Flood Impact and Risk Assessment

for

559 Anambah Road, Gosforth

for Thirdi Anambah Pty Limited

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Contents

Acronyms

1D	One-Dimensional
2D	Two-Dimensional
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARR 2019	Australian Rainfall and Runoff 2019
BoM	Bureau of Meteorology
DA	Development Application
DCP	Development Control Plan
DRAINS	1D - Hydrodynamic Modelling Software
DTM	Digital Terrain Model
EY	Exceedances per Year
FIRA	Flood Impact and Risk Assessment
GPU	Graphics Processing Unit
GSDM	Generalised Short-Duration Method
Ha	Hectares – Measure of Area
HPC	Heavily Parallelised Computation
IFD	Intensity-Frequency-Duration
LGA	Local Government Area
LiDAR	Light Detection and Ranging Terrain Data (also see ALS)
m	Measure of length / height / distance (metres)
m AHD	Meters above Australian High Datum
m/s	Measure of velocity (metres per second)
m^3/s	Measure of flow rate (cubic metres per second)
PMF	Probable Maximum Flood
OSD	On-site Detention
RAFTS	Hydrologic model
SW	Storm Water
TP	Temporal Pattern
TUFLOW	A 1D and 2D hydraulic modelling software

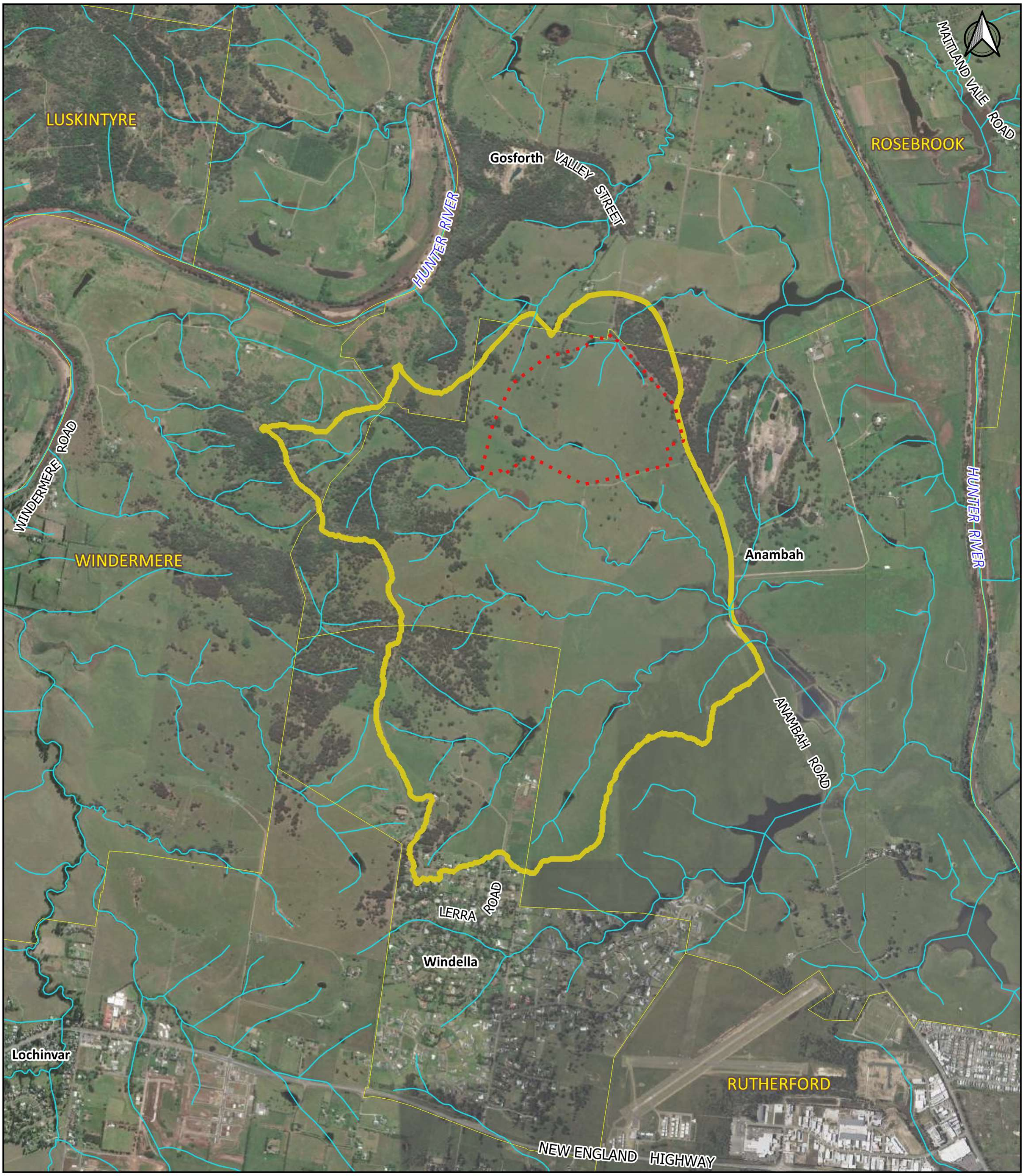
Introduction

Northrop Consulting Engineers have been engaged by Thirdi Anambah Pty Limited to prepare a Flood Impact and Risk Assessment (FIRA) for the proposed residential development located at 559 Anambah Road, Gosforth, herein referred to as the subject site or the site. The subject site locality is presented in **Figure 1** overleaf.

This FIRA aims to review the impact the proposed development has on existing flood behaviour within the subject site, adjacent properties and downstream areas, as well as undertake preliminary sizing of stormwater hydraulic structures including culverts and detention basins. This investigation has been prepared to support the Development Application (DA) to Maitland City Council (MCC).

This assessment has been prepared with the consideration of the following guidelines and documents:

- Maitland Development Control Plan (DCP 2011).
- Maitland City Council Manual of Engineering Standards – 6 Stormwater Drainage (MOES).
- Australian Rainfall and Runoff 2019 Guidelines (ARR 2019).
- Flood Risk Management Manual – The Management of Flood Liable Land (NSW Government June 2023 – “the manual”).



Legend

- Subject Site
- Study Catchment
- Hydrolines
- Suburbs

0 600 1,200 Metres

1:30,000

Figure 1

Locality

559 Anambah Road

NORTHROP

Data Source: NSW LPI - cadastre, Virtual Earth, Nearmap - aerial

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Methodology

This assessment has been undertaken generally using the following procedure:

- Desktop review of available previous investigations and information including design plans, LiDAR and survey data, stormwater infrastructure information and land use classifications.
- Preparation of a RAFTS (in DRAINS) hydrological model to determine the 10%, 5%, 1%, 1 in 500 AEP and PMF flows derived from the local upstream catchment and complete preliminary sizing of hydraulic structures.
- Preparation of an Existing Case two-dimensional TUFLOW hydraulic model to quantify the existing flood behaviour across the model extent.
- Modification of the Existing Case RAFTS (in DRAINS) hydrologic and TUFLOW hydraulic models to include the proposed development layout and terrain, creating the Developed Case and Developed Case Stage 1 scenarios. This model was also used to assess the performance of the proposed detention storages and hydraulic structures.
- A comparison of the Existing and Developed case results to review the impact the proposed development has on the existing flood behaviour on-site, in adjacent properties and downstream areas has also been prepared.

This study has been prepared with consideration to the following plans and reports:

- Masterplan layout prepared by Groundswell Engineers.
- Civil drawings and design surfaces prepared by Northrop Consulting Engineers.
- Detailed site survey plan prepared by Delfs Lascelles Surveyors.
- Council's Lochinvar Flood Study prepared by WMAwater in 2019.

Subject Site and Proposed Development

Subject Site

The subject site is located within the Maitland City Council (MCC) Local Government Area (LGA) at 559 Anambah Road, Gosforth and is contained within parcels of land known as Lot 55 DP 8741070 and part of Lot 177 DP 874171. The total site area is approximately 66 hectares with terrain elevations ranging from approximately 19m AHD to 58m AHD. An average slope of approximately six percent is observed across the site. The site current land use is predominantly grassland, scattered trees/shrubs and farm dams.

The site is surrounded by rural landscapes and has approximately 700m frontage adjacent to Anambah Road to the north-east. The typical existing site frontage is presented in **Photos 1** and **2** below.

Photo 1 – Anambah Road Frontage (Google Maps 2024), Looking to North-West

Photo 2 – Anambah Road Frontage (Google Maps 2024), Looking to South

Study Catchment

The study catchment extent is shown in the above **Figure 1**. The catchment predominantly falls from the west and directs runoff towards the Hunter River floodplain. Three major ephemeral watercourses traverse the catchment and generally drain from the west to the east towards Anambah Road culvert crossings. From Anambah Road, these watercourse discharge to the Hunter River. There are also two minor drainage paths discharging to the north. A summary of the catchment characteristics is presented in **Table 1** below.

Table 1 – Study Catchment Characteristics

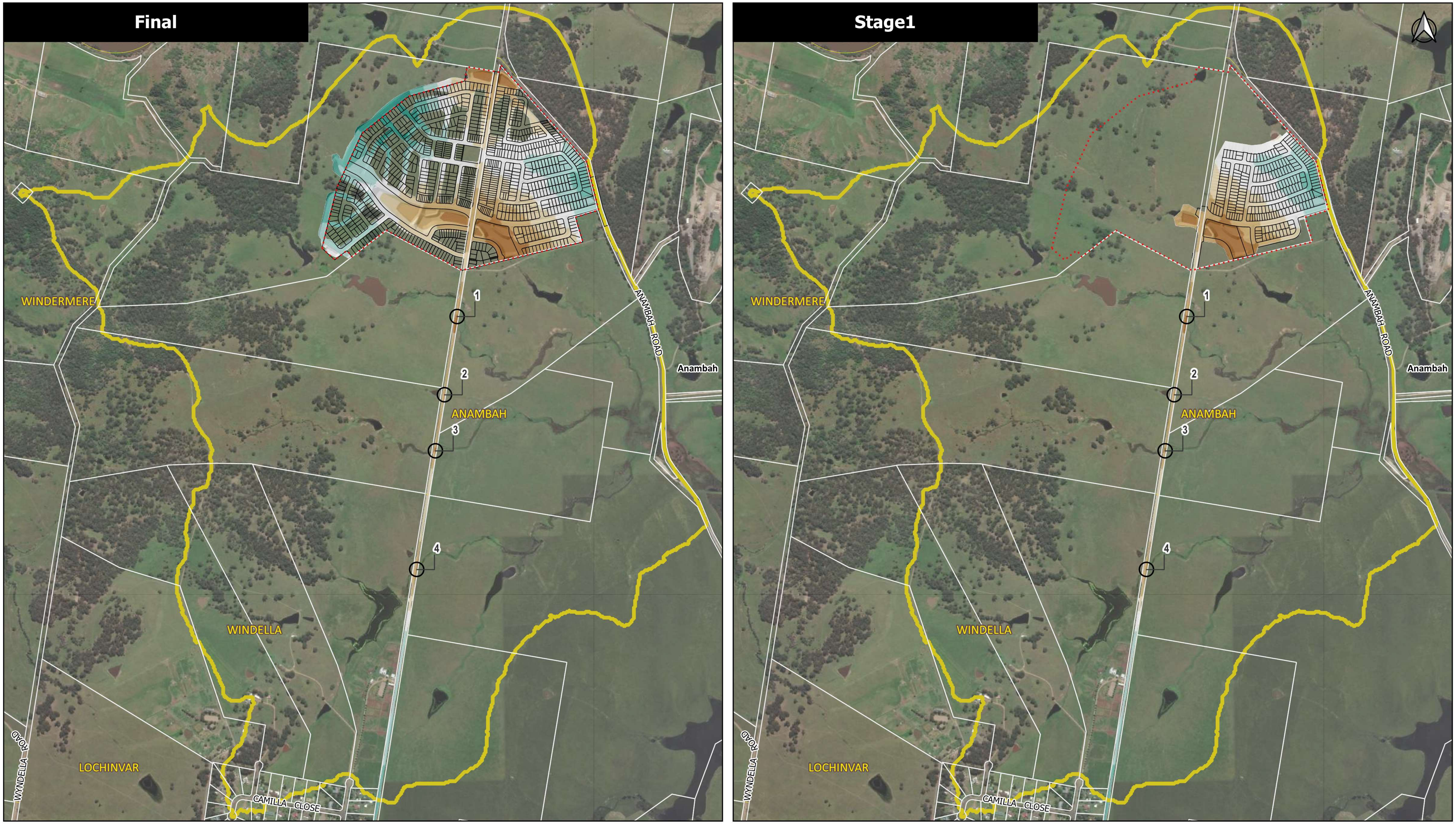
Characteristics	Value
Total Area (ha)	555
Average Elevation (m AHD)	44
Highest Elevation (m AHD)	173
Lowest Elevation (m AHD)	8
Average Slope (%)	9
Typical Land Use	Grassland and Pastures, Bushland, Scattered Shrubs and Trees, Farm Dams, Rural Residential, Low-density Residential, Sealed and Unsealed Roads.

Proposed Development

The proposed residential subdivision consists of up to 900 low and medium density residential lots, including three local parks, one located centrally within the site and two adjacent to the central watercourse, internal access roads, and stormwater quantity and quality treatment infrastructure.

As a part of the development, construction of a secondary access road is proposed along the existing River Road reserve. The road will establish a vehicular connection with residential areas of Windella located approximately 2.2km to south and provide flood free egress (up to the 1% AEP local catchment flood) for the development in case of potential inundation of Anambah Road during major local catchment flood events and/or Hunter River flooding.

This report has been prepared to support a Development Application for the proposed concept master plan and Stage 1 works. The proposed subdivision works for Stage 1 relate to the southeastern section of the subject site. The proposed subdivision layouts, design surfaces for both the concept master plan and Stage 1 including locations of the proposed four hydraulic structures (culverts) along River Road, are shown in **Figure 2** overleaf.



Legend

- Subject Site
- Cadastre
- Study Catchment
- Proposed Lots
- Proposed Hydraulic Structures

Design Surface(mAHD)

- <= 25.6
- 25.6 - 31.0
- 31.0 - 36.4
- 36.4 - 41.8
- 41.8 - 47.2
- 47.2 - 52.6
- > 52.6

0 200 400 Metres

1:15,000

Figure 2

Proposed Development

559 Anambah Road

NORTHROP

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial

Model Parameters

Detailed two-dimensional hydraulic modelling was undertaken using the TUFLOW hydrodynamic modelling software. One-dimensional DRAINS modelling software has been used to configure and size on-site detention basins/hydraulic structures and generate runoff inflows for the TUFLOW model. The hydrological and hydraulic model parameters are presented below.

Hydrological Model

The DRAINS modelling software with RAFTS hydrology was used in this assessment. As recommended by the latest Australian Rainfall and Runoff (ARR) 2019 guidelines the Initial and Continuing Loss (ILCL) model, coupled with median pre-burst rainfall has been adopted in this study.

Hydrological parameters including rainfall losses, pre-burst rainfall depths and catchment Manning's 'n' values were sourced from Council's Lochinvar Flood Study (WMAwater 2019). The Lochinvar Creek catchment is an adjacent catchment located immediately west of the study catchment.

The input data for the hydrology model used in this study includes sub-catchment data, design rainfall, temporal patterns, pre-burst rainfall and the Initial and Continuing Losses. These are summarised below in **Table 2**.

Sub-Catchment Properties

Sub-catchments have been delineated using a combination of LiDAR, aerial imagery, cadastral boundaries, and detailed survey for the existing, developed and Stage 1 development cases. The following **Table 2** presents the sub-catchment properties, and the catchment extents for both existing and developed cases are presented in **Figure 3** overleaf.

Table 2 – Existing Sub-Catchment Properties

Catchment Reference	Area (ha)	Vectored Slope (%)	Effective Impervious (%)	Catchment Reference	Area (ha)	Vectored Slope (%)	Effective Impervious (%)
C01	5.57	8.3	0	C26	10.84	6.5	0
C02	16.43	13.3	0	C27	15.68	6.5	0
C03	5.39	11.0	0	C28	10.04	10.1	0
C04	22.14	7.8	0	C29	9.27	12.8	0
C05	6.67	6.4	0	C30	13.25	14.9	0
C06	15.75	14.5	0	C31	5.02	6.3	0
C07	12.03	21.3	0	C32	14.45	10.7	0
C08	9.70	15.7	0	C33	11.76	8.6	0
C09	8.44	8.8	0	C34	10.28	6.4	0
C10	17.14	7.2	0	C35	3.89	8.4	0
C11	8.70	7.0	0	C36	10.63	13.8	0
C12	9.45	7.3	0	C37	10.31	7.8	0
C13	5.60	13.0	0	C38	4.33	9.0	0
C14	6.11	5.9	0	C39	9.88	7.9	0
C15	20.55	6.8	0	C40	7.23	12.5	0
C16	14.97	8.4	0	C41	10.56	25.2	0

Catchment Reference	Area (ha)	Vectored Slope (%)	Effective Impervious (%)	Catchment Reference	Area (ha)	Vectored Slope (%)	Effective Impervious (%)
C17	19.43	10.4	0	C42	10.07	6.7	0
C18	19.54	8.3	0	C43	6.07	12.5	0
C19	26.07	7.6	0	C44	8.43	5.9	0
C20	9.84	9.0	0	C45	12.05	7.8	0
C21	15.10	7.3	0	C46	14.01	5.9	0
C22	9.63	12.4	0	C47	10.73	16.1	0
C23	12.78	6.6	0	C48	7.33	18.5	0
C24	17.31	6.4	0	C49	7.50	7.7	0
C25	7.38	5.5	0				

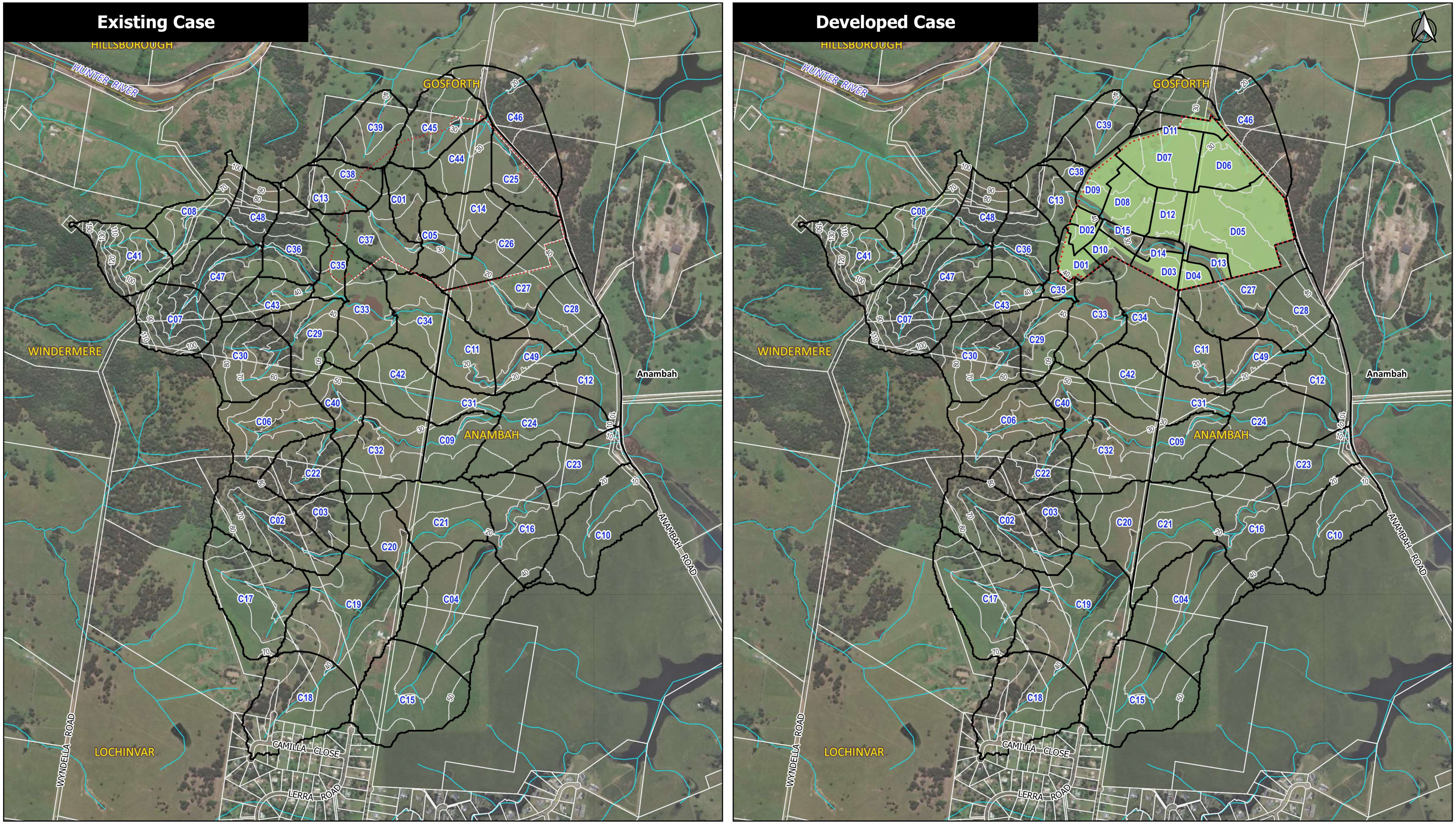
Sub-catchments over the extent of the proposed development have been further refined to capture proposed modifications to the terrain and land use introduced as part of the development. A typical impervious fraction of 64% has been assumed over the extent of the proposed development.

A summary of the developed catchments is presented in the below **Table 3** and **Figure 3** overleaf.

Table 3 - Developed Case Catchment Properties

Catchment Reference	Area (ha)	Vectored Slope (%)	Effective Impervious (%)	Catchment Reference	Area (ha)	Vectored Slope (%)	Effective Impervious (%)
C02	16.43	13.3	0	C35	2.06	9.7	0
C03	5.39	11	0	C36	10.63	13.8	0
C04	22.14	7.8	0	C38	1.86	9.3	0
C06	15.75	14.5	0	C39	8.95	8.1	0
C07	12.03	21.3	0	C40	7.23	12.5	0
C08	9.7	15.7	0	C41	10.56	25.2	0
C09	8.44	8.8	0	C42	10.07	6.7	0
C10	17.14	7.2	0	C43	6.07	12.5	0
C11	8.7	7	0	C45	5.09	7.3	0
C12	9.45	7.3	0	C46	14.76	5.9	0
C13	6.02	12.1	0	C47	10.73	16.1	0
C15	20.55	6.8	0	C48	7.33	18.5	0
C16	14.97	8.4	0	C49	7.5	7.7	0
C17	19.43	10.4	0	D01	2.9	3.5	65
C18	19.54	8.3	0	D02	1.33	3.5	65
C19	26.07	7.6	0	D03	2.9	3	65
C20	9.88	9.1	0	D04	1.76	3.5	65
C21	15.06	7.3	0	D05	18.68	3	65
C22	9.63	12.4	0	D06	6.48	3	65

Catchment Reference	Area (ha)	Vectored Slope (%)	Effective Impervious (%)	Catchment Reference	Area (ha)	Vectored Slope (%)	Effective Impervious (%)
C23	12.78	6.6	0	D07	9.78	3.5	65
C24	17.31	6.4	0	D08	6.24	3.5	65
C27	12.75	6.4	0	D09	3.89	3.5	65
C28	10.04	10.1	0	D10	2.27	3.5	65
C29	9.27	12.8	0	D11	3.05	3	0
C30	13.25	14.9	0	D12	3.78	3.5	65
C31	5.02	6.3	0	D13	2.04	5	0
C32	14.45	10.7	0	D14	1.58	5	0
C33	10.72	8.9	0	D15	1.69	5	0
C34	11.11	6.1	0	D16	1.09	5	0



Legend

- Subject Site
- Cadastre
- Hydrolines
- Catchments
- Contours(mAHD)

0 300 600 Metres

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Figure 3

DRAINS Model Catchments

559 Anambah Road

NORTHROP

Burst Rainfall

The latest ARR 2019 rainfall has been obtained from the Bureau of Meteorology (BoM) while the accompanying rainfall temporal patterns have been obtained by the ARR Data Hub for a location over the study catchment.

ARR 2019 recommends the use of the storm ensemble method using 10 temporal patterns for each storm duration. For this investigation, storm durations ranging from the 10, 15, 20, 25, 30, 45-minute, 1, 1.5, 2, 2.5, 3, 4, 4.5, 5, 6-hour for 10%, 5%, 1%, 1 in 500 AEP and PMF design storm events were assessed in the hydrological model. The following **Table 4** presents the rainfall depths used for the investigation.

An Areal Reduction Factors (ARF) were not applied to design rainfall due to the size of the catchments. We believe this is an appropriately conservative assumption.

Table 4 - IFD Rainfall Depths (mm)

Duration	10% AEP	5% AEP	1% AEP	1 in 500 AEP	PMF
10 min	20.2	23.8	33.3	44.0	-
15 min	25.3	29.8	41.8	55.2	160
20 min	29.0	34.2	47.9	63.4	-
25 min	32.0	37.7	52.6	69.7	-
30 min	34.4	40.6	56.4	74.9	230
45 min	39.9	47.0	64.9	86.3	300
1 hour	43.9	51.6	71.2	94.5	340
1.5 hour	50.0	58.7	80.7	107	420
2 hour	54.9	64.4	88.4	117	480
2.5 hour	-	-	-	-	520
3 hour	62.7	73.7	101	134	560
4 hour	-	-	-	-	620
4.5 hour	72.4	85.2	118	155	-
5 hour	-	-	-	-	680
6 hour	80.7	95.2	133	174	720

Pre-Burst Rainfall

The median (50th-percentile) pre-burst rainfall depths have been adopted for the purposes of the investigation. These were obtained from the ARR Data Hub for a location over the study catchment and consistent with the pre-burst depths used in the Lochinvar Flood Study. **Table 5** presents the median pre-burst rainfall depths used for the assessment.

Table 5 - Median Pre-Burst Rainfall Depths (mm)

Duration	10% AEP	5% AEP	1% AEP	1 in 500 AEP
10 min	1.6	1.9	1.4	1.4
15 min	1.6	1.9	1.4	1.4
20 min	1.6	1.9	1.4	1.4

Duration	10% AEP	5% AEP	1% AEP	1 in 500 AEP
25 min	1.6	1.9	1.4	1.4
30 min	1.6	1.9	1.4	1.4
45 min	1.6	1.9	1.4	1.4
1 hour	1.6	1.9	1.4	1.4
1.5 hour	1.6	2.1	1.2	1.2
2 hour	2.5	3.3	3.4	3.4
3 hour	1.2	1.3	2.7	2.7
4.5 hour	3.3	4	5.7	5.7
6 hour	5.3	6.6	8.7	8.7

Infiltration Losses and Catchment Roughness

As mentioned above, the Initial and Continuing Loss (ILCL) model has been used for this study with the storm losses obtained from Council's Lochinvar Flood Study. The ILCL method simulates catchment storage as an initial loss in rainfall followed by a constant loss rate (continuing loss). For the PMF event, zero initial and continuing losses were adopted. The following **Table 6** presents the Initial and Continuing losses used for the analysis.

Table 6 – Infiltration Loss Parameters

Land Use	Initial Loss (mm)	Continuing Loss (mm/hr)
Modelled Pervious	18.0	2.0
Modelled Effective Impervious	0.0	0.0
PMF Modelled Pervious	0.0	0.0
PMF Modelled Effective Impervious	0.0	0.0

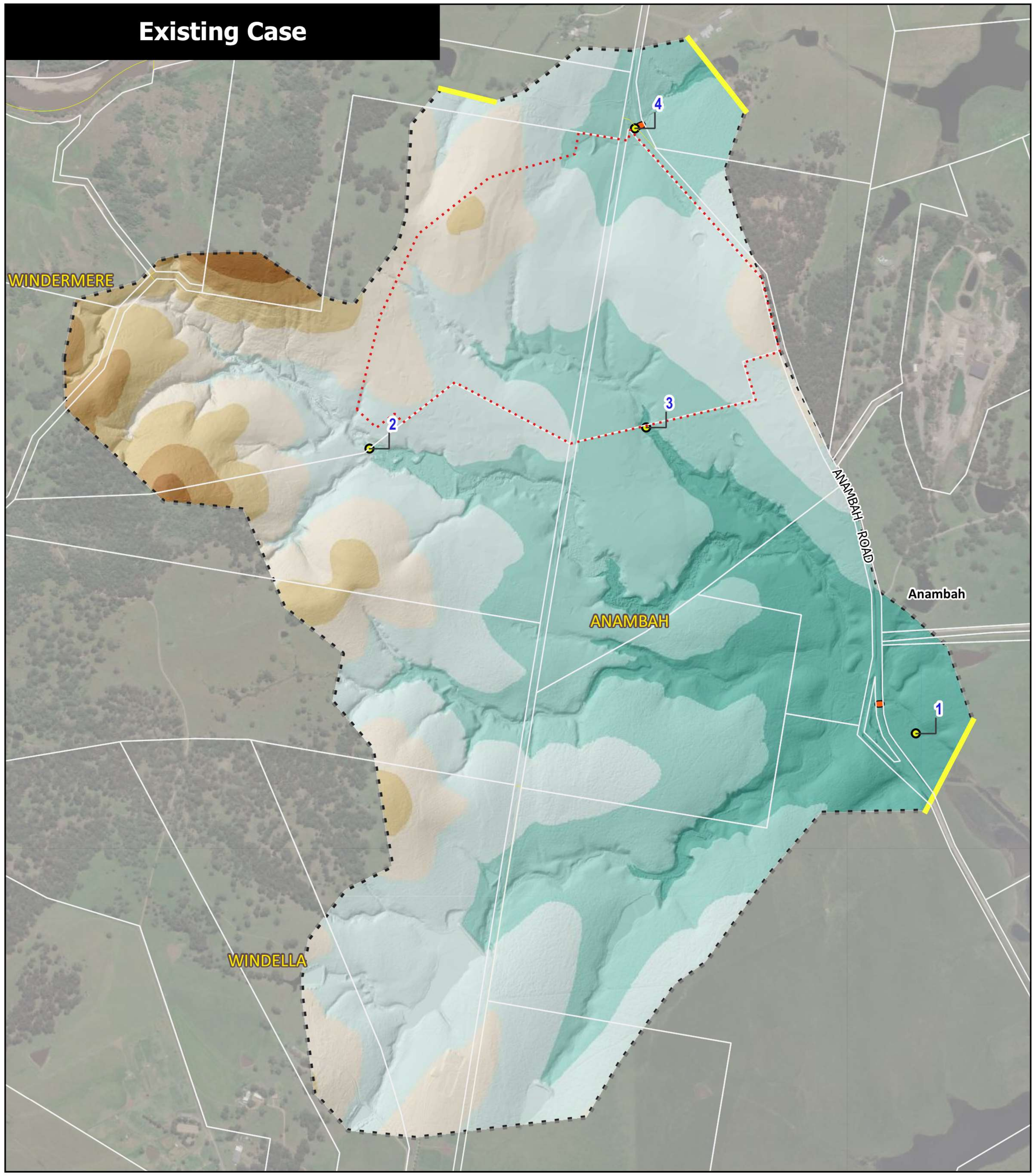
A hydrological roughness of 0.015 has been used for impervious areas which is consistent with concrete surfaces and roads while a roughness value of 0.040 have been adopted for pervious areas which are consistent with predominantly grassed areas expected over rural catchments.

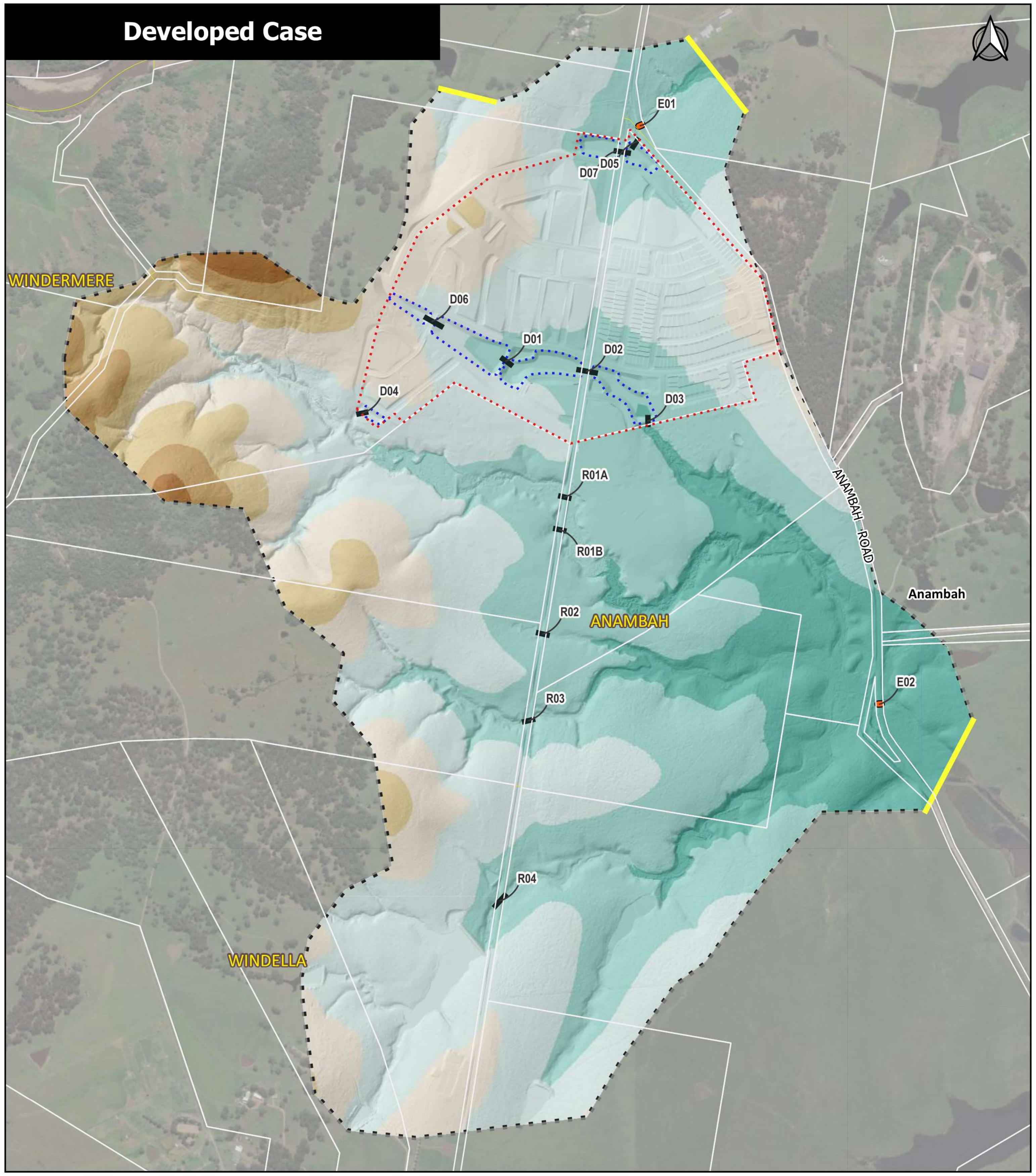
Hydraulic Model

The hydraulic model used for this study is the combined 1D/2D TUFLOW hydrodynamic software. For this study, the TUFLOW version 2020-10-AD with HPC GPU solver has been used.

Model Domain

The TUFLOW model extent is presented in **Figure 4** overleaf for both existing, developed and developed Stage1 conditions. The TUFLOW model terrain was developed using a combination of drone-captured and publicly available LiDAR terrain data, detailed topographical survey and design surfaces. A 1.5 metre grid size was adopted in this flood assessment as it was determined to provide a reasonable balance between model run time and flood behaviour through watercourses.





Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent
- Downstream Boundaries
- Existing Culverts
- Proposed Structures
- Detention Basins
- Flow Reporting Locations

Terrain(mAHD)

- <= 20.4
- 20.4 - 32.5
- 32.5 - 44.7
- 44.7 - 56.8
- 56.8 - 68.9
- 68.9 - 81.1
- > 81.1

0 200 400 Metres
1:14,000

Figure 4
TUFLOW Model Setup

559 Anambah Road NORTHROP

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial

Boundary Conditions

Sub-catchment flows derived by the RAFTS (in DRAINS) model were applied directly to the two-dimensional grid via a series of inflow polygons. Three model outlet boundaries are shown in **Figure 4**. A "HQ" boundary was used for each of the outlets with a "free outflow" tailwater condition and slopes generally consistent with the observed existing terrain grades at the location of the outlet boundaries.

Hydraulic Structures

The location of the modelled existing and developed case stormwater infrastructure entered the two-dimensional TUFLOW model is presented in **Figure 4**.

A summary of modelled existing and proposed hydraulic structures (refer to **Figure 4** for locations) is presented in the following **Table 7**. A blockage factor of 25% has been adopted for all road crossing structures for all modelled events. The applied 25% blockage is generally consistent with the latest ARR 2019 blockage guidelines for small predominantly rural catchments with moderate slope.

Table 7– Proposed Hydraulic Structures

Culvert Reference	Description	Type and Size
E01	Existing Anambah Rd Crossing North	RCP 2 x D0.75m
E02	Existing Anambah Rd Crossing South	RCP 4 x D1.80m
R01A	Proposed River Road	RCBC 6 x W2.70m x H0.90m
R01B	Proposed River Road	RCBC 1 x W2.70m x H0.90m
R02	Proposed River Road	RCBC 3 x W1.20m x H0.90m
R03	Proposed River Road	RCBC 5 x W1.80m x H0.90m
R04	Proposed River Road	RCBC 3 x W3.60m x H1.20m
D06	Proposed Central Corridor Upstream Basin	RCBC 1 x W1.20m x H0.90m
D01	Proposed Central Corridor Upstream Basin	RCBC 1 x W1.50 x H1.20m Low Flow Opening: 1 x W0.60m x H0.45m High Flow Opening: 1 x W1.50m x H0.60m Weir width 15m, depth 0.20m
D02	Proposed Central Corridor Upstream Basin	RCBC 1 x W1.50m x H1.20m
D03	Proposed Central Corridor Upstream Basin Outlet	RCBC 3 x W1.80m x H1.80m Low Flow Opening: 2 x W0.90m x H0.45m High Flow Opening: 3 x W1.80m x H1.00m Weir width ~ 15m, depth 0.35m
D04	Proposed South-West Basin Outlet	RCBC 1 x W0.90m x H0.90m

D05	Proposed Northern Basins Outlet	RCBC 2 x W1.50m x H1.50m Low Flow Opening: 2 x W0.60m x H0.30m High Flow Opening: 2 x W1.50m x H0.60m Weir width 7m, depth 0.3m
D07	Proposed Northern Basins Connection Structure	RCBC 1 x W0.90m x H0.90m

Hydraulic Roughness

The following **Table 8** below presents the modelled land use and the adopted surface roughness values. The adopted surface roughness values are consistent with values used in the Lochinvar Flood Study. The modelled TUFLOW land use roughness areas for both existing and developed conditions are shown in **Figure 5** overleaf.

Table 8 - Land Use Roughness (Manning's)

Land Use	Roughness (Manning's)
Dense Vegetation	0.080
Open Water	0.022
Grassland and Pastures	0.040
Creeks	0.035
Roads, Concrete Surfaces	0.020
Development Lots	0.050

Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent

Roughness

- Grassland
- Dense Vegetation
- Open Water
- Roads
- Creeks
- Residential

0 200 400 Metres
1:14,000

Figure 5

TUFLOW Model Roughness

559 Anambah Road

NORTHROP

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Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial

Results

Critical Duration

To determine the critical storm duration for the subject site and vicinity the guidance provided in the latest ARR 2019 guidelines was considered as summarised below:

- Classification of the median value of the ten temporal patterns (TP) for each storm duration.
- Selection of the duration that produces the maximum median value for each return interval.

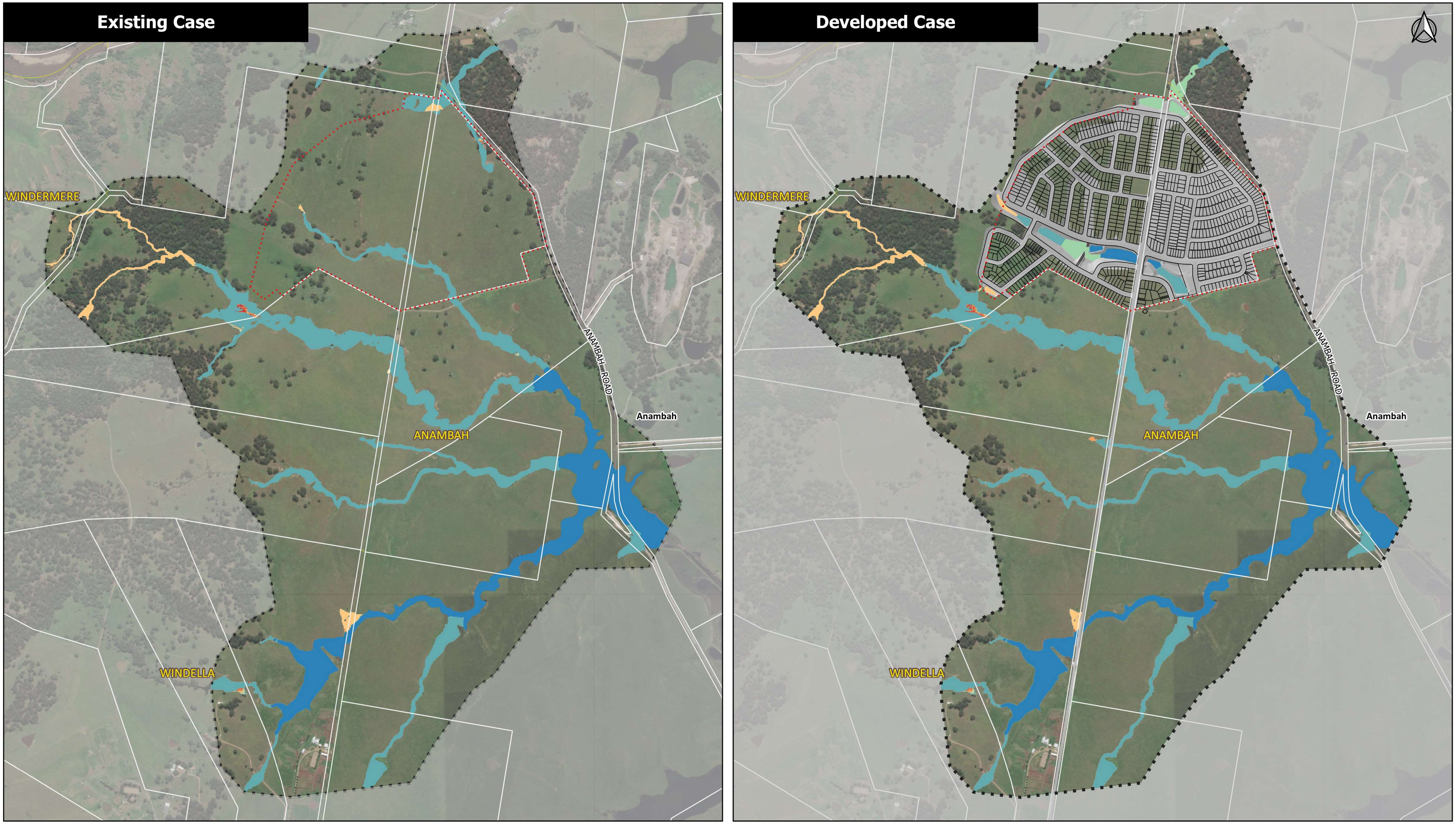
The flood elevation results were used in this investigation to define the maximum median value.

All ten rainfall patterns for the 10, 15, 20, 25, 30, 45, 60-minute and 1.5, 2, 3, 4.5, and 6-hour durations were entered into the two-dimensional model to determine the critical storm duration for the 10%, 5%, 1% and 1 in 500 AEP flood events for local catchment flooding. Similarly, the 15, 30, 45, 60-minute and 1.5, 2, 2.5, 3, 4, 5 and 6-hour durations were used to determine the critical duration for the PMF event.

The below **Table 9** presents the critical durations and rainfall temporal patterns modelled during the existing and developed case scenarios for 10%, 5%, 1%, 1 in 500 AEP and PMF design flood events. 1% AEP critical duration maps for both existing and developed cases are presented in **Figure 6** overleaf.

Table 9 - Critical Durations and Patterns

Event	10% AEP	5% AEP	1% AEP	1 in 500 AEP	PMF
1	1hr TP3	20min TP2	10m TP7	10m TP7	15m
2	1hr TP6	1hr TP3	20m TP4	20m TP4	30m
3	1hr TP7	1hr TP6	25m TP1	25m TP1	45m
4	1.5hr TP4	1hr TP7	25m TP5	25m TP5	-
5	1.5hr TP6	1.5hr TP6	25m TP6	25m TP6	-
6	2hr TP1	1.5hr TP7	25m TP7	25m TP7	-
7	2hr TP7	2hr TP5	45m TP6	45m TP6	-
8	-	2hr TP7	45m TP8	2hr TP10	-
9	-	-	2hr TP4	-	-
10	-	-	2hr TP10	-	-



Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent

Durations

- 10min TP7
- 20min TP4
- 25min TP1
- 25min TP5
- 25min TP6
- 25min TP7
- 45min TP6
- 45min TP8
- 2hour TP4
- 2hour TP10

0 200 400 Metres

1:14,000

Figure 6

1% AEP Flood Durations

559 Anambah Road

NORTHROP

19/5/2025 A3 X:\PROJECTS\NEWCASTLE\YEAR 2022 Jobs\NL222055 - Anambah Road\D - DESIGN\FIGURES\Figures_rev_Site1_v2.qgz

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial

Flood Behaviour

Flood Depth, Elevation, Velocity and Hydraulic Hazard

Maximum modelled flood depth/elevations, velocity and hazard for the 10%, 5%, 1%, 1 in 500 AEP and PMF local catchment flood events for the existing and developed case scenarios are presented in **Figures BC1-1** to **BC6-3** of **Appendix A**.

Similarly, the 1% AEP flood depth/elevation, velocity and hazard for the Stage 1 of the development are presented in **Figures BC5-1** to **BC5-3** of **Appendix A**.

Flood hazard conditions have been assessed based on the latest ARR 2019 guidelines and Australian Institute of Disaster Resilience (AIDR) hazard categories presented in **Figure 7** below.

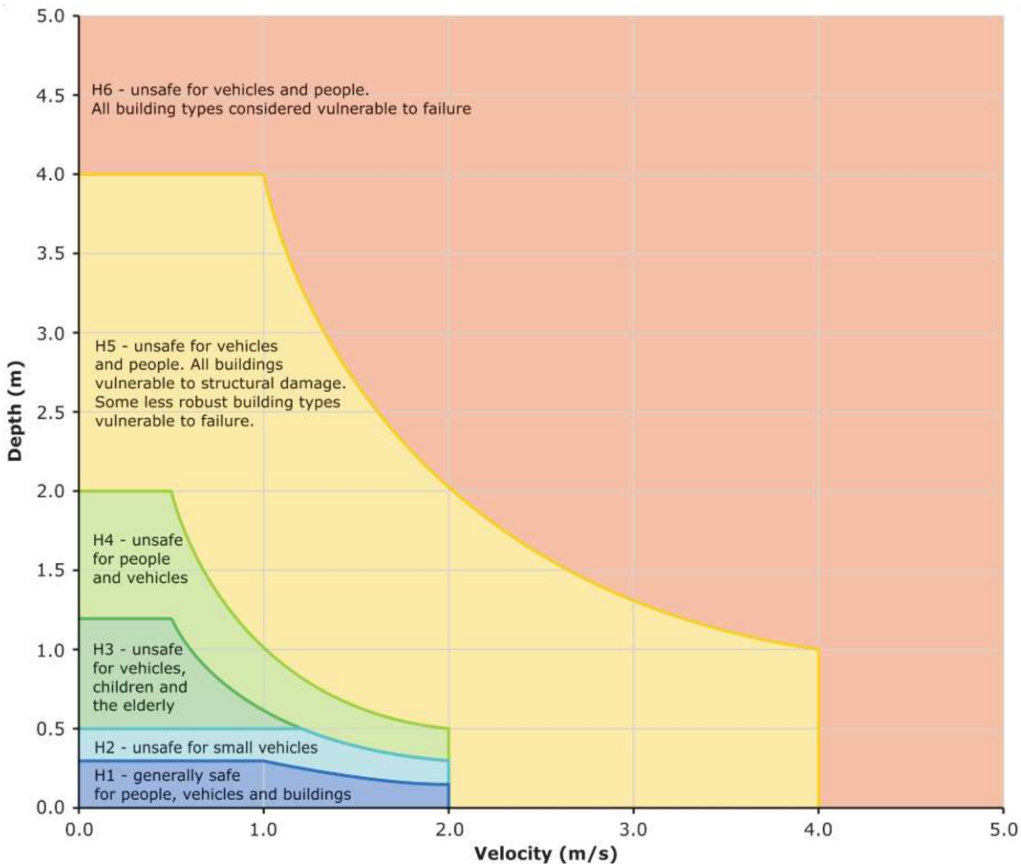


Figure 7 - Australian Rainfall and Runoff (2019) Hazard Categories

Peak Flows

Modelled local catchment peak flows for the 1EY, 10%, 5%, 1%, 1 in 500 AEP and PMF local catchment flood events for the existing and developed case scenarios at the flow reporting locations (refer to **Figure 4**) are presented in **Table 10** below.

Table 10 - Peak Flows at Reporting Locations

Location Reference	Location Description	Flood Event (AEP)	Existing Case (m^3/s)	Developed Case (m^3/s)	Difference (m^3/s)	Difference (%)
1	200m D/S of Anambah Road South Crossing	1EY	6.04	6.26	**0.2**	**3.6**
		10%	25.0	25.2	**0.2**	**0.9**
		5%	38.9	39.1	**0.2**	**0.5**
		1%	87.9	86.6	**-1.3**	**-1.5**
		1 in 500	118	111	**-7.1**	**-6.0**
		PMF	659	654	**-4.7**	**-0.7**
2	100m D/S of South-West Basin Outlet	1EY	0.56	0.48	**-0.1**	**-14.3**
		10%	8.83	8.91	**0.1**	**0.9**
		5%	9.59	9.53	**-0.1**	**-0.6**
		1%	22.6	22.6	**-0.1**	**-0.3**
		1 in 500	27.6	27.9	**0.3**	**1.0**
		PMF	129	130	**1.0**	**0.8**
3	D/S of Central Corridor Basins Outlet	1EY	1.67	1.58	**-0.1**	**-5.4**
		10%	7.02	5.39	**-1.6**	**-23.2**
		5%	9.00	6.52	**-2.5**	**-27.6**
		1%	15.9	9.84	**-6.1**	**-38.2**
		1 in 500	20.7	12.9	**-7.8**	**-37.8**
		PMF	84.8	76.4	**-8.5**	**-10.0**
4	20m D/S of Northern Basins Outlet	1EY	0.68	0.63	**-0.1**	**-7.4**
		10%	2.69	1.87	**-0.8**	**-30.5**
		5%	3.25	2.04	**-1.2**	**-37.2**
		1%	5.32	2.93	**-2.4**	**-44.9**
		1 in 500	7.59	6.33	**-1.3**	**-16.6**
		PMF	33.1	35.5	**2.4**	**7.3**

The results in the **Table 10** show that the proposed stormwater detention infrastructure is suitable to attenuate peak flows from the development generally for all modelled events between the 1EY and 1% AEP. A few peak flow increases are observed in locations 1 and 2 which are typically less than one percent and are therefore considered minor in magnitude. These increases are discussed further in the Discussion section of this report.

Flood Immunity

Developed case modelling indicates the proposed River Road has 1% AEP local catchment flood immunity and will be trafficable in up to and including 1 in 500 AEP local event (H1 flood hazard observed across the road surface during 1 in 500 AEP event at the proposed culvert R01B).

Modelling also indicates that Anambah Road at the south Anambah Road culvert crossing has 10% AEP local catchment flood immunity (approximately 200mm freeboard to the road surface) and trafficable for up to 5% AEP local event including small vehicles (H1 flood hazard).

Similarly, Anambah Road at the northern culvert crossing is flood free during the 5% AEP event (approximately 200mm freeboard maintained to the road edge) and generally safe for all vehicles for up to 1% AEP event (H1 flood hazard).

The Stage 1 developed case modelling suggests the proposed River Road is trafficable for up to 1% AEP event with H1 flood hazard observed across the road surface at the proposed culvert D02.

Flood Level Effects

Figures D1, D2, D3, D4 and **D6** of **Appendix B** presents the change in flood levels for the modelled 10%, 5%, 1%, 1 in 500 AEP and PMF flood events. The 1% AEP flood impact for Stage 1 only of the development presented in **Figure D5** of **Appendix B**.

The results presented in **Figures D1 to D6 Appendix B** typically shows a reduction in flood levels is expected to occur during all modelled events downstream of the proposed development.

During the 10% AEP event, a localised increase of up to 22mm is observed upstream of the southern Anambah Road culvert crossing. The increase is expected to be due to the River Road and associated hydraulic structures construction, leading to a slight alteration in the coincident of the peak flows in the watercourses in the upstream area of the Anambah Road culvert crossing. This increase is relatively minor in extent and magnitude and there is no change in the existing flood hazard conditions. As such, this is not considered to create a significant adverse impact in this location.

Similarly, during the 1 in 500 AEP event, an increase of up to 145mm is observed upstream of the proposed River Road culvert R01 (refer to **Figure 4** for location). This increase is expected due to the proposed road fill across the existing watercourse. The increase is not considered to create significant adverse impact as the increase is localised within the watercourse.

During the PMF event, **Figure D6** of **Appendix B** shows an increase of up to approximately 100mm, 500mm and 550mm are observed in watercourses upstream of the existing Anambah Road northern crossing, and upstream of the proposed River Road crossings R01 and R03, respectively. As the PMF design storm event has an extremely rare chance of occurring, it is not typically used to guide development and generally, the greatest concern during an event of this nature is whether a change in the risk to life occurs as a result of the development.

Review of **Figure BC6-3** of **Appendix A** shows no significant changes in flood hazard conditions observed during the PMF. H5 and H6 flood hazard conditions are already observed across the watercourses under the existing conditions, and as such, no increase in the risk to life and, therefore, a significant adverse impact are expected during the PMF local flood event developed conditions.

Based on the above, the proposed development is not considered to create a significant adverse impact on the subject site, in adjacent properties or downstream areas.

Discussion

Suitability of Flood Level Impacts

As discussed above, where there is an increase greater than 10mm, a merit-based assessment has been carried out to determine whether the increase is likely to cause a significant adverse impact.

Through consideration of the magnitude of the increase, likelihood of the event, the existing development in the area of increase, and hazard category changes in the area of increase, we do not believe the flood level increases determined as part of this investigation cause a significant adverse impact.

Consideration of Changes in Flood Behaviour

Consideration of other flood characteristics and the likely changes resulting from the development is presented below in Table 11.

Table 11 - Consideration of Impacts on Flood Behaviour

Characteristic	Commentary	Assessment of Significance
Flood Level Changes	The development is generally located outside the Hunter River floodplain. No changes in flood levels in this event are expected. As discussed above, minor localised changes in flood level have been determined. We do not believe this results in a significant adverse impact.	Minor
Velocity Changes	The development is generally located outside the Hunter River floodplain. No velocity changes in this event are expected. Peak flow differences have been determined as generally a reduction or small increases less than two percent. We believe this will result in a commensurate reduction, or no significant change in flood velocities.	Not significant
Flood Function Changes	The development is generally located outside the Hunter River floodplain. No changes to flood function in this event are expected. Local drainage gullies have been maintained in the riparian corridor design for the development. We believe the flood function of these gullies will be maintained on this basis.	Not significant
Hazard Categorisation Changes	The development is generally located outside the Hunter River floodplain. No changes to flood hazard are expected in this event. No significant changes to local flood hazard are expected as a result of the proposed development.	Not significant
Change in Flooding Duration	The development is generally located outside the Hunter River floodplain. No change in flood duration is expected for this event.	Not significant

Characteristic	Commentary	Assessment of Significance
	The local catchment has a duration of concentration for flood levels of events two hours or less. We note some increases in the rising and falling limbs of the hydrographs may occur due to the increase in impervious fraction, and the presence of detention and this is not expected to be a significant increase.	
Change in Frequency of Inundation	New lots are to be constructed above the Flood Planning Level and not inundated in this event. Since not changes are proposed to the Hunter River floodplain no change to the frequency of inundation of Anambah Road in this event is expected.	Not significant
Change in Warning and Evacuation Time	The development is generally located outside the Hunter River floodplain. There will be no changes to warning or evacuation time in this event. For the local catchment the warning time will be short due to the critical durations for flood levels. Flood free land in the local PMF will be available within the development footprint and the duration of isolation in this event is expected to follow the duration of rainfall.	Not significant

Alignment to Existing Floodplain Risk Management Study

Consideration with compliance with the Hunter River Floodplain Risk Management Study and Plan (MRFRMSP, 2015) has been assessed in the below Table 12.

This plan considers three broad categories for floodplain risk management including the following.

- Flood modification measures.
- Property modification measures.
- Response modification measures.

Table 12 - Alignment to HRFRMSP

Category	Measure	Commentary	Compliant
Flood	New Levee Banks	This is not applicable as the development is predominately located out of the Hunter River floodplain.	Not applicable
Flood	Alterations to existing levees	This is not applicable as the development does not propose any modifications to existing levees or spillways.	Not applicable
Property	Minimise risk to property	The proposal locates new lots outside the flood planning area in the developed case, designs the riparian corridor to enhance flood resilience, and adopts development controls appropriate to the proposal.	Yes

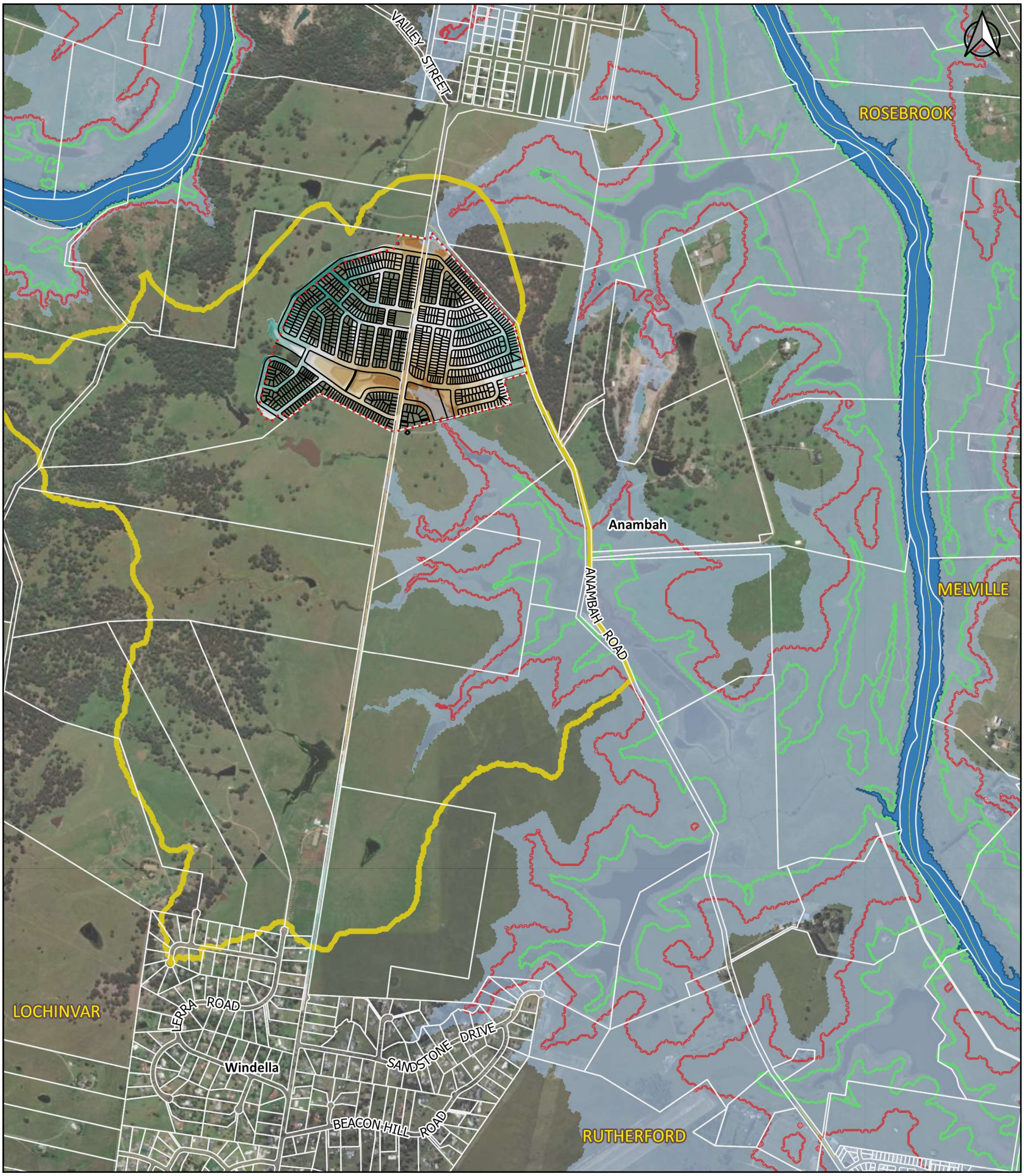
Category	Measure	Commentary	Compliant
Property	House raising and flood proofing	Not applicable. This measure relates more to existing flood prone development.	Not applicable
Property	Amphibious housing	Not applicable. This is not proposed as part of the development.	Not applicable
Property	Rezoning	Not applicable. This site is already zoned for the use proposed in the development.	Not applicable
Property	Voluntary purchase	Not applicable. The development is generally located outside the Hunter River floodplain.	Not applicable
Property	Importation of fill	Redistribution of fill within the development to the creation of River Road acts to improve the flood access immunity to the development.	Yes
Response	Evacuation routes	The site maintains flood free land in the Hunter River, and local catchment PMF events. The flood access immunity for the development has been enhanced through the construction of the River Road access to be above the 1% AEP in the local catchment events.	Yes
Response	Flood warning and evacuation planning	No changes to flood warning products are expected as a result of the development. Flood free land is available on-site in the Hunter River and local PMF events.	Yes
Response	Public information and raising flood awareness	These measures relate more to broad community awareness rather than specific items related to development.	Not applicable

Evacuation Route

Egress from the site is expected to be available via the proposed River Road link to Windella Estate and further to New England Highway when Anambah Road is compromised by flood waters during the major local catchment flood events or/and Hunter River flooding.

As requested by Council in the pre-DA meeting, the immunity of this access has been adopted as the 1% AEP.

A figure showing the development relative to Hunter River flood events is presented overleaf in **Figure 8**.



Legend

- Subject Site
- Cadastre
- Study Catchment
- 0.5EY Hunter Rv Flood Extent
- 20% AEP Hunter Rv Flood Extent
- 1% AEP Hunter Rv Flood Extent
- PMF Hunter Rv Flood Extent

Design Surface(mAHD)

- <= 25.6
- 25.6 - 31.0
- 31.0 - 36.4
- 36.4 - 41.8
- 41.8 - 47.2
- 47.2 - 52.6
- > 52.6

0 400 800 Metres

1:22,500

Figure 8

Hunter River Flood Extents

559 Anambah Road

NORTHROP

Data Source: NSW LPI - cadastre, Virtual Earth, Nearmap - aerial

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Risk Assessment

An assessment of the development risks, from a floodplain risk management perspective is presented below in Table 13.

Table 13 - Risk Assessment

Risk Category	Description	Commentary on Measures to Mitigate	Mitigated
Property	Flood levels affecting new dwellings.	New lots situated above the flood planning level.	Yes
Property	Impacts on surrounding properties.	Detention and road crossing implemented to reduce peak flows from the unmitigated condition on downstream lots.	Yes
Life	Emergency access and response measures.	Provision of River Road at the 1% AEP, and flood free land located above the PMF within the development.	Yes
Environment	Velocities in riparian corridors and downstream.	Provision of riparian corridor design to minimise changes in velocity downstream.	Yes

Compliance with Council Policies

Compliance with Council's LEP requirements are presented below in Table 14.

Table 14 – LEP requirements

Requirement	Response
5.21 Flood Planning	
(1) The objectives of this clause are as follows	
(a) to minimise the flood risk to life and property associated with the use of land,	This is noted. Discussed below.
(b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change,	This is noted. Discussed below.
(c) to avoid adverse or cumulative impacts on flood behaviour and the environment,	This is noted. Discussed below.
(d) to enable the safe occupation and efficient evacuation of people in the event of a flood.	This is noted. Discussed below.
(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development	
(a) is compatible with the flood function and behaviour on the land, and	The subject site is generally located outside the Hunter River floodplain, and function of the local drainage gullies has been considered in the riparian corridor design. We believe the development is compatible with the flood function of the land.
(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and	Consideration has been given to changes in flood levels and behaviour. It was determined the changes in level were localized and did not affect the flood hazard. On this basis we believe the level changes are not detrimental.
(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and	The provision of River Road at the 1% AEP facilitates a higher level of access immunity for the proposed development.
(d) incorporates appropriate measures to manage risk to life in the event of a flood, and	We believe the provision of River Road is an appropriate measure to manage the risk to life in the event of a flood.
(c) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses.	Standard engineering responses to water quality treatment and riparian corridor design have been documented in the civil design to respond to this item.
(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters	

Requirement	Response
(a) the impact of the development on projected changes to flood behaviour as a result of climate change,	The 1 in 500 AEP has been considered here as a proxy for climate change.
(b) the intended design and scale of buildings resulting from the development,	The scale of the development does not result in significant adverse impacts and on this basis, we believe it is acceptable from a floodplain risk management perspective.
(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,	The development incorporates the construction of a new secondary vehicular access which is flood free in both the Hunter River and local catchment 1% AEP events to the existing Windella township.
(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.	There is potential to remove development, which we believe is unnecessary due to the location of the development generally outside the Hunter River floodplain, and proximity to the coast.

Conclusion

A Flood Impact and Risk Assessment has been prepared for the proposed development including Stage 1 of development located at 559 Anambah Road, Gosforth NSW.

It was concluded that the proposed development.

- Is not expected to create a significant adverse impact to the existing flood behaviour on the subject site, in surrounding the subject site and downstream areas.
- Includes appropriate measures to manage risk to property.
- Includes appropriate measures to manage risk to life.
- Includes appropriate measures to manage risk to the environment.

We commend our findings to Council for their review.

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 Thirdi Anambah Pty Limited. 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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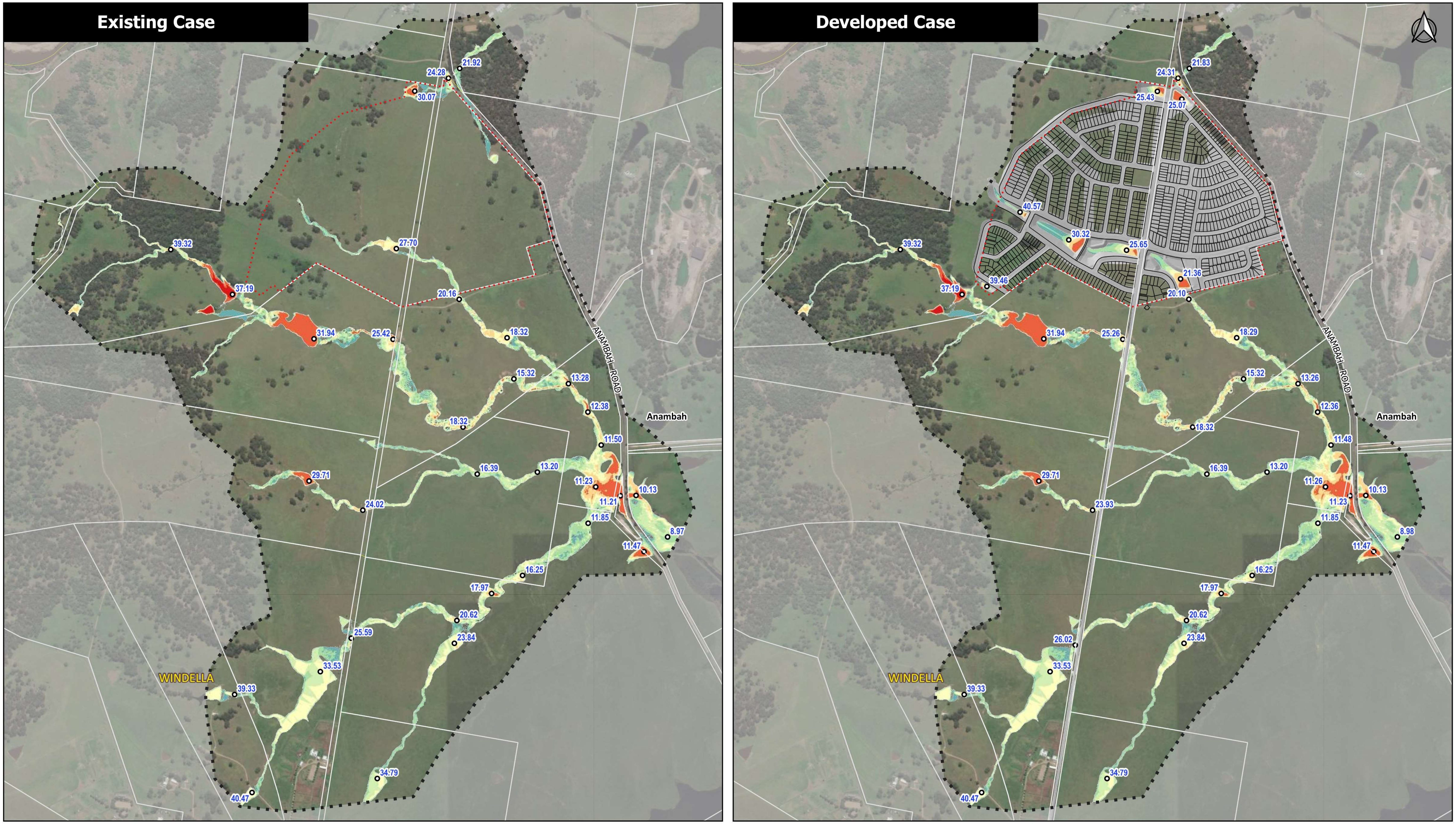
Document Register

Rev	Status	Prepared	Approved	Date
1	Draft	RB	GB	20/08/2024
A	For Approval	RB	GB	30/08/2024
B	Updated Layout - Approval	RB	LG	28/05/2025

Appendix A – Flood Figures



Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent
- Spot Water Level(mAHD)

Depth(m)

- < 0.02
- 0.02 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 0.70
- 0.70 - 1.00
- 1.00 - 2.00
- > 2.00

0 200 400 Metres

1:13,500

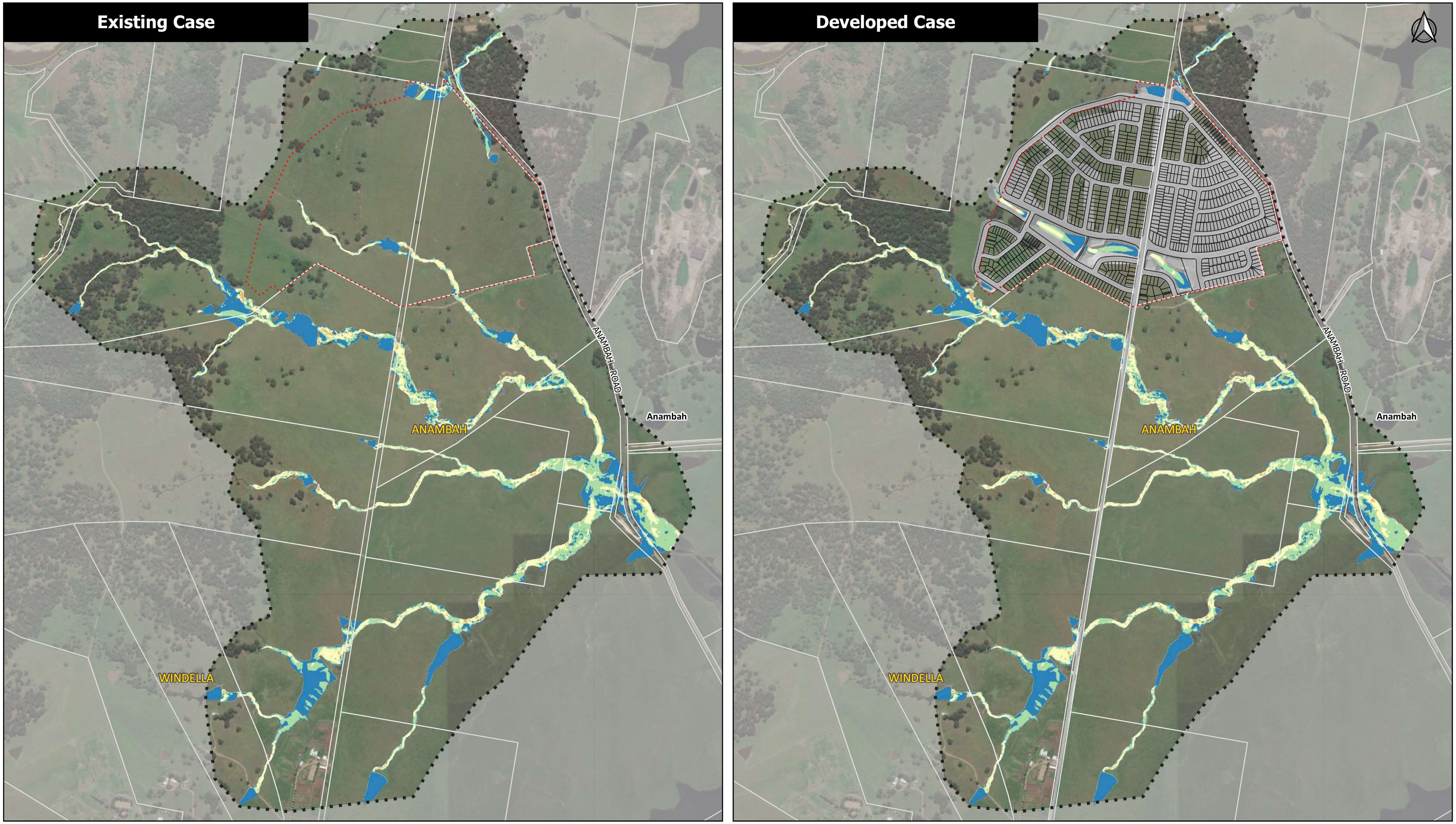
Figure BC1-1

10% AEP Flood Depth and Elevation

559 Anambah Road

NORTHROP

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial



Legend

Subject Site
Cadastre
TUFLOW Model Extent

Velocity(m/s)

- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

0 200 400 Metres
1:13,500

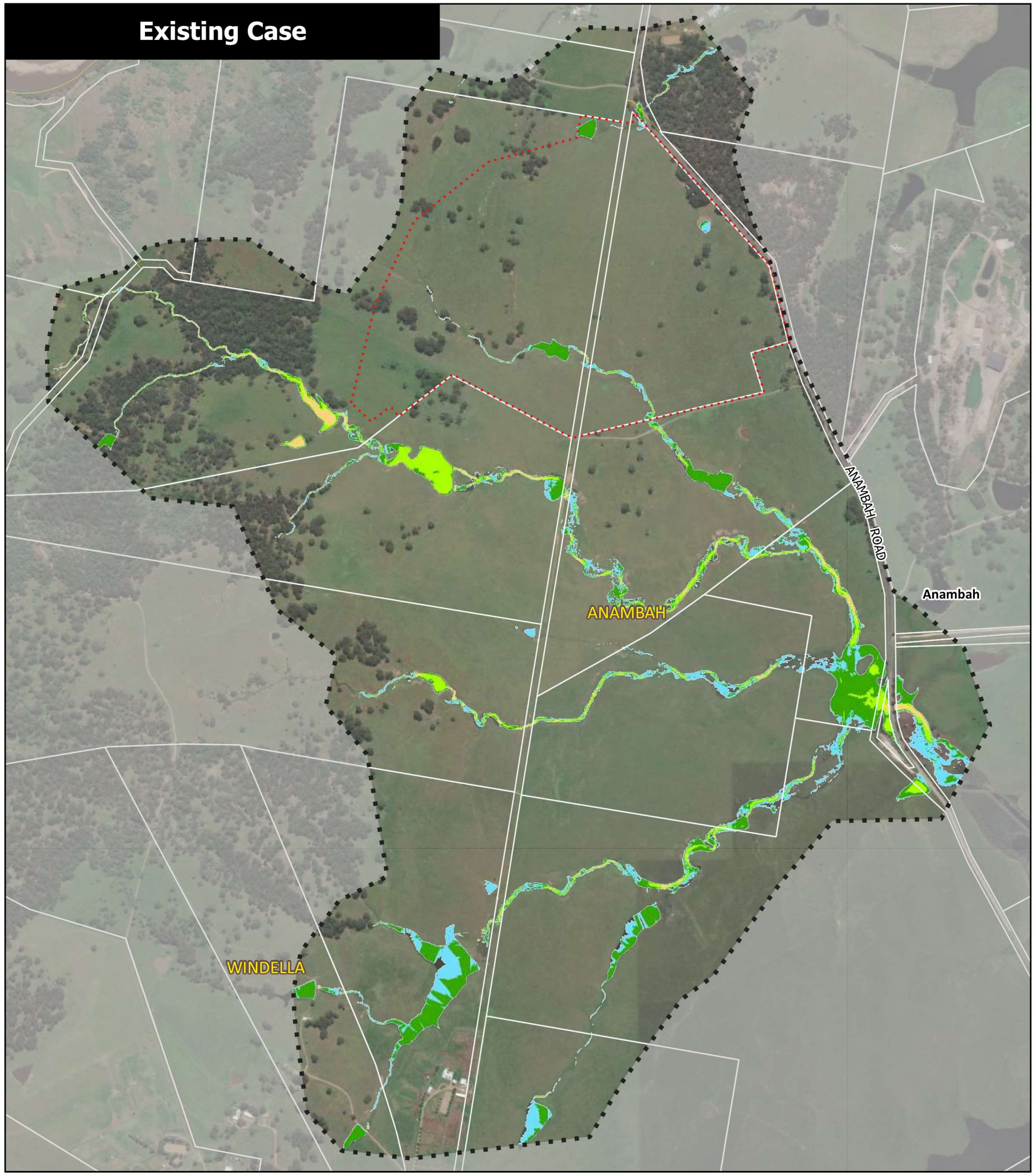
Figure BC1-2

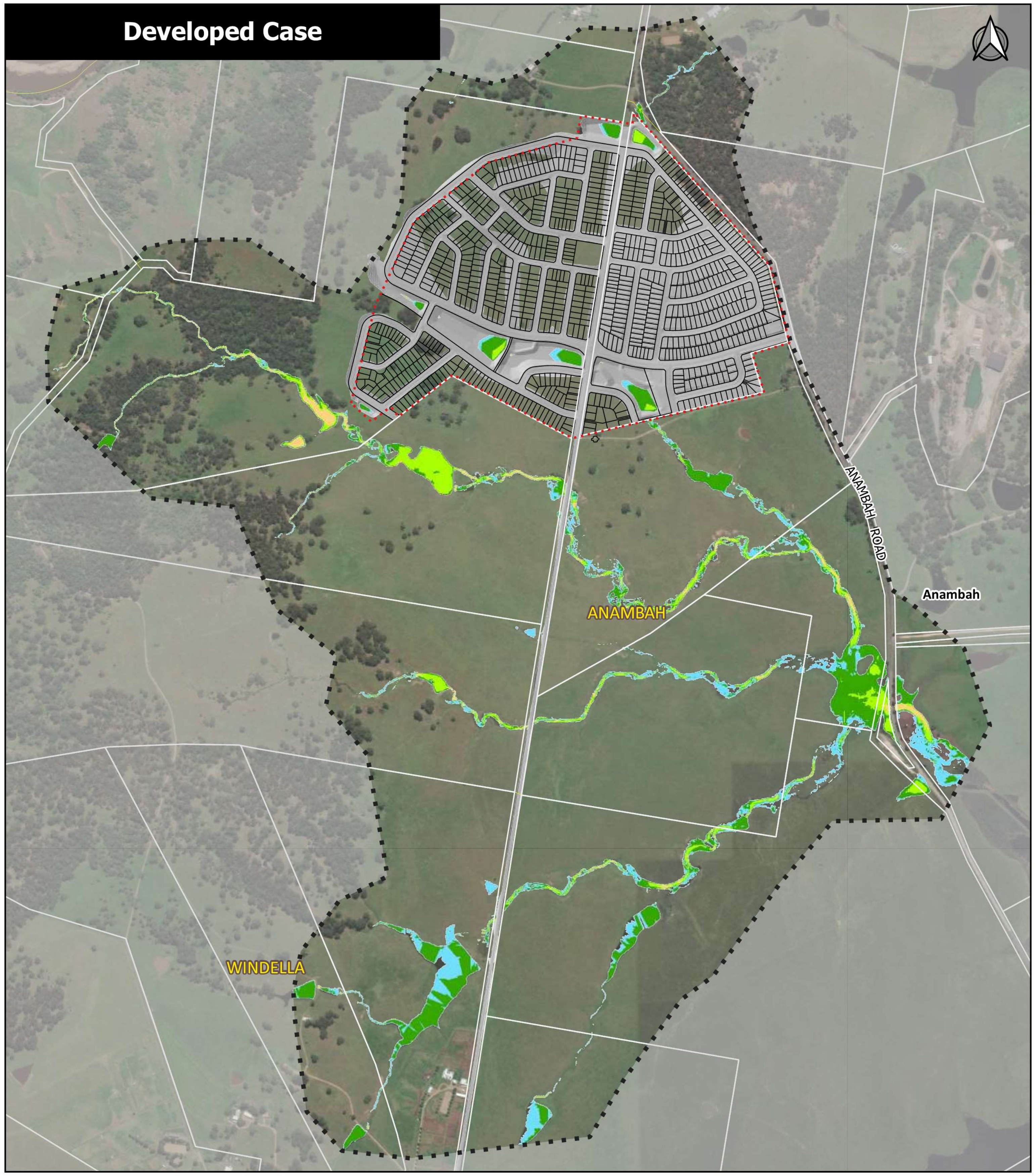
10% AEP Flood Velocity

559 Anambah Road

NORTHROP

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial





Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent

Hazard Category

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

0 200 400 Metres

1:13,500

Figure BC1-3

10% AEP Flood Hazard

559 Anambah Road

NORTHROP

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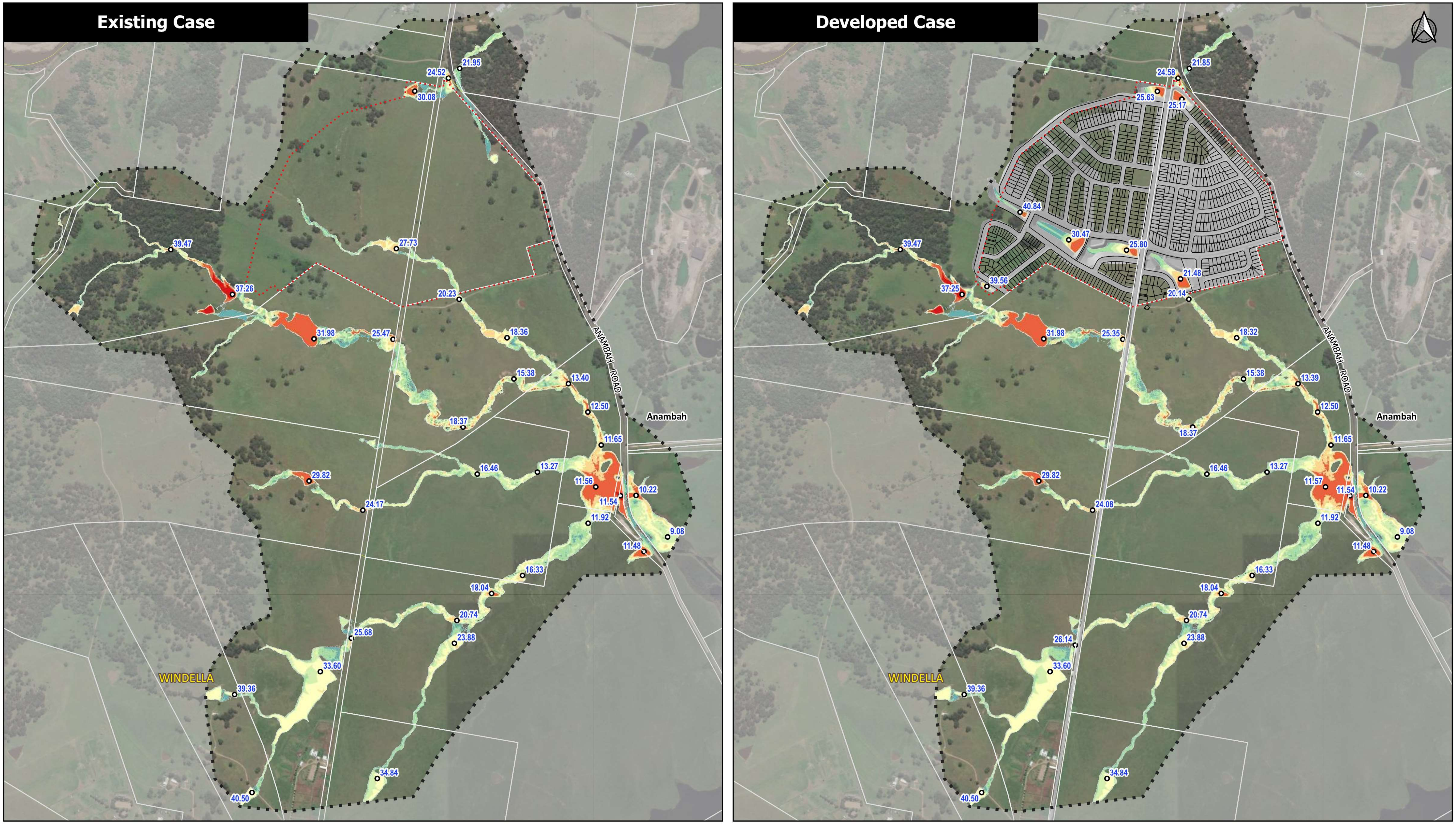
Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial



Legend

Subject Site
Cadastre
TUFLOW Model Extent
Spot Water Level(mAHD)

Depth(m)
< 0.02
0.02 - 0.10
0.10 - 0.30
0.30 - 0.50
0.50 - 0.70
0.70 - 1.00
1.00 - 2.00
> 2.00

0 200 400 Metres
1:13,500

Figure BC2-1

5% AEP Flood Depth and Elevation

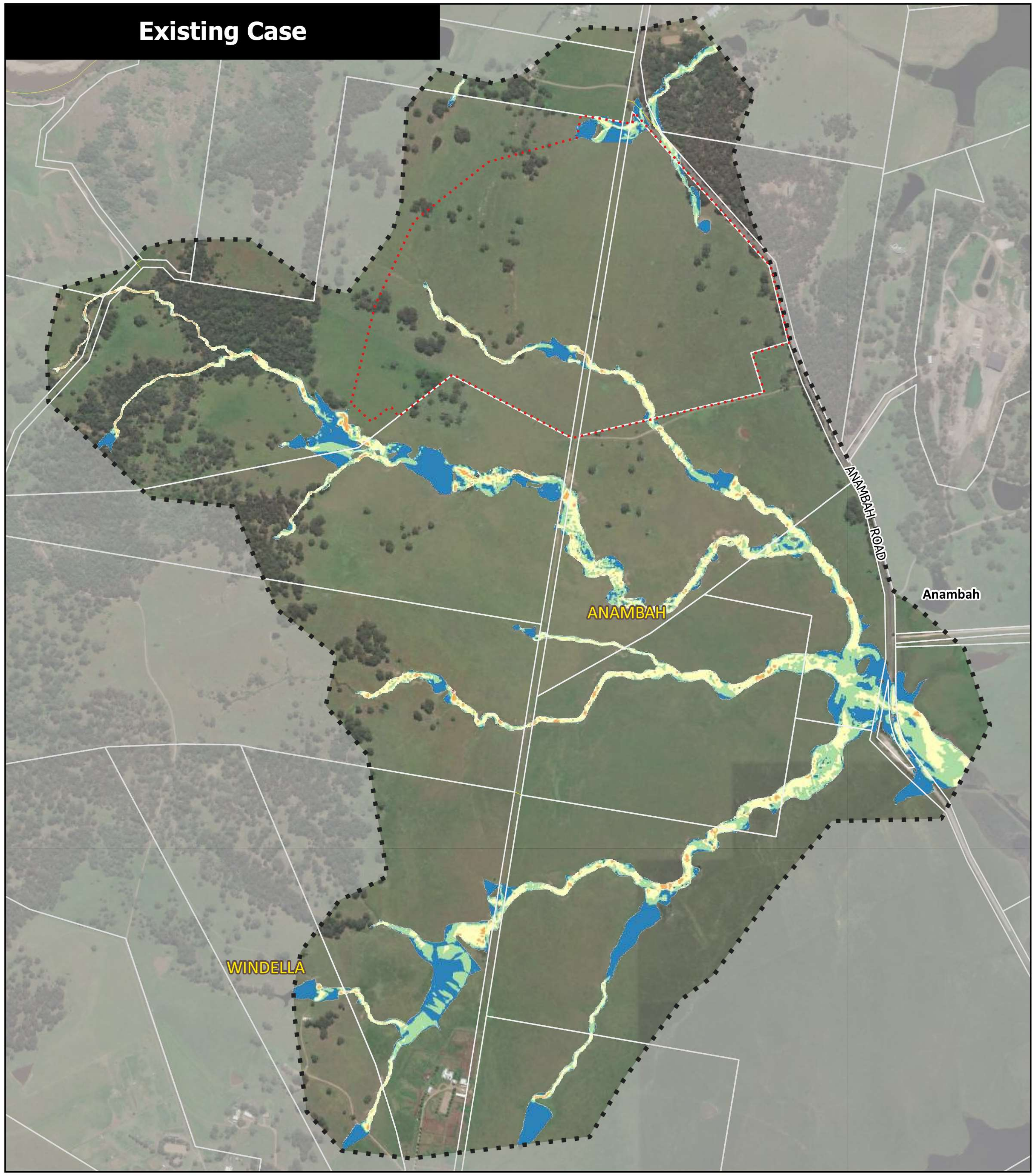
559 Anambah Road

NORTHROP

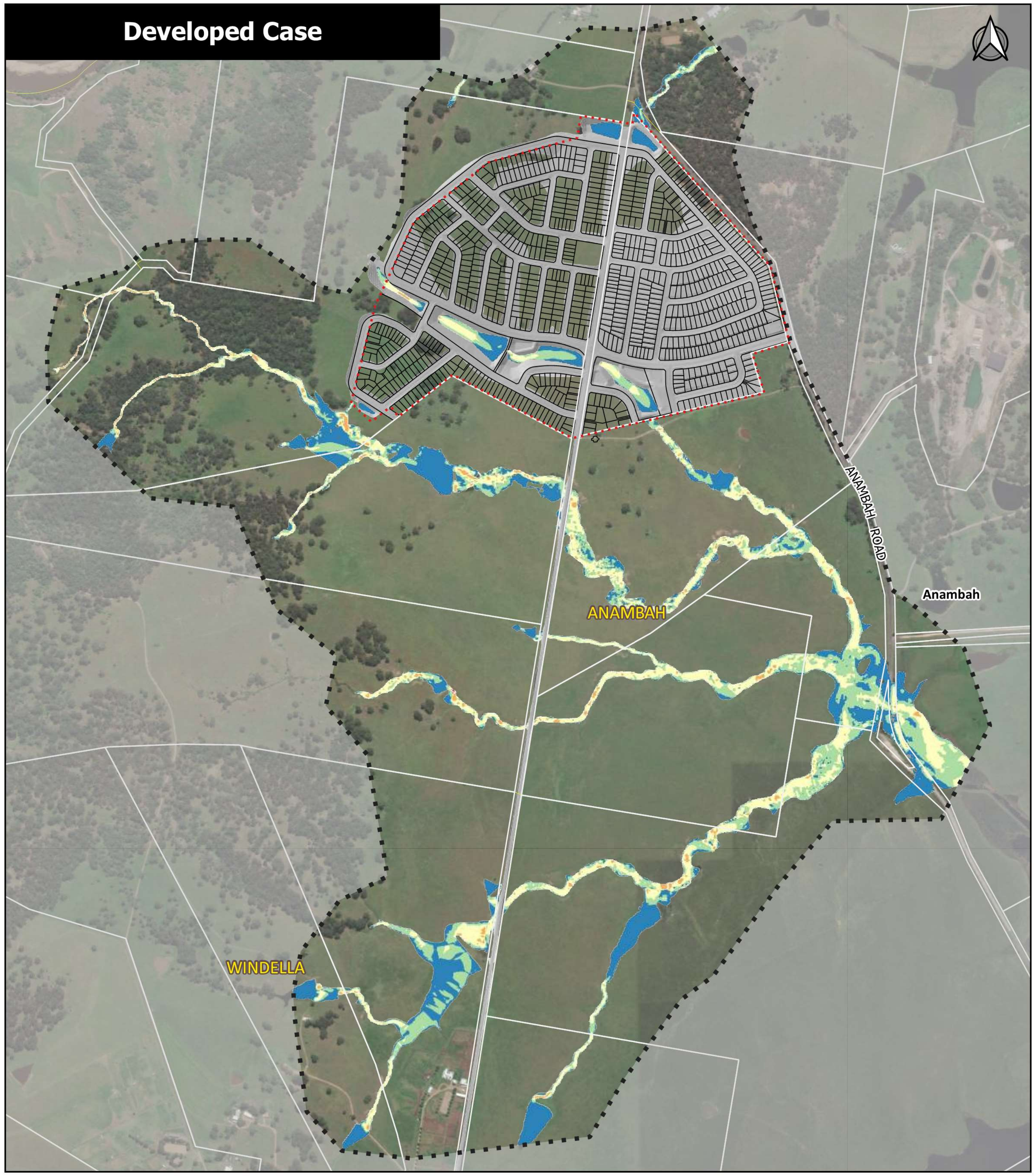
19/5/2025 A3 X:\PROJECTS\NEWCASTLE\YEAR 2022 Jobs\NL222055 - Anambah Road\D - DESIGN\FIGURES\Figures_rev_Site1_v2.qgz

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial

Existing Case



Developed Case



Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent

Velocity(m/s)

- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

0 200 400 Metres

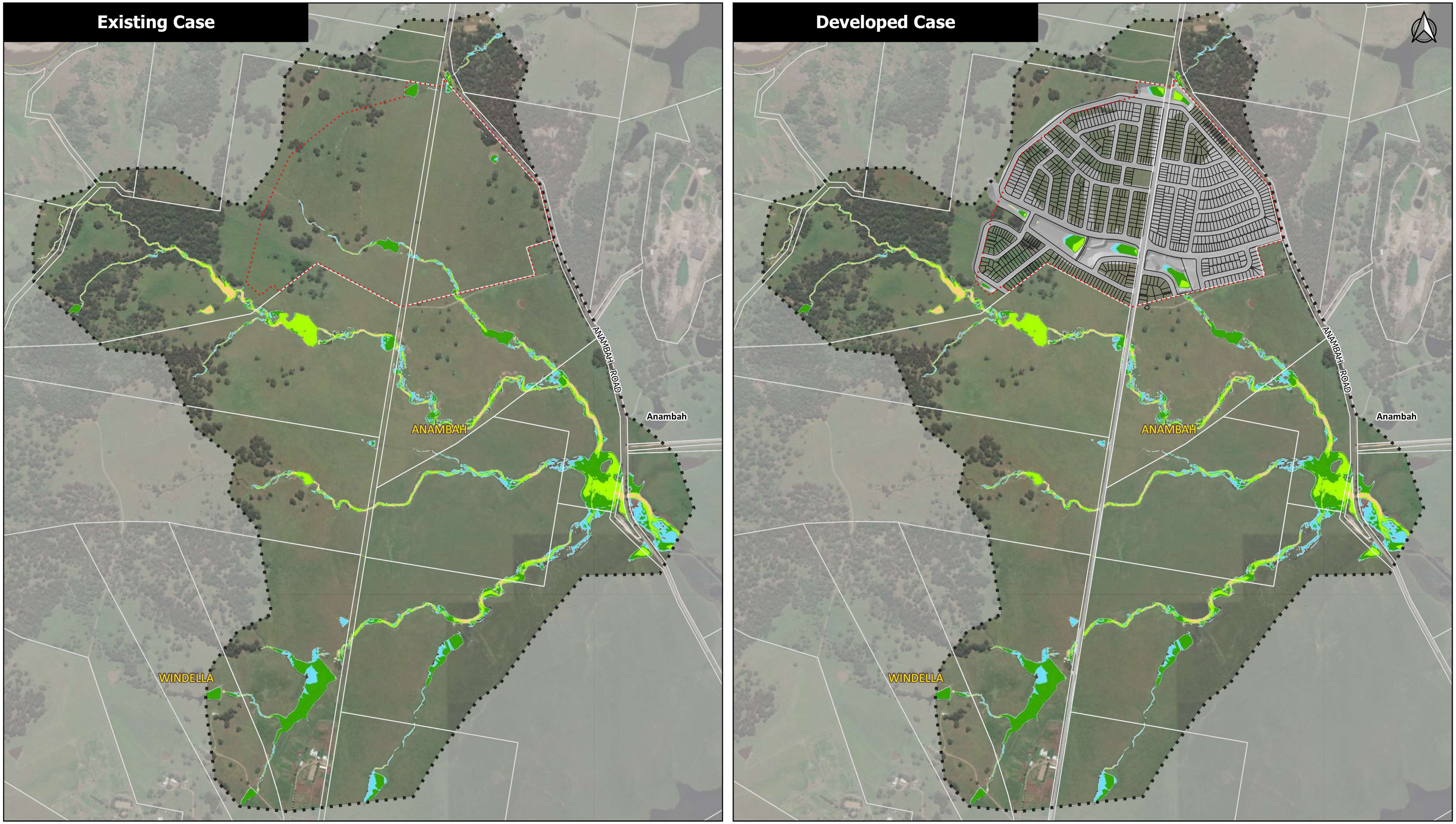
1:13,500

Figure BC2-2

5% AEP Flood Velocity

559 Anambah Road NORTHROP

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial



Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent

Hazard Category

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

0 200 400 Metres

1:13,500

Figure BC2-3

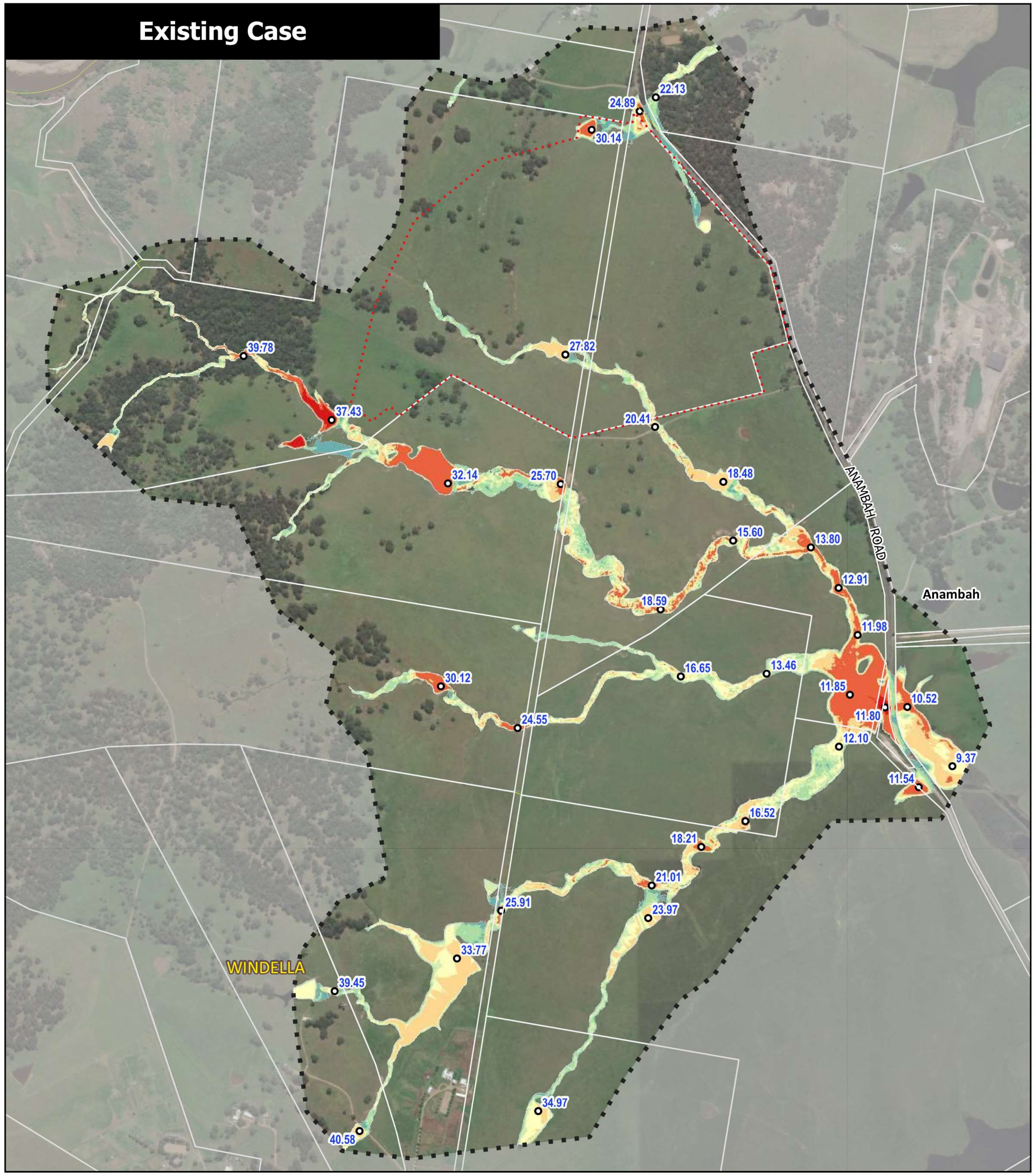
5% AEP Flood Hazard

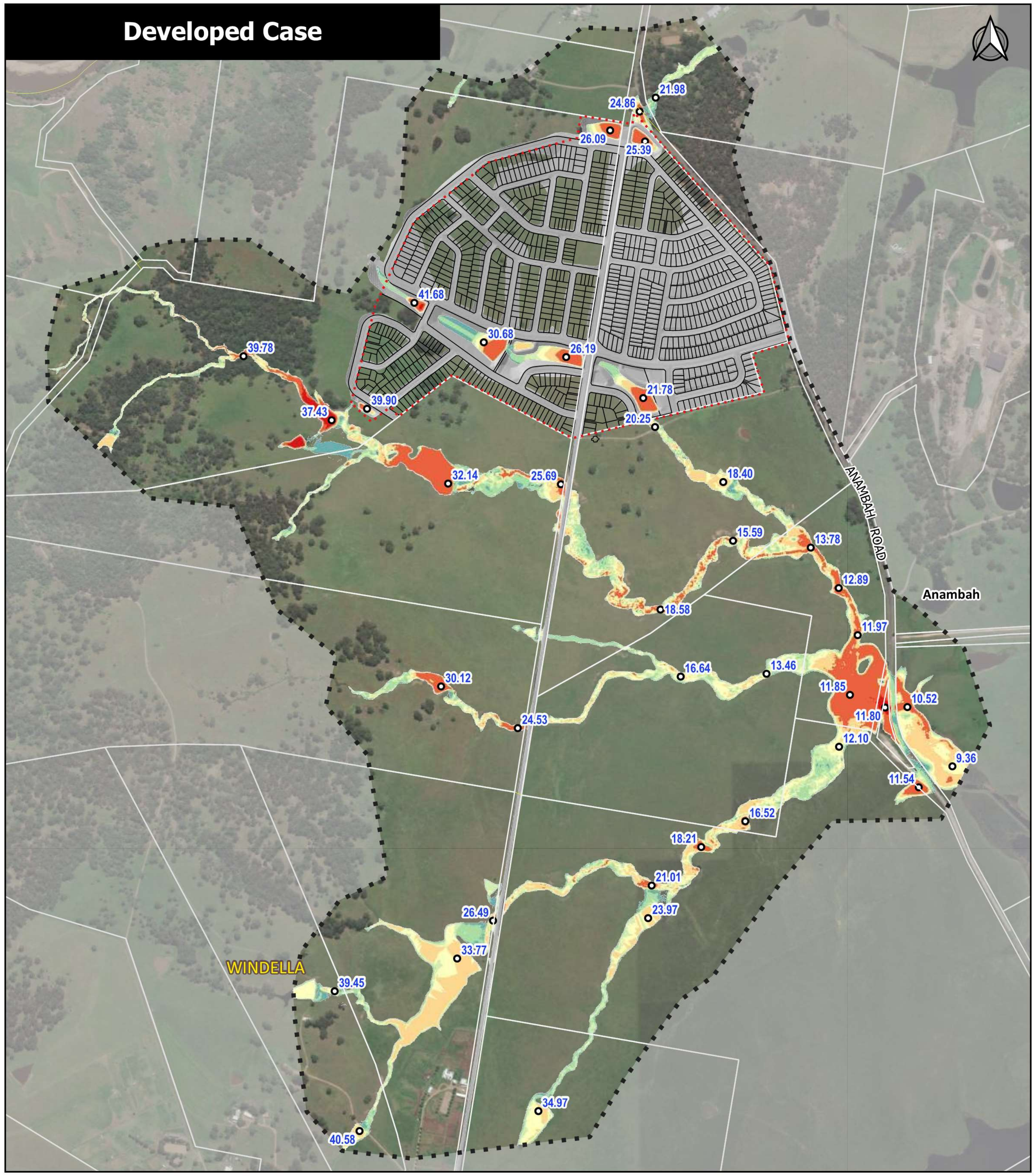
559 Anambah Road

NORTHROP

19/5/2025 A3 X:\PROJECTS\NEWCASTLE\YEAR 2022 Jobs\NL222055 - Anambah Road\D - DESIGN\FIGURES\Figures_rev_Site1_v2.qgz

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial





Legend

Subject Site
Cadastre
TUFLOW Model Extent
Spot Water Level(mAHD)

Depth(m)
< 0.02
0.02 - 0.10
0.10 - 0.30
0.30 - 0.50
0.50 - 0.70
0.70 - 1.00
1.00 - 2.00
> 2.00

0 200 400 Metres
1:13,500

Figure BC3-1

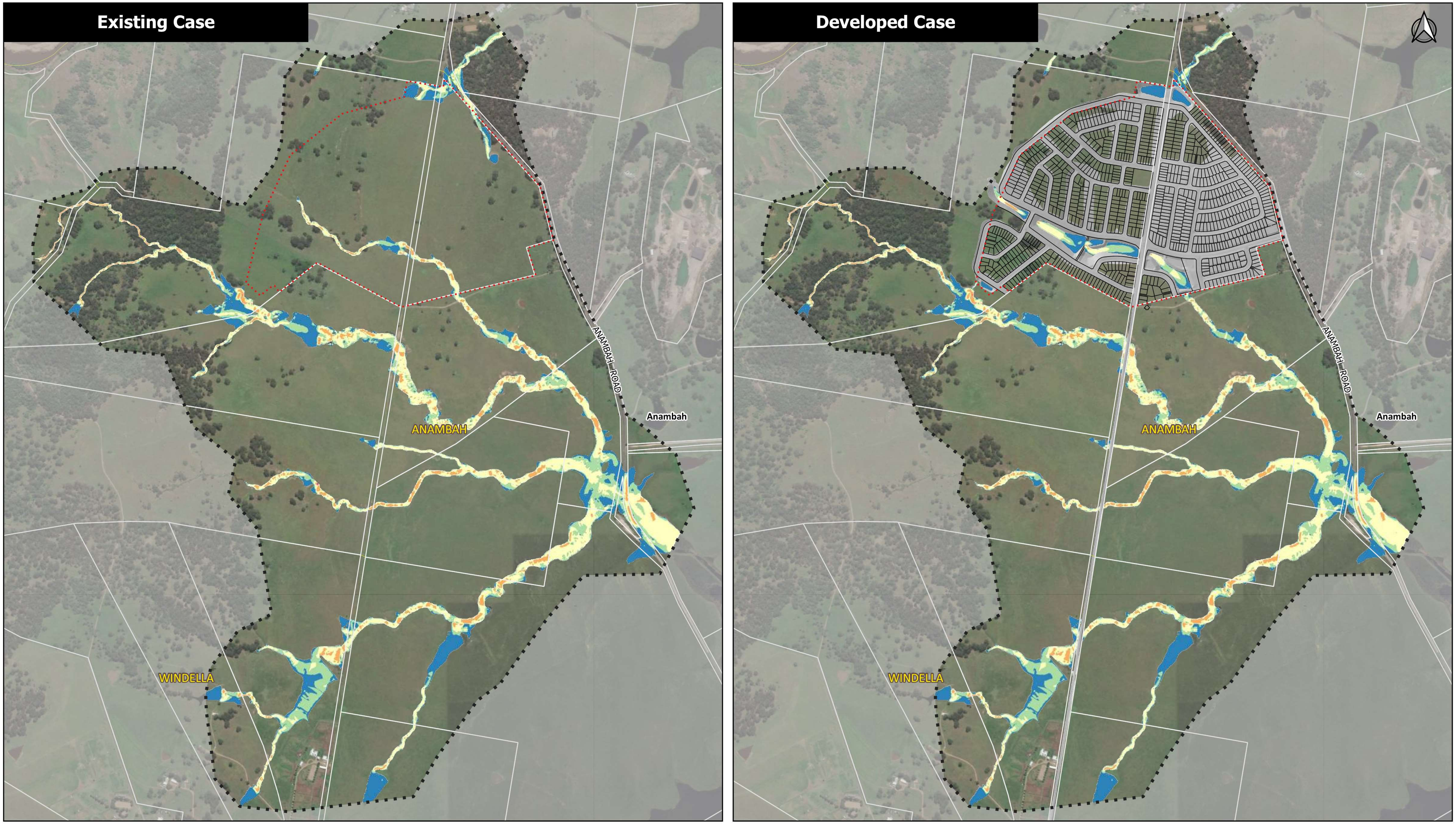
1% AEP Flood Depth and Elevation

559 Anambah Road

NORTHROP

19/5/2025 A3 X:\PROJECTS\NEWCASTLE\YEAR 2022 Jobs\NL222055 - Anambah Road\D - DESIGN\FIGURES\Figures_rev_Site1_v2.qgz

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial



Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent

Velocity(m/s)

- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

0 200 400 Metres

1:13,500

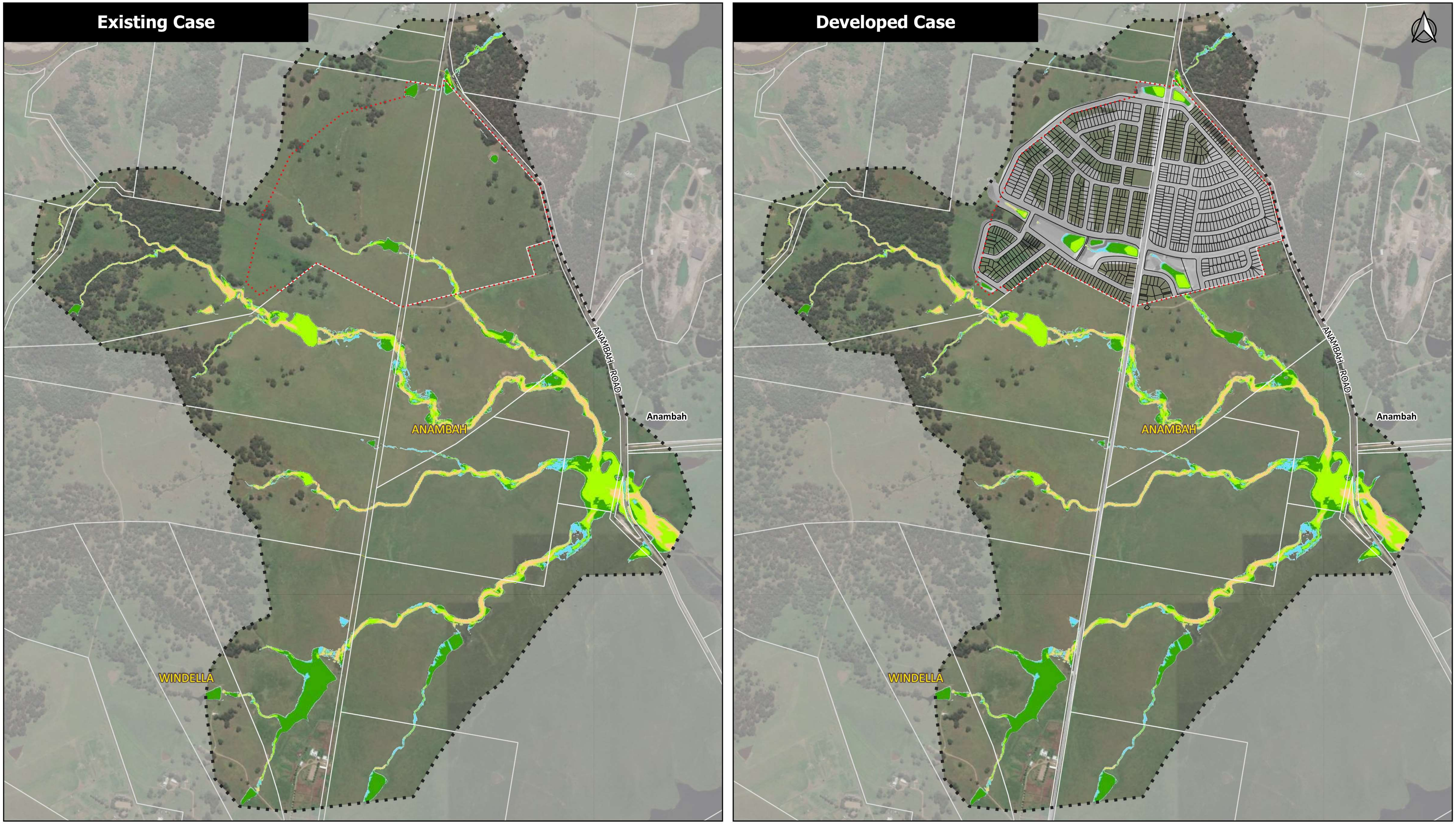
Figure BC3-2

1% AEP Flood Velocity

559 Anambah Road

NORTHROP

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial



Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent

Hazard Category

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

0 200 400 Metres

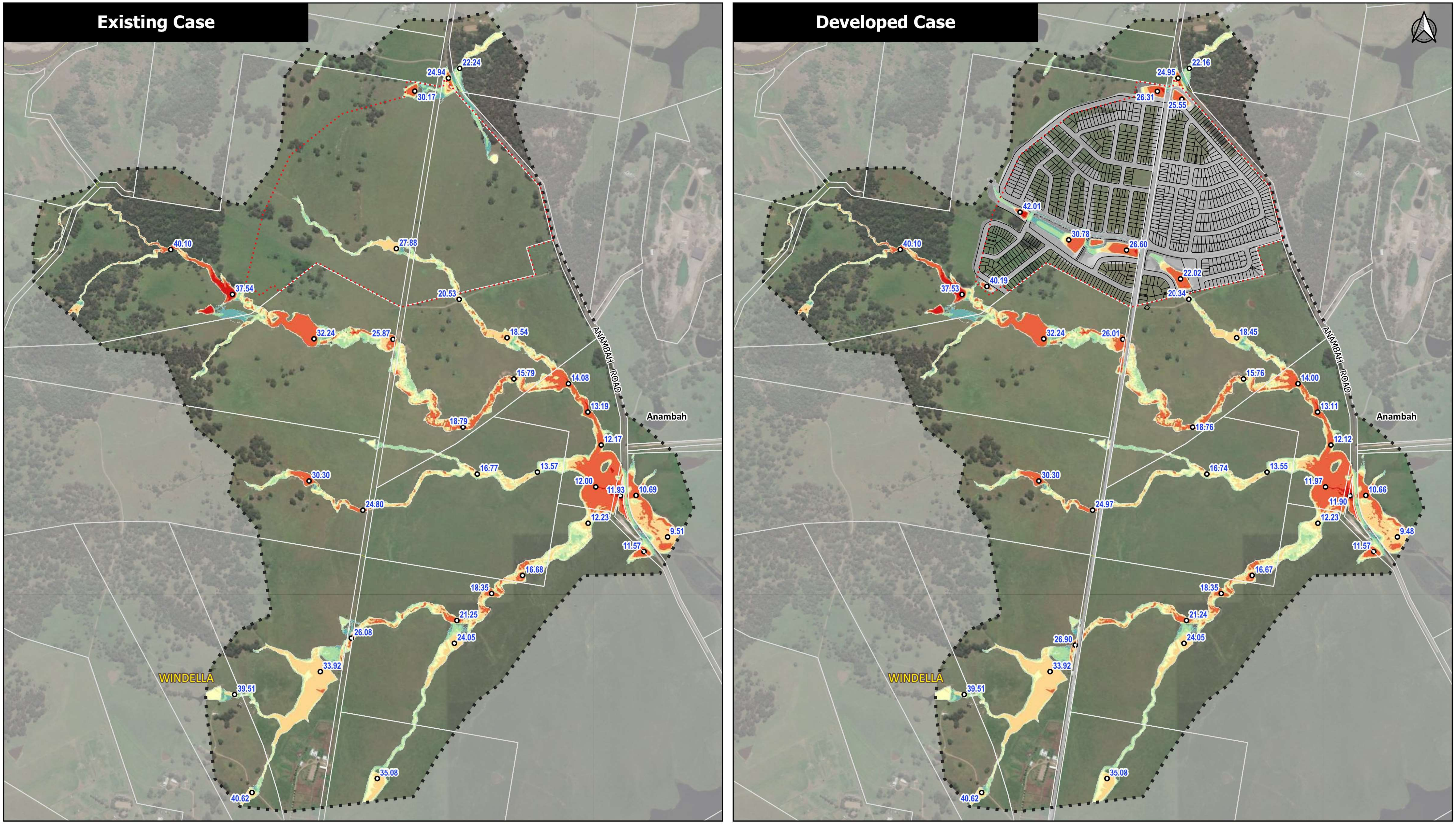
1:13,500

Figure BC3-3

1% AEP Flood Hazard

559 Anambah Road

NORTHROP



Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent
- Spot Water Level(mAHD)

Depth(m)

- < 0.02
- 0.02 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 0.70
- 0.70 - 1.00
- 1.00 - 2.00
- > 2.00

0 200 400 Metres

1:13,500

Figure BC4-1

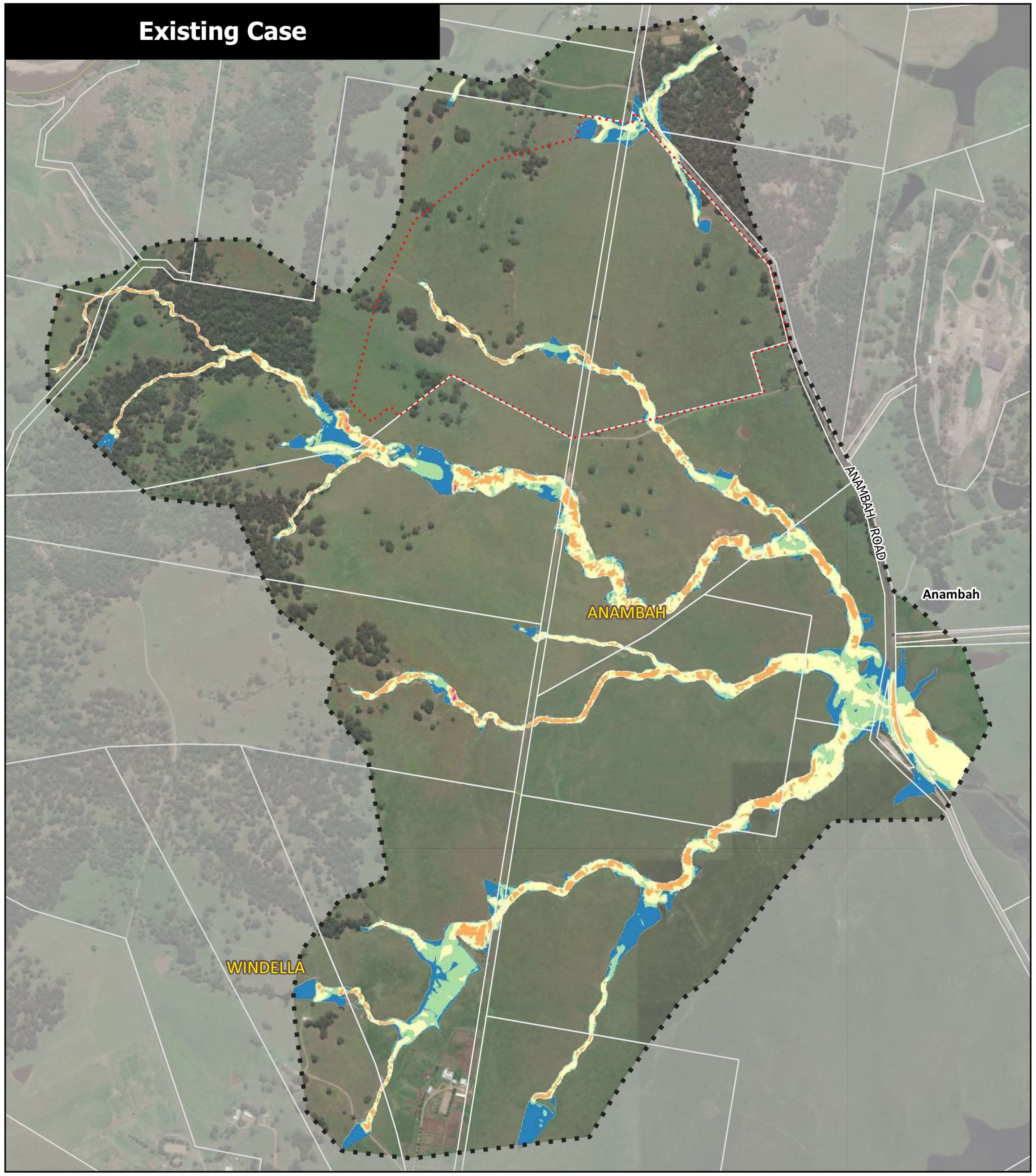
1 in 500 AEP Flood Depth and Elevation

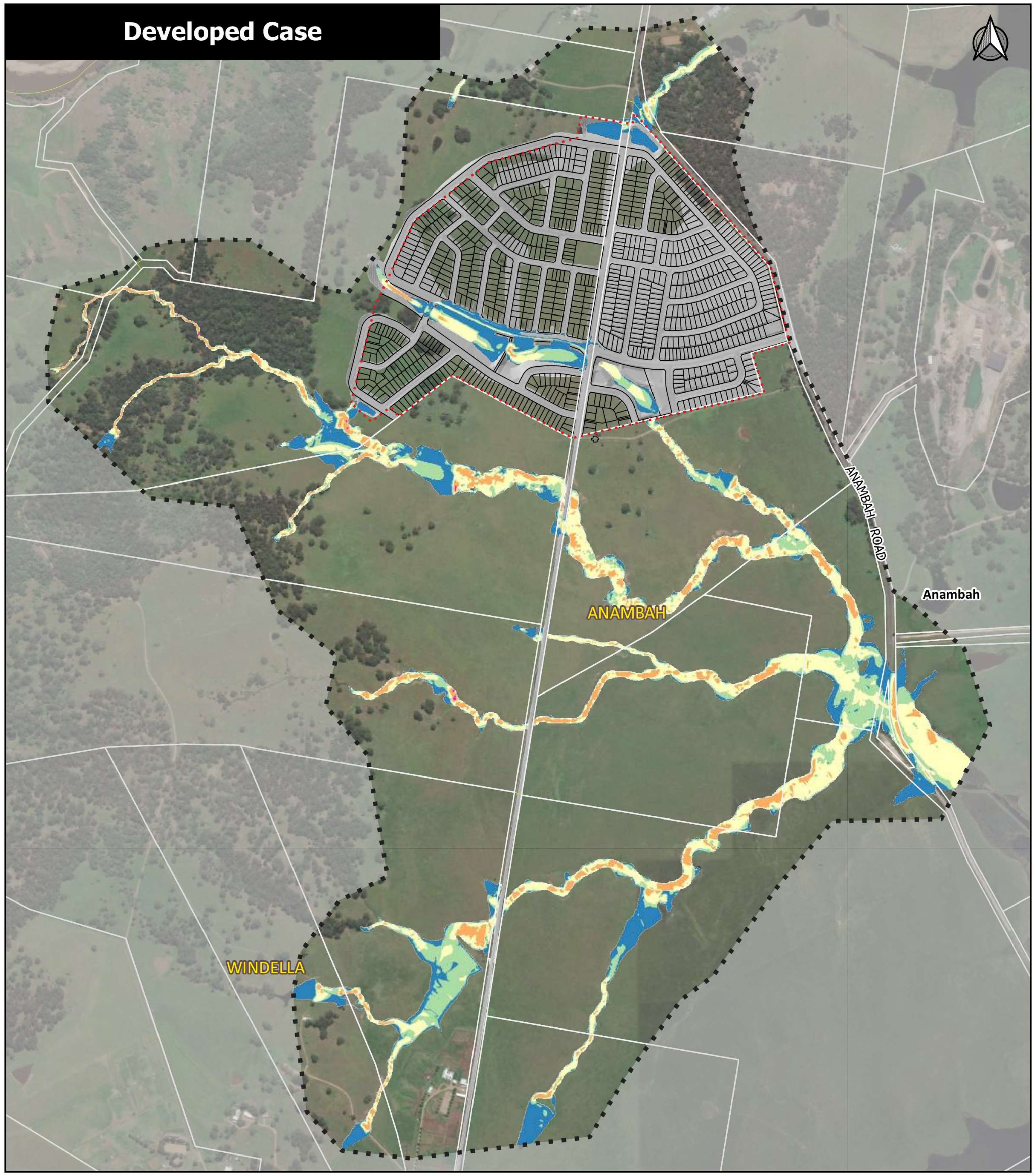
559 Anambah Road

NORTHROP

19/5/2025 A3 X:\PROJECTS\NEWCASTLE\YEAR 2022 Jobs\NL222055 - Anambah Road\D - DESIGN\FIGURES\Figures_rev_Site1_v2.qgz

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial





Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent

Velocity(m/s)

- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

0 200 400 Metres

1:13,500

Figure BC4-2

1 in 500 AEP Flood Velocity

559 Anambah Road

NORTHROP

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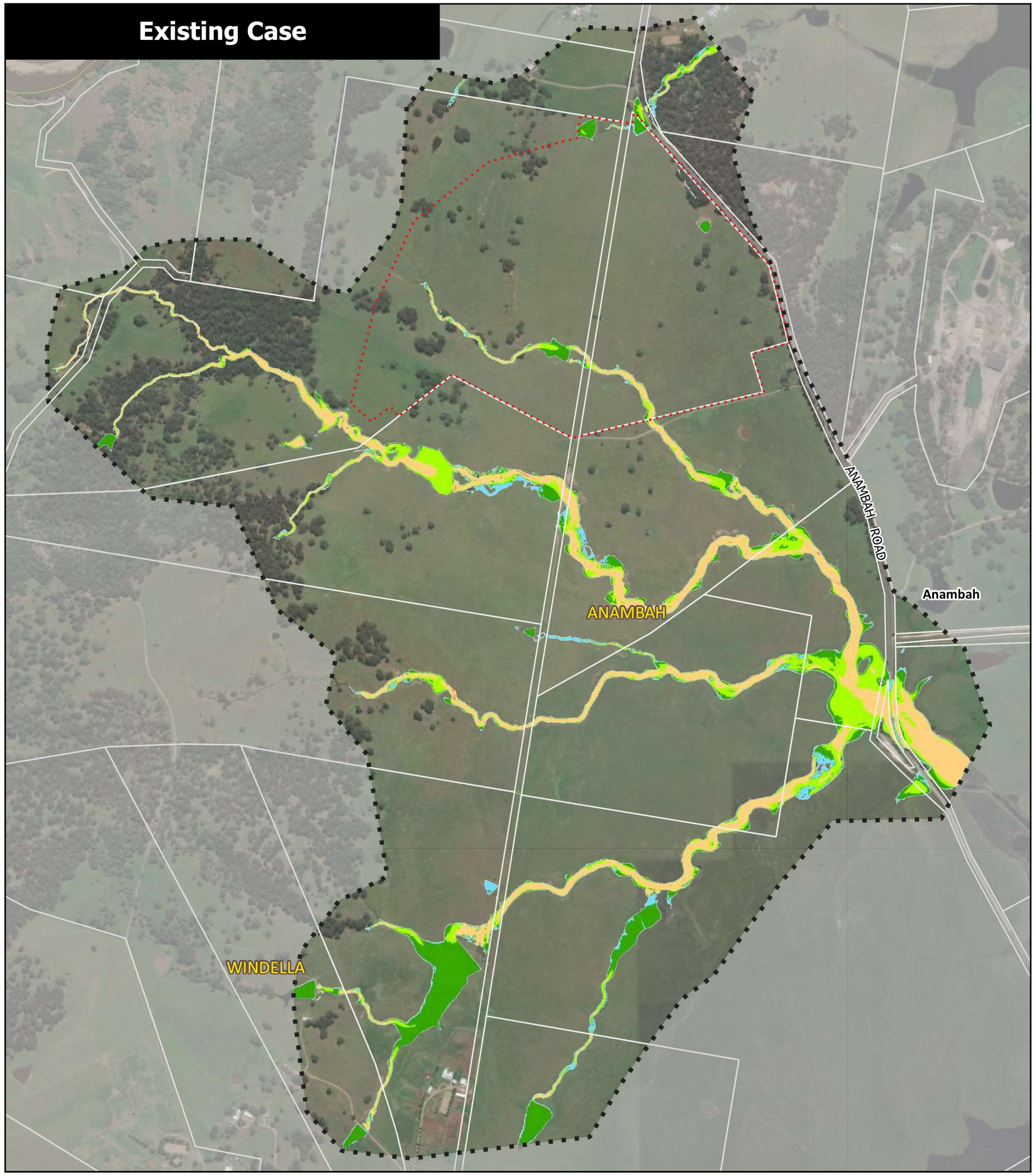
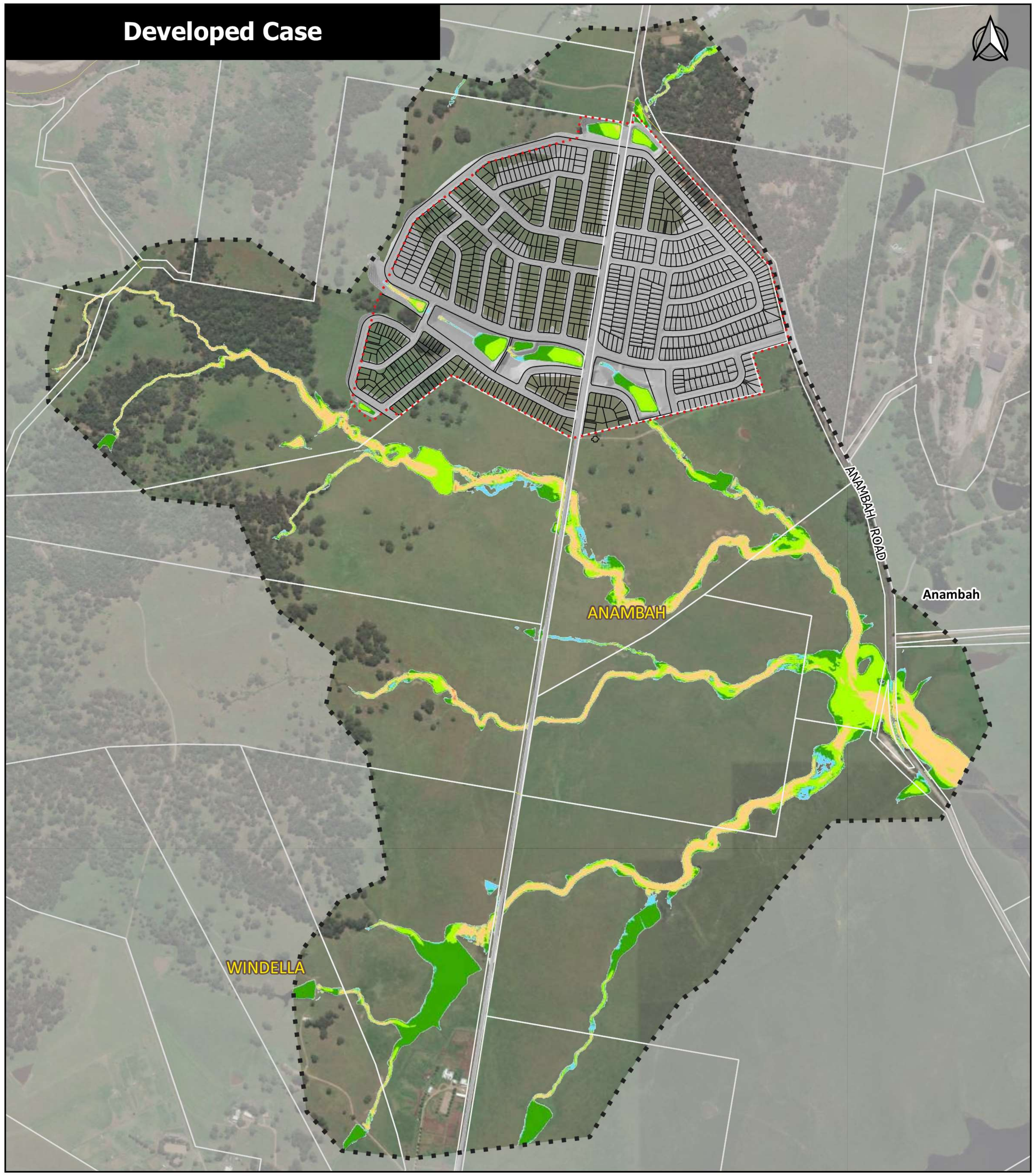
Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial





Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent

Hazard Category

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

0 200 400 Metres

1:13,500

Figure BC4-3

1 in 500 AEP Flood Hazard

559 Anambah Road NORTHROP

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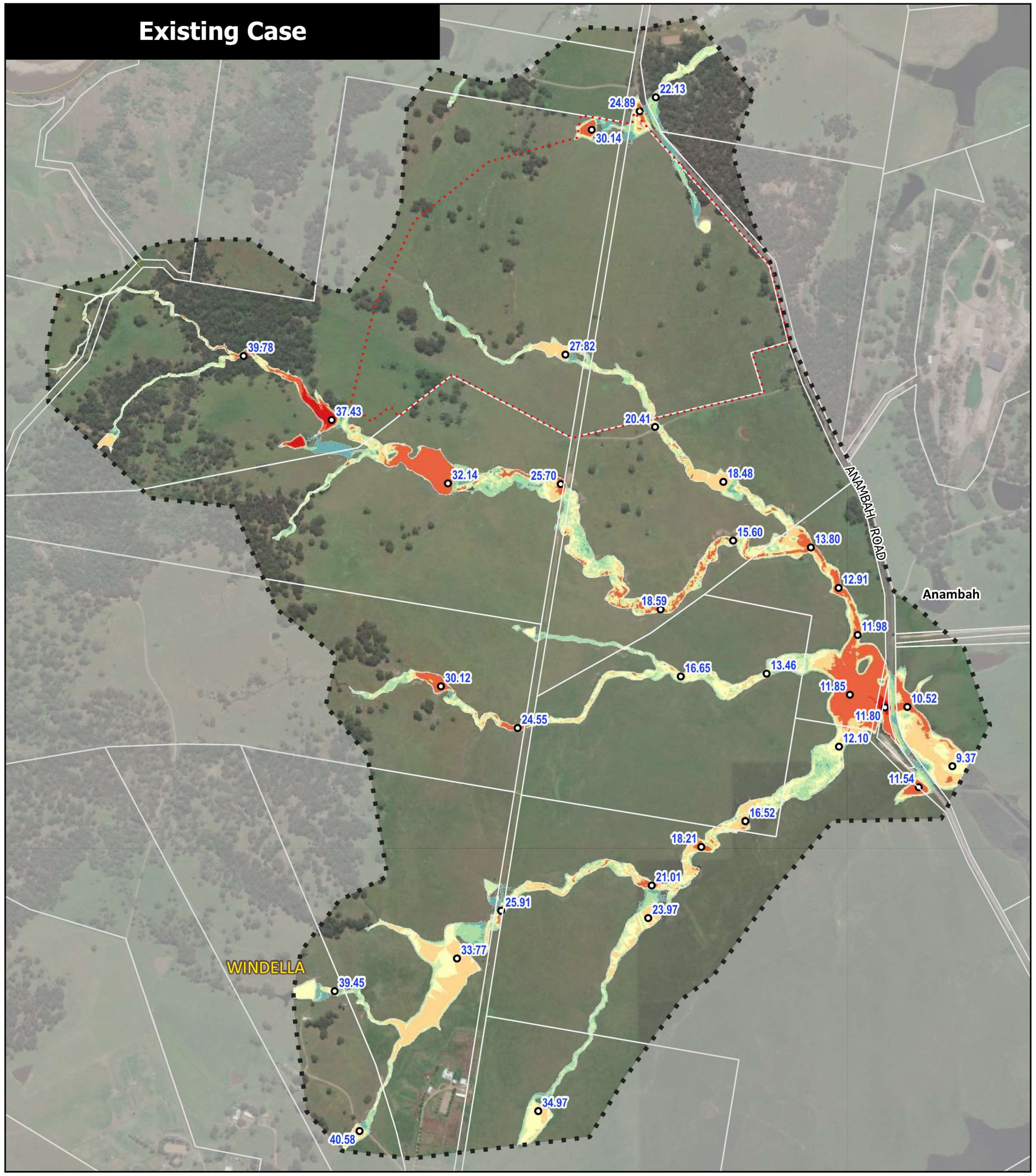
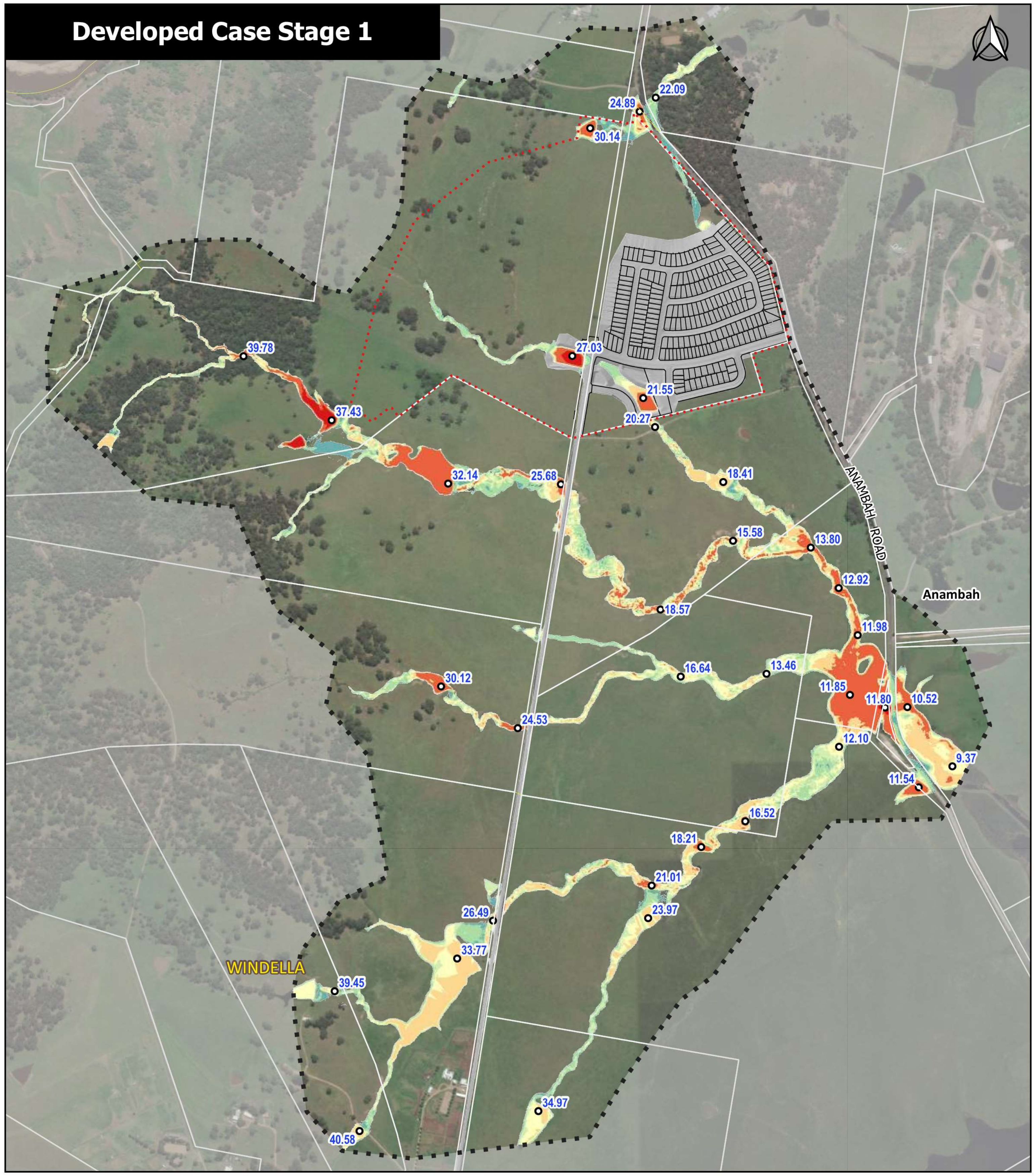
Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial

Existing Case



Developed Case Stage 1



Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent
- Spot Water Level(mAHD)

Depth(m)

- < 0.02
- 0.02 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 0.70
- 0.70 - 1.00
- 1.00 - 2.00
- > 2.00

0 200 400 Metres

1:13,500

Figure BC5-1

1% AEP Flood Depth and Elevation

559 Anambah Road

NORTHROP

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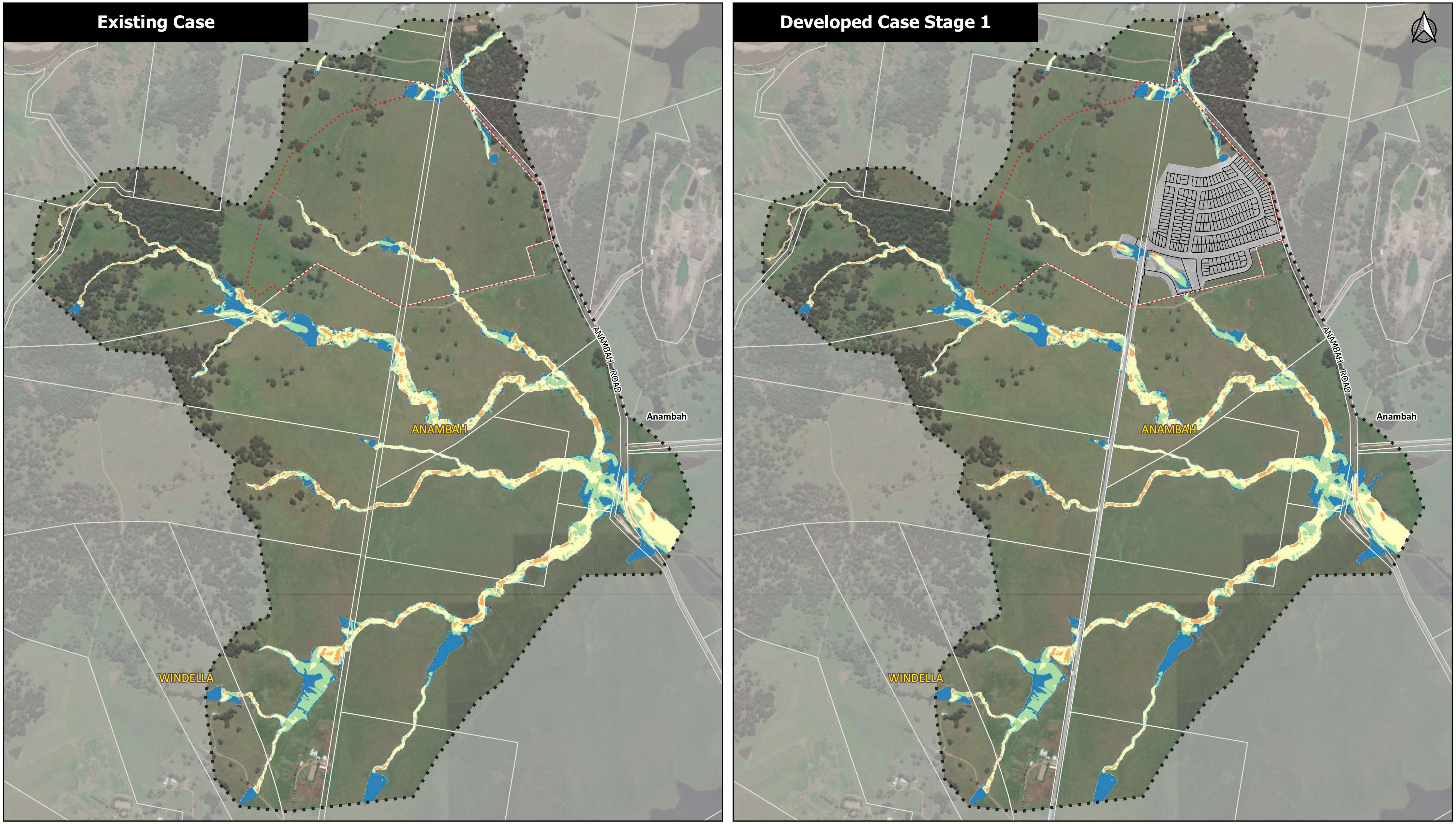
Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial



Legend

Subject Site
Cadastre
TUFLOW Model Extent

Velocity(m/s)
- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

0 200 400 Metres
1:13,500

Figure BC5-2

1% AEP Flood Velocity

559 Anambah Road

NORTHROP

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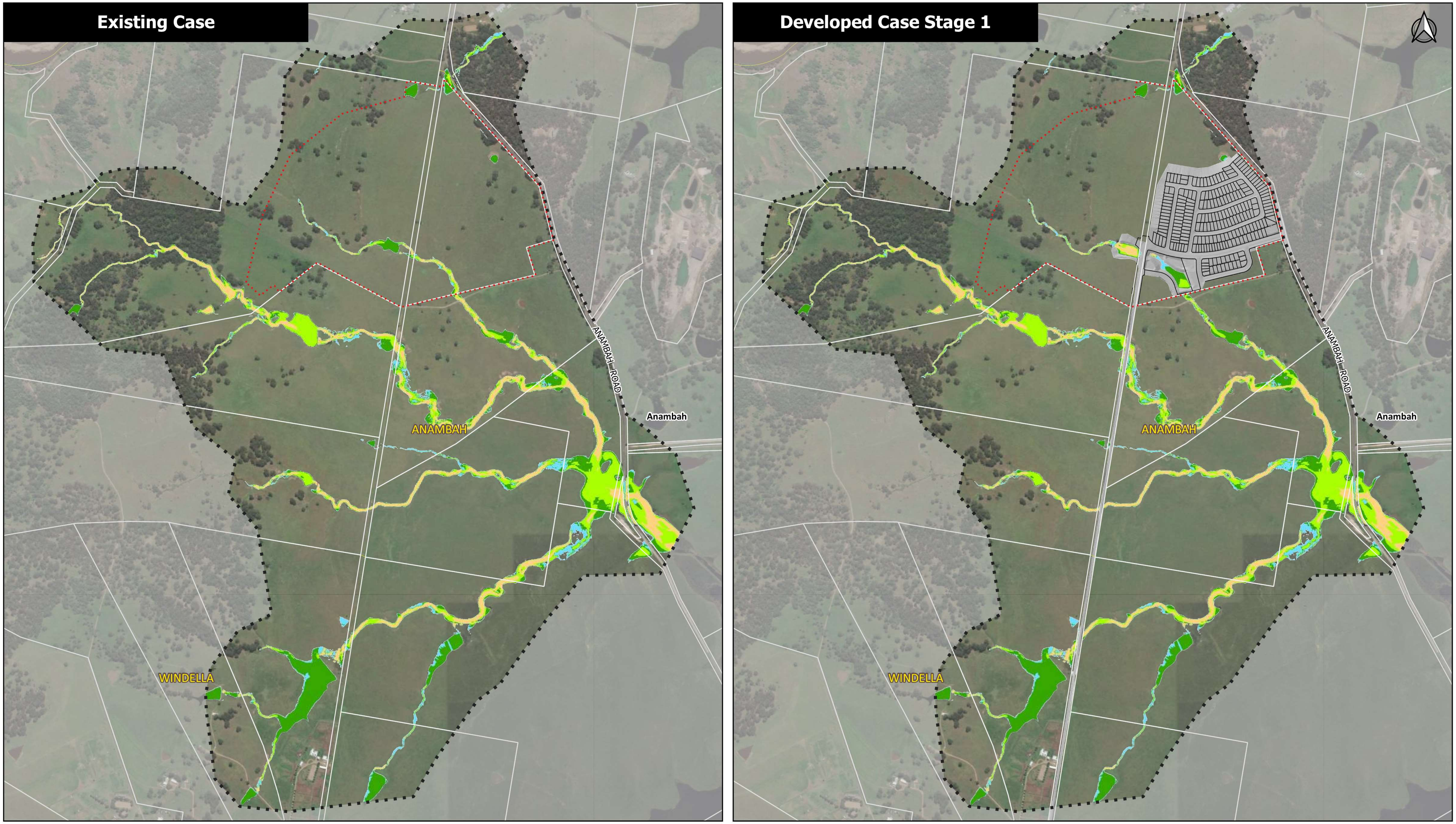
Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial



Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent

Hazard Category

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

0 200 400 Metres

1:13,500

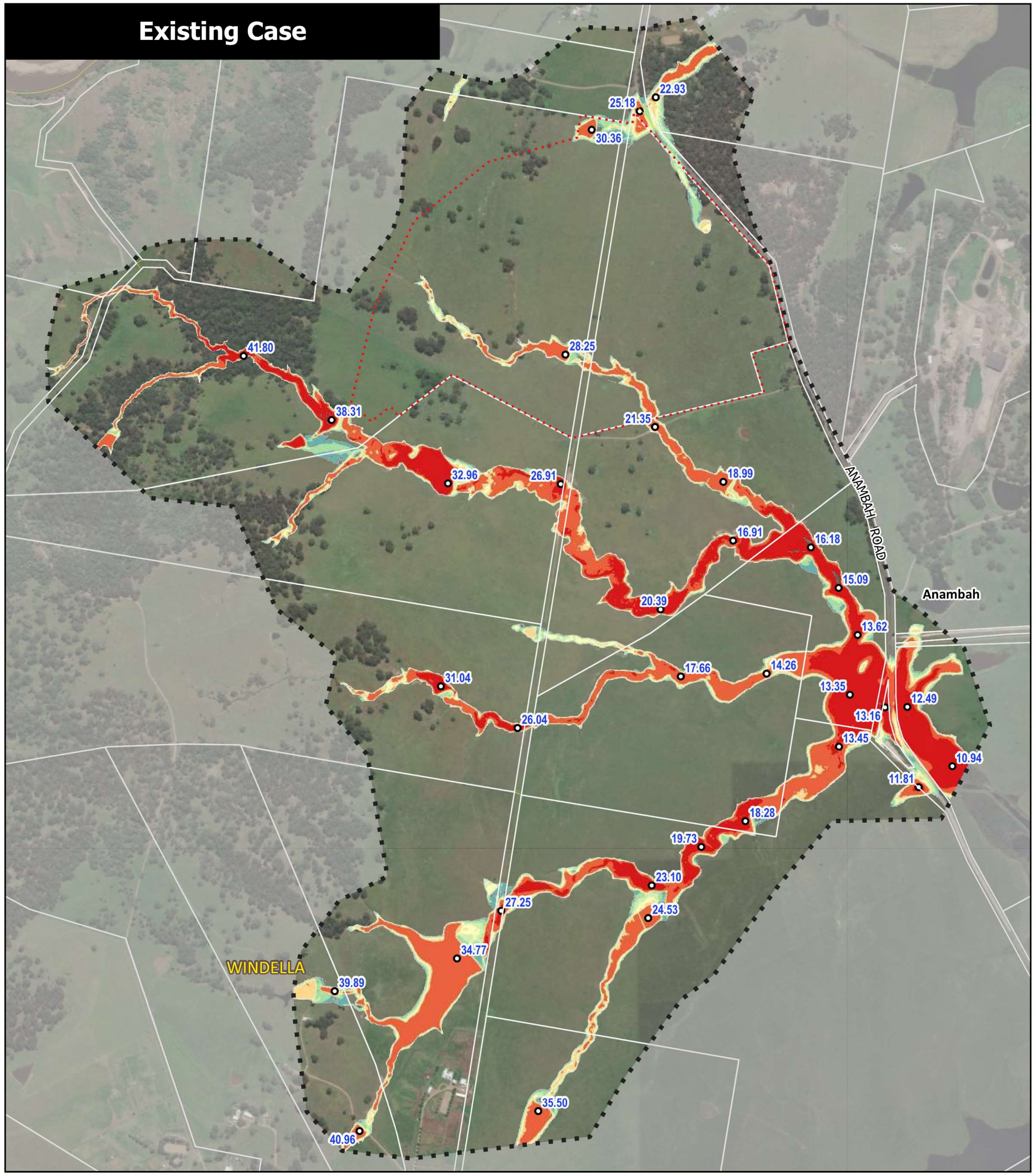
Figure BC5-3

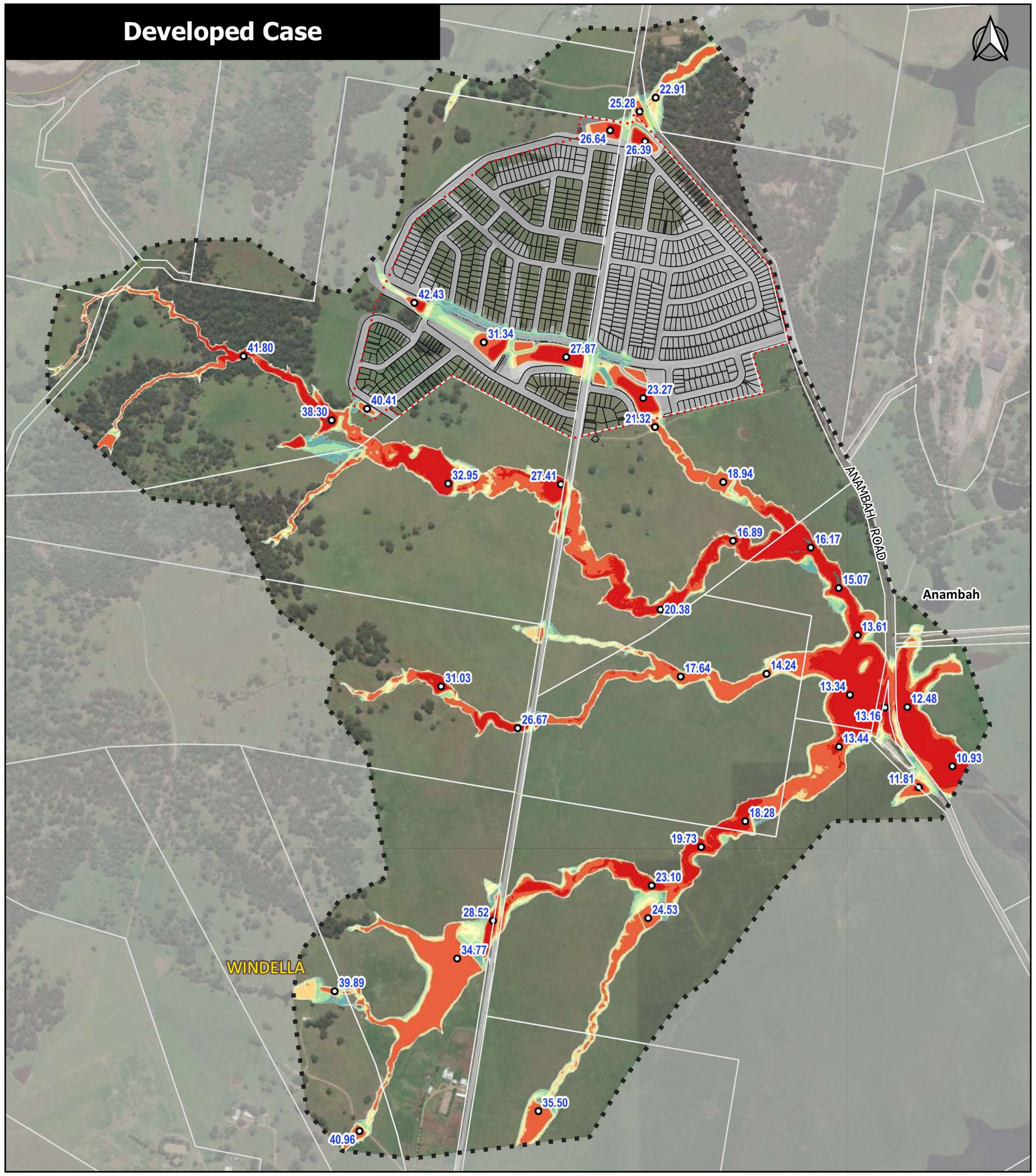
1% AEP Flood Hazard

559 Anambah Road

NORTHROP

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial





Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent
- Spot Water Level(mAHD)

Depth(m)

- < 0.02
- 0.02 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 0.70
- 0.70 - 1.00
- 1.00 - 2.00
- > 2.00

0 200 400 Metres

1:13,500

Figure BC6-1

PMF Flood Depth and Elevation

559 Anambah Road

NORTHROP

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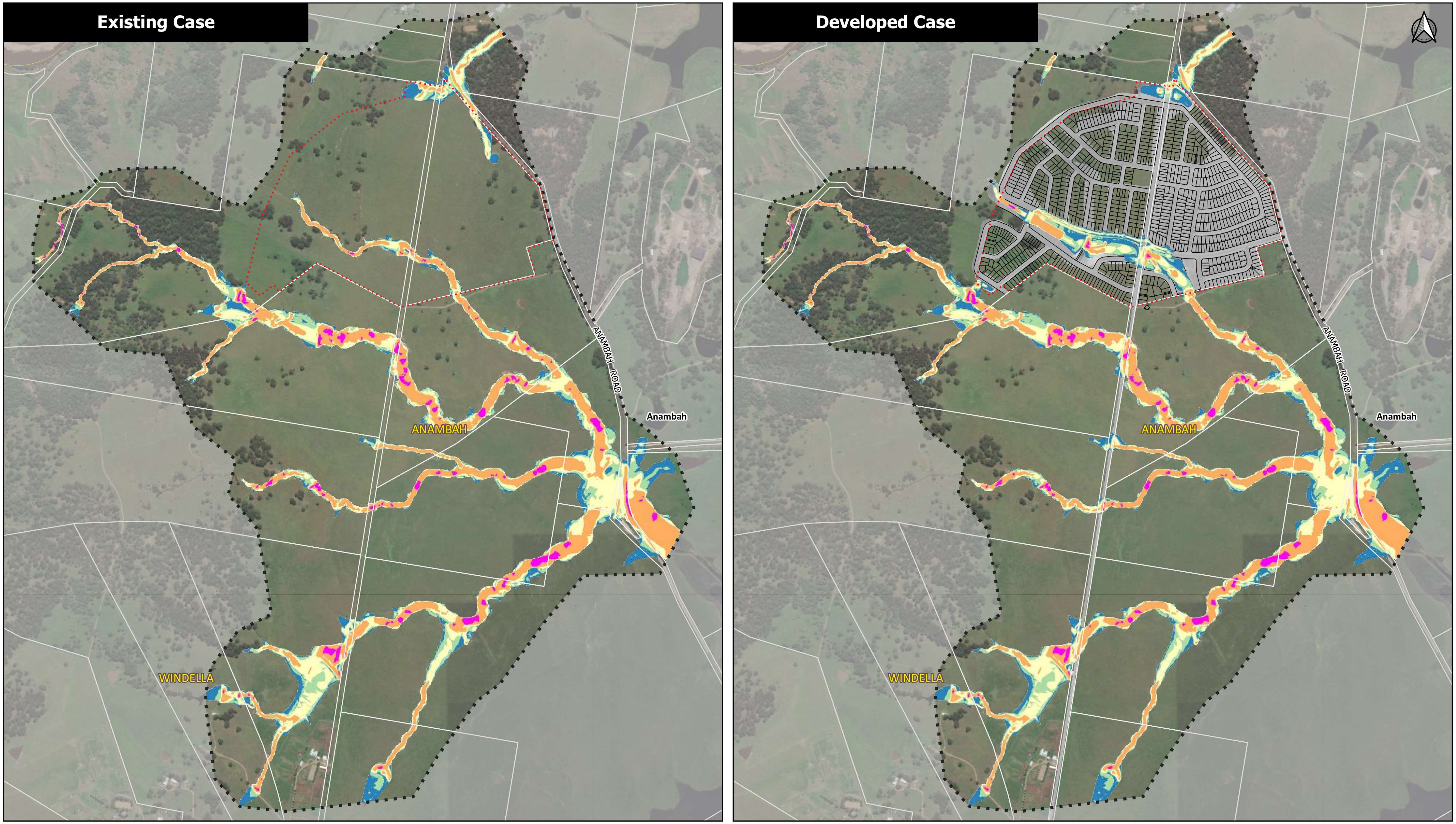
Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial



Legend

Subject Site
Cadastre
TUFLOW Model Extent

Velocity(m/s)

- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- > 6.0

0 200 400 Metres

1:13,500

Figure BC6-2

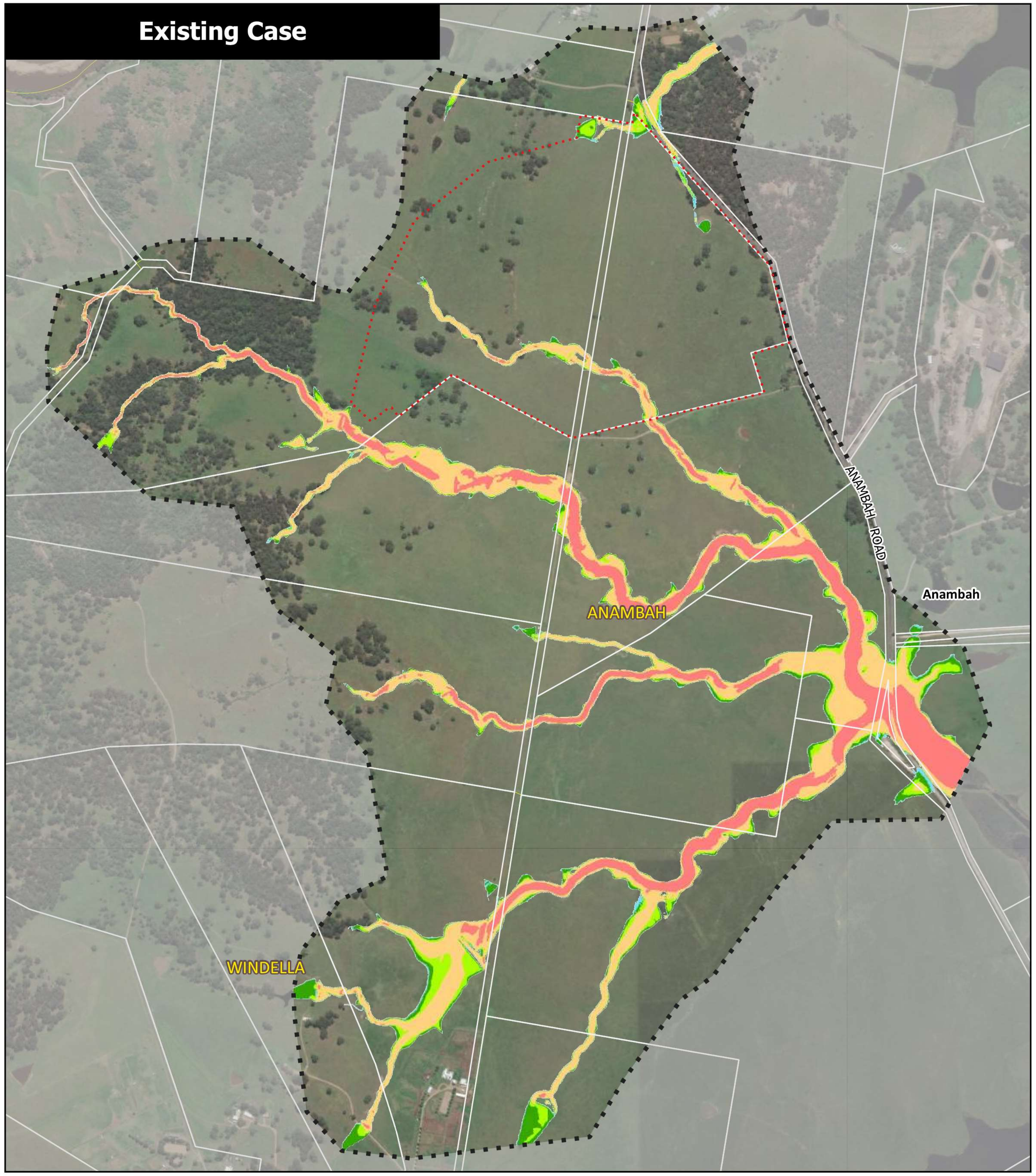
PMF Flood Velocity

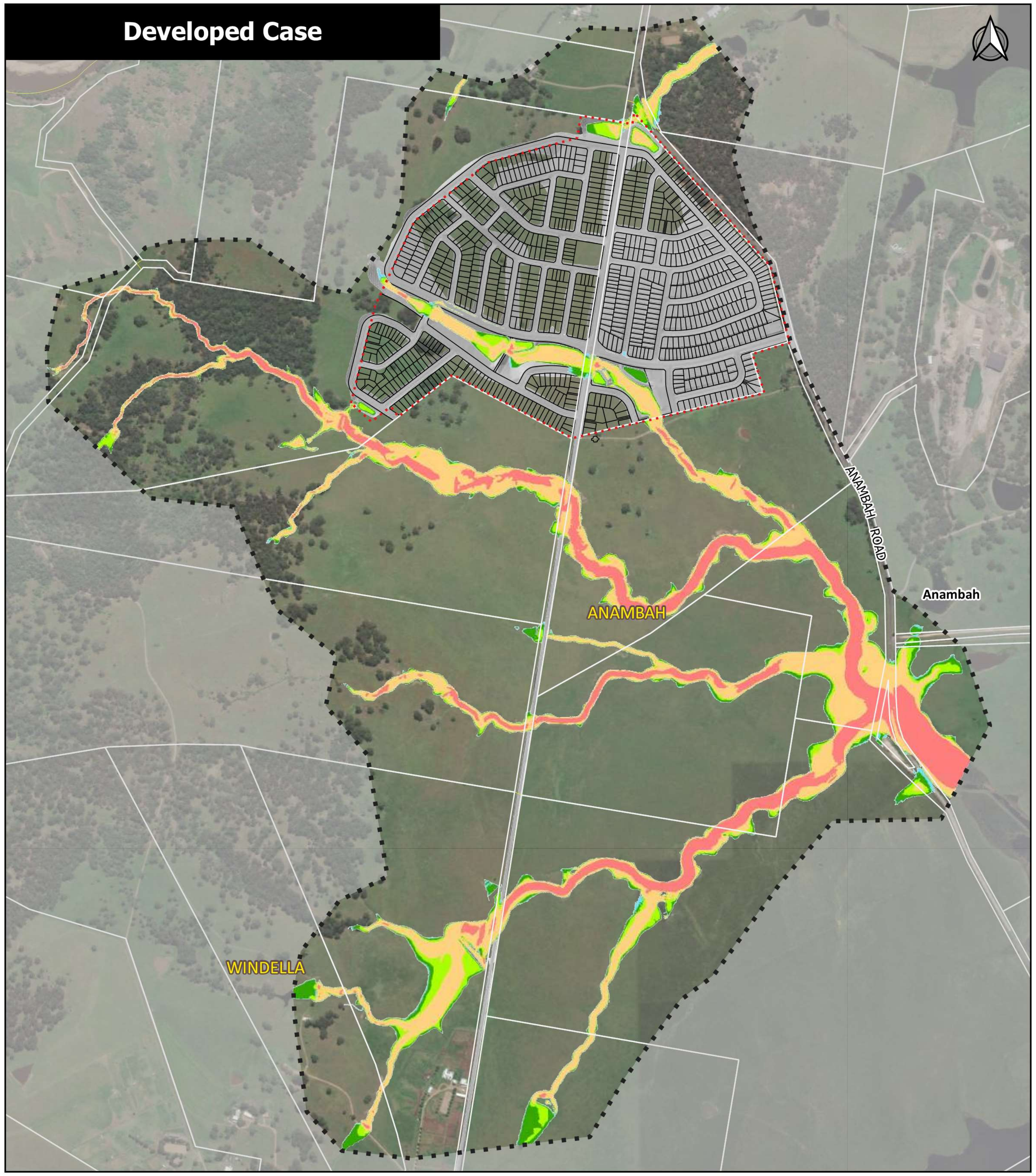
559 Anambah Road

NORTHROP

19/5/2025 A3 X:\PROJECTS\NEWCASTLE\YEAR 2022 Jobs\NL222055 - Anambah Road\D - DESIGN\FIGURES\Figures_rev_Site1_v2.qgz

Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial





Legend

- Subject Site
- Cadastre
- TUFLOW Model Extent

Hazard Category

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

0 200 400 Metres

1:13,500

Figure BC6-3

PMF Flood Hazard

559 Anambah Road

NORTHROP

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Data Source: LPI NSW - Cadastre, Virtual Earth, Nearmap - aerial

Appendix B – Flood Impact Figures

Legend

- Subject Site
- Cadastre
- Proposed Lots

Difference(m)

- <-0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01

Less than +/-10mm

- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- >0.10

0 200 400 Metres

1:14,000

Figure D1

10% AEP Flood Elevation Difference Pre-to-Post Comparison

559 Anambah Road

NORTHROP

Data Source: NSW LPI - cadastre, Virtual Earth, Nearmap - aerial

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Legend

- Subject Site
- Cadastre
- Proposed Lots

Difference(m)

- <-0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01

Less than +/-10mm

- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- >0.10

0 200 400 Metres

1:14,000

Figure D2

5% AEP Flood Elevation Difference Pre-to-Post Comparison

559 Anambah Road

NORTHROP

Data Source: NSW LPI - cadastre, Virtual Earth, Nearmap - aerial

19/5/2025 X:\PROJECTS\NEWCASTLE\YEAR 2022 Jobs\NL222055 - Anambah Road\D - DESIGN\FIGURES\Figures_rev_Site1_v2.qgz

Legend

- Subject Site
- Cadastre
- Proposed Lots

Difference(m)

- <-0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01

Less than +/-10mm

- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- >0.10

0 200 400 Metres

1:14,000

Figure D3

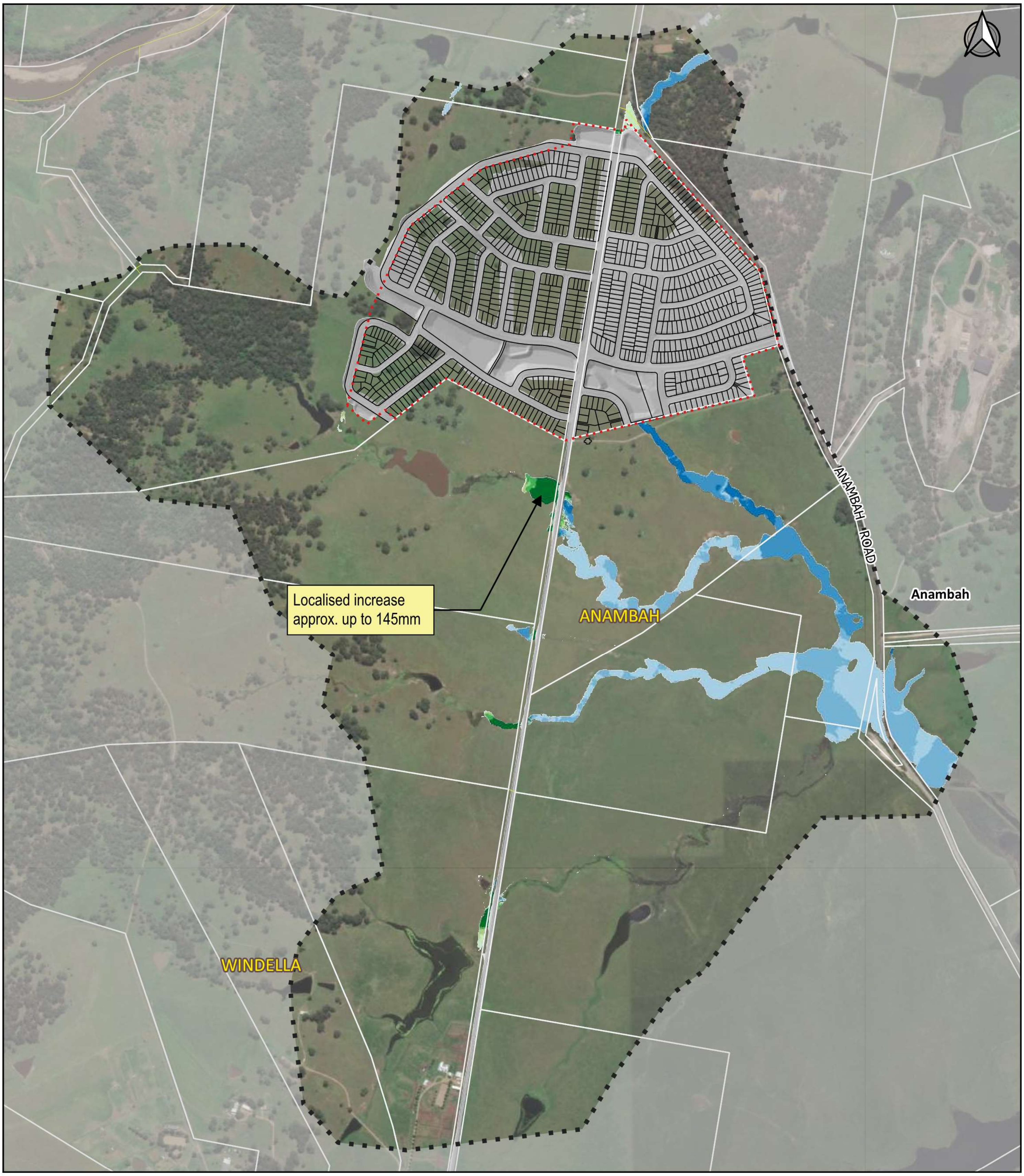
1% AEP Flood Elevation Difference Pre-to-Post Comparison

559 Anambah Road

NORTHROP

Data Source: NSW LPI - cadastre, Virtual Earth, Nearmap - aerial

19/5/2025 X:\PROJECTS\NEWCASTLE\YEAR 2022 Jobs\NL222055 - Anambah Road\D - DESIGN\FIGURES\Figures_rev_Site1_v2.qgz



Legend

Subject Site
Cadastre
Proposed Lots

Difference(m)
- <-0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01

Less than +/-10mm
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- >0.10

0 200 400 Metres
1:14,000

Figure D4

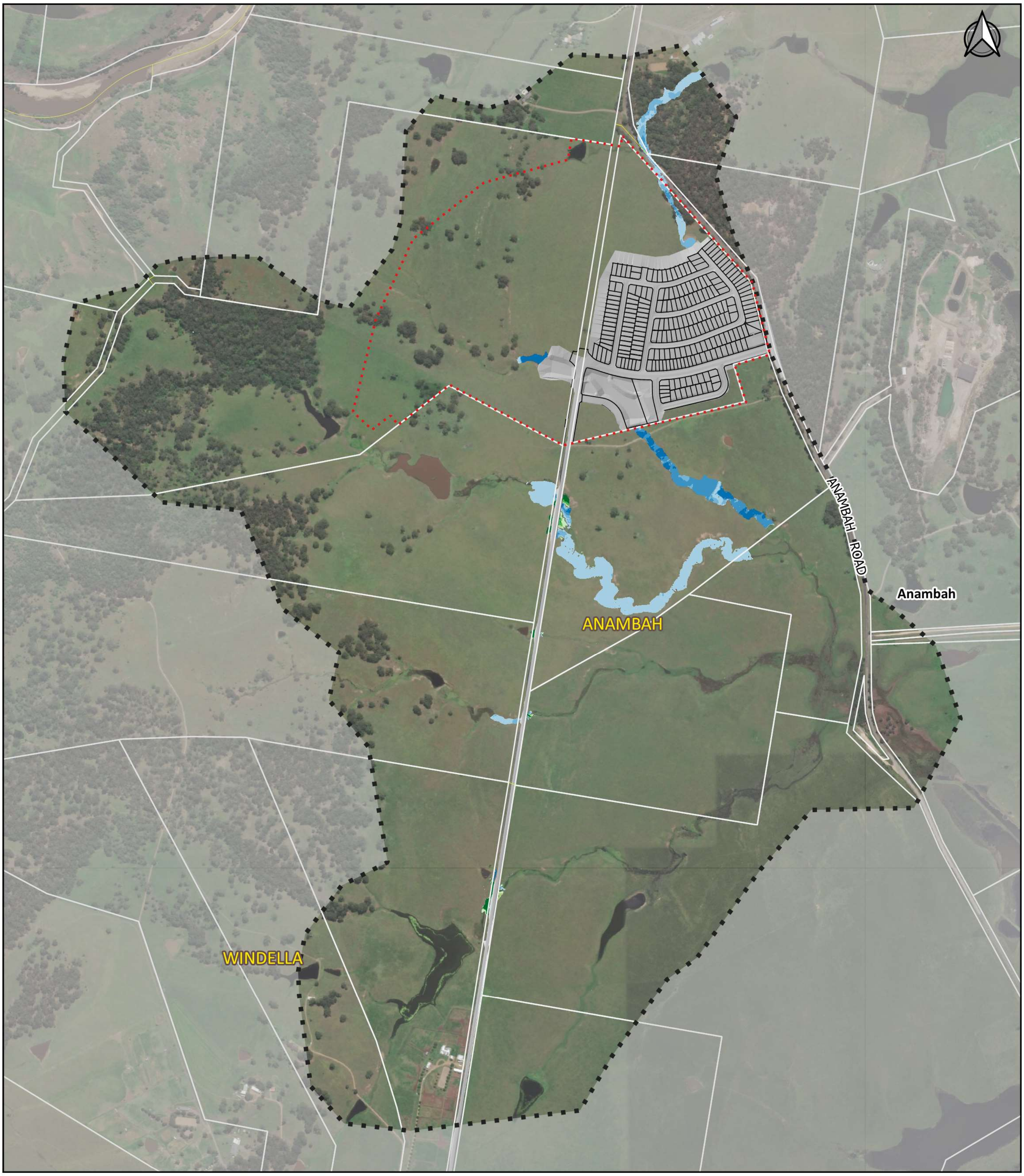
1 in 500 AEP Flood Elevation Difference Pre-to-Post Comparison

559 Anambah Road

NORTHROP

Data Source: NSW LPI - cadastre, Virtual Earth, Nearmap - aerial

19/5/2025 X:\PROJECTS\NEWCASTLE\YEAR 2022 Jobs\NL222055 - Anambah Road\D - DESIGN\FIGURES\Figures_rev_Site1_v2.qgz



Legend

- Subject Site
- Cadastre
- Proposed Lots

Difference(m)

- <-0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01
- Less than +/-10mm
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- >0.10

0 200 400 Metres

1:14,500

Figure D5

1% AEP Flood Elevation Difference Development Stage1 Pre-to-Post Comparison

559 Anambah Road

NORTHROP

Data Source: NSW LPI - cadastre, Virtual Earth, Nearmap - aerial

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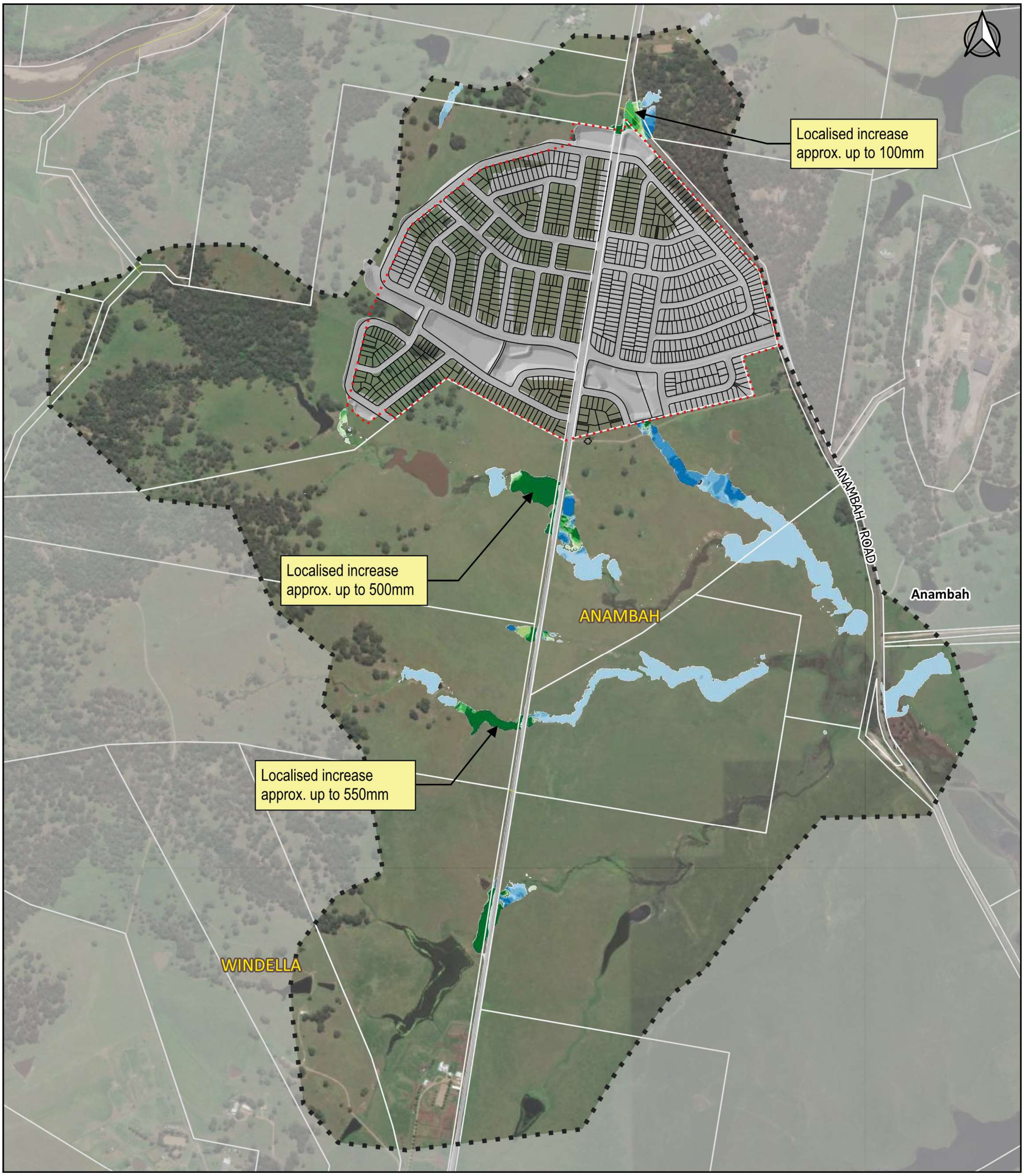

Legend

Subject Site
Cadastre
Proposed Lots

Difference(m)
- <-0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01

Less than +/-10mm
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- >0.10

0 200 400 Metres
1:14,000

Figure D6

PMF Flood Elevation Difference Pre-to-Post Comparison

559 Anambah Road

NORTHROP

Data Source: NSW LPI - cadastre, Virtual Earth, Nearmap - aerial

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