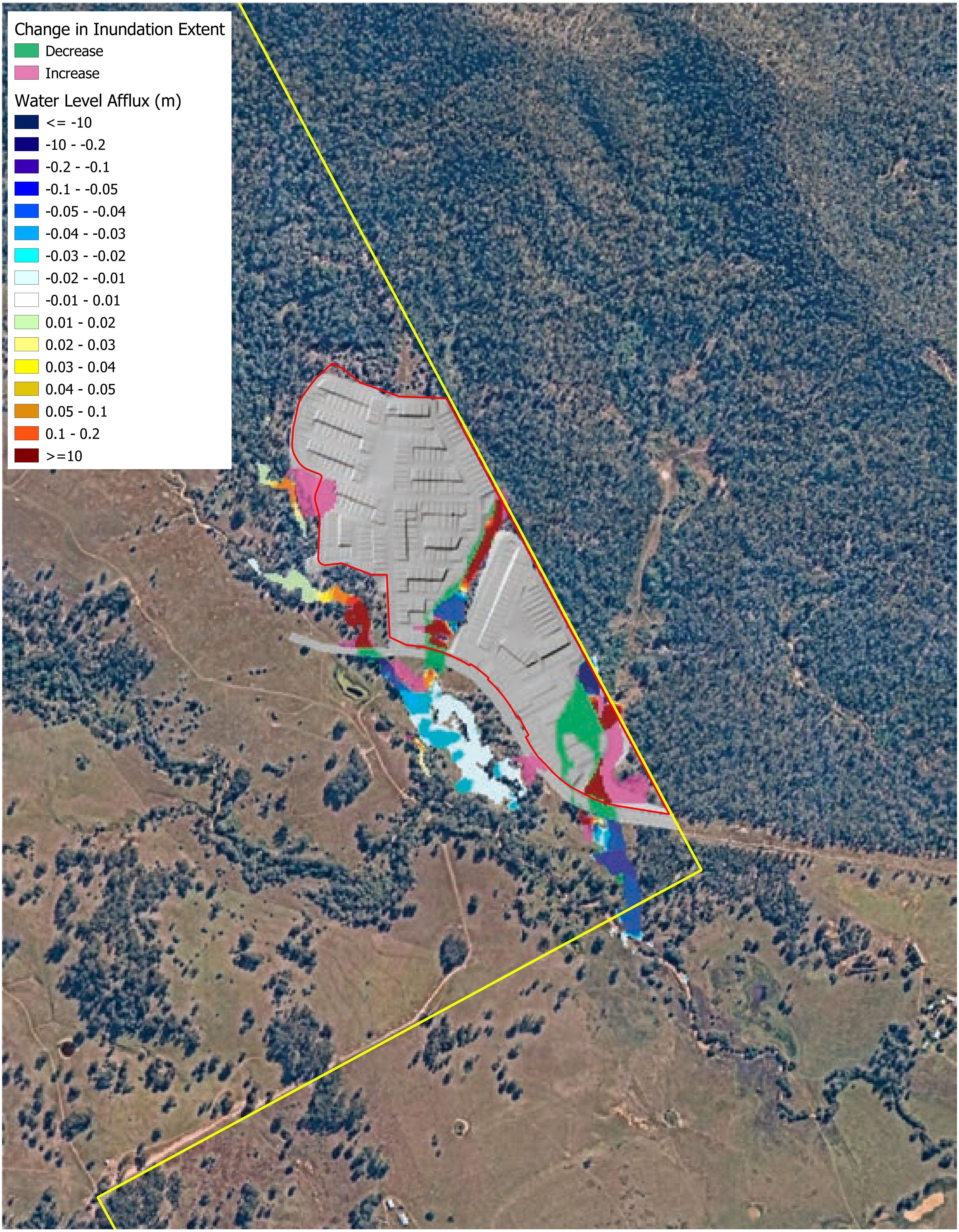

Legend

Flinders Precinct 1 Boundary

Neighbourhood 3A and 3B Boundary

Title: **50 Year Peak Water Level Afflux**

Drawing: **B-18**

Rev: **A**

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Appendix C MUSIC Modelling Methodology

C.1 Preamble

As identified in Section 6.3, MUSIC software has been used to assess the generation and management/ treatment of flows and pollutant loads from various catchments and the performance of existing and potential stormwater treatment devices within the study area.

This appendix provides a detailed description of the modelling methodology applied.

C.2 Software

The performance of possible stormwater treatment strategies in managing stormwater pollutants has been assessed using the MUSIC software package (Version 6.3) developed by the CRC for Catchment Hydrology and now supported by eWater. MUSIC is well suited to model a prediction of annual discharge of TSS, TP, TN and GP loads from several types of catchments. The software has been specifically designed to allow comparisons to be made between different stormwater management systems.

C.3 Source Nodes

The user is required to specify source nodes within MUSIC. The source nodes in this instance represent the pollutant generating areas of the proposed development. Land uses have been adopted in MUSIC to represent, as accurately as possible, how the contributing catchments generate stormwater based on the proposed site plans in Appendix A. The source node properties applied are summarised in Table C-1.

Rainfall-runoff and pollutant export characteristics for the contributing catchment land uses have been derived from the *MUSIC Modelling Guidelines* (Water by Design 2010b).

Table C-1 Summary of Source Node Properties Applied in MUSIC Modelling

Land Use	MUSIC Adapted Land Use	Total Impervious Fraction	Area (ha)	Comments
Ground	Residential (30 dwellings/ha)	30	8.217	Rainfall-runoff parameters and export pollutant characteristics and impervious fraction in accordance with the *MUSIC Modelling Guidelines* (Water by Design, 2010).
Road		65	9.611	
Roof		100	10.044	
Park		20	2.996	

C.3.1 Meteorological Data

In accordance with Water by Design (2010b), meteorological data has been obtained for MUSIC from the Beaudesert Cryna Station (BOM Station no. 40014). Modelling of Neighbourhood 3A and 3B was performed over a period of ten years (from 1 January 1968 to 31 December 1977) at a 6-minute time step interval. Average potential evapo-transpiration data as described by Water by Design (2010b) has been adopted in the MUSIC modelling.

C.4 Proposed Treatment Strategy Elements

As outlined in Section 6.4, a stormwater quality management strategy consisting of education and bioretention basins has been proposed for Neighbourhoods 3A and 3B. The individual elements of this strategy are described in the subsequent sections below. The stormwater treatment nodes specified in MUSIC essentially represent the stormwater treatment train.

C.4.1 Education

Education can increase people's understanding and acceptance of water quality issues and stormwater treatment devices. It is proposed that signage be installed at appropriate locations (e.g. adjacent to proposed bioretention systems). Through advanced awareness, it is possible that pollutant loads may be reduced at source level.

It should be noted that education will need to be ongoing and relate to both pre and post development for all stakeholders.

Examples of educational signage to improve understanding of water quality issues are given in Figure C-1. No reduction in source pollutant loads have been assumed within the MUSIC model.

Figure C-1 Examples of Educational Signage

C.4.2 Bioretention Basins

A bioretention basin is a soil and plant-based stormwater management measure. A typical basin consists of a porous medium such as sandy loam. Vegetation is also established within the bioretention basin to promote evapotranspiration, maintain soil porosity, encourage biological activity, and promote uptake of some pollutants.

A series of bioretention basins are proposed to be incorporated throughout the development. The bioretention basins will receive stormwater flows from the urbanised residential areas from each of the subcatchments identified in Figure 6-2.

For the purposes of this conceptual stormwater management strategy, the approximate filter media area for proposed bioretention basins has been derived as a percentage of the development area. All bioretention basins have been assumed to have a filter depth of 0.5m and an extended detention depth of 0.3m. The filter media for the bioretention system has been modelled as a sandy loam media of effective diameter 0.35 mm and a saturated hydraulic conductivity of approximately 200 mm/hr. The modelling also assumes total nitrogen and orthophosphate concentrations of 400 and 30 mg/kg respectively (as identified by Healthy Land and Water (2018)), and that they will be vegetated with ‘effective nutrient removal plants’.

Figure C-2 provides a conceptual cross section of a bioretention basin, illustrating the modelled properties of the system. Examples of bioretention basins are provided in Figure C-3.

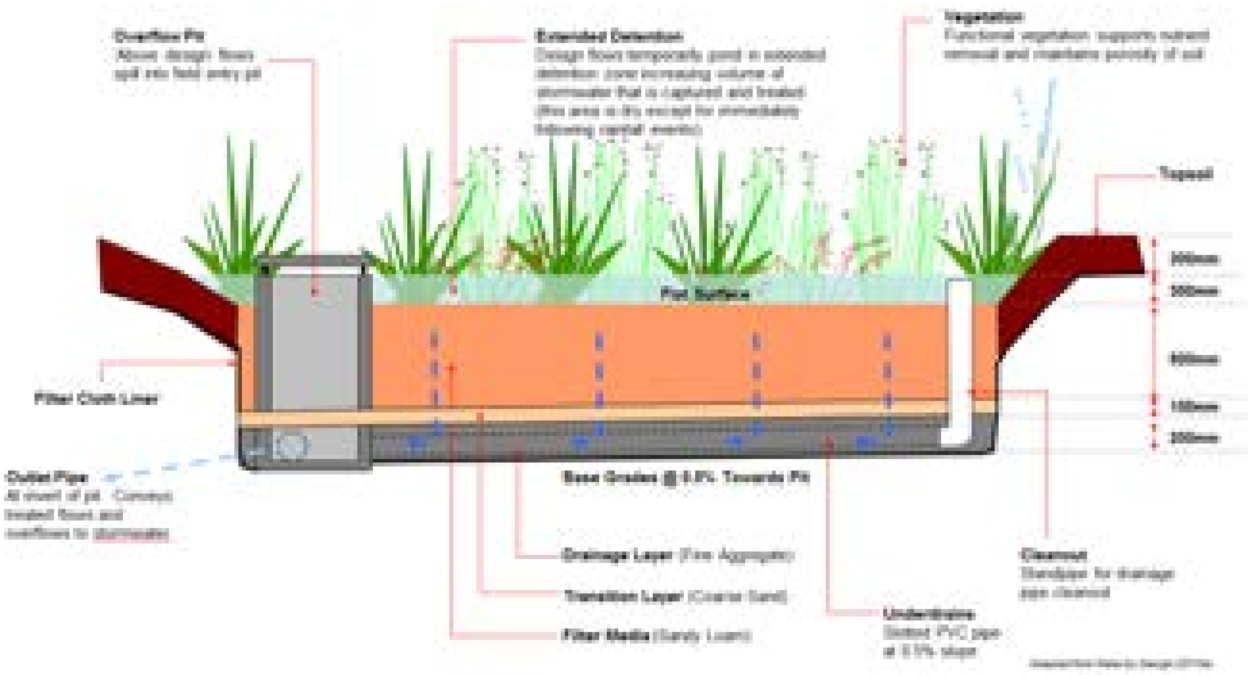

Figure C-2 Conceptual Cross Section of Bioretention Basin Properties

Figure C-3 Bioretention Basin Examples

BMT has a proven record in addressing today's engineering and environmental issues.

Our dedication to developing innovative approaches and solutions enhances our ability to meet our client's most challenging needs.

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