



Flood Modelling Assessment

for

Gables West

for Enspire Solutions Pty Ltd

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Acronyms

ABCB	Australian Building Codes Board
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ALS	Airborne Laser Survey (LiDAR)
ARI	Average Recurrence Interval
B _{des}	Design blockage per The Gables Blockage Strategy
B _{severe}	High blockage per The Gables Blockage Strategy (typically 80% at outlet structures)
BoM	Bureau of Meteorology
CC	Construction Certificate
DA	Development Application
DEM	Digital Elevation Model (A grid of terrain elevations usually obtained from ALS)
DV	Product of Depth and Velocity
EY	Exceedances Per Year
FSL	Full Supply Level
ha	Measure of area (hectares or 10,000 square metres)
LGA	Local Government Authority
LiDAR	Light Detection and Ranging (also see ALS)
m	Measure of length / height / distance (metres)
m AHD	Meters above Australian High Datum
ML	Measure of volume (megalitres or 1,000 cubic metres)
m/s	Measure of velocity (metres per second)
m ³ /s	Measure of flow rate (cubic metres per second)
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PMPDF	Probable Maximum Precipitation Design Flood

		Date
Prepared by	NM	05/12/2022
Checked by	GB	05/12/2022
Admin	GB	05/12/2022

THSC The Hills Shire Council

TUFLOW A 1D and 2D hydraulic modelling software

Introduction and Background

Northrop Consulting Engineers Pty Ltd (Northrop) have been engaged by Enspire Solutions Pty Ltd (Enspire) to prepare a flood modelling assessment for West Gables development.

Gables is a master planned suburb approximately 380 hectares in size and designed to accommodate over 4,100 dwellings, a retail and mixed-use centre, school and public open space areas. At the centre of this development is a constructed lake and detention basin, providing visual amenity, water quality treatment and flood mitigation functions.

A Flood Impact Assessment for the overall Gables precinct development was previously prepared by J. Wyndham Prince (April 2015), that was further refined for the proposed lake and basin site in their report Box Hill North Main Detention Basins and Lake Stormwater Management Strategy and Flood Assessment Report (October 2016).

A joint venture between Stockland and Allam Group aims to rezone and develop land on the perimeter of the original masterplan community. This will cater for additional dwellings and incorporate local parks and associated water quality and quantity management infrastructure.

The purpose of this correspondence is to present the flood modelling assessment for this additional development and consider the impact to both pre-Gables conditions and the existing approved layout and lake structures.

Included herein is a list of related and supporting documentation, description of the study area, methodology used to undertake the assessment, outline of the modelling undertaken, presentation of the results of the modelling and assessment, and discussion around the implications of the results.

Related Reports and Documents

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

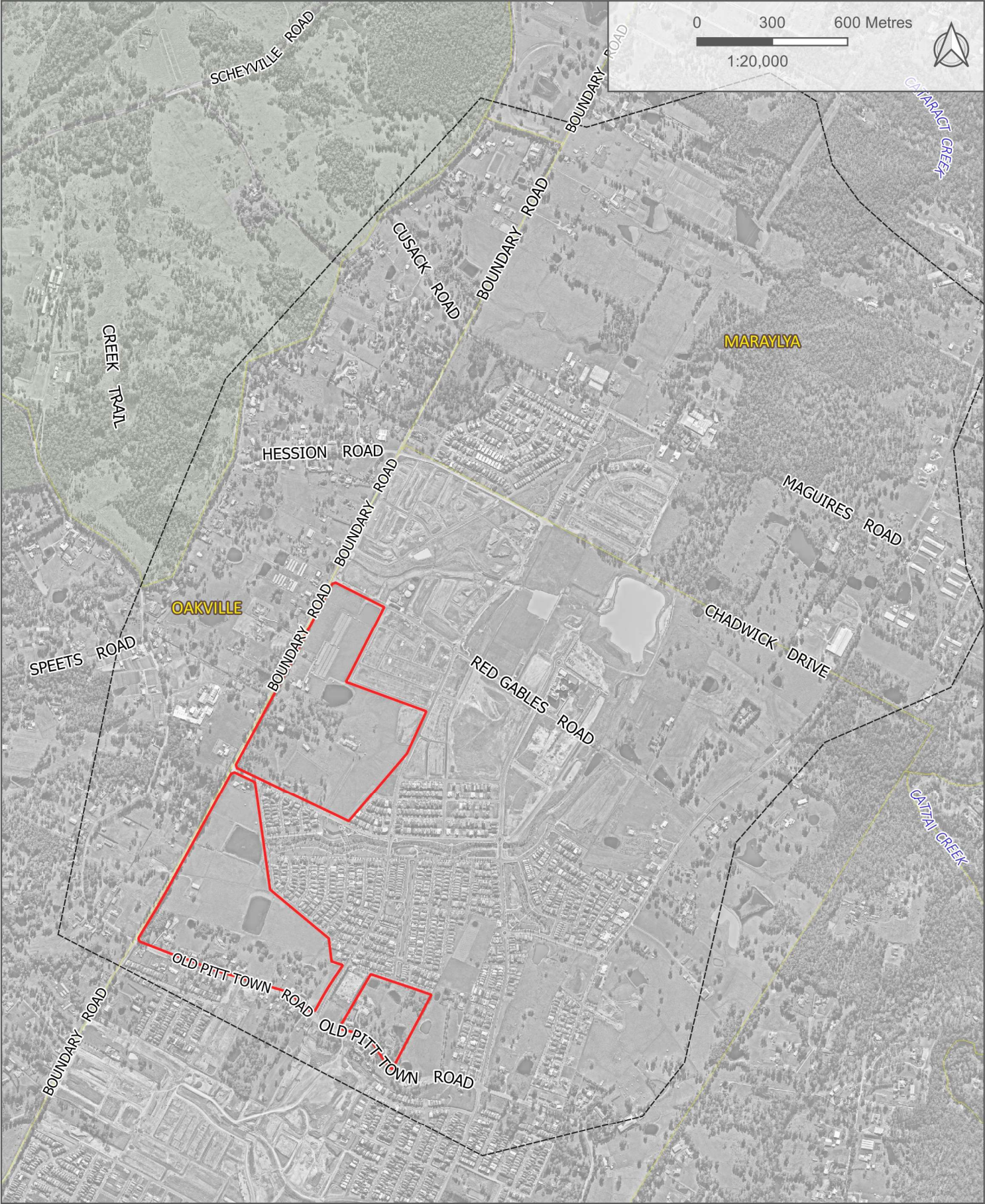
1. Civil Engineering Drawings prepared by Enspire Solutions
2. The Gables Lake CC TUFLOW Modelling Preliminary Submission prepared by Northrop Engineers, dated 11 February 2019
3. The Gables Lake CC Review emails prepared by The Hills Shire Council, dated various 3 May 2019 through 30 May 2019
4. The Gables Precinct Town Centre Main Detention Basins and Lake Civil Engineering Assessment Report – Revision 6 prepared by Northrop Consulting Engineers, May 2019
5. The Gables Precinct Town Centre Main Detention Basins and Lake Dam Break Assessment Civil Engineering Report – Revision 5 prepared by Northrop Consulting Engineers, May 2019
6. The Gables Blockage Strategy prepared by Northrop Consulting Engineers dated 3 May 2019
7. Response to Council Comments and Sensitivity Analysis for The Gables Town Centre Lake prepared by Northrop Consulting Engineers dated 8 May 2019
8. The Gables TUFLOW Submission Requirements prepared by Northrop Consulting Engineers dated 3 May 2019
9. Letter to Dams Safety Committee from J Wyndham Prince dated 9 September 2016 regarding Consequence Categories
10. Letter to Dams Safety Committee from J Wyndham Prince dated 19 October 2016 regarding Consequence Categories
11. Letter from Dams Safety Committee to J Wyndham Prince dated 4 November 2016 requesting further information
12. Letter to Dams Safety Committee from J Wyndham Prince dated 8 December 2016 responding to RFI regarding impact on Maguires Road
13. Letter from Dams Safety Committee to J Wyndham Prince dated 21 February 2017 outlining Flood Consequence Category and Sunny Day Consequence Category for the dam
14. Box Hill and Box Hill Industrial Precincts – Water Cycle Management Strategy Report prepared by J. Wyndham Prince, July 2013
15. Box Hill North Flood Impact Assessment prepared by J. Wyndham Prince, April 2015
16. Box Hill North Main Detention Basins and Lake Stormwater Management Strategy and Flood Assessment Report prepared by J. Wyndham Prince, October 2016
17. Letter to Hills Shire Council regarding TUFLOW Model for the Gables Urban Release Area, Box Hill prepared by Northrop Consulting Engineers dated 3 November 2017
18. Letters received from Dams Safety Committee Re: The Gables Basin dated 28 March 2018.
19. Peer Review for The Gables Dam prepared by Hunter H₂O dated 19 April 2018
20. Peer Review for The Gables Dam prepared by Hunter H₂O dated 20 September 2018

Study Area

The subject site is located adjacent to an unnamed tributary of Cataract Creek. The area is currently rural and is characterised by open pastures, and farm dams.

The area immediately downstream of development consists of the Gables development.

An aerial photo showing the locality is presented in Figure 1 overleaf.



Legend

Project Area Flood Model Extent

Figure 1

Locality

West Gables

Methodology

The flood modelling was undertaken using the following steps;

- Review of existing modelling and consents, and proposed design layout and surfaces.
- Amend TUFLOW model to accommodate design changes.
- Run and assess models with respect to previous documentation.
- Prepare figures to graphically represent results.

Outcomes have been detailed in this correspondence.

Flood Model Setup

Model Approach

A computational flood model has been prepared for the development design and assessment in conjunction with The Hills Shire Council. It covers approximately nine square kilometres (900 ha) from the top of catchment upstream of Old Pitt Town Road, to approximately two kilometres downstream of the basin and lake.

The model was developed using the TUFLOW software and a rainfall on grid hydrology approach.

Hydrology

Rainfall depths and temporal patterns from Australian Rainfall and Runoff (ARR) 1987 have been adopted. Probable Maximum Precipitation (PMP) has been estimated using the Generalised Short Duration Method (GSDM) and interpolation of these two sources has been undertaken for events between the reasonable limit of ARR procedures and the PMP.

Roughness and Losses

Roughness values and associated losses are presented in Table 1 below. Spatial distribution for the existing and ultimate developed cases is presented overleaf in Figure 2 and Figure 3.

Table 1 - Manning's Roughness

ID	Landuse	Manning's n	Initial Loss (mm)	Continuing Loss (mm/hr)
1	Floodplain High Grass	0.035	15	2.5
2	Roads	0.015	1	0
3	Light Vegetation	0.04	15	2.5
4	Medium Vegetation	0.05	15	2.5
5	Dense Vegetation	0.10	15	2.5
6	Dams	0.025	0	0
7	Buildings Within the Floodplain	0.30	0	0
8	Buildings Outside the Floodplain	0.025	0	0
9	Waterway with Minimal Vegetation	0.03	15	2.5
10	Waterway with Medium Vegetation and Raingardens	0.05	15	2.5
11	Waterway with Dense Vegetation	0.08	15	2.5
12	Residential Lots Combined	0.30	1	0
13	Open Space and Sports Fields	0.025	5	1
14	Drainage Channel	0.07	15	2.5
15	Dense Vegetation Sensitivity	0.15	15	2.5
16	Rock Armouring	0.04	15	2.5

Existing Farm Dams

Existing farm dams have been modelled as full to their lowest spill crest using a 2d_iwl layer. Spatial distribution is presented overleaf in Figure 4 and Figure 5.

Basin Outlets and Configuration

Basin configurations are presented in Table 2 below and the civil drawings are presented in Appendix A.

Table 2 – Basin configuration

	Basin 1 + 2	Basin 3	Basin 4	Basin 5	Basin 6	Basin 7
Invert (m AHD)	41.40	48.85	44.88	41.93	37.80	40.35
Outlet Type	RCBC	RCP	RCP	RCP	RCP	RCP
Outlet Dimensions (mm)	1200 x 900	450	900	750	600	750
Outlet Pipe Invert (m AHD)	41.40	48.85	43.60	40.95	37.80	38.75

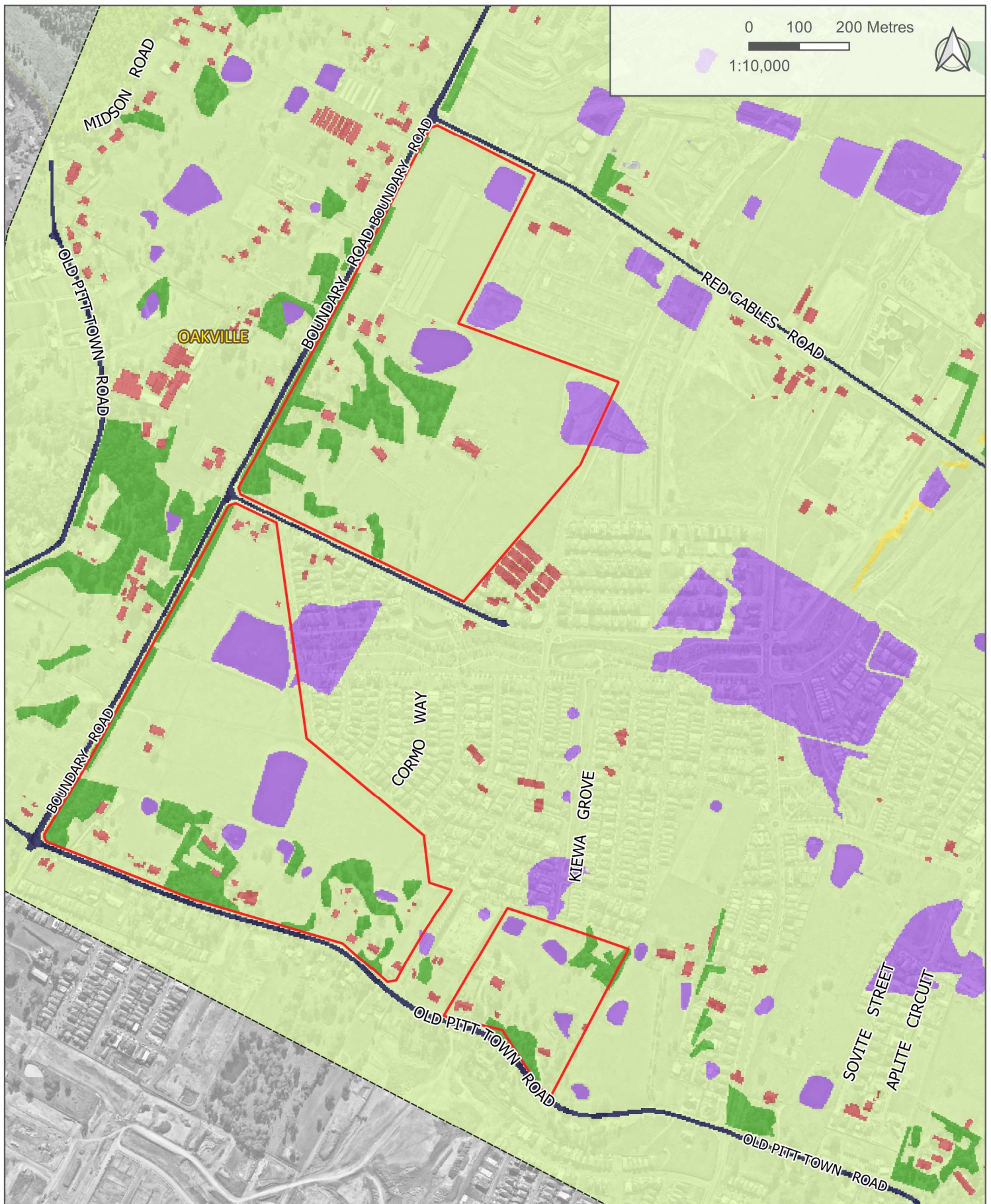
Topography

Existing and developed topography are presented overleaf in Figure 6 and Figure 7.

Scenarios

The adopted scenarios in this submission are EXIST_04 for the existing case, and WestGables_004 for the developed case. Comparisons are made between these two scenarios and the previous adopted lake CC model (with minor amendments) UltDev_014.

This considers comparisons in flood behaviour if The Gables never went ahead, and a comparison with the current approved development.



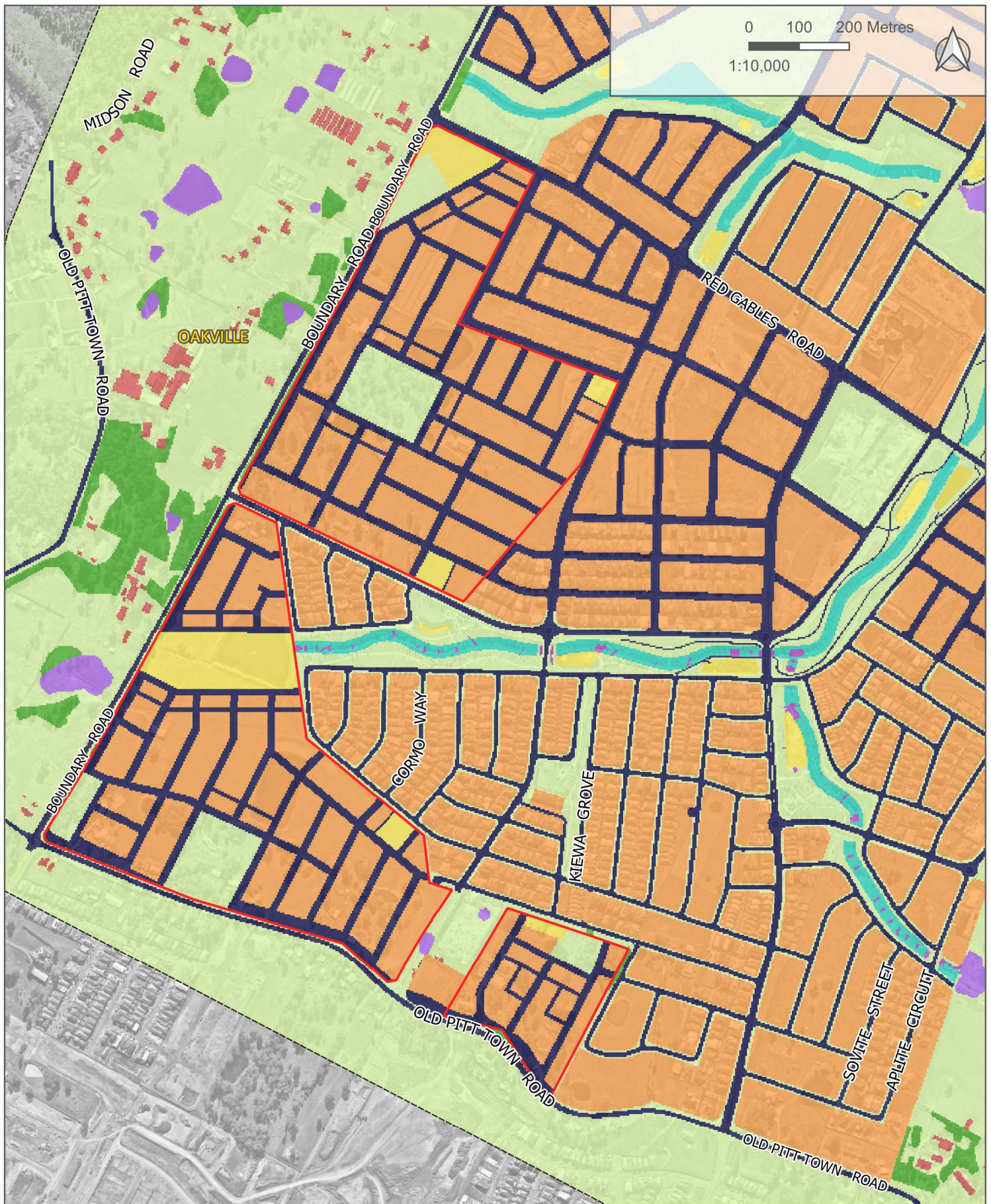
Legend

 Project Area	 n = 0.04	 n = 0.08
 Flood Model Extent	 n = 0.10	 n = 0.30
Roughness	 n = 0.025	 n = 0.07
 n = 0.035	 n = 0.025	 n = 0.04
 n = 0.015	 n = 0.05	

Figure 2

Existing Case Roughness

West Gables



Legend

 Project Area	 n = 0.04	 n = 0.08
 Flood Model Extent	 n = 0.10	 n = 0.30
Roughness	 n = 0.025	 n = 0.07
 n = 0.035	 n = 0.025	 n = 0.04
 n = 0.015	 n = 0.05	

Figure 3

Developed Case Roughness

West Gables



Legend

- Project Area
- Flood Model Extent
- 2D Initial Water Levels

Figure 4

Existing Initial Water Levels

West Gables



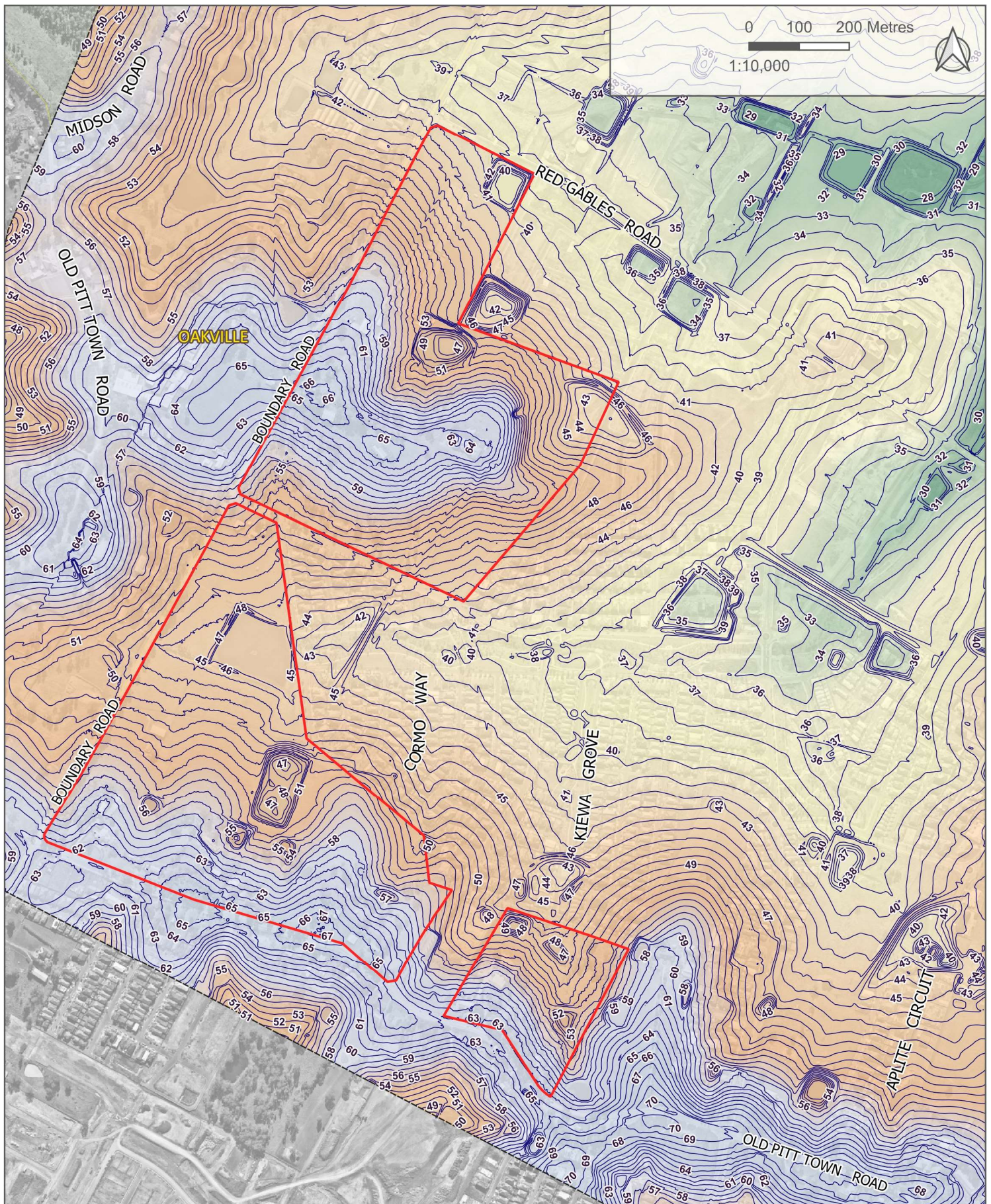
Legend

- Project Area
- Flood Model Extent
- 2D Initial Water Levels

Figure 5

Developed Initial Water Levels

West Gables



Legend

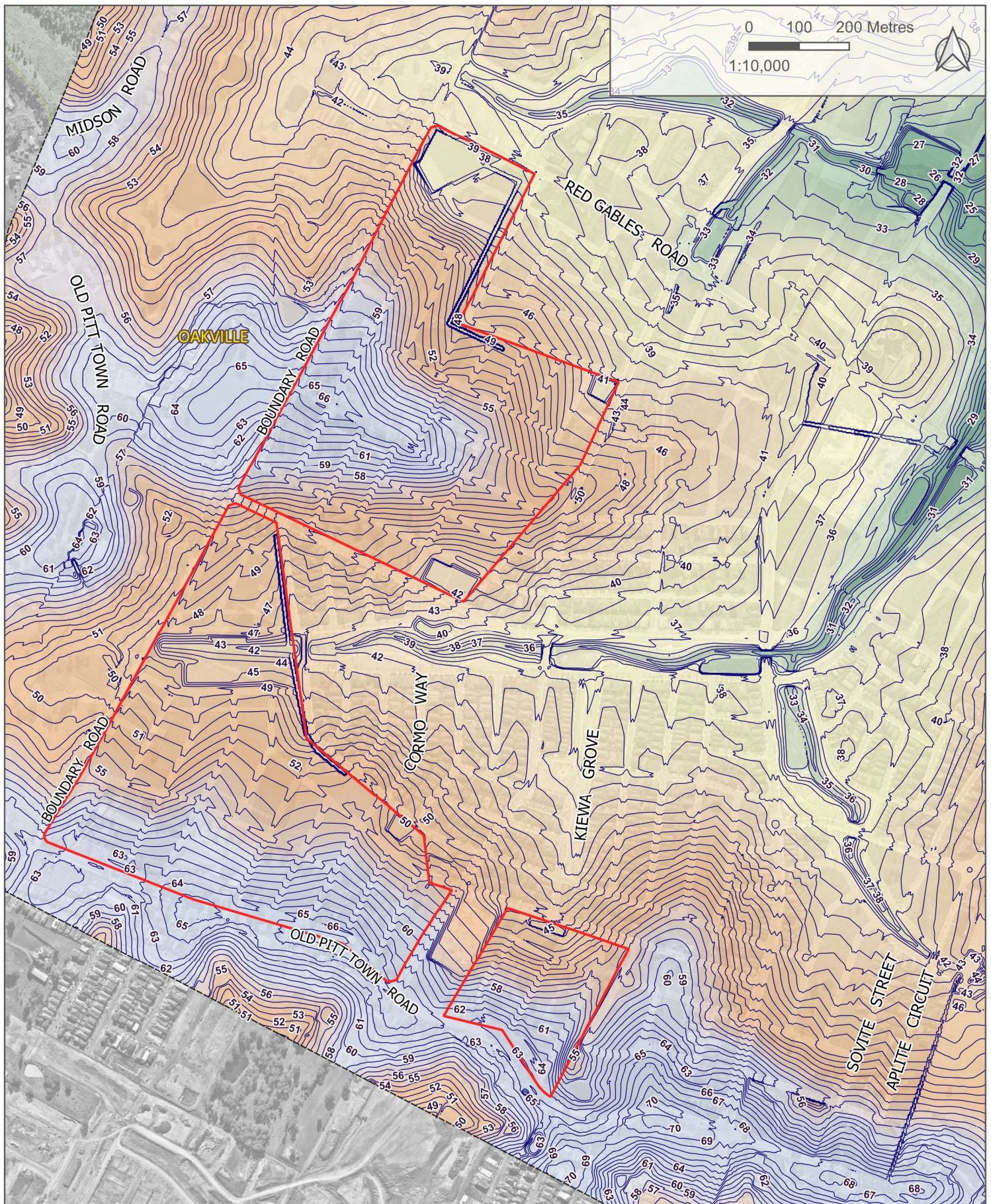
- Project Area
- Flood Model Extent
- Elevation (m AHD)
- 70
- 30
- 1m Contour

Figure 6

Existing Topography

West Gables





Legend

- Project Area
- Flood Model Extent
- Elevation (m AHD)
 - 70
 - 30
- 1m Contour

Figure 7

Developed Topography

West Gables

Flood Modelling Results

Flood Levels and Peak Flows

Flood reporting locations are presented overleaf in Figure 8.

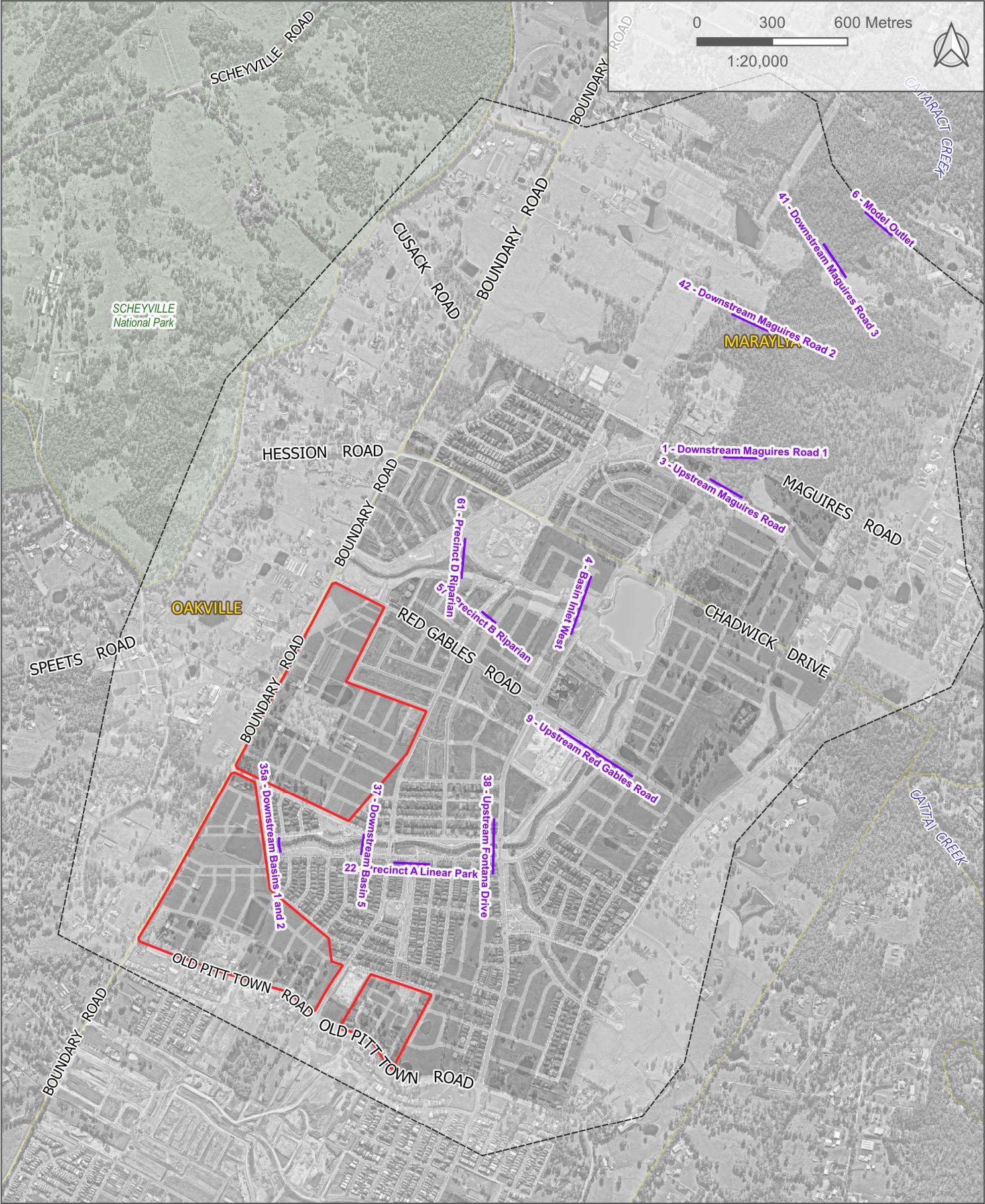
The basin levels calculated in this analysis are presented below in Table 3. Table 4 demonstrates a comparison of the downstream riparian flow rates.

Table 3 - Flood modelling results – peak flows

	Basin 1 + 2	Basin 3	Basin 4	Basin 5	Basin 6	Basin 7
39.35% AEP	42.80	49.65	44.90	42.33	38.57	40.57
10% AEP	43.33	49.95	44.92	42.43	38.74	40.72
1%AEP (Bdes)	44.03	50.33	44.98	42.67	39.05	40.98
PMF	45.44	50.69	46.33	43.46	40.02	41.85

Table 4 – 1% AEP peak flow results

Location	EXIST_04 (m ³ /s)	UltDev_014 (m ³ /s)	WestGables_004 (m ³ /s)
6 – Model Outlet	69.4	73.5	74.2
41 – Downstream Maguires Road 3	68.1	70.9	71.7
42 – Downstream Maguires Road 2	64.2	63.2	64.2
1 – Downstream Maguires Road 1	48.9	40.4	40.0
3 – Upstream Maguires Road	45.7	36.9	35.4
4 – Basin Inlet West	N/A	25.4	24.0
61 – Precinct D Riparian	N/A	16.2	16.9
57 – Precinct B Riparian	N/A	9.4	7.3
9 – Upstream Red Gables Road	N/A	50.3	49.4
38 – Upstream Fontana Drive	N/A	22.6	20.9
22 – Precinct A Linear Park	N/A	1.0	0.6
37 – Downstream Basin 5	N/A	9.4	8.3
35a – Downstream Basin 1 and 2	N/A	6.3	4.3



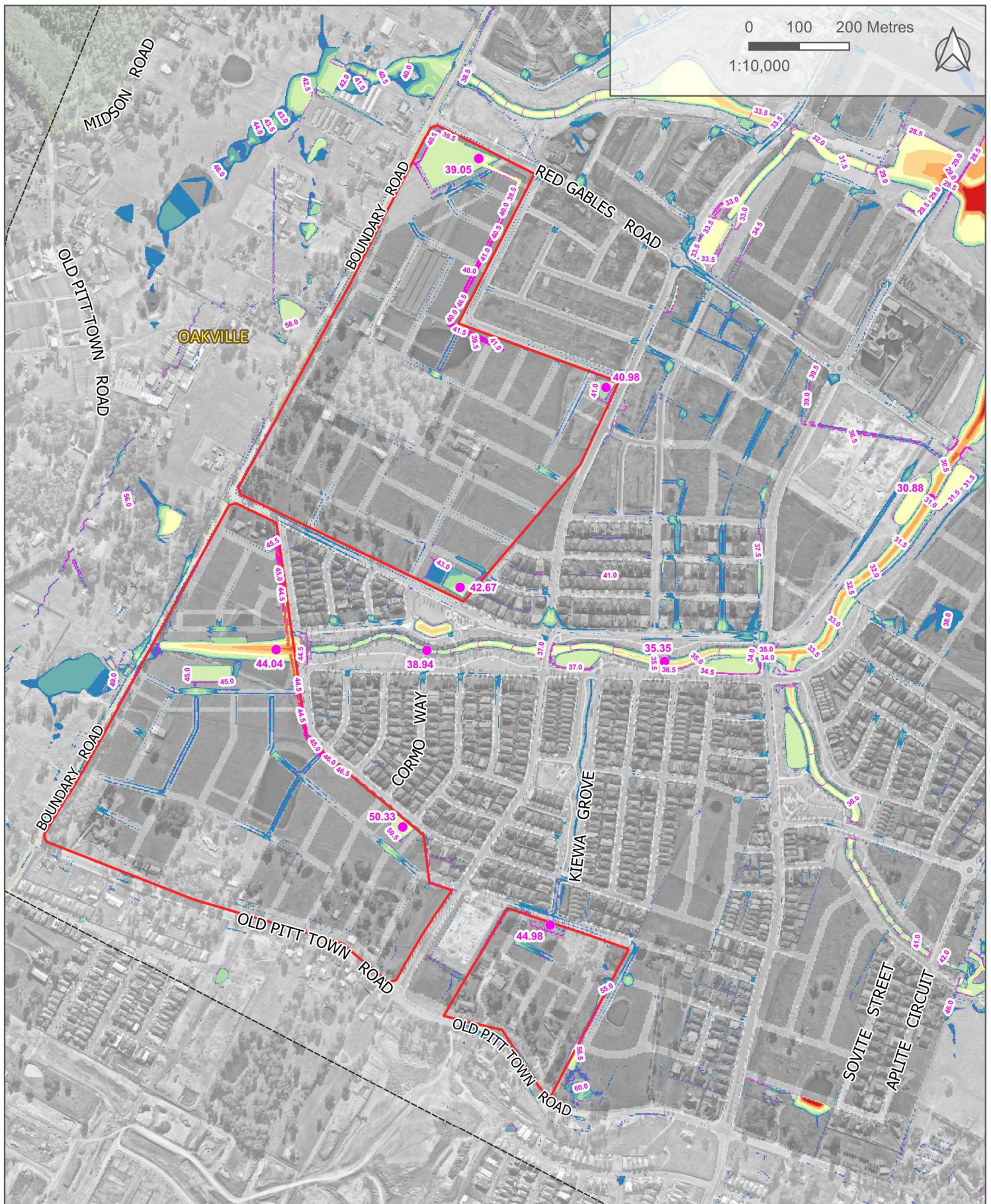
Legend

- Project Area
- Flood Model Extent
- Flow Reporting Points

Figure 8

Flow Reporting Locations

West Gables



Legend

 Project Area	Depth (m)	 1.0000 - 1.5000
 Flood Model Extent	 ≤ 0.1000	 1.5000 - 2.0000
● Reporting Point	 0.1000 - 0.2000	 2.0000 - 2.5000
— 500mm WSL	 0.2000 - 0.3000	 2.5000 - 3.0000
	 0.3000 - 0.5000	 > 3.0000
	 0.5000 - 1.0000	

Figure D1

1% AEP Depth and
Elevation

West Gables





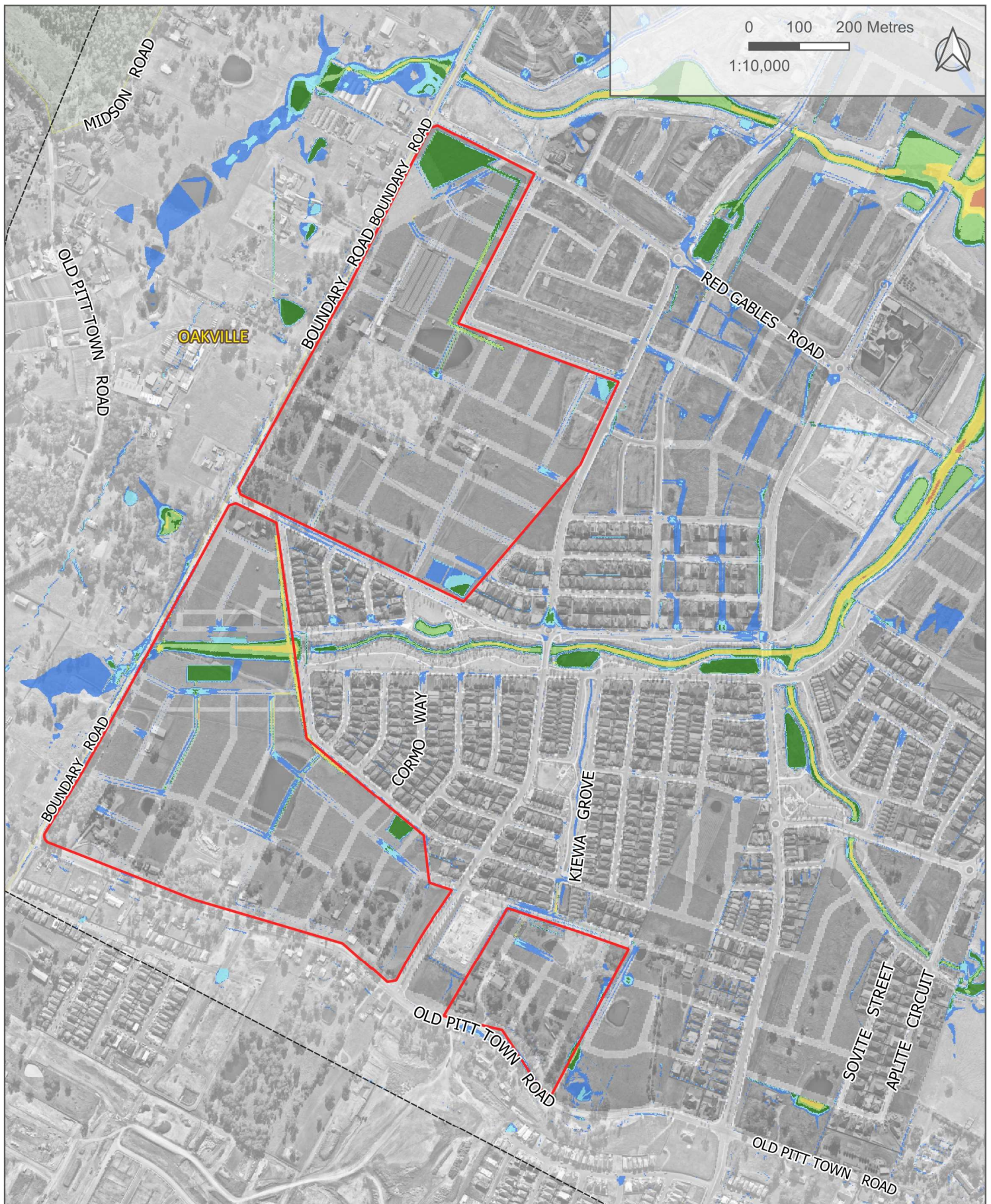
Legend

 Project Area	Velocity (m/s)	 1.0000 - 1.5000
 Flood Model Extent	 ≤ 0.5000	 1.5000 - 2.0000
	 0.5000 - 1.0000	 > 2.0000

Figure D2

1% AEP
Velocity

West Gables

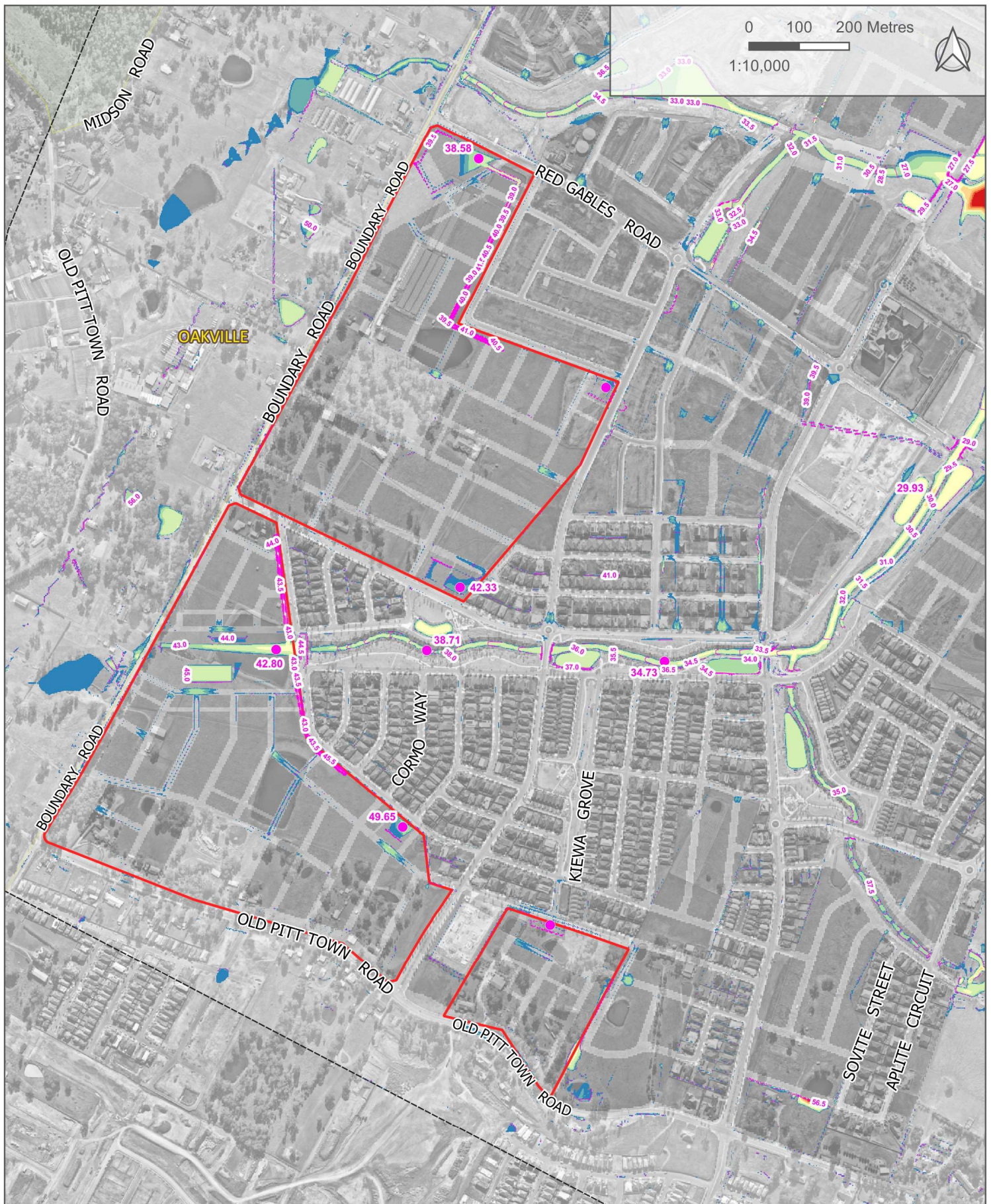


Legend

 Project Area	Hazard Categories	 H4
 Flood Model Extent	 H1	 H5
	 H2	 H6
	 H3	

Figure D3

1% AEP
AEMI Hazard
West Gables



Legend

 Project Area	Depth (m)	 1.0000 - 1.5000
 Flood Model Extent	 ≤ 0.1000	 1.5000 - 2.0000
● Reporting Point	 0.1000 - 0.2000	 2.0000 - 2.5000
— 500mm WSL	 0.2000 - 0.3000	 2.5000 - 3.0000
	 0.3000 - 0.5000	 > 3.0000
	 0.5000 - 1.0000	

Figure D4

39.35% AEP Depth and Elevation

West Gables





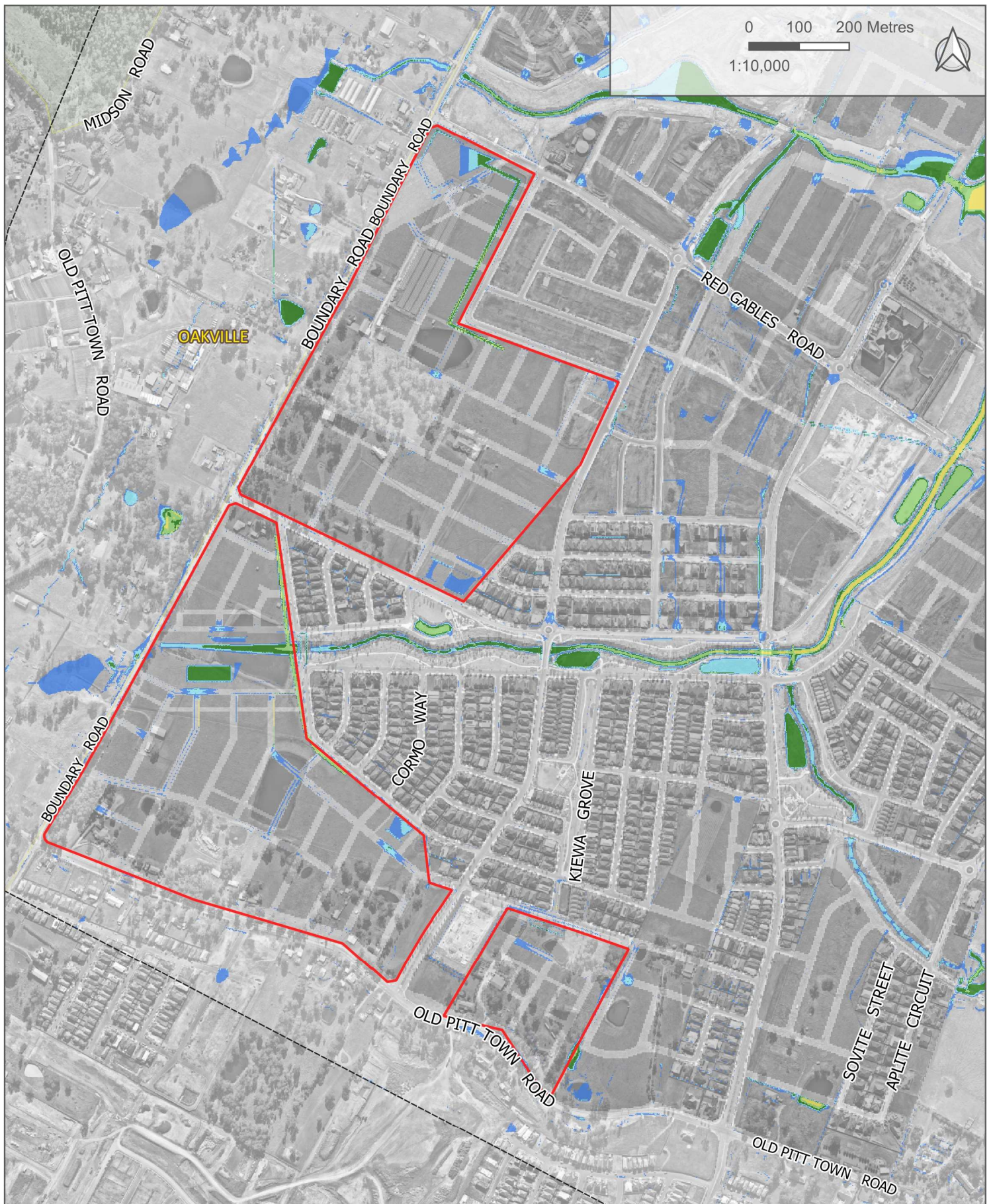
Legend

 Project Area	Velocity (m/s)	 1.0000 - 1.5000
 Flood Model Extent	 <= 0.5000	 1.5000 - 2.0000
	 0.5000 - 1.0000	 > 2.0000

Figure D5

39.35% AEP
Velocity

West Gables



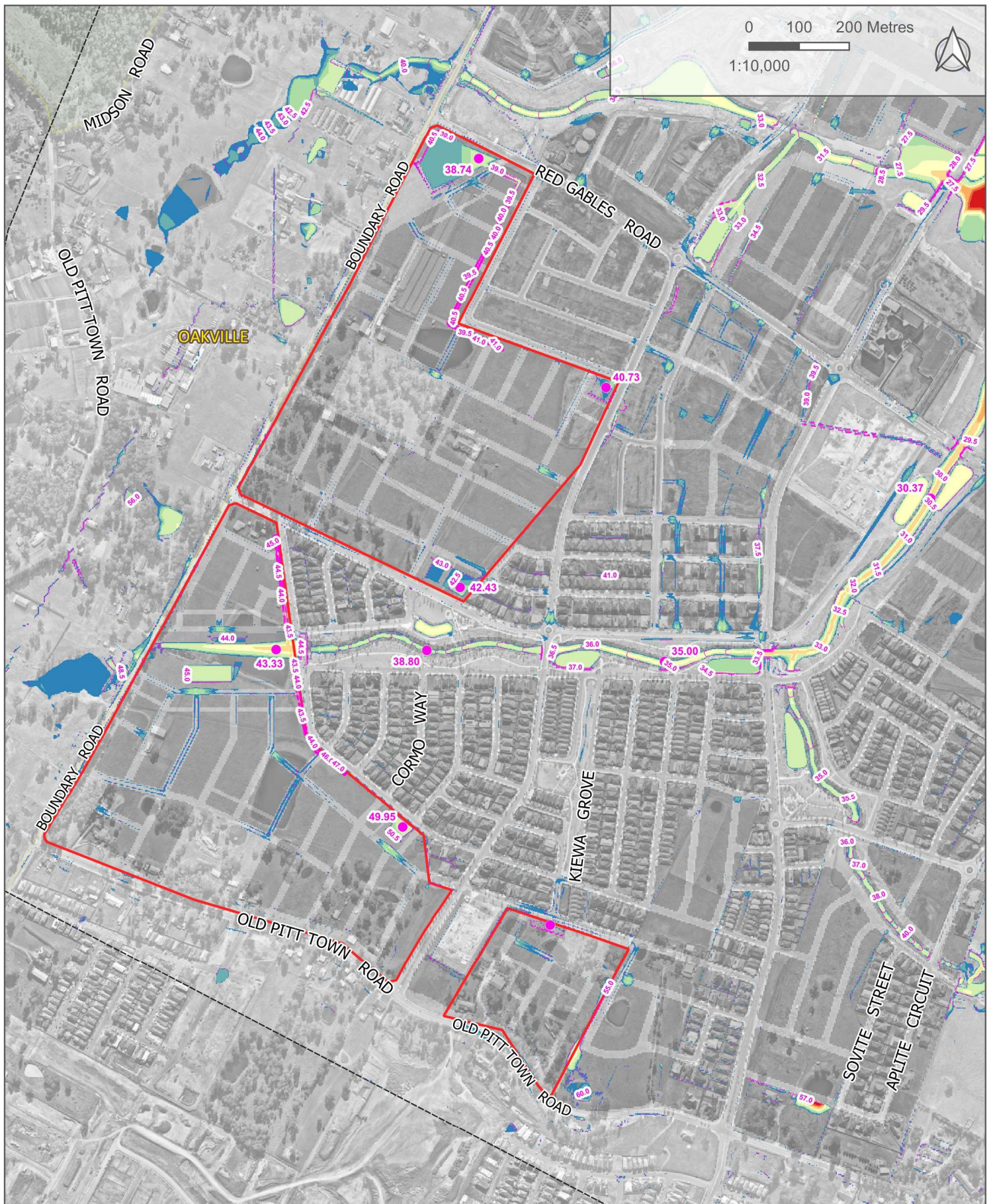
Legend

 Project Area	Hazard Categories	 H4
 Flood Model Extent	 H1	 H5
	 H2	 H6
	 H3	

Figure D6

39.35% AEP
AEMI Hazard

West Gables



Legend

 Project Area	Depth (m)	 1.0000 - 1.5000
 Flood Model Extent	 ≤ 0.1000	 1.5000 - 2.0000
● Reporting Point	 0.1000 - 0.2000	 2.0000 - 2.5000
— 500mm WSL	 0.2000 - 0.3000	 2.5000 - 3.0000
	 0.3000 - 0.5000	 > 3.0000
	 0.5000 - 1.0000	

Figure D7

10% AEP Depth and
Elevation

West Gables





0 100 200 Metres
1:10,000

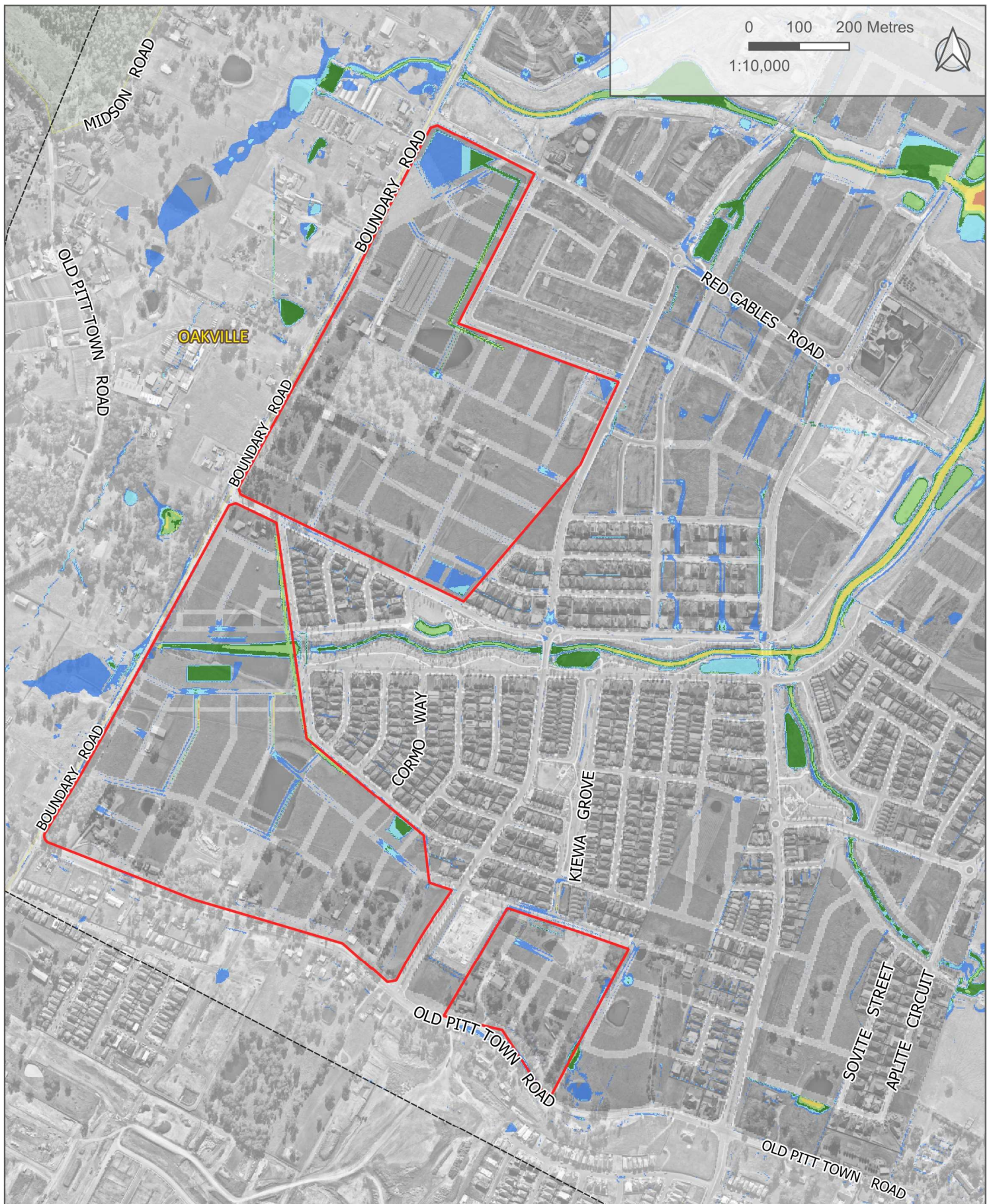
Legend

 Project Area	Velocity (m/s)	 1.0000 - 1.5000
 Flood Model Extent	 ≤ 0.5000	 1.5000 - 2.0000
	 0.5000 - 1.0000	 > 2.0000

Figure D8

10% AEP
Velocity

West Gables



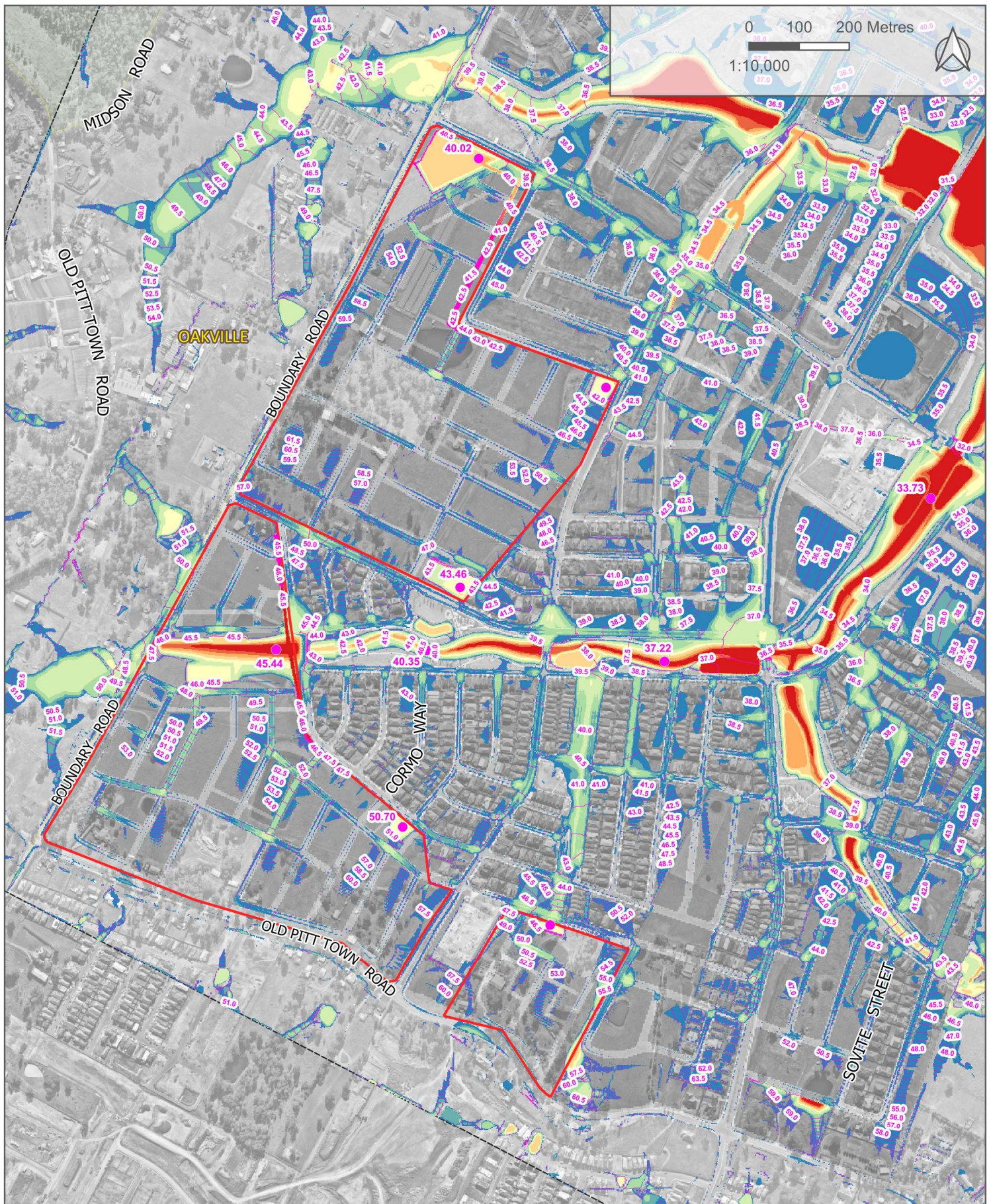
Legend

 Project Area	Hazard Categories	 H4
 Flood Model Extent	 H1	 H5
	 H2	 H6
	 H3	

Figure D9

10% AEP
AEMI Hazard

West Gables



Legend

 Project Area	Depth (m)	 1.0000 - 1.5000
 Flood Model Extent	 <= 0.1000	 1.5000 - 2.0000
● Reporting Point	 0.1000 - 0.2000	 2.0000 - 2.5000
— 500mm WSL	 0.2000 - 0.3000	 2.5000 - 3.0000
	 0.3000 - 0.5000	 > 3.0000
	 0.5000 - 1.0000	

Figure D10

PMF Depth and
Elevation

West Gables



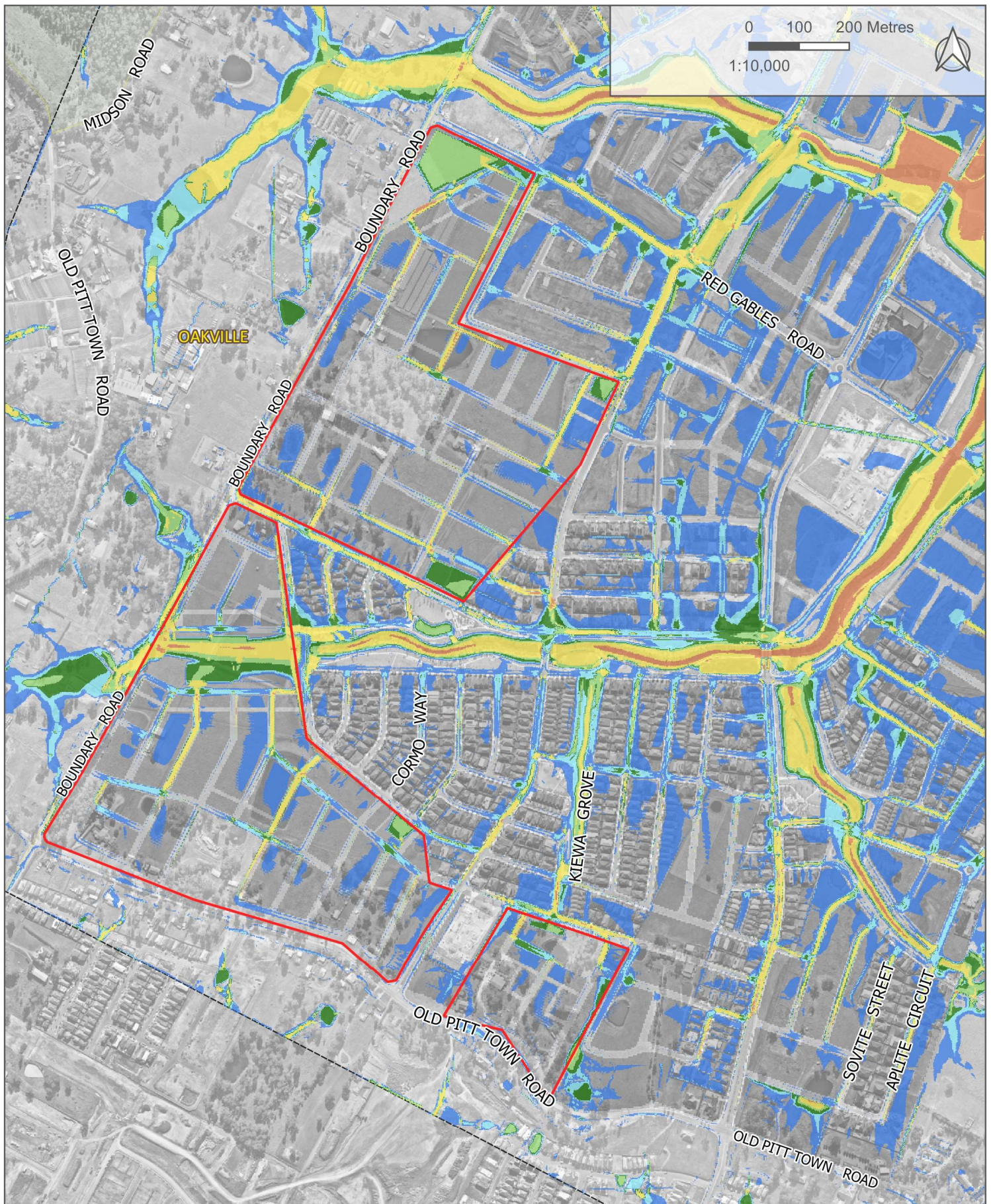
Legend

 Project Area	Velocity (m/s)	 1.0000 - 1.5000
 Flood Model Extent	 ≤ 0.5000	 1.5000 - 2.0000
	 0.5000 - 1.0000	 > 2.0000

Figure D11

PMF
Velocity

West Gables



Legend

 Project Area	Hazard Categories	 H4
 Flood Model Extent	 H1	 H5
	 H2	 H6
	 H3	

Figure D12

PMF
AEMI Hazard
West Gables

Discussion

Flood Extents and Velocity Mapping

Whilst the modelling reports flood behaviour at every grid cell, it has previously been assumed (and agreed with The Hills Shire Council) that any flow under 100mm depth is classified as sheet flow and not reported in the figures.

It is noted that in some areas, flow depth greater than 100mm is present on lots or within roadways. This is due to the pit and pipe network not being included in these areas of the model. Detailed one dimensional analysis of the road stormwater network will be undertaken for each subdivision stage to ensure flood extents are minimised and safe depths, velocities and velocity depth products maintained, and no residential lots are classified as “Flood Controlled”.

Flood Elevation Comparison

A flood elevation comparison in the 1% AEP is presented in Figure C1 and C2 overleaf.

A 65mm increase is calculated in the Bdes 1% AEP developed to existing comparison at the model outlet. This is generally consistent with the previous Lake CC reporting.

In the comparison with the existing developed case, there is a reduction through much of the main riparian corridor, and an approximately 100mm reduction in the main lake.

There is an isolated increase in the Precinct D riparian corridor of approximately 30mm and an increase downstream of Maguires Road (west) culverts due to a change in configuration since the previous submission. Levels near the model outlet are +/-3mm from this previous package.

This demonstrates the detention concept for West Gables in most areas improves the flood conditions through the Gables proper and to adjacent properties downstream.

Velocity Comparison

A flood velocity comparison in the 39.35% AEP with the existing case is presented overleaf in Figure C3.

This demonstrates most of the velocity increases are limited to 0.5m/s and velocities are generally lower than the erosive threshold for grass at 1.5m/s.

Changes Since Gables Modelling Submission

The following changes have been made in the existing case.

- Removal of farm dam upstream of Boundary Road outside of the project area.
- Inclusion of detailed survey.
- Amendment of basin initial water levels based on detailed survey.

Changes to the developed case include.

- Amendment of the Manning's roughness layer
- Amendment of topography.
- Dam outlets represented in the 1D domain.
- Terrain adjustment to funnel water into Basins 1 and 2, and Basin 6. This represents the future trunk drainage arrangement.

Blockage

The Gables subdivision is subject to a blockage guideline. In the absence of a guideline for the Gables West project area, basins were modelled as zero blockage.

This demonstrates a conservative assumption that maximum flow is released downstream into the catchment. The design blockage scenario was applied through the rest of the Gables development.

We believe measures to mitigate blockage can be incorporated through detailed design of the outlet structures, including amended sizing to reflect a design blockage percentage, or debris control structures over the outlets of the smaller basins.

Upstream Catchments and Future Development

The tributary catchment for the combined on-line detention basin includes areas to the west of Boundary Road that belongs to Hawkesbury City Council LGA.

The design for this basin will assume the 'ultimate' development flows coming from this external catchment will be attenuated by a separate detention system west of Boundary Road which will be designed by others.

We expect that these basins will consider the impact on the downstream water levels in the same fashion that this assessment has considered the downstream Gables development.

Dam Safety NSW

The combined on-line detention basin is intended to be an earthen embankment.

We understand the geotechnical design, civil design and dam break assessment will be performed at DA stage.

We note the presence of dwellings downstream, and we believe there are feasible options to include in the dam design should the dam be declared by Dams Safety NSW.

These include the geotechnical design of the embankment, and the inclusion of a spillway to pass the Acceptable Flood Capacity (AFC) of the dam.

The design of the spillway will be undertaken at DA stage and we believe there is feasible geometry and riparian corridor width downstream to accommodate the AFC.

Response to Ministerial Directions Flooding

A response to the ministerial direction is presented below in Table 5.

Table 5 - Response to Ministerial Directions

Requirement	Response
4.1.1 A planning proposal must include provisions that give effect to and are consistent with:	
a) The NSW Flood Prone Land Policy.	The subject site is located within the Flood Planning Area and as such, the provisions of the NSW Flood Prone Land Policy and Floodplain Development Manual are applicable. The principles of the NSW Flood Prone Land Policy are expected to be satisfied through adoption of appropriate flood mitigation and development controls.

Requirement	Response
b) The principles of the Floodplain Development Manual 2005.	The Floodplain Development Manual (2005) has been superseded by the Flood Risk Management Manual (2023). The principles of the Manual are expected to be achievable through the implementation of development controls. Where storage has been removed from the floodplain, basins have been provided in an attempt to replicate existing conditions. This report assesses the potential impacts of the development on adjacent properties. These engineering basin concepts are expected to be further reviewed at Development Application Phase.
c) The considering Flooding in land use planning guideline 2021, and	The recommendations contained within this guideline are included under the The Hills LEP 2019. Key flood constraints outlined in this guideline are summarised as; • Flood Function • Flood Hazard • Flood Extent and Behaviour; and • Risk to Life These elements have all been discussed in this assessment.
d) Any adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 and adopted by the relevant council.	This assessment has considered the previous Box Hill North planning proposal, and Gables flood study as developed for the adjoining development.
4.1.2 A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Conservation Zones to a Residential, Business, Industrial or Special Purpose Zones.	The planning proposal does not propose to rezone Recreation, Rural, Special Purpose or Conservation Zones to a Residential, Business, Industrial or Special Purpose Zones.
4.1.3 A planning proposal must not contain provisions that apply to the flood planning area which:	
a) Permit development in floodway areas,	The topography has been modified to located development outside the floodway in line with the wider

Requirement	Response
	Gables development.
b) Permit development that will result in significant flood impacts to other properties,	Detention has been incorporated which generally results in a reduction in flood levels from the currently approved condition. Areas of minor increase have been discussed in the sections preceding.
c) Permit development for the purpose of residential accommodation in high hazard areas,	The topography has been amended to lower the hazard of the developed area in line with the wider Gables development. Flood hazard is generally H1 across future residential lots.
d) Permit a significant increase in the development and/or dwelling density of that land.	Topography has modified the flood behaviour to prevent densification of development within the flood planning area. This is consistent with the wider Gables development.
e) Permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and senior housing, in areas where the occupants of the development cannot effectively evacuate,	Not applicable.
f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require development consent,	Not applicable.
g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or	This development adds to the existing development of this catchment. We believe it is unlikely to significantly contribute to additional government spending.
h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.	Not applicable.
4.1.5 For the purposes of preparing a planning proposal, the flood	The definition of Flood Planning Area in The Hills LEP (2019) is consistent with the NSW Flood Risk

Requirement	Response
planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council.	Management Manual (2023). As such, the Flood Planning Area for the subject site is expected to be defined as the 1% AEP + 500mm.



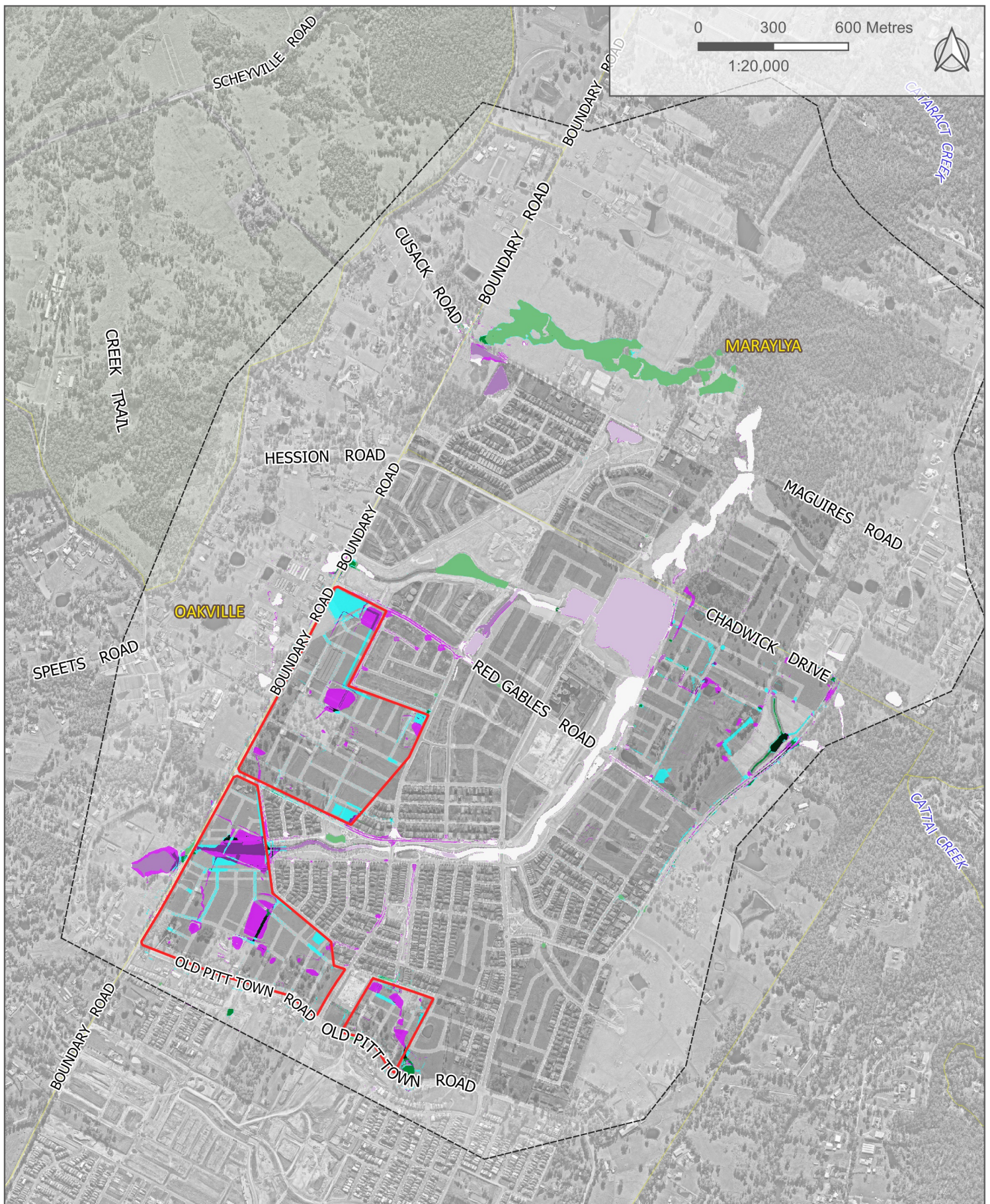
Legend

 Project Area	 Was Dry Now Wet	 -0.0500 - -0.0100
 Flood Model Extent	Difference (m)	 -0.0100 - 0.0100
Wet Dry	 ≤ -0.5000	 0.0100 - 0.0500
 Was Wet Now Dry	 -0.5000 - -0.1000	 0.0500 - 0.5000
	 -0.1000 - -0.0500	 > 0.5000

Figure C1

1% AEP Comparison Elevation
WestGables_004 minus EXIST_04

West Gables



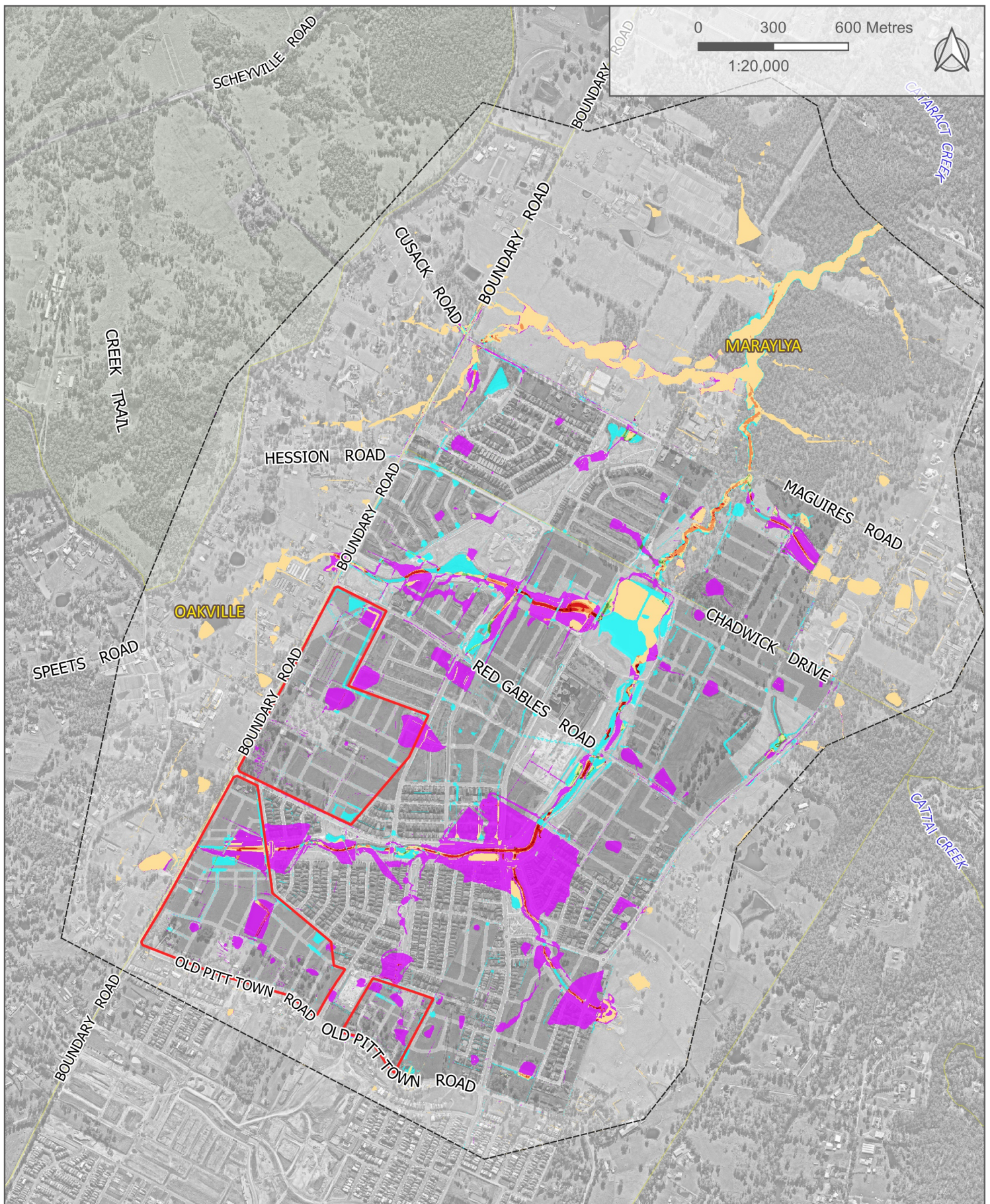
Legend

 Project Area	 Was Dry Now Wet	 -0.0500 - -0.0100
 Flood Model Extent	Difference (m)	 -0.0100 - 0.0100
Wet Dry	 ≤ -0.5000	 0.0100 - 0.0500
 Was Wet Now Dry	 -0.5000 - -0.1000	 0.0500 - 0.5000
	 -0.1000 - -0.0500	 > 0.5000

Figure C2

1% AEP Comparison Elevation
WestGables_004 minus UltDev_014

West Gables



Legend

 Project Area	 Was Dry Now Wet	 -0.5000 - -0.2000
 Flood Model Extent	Difference (m/s)	 -0.2000 - 0.2000
Wet Dry	 ≤ -1.0000	 0.2000 - 0.5000
 Was Wet Now Dry	 -1.0000 - -0.5000	 0.5000 - 1.0000
	 1.0000 - 2.0000	

Figure C3

39.35% AEP Comparison Velocity
WestGables_004 minus EXIST_04

West Gables

Conclusions

Northrop Consulting Engineers have been engaged by Enspire Solutions to complete flood modelling for the proposed Gables West development. This has been undertaken using the catchment wide TUFLOW model to assess the impacts relative to the pre-Gables development case, and currently approved masterplan layout.

The following preliminary conclusions have been drawn from the assessment.

- We believe it is feasible to incorporate detention within the development to mitigate impacts on the Gables Lake and downstream properties, when compared to previous approvals.
- We believe it is feasible to contain the 1% AEP within the riparian corridors through the development which is similar to the previously approved masterplan development.

We submit our findings for consideration.

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 Ensfire Solutions 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.

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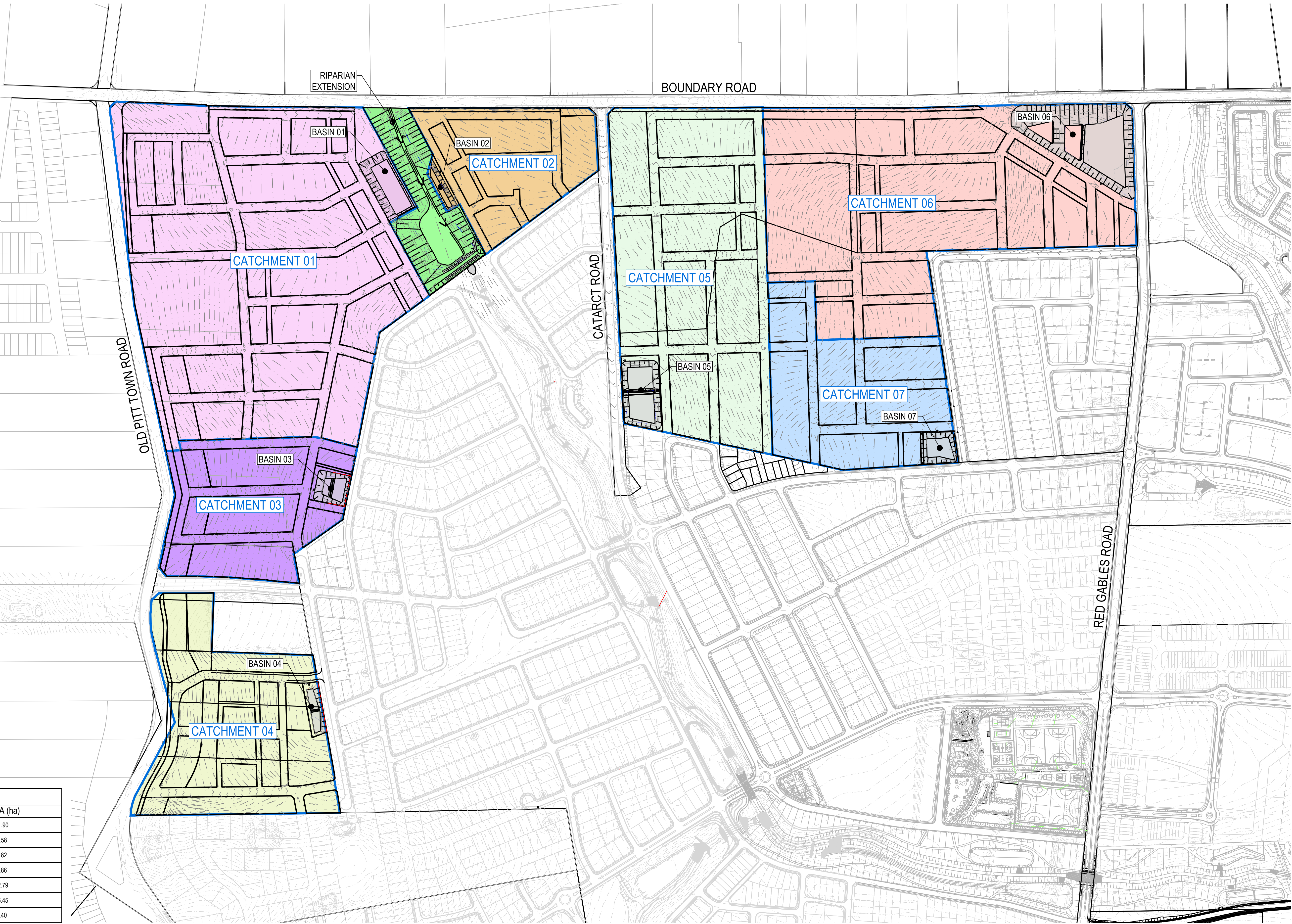
Document Register

Rev	Status	Prepared	Approved	Date
1	Draft	GB	GB	6 July 2022
2	Approval	GB	GB	5 December 2022
3	Revised for Approval	GB	GB	12 March 2024

Appendix A – Civil Engineering Drawings

LEGEND

100.00



CATCHMENTS		
CATCHMENT	AREA (ha)	
01	21.90	
02	4.58	
03	5.82	
04	7.86	
05	12.79	
06	16.45	
07	6.40	

REV.	DATE	DESCRIPTION	HD	CWH	DRN	DES.	VERIF.	APPD.
2	5/12/2022	ISSUED FOR INFORMATION	HD	HD	-	RH		
1	6/07/2022	ISSUED FOR INFORMATION	CWH	HD	-	RH		

Client



Stockland

its your place



THE GABLES

BOX HILL

Scale

0

50

100

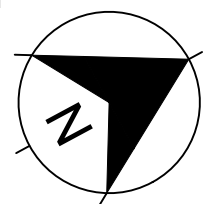
200

300m

SCALE 1:3000

@A1

North



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Enspire Solutions Pty Ltd
Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135

Project
WEST GABLES
REZONING

Title
CONCEPT STORMWATER
DRAINAGE CATCHMENT PLAN

Scale
1:3000

Date
6/07/2022

Size
A1

Datum
GDA94

Status
FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number
220012-SK-0001

Revision
2

LEGEND

- SITE BOUNDARY
- CONTOUR
- BATTER
- RW
- RETAINING WALL
- FINISHED LEVEL
- INVERT LEVEL
- CHANNEL
- STORMWATER DRAINAGE LINE
- FLOW DIRECTION
- KERB INLET PIT
- SURFACE INLET PIT/JUNCTION PIT
- HEADWALL



REV.	DATE	DESCRIPTION	HD	HD	-	RH
2	5/12/2022	ISSUED FOR INFORMATION	HD	HD	-	RH
1	6/07/2022	ISSUED FOR INFORMATION	CWH	HD	-	RH

Client

**Stockland**
it's your place

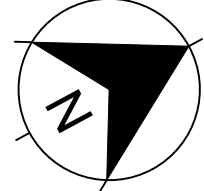
**THE GABLES**
BOX HILL

Scale

0 10 20 30 40 50m

SCALE 1:500 @A1

North



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Level 4, 153 Walker Street, North Sydney NSW 2060
ABN: 71 624 801 690
Phone: 02 9922 6135

Project
WEST GABLES
REZONING

Title
CONCEPT STORMWATER
BIO-RETENTION / OSD BASINS 01&02

Scale
1:500

Date
6/07/2022

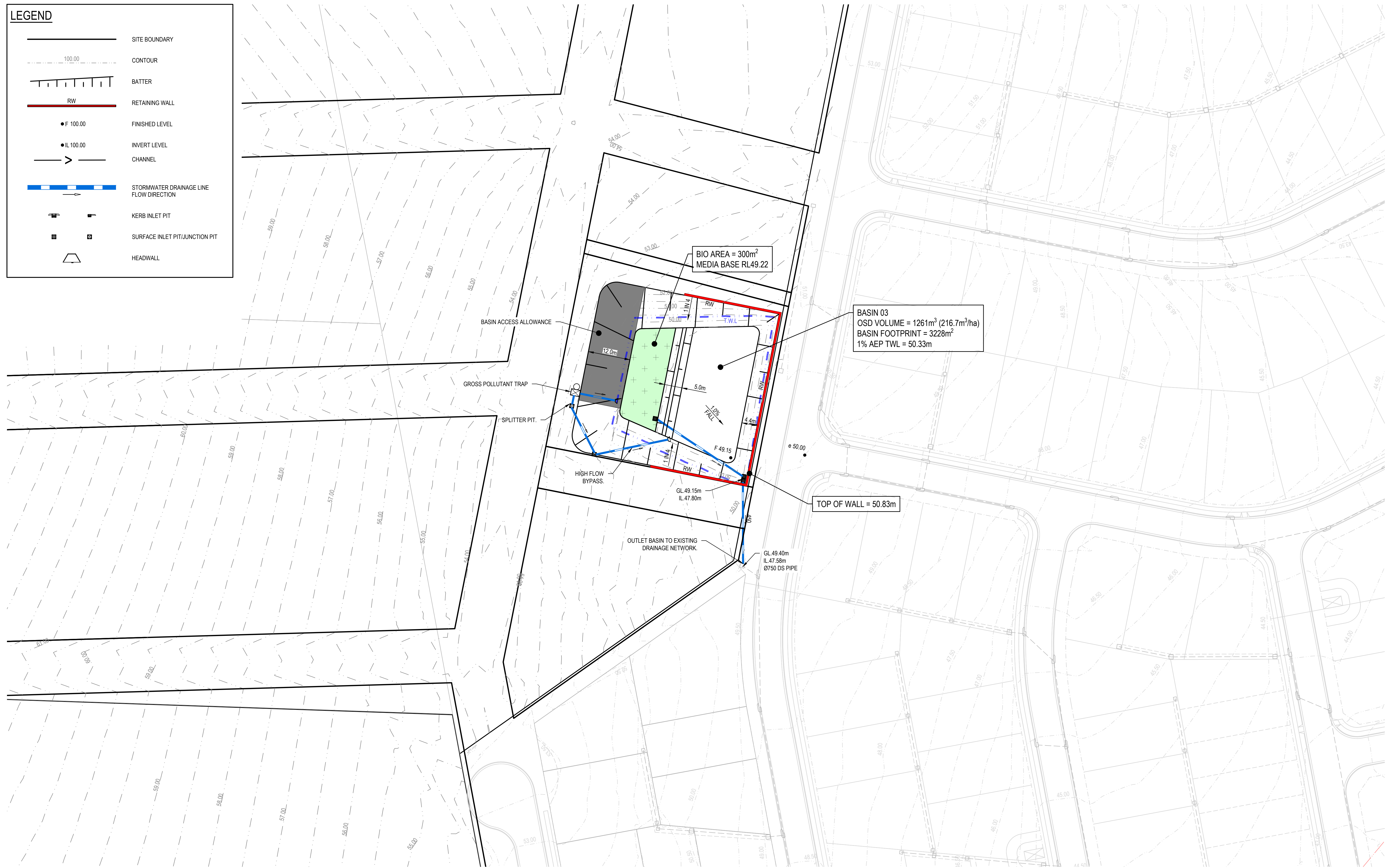
Size
A1

Datum
GDA94

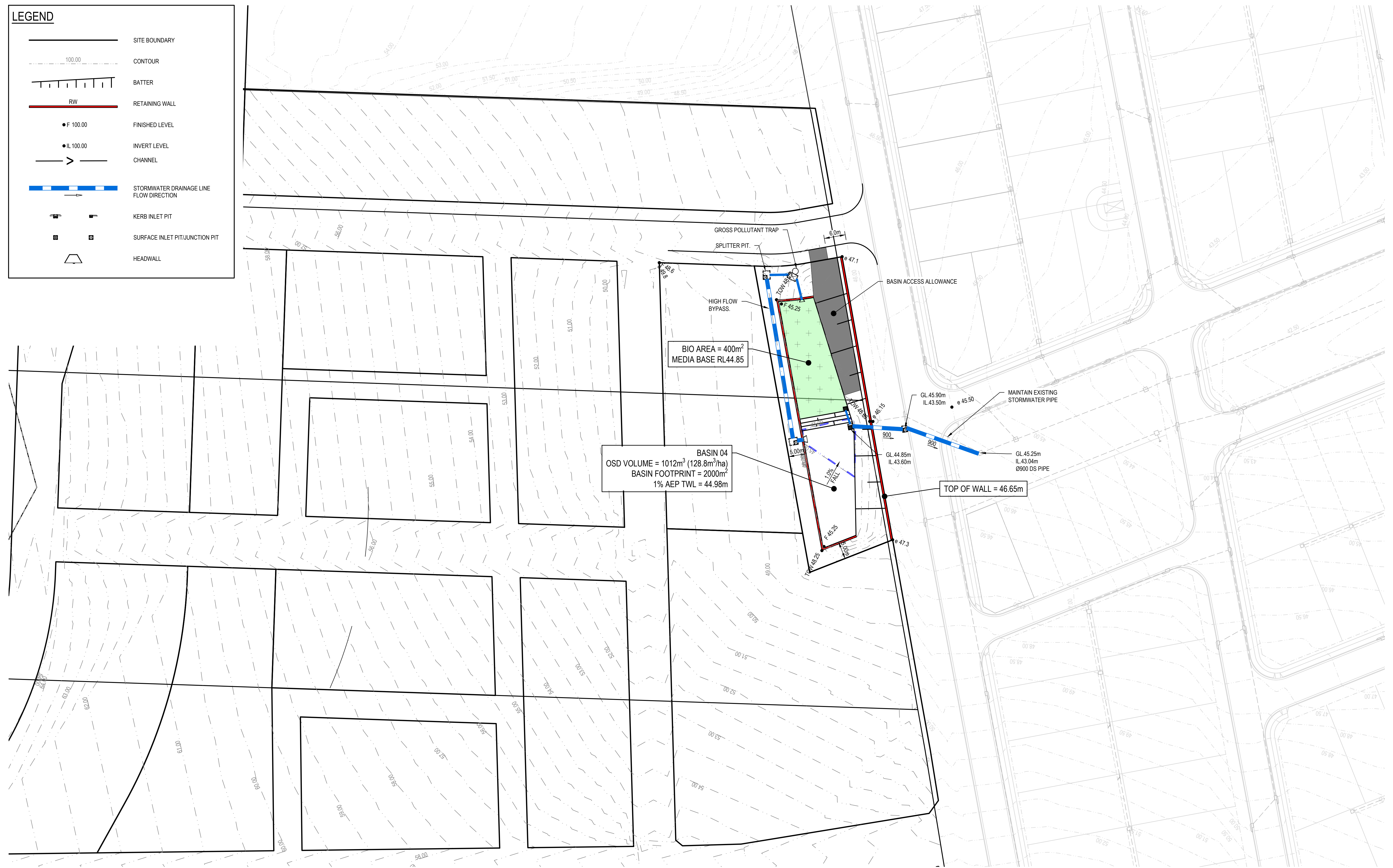
Status
FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION

Project Number/Drawing Number
220012-SK-0002

Revision
2



Client  Stockland <i>it's your place</i>  THE GABLES BOX HILL	Scale  01020304050m SCALE 1:500 @A1	North 	 enspire Enspire Solutions Pty Ltd Level 4, 153 Walker Street, North Sydney NSW 2060 ABN: 71 624 801 690 Phone: 02 9922 6135	Project WEST GABLES REZONING	Scale 1:500	Status FOR INFORMATION ONLY NOT TO BE USED FOR CONSTRUCTION			
				Title CONCEPT STORMWATER BIO-RETENTION / OSD BASINS 03	Date 6/07/2022		Size A1	Project Number/Drawing Number 220012-SK-0003	Revision 2
				Datum GDA94					
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				Title CONCEPT STORMWATER BIO-RETENTION / OSD BASINS 04	Date 6/07/2022		Size A1	Project Number/Drawing Number 220012-SK-0004	Revision 2
				Datum GDA94					



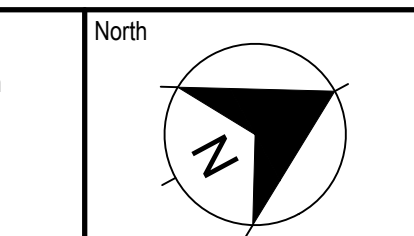
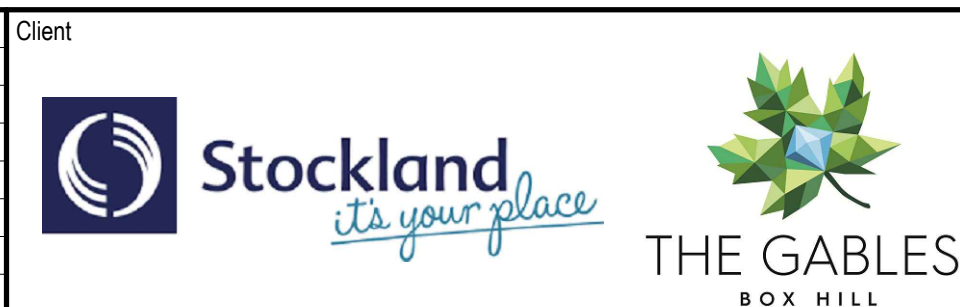
Client  Stockland <i>it's your place</i>  THE GABLES BOX HILL	Scale  01020304050m SCALE 1:500 @A1	North 	 Enspire Solutions Pty Ltd Level 4, 153 Walker Street, North Sydney NSW 2060 ABN: 71 624 801 690 Phone: 02 9922 6135	Project WEST GABLES REZONING	Scale 1:500	Status FOR INFORMATION ONLY NOT TO BE USED FOR CONSTRUCTION
				Date 6/07/2022	Size A1	
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LEGEND

- SITE BOUNDARY
- 100.00
— CONTOUR
- BATTER
- RW
— RETAINING WALL
- F 100.00
● IL 100.00
— FINISHED LEVEL
- INVERT LEVEL
- CHANNEL
- STORMWATER DRAINAGE LINE
— FLOW DIRECTION
- KERB INLET PIT
- SURFACE INLET PIT/JUNCTION PIT
- HEADWALL



REV.	DATE	DESCRIPTION	DRN.	DES.	VERIF.	APPD.
2	5/12/2022	ISSUED FOR INFORMATION	HD	HD	-	RH
1	6/07/2022	ISSUED FOR INFORMATION	CWH	HD	-	RH



Project	WEST GABLES REZONING
Title	CONCEPT STORMWATER BIO-RETENTION / OSD BASINS 06

Scale	1:500	Status	FOR INFORMATION ONLY NOT TO BE USED FOR CONSTRUCTION
Date	6/07/2022		
Size	A1	Project Number/Drawing Number	220012-SK-0006
Datum	GDA94	Revision	2



Client  Stockland its your place  THE GABLES BOX HILL	Scale  0 10 20 30 40 50m SCALE 1:500 @A1 The copyright of this drawing remains with Enspire Solutions Pty Ltd and must not be copied wholly or in part without the permission of Enspire Solutions Pty Ltd.	North 	 enspire Enspire Solutions Pty Ltd Level 4, 153 Walker Street, North Sydney NSW 2060 ABN: 71 624 801 690 Phone: 02 9922 6135	Project WEST GABLES REZONING	Scale 1:500	Status FOR INFORMATION ONLY NOT TO BE USED FOR CONSTRUCTION	
				Date 6/07/2022	Size A1		Project Number/Drawing Number 220012-SK-0007
				Title CONCEPT STORMWATER BIO-RETENTION / OSD BASIN 07	Datum GDA94		

Appendix B – Existing Flooding Scenario Submission

27 July 2022

SY171804

The Hills Shire Council
Anisul Huq
3 Columbia Court
Baulkham Hills NSW 2153

Dear Anisul,

Re: West Gables Development – Pre-Development Flood Model

Northrop Consulting Engineers have been engaged by Enspire Solutions to provide flood modelling services to support the West Gables Development area on behalf of Stockland and Allam Group. As part of this process we have reviewed the existing case flood model (EXIST_03) used for The Gables Development (model originally developed by JWP and amended by Northrop 2017-2022), identified parameters for modification, run the updated existing case, and compared to previous submissions.

A meeting was held with Council on the 14th July 2022 where it was requested to undertake a sensitivity analysis with the basin upstream of Boundary Road that has been removed, included back into the model.

The purpose of this correspondence is to summarise the updated model parameters and present a comparison of the existing flood levels for the EXIST_05 and EXIST_04 scenarios, to the previously submitted EXIST_03.

TUFLOW Version

The EXIST_04 and EXIST_05 models have been assessed using TUFLOW Classic, Version 2016-03-AE double precision solver.

Model Parameters

The following changes to the EXIST_03 model is included in the EXIST_04 scenario.

- A new surface was included in the model to reflect the existing ground conditions of the Gables West project area.
- The existing basin in the Gables West project area and the basin adjacent to Precinct B were clipped out from the new survey as the survey is not representing the existing conditions of the basins correctly.
- Two lots in Valletta Drive (Lot 1 DP1213569 and Lot 2 DP1213569) immediately south of the Gables development were clipped out the new surface as there has been significant development within these lots as a result of the Gables development.
- The Manning's roughness for the EXIST_04 is presented in Attachment 1 - Figure A1. This included the removal of a basin upstream of Boundary Road.

- Initial water level (IWL) of farm dams in the development area were updated based on the survey provided. Attachment 1 – Figure A2 presents the adopted initial water levels and any change in IWL compared with the EXIST_03 model. Initial water levels were adopted at the lowest spillway level per previous model approach.

No changes have been made to the existing hydraulic controls and blockage factors.

The following changes were made to the EXIST_04 model to represent the EXIST_05 scenario.

- The Manning's roughness for the EXIST_05 scenario is the same as EXIST_03.
- The initial water level for the basin upstream of Boundary Road was reinstated.
- The detailed survey was clipped out of the basin upstream of Boundary Road to represent the EXIST_03 condition in this area.



Figure 1 - Nearmap aerial, September 2013



Figure 2 - Nearmap aerial, June 2022

Results and Discussion

The flood elevation difference between EXIST_04 and EXIST_03 for the 39.35% AEP and 1% AEP events are presented in Attachment 1 – Figure A3 and Figure A4.

A summary of the results and a discussion are presented herein.

- A decrease of approximately 448mm in flood level was observed immediately upstream of Boundary Road during the 39.95% AEP event. The main reason is the removal of the basin outside the Gables and Gables West project area and the location is shown in Attachment 1 - Figure A1. As a result, this basin is not included in the new Gables West survey and hence, in the EXIST_04 model. A similar decrease of approximately 384mm was observed during the 1% AEP event.
- The removal of the basin has also resulted in increases in flood level through the upper reaches of the site approximately of up to 30mm and 21mm during the 1% AEP and 39.35% AEP events respectively. However, the change in the existing flood level in downstream areas of the Gables and Gables West project is less than 10mm.
- Increases of up to 504mm and 376mm are shown in two basins in the Gables West project area (one basin near Red Gables Road and the other is adjacent to the Sundowner Parkway) and this increase can be attributed to the increased initial water levels of the basins based on the new survey.
- The same assumption was made for initial water level in basins (i.e. basins are full to their lowest spillway crest). This was considered reasonable as it matches with the previous assumptions for the existing case model, basins are unlikely to be completely empty at the start of rainfall burst. Pre burst rainfall is likely, with a 10% to 90% pre-burst rainfall depth range of 0mm to 113mm in the 2-hour event.

The flood elevation difference between sensitivity model, EXIST_05 and EXIST_03 for the 39.35% AEP and 1% AEP events are presented in Attachment 1 – Figure A5 and Figure A6.

This demonstrates a reduction in flood level of approximately up to 8mm downstream of the west Gables project area during the 39.35% AEP event. During the 1% AEP event, change in the existing flood level in downstream areas of the Gables and Gables West project is less than 5mm. Overall, the results from the sensitivity analysis confirm that the increases shown through the upper reaches of the site in the previous EXIST_04 run are mostly due to the removal of the basin.

Conclusion

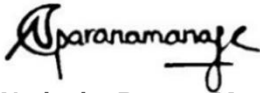
It was determined that both scenarios considered.

- Represents a “predeveloped” condition for the Gables and Gables West Project areas.
- Does not produce any significant increases in flood levels over the properties upstream or downstream in the 1% AEP and 39.35% AEP events.
- Is producing expected results compared to previous submissions.

The sensitivity analysis undertaken using the EXIST_05 model shows that the increases shown through the upper reaches of the site in the EXIST_04 run are mostly due to the removal of the basin.

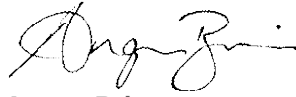
Either model can be used as a base model for the proposed Gables West Development project, and we request Council to confirm which scenario is preferred.

Prepared by



Nadeeka Parana Manage
Environmental Engineer
BEng (Environmental)(Hons)
PhD (Environmental Eng.)

Reviewed by



Angus Brien
Principal | Group Manager | Civil Engineer
BEng (Civil)(Hons)

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 The Hills Shire Council. 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.

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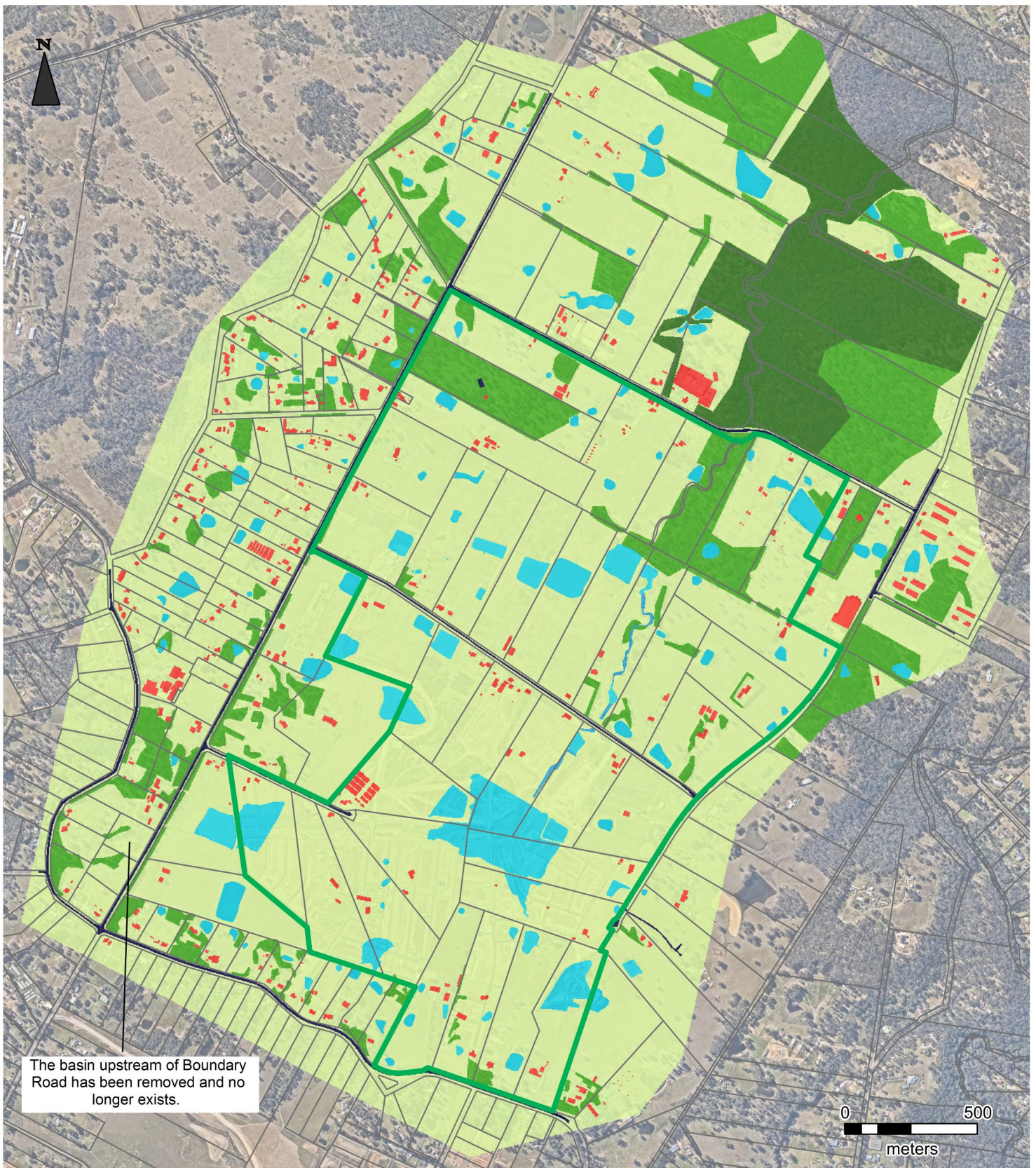
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Document Register

Rev	Status	Prepared	Approved	Date
A	Approval	N Parana Manage	A Brien	27 June 2022
B	Approval	A Brien	A Brien	28 June 2022
C	Approval	N Parana Manage	A Brien	27 July 2022

Attachment 1 – Result Figures



Legend

- Gables Development
- Lot

Manning's Roughness Value

 n = 0.012	 n = 0.30	 n = 0.025
 n = 0.02	 n = 0.08	 n = 0.10
 n = 0.04	 n = 0.05	 n = 0.05
 n = 0.15	 n = 0.03	 n = 0.04
 n = 0.07	 n = 0.025	 n = 0.015
 n = 0.025	 n = 0.30	 n = 0.035



THE GABLES
BOX HILL

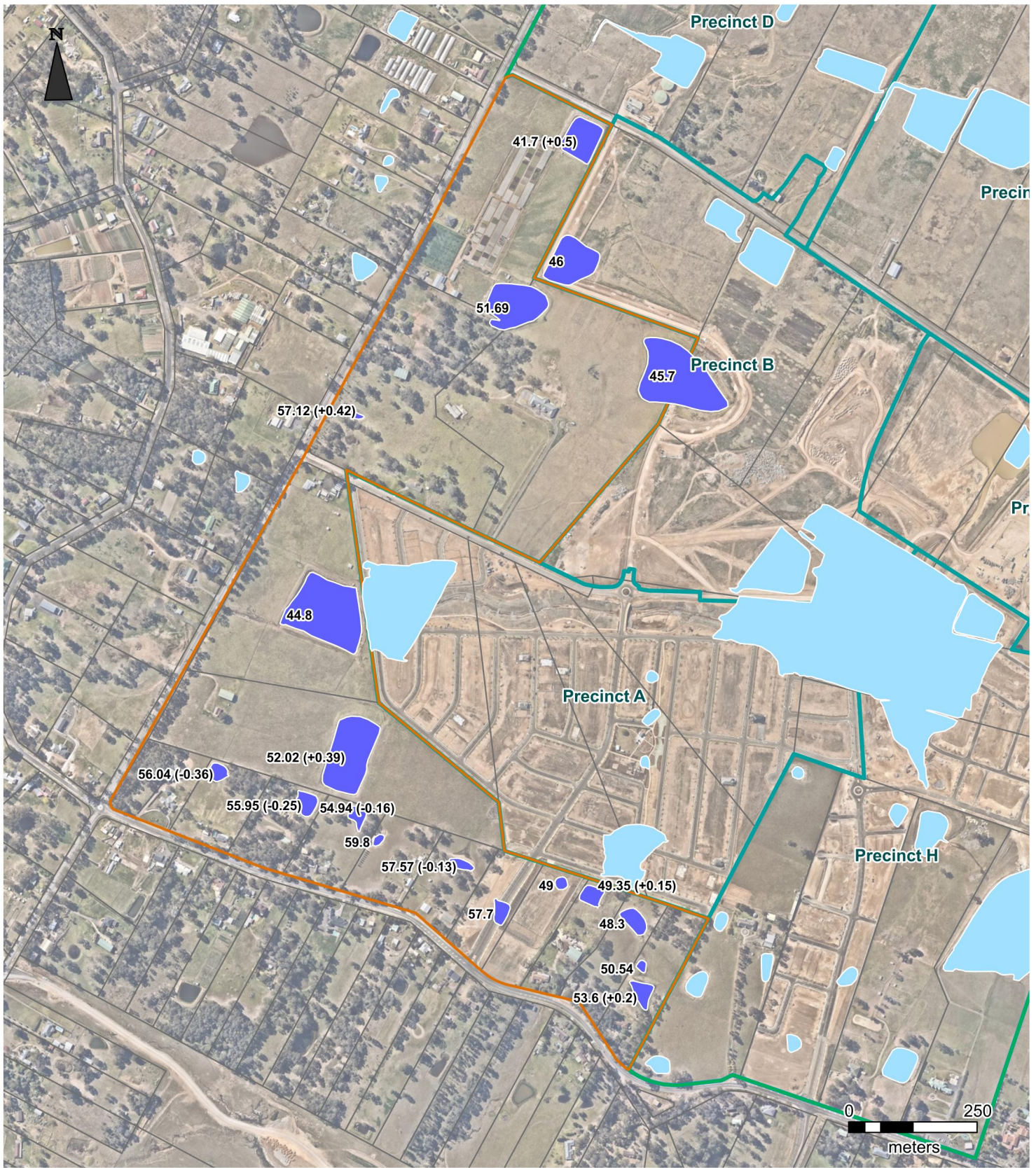
EXIST_04

Manning's Roughness



Figure A1

27-06-2022



Legend

- Gables Development
- Gables West Development

Basins Gables West

Precincts



THE GABLES
BOX HILL

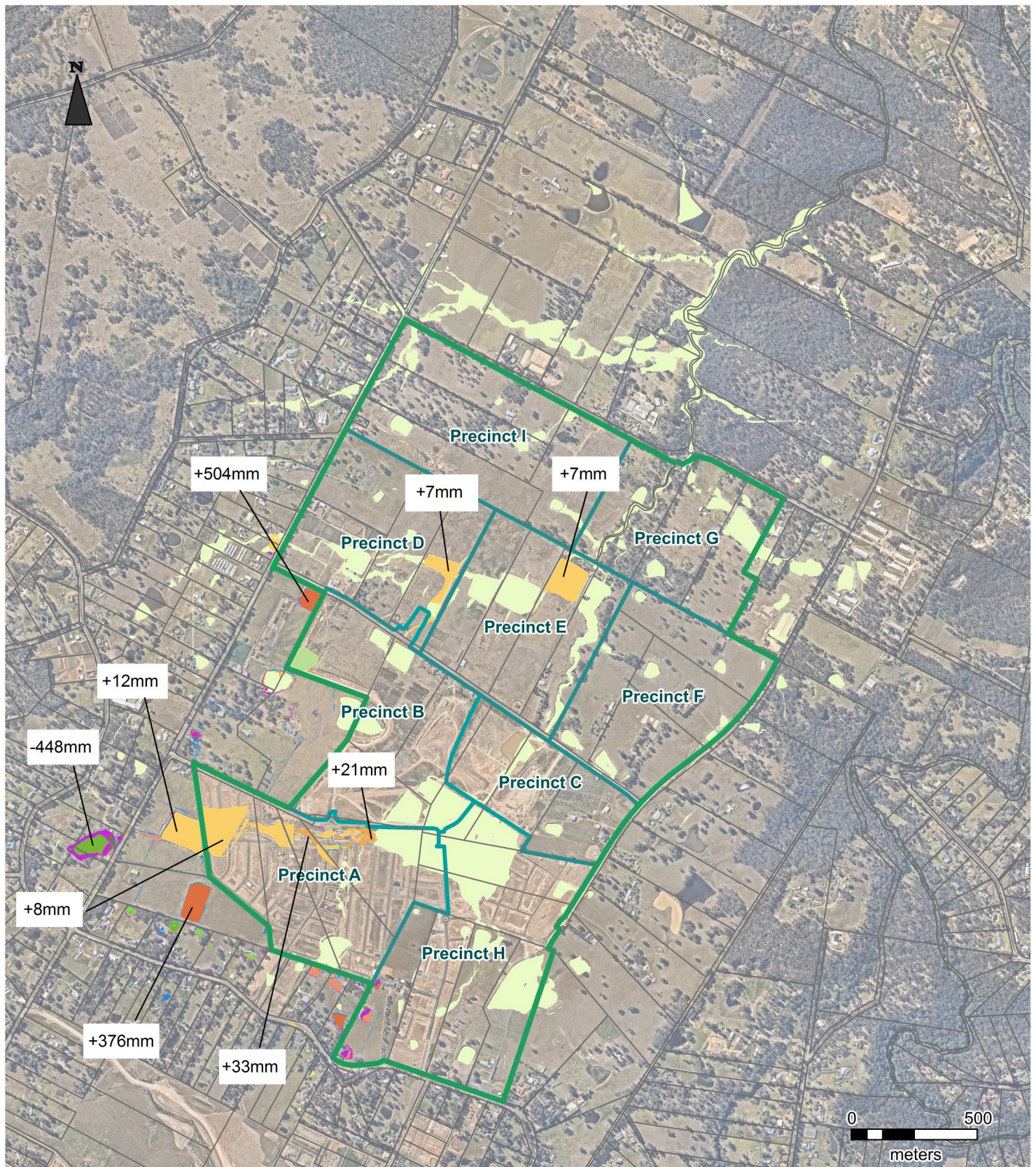
EXIST_04

Initial Water Level



Figure A2

27-06-2022



Legend

- Gables Development
- Precincts

Wet / Dry
Value

- Was Dry Now Wet
- Was Wet Now Dry

Elevation Difference (m)
Value

	Plus greater than 2		0.02 to 0.005		-0.5 to -0.2
	2 to 0.5		0.005 to -0.005		-2 to -0.5
	0.5 to 0.2		-0.02 to -0.005		Minus greater than 2
	0.2 to 0.05		-0.05 to -0.02		
	0.05 to 0.02		-0.2 to -0.05		



THE GABLES
BOX HILL

EXIST_04 Minus EXIST_03

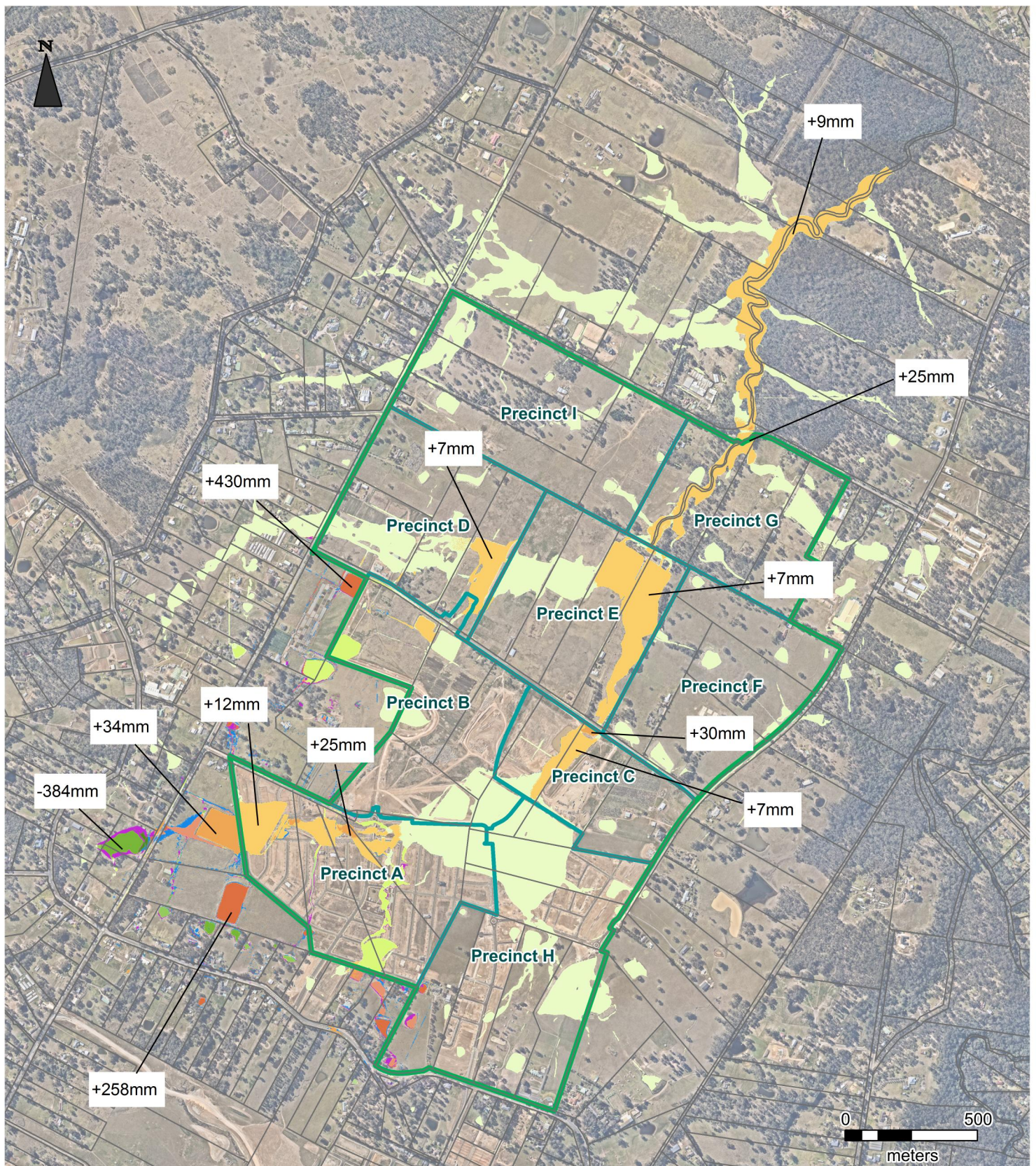
39.35% AEP

120m and 540m Envelope
Bdes Elevation Difference

Figure A3

27-06-2022





Legend

- Gables Development
- Precincts

Wet / Dry Value

- Was Dry Now Wet
- Was Wet Now Dry

Elevation Difference (m) Value

 Plus greater than 2	 0.02 to 0.005	 -0.5 to -0.2
 2 to 0.5	 0.005 to -0.005	 -2 to -0.5
 0.5 to 0.2	 -0.02 to -0.005	 Minus greater than 2
 0.2 to 0.05	 -0.05 to -0.02	
 0.05 to 0.02	 -0.2 to -0.05	



THE GABLES
BOX HILL

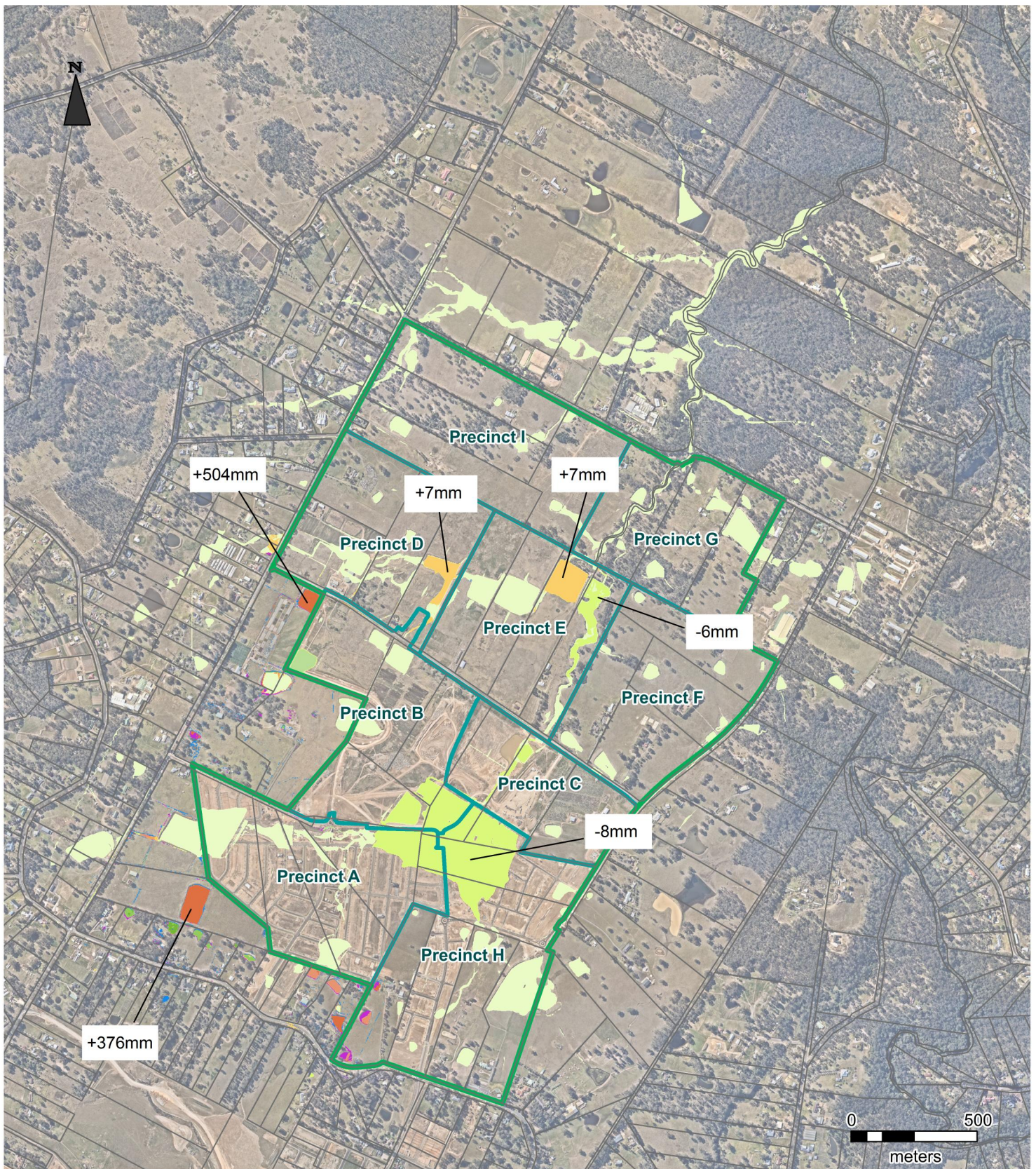
EXIST_04 Minus EXIST_03

1% AEP
120m and 540m Envelope
Bdes Elevation Difference

Figure A4



27-06-2022



Legend

- Gables Development
- Precincts

Wet / Dry
Value

- Was Dry Now Wet
- Was Wet Now Dry

Elevation Difference (m)
Value

 Plus greater than 2	 0.02 to 0.005	 -0.5 to -0.2
 2 to 0.5	 0.005 to -0.005	 -2 to -0.5
 0.5 to 0.2	 -0.02 to -0.005	 Minus greater than 2
 0.2 to 0.05	 -0.05 to -0.02	
 0.05 to 0.02	 -0.2 to -0.05	



THE GABLES
BOX HILL

EXIST_05 Minus EXIST_03

39.35% AEP

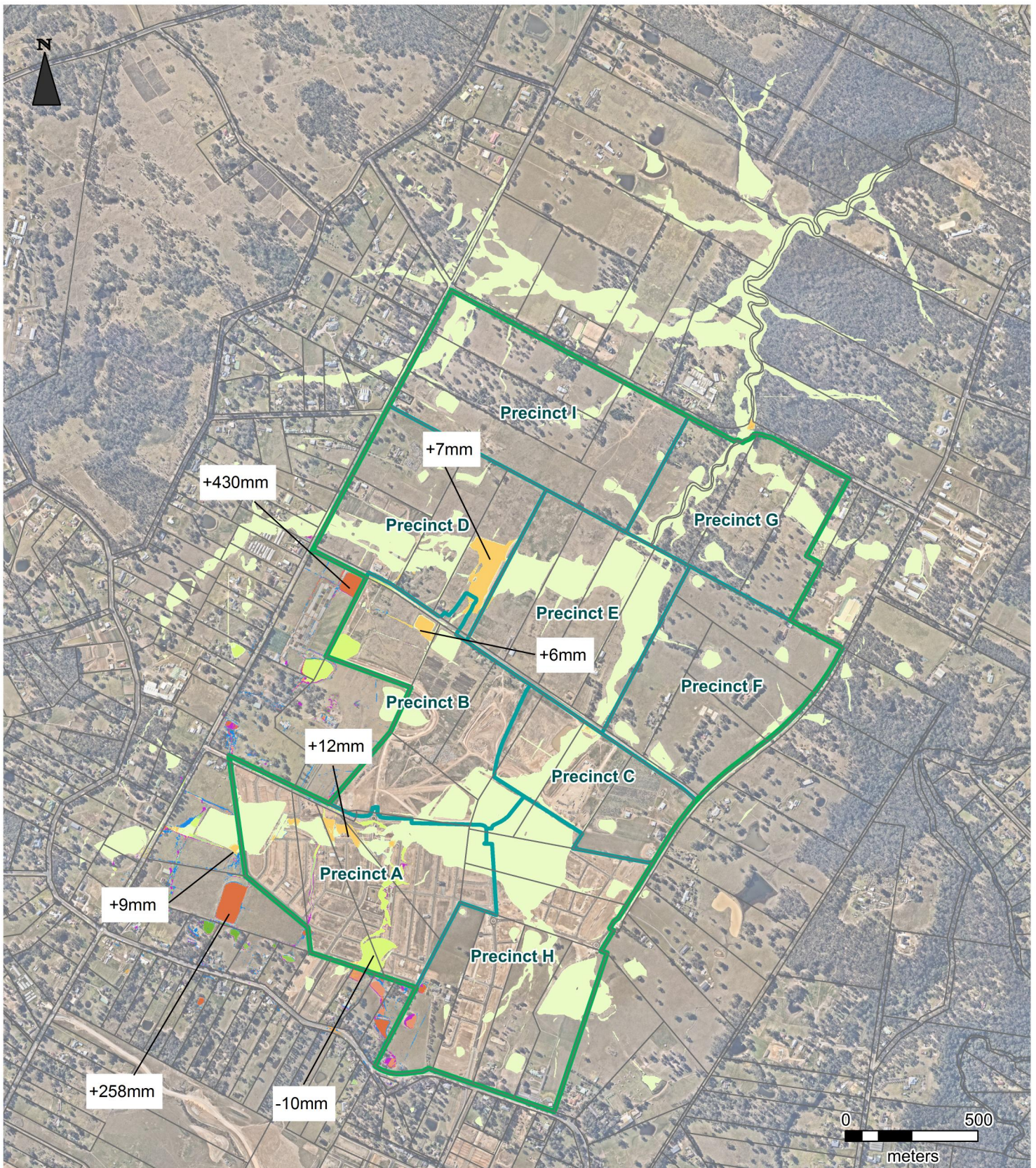
120m and 540m Envelope

Bdes Elevation Difference

Figure A5

22-07-2022





Legend

- Gables Development
- Precincts

Wet / Dry
Value

- Was Dry Now Wet
- Was Wet Now Dry

Elevation Difference (m)
Value

	Plus greater than 2		0.02 to 0.005		-0.5 to -0.2
	2 to 0.5		0.005 to -0.005		-2 to -0.5
	0.5 to 0.2		-0.02 to -0.005		Minus greater than 2
	0.2 to 0.05		-0.05 to -0.02		
	0.05 to 0.02		-0.2 to -0.05		



THE GABLES
BOX HILL

EXIST_05 Minus EXIST_03

1% AEP
120m and 540m Envelope
Bdes Elevation Difference

Figure A6



22-07-2022

Attachment 2 – Submission Checklist

Item Number	Submitted	Meeting	Approved	TUFLOW Submission Checklist (Items to be added as required)	Comments
0	☒	☐	☐	Readme files identifying; • Purpose of submission; • Changes since previous version; and • Folder structure.	Readme file submitted in root folder.
1	☒	☐	☐	Model control files (*.tcf, *.tgc, *.tbc, *.tef) simplified with scenario for assessment. Files to include a comment header describing generally; • The purpose of the run; • The version the model has been based on; and • Changes made since last iteration (preliminary submission) of this model. All commands to have a comment describing their purpose.	Model control files have been submitted in 1 - Model Control Files
2	☒	☐	☐	Model input files provided for all events and durations considered using “copyall” function. This produces a *.zip file with all GIS files and DEMs called in running the model.	Copy all zip files have been submitted in 2 - Model Input Files Events and durations considered are summarised overleaf.
3	☒	☐	☐	Modelling log (*.xls) replicating comments in control files.	Updated modelling log has been submitted in 3 - Modelling Log
4	☒	☐	☐	Figures showing model setup and results.	Model figures *.pdf submitted in 4 - Model Setup and Results Figures.
5	☒	☐	☐	MapInfo workspaces. To generally include; • Figure workspaces used for Item 4; • Inputs used in creating the TUFLOW scenarios; and • Filtered results grids.	Packaged MapInfo workspaces have been included in 5 - Mapinfo Workspaces.
6	☒	☐	☐	Check files for all event and duration runs.	Check files included in 6 - Model Check Files

Item Number	Submitted	Meeting	Approved	TUFLOW Submission Checklist (Items to be added as required)	Comments
7	☒	☐	☐	Results files for all event and duration runs.	Result files included in 7 - Model Results Files
8	☐	☐	☐	Civil drawings used in support of the submission.	No drawings for this submission.
9	☒	☐	☐	Updated correspondence and reports (as required).	Supporting memo provided in 9 – Reports and Correspondence.
10	☐	☐	☐	Additional items if required for submission (F10, F11 etc).	No additional items submitted.

2 – Events and Durations Considered

EXIST_04 Runs

AEP / min	10	15	25	30	45	60	90	120	150	180	270	360	540	720
39.35% B _{des}								C					C	
18.13% B _{des}														
10% B _{des}														
5% B _{des}														
1% B _{des}								C					C	
1% Zero														

EXIST_05 Runs

AEP / min	10	15	25	30	45	60	90	120	150	180	270	360	540	720
39.35% B _{des}								C					C	
18.13% B _{des}														
10% B _{des}														
5% B _{des}														
1% B _{des}								C					C	
1% Zero														