Peelwood Road, Laggan

(Lot 2 DP 1233492, Lot 1 DP 239858 and Lot 1 DP 1253980)

Flood Impact and Risk Assessment (FIRA)

Revision 1
December 2023

Catchment Simulation Solutions

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TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES (APPENDIX A)

Existing Conditions Flood Maps

Proposed Conditions Flood Maps

Climate Change Flood Maps

Blockage Sensitivity Flood Maps

Flood Planning Maps

1 INTRODUCTION

Upper Lachlan Shire Council, on behalf of Ian Miller of Sutton Park Pty Ltd, is proposing to amend the Upper Lachlan Local Environment Plan (LEP) 2010 by rezoning land located at Lot 2 DP 1233492, Lot 1 DP 239858 and Lot 1 DP 1253980 at Laggan, NSW (herein referred to as 'the site'). The planning proposal seeks to upzone the southern portion of the overall site from RU2 (rural) zoning to RU5 (village) zoning to allow for future subdivision into smaller lots. The northern portion of the site is to be rezoned from RU2 to C3 (Environmental Management). The location of the site is shown in **Figure 1**, which is enclosed in **Appendix A**. **Figure 1** shows that the site is currently undeveloped with rural pasture and scattered trees.

The planning proposal has been through the Department of Planning and Environment (DPE) gateway process which has identified that parts of the site are likely to experience overland flow. Therefore, any potential changes across the site have the potential to alter existing flood behaviour which may adversely impact on nearby properties. Furthermore, rezoning of the existing site to allow intensification of development across flood liable land is potentially inconsistent with Section 9.1 Ministerial Direction 4.1 *Flooding*. As such, any rezoning must manage the flooding to ensure the existing flood risk is not increased.

In recognition of the existing overland flow risk through the site and the potential for any future development to adversely impact on flooding across neighbouring properties, DPE requested a Flood Impact and Risk Assessment be prepared that addressed the following requirements:

- The impact on flooding of the development – including local overland flows and the range of possible floods up to the Probable Maximum Flood (PMF)
- The impact of the development on flood behaviour – particularly adverse impacts on existing communities downstream of the site
- The impact of flooding on the safety of people for the full range of possible floods
- The implications of climate change on flooding – particularly increased rainfall intensity on flood behaviour, and
- The impact of landform modifications to the natural environment including spatial requirements for natural waterway function, rehabilitation of the riparian zone, stormwater management infrastructure utilised to offset impacts (water quality and quantity) and associated impacts on flood behaviour/flood planning levels.

Ian Miller of Sutton Park Pty Ltd subsequently engaged Catchment Simulation Solutions to prepare the Flood Impact and Risk. The following report summarises the outcomes of this assessment.

2 EXISTING FLOOD BEHAVIOUR

2.1 General

In order to understand the potential impact of the rezoning, including future subdivision and development on flood behaviour, it is first necessary to define flood behaviour for "existing" conditions. No previous flood investigation has been completed across this portion of the Upper Lachlan Shire Local Government Area (LGA). Therefore, it was necessary to develop new hydrologic and hydraulic models of the local catchment, as well as the adjacent tributaries.

The hydrologic model, which is used to simulate rainfall-runoff processes, was developed using the XP-RAFTS software. The hydraulic model, which is used to simulate movement of runoff along the various watercourses, was developed using the TUFLOW software.

The following chapter describes the model development process as well as the outcomes of the existing flood assessment.

2.2 XP-RAFTS Modelling

2.2.1 Catchment Delineation

As shown in **Figure 1**, a number of small tributaries extend through the site. The tributaries form part of the wider Reedy Creek catchment.

The CatchmentSIM software was used to delineate the contributing catchment draining along the tributaries within the site as well as the balance of the Reedy Creek catchment (extending approximately 2.8 km downstream of the site). The model was extended to include the Reedy Creek catchment to enable the potential flood impacts of Reedy Creek on the site, as well as the potential impacts of the development on Reedy Creek flood behaviour to be quantified.

The subcatchment delineation was based on a 2 metre Digital Elevation Model (DEM) that was developed from 2016 LiDAR data obtained from the ELVIS website. The overall catchment was broken up into a number of smaller subcatchments to better define the spatial variation of hydrologic properties across the catchment. The adopted subcatchments are shown on **Figure 2**.

A variety of hydrologic parameters were calculated for each subcatchment to enable the hydrologic model to be parameterised. This included:

- Subcatchment area
- Subcatchment slope
- Percentage impervious
- Roughness (PERN)
- Flow path length.

The subcatchment area, subcatchment slope and flow path length were calculated automatically by the CatchmentSIM software based on the underlying DEM.

The percentage impervious and subcatchment roughness were calculated by developing a series of land use polygons representing each major land use across the catchment. A representative impervious percentage and roughness was assigned to each of the land use types and is listed in **Table 1**. This information was then used to calculate a weighted average impervious percentage and roughness value for each subcatchment. The adopted subcatchment properties are provided in **Appendix B**.

Table 1 Adopted land use Impervious percentage and Manning's "n" Roughness Values

Material Description	Impervious (%)	Roughness
Grass	0	0.030
Trees	0	0.100
Waterbodies	100	0.030
Roadway	100	0.015
Gravel Roadway	100	0.018
Concrete	100	0.015
Building	100	XP-RAFTS: 0.025 TUFLOW: 1.000

Although no flood study has been undertaken across the Laggan district, flood and floodplain risk management studies within the nearby Crookwell and Taralga townships (also located within the Upper Lachlan Shire) have been completed. As there is a high level of similarity in topography and land use within the areas covered by these studies, the hydrologic parameters adopted in these studies (specifically '*The Village of Crookwell Flood Study*' (Lyall and Associates, 2014)) were carried across to the current assessment and are reflected in **Table 1**.

2.2.2 Model Development

The subcatchment information described in the previous sections formed the basis for developing a XP-RAFTS hydrologic model of the catchment. The subcatchment and node-link layout is shown on **Figure 2**. Each subcatchment "node" was parameterised based on the information contained in **Appendix B**.

Time delay routing links were adopted to represent the routing of flows between subcatchment "nodes". The Bransby-Williams equation was adopted for the lag calculations with a 0.6 factor applied to convert from time of concentration to a main stream channel lag.

2.2.3 Rainfall

The rainfall depths were downloaded from the Bureau of Meteorology 2016 IFD website for the 63.2%, 50%, 20%, 10%, 5%, 2%, 1% and 0.5% AEP events. The adopted rainfall depths for each frequency are reproduced in **Table 2**.

Table 2 Design Rainfall Depths

Duration	Rainfall Depth (mm)								
	63.2% AEP	50% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP	PMP
5 mins	4.62	5.13	6.73	7.82	8.88	10.3	11.3	12.6	N/A
10 mins	7.11	7.93	10.5	12.3	14	16.4	18.2	20.2	N/A
15 min	8.75	9.77	13	15.2	17.3	20.2	22.5	25	130
20 mins	9.98	11.1	14.8	17.3	19.7	23	25.5	28.4	N/A
25 mins	11	12.2	16.2	18.9	21.5	25.1	27.8	30.9	N/A
30 mins	11.8	13.1	17.3	20.2	23.1	26.8	29.7	33	190
45 mins	13.8	15.3	20	23.3	26.5	30.7	34	37.7	240
1 hour	15.3	16.9	22.1	25.6	29.1	33.7	37.2	41.3	280
1.5 hour	17.7	19.5	25.4	29.3	33.2	38.3	42.3	47	360
2 hours	19.6	21.7	28.1	32.4	36.7	42.3	46.6	51.8	420
3 hours	22.9	25.2	32.6	37.6	42.6	49.1	54.2	60.3	510
4.5 hours	26.8	29.6	38.3	44.2	50.1	58	64.1	71.3	N/A
6 hours	30.1	33.2	43.2	50	56.8	65.9	73	81.2	680
9 hours	35.4	39.2	51.4	59.8	68.2	79.6	88.4	98.4	N/A
12 hours	39.7	44.1	58.2	68.1	77.9	91.2	102	113	N/A
18 hours	46.4	51.7	69.1	81.4	93.7	110	123	137	N/A
24 hours	51.4	57.5	77.6	91.8	106	125	140	156	N/A
36 hours	58.5	65.9	89.9	107	124	147	164	183	N/A
48 hours	63.5	71.7	98.4	118	137	162	181	201	N/A
72 hours	70.1	79.3	109	131	153	180	201	222	N/A
96 hours	74.6	84.4	116	139	162	191	213	235	N/A

Probable Maximum Precipitation

As part of the current study, it was also necessary to define flood characteristics for the Probable Maximum Flood (PMF). The PMF is considered to be the largest flood that could conceivably occur across a particular area. The PMF is estimated by routing the Probable Maximum Precipitation (PMP) through the XP-RAFTS model. The PMP is defined as the greatest depth of rainfall that is meteorologically possible at a specific location.

PMP depths were derived for a range of storm durations up to and including the 6-hour event based on procedures set out in the Bureau of Meteorology's *'Generalised Short Duration Method'* (GSDM) (Bureau of Meteorology, 2003). The GSDM PMP calculations are provided in **Appendix C** and a summary of rainfall depths is included in **Table 2**.

2.2.4 Rainfall Losses

The initial-continuing loss model was applied as part of the design storm simulations to simulate rainfall losses across the catchment. The burst losses for pervious sections of the catchment were assigned using the ARR2019 data hub "probability neutral" burst losses. The pervious continuing loss rates were applied as per the revised New South Wales jurisdictional guidance published on the ARR data hub. This involves applying a 0.4 factor to the published data hub value of 4.30mm/hr (i.e., 0.4 x 4.3mm/hr = 1.72 mm/hr). For impervious surfaces, a burst loss of 0 mm and a continuing loss rate of 0 mm/hr were adopted.

2.2.5 Temporal Patterns

ARR2019 employs 10 different temporal patterns for each AEP/storm duration to define the time variation in rainfall during each storm. The use of a variety of different temporal patterns is intended to reflect the natural variability of a typical rainfall event (i.e., no two storms will be the same).

The temporal patterns for the study area were downloaded from the ARR data hub and were used to simulate the temporal distribution of rainfall for each design storm. In accordance with ARR2019 for catchments with an area less than 75 km^2, the "point" temporal patterns rather than "areal" temporal patterns were selected to describe the temporal variation in rainfall.

ARR2019 groups the temporal patterns into "frequent", "intermediate" and "rare" bins, which were applied to each design storm as follows:

- Frequent temporal patterns: 50% AEP and 20% AEP
- Intermediate temporal patterns: 10% AEP and 5% AEP
- Rare temporal patterns: 2% AEP, 1% AEP, 0.5% AEP and 0.2% AEP

For the PMP, a single temporal pattern was adopted for each PMP storm simulation in line with the approach recommended in the *'Generalised Short Duration Method'* (GSDM) (Bureau of Meteorology, 2003).

2.2.6 Results

Peak discharges were generated for the full range of storm durations and temporal patterns for each subcatchment for the 63.2%, 50%, 20%, 10%, 5%, 2%, 1% and 0.5% AEP events. The critical storm duration for each XP-RAFTS subcatchment was then determined. This involved calculating the average design discharge for each subcatchment (based on consideration of a suite of ten temporal patterns for each storm frequency and duration). The storm duration that produced the highest average discharge was adopted as the critical duration for each subcatchment. The critical duration for each XP-RAFTS model subcatchment is summarised in **Appendix D**. The most suitable ARR2019 temporal pattern for each subcatchment (i.e., the temporal pattern that generated the next highest peak discharge above the average) was also extracted and is included in **Appendix D** along with the corresponding peak discharge.

The storm duration/temporal pattern combinations that produced the critical flow within the site, as well as on Reedy Creek adjacent to the site for each flood event is presented in **Table 3**. All of the storm duration/temporal pattern combinations in **Table 3** were adopted as part of all subsequent analysis to define design flood behaviour for this study.

2.3 TUFLOW Modelling

2.3.1 Model Development

A hydraulic model of the local watercourses was developed using the TUFLOW software. Key features of the TUFLOW model are summarised below:

- Model Domain: the TUFLOW hydraulic model area extends across the full extent of the site as well as Reedy Creek upstream and downstream of the site. This includes locating the downstream model boundary 300 metres south of the Golspie Road crossing of Reedy Creek (i.e., well downstream of the site) to ensure the adopted downstream boundary condition did not impact on flood behaviour in the vicinity of the site. The extent of the model is shown on **Figure 3**.

Table 3 Adopted storm duration and temporal patterns.

Adopted Storm Duration	Adopted Storm Temporal Pattern									
	63.2% AEP	50% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP	0.2% AEP	PMP#
45						3844	3844	3844	3844	N/A
60					3887	3819	3819	3819	3877	N/A
90				3915	3918					
120			3956	3901	3901					
180										N/A
270			4021					3992	3992	
360						3862	4025			
540				4059	4059					
720		4100								
1440	4155									

Only one temporal pattern is provided by the GSDM PMP Method

- Grid Size: a 2 metre grid size was used to represent the variation in terrain and hydraulic properties (e.g., hydraulic roughness) across the catchment.
- Topography:2016 LiDAR data was used to assign elevations to each TUFLOW model grid cell. Minor terrain modifications were also included in areas where the LiDAR data provided a less reliable representation of the ground surface, such as along the watercourses.
- Land Use and Hydraulic Roughness: the land use types across the model domain were used within the TUFLOW model to assign hydraulic roughness coefficients to each grid cell. The adopted roughness coefficients are included in **Table 1** and the extent of each land use is shown on **Figure 3**.

- Buildings: Buildings can provide a significant impediment to flow. Therefore, as shown in **Table 1**, buildings were represented in the TUFLOW model using a high roughness value of = 1.0 to reflect this flow impediment.
- Farm Dams: A number of farm dams are located near the site as well as within the upstream catchment. Although these water bodies do have the potential to temporarily store water during rainfall events, none of the storages are explicitly designed to serve as flood detention basins. As a result, these dams were assumed to be "full" at the start of each simulation and provided no attenuation of flows.
- Inflow hydrographs: The critical flow hydrographs generated by the XP-RAFTS model (as outlined in **Table 3**) were used to define inflows to the hydraulic model. The local hydrographs were applied to the outlet of each XP-RAFTS model subcatchment that fell within the TUFLOW model domain, and total inflows were applied within subcatchments that had additional upstream contributing subcatchments not included within the TUFLOW model domain.
- Downstream Boundary: The downstream boundary condition was defined using a 'normal depth' (i.e.: Manning's) calculation. A slope of 5% was adopted based on the available LiDAR at the downstream model boundary.
- Hydraulic Structures: Culverts were included at waterway crossings of major roadways based on site inspections and field measurements. Although the culvert dimensions are not of a survey standard, they are considered sufficient for the current assessment.
- Hydraulic Structure Blockage: Blockage for all culverts have been calculated based on procedures outlined in *'Australian Rainfall and Runoff – Project 11: Blockage Guidelines for Culverts and Small Bridges'* (Engineers Australia, 2015). The blockage calculations and adopted blockage factors are contained within **Appendix E**. A 'high blockage' sensitivity assessment has also been completed and is discussed in Section 3.6.

2.3.2 Results

The TUFLOW model was used to simulate flood behaviour for the 63.2%, 50%, 20%, 10%, 5%, 2%, 1% and 0.5% AEP events and PMF for existing topographic and development conditions for the critical duration and temporal patterns detailed in **Table 3**.

Flood mapping was prepared for each design flood by enveloping the peak flood behaviour from all duration/temporal pattern combinations for that event, and is presented in **Appendix A** as follows:

- Peak floodwater depths and levels: **Figures 4** to **12**.
- Peak velocity: **Figures 13** to **21**.

Figure 4 through **Figure 12** shows that there several flow paths that extend through the site. This includes a flow path that enters near the south-western corner of the lot and passes through the southern portion of the site in a north-easterly direction, before changing direction to the south-east and flowing into a farm dam. The flow path is then drained via a culvert across Peelwood Road to Reedy Creek to the east. Multiple flow paths enter near the west-north-western corner of the site; however, these combine to form one flow path which moves in an easterly direction to Peelwood Road, before draining through another culvert towards Reedy Creek.

The depth results indicate that:

- Depths along the southern flow path can vary from less than 0.1 metre in events up to and including the 5% AEP flood, to over 0.4 meters in the PMF.
- Depths within the farm dam can vary from 0.7 metres to 1.2 metres in the 63.2% AEP and PMF respectively.
- Depths along the northern flow paths(s) vary from a maximum of 0.4 metres in the 63.2% AEP event to 1.5 metres in the PMF.

Figures 10 through **Figure 15** indicate that:

- Peak velocities within the southern flow path can reach up to 1.2 m/s in the 63.2% AEP event and 3.7 m/s in the PMF.
- Velocities along the northern flow path(s) can vary from a maximum of 1.8 m/s in the 63.2% AEP event to 4.7m/s in the PMF.

Hydraulic Categories

Hydraulic Categories for the 1% AEP flood and PMF under existing conditions were also calculated. This involved subdividing the floodplain into floodway, flood storage and flood fringe categories in accordance with definitions provided in the '*Flood Function – Flood risk management guideline FB02'* (NSW Government Department of Planning and Environment, 2023).

Criteria for defining hydraulic categories is not explicitly available as these will typically vary from catchment to catchment. However, *'The Villages of Crookwell, Gunning, Collector and Taralga Floodplain Risk Management Study and Draft Plan'* (Lyall & Associates, 2017) established hydraulic categories. Due to the similarities of the catchments in this study with the Reedy Creek catchment, it was considered reasonable to apply the same criteria to the current study.

This included defining floodways based on criteria defined by Howells et al (2004), as follows:

- Velocity x Depth > 0.25m^2/s AND Velocity > 0.25m/s, OR
- Velocity > 1m/s.

Flood storage and flood fringe areas were subsequently defined based on the following:

- Flood Storage: Areas not defined as floodway AND Depth > 0.4m.
- Flood Fringe: Remaining areas.

These criteria were applied to the 1% AEP and PMF results from the flood modelling and the resulting hydraulic categories are presented in **Figure 22** and **23** respectively.

Figure 22 indicates that, within the development site, the majority of both the southern and northern flow paths act as floodway areas, with flood fringe present along the edges of the floodway. Little to no flood storage is present apart from within farm dams. **Figure 23** shows that in the PMF, most of the inundation within the site would be classified as floodway.

Flood Hazard

To confirm the nature and extent of the existing flood hazard across the site, flood hazard mapping was prepared based upon flood hazard vulnerability curves presented in '*Flood Hazard – Flood risk management guideline FB03'* (NSW Government Department of Planning and Environment, 2023). The hazard curves, which are reproduced in **Plate 1**, assess the potential vulnerability of people, cars and structures based upon the depth and velocity of floodwaters at a particular location. The maximum flood hazards for each design flood are presented in **Figures 24** to **32**.

Figures 24 to **32** show that the flood hazard along the southern flow path in the 63.2% AEP through the 0.5% AEP events is generally no higher than H1 apart from within the farm dam (due to the higher depths at this location) and on the upstream side of Peelwood Road as a result of water ponding on the upstream side of the roadway embankment. Along the northern flow paths, a hazard of up to H2 is typical, however, isolated portions of the flow paths can reach up to H5. During the PMF, a flood hazard of H5 is typical along all flow paths, with localised areas of H6 also present along part sections of the northern flow path(s).

These results indicate that the site would generally be safe for pedestrians in all events up to the 0.5% AEP. However, the PMF poses a more significant risk to life.

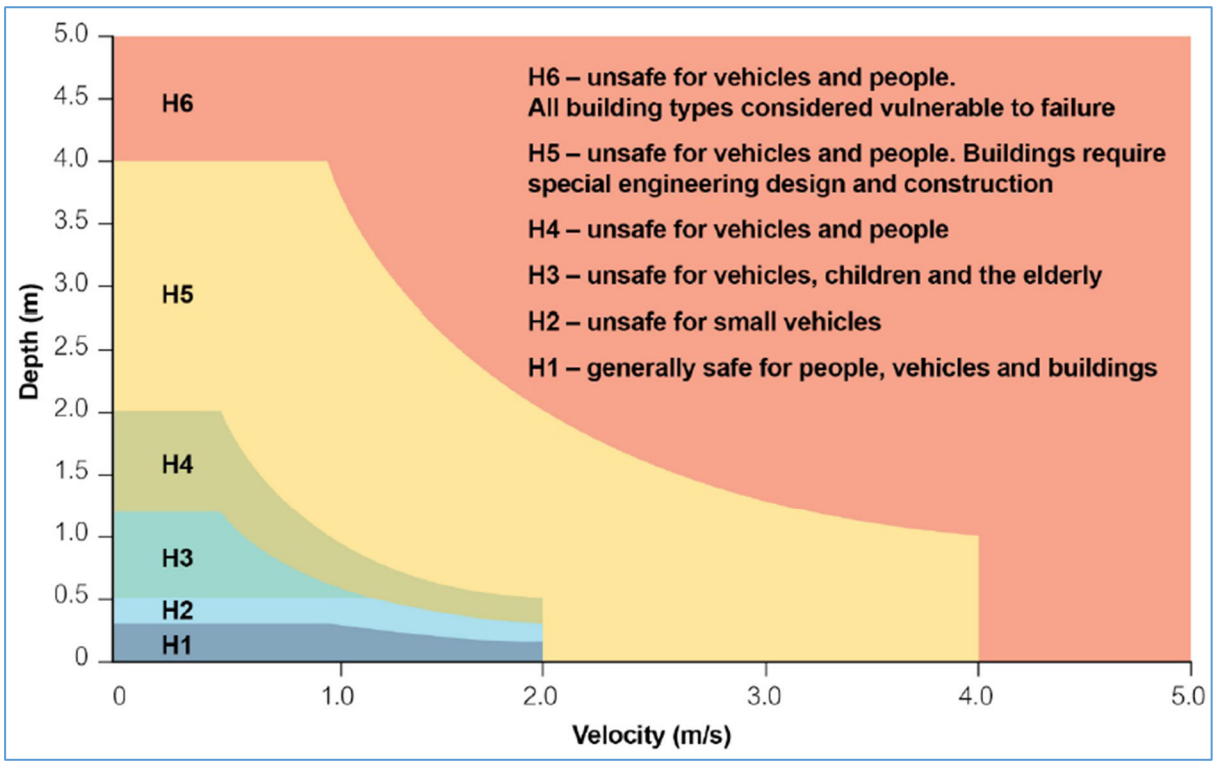

Plate 1 Flood hazard vulnerability curves (NSW Government, 2023)

3 Post-Development Flood Behaviour

3.1 Description of the Proposed Development

As previously discussed, Upper Lachlan Shire Council, on behalf of Ian Miller of Sutton Park Pty Ltd intends to rezone the existing lots from an RU2 (rural) zoning to RU5 (village) or C3 (Environmental Management) zoning to allow for future subdivision into smaller lots. A concept design for the future use of the site is provided in **Appendix F** and includes:

- Construction of a new internal loop roadway to/from Peelwood Road. The roadway will cross a watercourse at one location and require culverts to convey flow under the roadway.
- Subdivision to form 28 new lots, each with a building pad and asset protection zone (together forming an area of ~400m^2 per lot). Two of the lots will be located in the far northern portion of the site and placed into the proposed C3 (environmental management) zone, with the remaining 26 lots to be located in the southern portion of the site into the proposed RU5 zone.

The increased impervious surfaces that will occur as part of the subdivision has the potential to increase peak discharges leaving the site. The construction of roads and culverts along with building pads within the site also has the potential to redistribute flows. Both factors could impact on downstream properties.

The following sections describe the assessment that was completed to define "post-development" flood conditions. This includes a discussion on the potential impacts that the proposed works are likely to have on existing flood behaviour.

3.2 Model Updates

3.2.1 XP-RAFTS Model

The XP-RAFTS model that was used to define existing hydrology was updated to include the modified land use anticipated from the proposed works. This involved updating the existing land use polygons to account for the following changes:

- The new internal roadway
- The asset protection zones, which were assumed to be concrete (i.e.: impervious)
- The indicative building footprints

The updated land use polygons that were used to inform the hydrologic model modifications and are shown on **Figure 33**. The model parameters for areas located outside of the site were not altered from the "existing" conditions assessment.

3.2.2 TUFLOW Model

To quantify the impact that the proposed development is likely to have on existing flood behaviour, the TUFLOW model that was used to define "existing" flood behaviour was updated to reflect the concept design shown in **Appendix F**. This incorporated the following changes:

- Topographic changes across the new loop roadway, specifically at the location where the southern flow path intersects the proposed road. This was enforced by raising the terrain along the roadway to a level of 901.2m AHD.
- Lowering of the terrain immediately upstream of the proposed road to an elevation of 900m AHD (to facilitate the introduction of a new culvert for the southern flow path)
- Inclusion of a 6 x 2.4mW x 0.75mH RCBC culverts through the new roadway to convey overland flow.
- Raising of the proposed asset protection zones to be above the peak 1% AEP flood level.
- Modifications to the hydraulic roughness within the site to reflect the roadway, asset protection zones and building footprints.
- The post-development inflow hydrographs described in Section 3.2.1 were applied to the hydraulic model.

3.3 Results

3.3.1 XP-RAFTS Model

The updated XP-RAFTS model was used to re-simulate the 63.2%, 50%, 20%, 10%, 5%, 2%, 1% and 0.5% AEP events and PMF for all storm durations and temporal patterns for post-development catchment conditions. A complete listing of XP-RAFTS model outputs for each subcatchment for post-development conditions is provided in **Appendix G.**

A review of the post-development critical durations and temporal patterns showed that they were generally identical to the existing critical durations and temporal patterns. Therefore, the critical storms listed in **Table 3** were also retained as part of the post-development flood analysis.

The peak outflows from the local subcatchments incorporating the proposed development were compared against flows under existing conditions in order to gain an appreciation of the impact of the altered land use within the site on peak discharges. The peak flow comparison is presented in **Table 4** and indicate that peak flows at subcatchment L-11.06 (the subcatchment representing the outflow from the site from the southern flow path) is generally shown to decrease slightly (generally by < 3%) under proposed conditions for events greater than the 50% AEP. Increases of up to 5% are predicted in the 63.2% AEP event.

At subcatchment L-14.07 (the subcatchment representing the outflow from the site from the northern flow path) the peak flow from the site is also shown to decrease by up to 3%. The reduction in peak flow from the site is a result of the faster response time of the site from the greater proportion of impervious surfaces. This allows the peak flow from the site to runoff before the peak flow from the upper catchment arrives.

To further confirm whether the change in flows generated within the site will alter flood behaviour, a post-development hydraulic assessment was completed, which is discussed below.

Table 4 Peak flow comparison from the development site under existing and post-development conditions

Flood Event	Location			
	Southern Flow Path at Downstream Site Boundary (XP-RAFTS Node L-11.06)		Northern Flow Path at Downstream Site Boundary (XP-RAFTS Node L-14.07)	
	Existing	Proposed	Existing	Proposed
63.2% AEP	0.60	0.63	2.00	1.96
50% AEP	0.69	0.70	2.46	2.46
20% AEP	1.35	1.34	4.55	4.66
10% AEP	1.95	1.79	6.26	6.19
5% AEP	2.39	2.10	7.46	7.42
2% AEP	2.66	2.65	8.53	8.47
1% AEP	3.21	3.09	10.08	9.96
0.5% AEP	3.60	3.54	11.57	11.43
0.2% AEP	4.28	4.14	13.88	13.38
PMP	38.1	37.4	134	134

3.3.2 TUFLOW Model

The TUFLOW model was then used to simulate flood behaviour for the 63.2%, 50%, 20%, 10%, 5%, 2%, 1% and 0.5% AEP events and PMF events for the same critical duration and temporal pattern as existing conditions.

Flood mapping was prepared as per the following:

- Peak floodwater depths and levels are presented in **Figures 34** to **42**.
- Peak velocity results are presented in **Figures 43** to **51**.

Figure 34 through **42** shows that, as per existing conditions, there are multiple sources of floodwater entering the site and include a flow path that passes through the southern portion of the site, together with multiple flow paths that enter near the west-north-western corner of the site. The peak flood depths shown on **Figures 34** to **42** and peak velocities shown on **Figures 43** to **51** along all flow paths are generally no different from those under existing conditions, as described in Section 2.3.2. However, the inclusion of the roadway crossing of the southern flow path has resulted in higher depths on the upstream side of the roadway crossing. More specifically, depths of up to 0.3 metres are predicted in the 63.2% AEP event and 1.1 metres in the PMF. No overtopping of the roadway is predicted in any of the simulated design floods.

3.3.3 Hydraulic Categories

Hydraulic categories for the 1% AEP and PMF under proposed conditions have also been calculated and are presented on **Figures 52** and **53**. **Figure 52** and **Figure 53** show that, as per existing conditions, the majority of both the southern and northern flow paths act as floodway areas. However, no floodway areas are shown to occur within the proposed roadways or asset protection zones during the 1% AEP flood or PMF. Therefore, all floodways are sited away from any future dwellings. Therefore, the suggested development areas are considered to be appropriately sited in relation to the flood behaviour with development/earthworks located clear of floodways and flood storage areas.

3.3.4 Flood Hazard

Flood hazard categories were also defined for proposed conditions and is presented on **Figures 54** through **62.**

Figures 54 through **62** shows that, as per existing conditions, the flood hazard along the southern flow path in the 63.2% AEP through the 0.5% AEP events is generally no higher than H1 (apart from within the farm dam and on the upstream side of Peelwood Road). Along the northern flow paths, a hazard of up to H2 is typical, however, isolated portions of the flow paths can reach up to H5. During the PMF, a flood hazard of H5 is again typical along all flow paths, with localised areas of H6 along part sections of the northern flow paths.

The flood hazard mapping presented on **Figures 54** through **62** provides a valuable understanding of the potential risk to future people, vehicles and property within the development site as a result of flooding. More specifically, the hazard mapping allows identification of areas of the site which would not be safe for pedestrians or vehicles to navigate, and areas where construction of dwellings should be avoided. The hazard mapping indicates that:

- In all simulated design floods, the internal roadway is flood free,
- Asset protection zones are largely flood free, and where inundation is predicted, it is a maximum of H1 in the PMF,
- All future dwellings are flood free.

Overall, these results confirm that the site is safe for pedestrians and vehicles in all flood events up to and including the PMF.

3.4 Flood Impact Assessment

To gain an understanding of the location and magnitude of changes in flood behaviour as a result of the proposed works, flood level and velocity difference mapping has been prepared. The flood level and velocity differences have been calculated by subtracting the peak flood levels and velocities from 'existing' conditions from that of 'proposed' conditions. The resulting difference maps provide a contour map showing the magnitude and location of changes in flood level and velocity with the proposed works in place. The flood level difference maps are provided in **Figures 63** through **71**, and the velocity difference maps are provided on **Figures 72** through **80**.

Figures 63 through **71** indicate that flood levels within the site are predicted to remain largely unchanged relative to existing conditions. However, minor changes in flood level are predicted in all events in the vicinity of the internal roadway crossing of the southern flow path, and adjacent to the north-western asset protection zones. The flood level changes include:

- Flood level reductions upstream of the internal roadway crossing of between 0.3 and 0.4 metres in all events up to the 0.5% AEP as a result of minor terrain modifications (lowering) to facilitate the construction of the culverts. Flood level increases are predicted downstream of the crossing of up to 0.1 metres as a result of localised redistribution of flow from the proposed culverts.

- Flood level increases of up to 0.7 metres upstream of the internal roadway crossing in the PMF. Flood level increases and decreases of up to 0.5 metres are predicted downstream of the crossing.
- Minor increases of up to 0.02 metres to the north of an asset protection zone in the north-west of the site in events up to the 0.5% AEP. Localised flood level increases and decreases of up to 0.3 metres are predicted at this location in the PMF.

No changes in peak flood level are predicted outside of the development site.

Figures 72 through **80** indicate that changes in velocity are generally minor and concentrated around the internal roadway crossing of the southern flow path, and adjacent to the north-western asset protection zones. The changes in velocity include:

- Flood velocity reductions upstream of the internal roadway crossing of between 0.4 and 1 m/s in all events up to the 0.5% AEP. Velocity increases of up to 1m/s and decreases of 0.5 m/s are predicted downstream of the crossing.
- Velocity increases and decreases of up to 1.4m/s are predicted both upstream and downstream of the crossing in the PMF. Smaller and more localised velocity impacts are predicted within the channel downstream of the crossing, and within the farm dam.
- A mix of velocity increases and decreases of up to 0.6m/s are predicted to the north of an asset protection zone in the north-west of the site in all flood events. The changes in the PMF are more widespread than the more frequent flood events where the velocity impacts are localised.

Figures 72 through **80** also demonstrate that there are no increases in peak flood velocity outside of the development site.

Given the lack of any impacts on flood level or velocity in the vicinity of Peelwood Road, it can be concluded that there is unlikely to be any impact on rate of rise, duration of inundation or flood hazard on Peelwood Road, or any adjacent property.

3.5 Climate Change Assessment

Climate change and, in particular, rainfall increases have the potential to impact on present-day flood behaviour. As such, it was considered important to gain an understanding of the flood behaviour that could be expected under future climate change conditions. In this regard, the 0.5% AEP and 0.2% AEP flood events have been used as proxies for the 1% AEP under future climate change conditions (representing increases in 1% AEP rainfall intensity of 11% and 26% respectively).

Additional XP-RAFTS simulations were completed for the additional 0.2% AEP event (as noted earlier, the 0.5% AEP event had already been defined within the current assessment). This was undertaken by inputting design rainfall from the Bureau of Meteorology 2016 IFD webpage and determining the critical duration and temporal pattern for the site. This yielded critical durations as per **Table 3**. The inflow hydrographs were then generated and applied to the TUFLOW model for proposed conditions.

Flood level and velocity difference mapping was then prepared by subtracting the 1% AEP event from the 0.5% AEP and 0.2% AEP events for proposed conditions. The differences are presented as:

- **Figure 81** – Peak flood level differences between the 0.5% AEP and 1% AEP events
- **Figure 82** – Peak velocity differences between the 0.5% AEP and 1% AEP events
- **Figure 83** – Peak flood level differences between the 0.2% AEP and 1% AEP events
- **Figure 84** – Peak velocity differences between the 0.2% AEP and 1% AEP events

Figure 81 shows that a ~11% increase in 1% AEP rainfall intensity is predicted to increase flood level by generally no more than 0.02 metres within the site. Some isolated areas of 'now wet' are also anticipated, particularly on Peelwood Road which may impact trafficability of the roadway. **Figure 82** shows that flood velocities are predicted to typically increase by 0.15m/s along most of the flow paths within the site.

Figure 83 shows that a ~26% increase in 1% AEP rainfall intensity produces flood level increases that are generally no greater than 0.04 metres along the southern flow path within the site, apart from the farm dam which experiences an increase of 0.06 metres. The northern flow path experiences flood level increases of generally no more than 0.1 metres as well as some areas of 'now wet'. The results shown on **Figure 84** indicates that an increase in peak velocity of more than 0.15m/s is typical within the site and can exceed 0.3m/s across large proportions of the flow paths throughout the site.

Although rainfall increases does have the potential to increase flood levels and velocities along each of the flow paths through the site, the impacts are not sufficiently large to extend into areas where future development is likely to occur. As a result, climate change is not predicted to produce any significant impact on the potential future works within the development site.

3.6 Blockage Assessment

Blockage of culverts has the potential to impact on flood behaviour in the vicinity of such structures. As such, it was considered important to gain an understanding of how a high level of structure blockage could impact on flooding across the site. In this regard, a blockage sensitivity assessment was completed for the 1% AEP and PMF flood events. The sensitivity assessment was undertaken using the following methodology:

- If the blockage applied to a culvert was 0% in the 1% AEP event, it was increased to 50% blocked.
- If the blockage applied to a culvert was > 0% in the 1% AEP event, it was increased to 100% blocked.

This methodology was adopted as it considers the design blockage applied to a culvert when deciding how much to increase the applied blockage under the sensitivity assessment. This avoids an extremely conservative approach of applying 100% blockage regardless of the size of the culvert and the contributing debris size.

The peak flood depth and level results of the 1% AEP event with higher blockage are presented on **Figure 85** and indicate that flood depths of over 0.4 metres are predicted on the upstream side of the internal roadway crossing of the southern flow path and additional inundation with depth of up to 0.2 metres are predicted on Peelwood Road near the northern portion of the site.

Peak flood level differences calculated by subtracting the 'design blockage' 1% AEP peak flood levels from the 'high blockage' 1% AEP levels are also presented on **Figure 86.** This indicates that the blockage produces increases in flood level of 0.3 metres on the upstream side of the internal roadway crossing, as well as increases of up to 0.2 metres on the upstream side of Peelwood Road. These impacts are predicted to propagates onto, and downstream of Peelwood Road towards Reedy Creek. It is noted that the flood level increases do not extend across the proposed asset protection zones or building footprints within the site.

Figure 87 demonstrates that in the PMF, depths on the upstream side of the roadway crossing are predicted to reach 1.5 metres with the higher blockage applied. This is sufficient for the road to overtop and produce inundation depths across the roadway surface of up to 0.25 metres. Some shallow inundation of less than 0.1 metres is predicted to move along the internal roadway and into the frontages of some of the proposed lots. No inundation is predicted near any proposed dwelling; however, some asset protection zones are inundated with depths of less than 0.1 metres.

Peak flood level differences for the PMF event were also calculated by subtracting the 'design blockage' PMF peak flood levels from the 'high blockage' PMF levels and this is presented on **Figure 88**. These results show that flood level increases of 0.6 metres are predicted on the upstream side of the internal roadway crossing, as well as areas of 'now wet' towards the east of the crossing (along the internal roadway and some proposed lots). Some increases of 0.1 metres also extend to the downstream side of the crossing, and to the north of some of the proposed dwelling locations. Minor increases of less than 0.05 metres in the vicinity of culvert crossings of Peelwood Road are also predicted.

Overall, the blockage sensitivity assessment indicates that the culverts are sufficiently sized to avoid any significant impacts during the 1% AEP event under a high blockage scenario. During the PMF, a high blockage scenario will produce additional inundation of the site, however, it will not impact any proposed dwellings nor produce any high hazard flood behaviour within areas frequented by occupants (e.g., internal roadway).

3.7 Flood Planning Level/Area

Flood planning levels (FPLs) and the flood planning area (FPA) are important tools in the management of flood risk. The flood planning area is used to define the area where flood-related development controls apply. For those areas contained within the flood planning area, the flood planning levels are frequently used to establish the elevation of key components of a development, such as minimum floor levels.

The flood planning level is typically derived by adding a freeboard to a specific design flood. This specified design flood is frequently referred to as the "planning" flood. The freeboard is intended to account for any uncertainties in the derivation of the planning flood level.
The '*Flood risk management manual*' (NSW Government, 2023) does not explicitly state which design flood event should be used as the "planning" flood, nor the required freeboard amount that should be applied. In this regard, local guidance was sought from *'The Villages of Crookwell, Gunning, Collector and Taralga Floodplain Risk Management Study and Draft Plan'* (Lyall & Associates, 2017) which defined a variable flood planning area for different sections of the floodplain, namely:

- Main Stream Flooding (MSF): 1%AEP + 0.5 metres.
- Minor Tributary Flooding (MTF): Areas where depths in the 1% AEP exceed 0.15 metres.
- Major Overland Flow (MOF): Extent of high and low hazard floodways AND areas where depths in the 1% AEP exceed 0.15 metres.

Although this site is located outside of the four townships that the floodplain risk management study was prepared for, it was considered that these definitions provide the best local guidance and were adopted for the current assessment. On review of the definitions of the sections of the floodplain, the site would fall within the MTF or MOF categories. To provide a conservative approach, the definition of MTF has been applied across the entire site of works.

The flood planning area was subsequently defined using the peak depths for the 1% AEP event shown on **Figure 40**. The flood planning level was then extracted based upon the peak 1% AEP flood level within the flood planning area, and both the flood planning level contours and area are shown on **Figure 89** (note that the flood planning area has been clipped to the development site which is the focus of this assessment). The 1% AEP and PMF extents have also been shown on **Figure 89** to define significant areas of the floodplain (1%AEP extent) and the extent of the floodplain (PMF extent).

As shown on **Figure 89**, although the flood planning area extends across parts of the overall site, there remains a significant portion of the site which is located outside of the flood planning area. This includes all internal roadways and asset protection zones (and, therefore, future dwelling locations).

3.8 Emergency Response Considerations

As discussed in Section 3.3.2, and shown on **Figures 34** to **42**, no inundation of the internal roadway or asset protection zones (and therefore proposed dwellings) is predicted in any 'base' design flood. Therefore, all future dwelling will be elevated above all potential floods and evacuation from the site will not be necessary. However, emergency access to and from the site may still be necessary (e.g., medical emergency). In this regard, the maximum flood hazard along Peelwood Road was interrogated between the site and the nearby township of Laggan.

Figures 54 through **61** indicates that the maximum flood hazard on Peelwood Road through to the southern side of Laggan in events up to the 0.5% AEP does not exceed H2. Although driving through floodwaters is never advocated, this hazard would be considered safe for emergency vehicular access. However, in the PMF, areas of H5 hazard are present along a flow path passing through Laggan, meaning safe access to/from the site is not available by vehicle to the southern side of Laggan in the PMF.

The PMF results were further interrogated to determine the duration that Peelwood Road through Laggan would be cut. The criteria for the roadway being 'cut' was based on Peelwood Road experiencing a hazard of H3 or greater based on the flood hazard mapping shown on **Figure 62**. This indicates that the roadway south of Laggan would be cut soon after the onset of rainfall (with 0.5 hours) during a PMF, and would remain cut for the duration of the rainfall event. For example, the roadway would be cut for roughly 45 minutes for the 45-minute PMF storm event which is critical along this tributary.

It should also be noted that in the PMF event, the two lots within the very northern portion of the site (located within the proposed C3 zone) are completely prevented from accessing Laggan as two locations of Peelwood Road are impacted by H5 hazard. Given that only two lots are impacted and the rarity of the PMF, this is not considered to be a significant risk to life, and the occupants would be able to safely shelter in place for the short duration that Peelwood Road is cut.

4 REGULATORY REQUIREMENTS

The rezoning of flood liable land requires that the future rezoning and any potential development resulting from it can comply with all local and state government legislation/requirements. These are detailed in the following sections.

4.1 Upper Lachlan Local Environment Plan 2010

The Upper Lachlan Local Environment Plan 2010 (LEP2010) outlines a number of requirements and matters that need consideration when deciding to grant development consent on flood liable land.

Section 5.21(2) and 5.21(3) of LEP2010 primarily deals with ways in which the proposed development will interact and impact on existing flood behaviour, and how the flood risk is managed. Details of how the proposed development intends to meet each specific requirement of LEP2010 are summarised in **Table 5**.

Table 5 Upper Lachlan LEP2010 requirements and matters to be considered

Council Requirement	Does Development Meet this Requirement?
Section 5.21(2)	
a) The development is compatible with the flood function and behaviour on the land	The flood function (hydraulic categories) on the land for the 1% AEP and PMF have been defined for existing (**Figures 22-23**) and proposed conditions (**Figures 52-53**). These figures indicate that the majority of the flow paths through the site are classified as 'floodway' areas. The location of the proposed roadways and asset protection zones (and therefore future dwellings) are located clear of floodways and flood storage areas, and the proposed works are, therefore, compatible with the flood function in all floods.
b) The development will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties	Flood level and velocity differences have been calculated (**Figures 63-80**) for the full range of flood events and indicate that the proposed works are not predicted to impact flood behaviour or increase the flood affectation of other developments or properties in all flood events.
c) The development 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	The subdivision layout proposed as part of the planning proposal has been designed to minimise interaction with floodwater. In this regard, safe occupation and efficient evacuation is facilitated by: - only one crossing of the overland flow path through the site, which is located such that no inundation across the roadway surface occurs in any flood event. - all proposed asset protection zones (and therefore future dwelling locations) are located above the 1 in 100 year ARI (1% AEP) level and have flood free access from the dwellings to the internal access roadway.

Council Requirement	Does Development Meet this Requirement?
	- Access to, or egress from the site is available via the southern access to Peelwood Road to the northern side of Laggan in all flood events, and safe movement to the southern side of Laggan is available in events up to and including the 0.5% AEP. - Although evacuation is not considered necessary in any flood event, the additional population that will reside in the development site are not considered to exceed the capacity of any evacuation routes given the major arterial nature of Peelwood Road. Therefore, the development will not adversely affect the safe occupation or efficient evacuation of people from the site. If evacuation from the site is required, this could be safely completed on foot or by vehicle by exiting the site through the southern access to Peelwood Road and relocating to the Laggan Memorial Hall.
d) The development incorporates appropriate measures to manage risk to life in the event of a flood	The subdivision layout proposed as part of the planning proposal has been designed to minimise interaction with floodwater. In this regard, all proposed building footprints are located above the 1 in 100 year ARI (1% AEP) level and have flood free access from the dwellings to the internal access roadway.
e) The development will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses	Flood level and velocity differences have been calculated (**Figures 63-80**) for a range of flood events and indicate that the proposed works are not predicted to impact on flood levels or velocity outside of the site. Therefore, the development is not predicted to adversely impact the environment or cause erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses in all flood events. Small increases in flood level and velocity are predicted in close proximity to the roadway crossing of the southern flow path, however, this can be protected by appropriate scour protection measures as part of the future detailed design. Further, the northern flow path is to be with an area rezoned to C3 (Environmental Management) which will protect them from any future development.
Section 5.21(3)	
a) The development needs to consider the impact of the development on projected changes to flood behaviour as a result of climate change	An assessment of the impact on 1% AEP flood behaviour resulting from climate change has been undertaken (see Section 3.**5**) and concluded that flood behaviour does not significantly change due to rainfall increases of 11% and 26%, and, therefore, the impacts of the proposed development on 1% AEP flood behaviour would not be dissimilar to that documented in this report under existing climatic conditions.

Council Requirement	Does Development Meet this Requirement?
b) The development needs to consider the intended design and scale of buildings resulting from the development	The design and scale of the future subdivision is yet to be completed. However, it is expected that be sympathetic to and appropriate for the surrounding natural and built environment, be acceptable to the community and maintain economic feasibility. It also aims to facilitate the development of the subject site in a manner that is consistent with the desired future character of Laggan and in-line with other similar developments within the Upper Lachlan Shire (e.g.,: within the nearby township of Crookwell).
c) The development needs to consider whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood	See response to 5.21(2) c) and d)
d) The development needs to consider the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion	The proposed building are not predicted to be impacted in any flood event, nor under climate change conditions and is not in a location at risk of coastal erosion. Therefore, modifying, relocating, or removing buildings from their currently proposed locations to reduce the flood risk is not considered necessary.

4.2 Upper Lachlan Development Control Plan 2010

Section 4.5.1 of the Upper Lachlan Development Control Plan 2010 (DCP2010) outlines the flood related controls that are applicable to works in areas that are subject to discharge of a 1 in 100-year ARI mainstream flood event. The controls, together with commentary on how the future development can satisfy the controls are included in **Table 6**.

Table 6 Flood related development controls from the Upper Lachlan Development Control Plan 2010

DCP 2010 Control	Comment
Works cannot involve any physical alteration to waterway or floodway including vegetation clearing	No formal waterway currently exists through the development site, and there is little to no vegetation that will be cleared as part of the roadworks or future dwelling construction. The majority of the flow paths are considered to be classified as floodways, however, the only works to be undertaken within a floodway are at the intersection of the southern flow path and proposed internal roadway where some minor cut will be undertaken, and culverts installed.
Works cannot involve net filling exceeding $50m^3$, any reductions of on-site flood storage capacity is avoided and any changes to depth, duration, and velocity of floodwaters	The only filling proposed within the 100-year ARI flood extent is related to the internal roadway crossing of the southern flow path. These works also correspond with excavation on the upstream

of all floods up to and including the 100-year ARI are contained within the site	side of the road to facilitate drainage infrastructure. Net fill of only 12m^3 is predicted. Some very minor fill (2m^3) will also be placed in the 100-year ARI flood extent near the west-north-western lot to facilitate an asset protection zone. **Figures 63-80** indicate that there is no alterations to peak flood level or velocity of floodwaters outside of the site in the 100-year ARI event, and as such, indicates that no notable change to flood behaviour outside of the development site is predicted (i.e.: no loss of flood storage, no changes to flow paths outside of the site, no acceleration or retardation of flows, and no changes to warning times due to consistent flood behaviour outside of the site).
Works cannot involve any change in the flood characteristics of the 100-year ARI outside of the subject site that result in: - Loss of flood storage, or - Loss of/changes to flow paths, or - Acceleration or retardation of flows, or - Any reduction of warning times elsewhere on the floodplain	
All built form, infrastructure (unless designed to be inundated) and open space must be located on land that would not be subject to flooding during the 100-year ARI flood event	The proposed works ensure that all dwellings are located on land that is located above the 100-year ARI flood level (noting that this exceeds the requirements of the flood planning area definition, and ensures all built form and infrastructure is outside of the flood planning area and 100-year ARI flood extent). The only interaction of infrastructure with the 100-year ARI flood is the internal roadway culverts which are designed to withstand inundation.
Where there is existing development located on land that is subject to inundation during the 100-year ARI flood event, this development /activity must not be intensified through further development	There is no existing development subject to inundation during the 100-year ARI flood event within the site. All areas were increased development are proposed are located clear of the 100 year ARI flood extent.

4.3 NSW Flood Prone Land Policy

The key objectives of the NSW Flood Prone Land Policy are detailed in the *'Flood risk management manual'* (NSW Government, 2023) and are intended to reduce the impacts of flooding and flood liability on communities and individual owners and occupiers of flood prone property and to reduce private and public losses resulting from floods.

The proposed development adheres to these objectives by locating all proposed dwellings outside of the floodplain and ensuring that internal infrastructure, such as the access roadway, are elevated above the peak level of all design floods. This ensures that the future community will not be impacted by flooding. Furthermore, the development is not predicted to increase the flood risk external to the site. As a result, the development will not result in increased private and public losses from flooding.

Therefore, it is considered that the proposed proposal for rezoning of this land is in accordance with the objectives of the NSW Flood Prone Land Policy.

4.4 Considering Flooding in Land Use Planning Guideline (2021)

The '*Considering flooding in land use planning guideline'* (DPE, 2021) provides advice to Councils on flood-related land use planning and areas where flood-related development controls should apply. This guideline applies to the current assessment as it is a planning proposal. As such, it is important to ensure that the rezoning and development of the land is consistent with this guideline. The key objectives of the guideline and commentary on how the planning proposal intends to comply with these requirements are outlined in **Table 7**.

Table 7 Summary of the specific guidance provided as part of the gateway determination.

Requirement	Comment
Considering the full range of flood events up to and including the PMF	The current assessment has defined flood behaviour for both existing and proposed conditions for all events, up to and including the PMF.
Considering the key constraints that result from flooding on land, namely: flood function, flood hazard, extent and flood behaviour and risk to life	The current assessment has defined the flood function (hydraulic categories) for the 1% AEP and PMF events, and flood hazard, extent and behaviour for the full range of events up to the PMF. All proposed building will be situated clear of all design floods, ensuring the flood risk is suitably mitigated and the existing flood function through and downstream of the site will be retained.
Definition of the Flood Planning Area (FPA) based on a Defined Flood Event (DFE)	As discussed in Section 3.7, the FPA has been adopted based on the definition provided within *'The Villages of Crookwell, Gunning, Collector and Taralga Floodplain Risk Management Study and Draft Plan'* (Lyall & Associates, 2017) which used the 1% AEP event as the DFE.
Adherence to the flood planning clause in the standard instrument (LEP2010)	As per **Section 4.1**, the planning proposal adheres to the requirement of Clause 5.21 of LEP2010

4.5 Specific Guidance

An outcome of the gateway determination was the need for an updated Flood Impact and Risk Assessment (FIRA) to be undertaken (noting a basic flood assessment was submitted with the original planning proposal). Along with this requirement was some specific guidance provided by the Department of Planning and Environment (DPE) Biodiversity and Conservation Division, Water, Floodplains and Coastal team. The information that was to be documented within the FIRA (as requested by DPE) is summarised in **Table 8**. **Table 8** also includes commentary on how the FIRA has addressed these requirements.

Table 8 Summary of the specific guidance provided as part of the gateway determination.

Requirement	Comment
The impact of flooding on the development – including local overland flows and the range of possible floods up to the Probable Maximum Flood (PMF)	As documented in Section 2 and Section 3, mainstream and overland flow paths for both existing and post-development conditions have been assessed for the 63.2%, 50%,20%, 5%, 1%, 0.5% AEP and PMF events, with no significant impact on the development from flooding predicted in any flood event.
The impact of the development on flood behaviour – particularly adverse impacts of existing communities downstream of the site	**Figures 63-80** indicate that there is no significant alterations to peak flood level or velocity of floodwaters outside of the site in the 100-year ARI event, and as such, indicates that no existing communities downstream of the site will be adversely impacted.
The impact of flooding on the safety of people for the full range of possible floods	The post-development hazard mapping presented on **Figures 54** through **62** indicates that the hazard along the southern flow path in the 63.2% AEP through the 0.5% AEP events is generally no higher than H1 (apart from within the farm dam and on the upstream side of Peelwood Road). Along the northern flow path(s), a hazard of up to H2 (i.e.: safe for people) is typical. The PMF does produce a hazard classification of H5/H6 along the flow paths, however, no roadways or future dwelling locations will be impacted by flooding in any flood event.
The implications of climate change on flooding – particularly increases rainfall intensity on flood behaviour	A climate change assessment was completed and determined that 11% and 26% increases in 1% AEP rainfall does not significantly change existing flood behaviour. Therefore, the impacts of climate change on flooding across the site are minor in nature.
The implications of landform modifications to the natural environment including spatial requirements for natural waterway function, rehabilitation of the riparian zone, stormwater management infrastructure utilised to offset impacts (water quality and quantity) and associated impacts on flood behaviour/flood planning levels.	Little to no landform changes are proposed which may impact natural waterway function or the riparian zone, and **Figures 63-80** indicate that there is no significant alterations to peak flood level or velocity of floodwaters in these areas.
The planning proposal or FIRA would benefit from detailing how each of the requirements of the section 9,1 Local Planning Direction 4.1 Flooding are proposed to be addressed with consideration of:	Details of how each of the requirements of Section 9,1 Local Planning Direction 4.1 Flooding are presented in Section 5.

Part (2)	
The proposed zoning maps show rezoning of land within the flood planning area from rural to village (residential) which is in contradiction to this requirement	As discussed in Section 5, the northern flow path is a third order (Strahler) stream, however this portion of the site will be zoned as C3 (Environmental Management). The southern flow path is a first order (Strahler)stream and will fall within the RU5 (village) rezoned area. It is considered that a first order stream can be appropriately incorporated into a RU5 zoning with appropriate site layout, which has been undertaken for the current assessment by placing all future development away from the stream.
Flood Planning Area (FPA) maps have not been provided	Section 3.7 details how the flood planning area has been derived and **Figure 89** illustrates the extent of the flood planning area and flood planning levels throughout the site.
Part (3)	
Hydraulic categories have not been defined	Hydraulic categories for the 1%AEP and PMF events have been prepared for both existing and proposed conditions. These have been used to inform the site layout and avoid development within floodway areas.
Developed scenario maps have not been provided: - It has not been demonstrated how flood risk will be managed on the site without causing off site impacts, particularly where the floodplain is proposed to be modified - It is also unclear what modifications to the floodplain are proposed. As such changes to flood levels, velocities and watercourse geomorphology need to be assessed along with management measures to demonstrate no off-site adverse impacts over the range of possible floods and to inform the flood planning area and associated zoning footprint for the safe development of land on the site	Minimal modification to the floodplain is proposed as part of this proposal. Flood level and velocity differences have been calculated (**Figures 63-80**) for a range of flood events and indicate that the proposed works are not predicted to cause any offsite impacts. Flood level and velocity differences have been calculated (**Figures 63-80**) for a range of flood events (63.2% AEP through to the PMF) and indicate that the proposed works are not predicted to cause any offsite impacts. The flood planning area has been defined (**Figure 89**) and demonstrates that no development will be undertaken within the flood planning area.
The flood risk assessment and associated modelling methodology needs to better demonstrate adequacy in a range of areas that include, but not limited to	

- The flood assessment does not appear to cover the entire extent of the planning proposal	This updated flood assessment covers the entire extent of the planning proposal, as well as the entire Reedy Creek catchment in the vicinity of the works.
- the scale of the development warrants a detailed risk assessment of the full range of floods up to the Probable Maximum Flood. This risk assessment would assist in determining a suitable design event for the estimation of flood planning levels to inform Flood Planning Areas	This updated flood assessment considers the full range of flood events (63.2% AEP through to the PMF). The flood planning area has been defined (**Figure 89**) based on definitions within *'The Villages of Crookwell, Gunning, Collector and Taralga Floodplain Risk Management Study and Draft Plan'* (Lyall & Associates, 2017).
- The flood assessment is required to undertake a climate change assessment as detailed in the Flood Planning Clause (5.21} of the Upper Lachlan Local Environmental Plan 2010 and to inform Flood Planning Areas	This updated flood assessment has undertaken a climate change assessment (**Section 3.5**) which has indicated that even with a 26% increase in rainfall intensity, peak 1% AEP flood levels are not generally predicted to increase by more than 0.1 metres (when considering the 0.2% AEP event as a proxy for a ~26% increase in rainfall intensity).
- The flood assessment has defined the site hydrology using the rational method. This method is not considered suitable for the proposed scale of development or for the assessment of the full range of flood magnitude required for this planning proposal	This updated flood assessment has adopted Australian Rainfall and Runoff 2019 (ARR2019) hydrologic procedures for the full range of flood events.
- It is recommended that the flood assessment adopts the suitable hydrologic parameters and modelling methodology from an adopted Floodplain Risk Management Study and Plan from a suitably equivalent catchment within the Upper Lachlan Shire LGA	The hydrologic parameters and modelling methodology has been based (where appropriate) on the *'The Village of Crookwell Flood Study'* (Lyall & Associates, 2014) noting that this study was undertaken prior to release of ARR2019 hydrologic procedures.
- The methodology used to determine the blockage factor and justification of the adopted factor is unclear	No blockage has been applied to the flood modelling in order to produce conservative flood behaviour within the site. However, a blockage sensitivity assessment has been undertaken (**Section 3.6**) for the new hydraulic structures introduced within the floodplain to assess the impact of 80% blockage on 1%AEP flood levels within the site, and the associated impact on the proposed works.
- As there is a proposed diversion of flood waters, particular consideration should be given to overland flow paths in events greater than the design event.	This updated flood assessment does not propose any diversion of flood water and this comment is no longer considered relevant.

Consideration should be given to the impacts of the diversion to other development the environment and risks associated with extreme blockage or failure of any stormwater infrastructure, proposed to convey floodwaters from upstream sources	
We also note that the planning proposal will result in watercourses and riparian corridors being zoned as RU5. It is suggested that these sensitive environmental areas are unsuitable for the proposed land-use and riparian areas be suitably zoned for their intended land use function, such an environmental zoning	As discussed in **Section 5**, the northern flow path is a third order (Strahler) stream, however this portion of the site will be zoned as C3 (Environmental Management). The southern flow path is a first order (Strahler) stream and will fall within the RU5 (village) rezoned area. It is considered that a first order stream can be appropriately incorporated into a RU5 zoning with appropriate site layout, which has been undertaken for the current assessment by placing all future development away from the stream.

5 Section 9.1: Local Planning Directions Direction 4.1: Flooding

Section 9.1(2) of the Environmental Planning and Assessment Act permits the Minister for Planning to issue a direction in relation to the making of local environmental plans. Several of these have been issued including Direction 4.1 which relates to flooding. The direction is outlined below, and commentary has been provided on how the planning proposal plans to meet those requirements.

Objectives

The objectives of this direction are:

(a) ensure that development of flood prone land is consistent with the NSW Government's Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005, and

Consistent: It is noted that the *Floodplain Development Manual 2005* has been superseded by the *Flood Risk Management Manual 2023*. Nevertheless, the underlying principles of both documents are consistent.
This FIRA was prepared based on hydrologic procedures outlined within *'Australian Rainfall and Runoff – A Guide to Flood Estimation'* (Ball et al, 2019) which reflects modern best practice.
The assessment has shown that the development proposal allows for development within the site that is compatible with the flood behaviour and function on the land by locating all proposed dwellings outside of the floodplain. A single internal road is the only component of the development that is in contact with floodwaters, and it is elevated above the PMF.
The works are also not predicted to adversely impact on peak flood level or velocity outside of the development site in any flood event. Therefore, the proposal does not increase any public or private losses from flooding.
Furthermore, the development of the site recognises the value of use, occupation and development of the land.
Each of these outcomes demonstrate that the development proposal meets the key objectives of the NSW Government's Flood Prone Land Policy and Floodplain Development Manual 2005.

(b) ensure that the provisions of an LEP that apply to flood prone land are commensurate with flood behaviour and includes consideration of the potential flood impacts both on and off the subject land.

Consistent: The proposed development arrangement is considered to provide suitable management of the flood behaviour and flood risk by locating habitable areas outside of the floodplain, having all proposed dwellings outside of the floodplain, and only a single crossing of the internal roadway with a watercourse. Consideration of the potential flood impacts of the range of flood events up to the PMF have been assessed and demonstrate

that no changes in peak flood level or velocity are predicted outside of the development site in any flood event, and only minor changes are predicted within the site.

Application

This direction applies to all relevant planning authorities that are responsible for flood prone land when preparing a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land.

Applies: The planning proposal is located within the Upper Lachlan Shire Council LGA. Upper Lachlan Shire Council are responsible for the management of flood prone land within the Upper Lachlan Shire Council LGA. The planning proposal aims to rezone land that is flood prone.

Direction 4.1

(1) A planning proposal must include provisions that give effect to and are consistent with:

(a) the NSW Flood Prone Land Policy

Consistent: Detailed discussion on how this proposal has demonstrated compliance with the NSW Flood Prone Land Policy is included in Section 4.3 as well as the previous page of this report.

(b) the principles of the Floodplain Development Manual 2005

Consistent: As outlined in Section 4.3, the proposal has demonstrated compliance with the NSW Flood Prone Land Policy and has adopted (where possible) hydrologic and hydraulic parameters, hydraulic category definitions and flood planning area definitions from *'The Villages of Crookwell, Gunning, Collector and Taralga Floodplain Risk Management Study and Draft Plan'* (Lyall & Associates, 2017) which was prepared in accordance with the NSW Floodplain Development Manual 2005 and is considered to be the best local guidance.

(c) The Considering flooding in land use planning guideline 2021, and

Consistent: Detailed discussion on how this proposal has demonstrated compliance with the 'Considering Flooding in Land Use Planning Guideline' 2021 is included in Section 4.4 of this report.

(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.

Not Applicable: No flood study or floodplain risk management study has been prepared/adopted for the catchment. However, as stated above, the planning proposal is supported by this FIRA which has been prepared in accordance with *'Australian Rainfall and Runoff – A Guide to Flood Estimation'* (Ball et al, 2019) and has attempted to maintain consistency with the *'The Villages of Crookwell, Gunning, Collector and Taralga Floodplain*

Risk Management Study and Draft Plan' (Lyall & Associates, 2017) which was prepared in accordance with the NSW Floodplain Development Manual 2005

(2) A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Conservation Zones to a Residential, Employment, Mixed Use, W4 Working Waterfront or Special Purpose Zones.

Inconsistent: The rezoning of the southern portion of the overall site from RU2 to RU5 will include land within the flood planning area. However, no development is proposed within the flood planning area, and the flow path through this portion of the site is only classified as a first order stream which can be appropriately incorporated into a RU5 zoning with appropriate site layout.

The zoning of the northern portion of the site is consistent as it is being zones as C3 (Environmental Management) and not residential.

(3) A planning proposal must not contain provisions that apply to the flood planning area which:

(a) permit development in floodway areas,

Consistent: No habitable development is proposed within any floodway area. A culvert crossing (with associated earthworks) will be installed along the southern flow path to permit the passage of flood flows beneath an internal roadway.

(b) permit development that will result in significant flood impacts to other properties,

Consistent: Flood level and velocity impacts have been mapped (**Figures 63-80**) for the 63.2%, 50%,20%, 5%, 1%, 0.5% AEP and PMF events. The mapping shows that no significant impacts on flood behaviour across other properties.

(b) © permit development for the purposes of residential accommodation in high hazard areas,

Consistent: No residential development is proposed within any high hazard areas during floods up to and including the PMF.

(d) permit a significant increase in the development and/or dwelling density of that land,

Consistent: The rezoning from RU2 to RU5 provides the opportunity for increased development within the site. However, no development or increase in dwelling density is proposed within the floodplain (i.e., PMF extent)

(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 seniors housing in areas where the occupants of the development cannot effectively evacuate,

Consistent: The development that would result from the panning proposal does not propose any of these development types.

(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,

Consistent: A development application will be lodged seeking consent for the proposed development following the approval of the planning proposal.

(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

Consistent: The proposed rezoning will locate all development (other than drainage infrastructure) outside of the flood planning area. This will prevent the need for increased government spending on flood mitigation.
Safe evacuation from the site is available via the internal access roadway to Peelwood Road, and south to Laggan in all flood events. Therefore, the proposal will not require increased spending on emergency management services and emergency response measures.

(h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.

Consistent: The proposed rezoning from RU2 (rural) zoning to RU5 (village) zoning will not permit hazardous industries or hazardous storage establishments as only residential development is proposed. Further, all proposed development (other than infrastructure) will be located outside of the flood planning area.

(4) A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which:

(a) permit development in floodway areas,
(b) permit development that will result in significant flood impacts to other properties,
(c) permit a significant increase in the dwelling density of that land,
(d) permit the development of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,
(e) are likely to affect the safe occupation of and efficient evacuation of the lot, or
(f) are likely to result in a significantly increased requirement for government spending on emergency management services, and flood mitigation and emergency response

measures, which can include but not limited to road infrastructure, flood mitigation infrastructure and utilities.

Consistent: Upper Lachlan Shire Council has adopted the Special Flood Considerations clause (clause 5.22 within the LEP). However, as no sensitive land uses are proposed, the special flood considerations clause does not apply.

(5) For the purposes of preparing a planning proposal, the flood 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.

Consistent: Flooding within the development site is considered to be 'Minor Tributary Flooding' as per definitions in the *'The Villages of Crookwell, Gunning, Collector and Taralga Floodplain Risk Management Study and Draft Plan'* (Lyall & Associates, 2017) which was undertaken for townships located within the Upper Lachlan Shire and is therefore considered to be the best local guidance. A flood planning area was developed for the current site in a manner consistent with this study.

Consistency

(9) A planning proposal may be inconsistent with this direction only if the planning proposal authority can satisfy the Planning Secretary (or their nominee) that:

(a) the planning proposal is in accordance with a floodplain risk management study or plan adopted by the relevant council in accordance with the principles and guidelines of the Floodplain Development Manual 2005, or

Not applicable: No floodplain risk management study or plan has been prepared or adopted by Upper Lachlan Shire for the area of the planning proposal. However, the planning proposal is considered to be consistent with the principles and guidelines of the Floodplain Development Manual 2005 and has followed similar procedures to the '*The Villages of Crookwell, Gunning, Collector and Taralga Floodplain Risk Management Study and Draft Plan*'.

(b) where there is no council adopted floodplain risk management study or plan, the planning proposal is consistent with the flood study adopted by the council prepared in accordance with the principles of the Floodplain Development Manual 2005 or

Not applicable: No flood study has been prepared or adopted by Upper Lachlan Shire for the area of the planning proposal. However, the planning proposal has used modern flood modelling software, the latest flood estimation guidance (i.e., Australian Rainfall & Runoff 2019) and has adopted similar hydrologic and hydraulic parameters to those documented in '*The Villages of Crookwell, Gunning, Collector and Taralga Floodplain Risk Management Study and Draft Plan*' which is the best local guidance available.

(c) the planning proposal is supported by a flood impact and risk assessment accepted by the relevant planning authority and is prepared in accordance with the principles

of the Floodplain Development Manual 2005 and consistent with the relevant planning authorities' requirements, or

Consistent: The planning proposal is supported by a Flood Impact and Risk Assessment (the current document) which has considered the range of possible floods, emergency response as well as the Upper Lachlan Shire Council flood related development controls and has been completed consistent with the principles and guidelines of the Floodplain Development Manual 2005 and floodplain risk management studies for nearby townships.

(d) the provisions of the planning proposal that are inconsistent are of minor significance as determined by the relevant planning authority.

Applicable: The planning proposal is inconsistent with Direction (2) whereby areas of the future RU5 zoned area fall within the flood planning area. However, no development is proposed within the flood planning area.

6 SUMMARY

Upper Lachlan Shire Council, on behalf of Ian Miller of Sutton Park Pty Ltd is proposing to rezone land located at Lot 2 DP 1233492, Lot 1 DP 239858 and Lot 1 DP 1253980 at Laggan, NSW, with the sites being rezoned from RU2 to RU5 or C3 zoning. This report serves as a flood impact and risk assessment that was completed to quantify the potential impacts of development of the site.

The assessment was completed using an XP-RAFTS hydrologic model to simulate catchment hydrology and a TUFLOW model to simulate flood hydraulics. Both models were developed specifically for the current assessment using current industry bast practice and similar hydrologic/hydraulic parameters to that used in '*The Village of Crookwell Flood Study'* (Lyall and Associates, 2014).

The models were used to simulate a range of design floods from the 63.2% AEP flood through to the PMF for 'existing' conditions. The outcomes of the existing conditions assessment showed that there are two main flow paths through the site; the southern one where the hazard generally remains below H2 for events up to the 0.5%AEP, and the northern one which experiences a hazard of up to H5 for events up to the 0.5%AEP. Both flow paths experience large areas of H5 in the PMF event.

Updates were then completed to the models to represent the proposed rezoning and development of the land. This included the internal roadway, asset protection zones and indicative building locations. Culverts through the internal access road were also represented within the TUFLOW model. All development was situated outside of the flood planning area, as well as flood extent of the PMF event.

A flood impact assessment was completed and shows that although the proposed works are predicted to produce localised changes in flood behaviour within the site, no changes are predicted outside of the site in all flood events.

An assessment of climate change impacts was also completed (using the 0.5% and 0.2% AEP events as proxies for increased rainfall intensity) and indicated that future increases in rainfall are not predicted to have a significant impact on present day design flood behaviour.

The flood planning area has been mapped based on the definition of minor tributary flooding from *'The Villages of Crookwell, Gunning, Collector and Taralga Floodplain Risk Management Study and Draft Plan'* (Lyall & Associates, 2017) which is considered to be the best local guidance. This confirms that all proposed development areas are located outside of the flood planning area.

Emergency response has been considered and although evacuation from the site is not considered necessary (i.e., all proposed dwellings can be located above the peak level of the PMF), access to the southern side of Laggan is available in all flood events up to the 0.5% AEP. Access to the southern side of Laggan would be restricted in the PMF event. However, this recedes quickly after rainfall stops.

Overall, the rezoning and development of the land is considered to adhere to the principles of the Floodplain Development Manual 2005, NSW Government's Flood Prone Land Policy, and Considering Flooding in Land Use Planning Guideline 2021. It also demonstrates compliance with the Upper Lachlan Shire Local Environment Plan 2010 and Upper Lachlan Shire Development Control Plan 2010. All specific guidance provided by the Department of Planning and Environment and Upper Lachlan Shire Council has also been addressed, which includes Ministerial Direction 4.1.

7 REFERENCES

- Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) (2019) *Australian Rainfall and Runoff: A Guide to Flood Estimation*, © Commonwealth of Australia (Geoscience Australia).
- Department of Planning and Environment (2021) *Considering flooding in land use planning guideline*
- Engineers Australia (2015). *Australian Rainfall and Runoff – Project 11: Blockage Guidelines for Culverts and Small Bridges*
- Lyall & Associates (2014). *The Village of Crookwell Flood Study*. Prepared for Upper Lachlan Shire Council
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- NSW Government. (2023). *Flood Risk Management Guideline FB02 - Flood Function*
- NSW Government. (2023). *Flood Risk Management Guideline FB03 – Flood Hazard*
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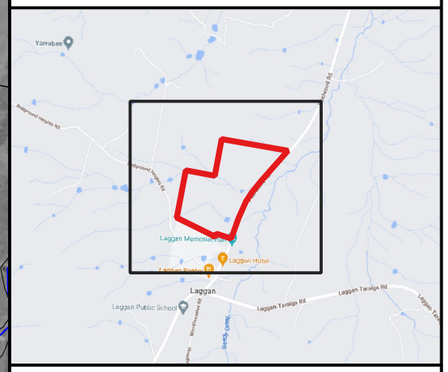
- Upper Lachlan Shire (2010) *Upper Lachlan Shire Development Control Plan*
- Upper Lachlan Shire (2010) *Upper Lachlan Local Environment Plan*

APPENDIX A
FIGURES



LEGEND

- Site Boundary
- Main Stream

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 1 :
Location of Development Site

Prepared by:

Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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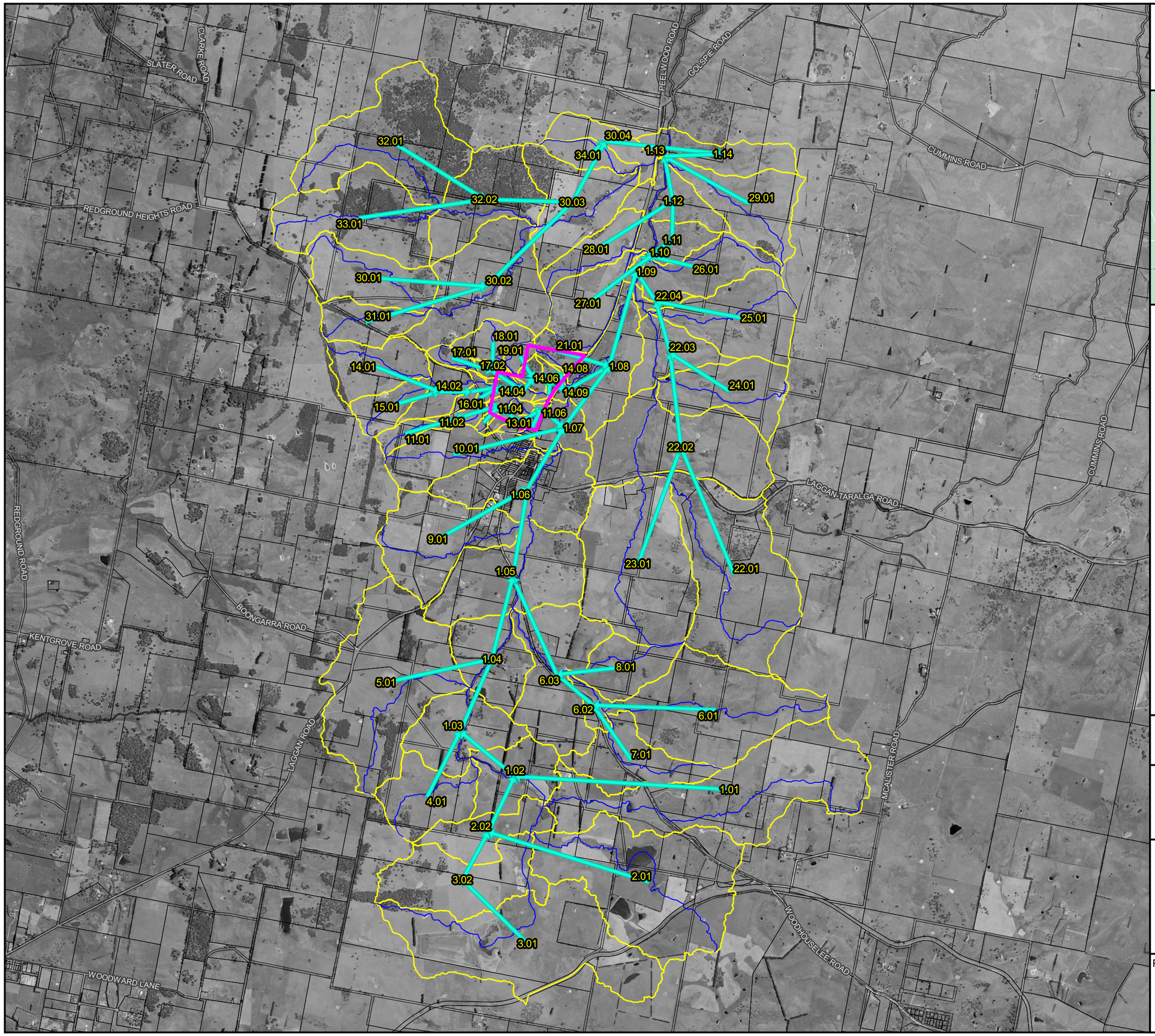

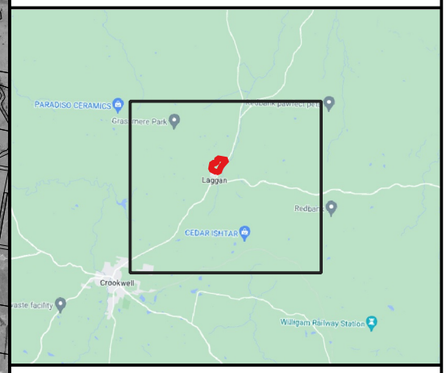

LEGEND

- Site Boundary
- Subcatchment Area (ID)
- Links
- Main Stream

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:35,000 (at A3)

0 400 800 1,200 1,600 m

Figure 2 :
XP-RAFTS Subcatchment Layout

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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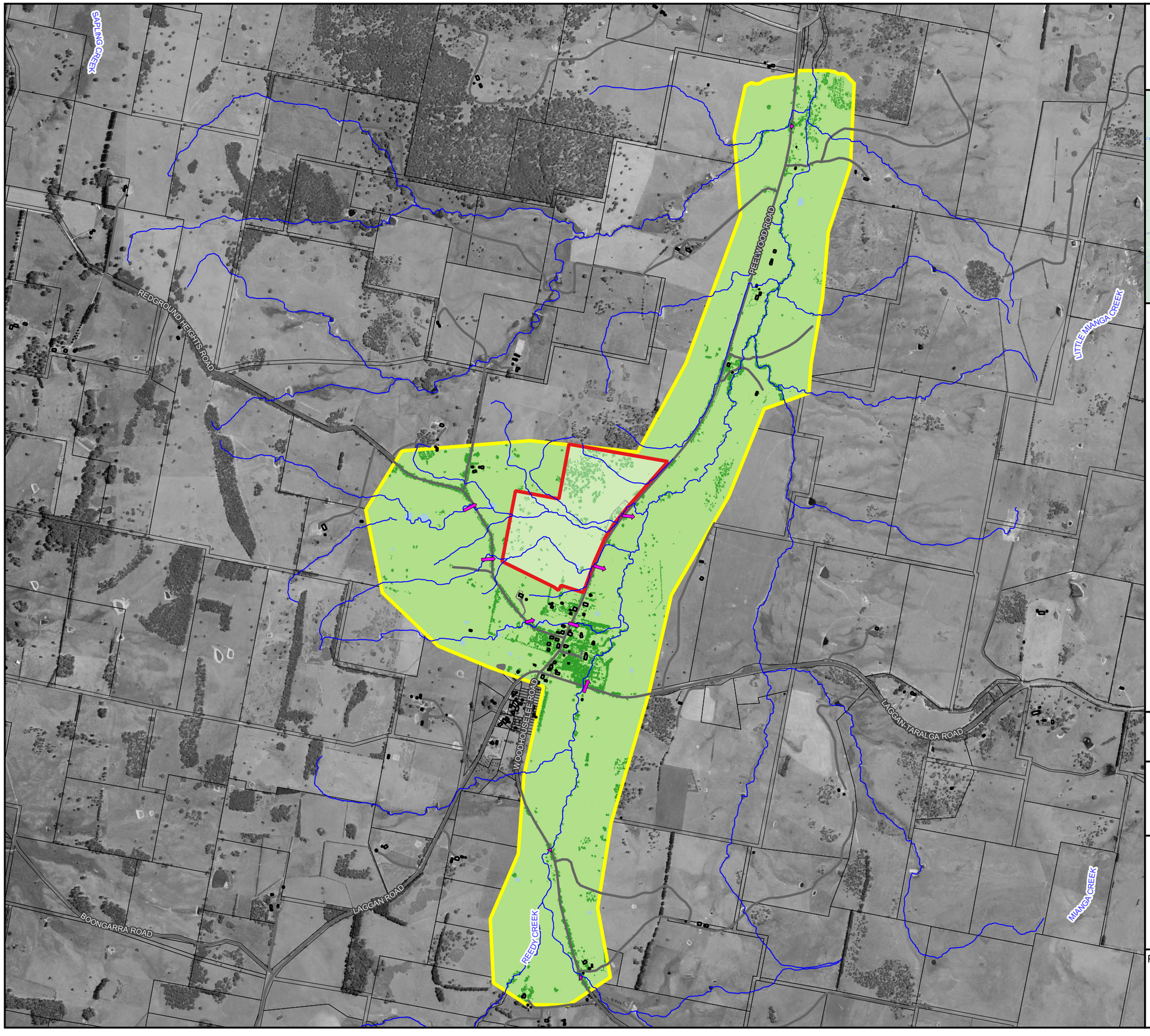

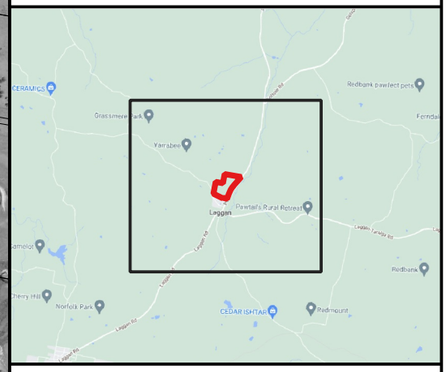

LEGEND

- Site Boundary
- TUFLOW model extent
- Culverts
- Existing Building Footprint

Materials

- Grass/ Open Area
- Trees
- Waterbodies
- Buildings
- Impervious

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:20,000 (at A3)

0 200 400 600 800 m

Figure 3 :
Existing TUFLOW Layout

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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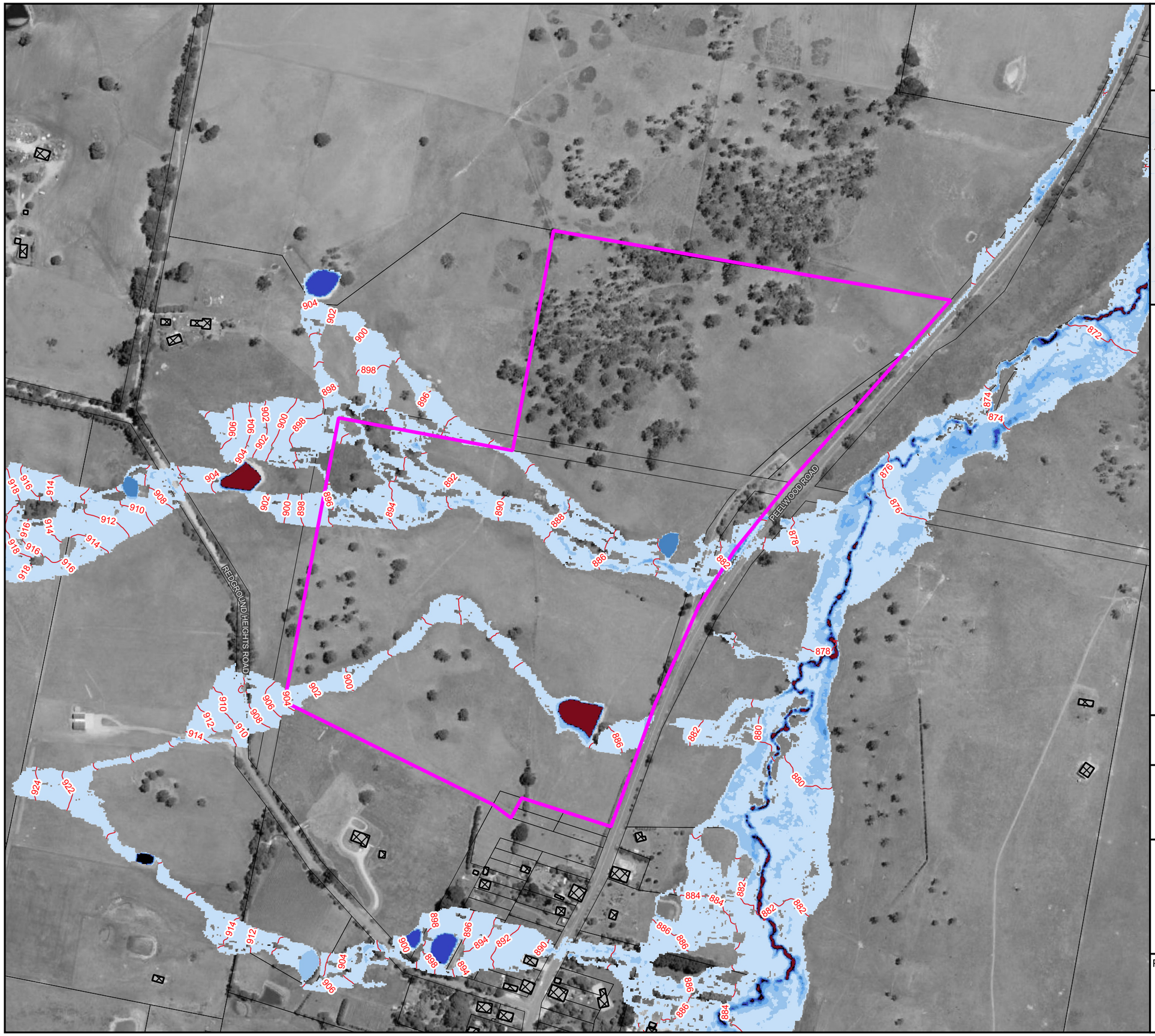

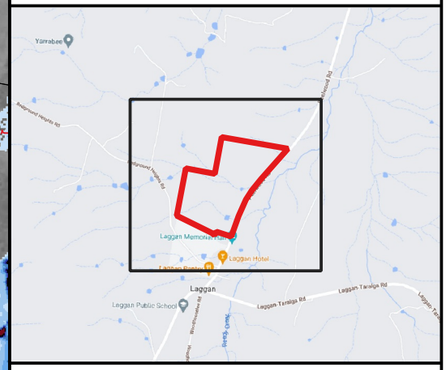

LEGEND

- Site Boundary
- Existing Building Footprint
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 4 :
Peak Floodwater Depths and Levels for the 63.2% AEP Flood for Existing Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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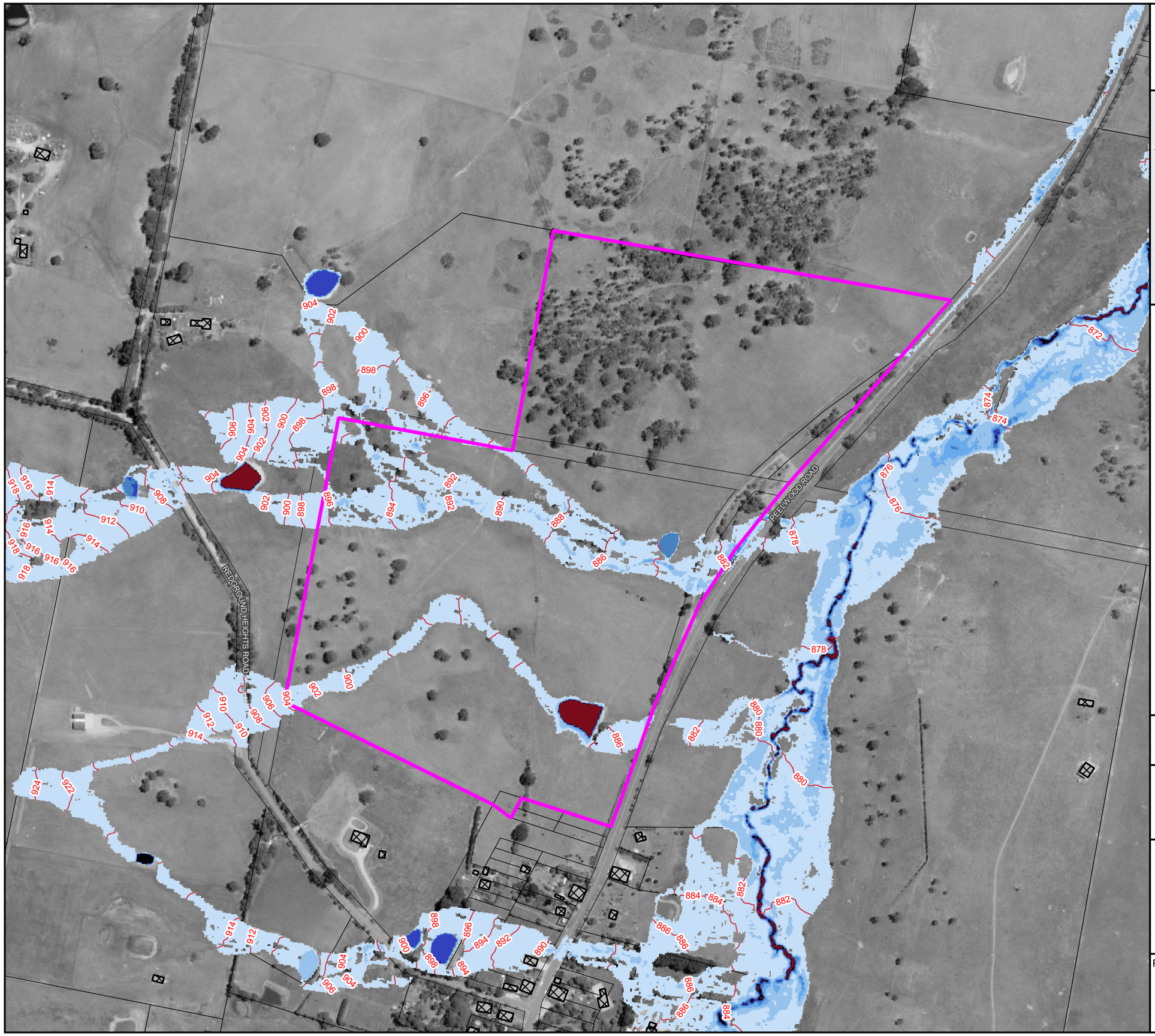

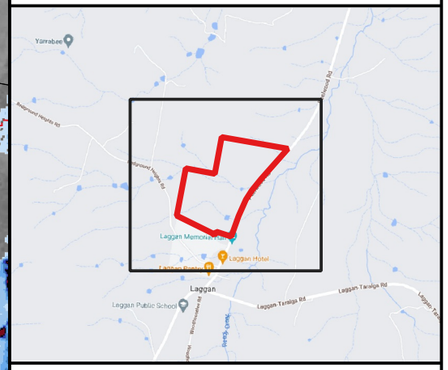

LEGEND

- Site Boundary
- Existing Building Footprint
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 5 :
Peak Floodwater Depths and Levels for the 50% AEP Flood for Existing Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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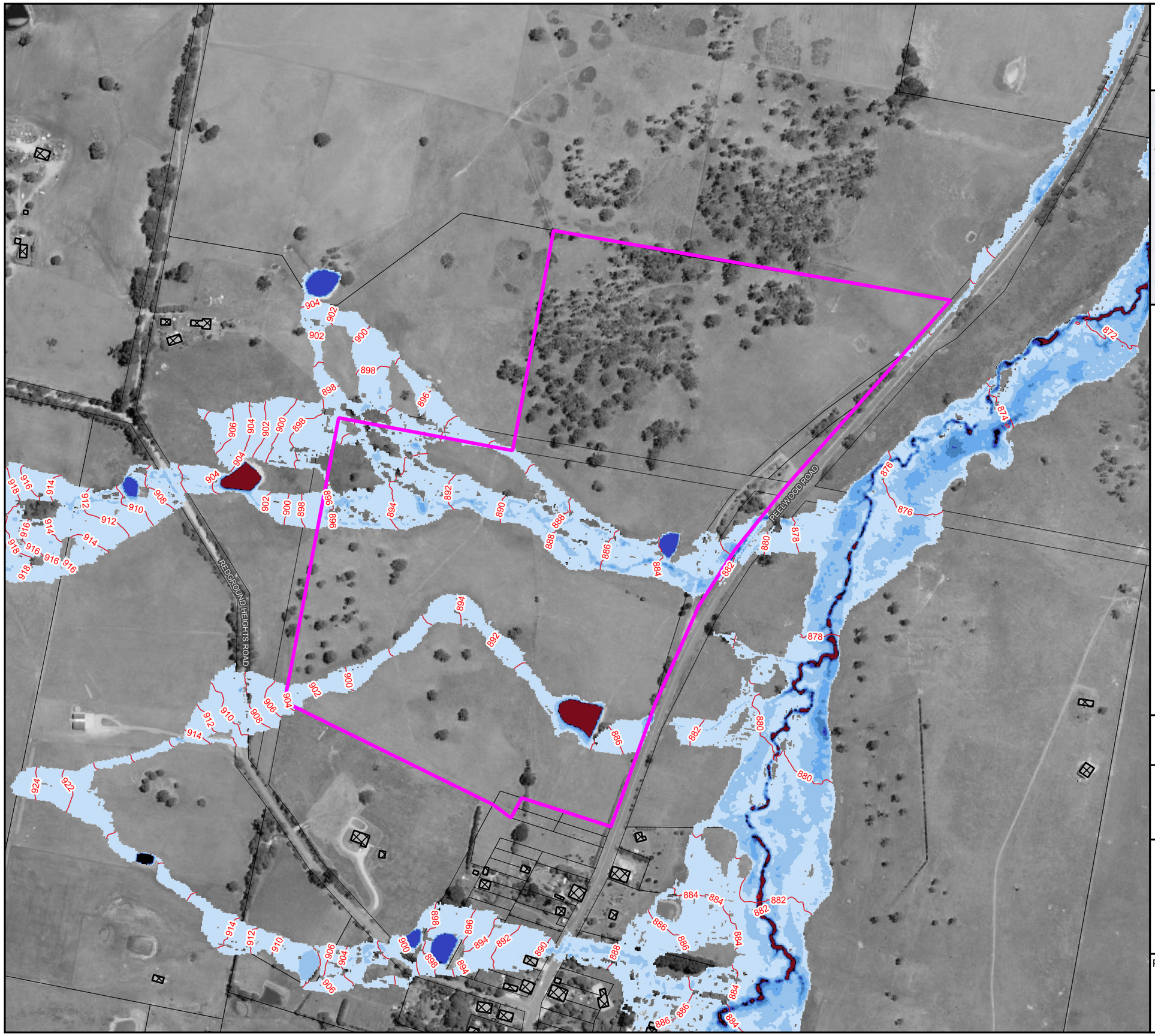

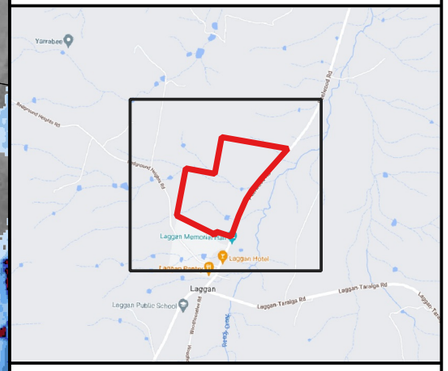

LEGEND

- Site Boundary
- Existing Building Footprint
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 6 :
Peak Floodwater Depths and Levels for the 20% AEP Flood for Existing Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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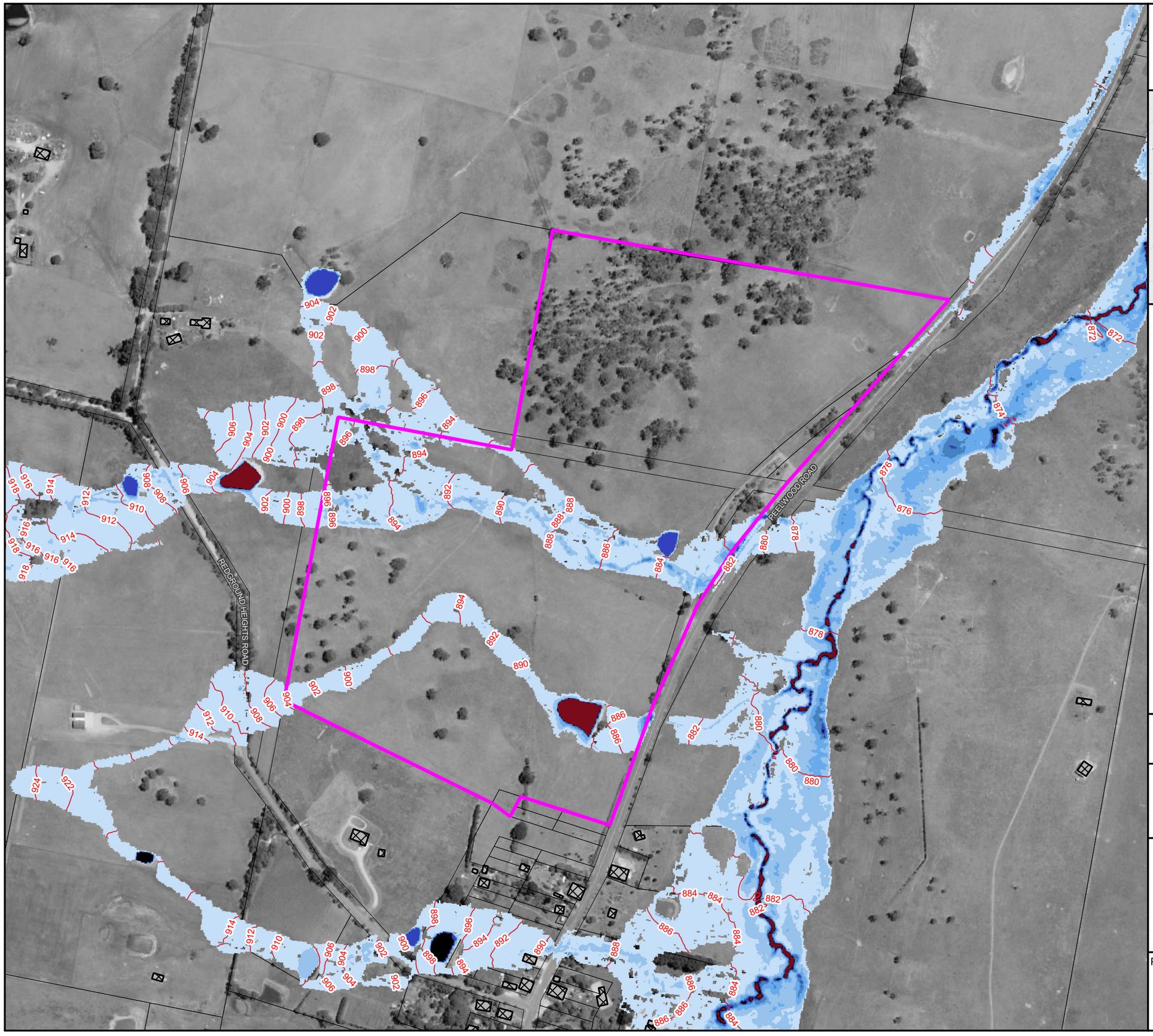
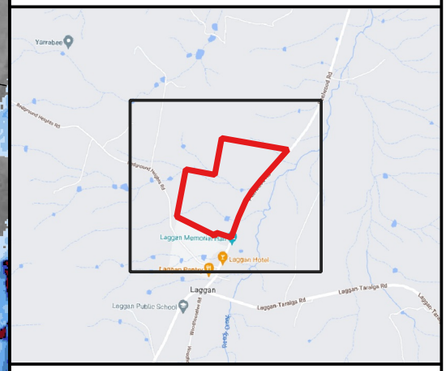




LEGEND

- Site Boundary
- Existing Building Footprint
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

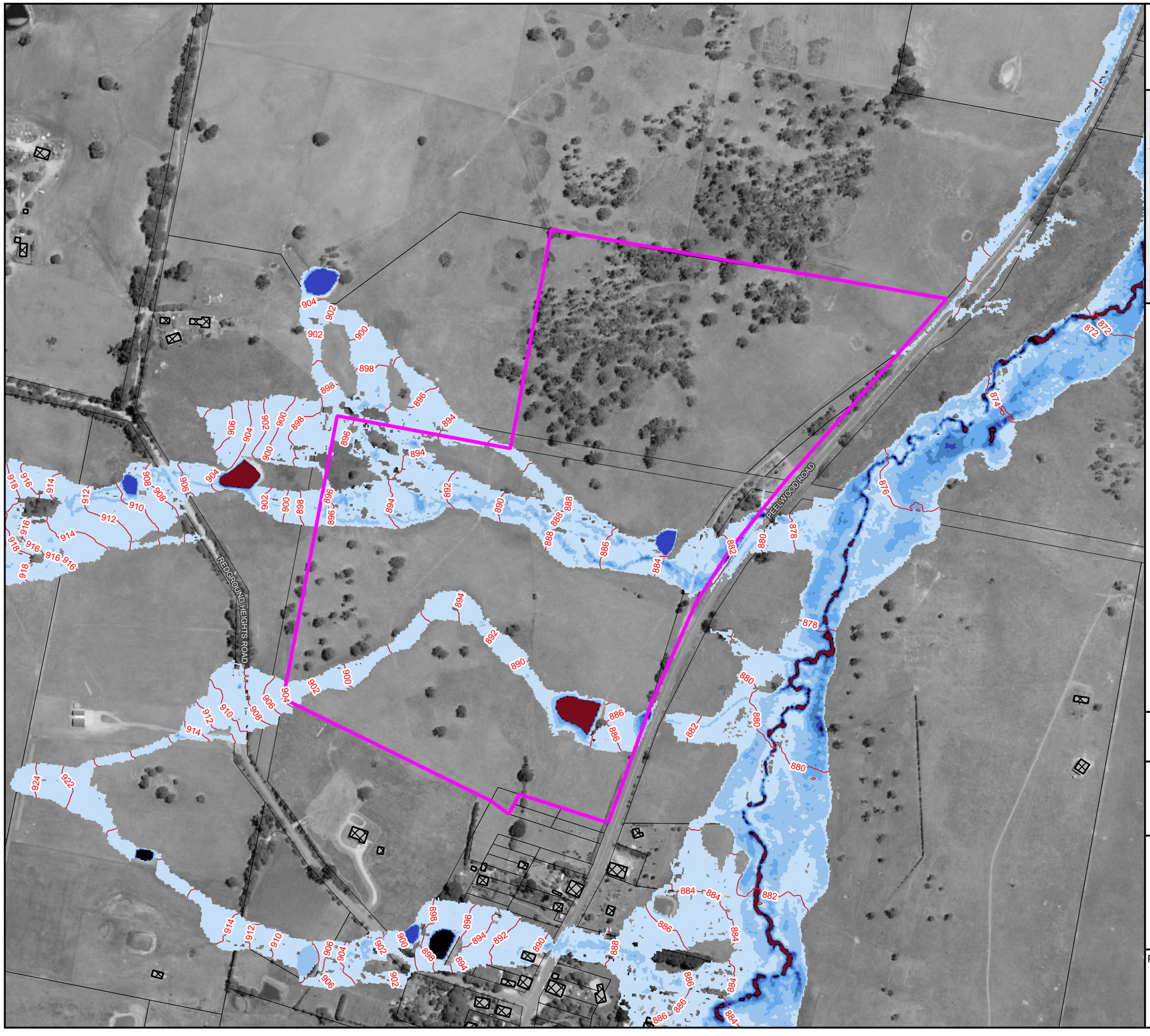
Scale: 1:5,000 (at A3)

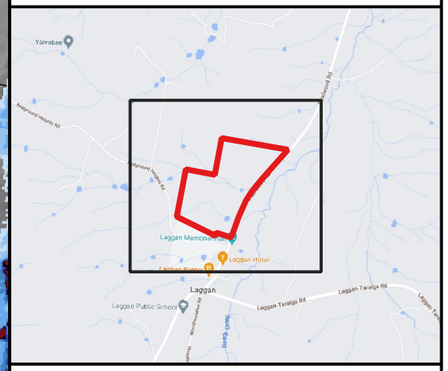
0 60 120 180 240 m

Figure 7 :
Peak Floodwater Depths and Levels for the 10% AEP Flood for Existing Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\-Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

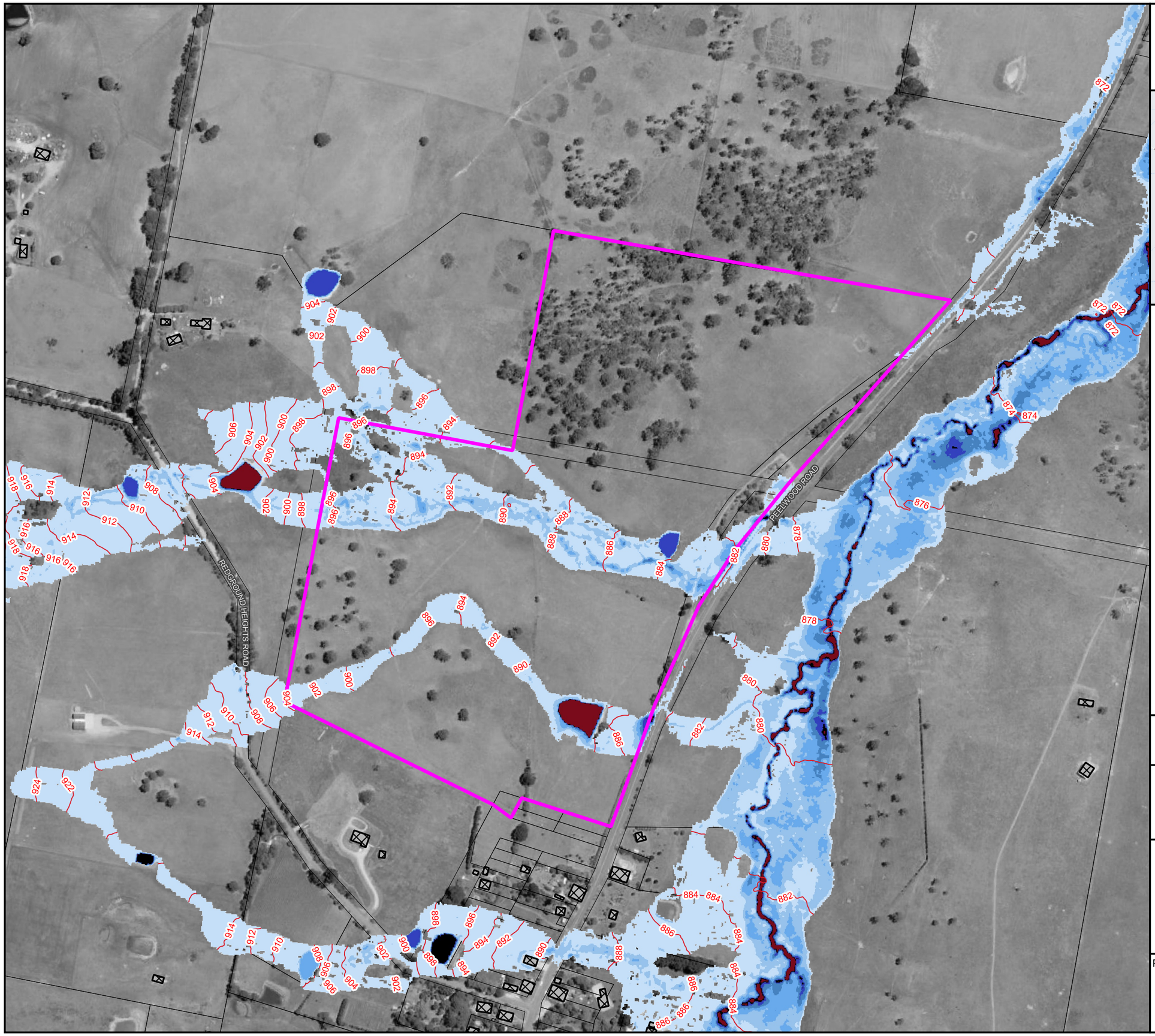
Scale: 1:5,000 (at A3)

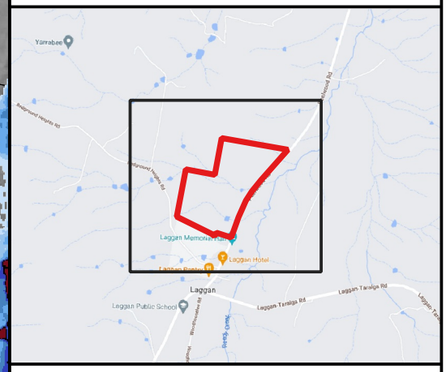
0 60 120 180 240 m

Figure 8 :
Peak Floodwater Depths and Levels for the 5% AEP Flood for Existing Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 9 :
Peak Floodwater Depths and Levels for the 2% AEP Flood for Existing Conditions

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Sydney, NSW, 2000

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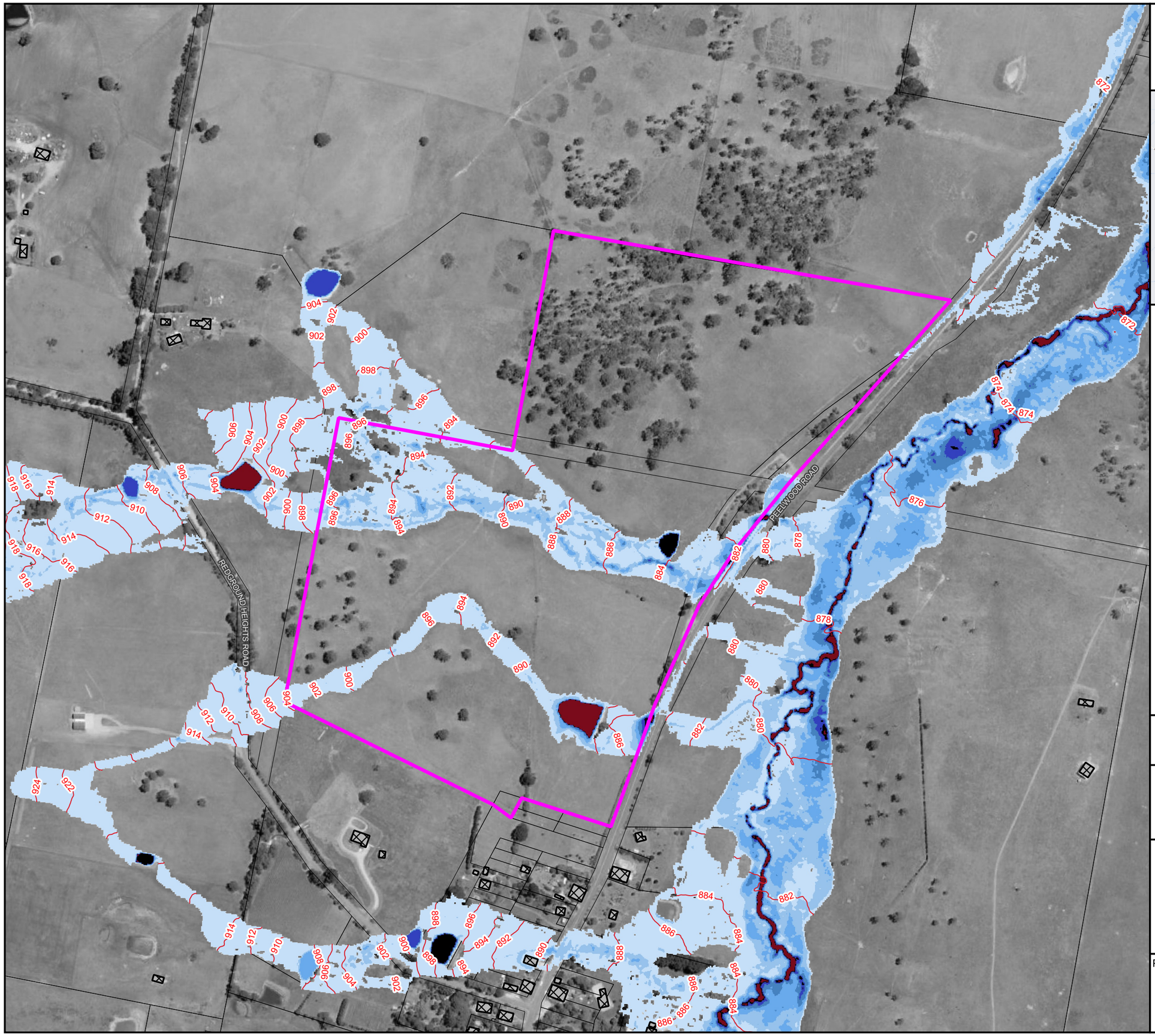

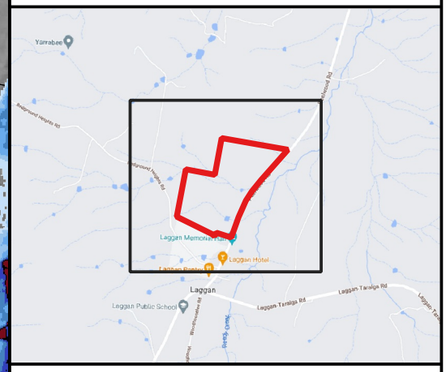

LEGEND

- Site Boundary
- Existing Building Footprint
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 10 :
Peak Floodwater Depths and Levels for the 1% AEP Flood for Existing Conditions

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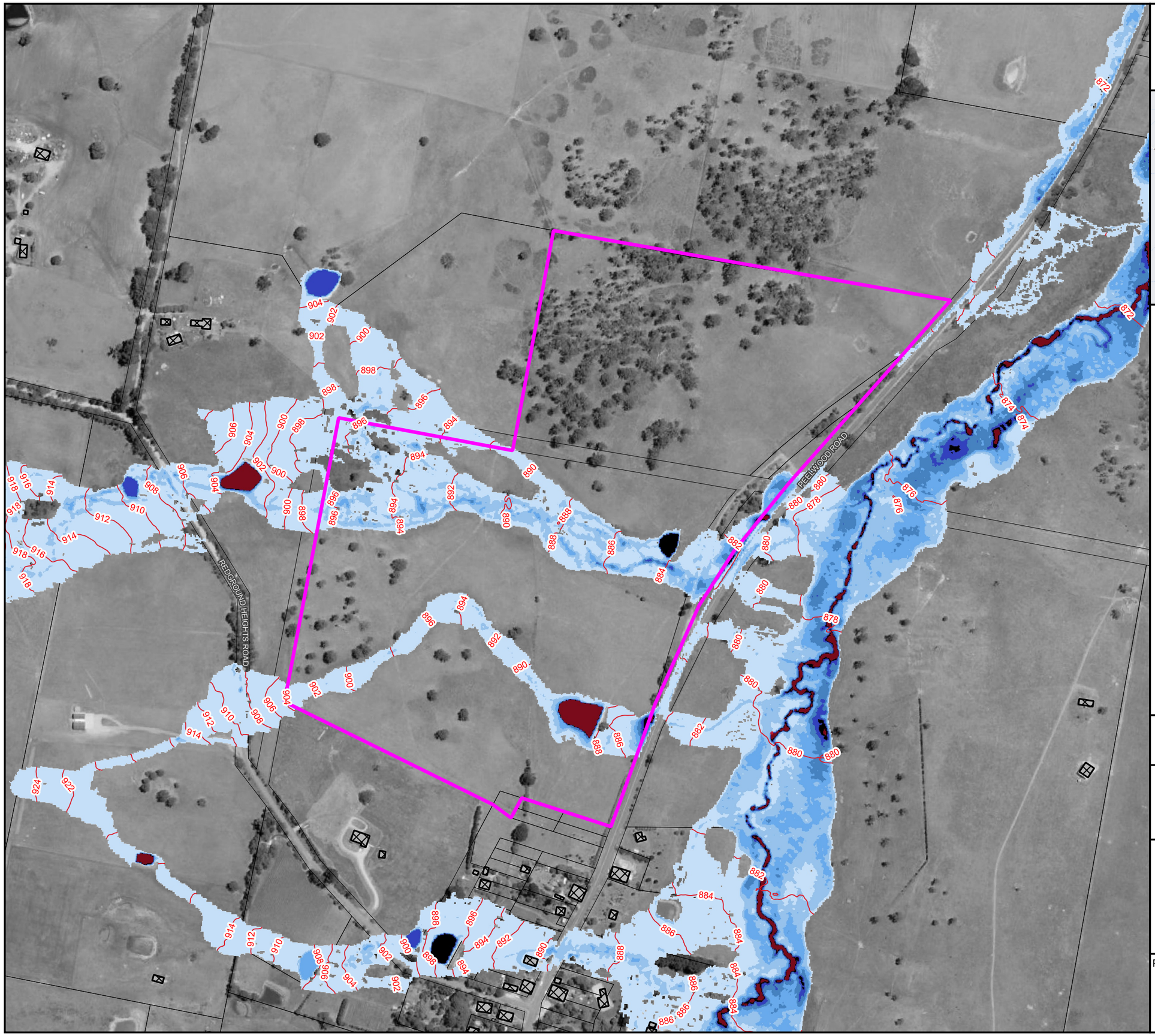

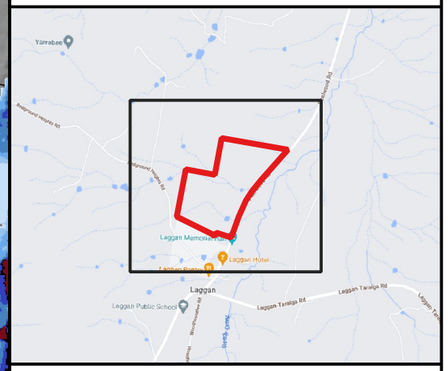

LEGEND

- Site Boundary
- Existing Building Footprint
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 11 :
Peak Floodwater Depths and Levels for the 0.5% AEP Flood for Existing Conditions

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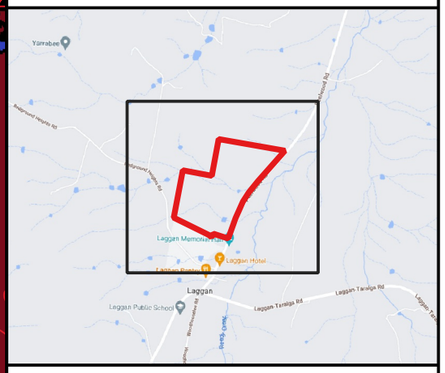
PEELWOOD ROAD

REDGROUND HEIGHTS ROAD



LEGEND

- Site Boundary
- Existing Building Footprint
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 12 :
Peak Floodwater Depths and Levels for the PMF for Existing Conditions

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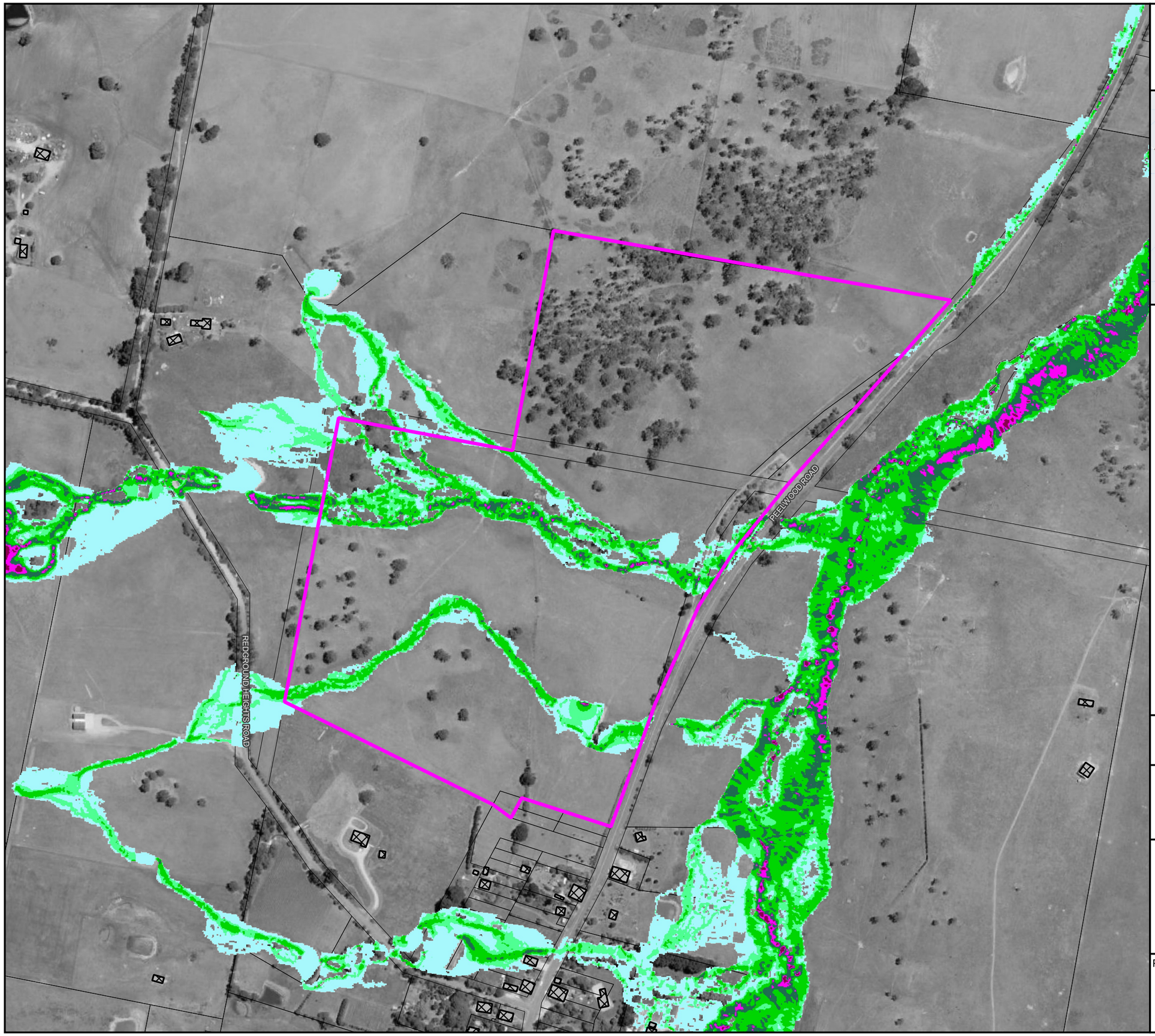

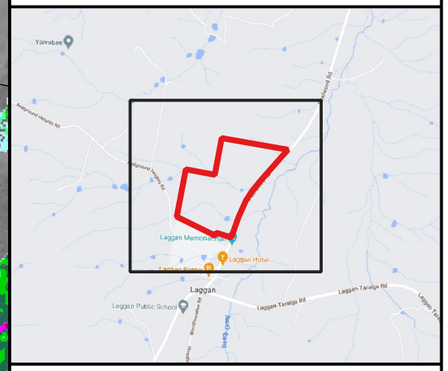

LEGEND

- Site Boundary
- Existing Building Footprint

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 13 :
Peak Flood Velocity for the 63.2% AEP Flood for Existing Conditions

Prepared by:
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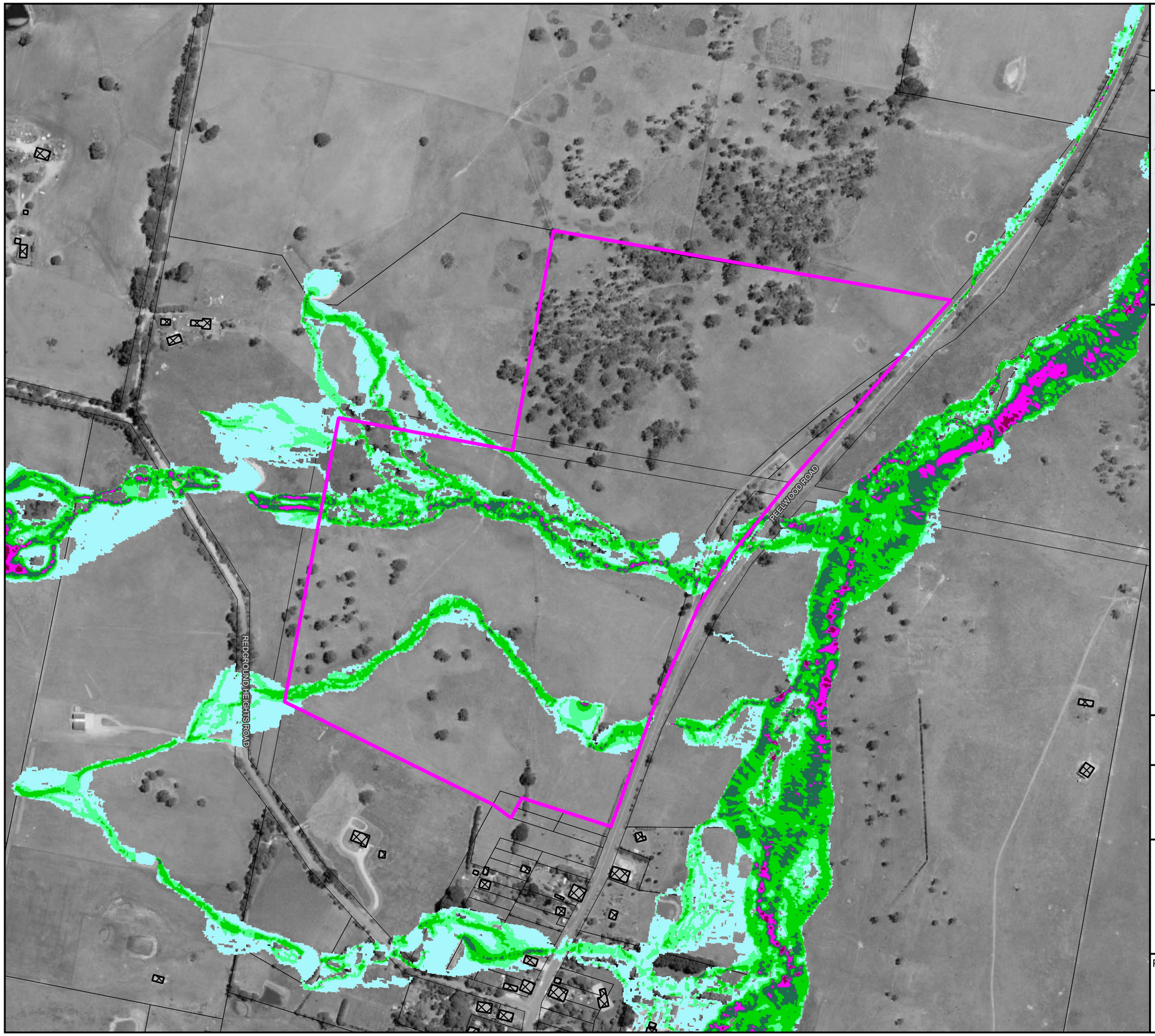

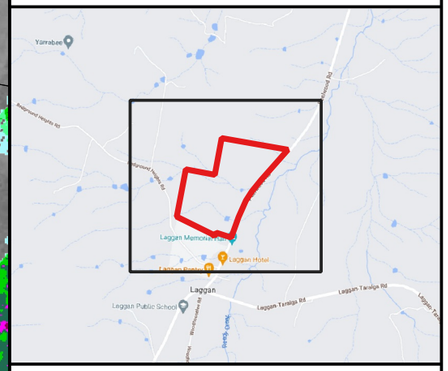

LEGEND

- Site Boundary
- Existing Building Footprint

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 14 :
Peak Flood Velocity for the 50% AEP Flood for Existing Conditions

Prepared by:
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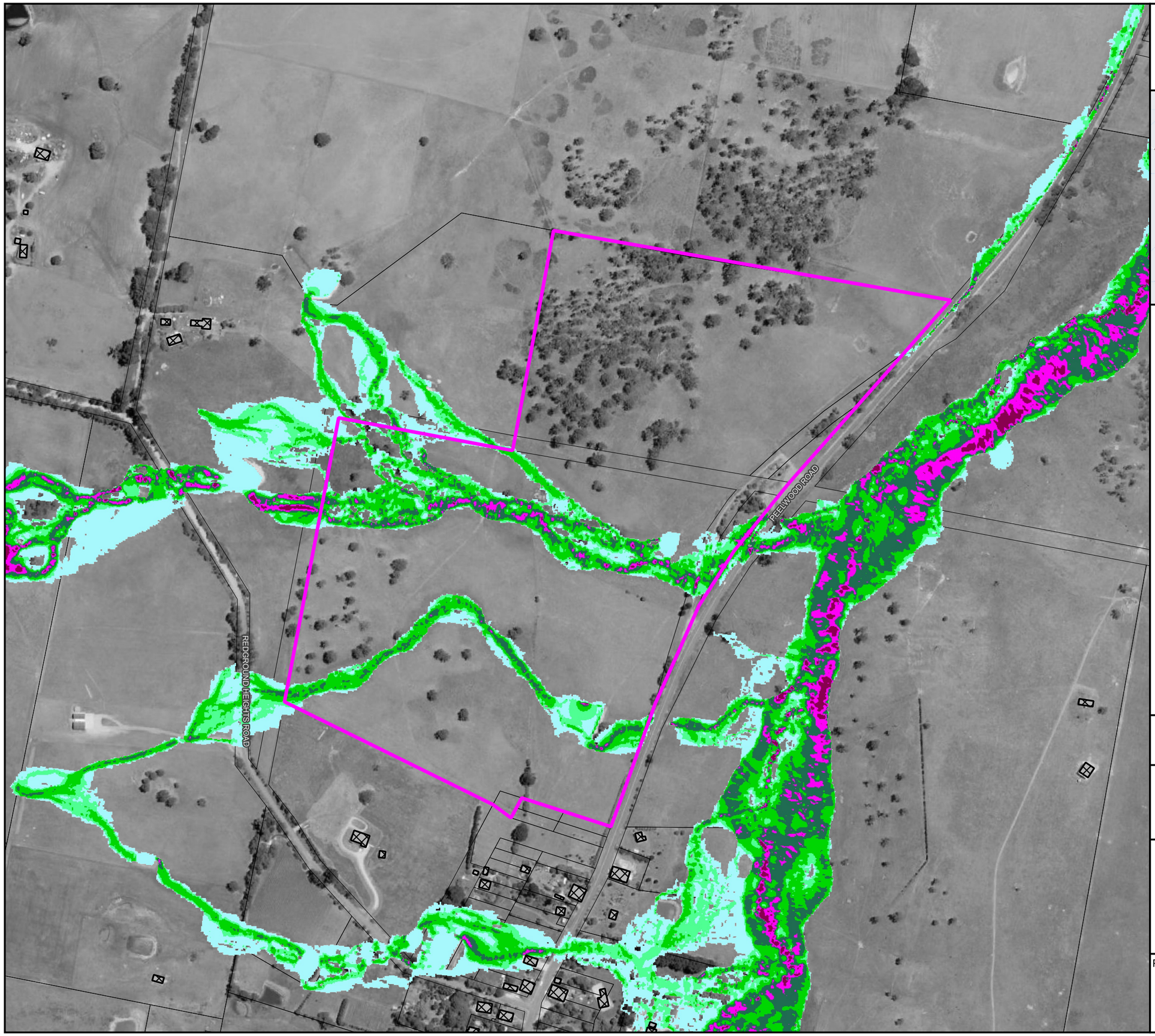

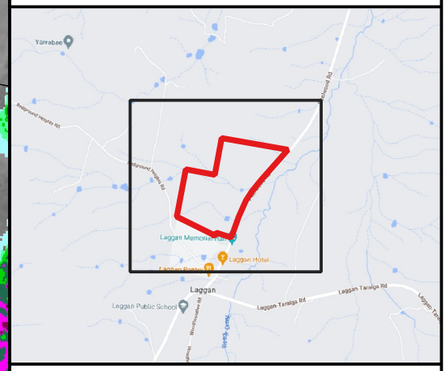

LEGEND

- Site Boundary
- Existing Building Footprint

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 15 :
Peak Flood Velocity for the 20% AEP Flood for Existing Conditions

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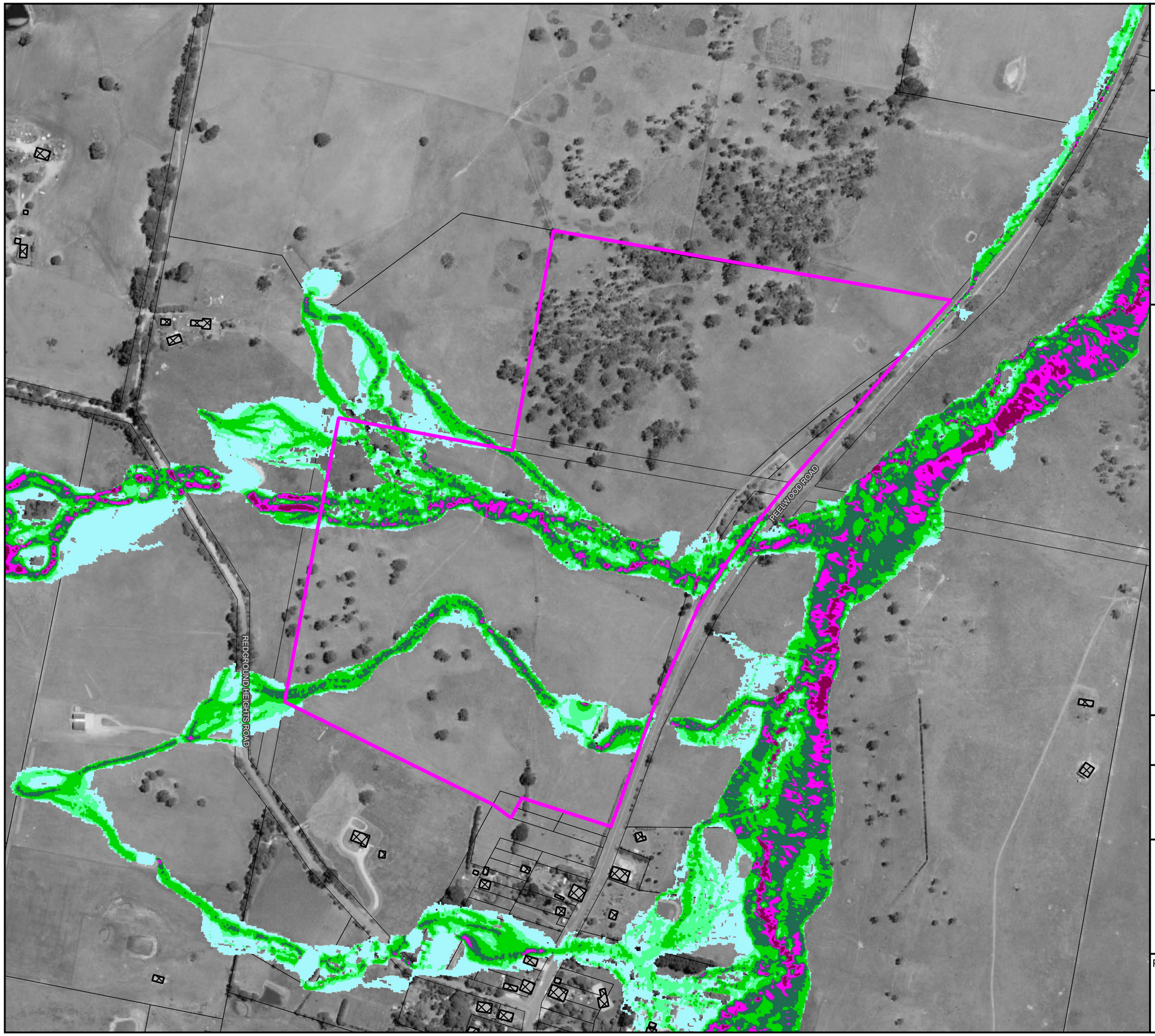

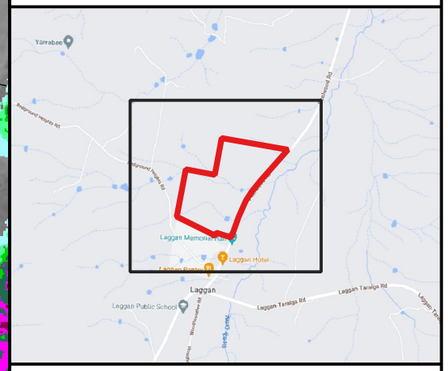

LEGEND

- Site Boundary
- Existing Building Footprint

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 16 :
Peak Flood Velocity for the 10% AEP Flood for Existing Conditions

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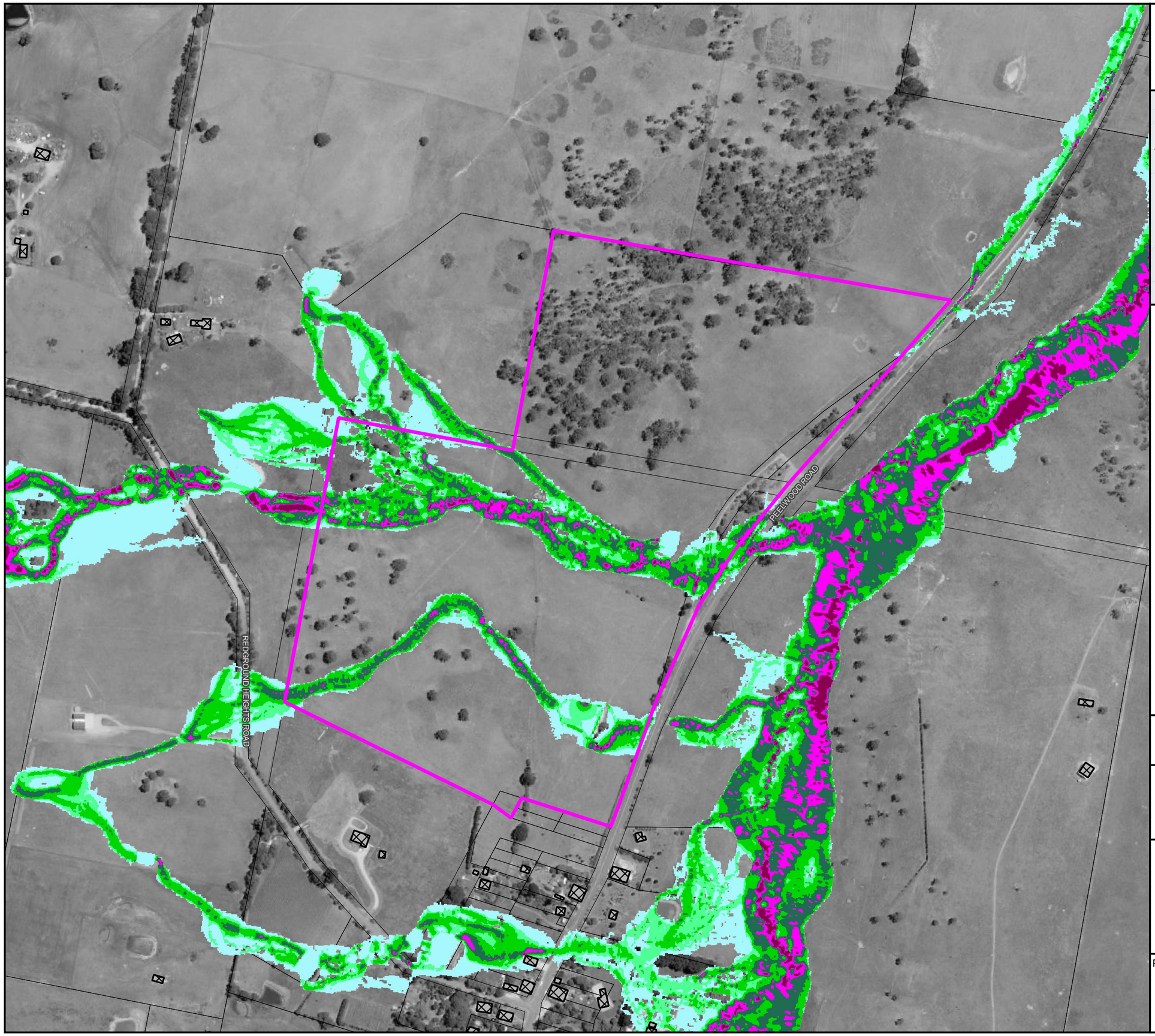

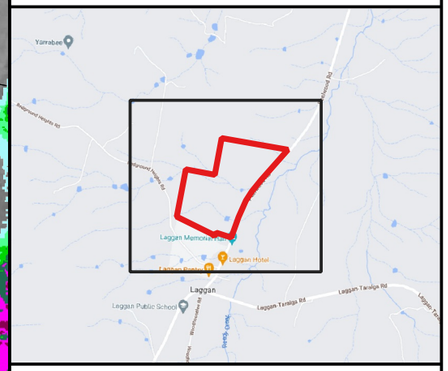

LEGEND

- Site Boundary
- Existing Building Footprint

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 17 :
Peak Flood Velocity for the 5% AEP Flood for Existing Conditions

Prepared by:

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Sydney, NSW, 2000

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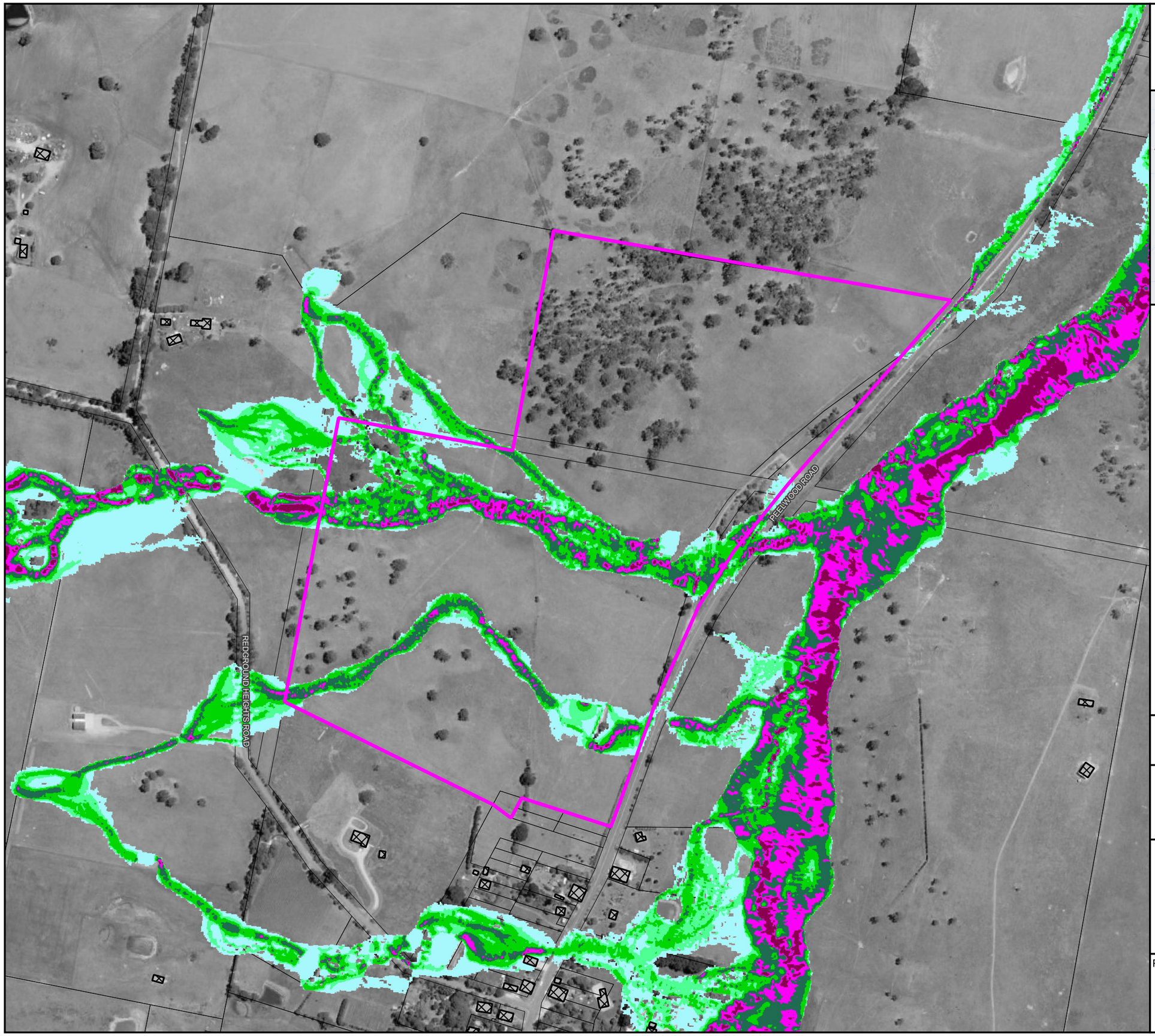

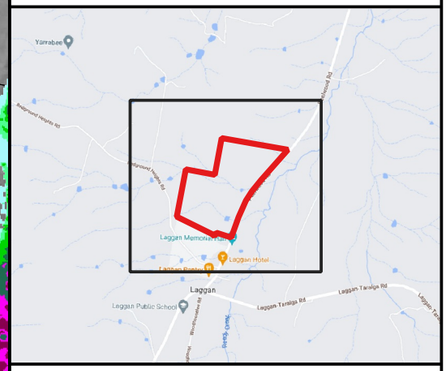

LEGEND

- Site Boundary
- Existing Building Footprint

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 18 :
Peak Flood Velocity for the 2% AEP Flood for Existing Conditions

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Sydney, NSW, 2000

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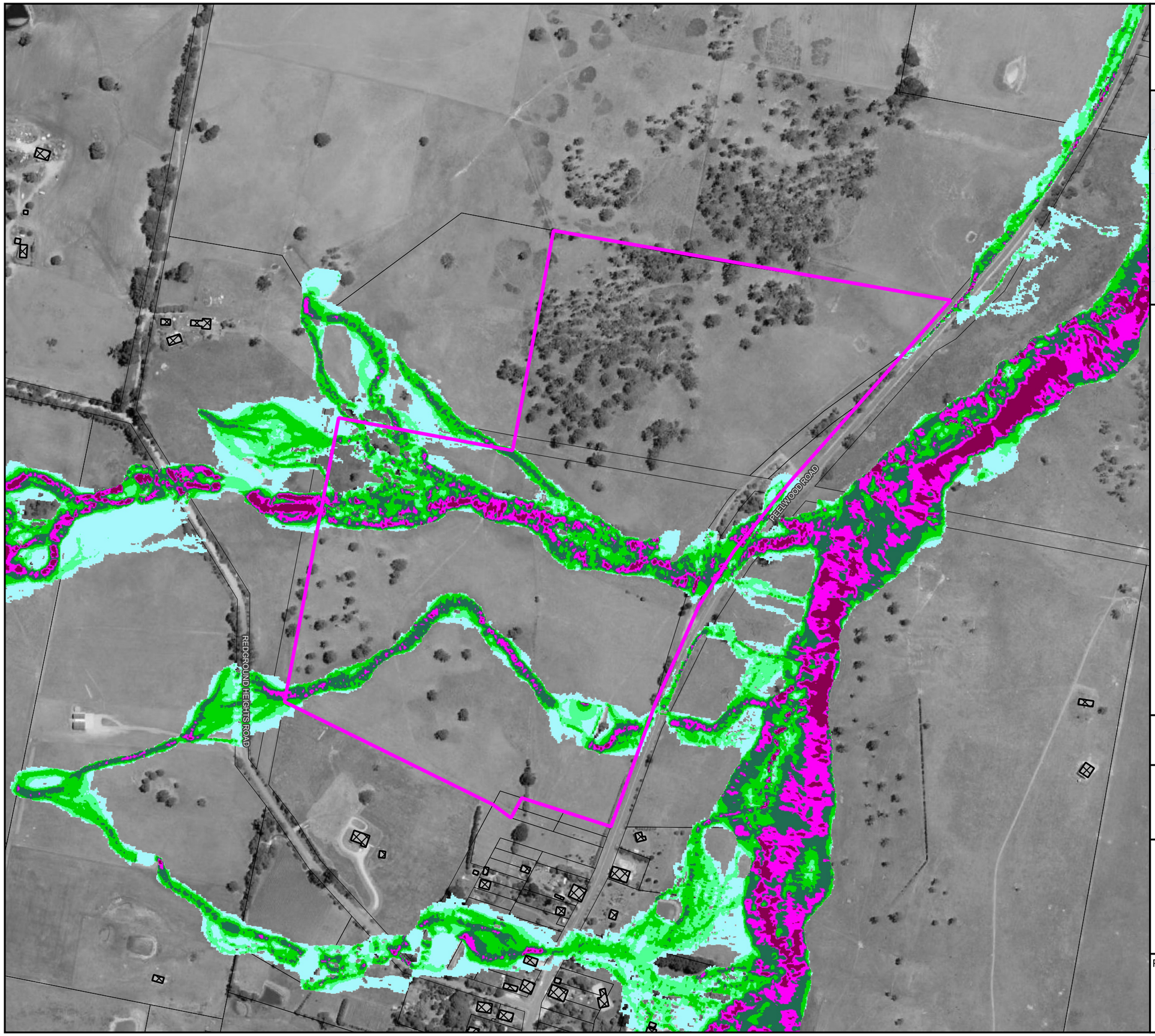

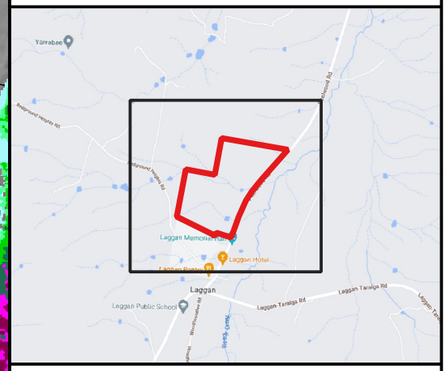

LEGEND

- Site Boundary
- Existing Building Footprint

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 19 :
Peak Flood Velocity for the 1% AEP Flood for Existing Conditions

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Sydney, NSW, 2000

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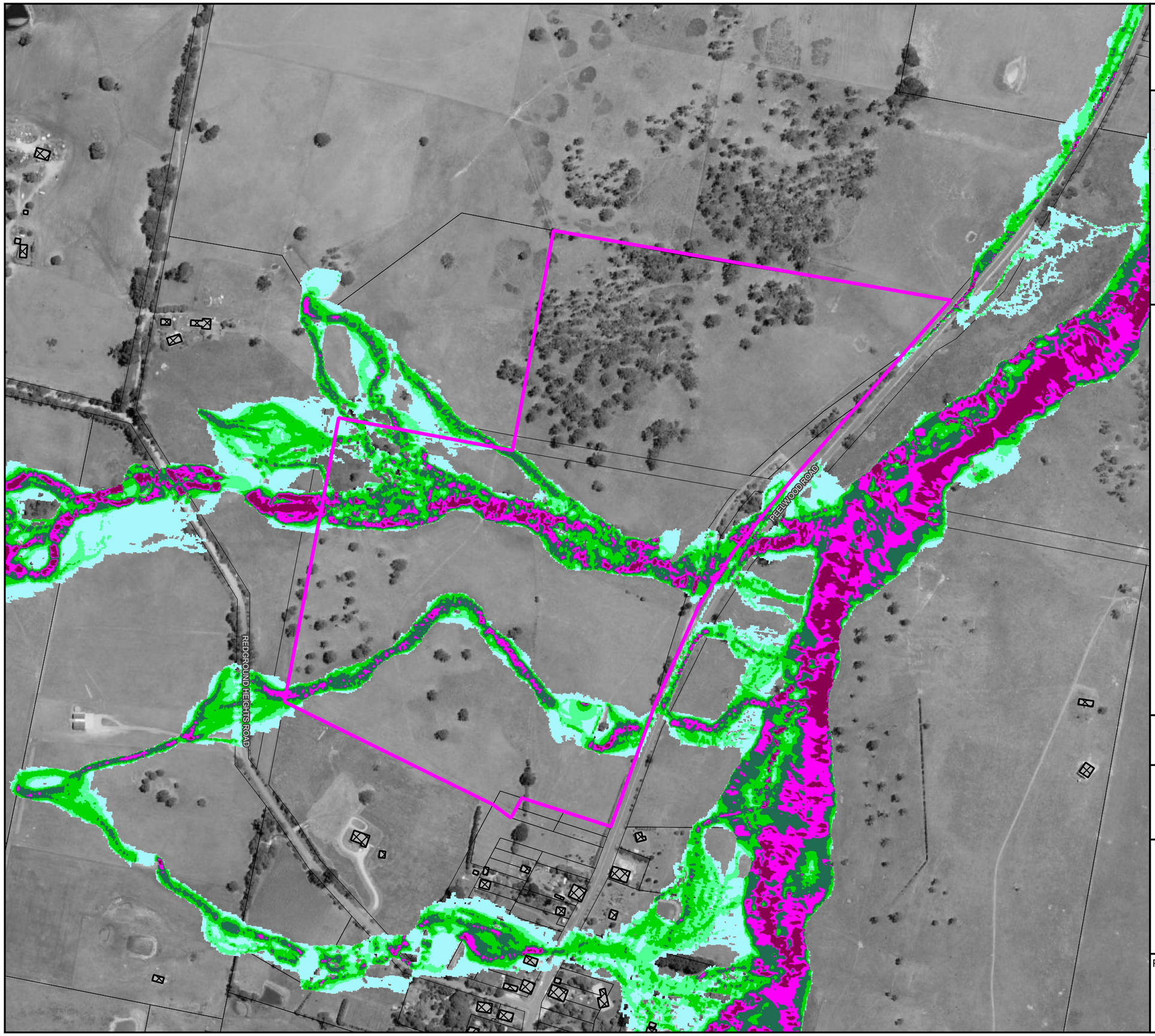

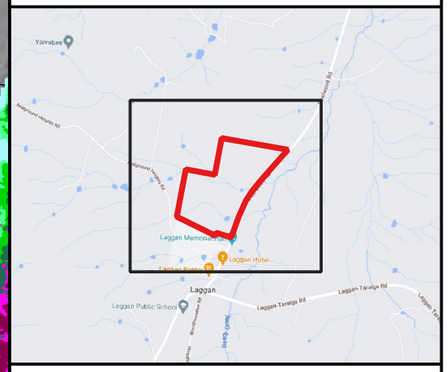

LEGEND

- Site Boundary
- Existing Building Footprint

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 20 :
Peak Flood Velocity for the 0.5% AEP Flood for Existing Conditions

Prepared by:
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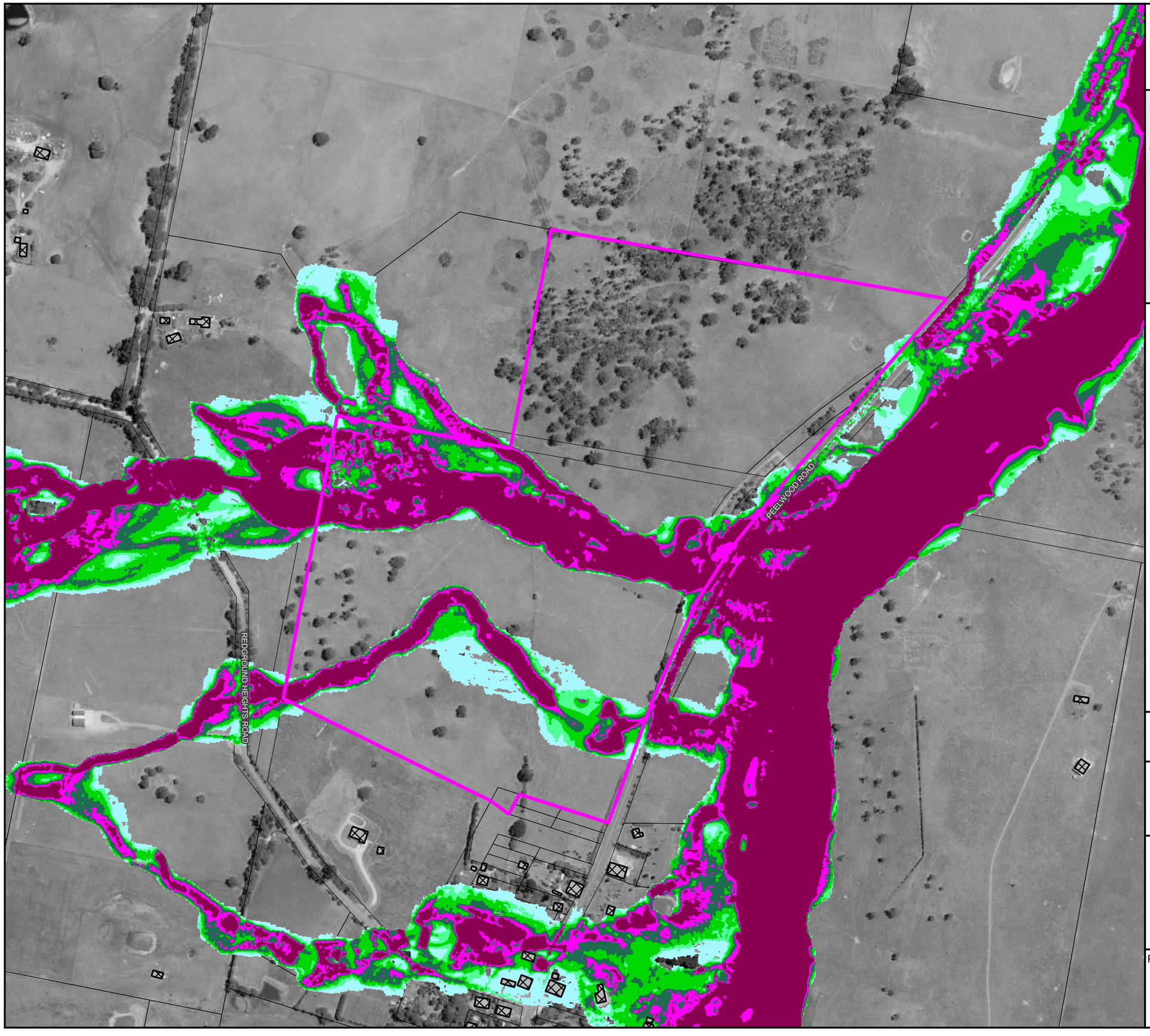

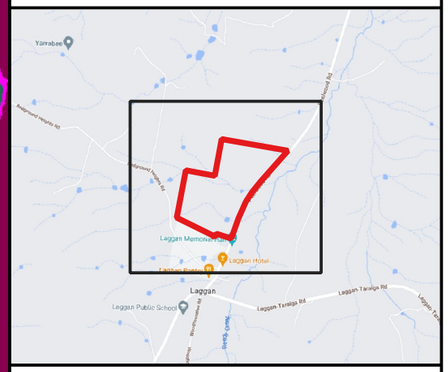

LEGEND

- Site Boundary
- Existing Building Footprint

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 21 :
Peak Flood Velocity for the PMF for Existing Conditions

Prepared by:

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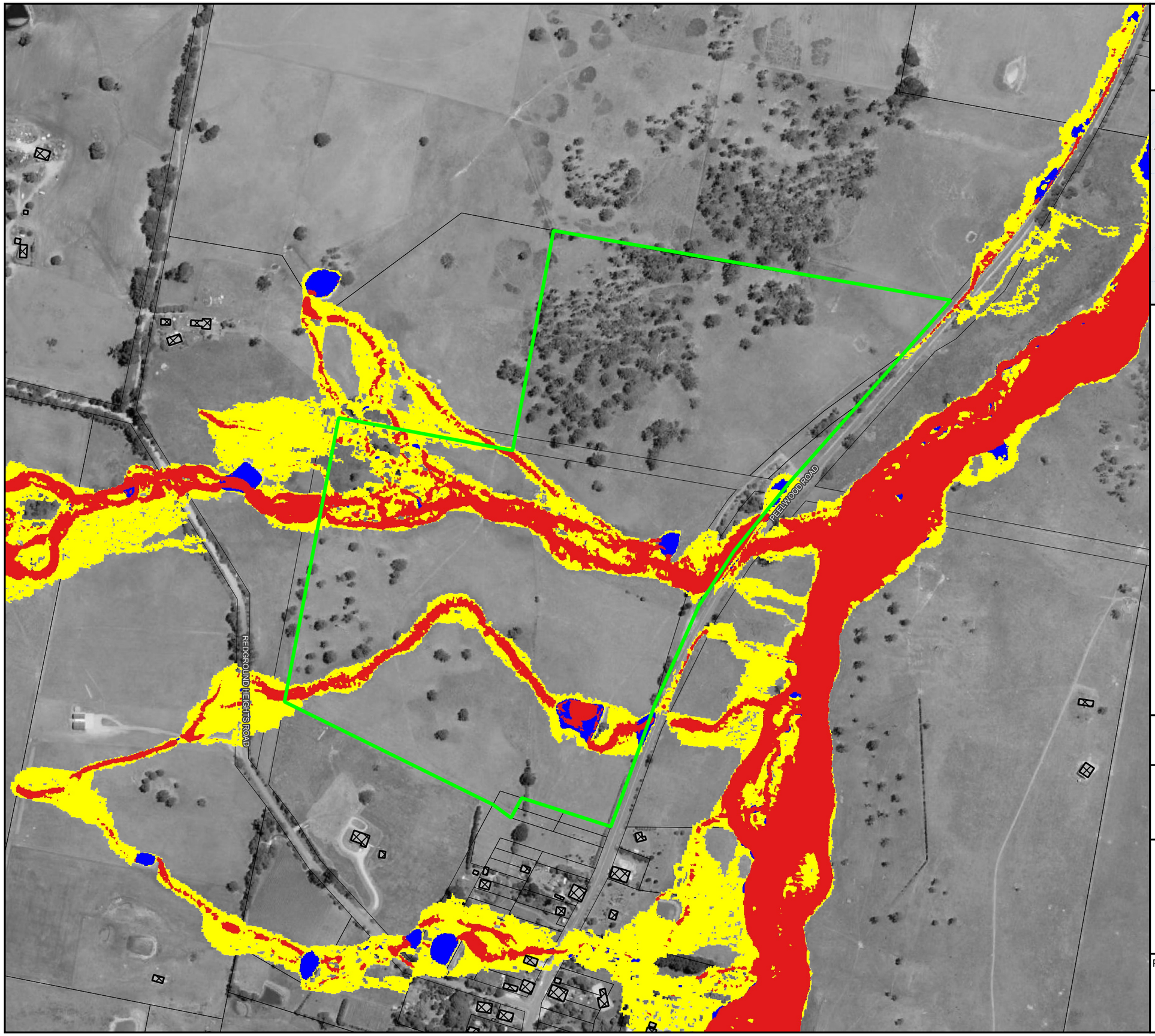

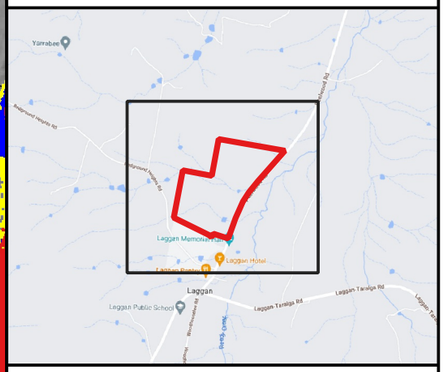

LEGEND

- Site Boundary

Hydraulic Categories

- Flood Fringe
- Flood Storage
- Floodway

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 22 :
Hydraulic Categories for the 1% AEP Flood for Existing Conditions

Prepared by:
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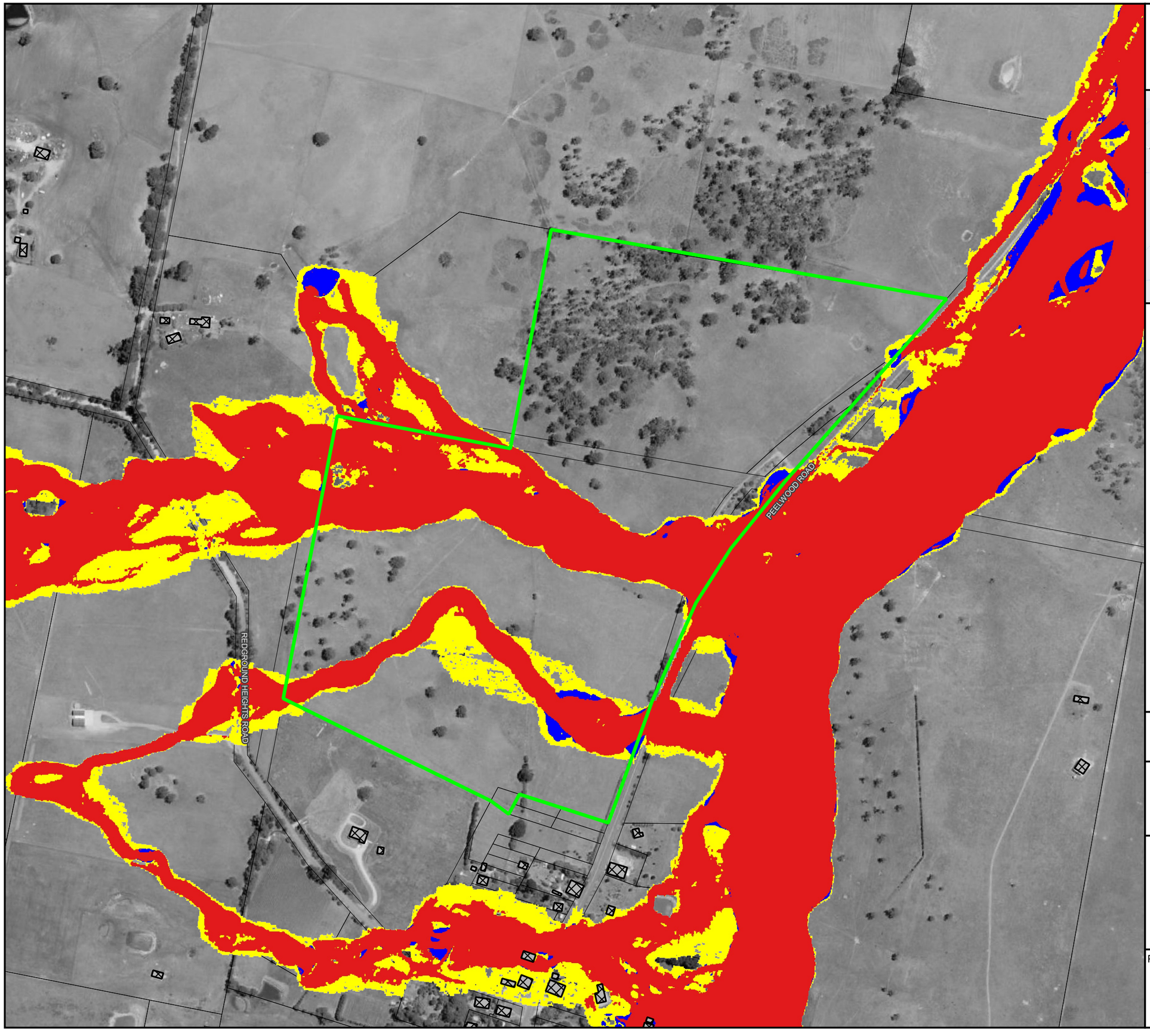

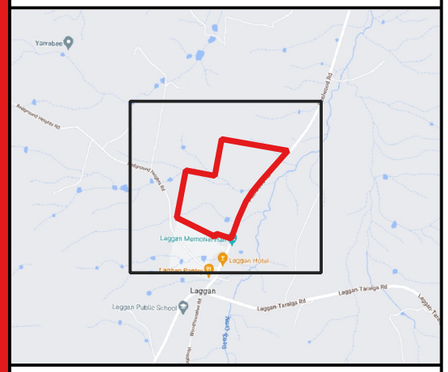

LEGEND

Site Boundary

Hydraulic Categories

- Flood Fringe
- Flood Storage
- Floodway

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 23 :
Hydraulic Categories for the PMF for Existing Conditions

Prepared by:
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Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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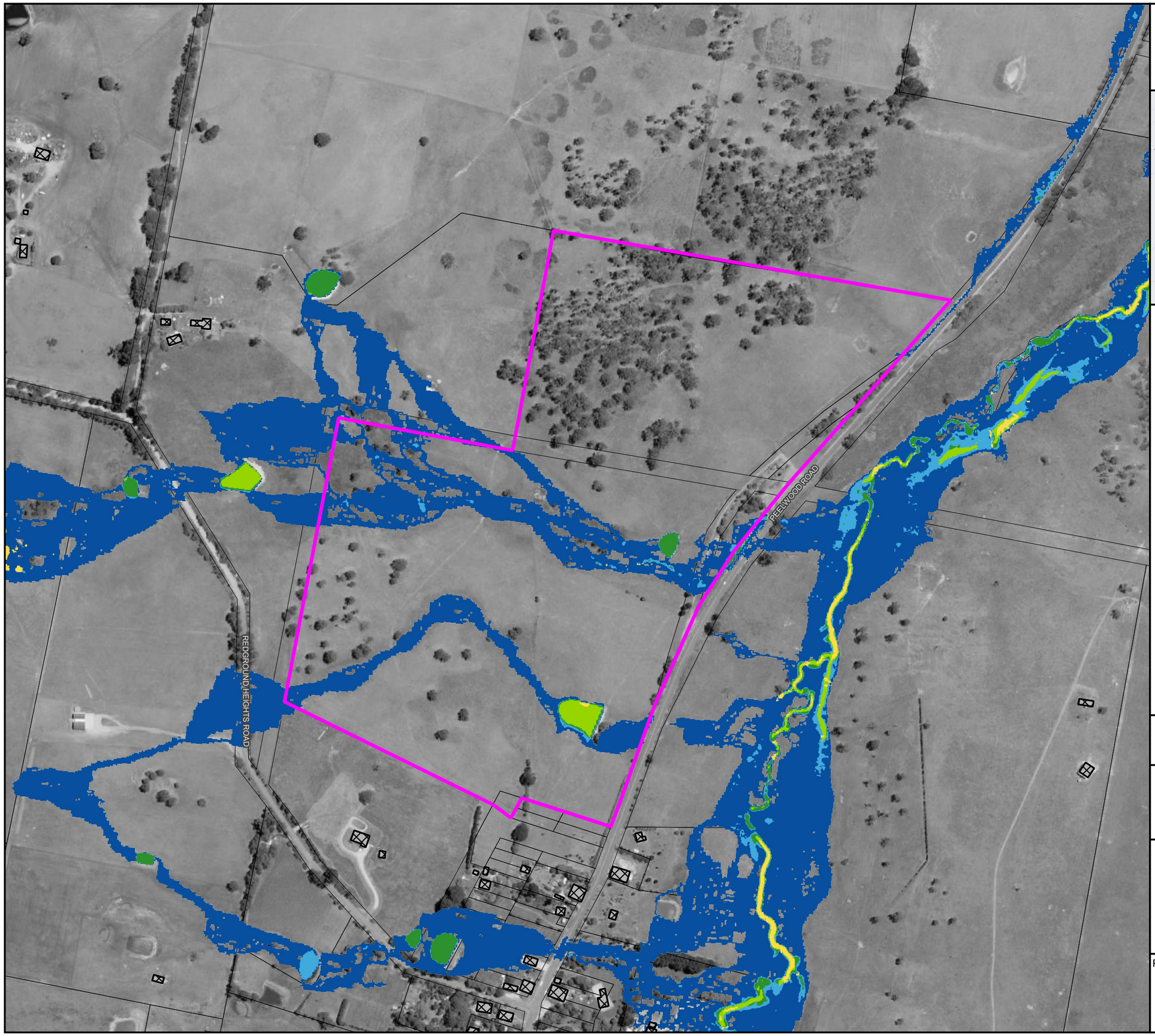

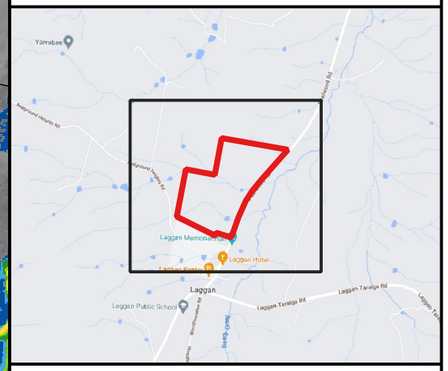

LEGEND

- Site Boundary
- Existing Building Footprint

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 24 :
Flood Hazard for the 63.2% AEP Flood for Existing Conditions

Prepared by:
Catchment Simulation Solutions
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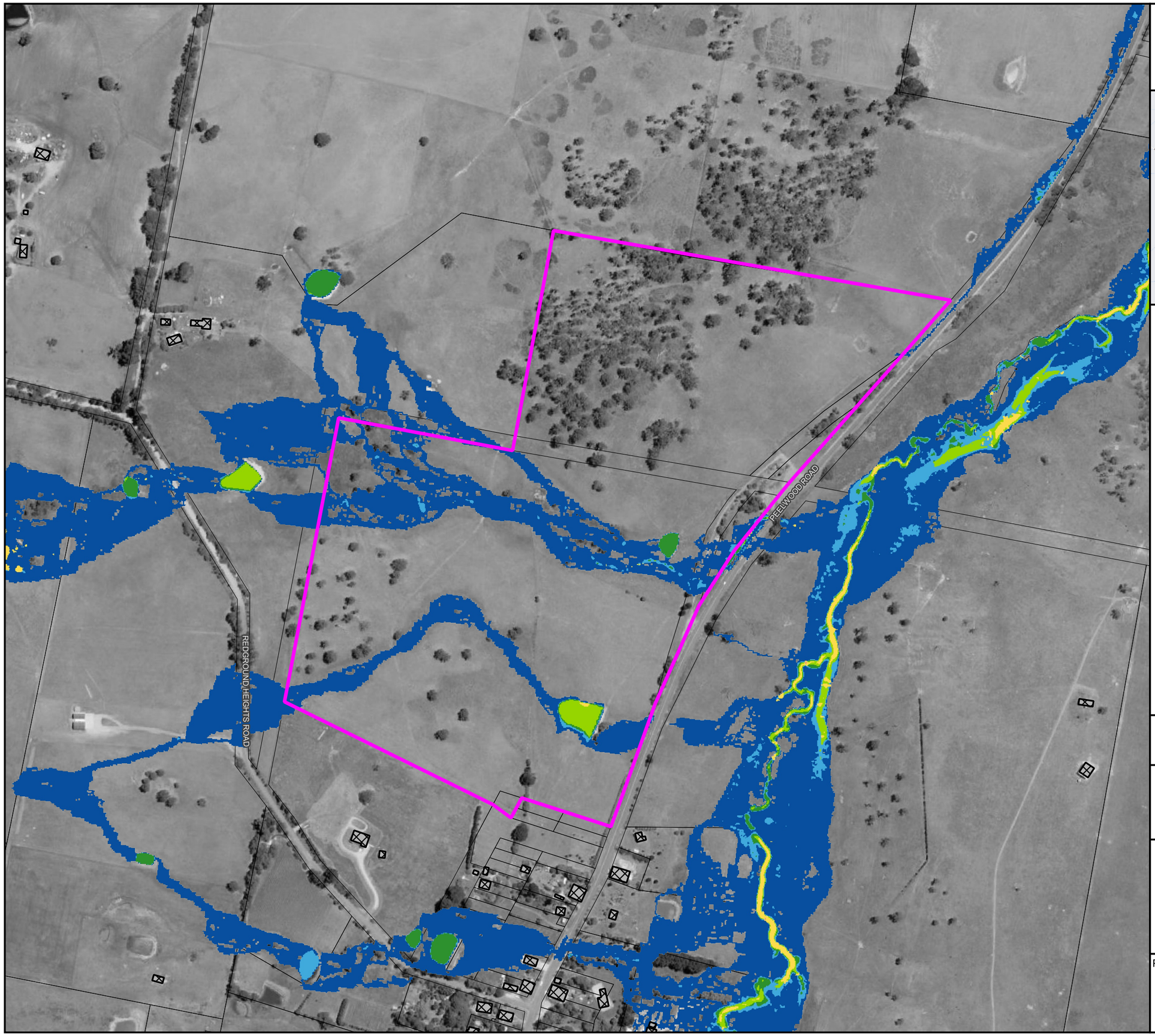
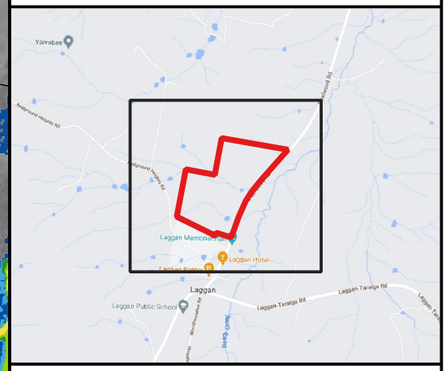
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

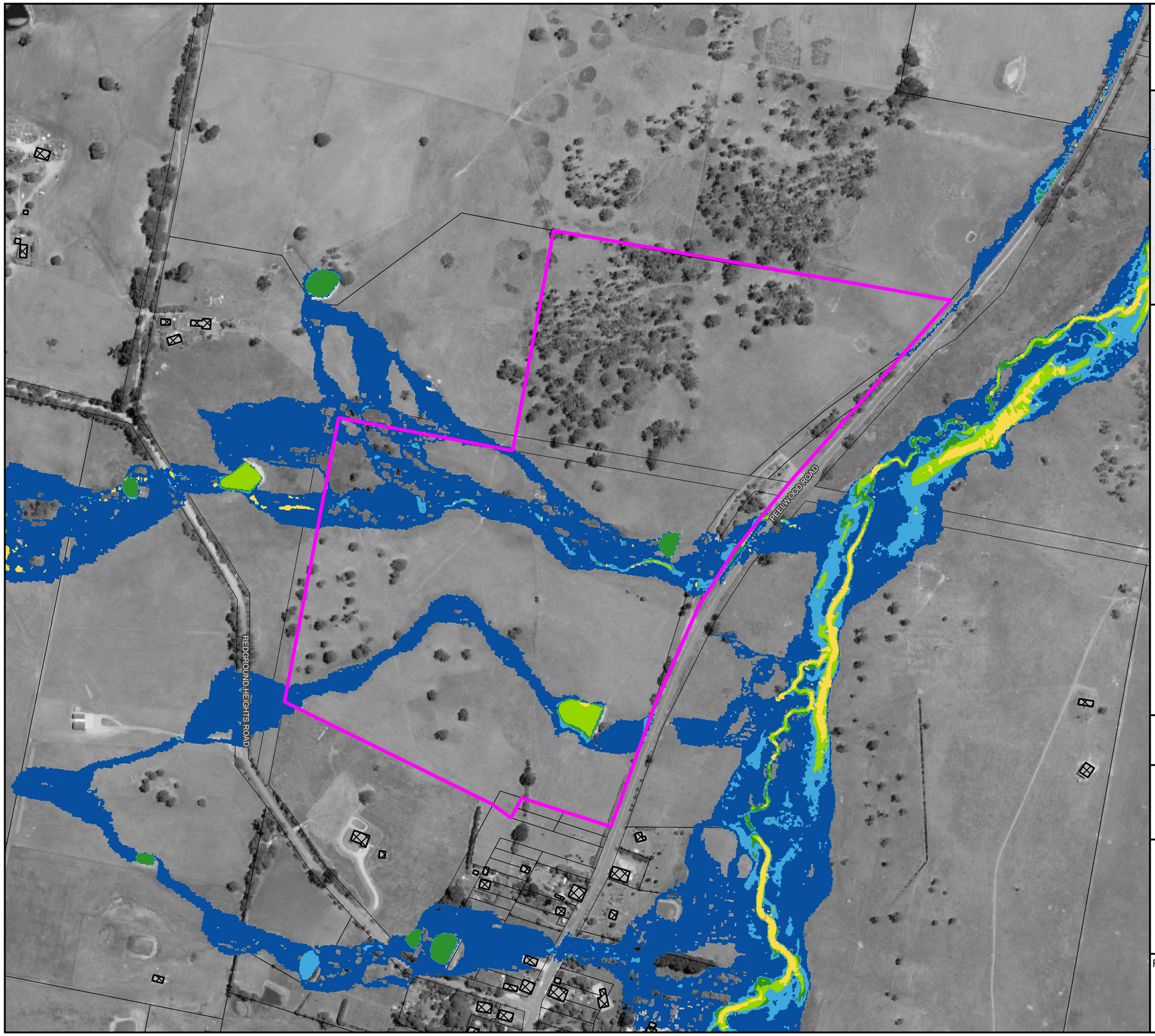
Scale: 1:5,000 (at A3)

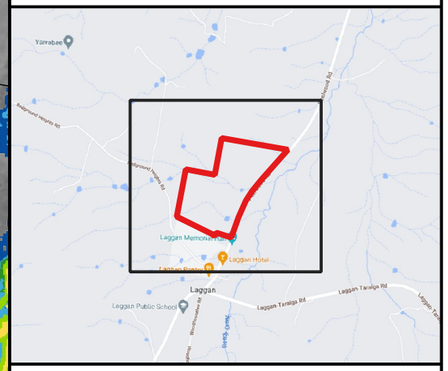
0 60 120 180 240 m

Figure 25 :
Flood Hazard for the 50% AEP Flood for Existing Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

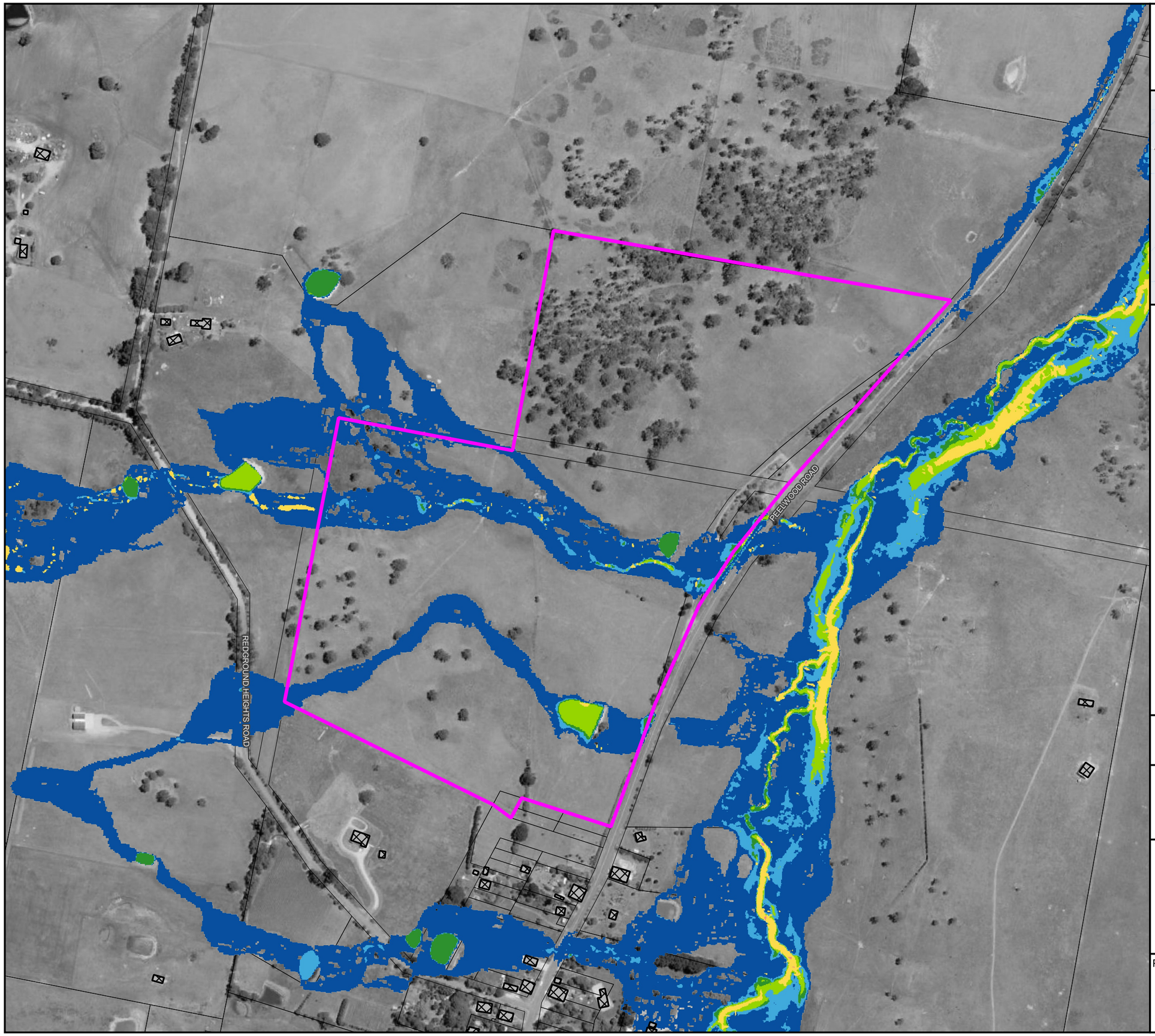
0 60 120 180 240 m

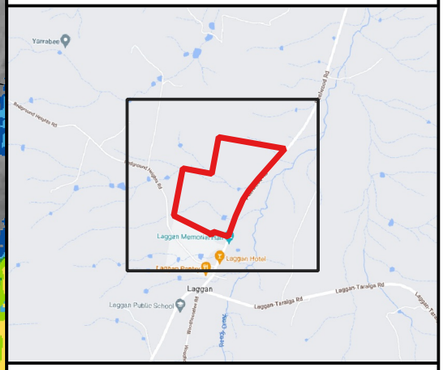
Figure 26 :
Flood Hazard for the 20% AEP Flood for Existing Conditions

Prepared by:

Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 27 :
Flood Hazard for the 10% AEP Flood for Existing Conditions

Prepared by:

Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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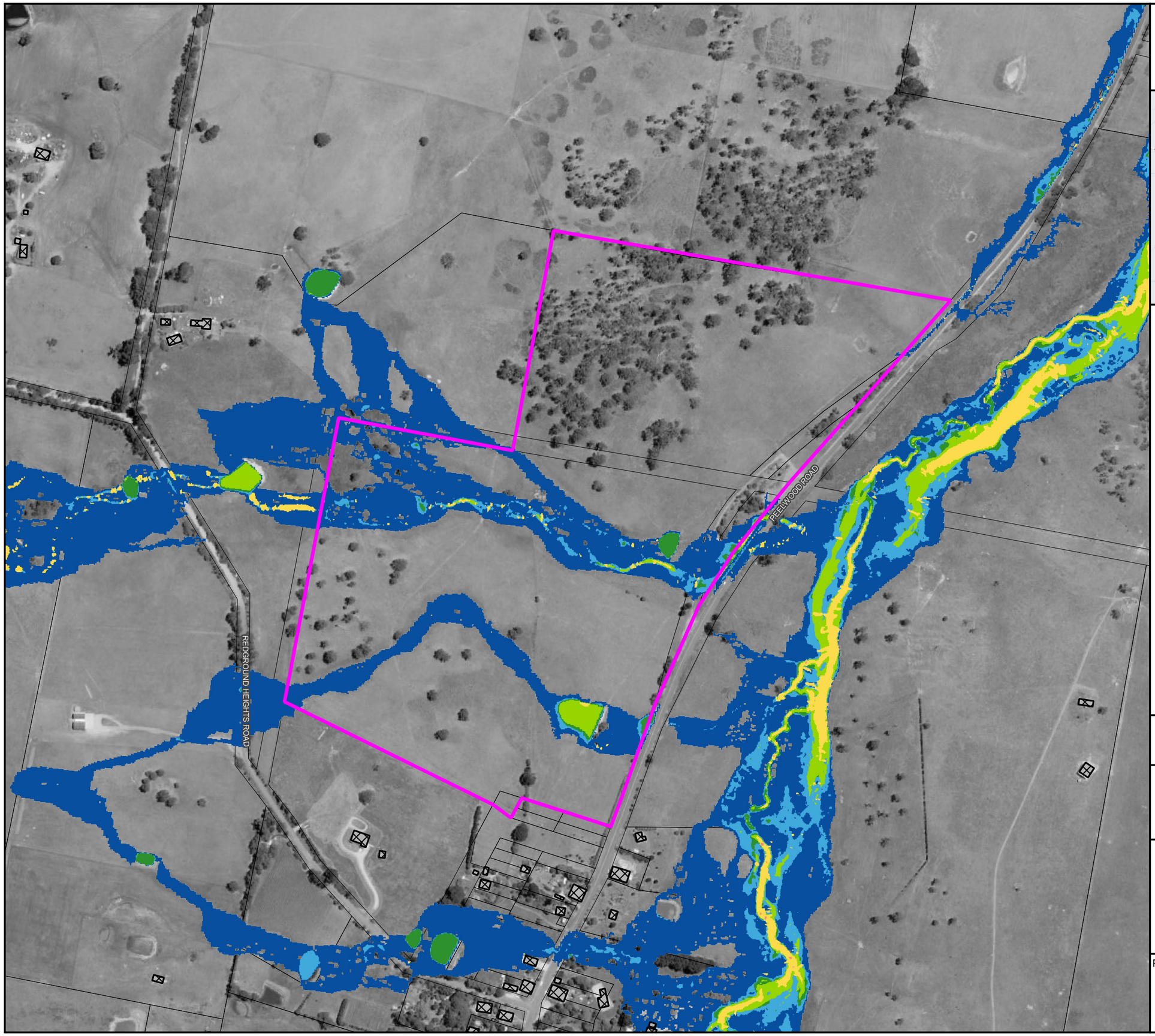

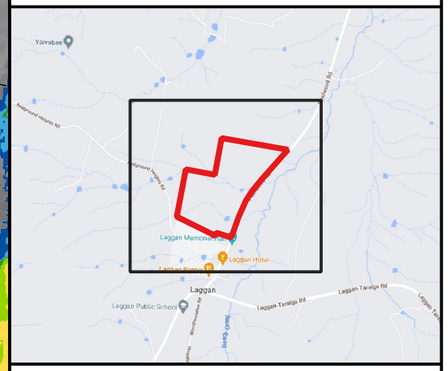

LEGEND

- Site Boundary
- Existing Building Footprint

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 28 :
Flood Hazard for the 5% AEP Flood for Existing Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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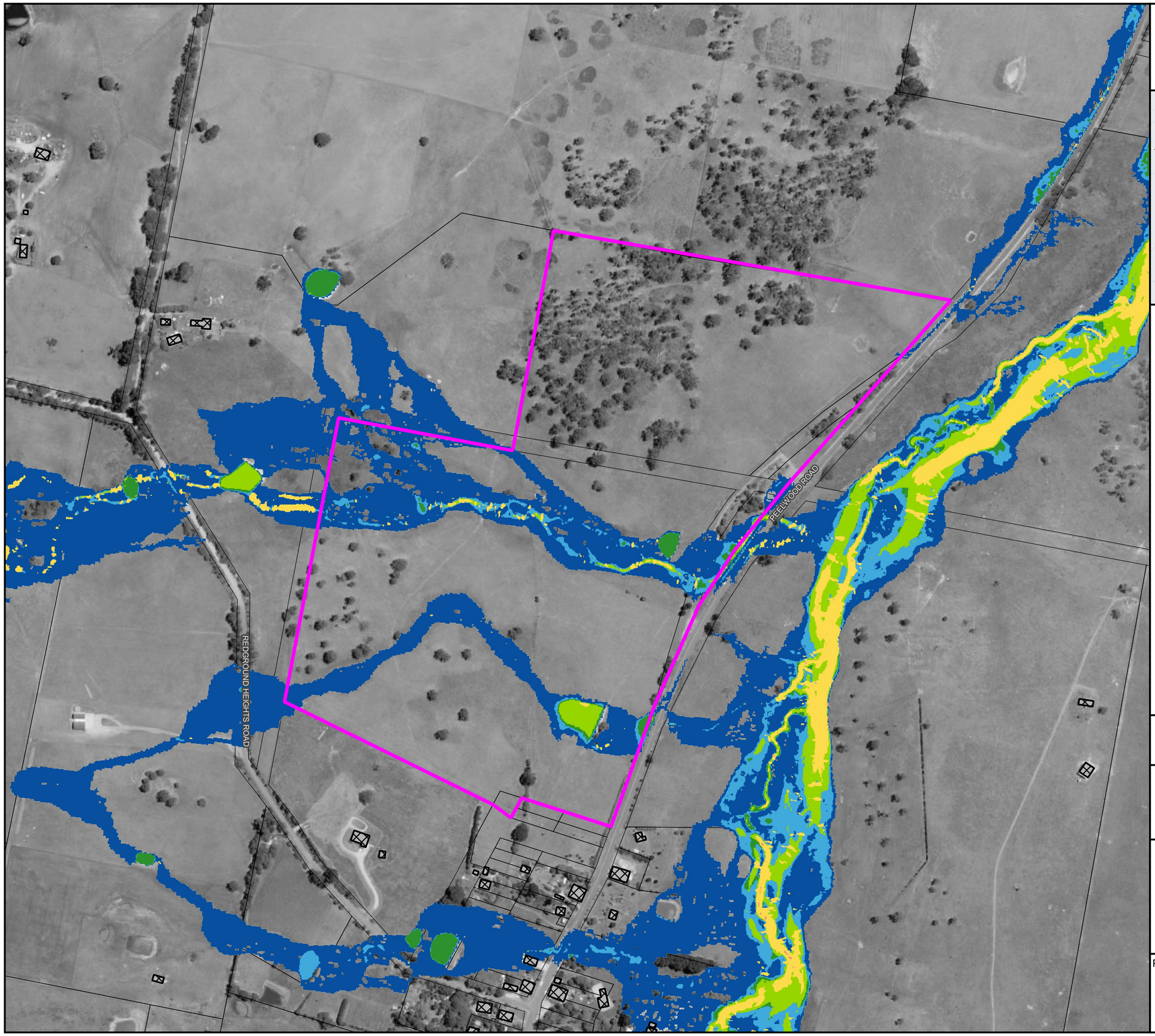

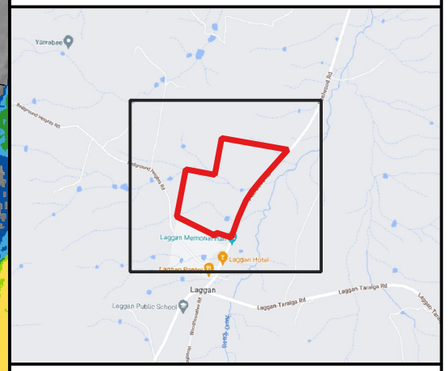

LEGEND

- Site Boundary
- Existing Building Footprint

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 29 :
Flood Hazard for the 2% AEP Flood for Existing Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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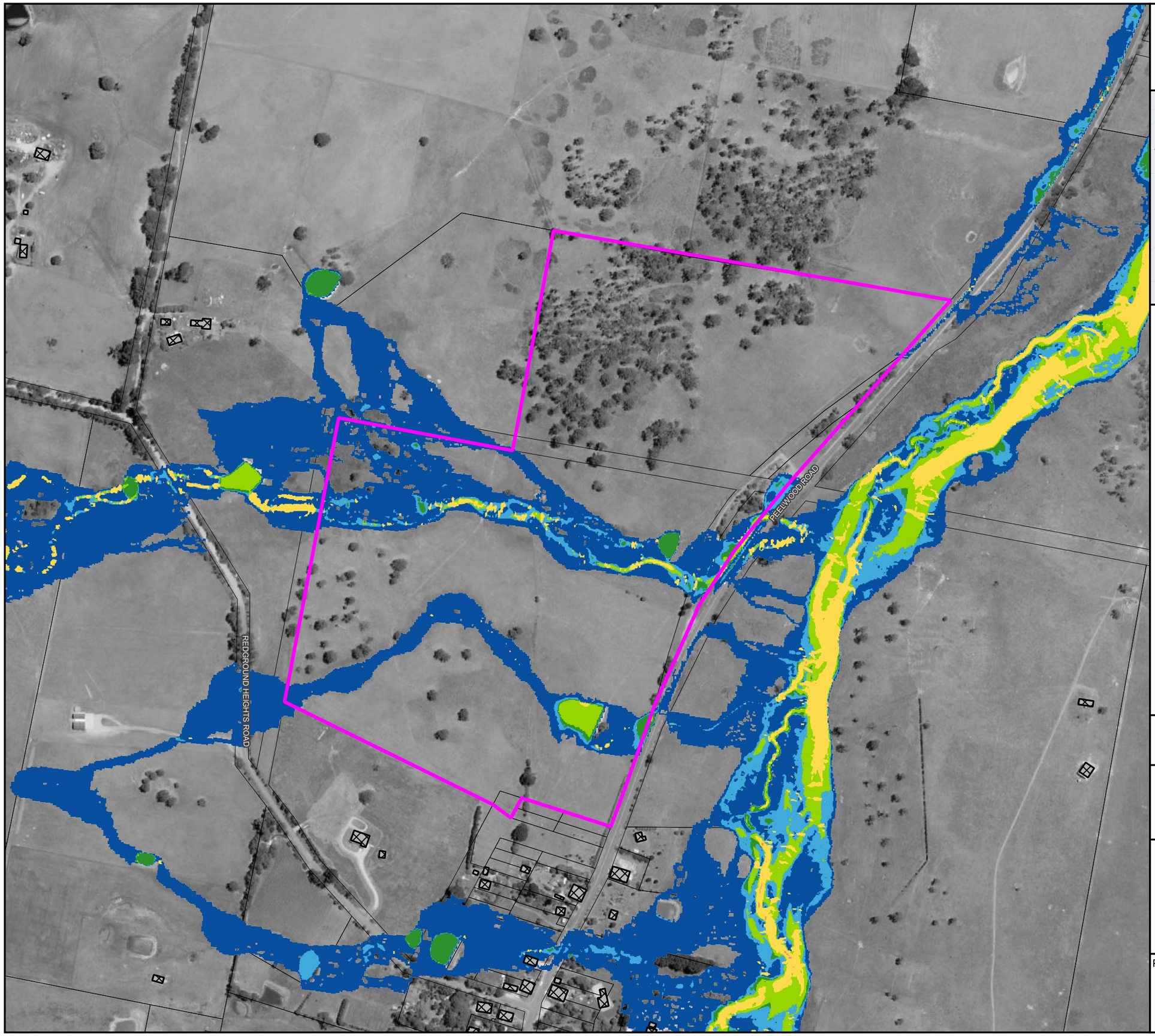

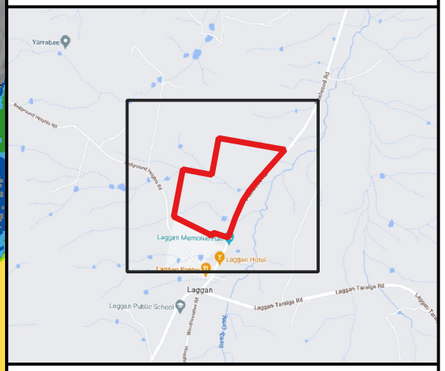

LEGEND

- Site Boundary
- Existing Building Footprint

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 30 :
Flood Hazard for the 1% AEP Flood for Existing Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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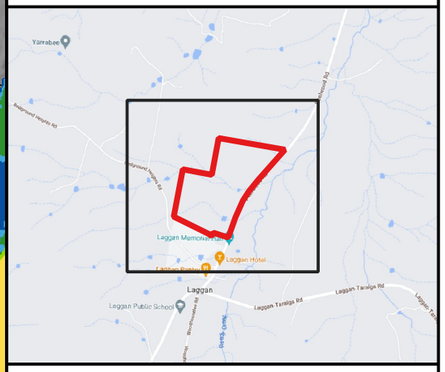
PEELWOOD ROAD

REDGROUND HEIGHTS ROAD



LEGEND

- Site Boundary
- Existing Building Footprint

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 31 :
Flood Hazard for the 0.5% AEP Flood for Existing Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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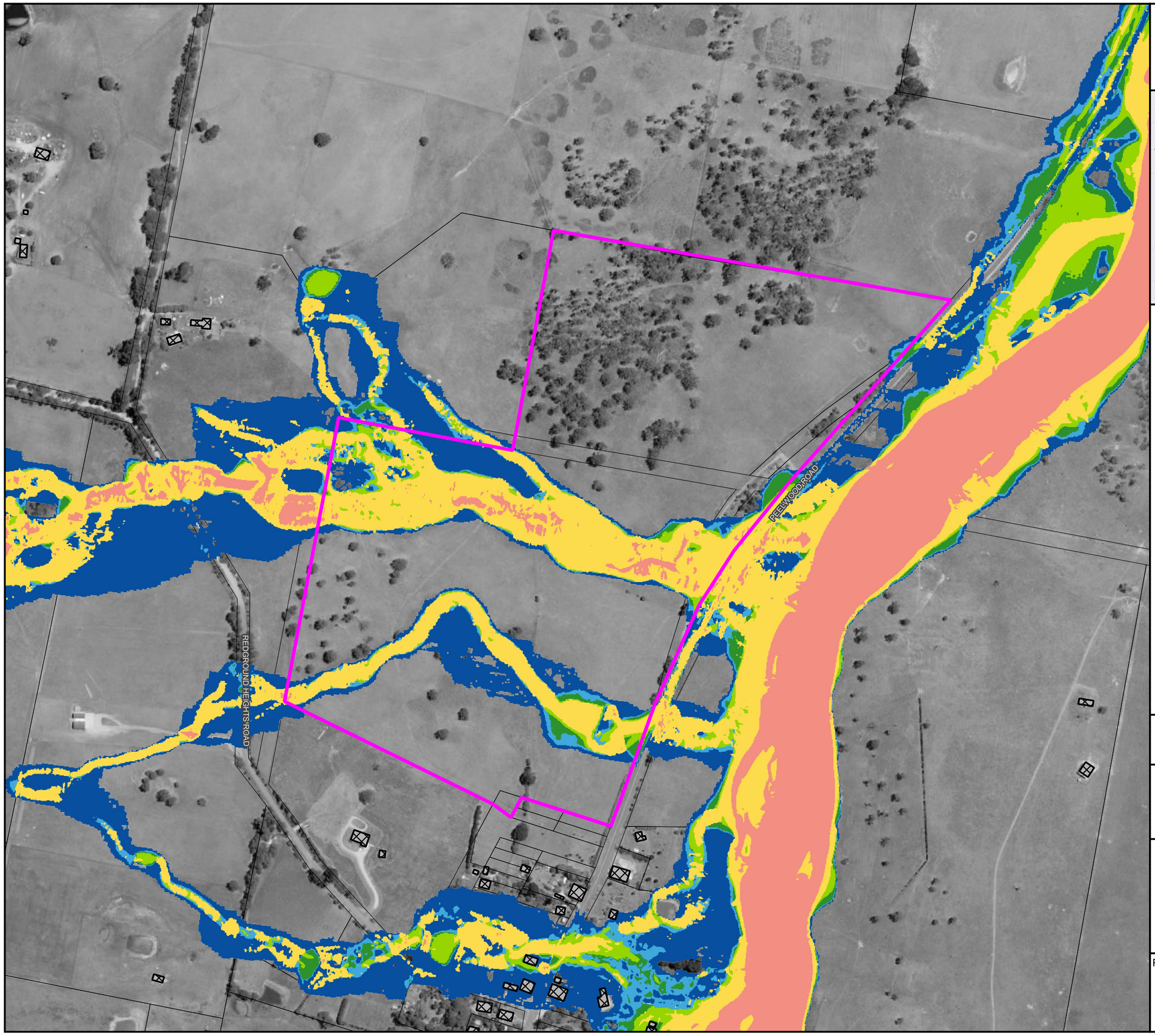

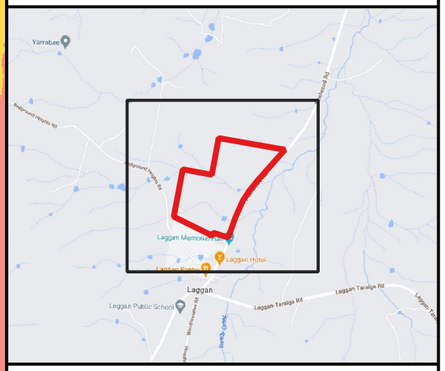

LEGEND

- Site Boundary
- Existing Building Footprint

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 32 :
Flood Hazard for the PMF for Existing Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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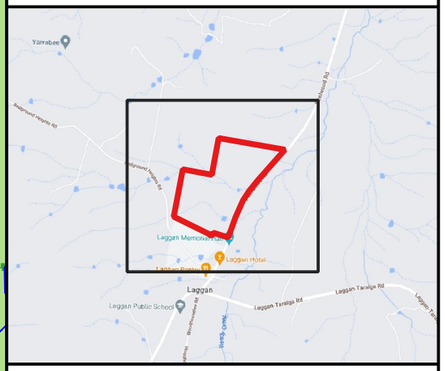

LEGEND

- Site Boundary
- TUFLOW model extent
- Culverts (Not To Scale)
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone

Materials

- Grass/ Open Area
- Trees
- Waterbodies
- Buildings
- Impervious

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 33 :
Post-Development TUFLOW Model Development

Prepared by:
Catchment Simulation Solutions
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Sydney, NSW, 2000

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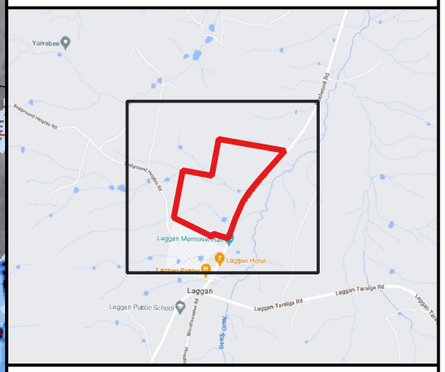

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 34 :
Peak Floodwater Depths and Levels for the 63.2% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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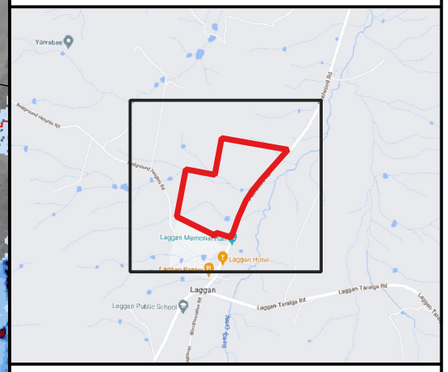

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 35 :
Peak Floodwater Depths and Levels for the 50% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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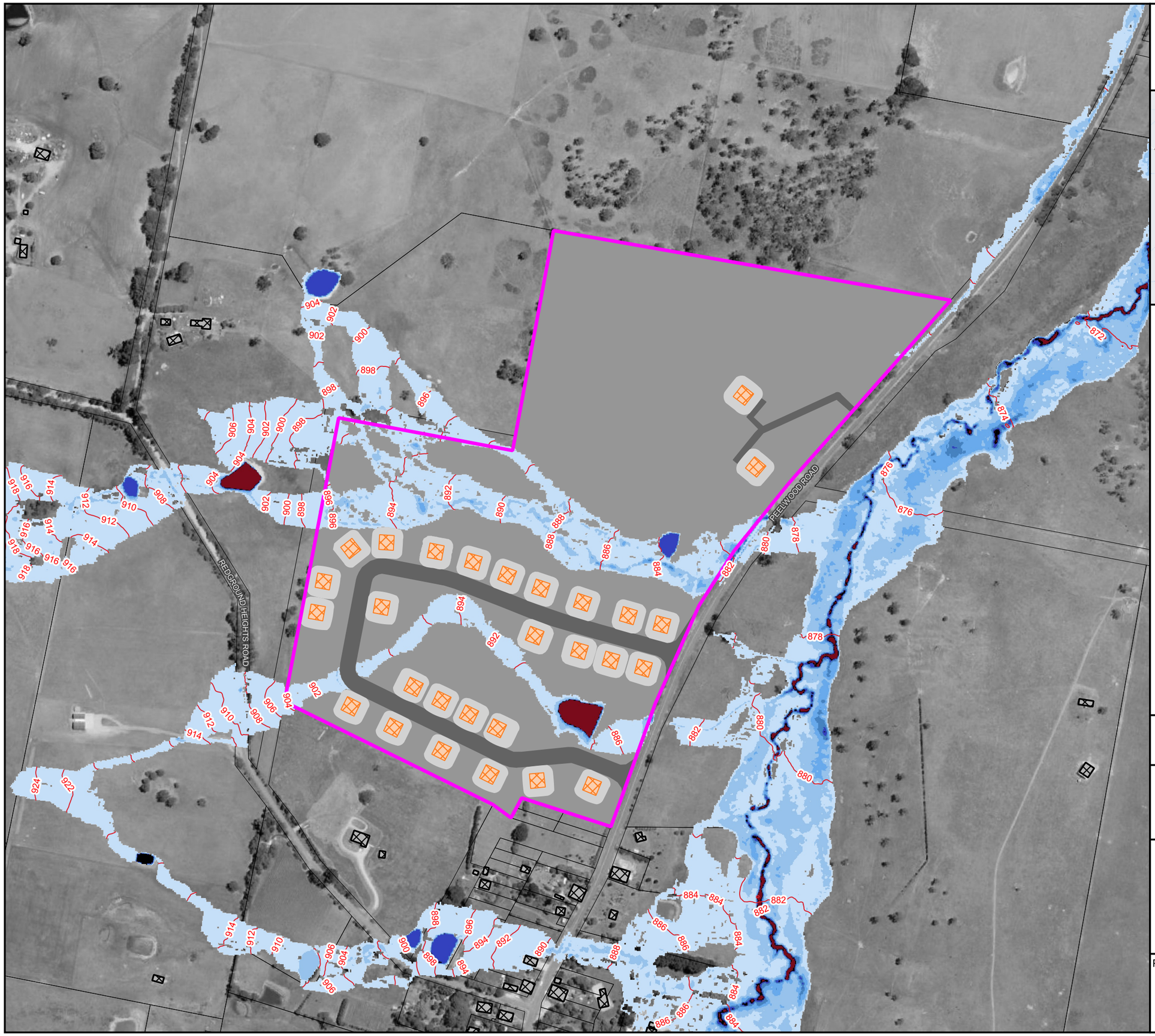

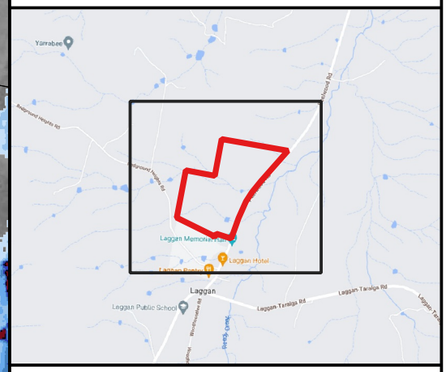

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 36 :
Peak Floodwater Depths and Levels for the 20% AEP Flood for Proposed Conditions

Prepared by:

Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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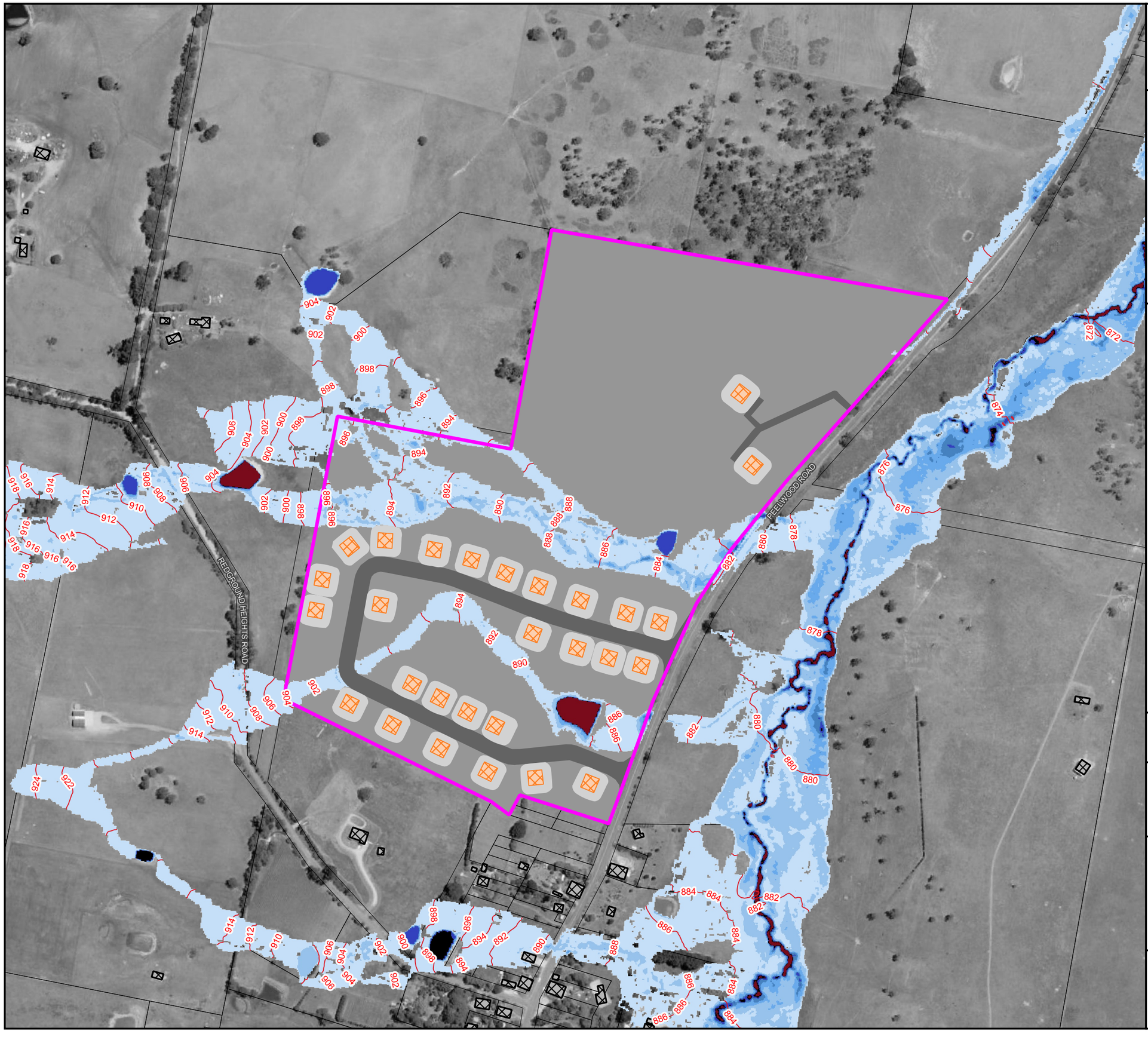

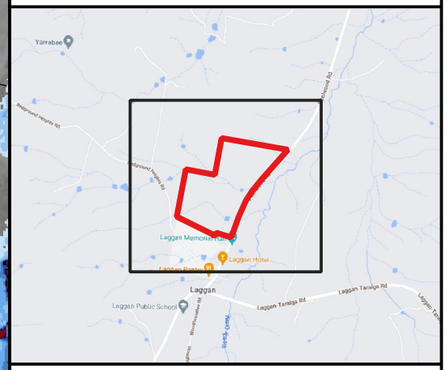

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 37 :
Peak Floodwater Depths and Levels for the 10% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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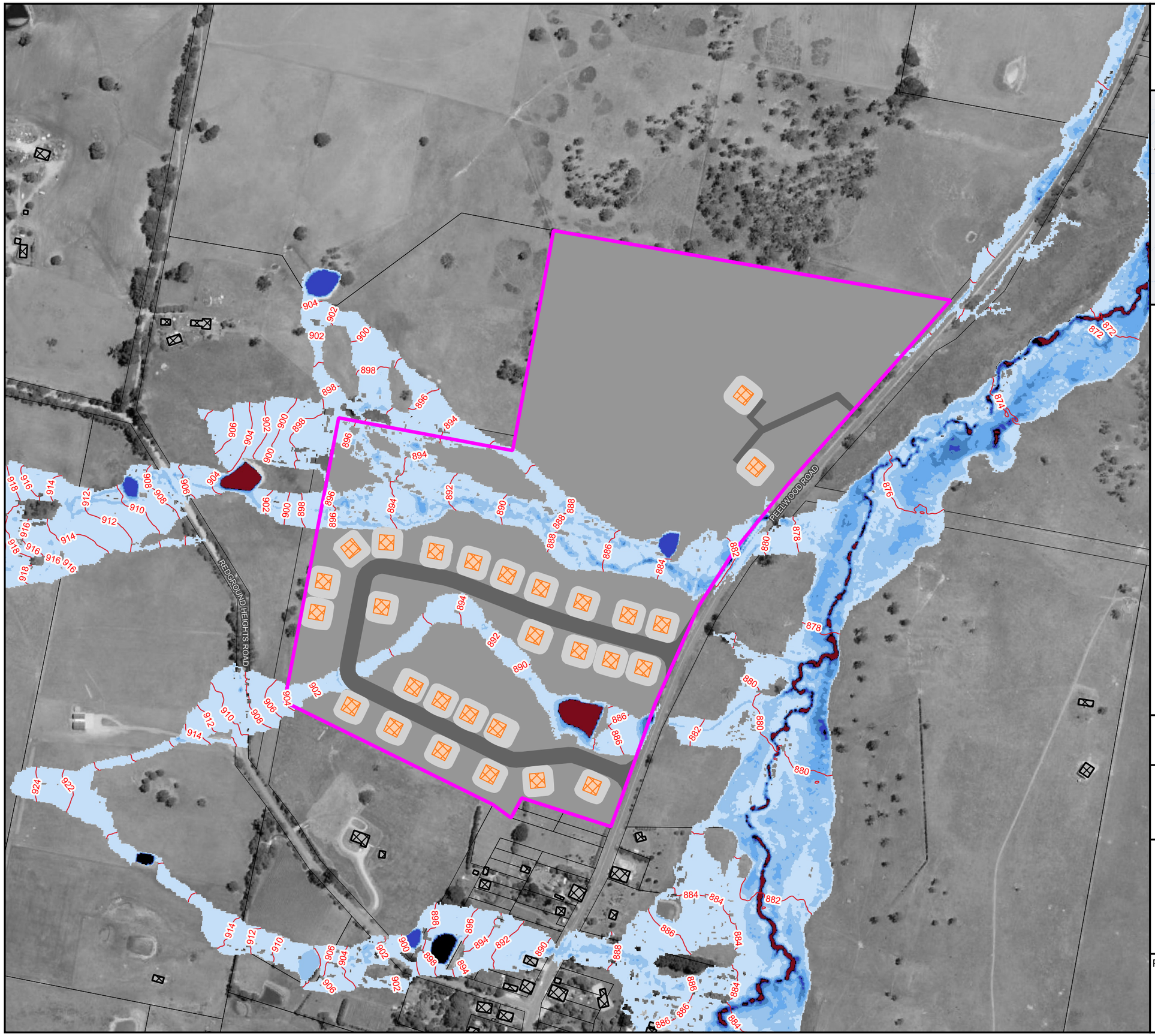

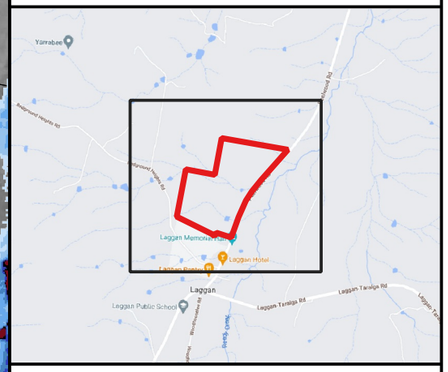

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 38 :
Peak Floodwater Depths and Levels for the 5% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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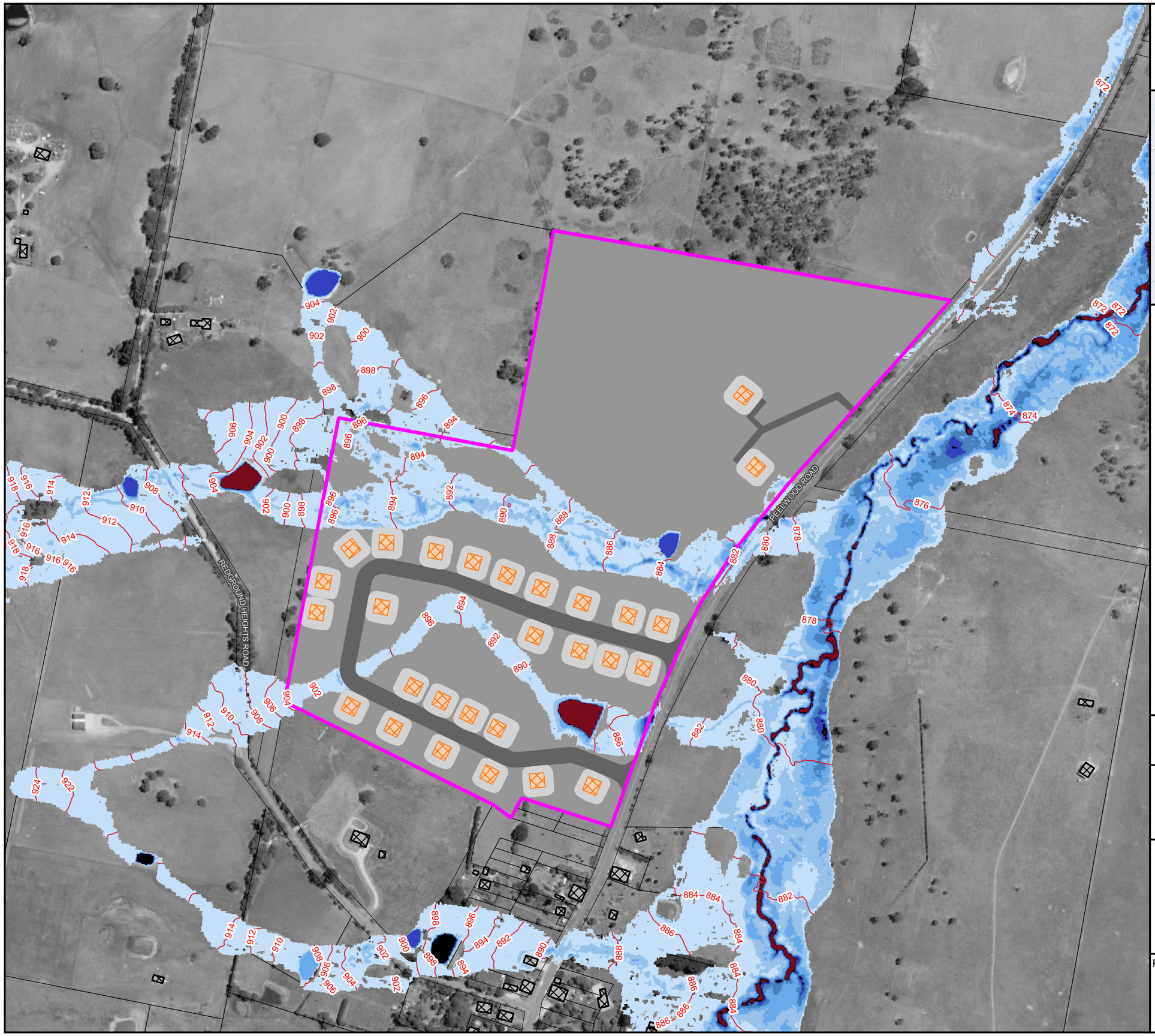

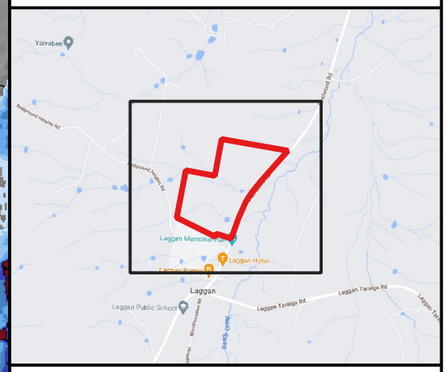

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 39 :
Peak Floodwater Depths and Levels for the 2% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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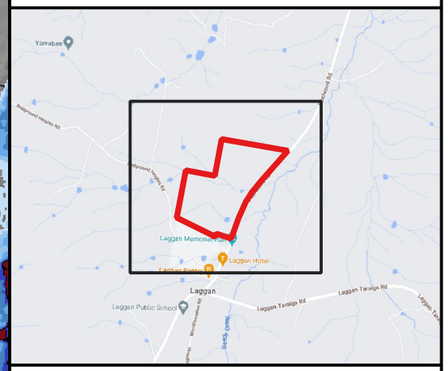
PEELWOOD ROAD

REDGROUND HEIGHTS ROAD



LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 40 :
Peak Floodwater Depths and Levels for the 1% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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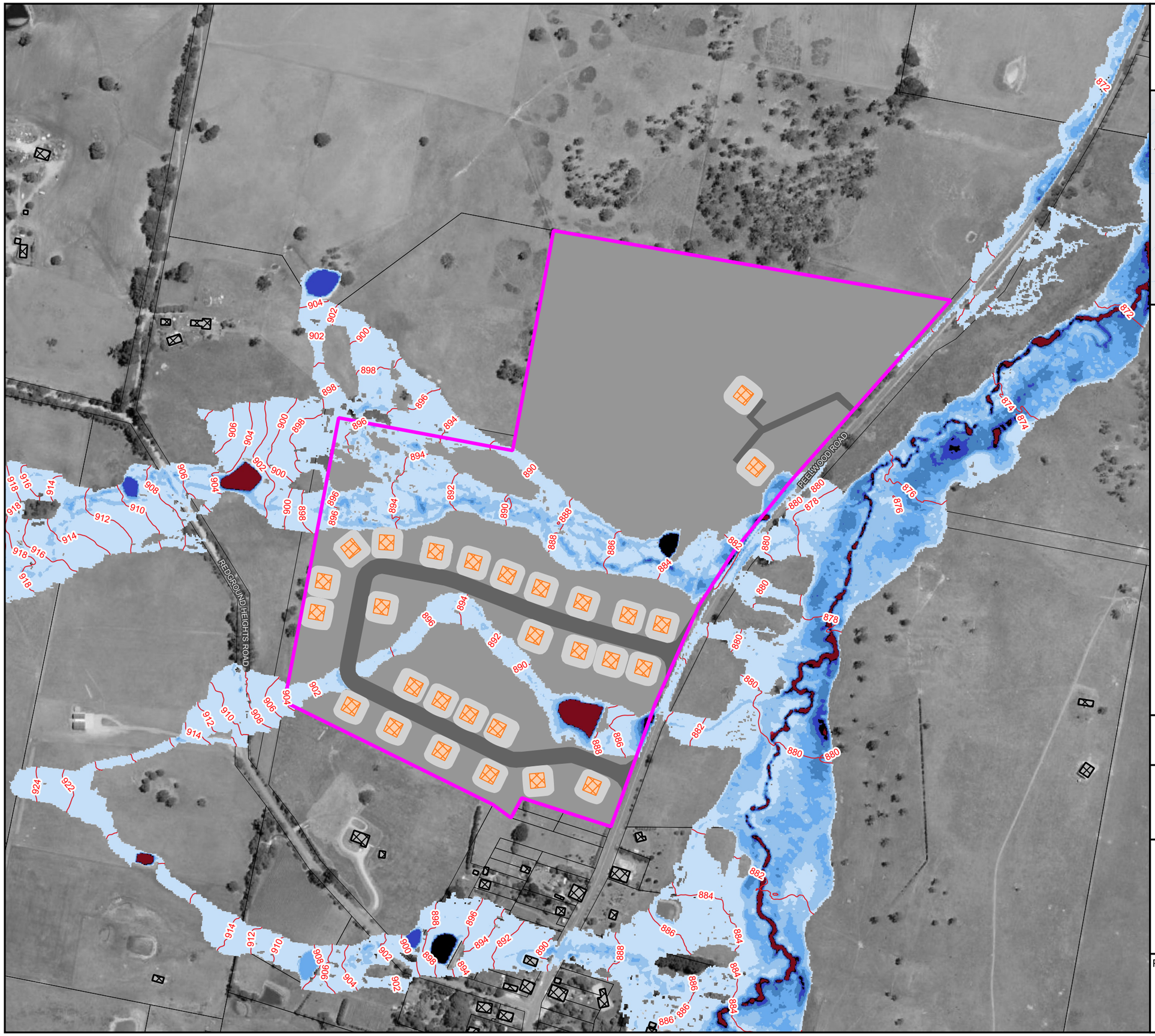

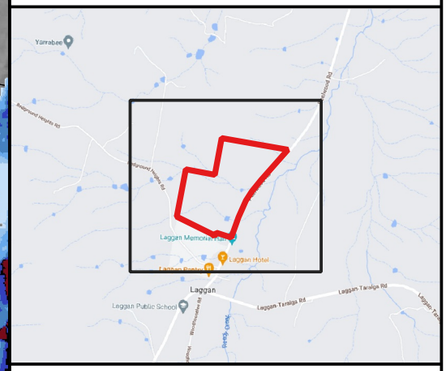

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 41 :
Peak Floodwater Depths and Levels for the 0.5% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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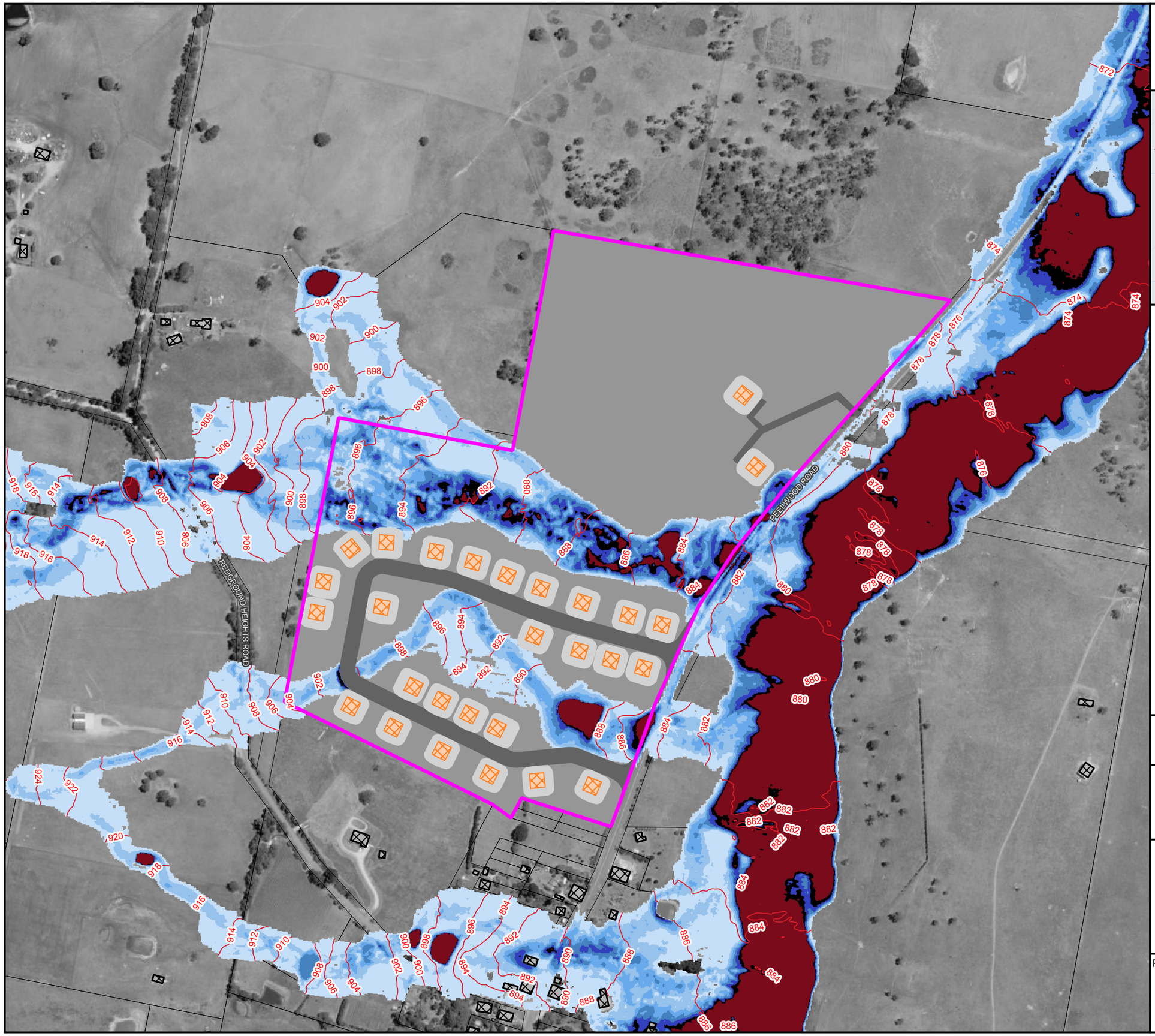
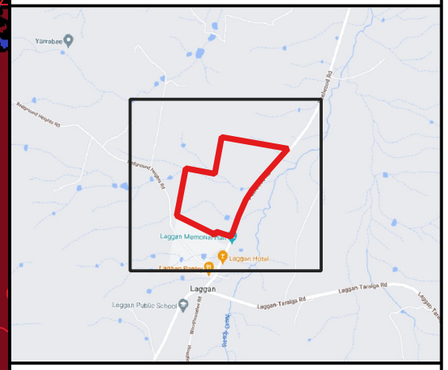




LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

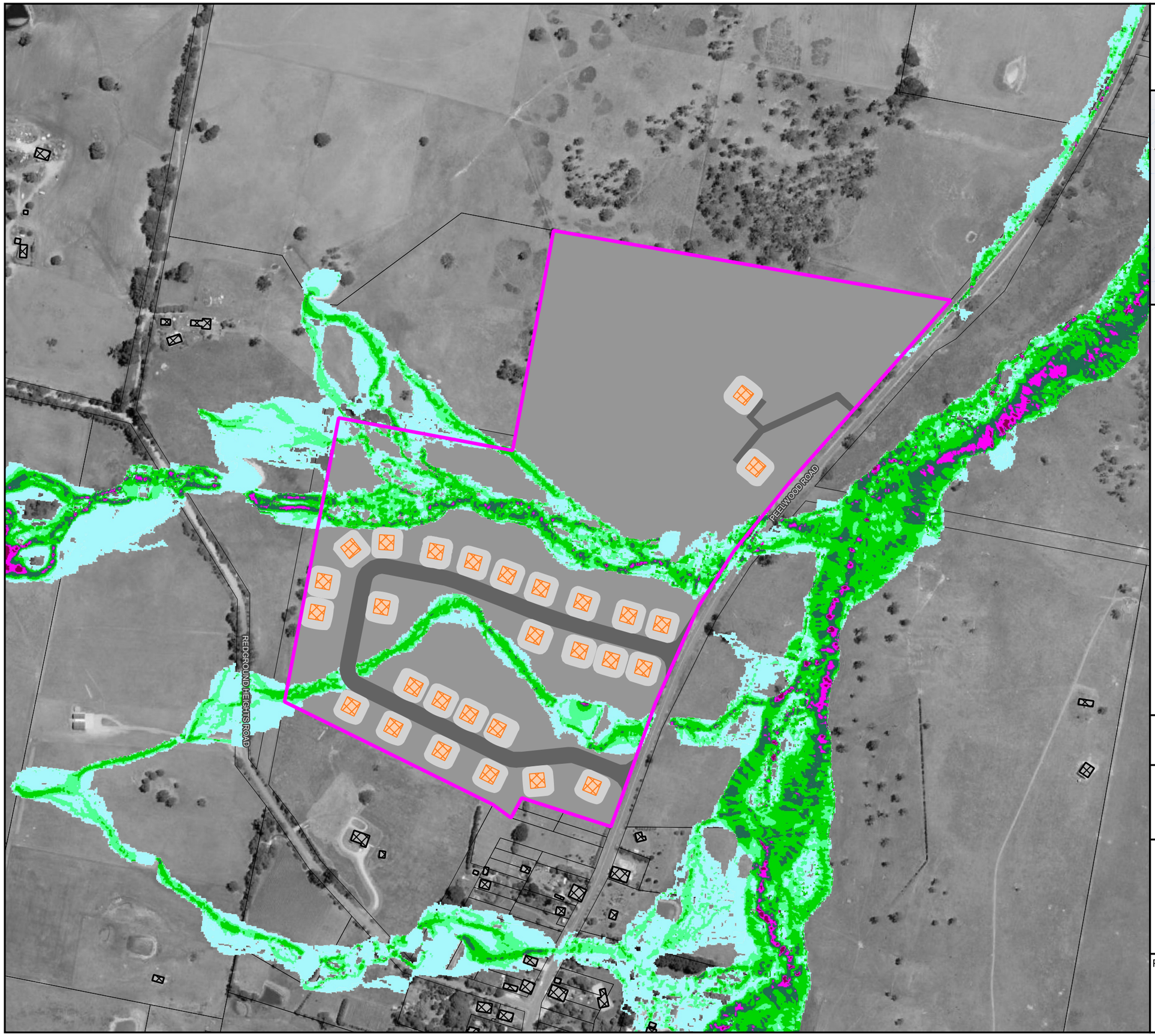
Scale: 1:5,000 (at A3)

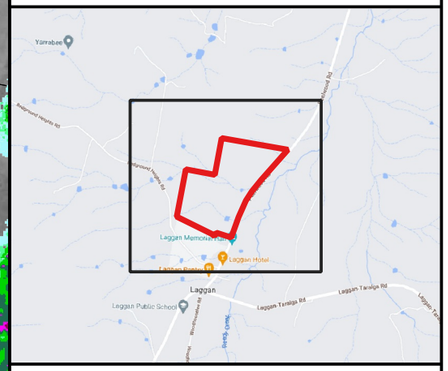
0 60 120 180 240 m

Figure 42 :
Peak Floodwater Depths and Levels for the PMF for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 43 :
Peak Flood Velocity for the 63.2% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
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Sydney, NSW, 2000

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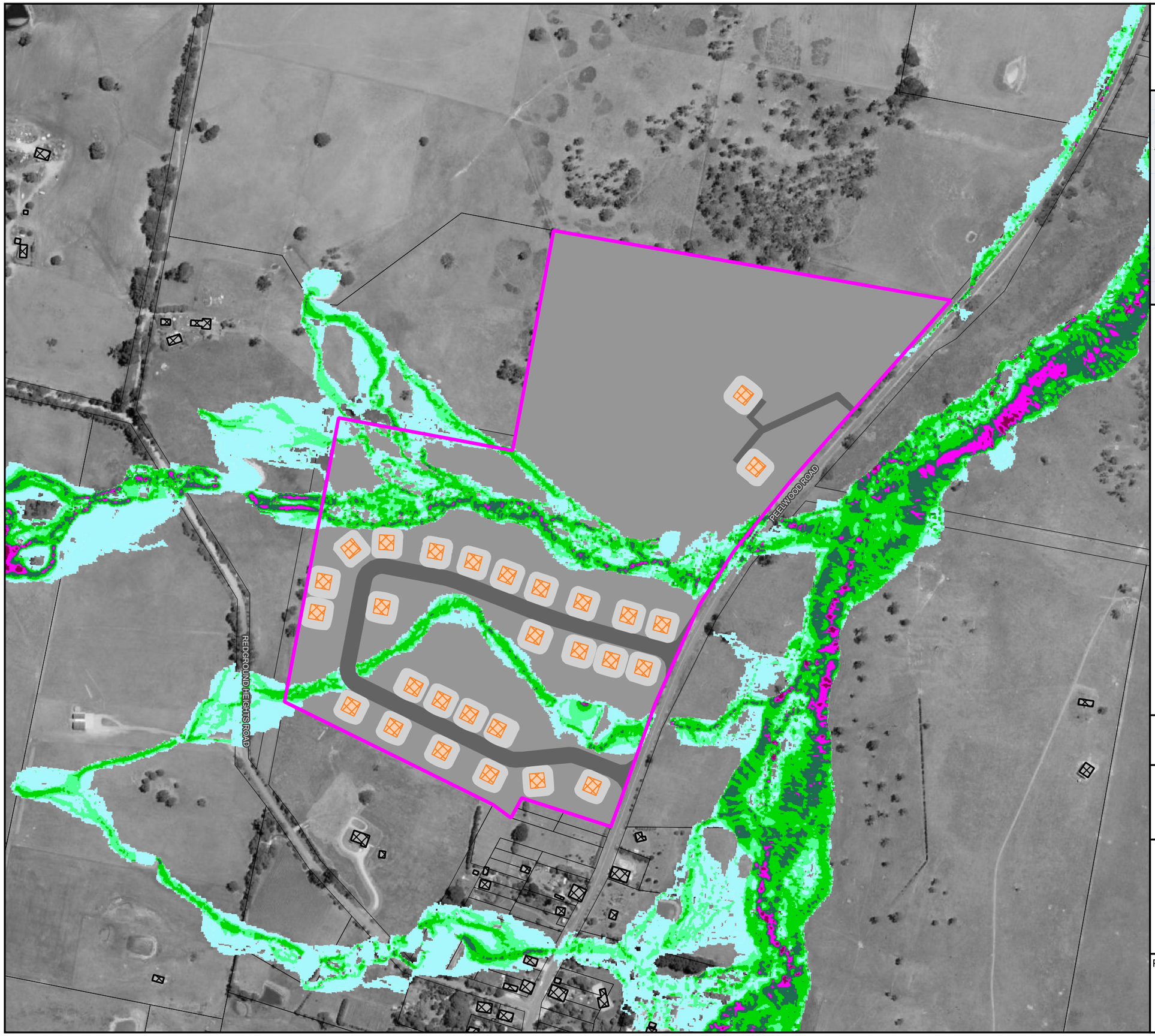

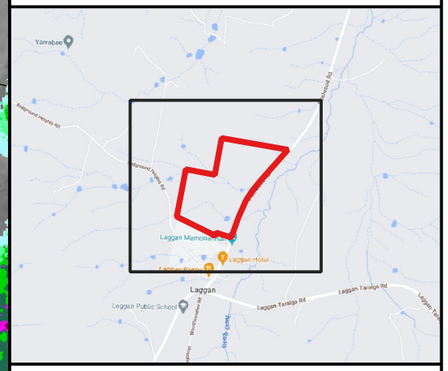

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 44 :
Peak Flood Velocity for the 50% AEP Flood for Proposed Conditions

Prepared by:
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Sydney, NSW, 2000

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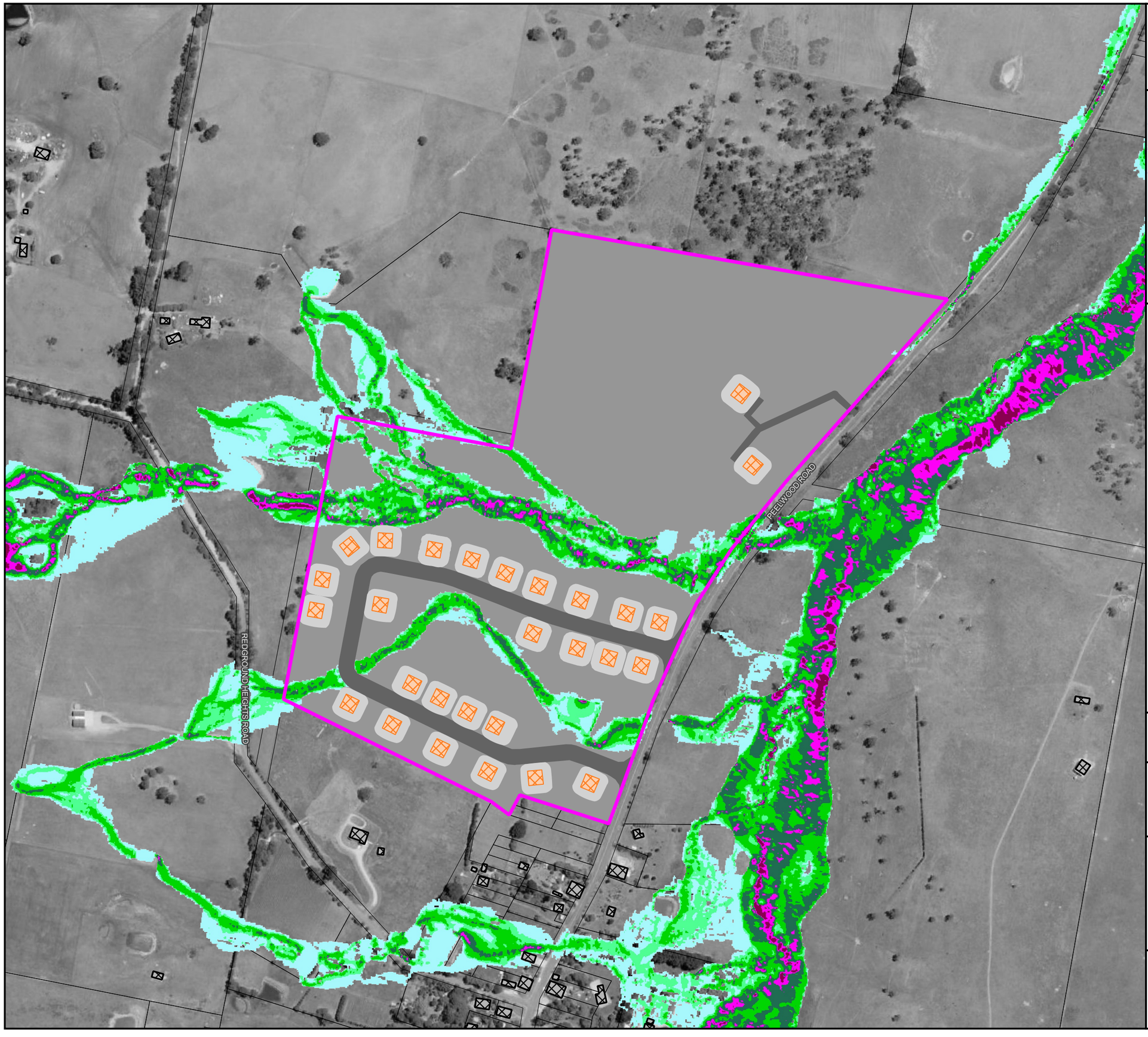

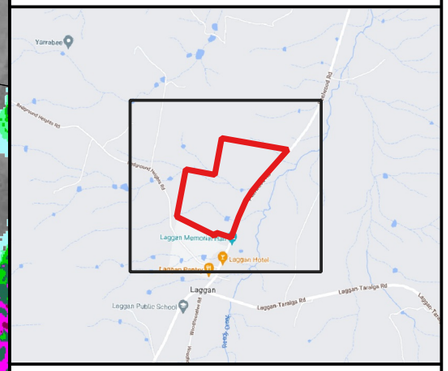

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 45 :
Peak Flood Velocity for the 20% AEP Flood for Proposed Conditions

Prepared by:

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Sydney, NSW, 2000

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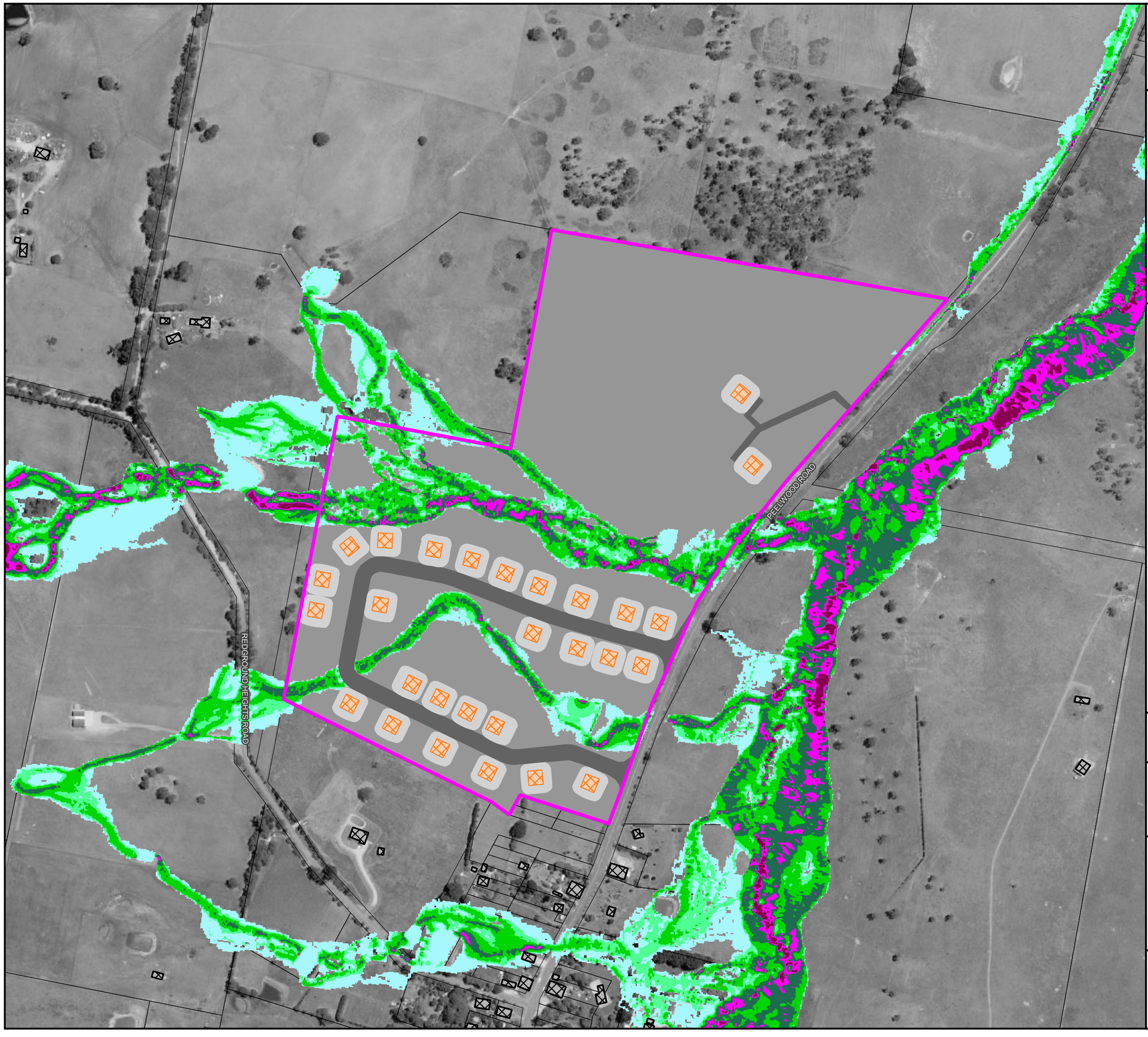

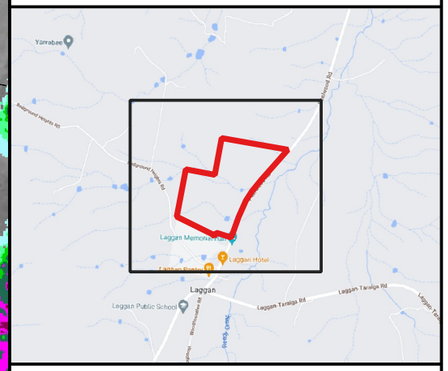

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 46 :
Peak Flood Velocity for the 10% AEP Flood for Proposed Conditions

Prepared by:

Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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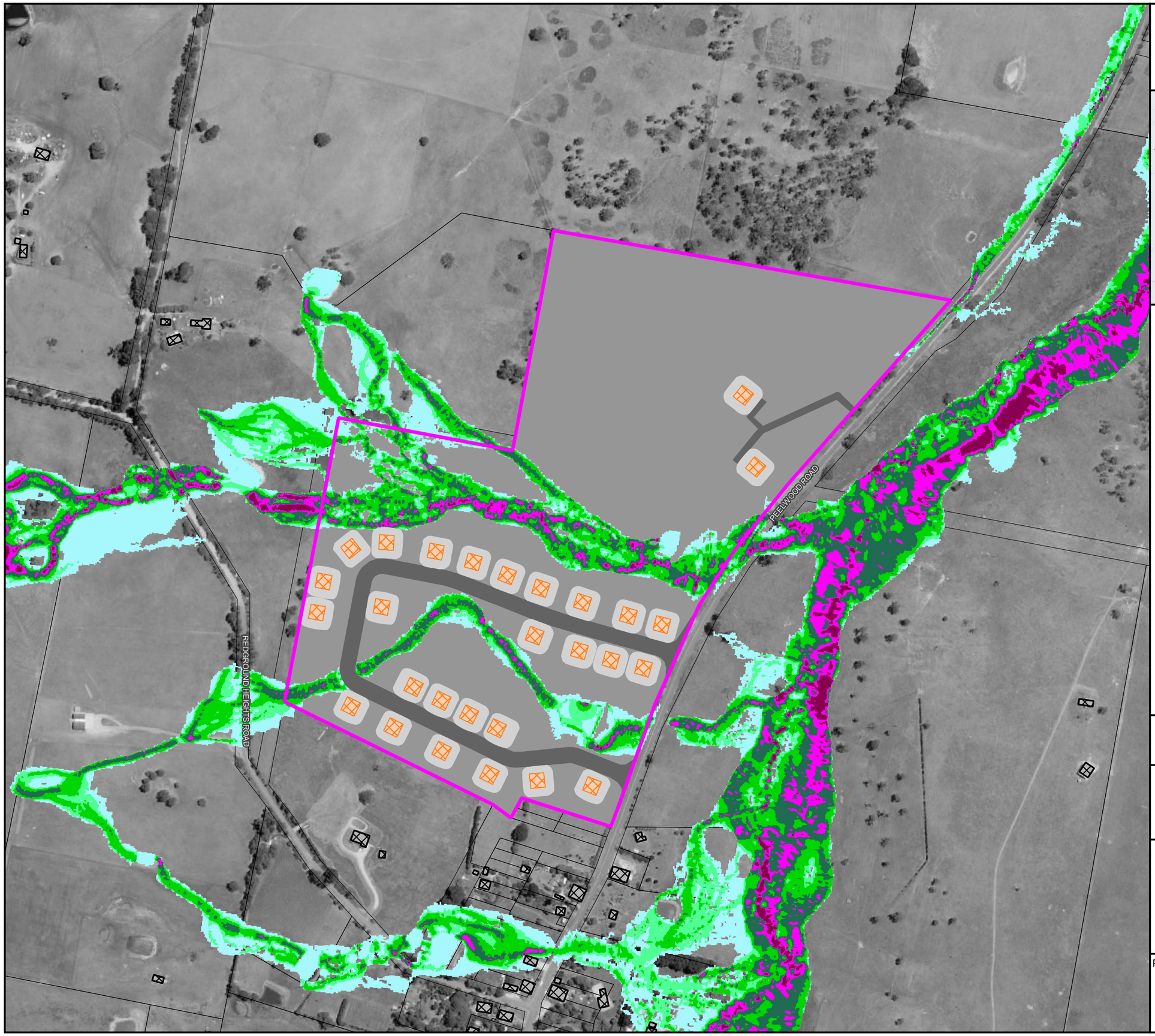
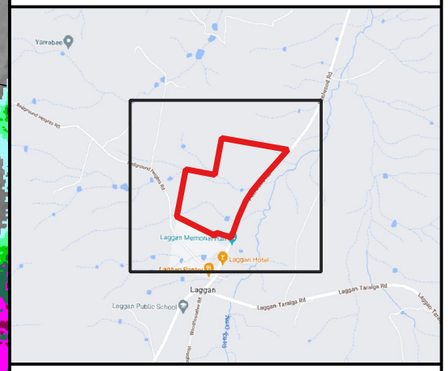




LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

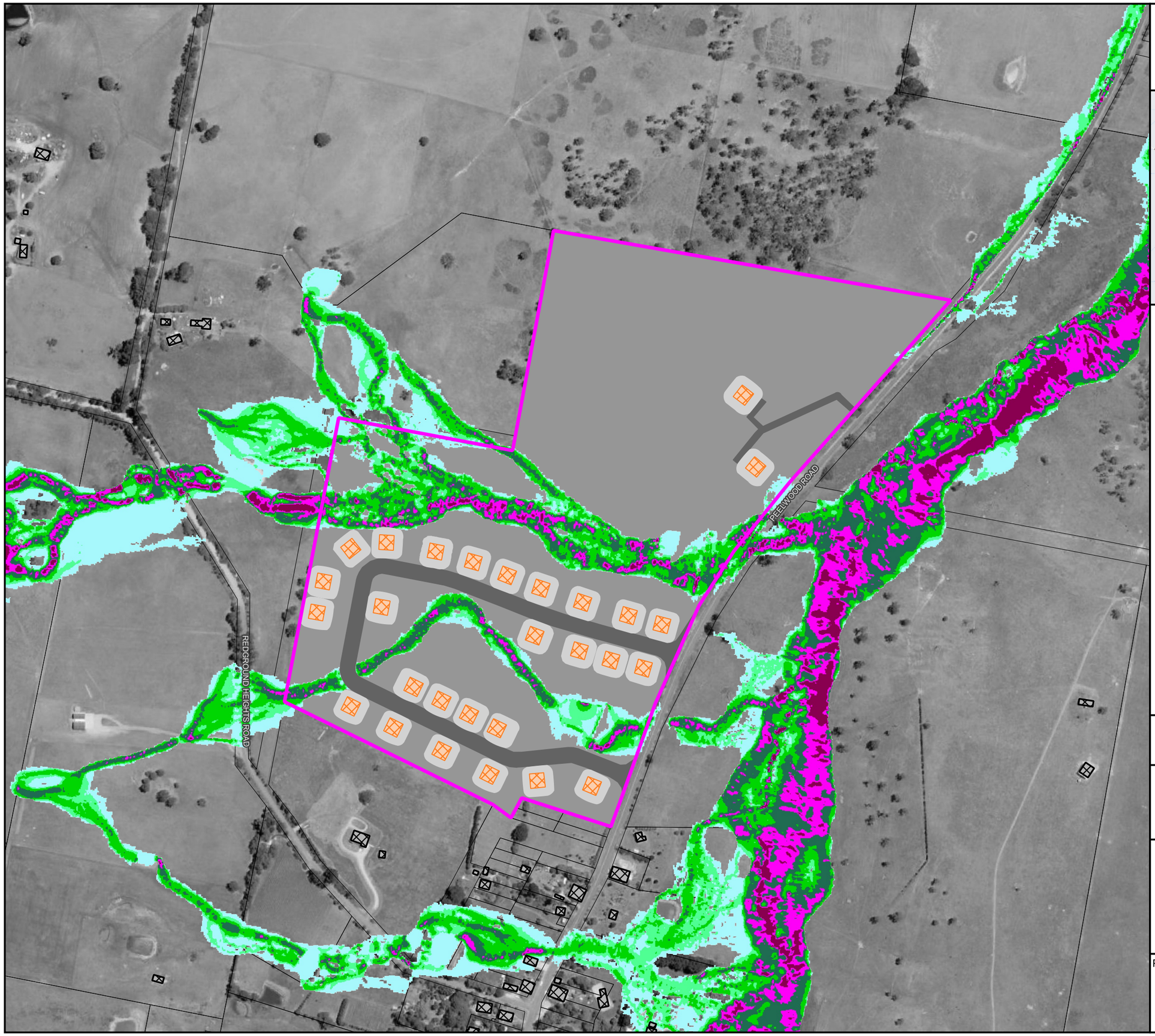
0 60 120 180 240 m

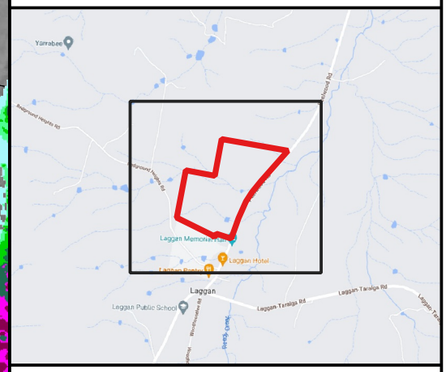
Figure 47 :
Peak Flood Velocity for the 5% AEP Flood for Proposed Conditions

Prepared by:

Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 48 :
Peak Flood Velocity for the 2% AEP Flood for Proposed Conditions

Prepared by:
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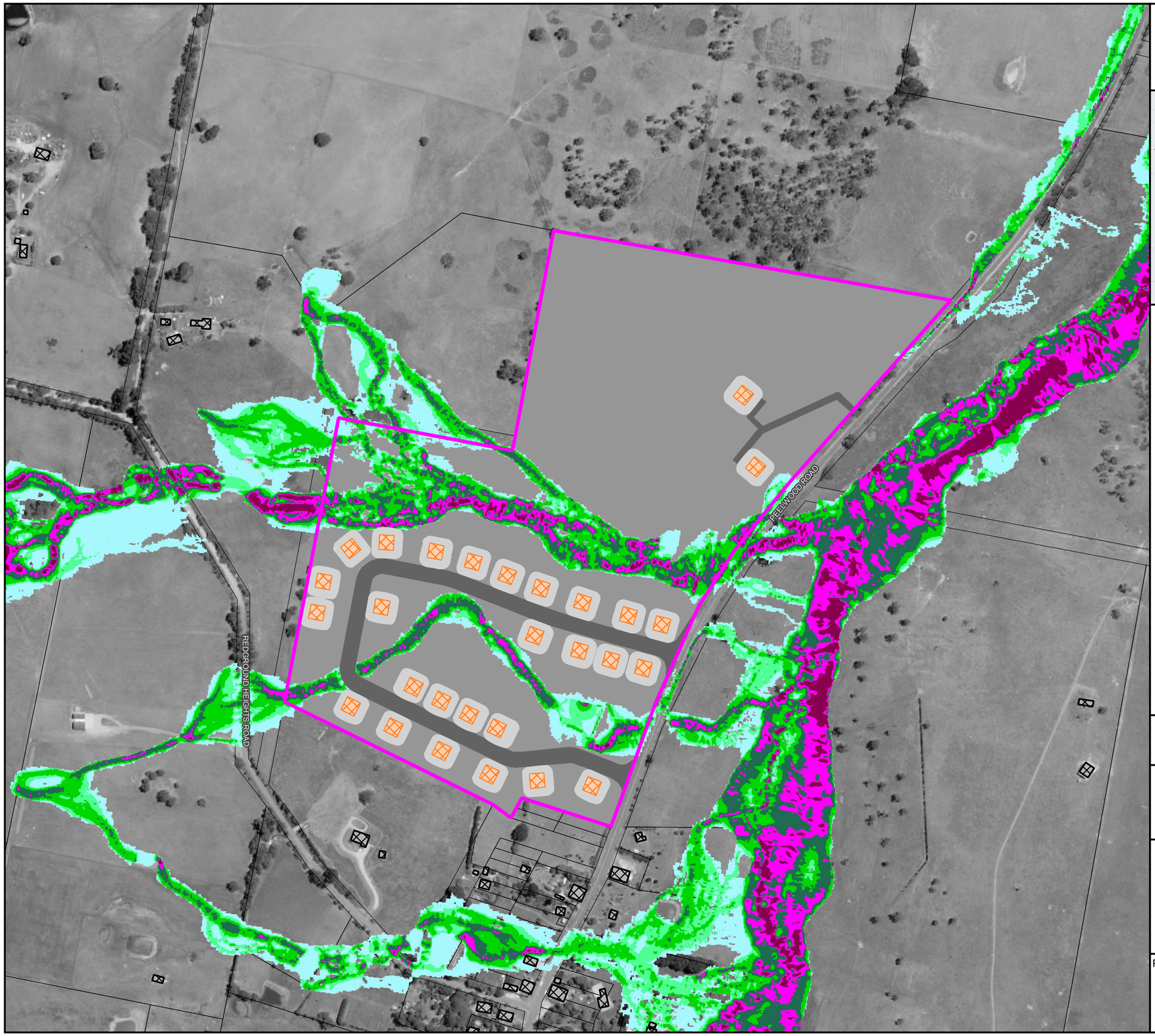
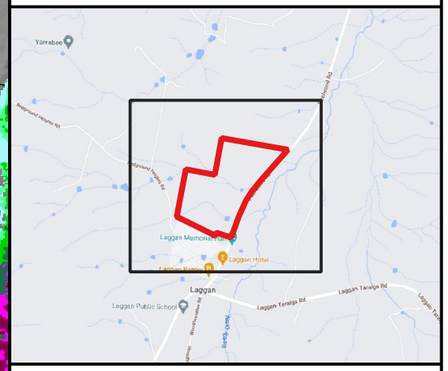
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 49 :
Peak Flood Velocity for the 1% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
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Sydney, NSW, 2000

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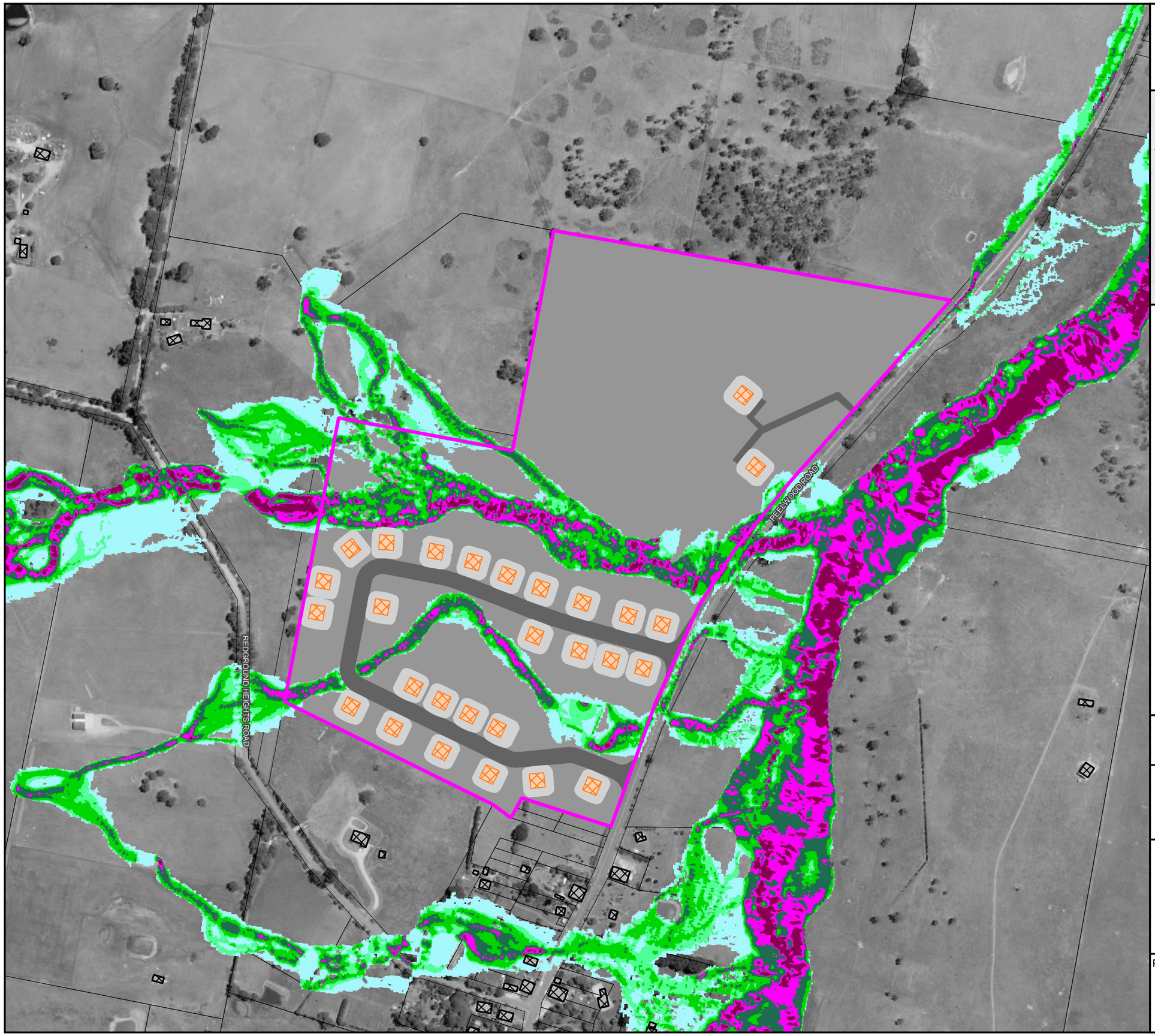

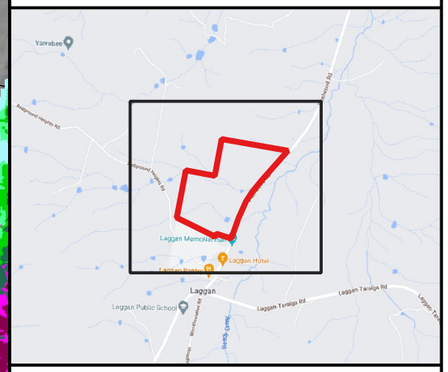

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 50 :
Peak Flood Velocity for the 0.5% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
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Sydney, NSW, 2000

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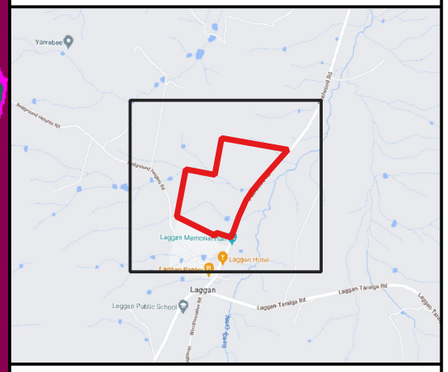

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Velocity (m/s)

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

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 51 :
Peak Flood Velocity for the PMF for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
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Sydney, NSW, 2000

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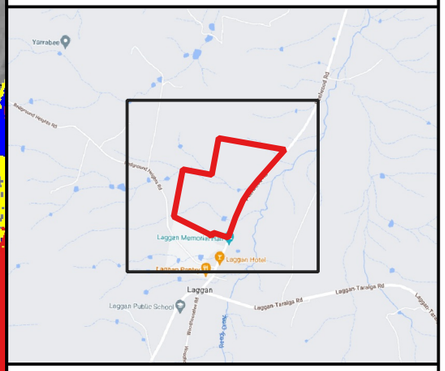
PEELWOOD ROAD

REDGROUND HEIGHTS ROAD



LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Hydraulic Categories

- Flood Fringe
- Flood Storage
- Floodway

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 52 :
Hydraulic Categories for the 1% AEP Flood for Proposed Conditions

Prepared by:

Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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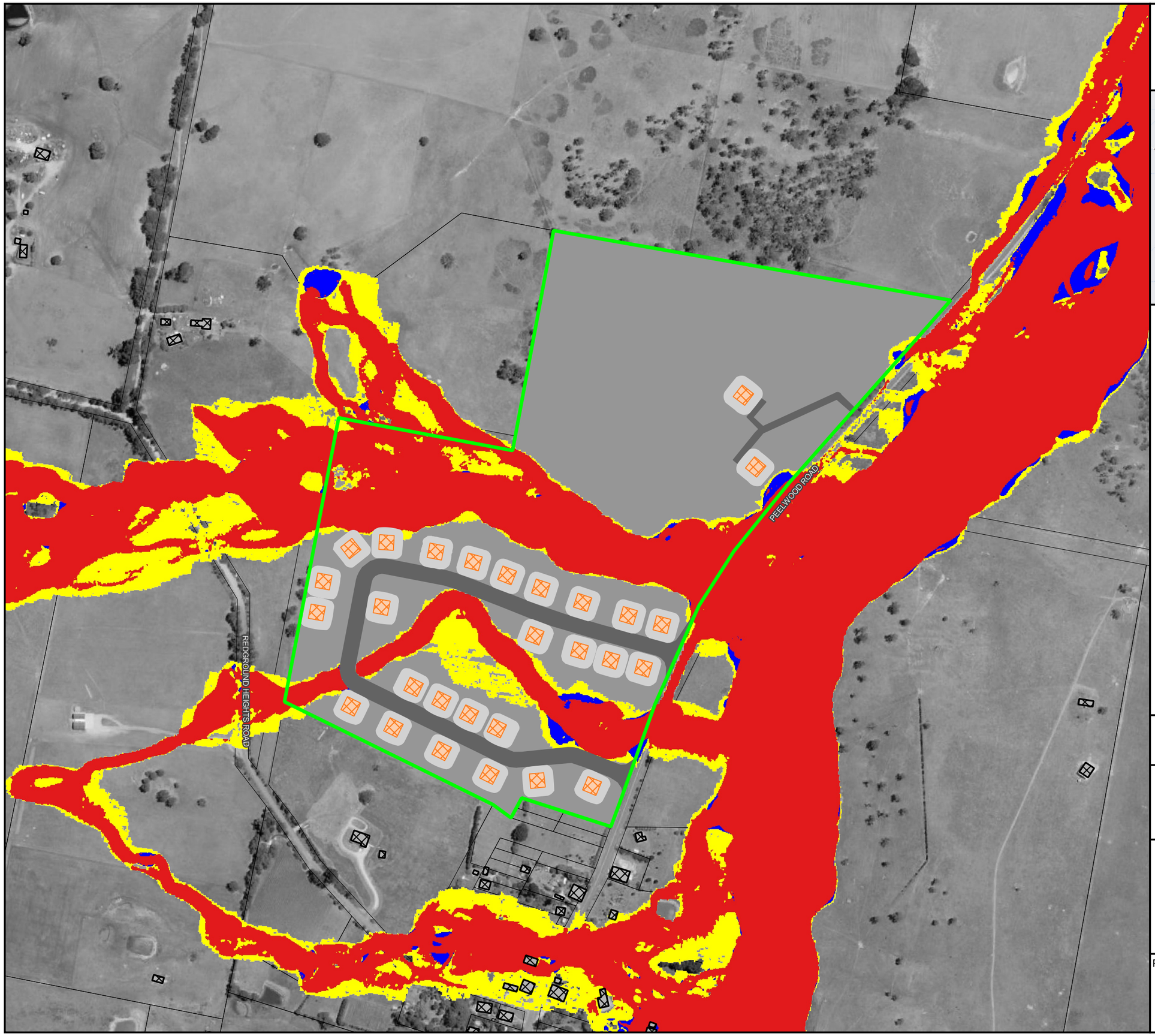
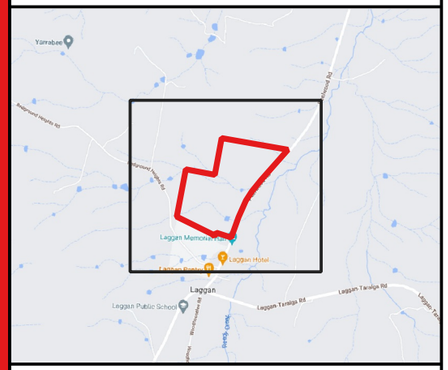




LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Hydraulic Categories

- Flood Fringe
- Flood Storage
- Floodway

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

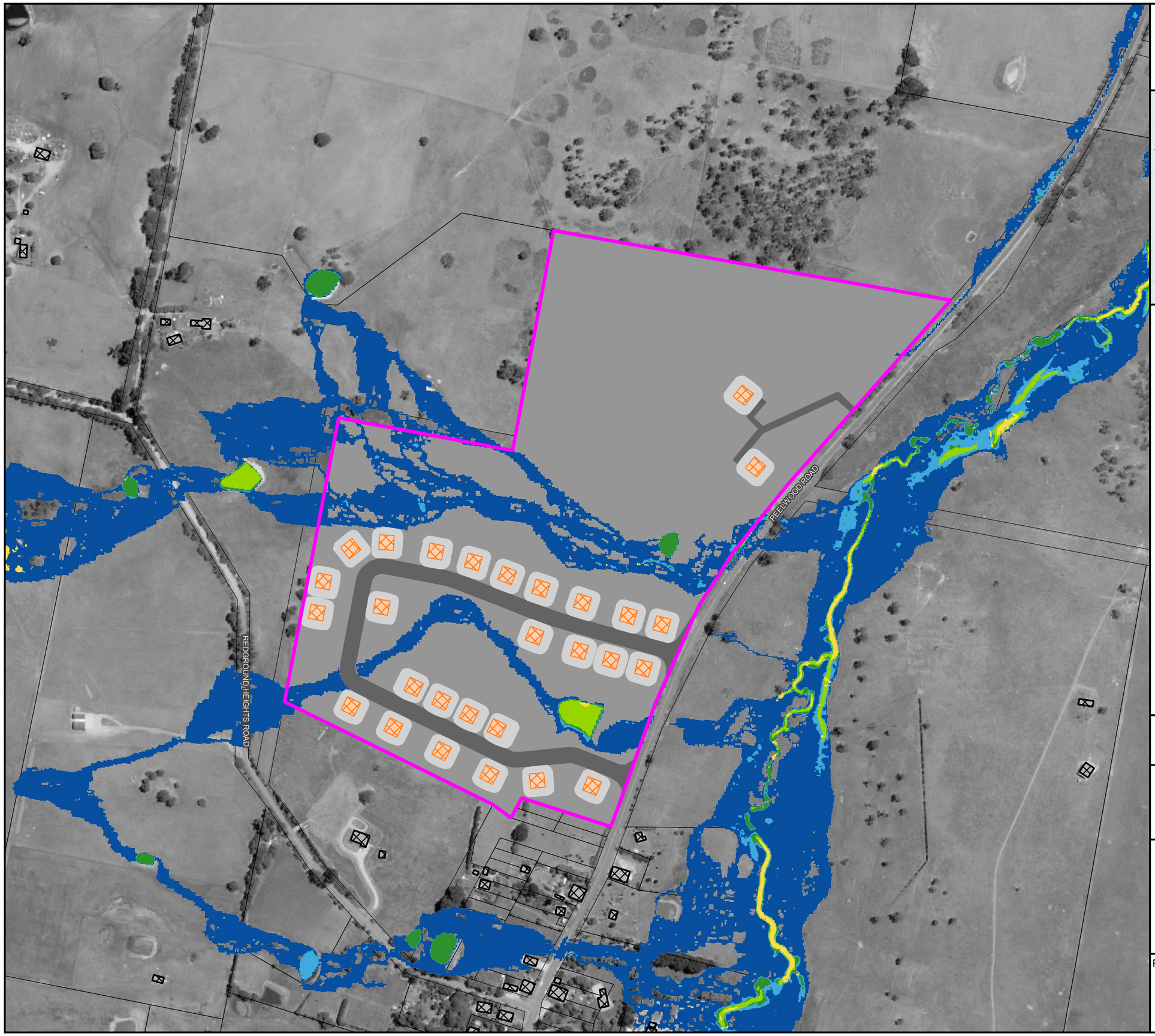
0 60 120 180 240 m

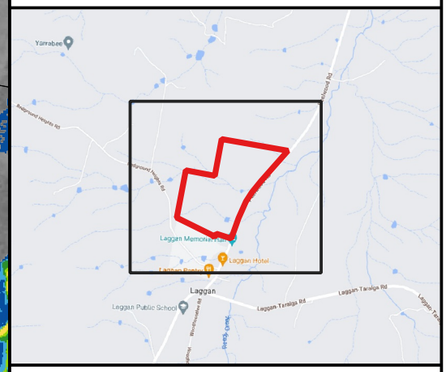
Figure 53 :
Hydraulic Categories for the PMF for Proposed Conditions

Prepared by:

Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

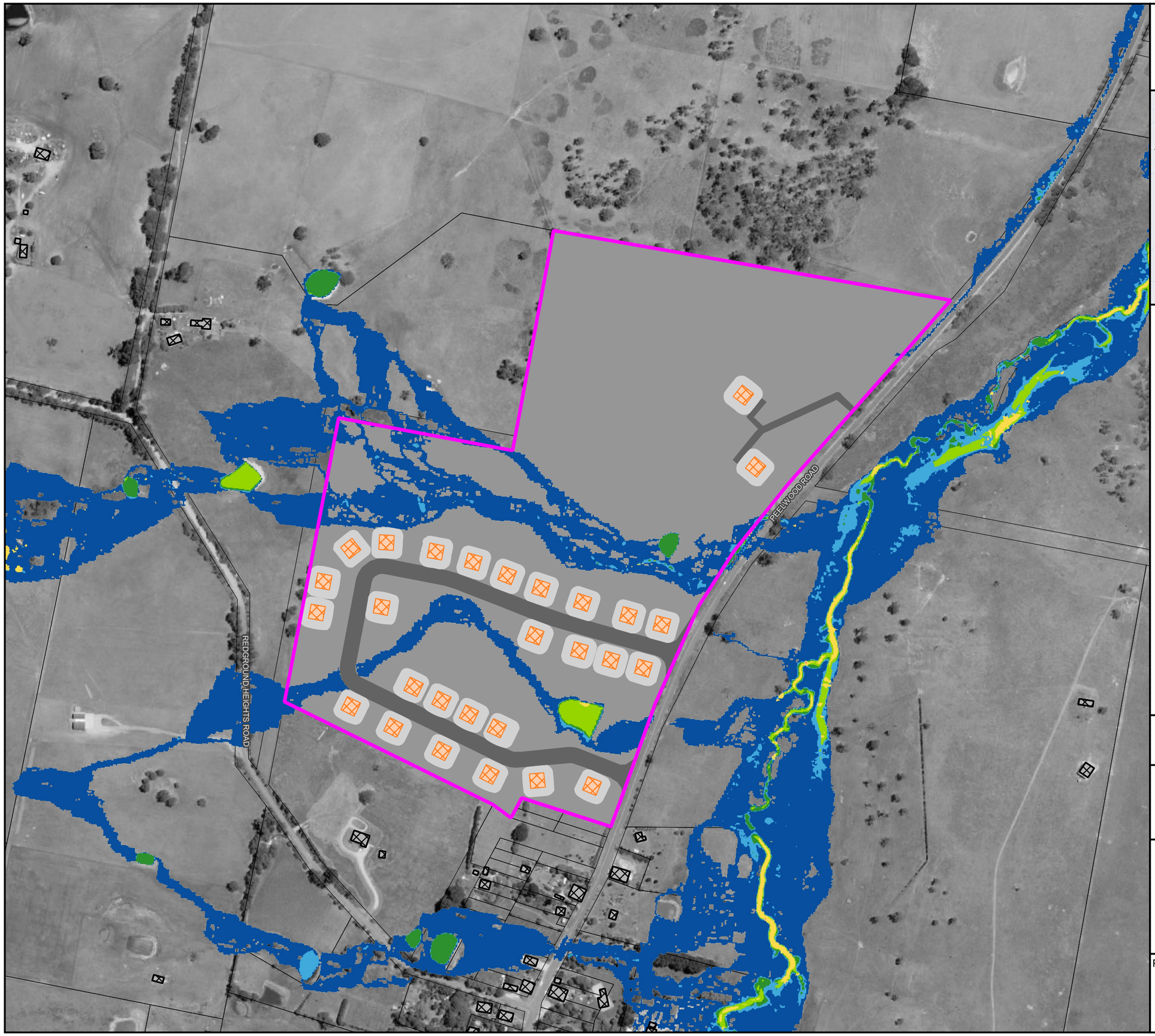
Scale: 1:5,000 (at A3)

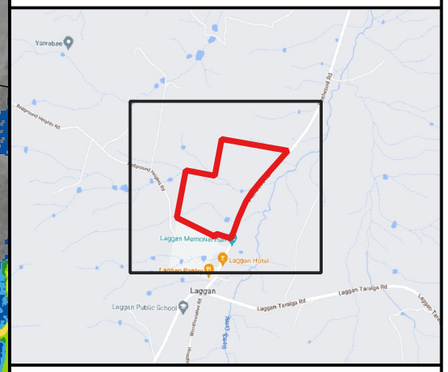
0 60 120 180 240 m

Figure 54 :
Flood Hazard for the 63.2% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

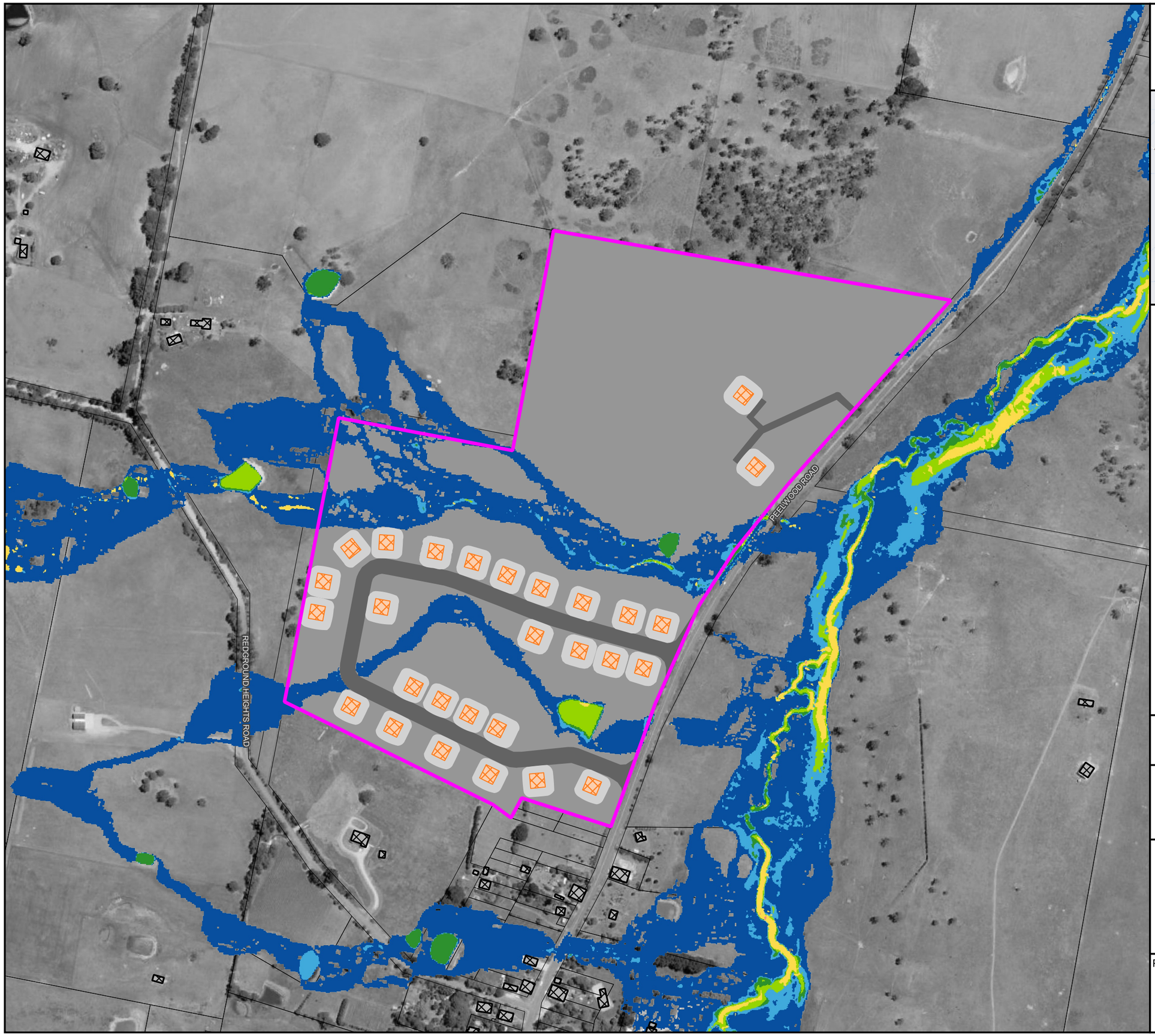
Scale: 1:5,000 (at A3)

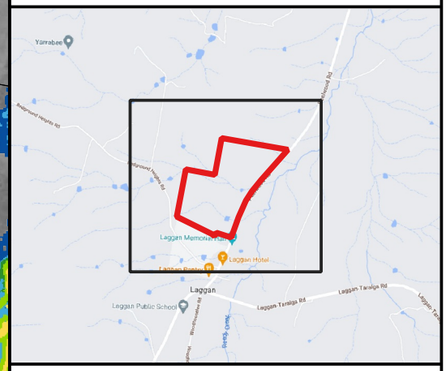
0 60 120 180 240 m

Figure 55 :
Flood Hazard for the 50% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

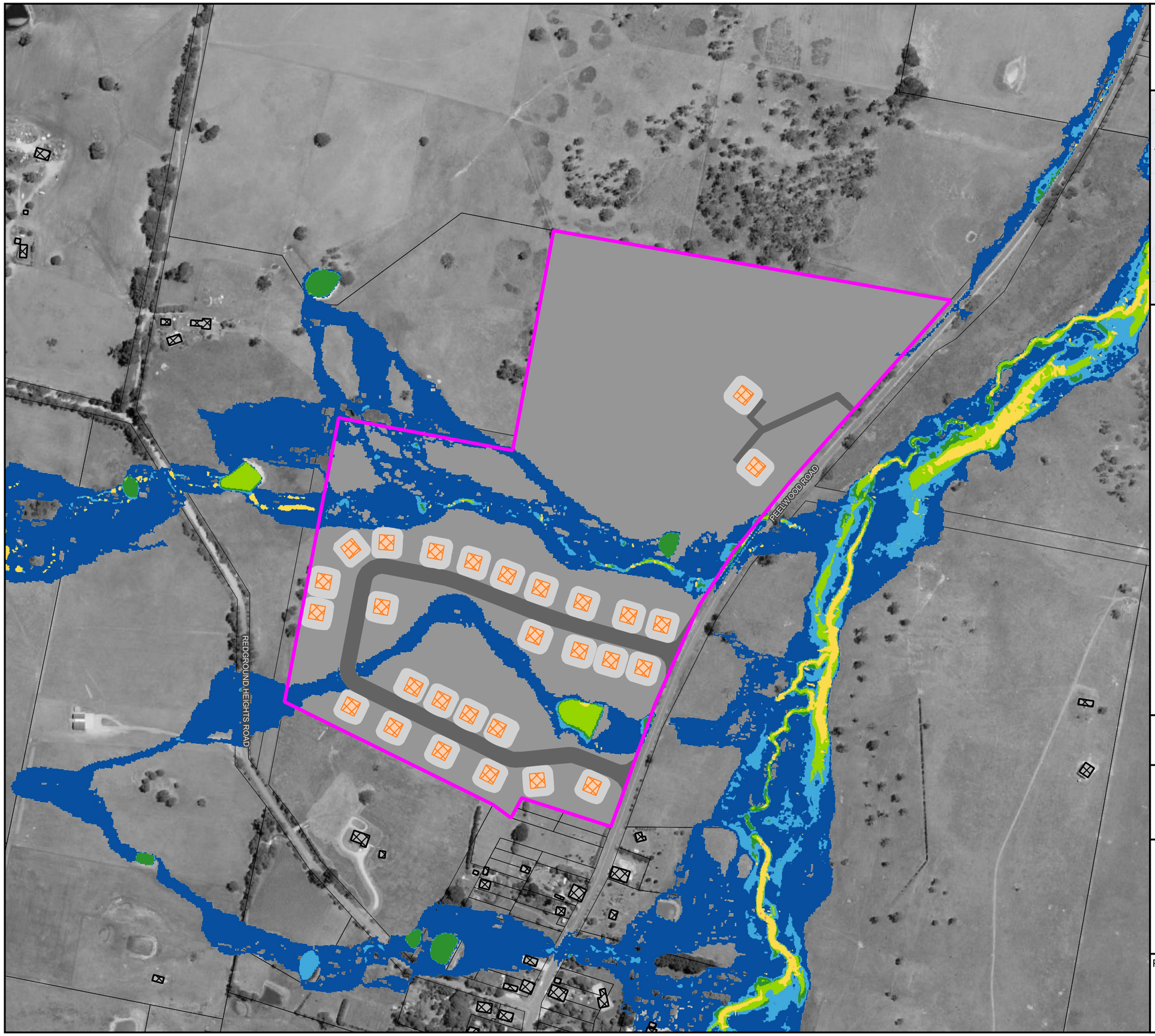
Scale: 1:5,000 (at A3)

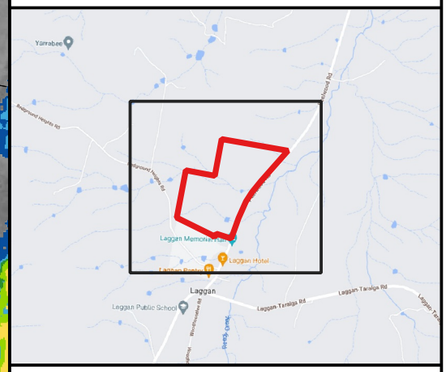
0 60 120 180 240 m

Figure 56 :
Flood Hazard for the 20% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\-Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

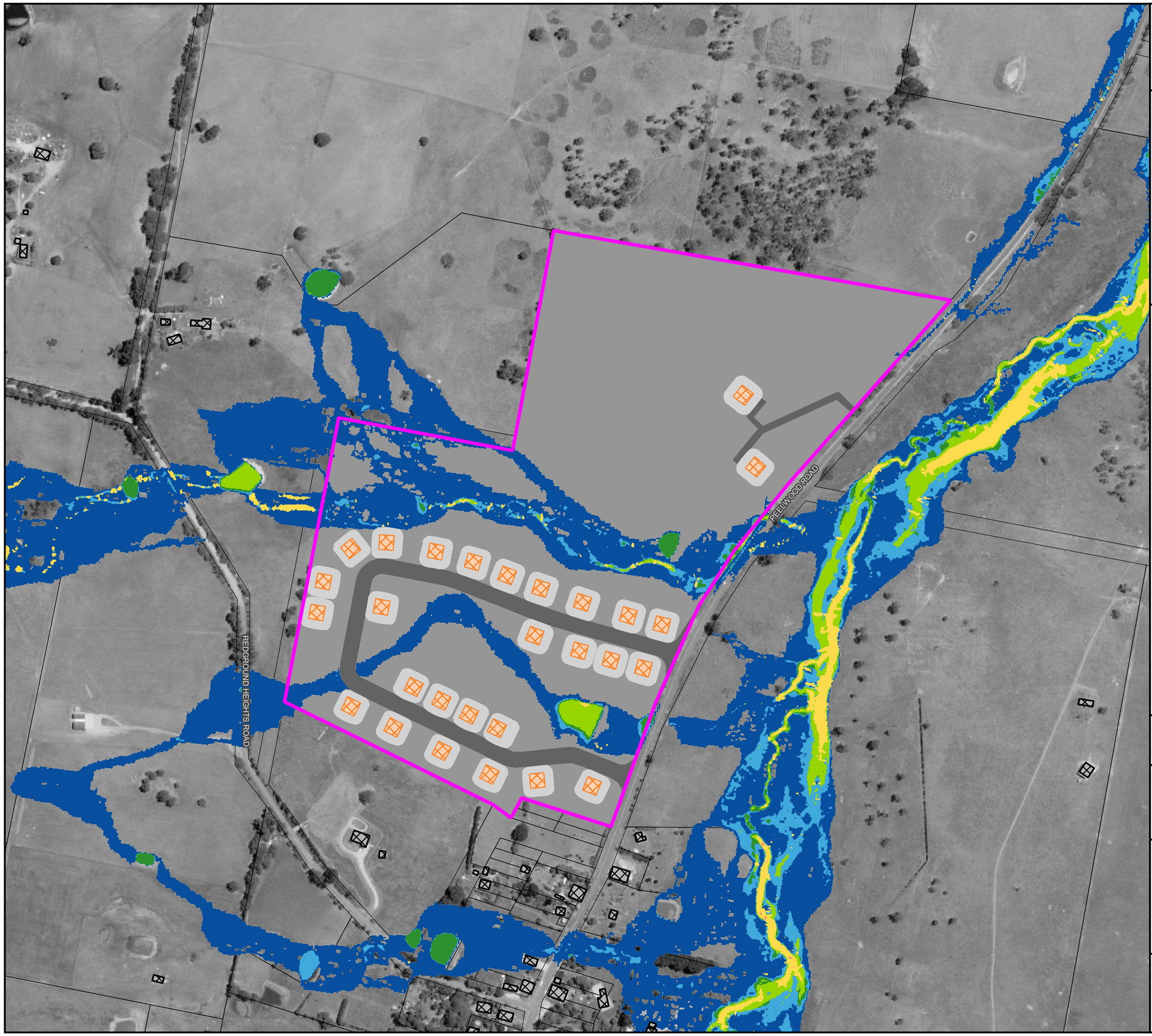
Scale: 1:5,000 (at A3)

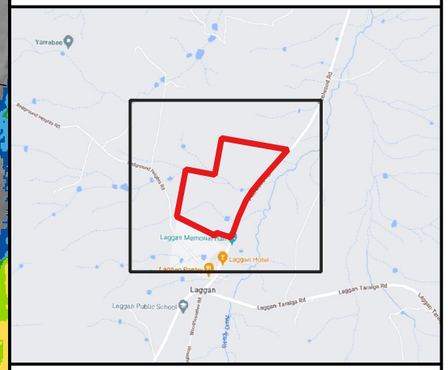
0 60 120 180 240 m

Figure 57 :
Flood Hazard for the 10% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

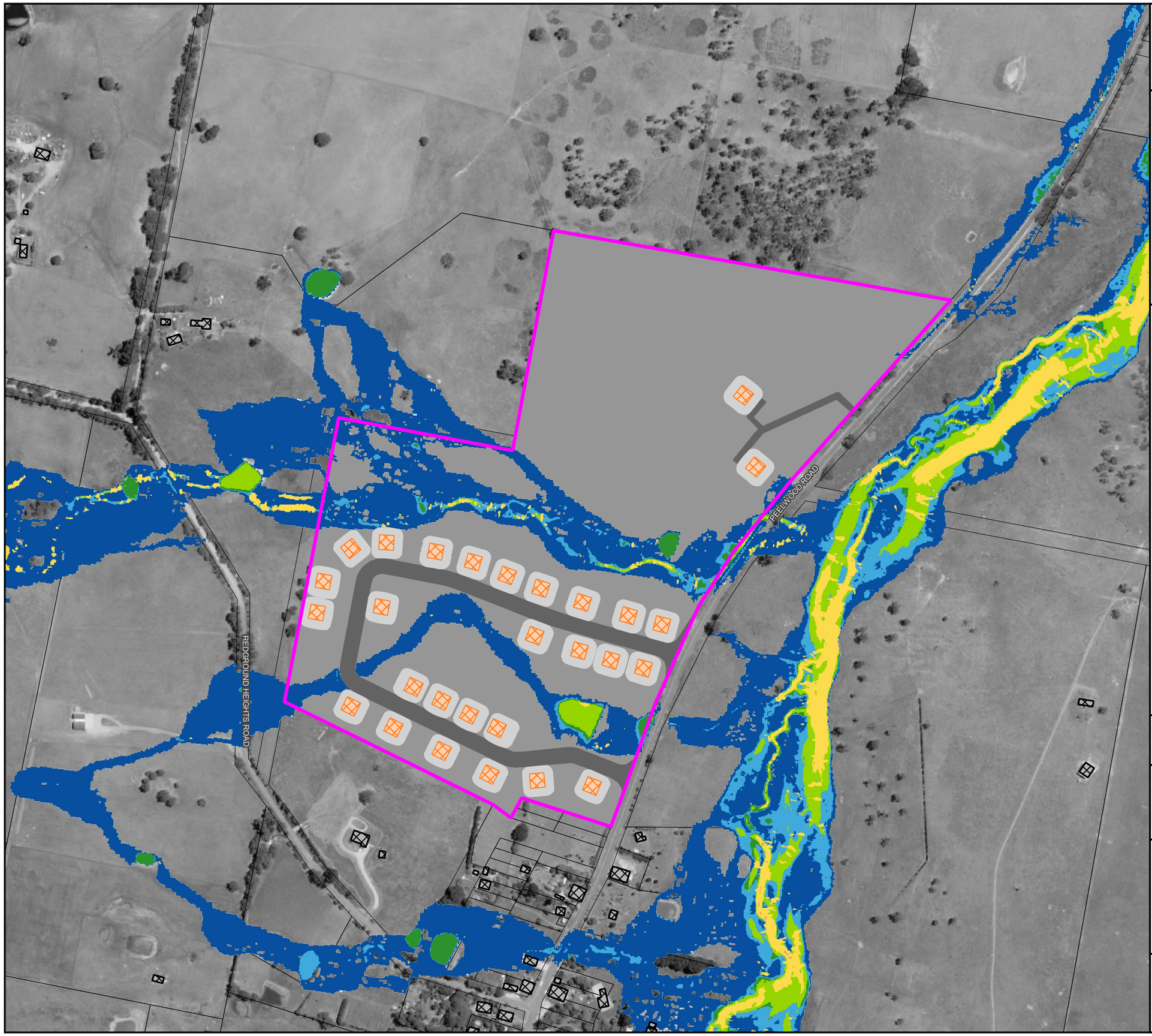
Scale: 1:5,000 (at A3)

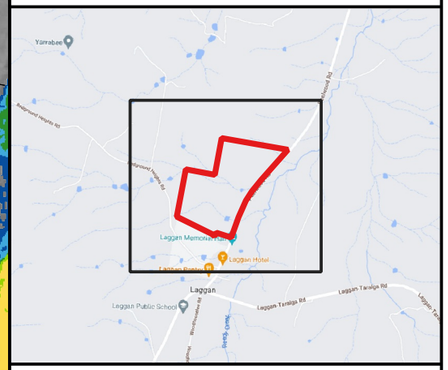
0 60 120 180 240 m

Figure 58 :
Flood Hazard for the 5% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz





LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 59 :
Flood Hazard for the 2% AEP Flood for Proposed Conditions

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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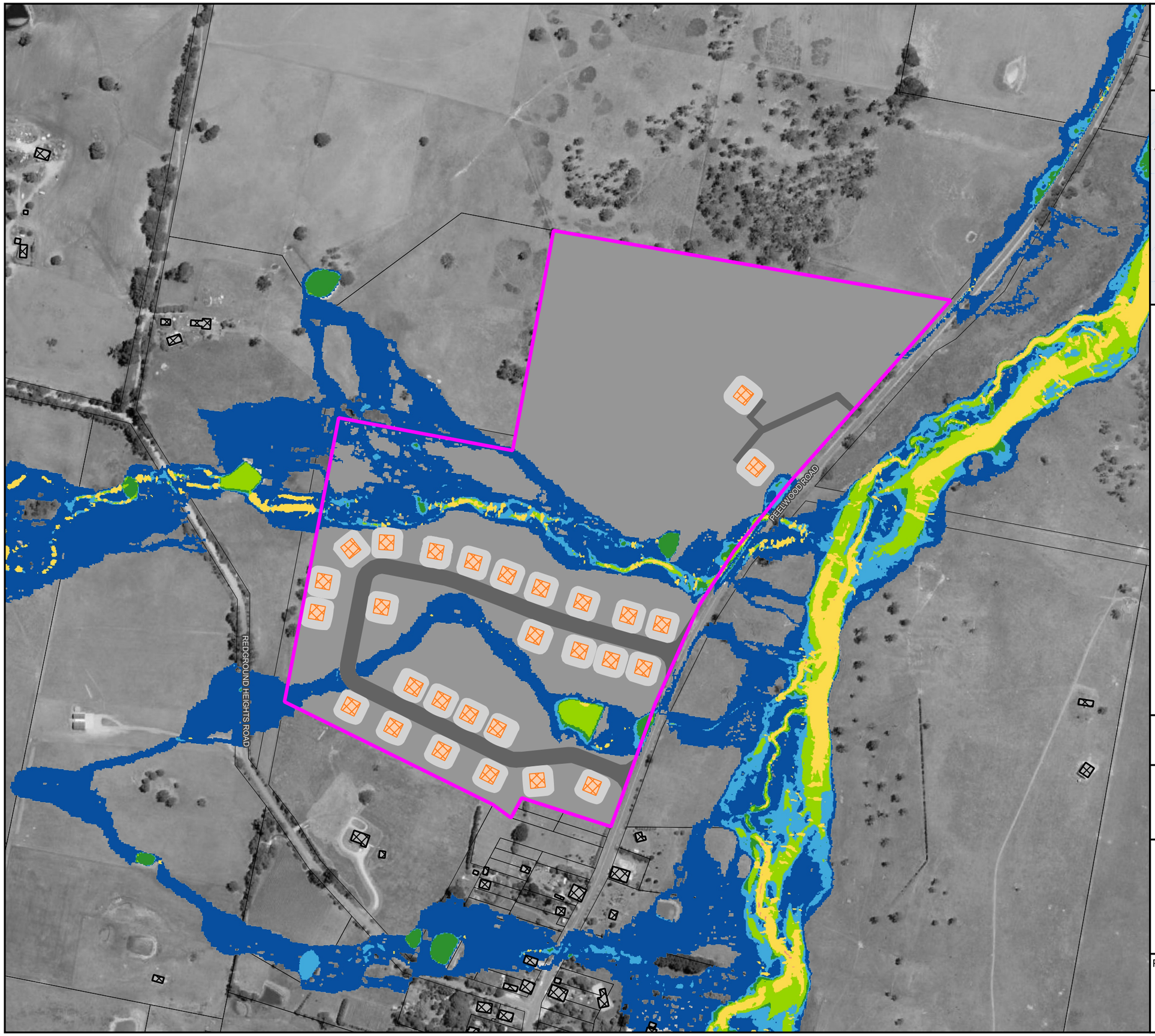

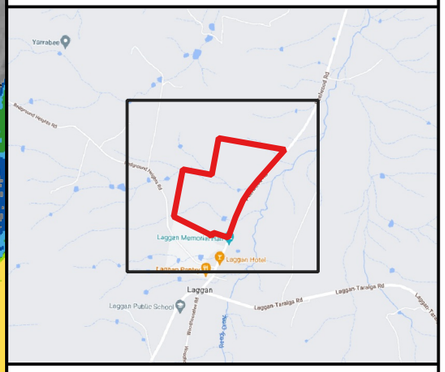

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 60 :
Flood Hazard for the 1% AEP Flood for Proposed Conditions

Prepared by:
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Sydney, NSW, 2000

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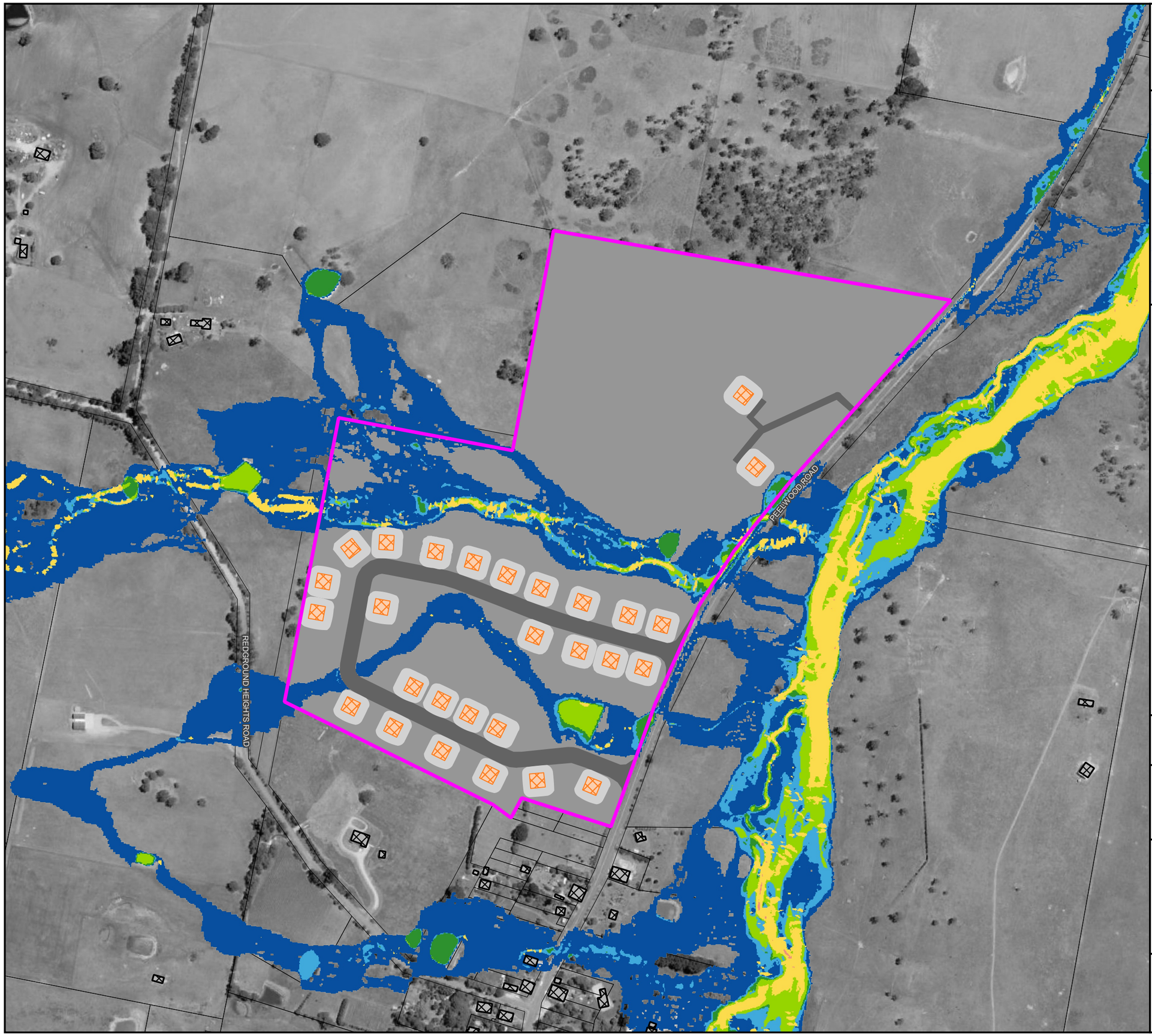

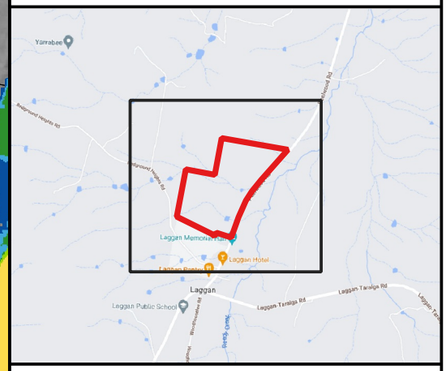

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 61 :
Flood Hazard for the 0.5% AEP Flood for Proposed Conditions

Prepared by:
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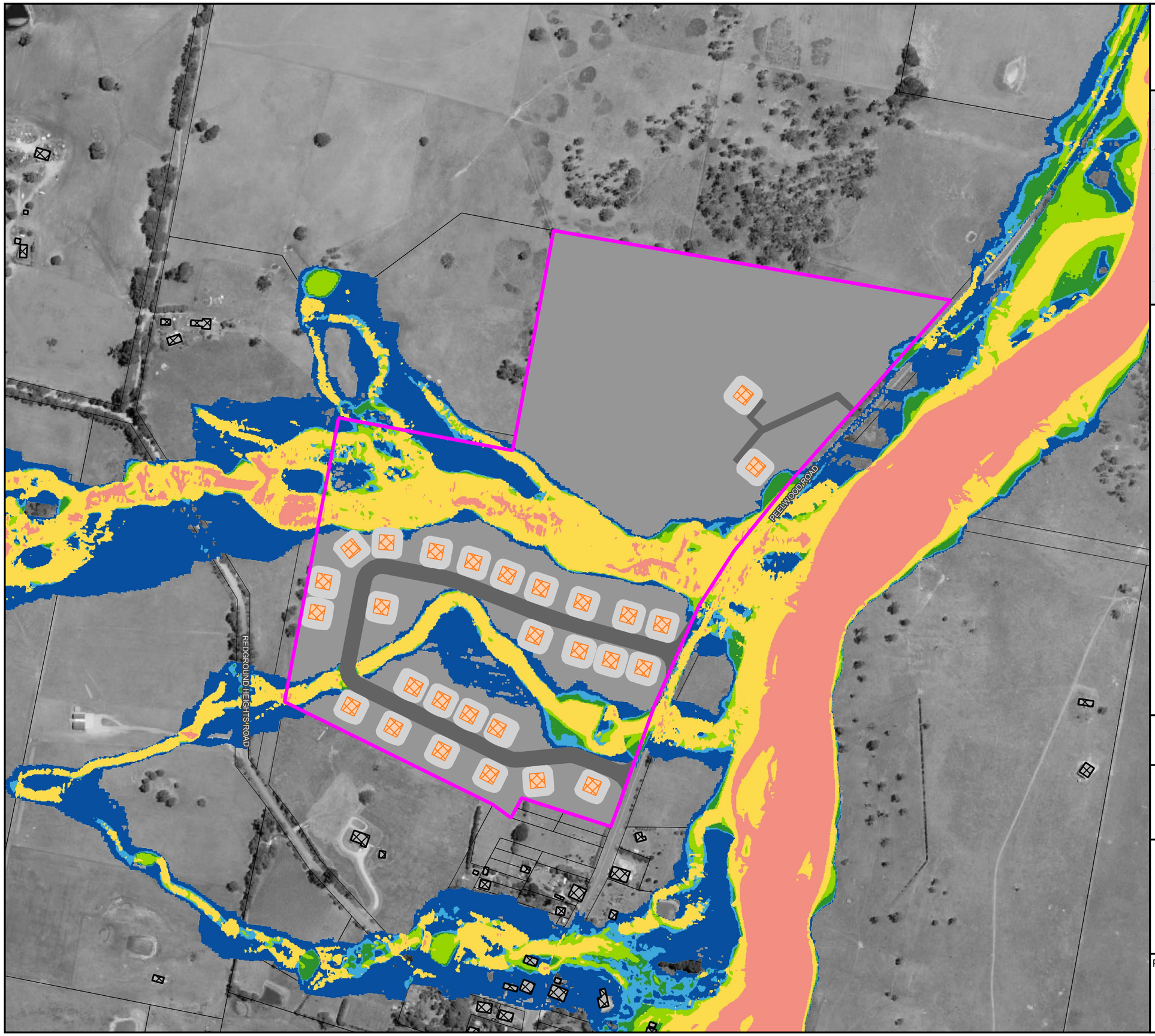

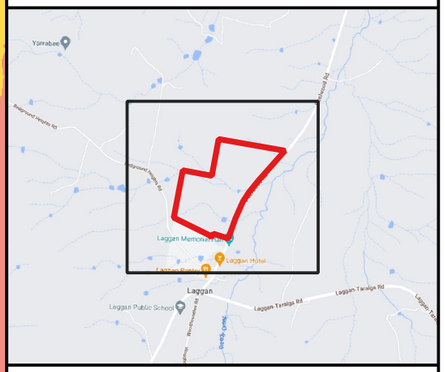

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Hazard Categories

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people and vehicles Buildings require special design
- H6 - Unsafe for people and vehicles All buildings vulnerable to failure

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 62 :
Flood Hazard for the PMF for Proposed Conditions

Prepared by:
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Sydney, NSW, 2000

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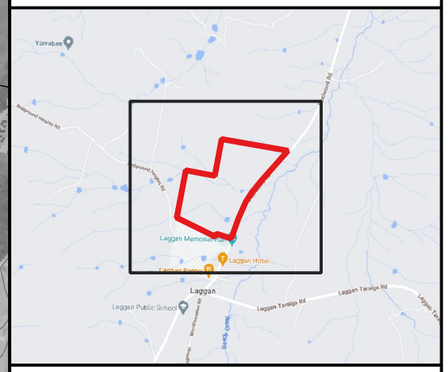

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 63 :
Predicted Change in Peak 63.2% AEP Flood Levels

Prepared by:
Catchment Simulation Solutions
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Sydney, NSW, 2000

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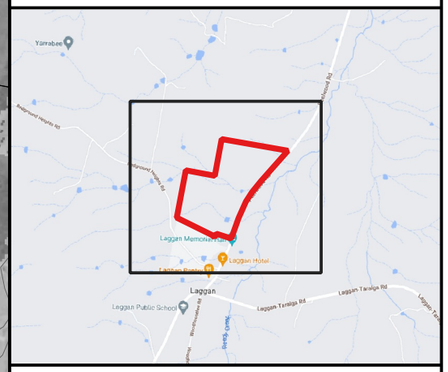

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 64 :
Predicted Change in Peak 50% AEP Flood Levels

Prepared by:
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Sydney, NSW, 2000

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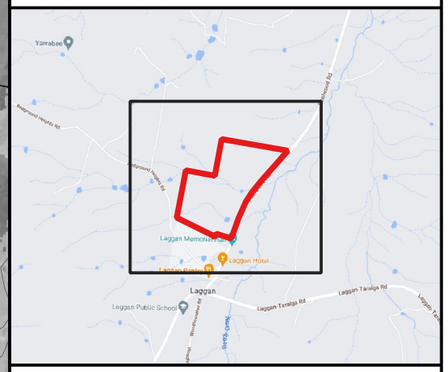

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 65 :
Predicted Change in Peak 20% AEP Flood Levels

Prepared by:
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Sydney, NSW, 2000

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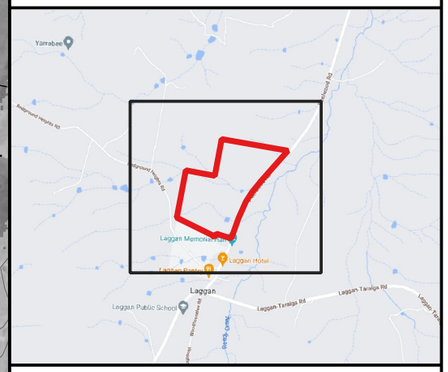

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 66 :
Predicted Change in Peak 10% AEP Flood Levels

Prepared by:
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Sydney, NSW, 2000

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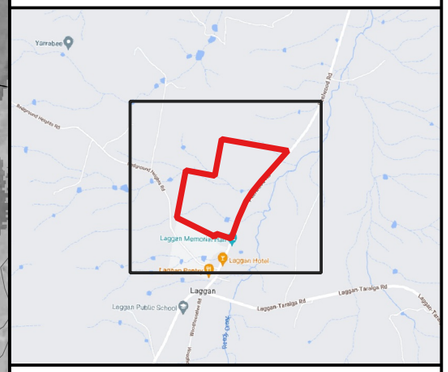

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 67 :
Predicted Change in Peak 5% AEP Flood Levels

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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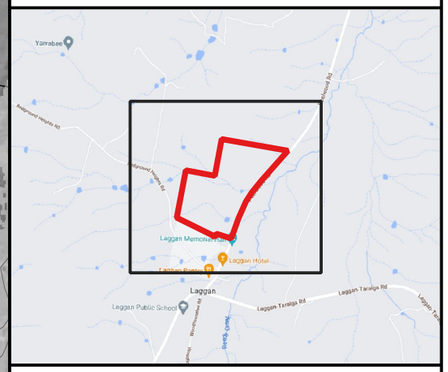

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 68 :
Predicted Change in Peak 2% AEP Flood Levels

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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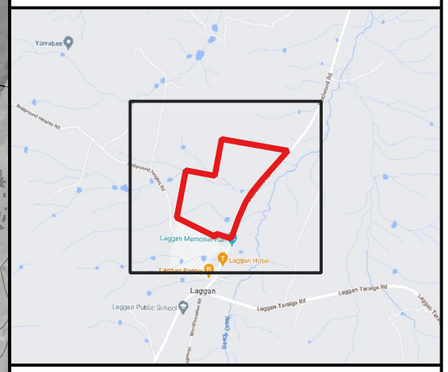

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 69 :
Predicted Change in Peak 1% AEP Flood Levels

Prepared by:
Catchment Simulation Solutions
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Sydney, NSW, 2000

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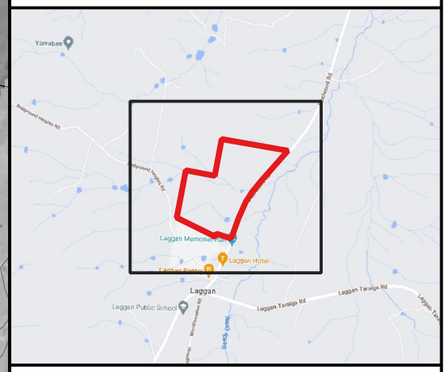

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 70 :
Predicted Change in Peak 0.5% AEP Flood Levels

Prepared by:
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Sydney, NSW, 2000

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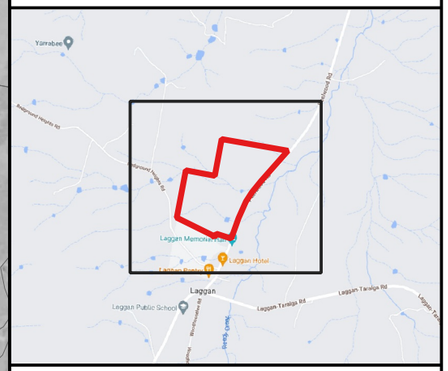

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 71 :
Predicted Change in Peak PMF Flood Levels

Prepared by:
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Sydney, NSW, 2000

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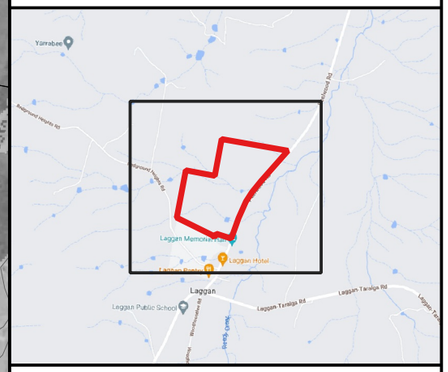

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Velocity Difference (m/s)

- < -0.50
- -0.25 to -0.50
- -0.15 to -0.25
- -0.05 - -0.15
- < +- 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.50
- > 0.50
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 72 :
Predicted Change in Peak 63.2% AEP Flood Velocity

Prepared by:
Catchment Simulation Solutions
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Sydney, NSW, 2000

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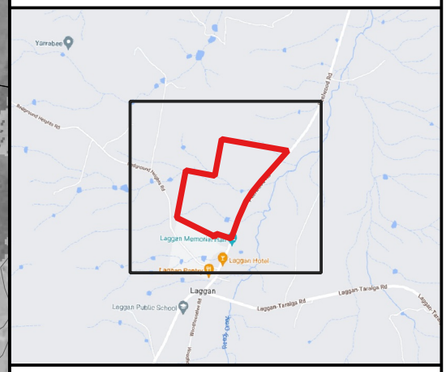

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Velocity Difference (m/s)

- < -0.50
- -0.25 to -0.50
- -0.15 to -0.25
- -0.05 - -0.15
- < +- 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.50
- > 0.50
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 73 :
Predicted Change in Peak 50% AEP Flood Velocity

Prepared by:
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Sydney, NSW, 2000

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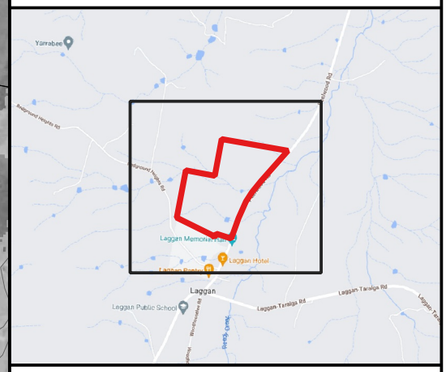

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Velocity Difference (m/s)

- < -0.50
- -0.25 to -0.50
- -0.15 to -0.25
- -0.05 - -0.15
- < +- 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.50
- > 0.50
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 74 :
Predicted Change in Peak 20% AEP Flood Velocity

Prepared by:
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Sydney, NSW, 2000

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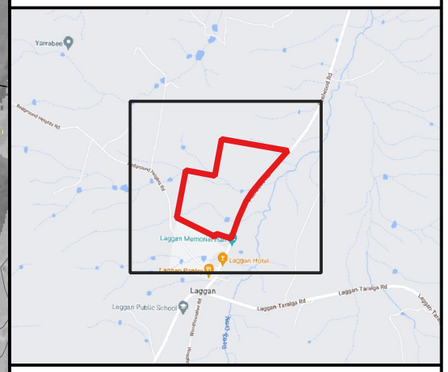

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Velocity Difference (m/s)

- < -0.50
- -0.25 to -0.50
- -0.15 to -0.25
- -0.05 - -0.15
- < +- 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.50
- > 0.50
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 75 :
Predicted Change in Peak 10% AEP Flood Velocity

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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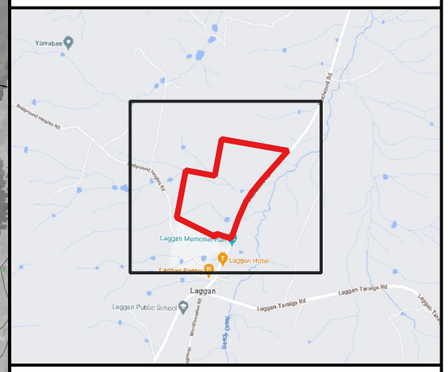

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Velocity Difference (m/s)

- < -0.50
- -0.25 to -0.50
- -0.15 to -0.25
- -0.05 - -0.15
- < +- 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.50
- > 0.50
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 76 :
Predicted Change in Peak 5% AEP Flood Velocity

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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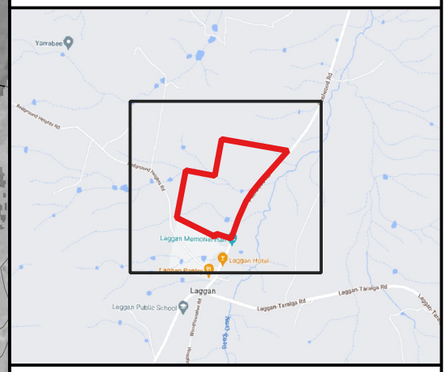


LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Velocity Difference (m/s)

- < -0.50
- -0.25 to -0.50
- -0.15 to -0.25
- -0.05 - -0.15
- < +- 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.50
- > 0.50
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

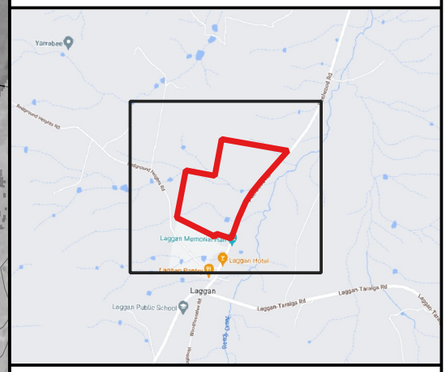
Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 77 :
Predicted Change in Peak 2% AEP Flood Velocity

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

File Path: T:\~Projects\J748 - Peelwood Rd Laggan\Figures\QGIS\Laggan_Figures.qgz



LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Velocity Difference (m/s)

- < -0.50
- -0.25 to -0.50
- -0.15 to -0.25
- -0.05 - -0.15
- < +- 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.50
- > 0.50
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 78 :
Predicted Change in Peak 1% AEP Flood Velocity

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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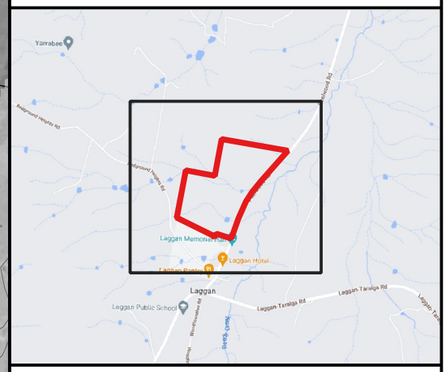

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Velocity Difference (m/s)

- < -0.50
- -0.25 to -0.50
- -0.15 to -0.25
- -0.05 - -0.15
- < +- 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.50
- > 0.50
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 79 :
Predicted Change in Peak 0.5% AEP Flood Velocity

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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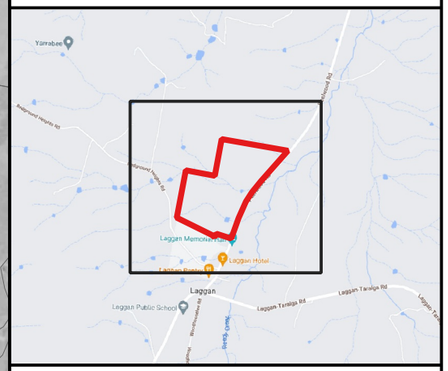

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Velocity Difference (m/s)

- < -0.50
- -0.25 to -0.50
- -0.15 to -0.25
- -0.05 - -0.15
- < +- 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.50
- > 0.50
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 80 :
Predicted Change in Peak PMF Flood Velocity

Prepared by:
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Sydney, NSW, 2000

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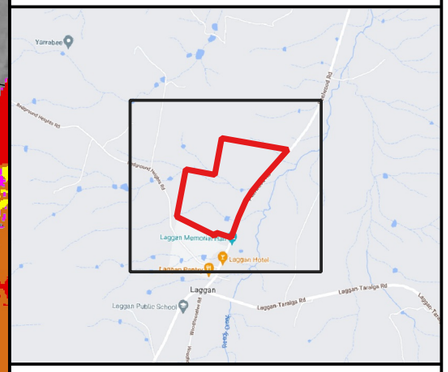

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 81 :
Predicted Change in Peak 1% AEP Flood Levels as a result of Climate Change using the 0.5% AEP Event as a Proxy

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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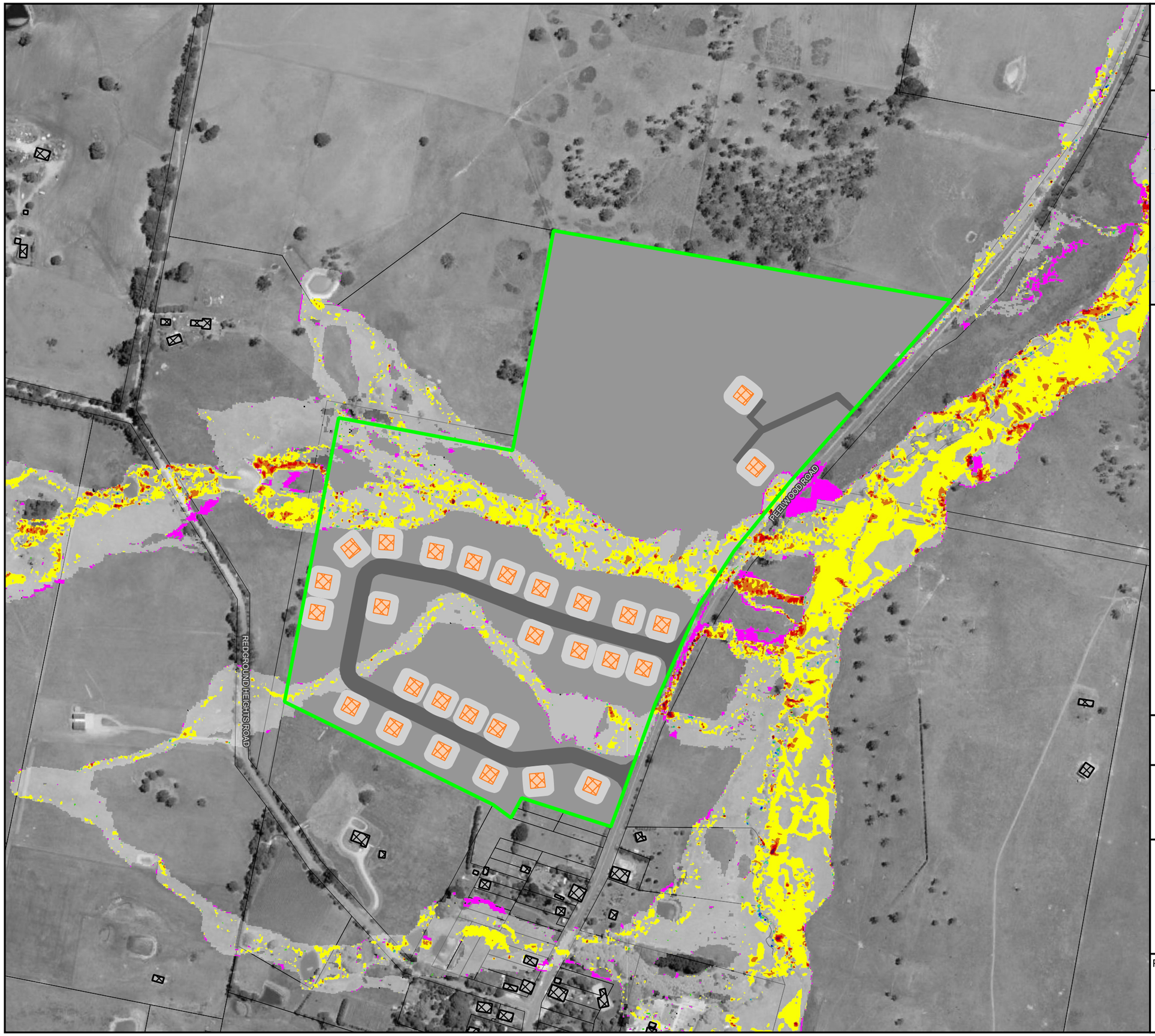

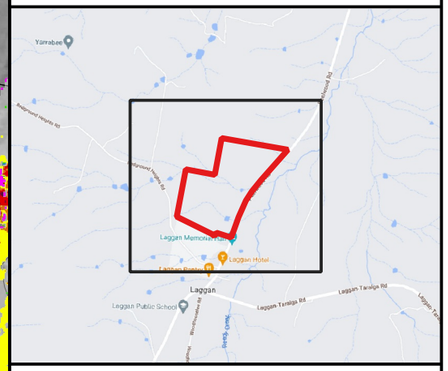

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Velocity Difference (m/s)

- < -0.50
- -0.25 to -0.50
- -0.15 to -0.25
- -0.05 - -0.15
- < +- 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.50
- > 0.50
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 82 :
Predicted Change in Peak 1% AEP Flood Velocity as a result of Climate Change using the 0.5% AEP Event as a Proxy

Prepared by:
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Sydney, NSW, 2000

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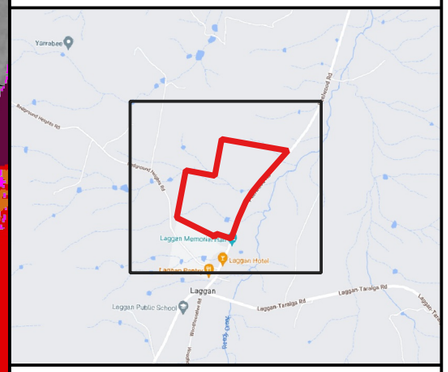

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 83 :
Predicted Change in Peak 1% AEP Flood Levels as a result of Climate Change using the 0.2% AEP Event as a Proxy

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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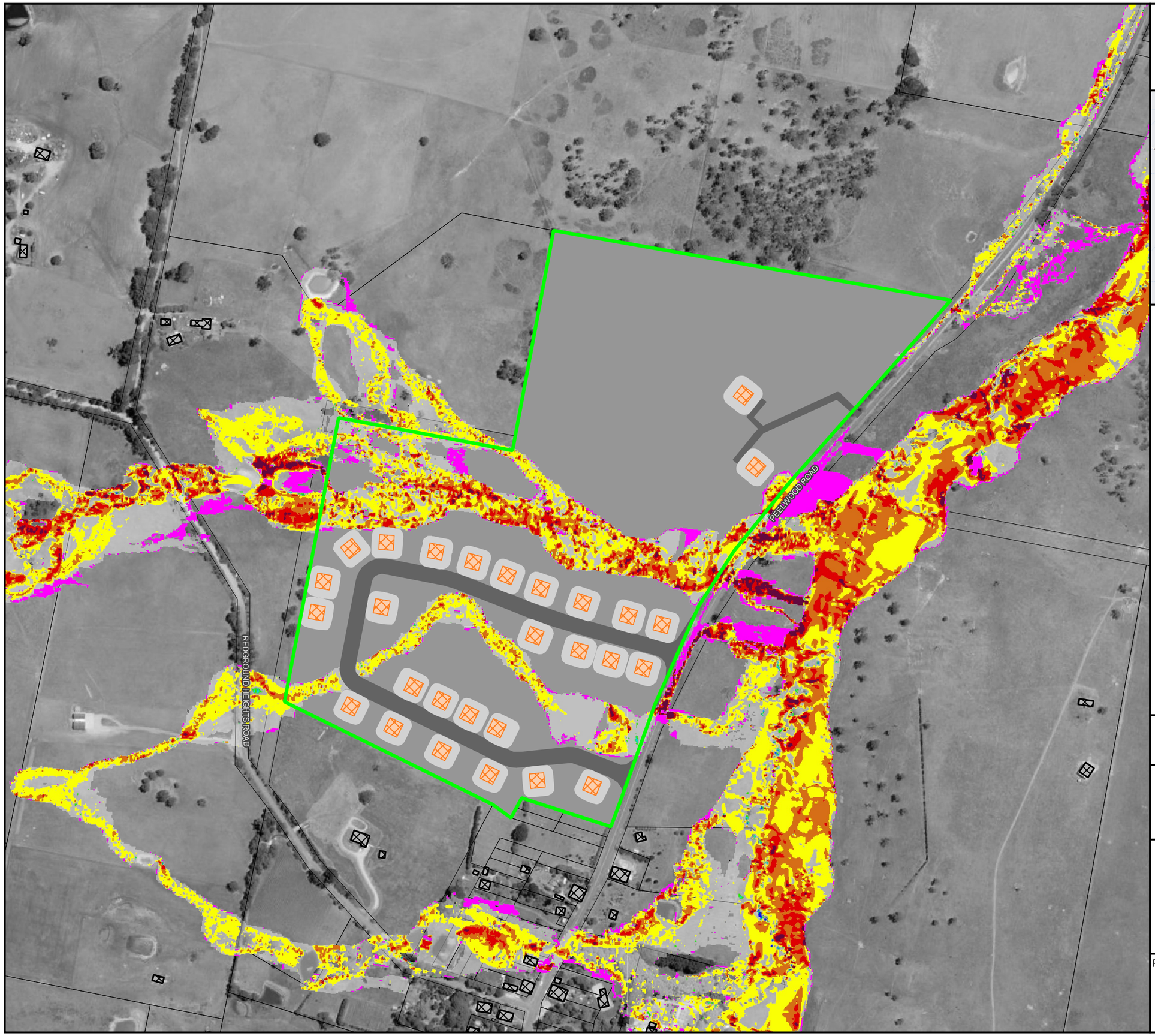

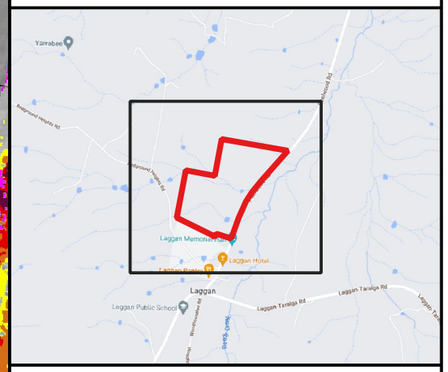

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Velocity Difference (m/s)

- < -0.50
- -0.25 to -0.50
- -0.15 to -0.25
- -0.05 - -0.15
- < +- 0.05
- 0.05 to 0.15
- 0.15 to 0.25
- 0.25 to 0.50
- > 0.50
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 84 :
Predicted Change in Peak 1% AEP Flood Velocity as a result of Climate Change using the 0.2% AEP Event as a Proxy

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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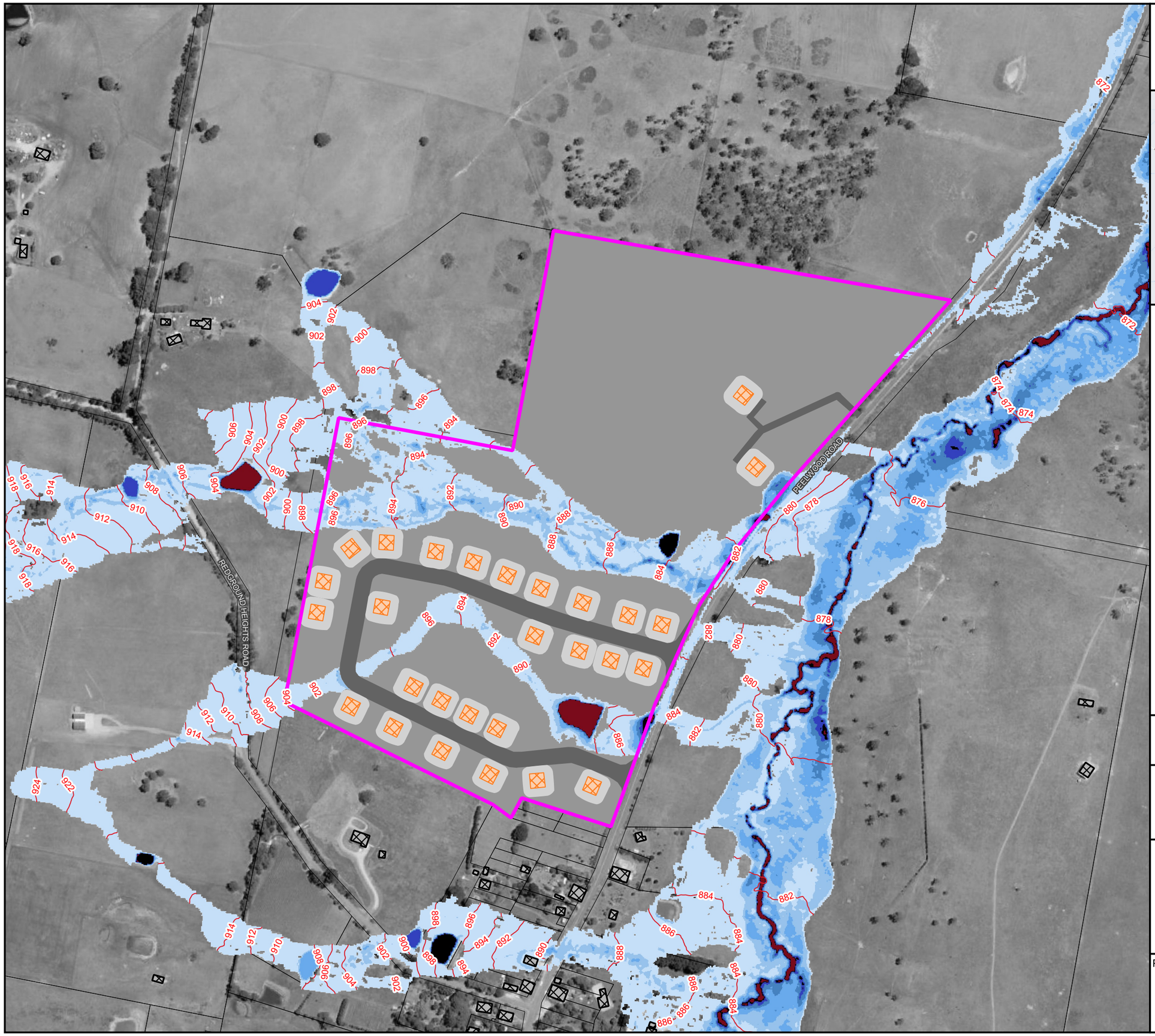

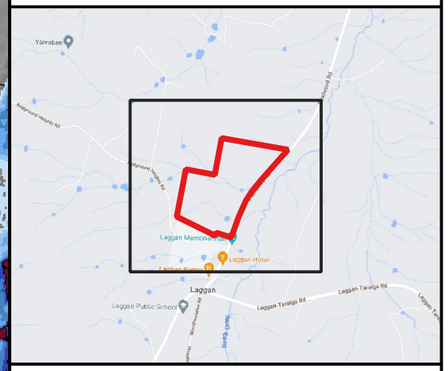

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 85 :
Peak Floodwater Depths and Levels for the 1% AEP Flood for Proposed Conditions with High Culvert Blockage

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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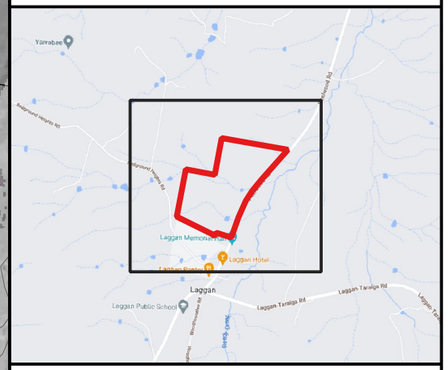

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 86 :
Predicted Change in Peak 1% AEP Flood Levels as a result High Culvert Blockage

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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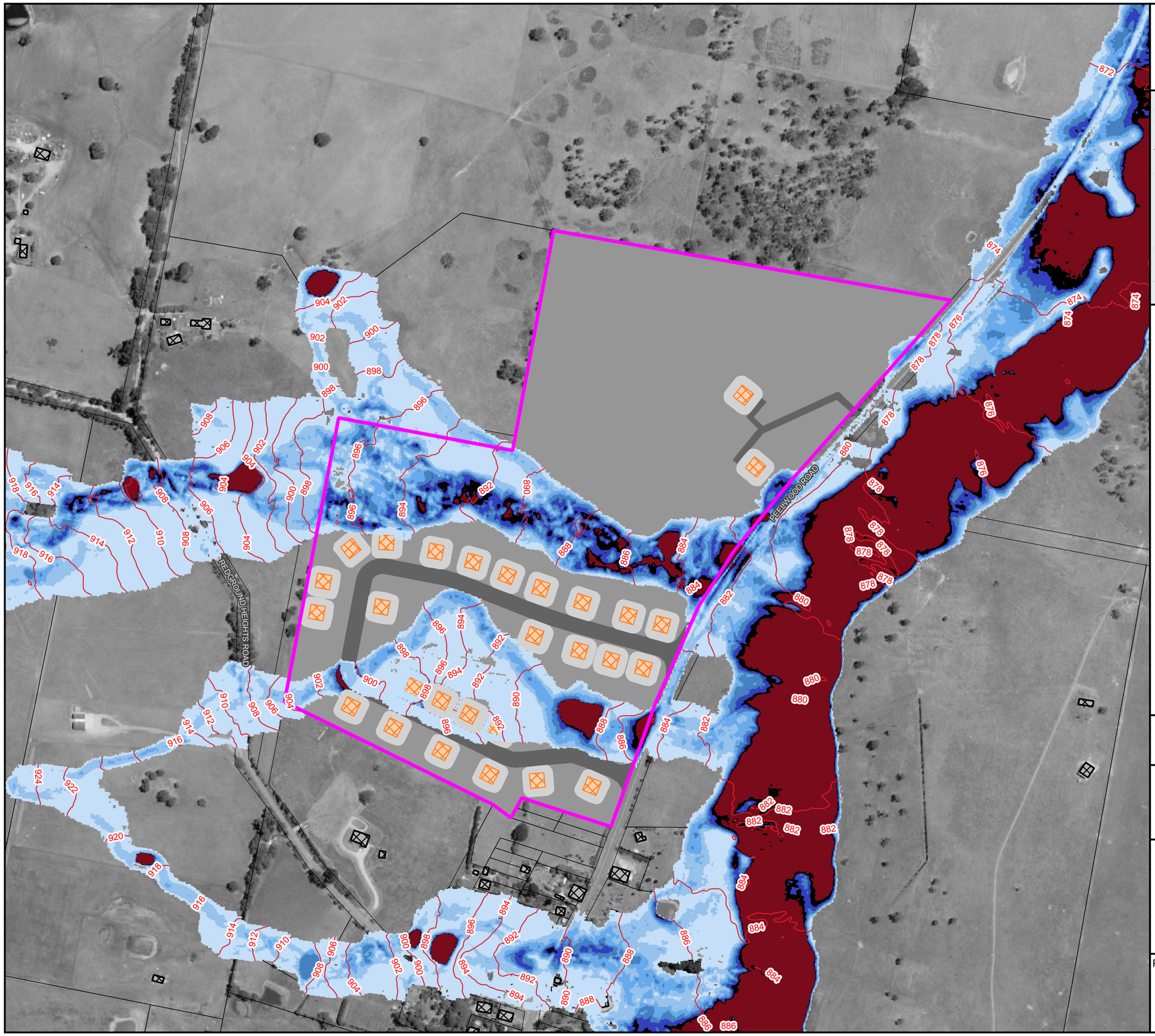

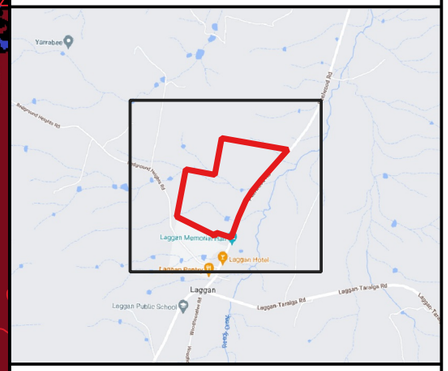

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road
- Flood Level Contour (2m interval)

Depth(m)

- 0.00 - 0.20
- 0.20 - 0.40
- 0.40 - 0.60
- 0.60 - 0.80
- 0.80 - 1.00
- 1.00 - 1.20
- > 1.20

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 87 :
Peak Floodwater Depths and Levels for the PMF for Proposed Conditions with High Culvert Blockage

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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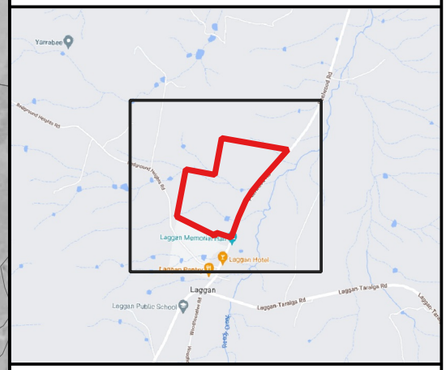

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road

Flood Level Difference (m)

- < -0.20
- -0.15 to -0.20
- -0.05 to -0.15
- -0.01 - -0.05
- < +- 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- > 0.20
- Was wet, now dry
- Was dry, now wet

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 88 :
Predicted Change in Peak PMF Floods Levels as a result High Culvert Blockage

Prepared by:
Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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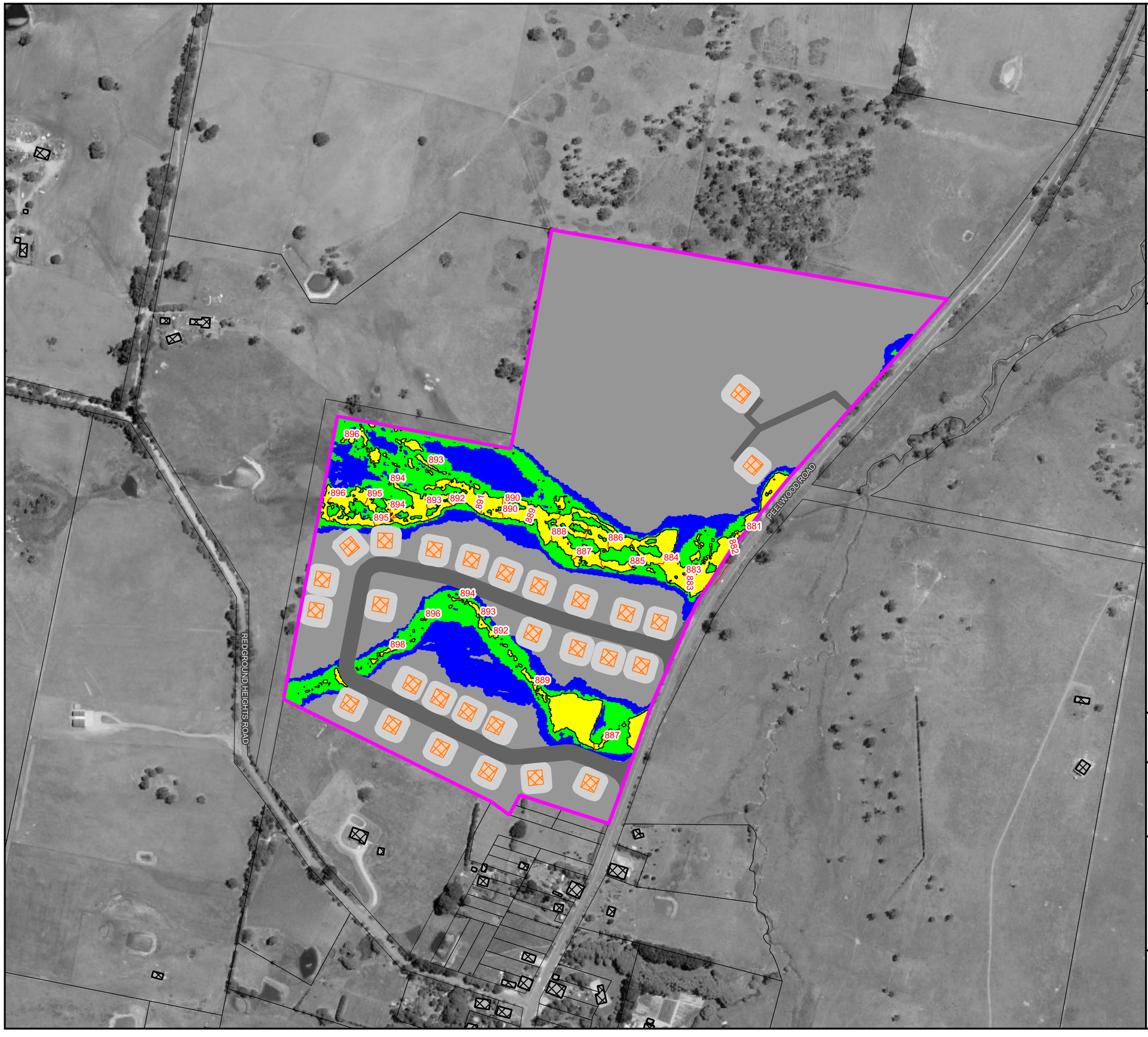

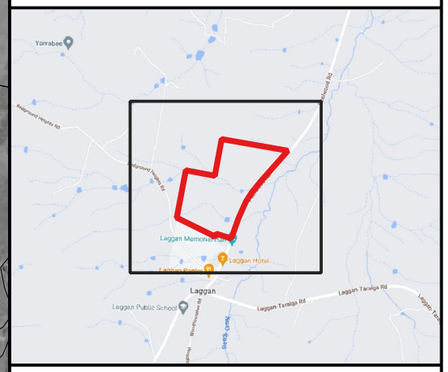

LEGEND

- Site Boundary
- Existing Building Footprint
- Proposed Building Footprint
- Bushfire Asset Protection Zone
- Road
- Flood Planning Level Contours (1m intervals)
- Flood Planning Area
- 1%AEP Flood Extent
- PMF Flood Extent

Notes:
Aerial photograph: NSW SixMaps

N

Scale: 1:5,000 (at A3)

0 60 120 180 240 m

Figure 89 :
Flood Planning Area and Levels

Prepared by:

Catchment Simulation Solutions
Suite 1, Level 10, 70 Phillip St
Sydney, NSW, 2000

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APPENDIX B
XP-RAFTS SUBCATCHMENT PARAMETERS

Existing XP-RAFTS Subcatchment Parameters

Subcatchment ID	Subcatchment Area (ha)	Total Upstream Area (ha)	Subcatchment Slope (%)	Impervious Area (ha)	Impervious Prop (%)	Main Stream Length (km)
1.01	176.53	176.53	1.37	2.37	1.34	4.19
1.02	45.93	688.8	1.59	4.97	10.81	1.1
1.03	57.4	797.08	3.24	0.46	0.8	0.95
1.04	51.28	1007.2	2.46	0.83	1.62	1
1.05	94.02	1419.56	2.34	2.04	2.17	1
1.06	78.68	1580.47	2.18	3.65	4.64	1.05
1.07	20.05	1689.25	1.88	0.46	2.28	0.72
1.08	54.01	1903.33	1.15	1.4	2.6	1.53
1.09	3.87	2491.1	0.32	0.11	2.92	0.36
1.1	0.32	2537.57	3.45	0	0	0.03
1.11	23.22	2605.49	2.95	0.19	0.81	0.45
1.12	32.71	2668.08	2.71	1.11	3.39	0.69
1.13	0.23	2729.27	2.39	0	0	0.06
1.14	37.63	3351.43	4.36	0.98	2.61	0.25
2.01	178.22	178.22	0.94	0.9	0.5	3.19
2.02	39.19	466.34	1.41	0.58	1.49	0.33
3.01	168.88	168.88	1.06	0.66	0.39	2.31
3.02	80.04	248.93	1	0	0	0.57
4.01	50.88	50.88	3.58	0.04	0.08	1.51
5.01	158.85	158.85	3.72	2.56	1.61	2.21
6.01	131.02	131.02	2.53	0.87	0.66	2.68
6.02	10.19	194.64	2.32	0.67	6.6	0.6
6.03	86.03	318.33	2.39	2.25	2.62	0.95
7.01	53.42	53.42	1.89	1.05	1.96	1.7
8.01	37.66	37.66	3.3	0.77	2.04	1.31
9.01	82.23	82.23	4.11	2.4	2.92	1.92
10.01	52.65	52.65	2.94	1.34	2.55	2.09
11.01	10.14	10.14	5.51	0	0	0.81
11.02	6.93	17.07	4.91	0.28	4.11	0.45
11.03	3.64	22.03	3.8	0	0.03	0.31
11.04	6.7	28.74	4.24	0.06	0.93	0.22
11.05	3.97	32.71	3.63	0.13	3.3	0.13
11.06	1.41	36.08	4.19	0.16	11.5	0.18
12.01	1.32	1.32	8.68	0.13	9.7	0.23
13.01	1.97	1.97	3.8	0.09	4.82	0.43
14.01	41.55	41.55	4.47	0.7	1.7	1.19
14.02	20.8	82.89	3.97	0.97	4.66	0.74
14.03	5	87.9	5.91	0.25	5.04	0.2
14.04	3.47	93.77	3.16	0	0	0.24
14.05	2.93	127.73	3.25	0	0	0.23
14.06	7.25	141.01	3.28	0.04	0.55	0.13
14.07	5.21	146.23	4.16	0.28	5.46	0.21
14.08	0.7	146.92	6.04	0.06	8.57	0.08
14.09	2.23	149.15	1.06	0.11	5.01	0.08
15.01	20.54	20.54	5.39	0.18	0.86	0.89
16.01	2.4	2.4	6.69	0.12	5.11	0.51
17.01	6.65	6.65	5.3	0.27	4.11	0.63
17.02	4.21	31.03	2.86	0.01	0.25	0.17
18.01	20.18	20.18	4.16	0.37	1.84	0.68
19.01	6.03	6.03	6.94	0	0	0.54

Existing XP-RAFTS Subcatchment Parameters

Subcatchment ID	Subcatchment Area (ha)	Total Upstream Area (ha)	Subcatchment Slope (%)	Impervious Area (ha)	Impervious Prop (%)	Main Stream Length (km)
20.01	0	0	0.01	0	66.67	0
21.01	10.92	10.92	5.03	0.13	1.15	0.66
22.01	152.94	152.94	2.98	2.02	1.32	3.16
22.02	114.29	410.85	2.48	1.67	1.46	1.08
22.03	35.72	505.5	2.39	0.01	0.01	0.75
22.04	6.43	583.9	2.01	0.08	1.24	0.4
23.01	143.62	143.62	2.18	1.88	1.31	2.31
24.01	58.93	58.93	5.45	0.24	0.41	1.5
25.01	71.98	71.98	4.6	0.22	0.3	1.77
26.01	46.16	46.16	4.29	0.32	0.7	1.73
27.01	44.7	44.7	1.31	0.75	1.68	1.64
28.01	29.88	29.88	2.64	0.71	2.38	1.8
29.01	60.96	60.96	5.29	0.56	0.92	1.77
30.01	58.21	58.21	3.81	0.3	0.51	1.75
30.02	101.27	190.82	2.1	3.43	3.39	1.94
30.03	67.74	542.5	2.6	1.09	1.61	1.41
30.04	24.4	584.52	3.13	0.25	1.02	0.35
31.01	31.34	31.34	4.15	0.68	2.17	1.27
32.01	121.48	121.48	4.93	0.84	0.69	2.01
32.02	67.62	283.94	3.52	0.75	1.12	1.13
33.01	94.84	94.84	4.79	0.28	0.3	1.93
34.01	17.63	17.63	3.59	0	0	1.21

Post-Development XP-RAFTS Subcatchment Parameters

Subcatchment ID	Subcatchment Area (ha)	Total Upstream Area (ha)	Subcatchment Slope (%)	Impervious Area (ha)	Impervious Prop (%)	Main Stream Length (km)
1.01	176.53	176.53	1.37	2.37	1.34	4.19
1.02	45.93	688.8	1.59	4.97	10.81	1.1
1.03	57.4	797.08	3.24	0.46	0.8	0.95
1.04	51.28	1007.2	2.46	0.83	1.62	1
1.05	94.02	1419.56	2.34	2.04	2.17	1
1.06	78.68	1580.47	2.18	3.65	4.64	1.05
1.07	20.05	1689.25	1.88	0.46	2.28	0.72
1.08	54.01	1903.33	1.15	1.42	2.63	1.53
1.09	3.87	2491.1	0.32	0.11	2.92	0.36
1.1	0.32	2537.57	3.45	0	0	0.03
1.11	23.22	2605.49	2.95	0.19	0.81	0.45
1.12	32.71	2668.08	2.71	1.11	3.39	0.69
1.13	0.23	2729.27	2.39	0	0	0.06
1.14	37.63	3351.43	4.36	0.98	2.61	0.25
2.01	178.22	178.22	0.94	0.9	0.5	3.19
2.02	39.19	466.34	1.41	0.58	1.49	0.33
3.01	168.88	168.88	1.06	0.66	0.39	2.31
3.02	80.04	248.93	1	0	0	0.57
4.01	50.88	50.88	3.58	0.04	0.08	1.51
5.01	158.85	158.85	3.72	2.56	1.61	2.21
6.01	131.02	131.02	2.53	0.87	0.66	2.68
6.02	10.19	194.64	2.32	0.67	6.6	0.6
6.03	86.03	318.33	2.39	2.25	2.62	0.95
7.01	53.42	53.42	1.89	1.05	1.96	1.7
8.01	37.66	37.66	3.3	0.77	2.04	1.31
9.01	82.23	82.23	4.11	2.4	2.92	1.92
10.01	52.65	52.65	2.94	1.34	2.55	2.09
11.01	10.14	10.14	5.51	0	0	0.81
11.02	6.93	17.07	4.91	0.28	4.11	0.45
11.03	3.64	22.03	3.8	0.94	25.91	0.31
11.04	6.7	28.74	4.24	1.81	27	0.22
11.05	3.97	32.71	3.63	0.97	24.43	0.13
11.06	1.41	36.08	4.19	0.74	52.2	0.18
12.01	1.32	1.32	8.68	0.13	9.7	0.23
13.01	1.97	1.97	3.8	0.39	19.76	0.43
14.01	41.55	41.55	4.47	0.7	1.7	1.19
14.02	20.8	82.89	3.97	0.97	4.66	0.74
14.03	5	87.9	5.91	0.25	5.04	0.2
14.04	3.47	93.77	3.16	0.81	23.32	0.24
14.05	2.93	127.73	3.25	0.97	33.07	0.23
14.06	7.25	141.01	3.28	0.2	2.82	0.13
14.07	5.21	146.23	4.16	1.06	20.25	0.21
14.08	0.7	146.92	6.04	0.16	23.58	0.08
14.09	2.23	149.15	1.06	0.11	5.01	0.08
15.01	20.54	20.54	5.39	0.18	0.86	0.89
16.01	2.4	2.4	6.69	0.12	5.11	0.51
17.01	6.65	6.65	5.3	0.27	4.11	0.63
17.02	4.21	31.03	2.86	0.01	0.25	0.17
18.01	20.18	20.18	4.16	0.37	1.84	0.68
19.01	6.03	6.03	6.94	0	0	0.54

Post-Development XP-RAFTS Subcatchment Parameters

Subcatchment ID	Subcatchment Area (ha)	Total Upstream Area (ha)	Subcatchment Slope (%)	Impervious Area (ha)	Impervious Prop (%)	Main Stream Length (km)
20.01	0	0	0.01	0	66.67	0
21.01	10.92	10.92	5.03	0.19	1.73	0.66
22.01	152.94	152.94	2.98	2.02	1.32	3.16
22.02	114.29	410.85	2.48	1.67	1.46	1.08
22.03	35.72	505.5	2.39	0.01	0.01	0.75
22.04	6.43	583.9	2.01	0.08	1.24	0.4
23.01	143.62	143.62	2.18	1.88	1.31	2.31
24.01	58.93	58.93	5.45	0.24	0.41	1.5
25.01	71.98	71.98	4.6	0.22	0.3	1.77
26.01	46.16	46.16	4.29	0.32	0.7	1.73
27.01	44.7	44.7	1.31	0.75	1.68	1.64
28.01	29.88	29.88	2.64	0.71	2.38	1.8
29.01	60.96	60.96	5.29	0.56	0.92	1.77
30.01	58.21	58.21	3.81	0.3	0.51	1.75
30.02	101.27	190.82	2.1	3.43	3.39	1.94
30.03	67.74	542.5	2.6	1.09	1.61	1.41
30.04	24.4	584.52	3.13	0.25	1.02	0.35
31.01	31.34	31.34	4.15	0.68	2.17	1.27
32.01	121.48	121.48	4.93	0.84	0.69	2.01
32.02	67.62	283.94	3.52	0.75	1.12	1.13
33.01	94.84	94.84	4.79	0.28	0.3	1.93
34.01	17.63	17.63	3.59	0	0	1.21

APPENDIX C
PMP CALCULATIONS

GSDM CALCULATION SHEET

LOCATION INFORMATION

Catchment Laggan — Area 33.51 km^2

State New South Wales — Duration Limit 6.0 hrs

Latitude 34.4090^0S — Longitude 149.5348^0E

Portion of Area Considered:

Smooth, **S** = 0.00 (0.0 - 1.0) — Rough, **R** = 1.00 (0.0 - 1.0)

ELEVATION ADJUSTMENT FACTOR (EAF)

Mean Elevation 936 m

Adjustment for Elevation (-0.05 per 300m above 1500m) 0.00

EAF = **1.00** (0.85 – 1.00)

MOISTURE ADJUSTMENT FACTOR (MAF)

MAF = **0.67** (0.40-1.00)

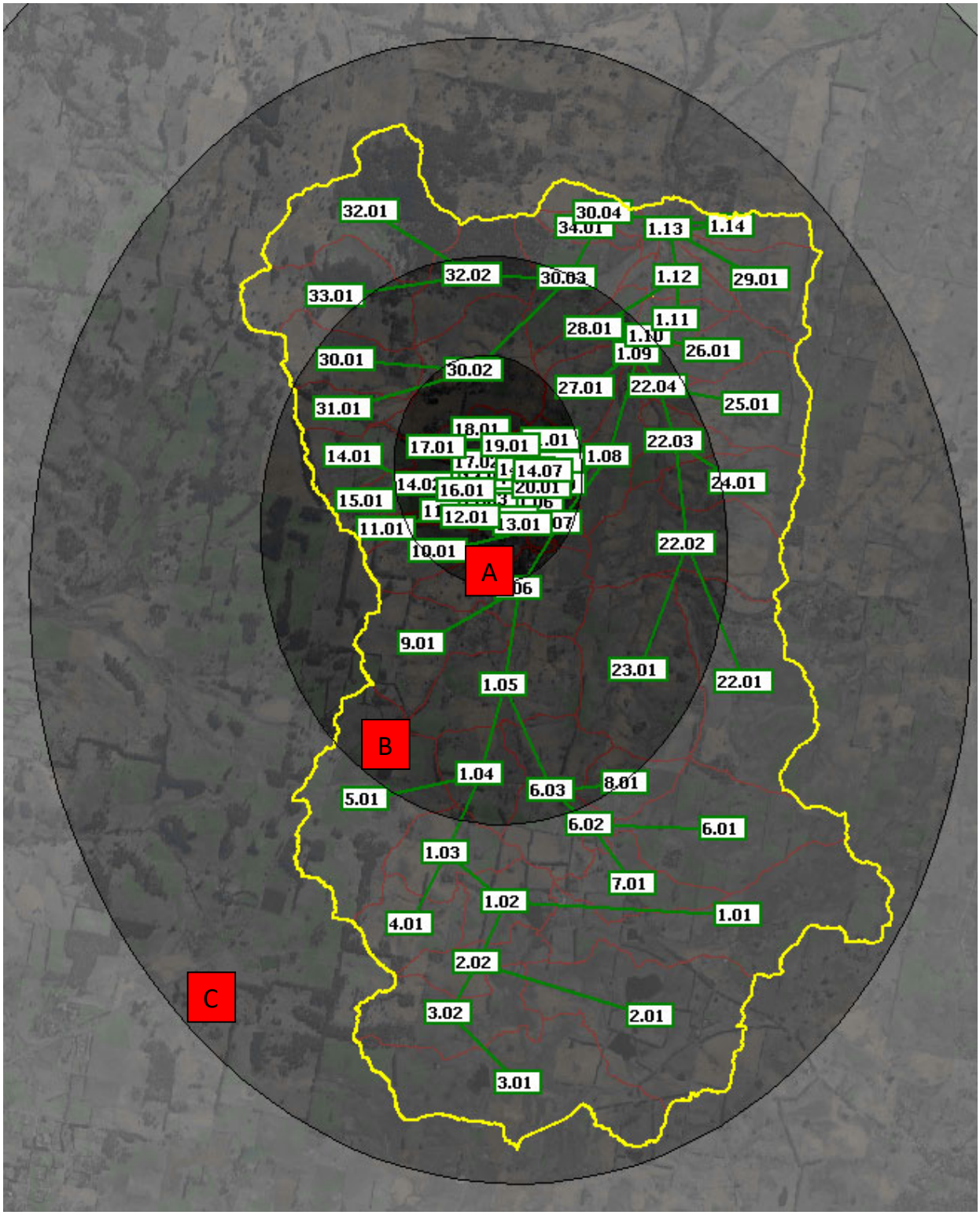
PMP VALUES (mm)

Duration (hours)	Initial Depth -Smooth (D_S)	Initial Depth -Rough (D_R)	PMP Estimate = (D_SxS + D_RxR) x MAF x EAF	Rounded PMP Estimate (nearest 10 mm)
0.25	191	191	128	130
0.50	281	281	188	190
0.75	358	358	240	240
1.00	424	424	284	280
1.50	485	544	365	360
2.00	544	633	424	420
2.50	580	704	472	470
3.00	609	764	512	510
4.00	679	871	583	580
5.00	732	956	641	640
6.00	776	1020	684	680

Prepared By Daniel Fedczyna — Date 13/10/2023

Checked By David Tetley — Date 20/10/2023

GSDM ELLIPSES



GSDM SPATIAL DISTRIBUTION

DURATION = 0.25 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.60	2.60	232	155	403	403	155
B	11.70	14.30	206	138	1976	1572	134
C	19.22	33.51	191	128	4294	2319	121
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 0.50 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.60	2.60	336	225	584	584	225
B	11.70	14.30	304	204	2913	2329	199
C	19.22	33.51	281	188	6306	3393	177
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 0.75 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.60	2.60	425	285	739	739	285
B	11.70	14.30	386	258	3693	2954	252
C	19.22	33.51	358	240	8034	4341	226
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 1.0 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.60	2.60	493	330	857	857	330
B	11.70	14.30	453	304	4339	3481	298
C	19.22	33.51	424	284	9524	5185	270
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 1.5 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.60	2.60	636	426	1106	1106	426
B	11.70	14.30	580	388	5554	4448	380
C	19.22	33.51	544	365	12225	6671	347
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 2.0 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.60	2.60	744	499	1294	1294	499
B	11.70	14.30	678	454	6496	5202	445
C	19.22	33.51	633	424	14214	7718	402
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 2.5 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.60	2.60	821	550	1428	1428	550
B	11.70	14.30	748	501	7166	5739	490
C	19.22	33.51	704	472	15816	8650	450
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 3.0 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.60	2.60	901	604	1567	1567	604
B	11.70	14.30	817	548	7829	6262	535
C	19.22	33.51	764	512	17163	9334	486
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 4.0 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.60	2.60	1030	690	1791	1791	690
B	11.70	14.30	935	627	8956	7165	612
C	19.22	33.51	871	583	19548	10592	551
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DURATION = 5.0 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.60	2.60	1135	761	1974	1974	761
B	11.70	14.30	1028	689	9845	7872	673
C	19.22	33.51	956	641	21470	11625	605
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

GSDM SPATIAL DISTRIBUTION (continued)

DURATION = 6.0 Hours							
Ellipse	**Catchment Area Between Ellipse (km^2)**	**Catchment Area Enclosed by Ellipse (km^2)**	**Initial Mean Rainfall Depth (mm)**	**Adjusted Mean Rainfall Depth (mm)**	**Rainfall Volume enclosed by Ellipse ($mm.km^2$)**	**Rainfall Volume between Ellipses ($mm.km^2$)**	**Mean Rainfall Depth between ellipses (mm)**
A	2.60	2.60	1200	804	2087	2087	804
B	11.70	14.30	1094	733	10478	8391	717
C	19.22	33.51	1020	684	22907	12430	647
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	N/A	N/A	N/A	N/A	N/A	N/A	N/A
F	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	N/A	N/A	N/A	N/A	N/A	N/A	N/A

APPENDIX D
XP-RAFTS SUBCATCHMENT OUTPUTS FOR EXISTING CONDITIONS

Existing XP-RAFTS Outputs

Subcatchment ID	63.2% AEP				50% AEP				20% AEP				10% AEP				5% AEP			
	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern
1.01	1.33	1.47	720	4097	1.7	1.92	720	4102	3.25	3.12	270	4014	4.26	4.26	360	4034	5.17	5.11	360	4033
1.02	4.72	5.08	720	4097	6.09	6.82	720	4102	11.37	10.95	270	4014	15.15	15.08	360	4040	18.41	18.6	360	4034
1.03	5.35	5.66	720	4097	6.9	7.69	720	4102	12.8	12.65	270	4014	16.98	17.03	360	4040	20.54	20.29	360	4034
1.04	6.91	7.63	720	4097	8.85	10.08	720	4102	15.94	15.92	720	4102	20.84	21.45	540	4059	25.19	25.58	540	4059
1.05	10.41	11.54	720	4097	13.12	14.81	720	4102	23.43	23.97	270	4016	30.2	30.19	540	4059	36.38	36.21	540	4059
1.06	11.4	12.71	720	4097	14.33	15.92	720	4102	25.46	26.03	270	4016	32.66	32.58	360	4033	39.26	39.17	540	4059
1.07	11.9	13.4	720	4097	14.95	16.39	720	4102	26.52	27.14	270	4016	33.85	33.82	540	4059	40.74	40.57	540	4059
1.08	13.05	14.46	720	4102	16.34	17.65	720	4102	28.75	29.61	270	4016	36.68	37.55	360	4033	44.1	45.05	540	4059
1.09	16.8	18.78	720	4102	20.99	22.98	720	4102	37.01	37.58	270	4016	47.7	48.37	360	4033	57.12	57.22	360	4034
1.10	16.95	18.94	720	4102	21.17	23.15	720	4102	37.3	37.91	270	4016	48.11	48.92	360	4033	57.61	57.56	360	4034
1.11	17.25	19.28	720	4102	21.53	23.54	720	4102	37.9	38.48	270	4016	48.92	49.83	360	4033	58.57	58.37	360	4034
1.12	17.44	19.45	720	4102	21.75	23.73	720	4102	38.23	38.81	270	4016	49.38	50.41	360	4033	59.11	58.72	360	4034
1.13	17.57	19.56	720	4102	21.92	23.84	720	4102	38.46	39.07	270	4016	49.72	50.85	360	4033	59.52	58.94	360	4034
1.14	21.74	23.86	720	4102	27.07	28.9	720	4102	47.82	47.4	270	4016	61.77	61.5	360	4033	73.88	72.45	540	4065
2.01	1.12	1.18	720	4097	1.48	1.68	720	4097	2.79	2.81	360	4046	3.75	3.8	540	4065	4.57	4.57	360	4040
2.02	3.11	3.33	720	4097	4.05	4.58	720	4102	7.6	7.57	360	4046	10.15	10.2	360	4040	12.39	12.34	360	4034
3.01	1.14	1.22	720	4097	1.49	1.68	720	4102	2.8	2.72	270	4014	3.73	3.73	360	4040	4.56	4.52	360	4034
3.02	1.68	1.82	720	4097	2.19	2.47	720	4102	4.12	3.98	270	4014	5.51	5.49	360	4040	6.72	6.69	360	4034
4.01	0.67	0.67	1440	4150	0.8	0.81	1440	4150	1.6	1.65	180	3982	2.15	2.21	120	3944	2.63	2.67	120	3913
5.01	1.63	1.8	1440	4158	1.99	2.13	1440	4158	4.04	4.12	180	3982	4.96	4.85	120	3901	6.21	6.19	120	3901
6.01	1.32	1.46	1440	4158	1.61	1.74	1440	4158	3.25	3.3	180	3982	4.01	3.89	120	3901	5.02	4.98	120	3901
6.02	1.97	2.19	1440	4158	2.4	2.6	1440	4158	4.87	4.97	180	3982	5.98	5.84	540	4060	7.47	7.39	120	3901
6.03	3.2	3.06	1440	4150	3.87	4.09	720	4102	7.53	7.67	180	3982	9.56	9.74	120	3913	11.83	12.02	120	3913
7.01	0.55	0.61	1440	4158	0.67	0.72	1440	4158	1.37	1.39	180	3982	1.67	1.64	120	3901	2.09	2.09	120	3901
8.01	0.54	0.55	1440	4155	0.64	0.66	1440	4155	1.26	1.35	180	3982	1.74	1.75	120	3913	2.14	2.15	90	3915
9.01	1.06	1.06	1440	4150	1.27	1.27	1440	4150	2.57	2.64	180	3982	3.36	3.4	120	3944	4.13	4.25	120	3913
10.01	0.64	0.64	1440	4158	0.77	0.75	1440	4158	1.56	1.59	180	3982	2	2.04	120	3944	2.47	2.51	120	3944
11.01	0.18	0.19	720	4093	0.21	0.23	720	4093	0.47	0.49	120	3956	0.67	0.67	60	3884	0.83	0.85	60	3884
11.02	0.29	0.3	720	4093	0.35	0.35	720	4093	0.74	0.77	120	3956	1.02	1.06	90	3915	1.25	1.29	60	3887
11.03	0.37	0.37	720	4100	0.44	0.43	720	4093	0.91	0.94	120	3956	1.28	1.32	90	3915	1.54	1.53	60	3885
11.04	0.47	0.48	720	4100	0.56	0.55	720	4100	1.13	1.18	120	3956	1.59	1.64	90	3915	1.89	1.85	90	3918
11.05	0.53	0.54	720	4100	0.63	0.63	720	4100	1.25	1.23	120	3955	1.76	1.83	120	3901	2.08	2.26	120	3901
11.06	0.58	0.6	720	4100	0.69	0.69	720	4100	1.34	1.35	120	3955	1.88	1.95	120	3901	2.23	2.39	120	3901
12.01	0.03	0.03	180	3985	0.04	0.04	180	3985	0.1	0.1	120	3952	0.15	0.15	30	3828	0.19	0.19	30	3828
13.01	0.04	0.04	720	4097	0.05	0.05	720	4097	0.1	0.1	120	3956	0.15	0.15	60	3884	0.18	0.18	60	3884
14.01	0.58	0.59	1440	4155	0.69	0.7	1440	4155	1.38	1.46	180	3982	1.89	1.91	120	3913	2.32	2.33	90	3915
14.02	1.16	1.21	1440	4155	1.39	1.42	720	4102	2.81	2.86	120	3955	3.89	3.78	120	3913	4.7	4.73	120	3901
14.03	1.22	1.25	1440	4155	1.46	1.5	720	4102	2.92	2.98	120	3955	4.03	3.97	120	3913	4.87	4.9	120	3901
14.04	1.28	1.3	1440	4155	1.54	1.6	720	4102	3.04	3.11	120	3955	4.2	4.18	120	3913	5.05	5.11	120	3901
14.05	1.75	1.78	1440	4155	2.08	2.19	720	4102	4.04	4.17	120	3956	5.61	5.64	120	3913	6.75	6.74	120	3913
14.06	1.92	1.95	1440	4155	2.28	2.39	720	4102	4.37	4.44	120	3956	6.08	6.13	120	3913	7.29	7.35	120	3913
14.07	1.97	2	1440	4155	2.34	2.46	720	4102	4.46	4.55	120	3956	6.2	6.26	120	3913	7.44	7.46	120	3901
14.08	1.98	2	1440	4155	2.35	2.47	720	4102	4.46	4.55	120	3956	6.21	6.26	120	3913	7.45	7.48	120	3901
14.09	2	2.02	1440	4155	2.37	2.51	720	4102	4.5	4.6	120	3956	6.26	6.32	120	3913	7.52	7.57	120	3913
15.01	0.33	0.37	1440	4154	0.4	0.41	540	4076	0.85	0.9	120	3956	1.22	1.21	60	3883	1.52	1.51	60	3884
16.01	0.05	0.05	720	4097	0.07	0.07	180	3979	0.15	0.16	120	3952	0.21	0.21	60	3882	0.27	0.28	30	3825
17.01	0.12	0.13	720	4097	0.14	0.16	720	4093	0.31	0.33	120	3956	0.45	0.45	60	3884	0.56	0.56	60	3884
17.02	0.49	0.54	1440	4154	0.58	0.58	720	4100	1.23	1.2	120	3955	1.72	1.71	120	3901	2.13	2.13	60	3883
18.01	0.32	0.35	1440	4155	0.37	0.41	1440	4155	0.78	0.77	120	3955	1.08	1.02	120	3901	1.36	1.34	60	3883
19.01	0.12	0.12	720	4097	0.14	0.14	720	4097	0.33	0.33	120	3956	0.47	0.47	60	3884	0.56	0.56	60	3888
20.01	0	0	1440	4149	0	0	1440	4149	0	0	1440	4149	0	0	1440	2625	0	0	1440	2625
21.01	0.17	0.19	1440	4155	0.2	0.2	540	4075	0.43	0.42	120	3955	0.59	0.59	60	3883	0.75	0.74	60	3883
22.01	1.55	1.72	1440	4158	1.89	2.04	1440	4158	3.82	3.89	180	3982	4.69	4.62	540	4060	5.87	5.83	120	3901
22.02	3.97	4.42	1440	4154	4.86	5.18	720	4102	9.66	9.8	180	3982	12	11.67	540	4060	14.8	14.76	120	3901
22.03	4.91	4.64	1440	4150	5.95	6.37	720	4102	11.68	11.86	180	3982	14.59	14	540	4063	17.99	18.34	120	3913
22.04	5.64	5.43	1440	4150	6.85	7.31	720	4102	13.15	13.77	270	4018	16.51	15.88	540	4060	20.31	20.61	120	3913
23.01	1.34	1.47	1440	4154	1.66	1.84	720	4102	3.3	3.34	270	4016	4.15	4.2	180	3969	5.01	4.91	120	3901
24.01	0.9	0.97	1440	4155	1.05	1.14	1440	4155	2.18	2.18	120	3955	3.03	2.87	120	3913	3.79	3.78	60	3883
25.01	1	1	1440	4155	1.19	1.2	1440	4155	2.36	2.49	180	3982	3.25	3.28	120	3913	3.98	4.02	90	3915
26.01	0.67	0.69	1440	4155	0.79	0.82	1440	4155	1.58	1.61	120	3955	2.2	2.17	120	3913	2.69	2.71	90	3915
27.01	0.43	0.47	1440	4154	0.53	0.58	720	4102	1.05	1.04	180	3985	1.31	1.33	180	3969	1.59	1.57	120	3901
28.01	0.41	0.4	1440	4155	0.49	0.48	1440	4155	0.97	1.01	180	3982	1.31	1.34	120	3913	1.6	1.61	90	3915
29.01	0.9	0.95	1440	4155	1.06	1.13	1440	4155	2.15	2.17	120	3955	2.99	2.91	120	3913	3.67	3.69	60	3883
30.01	0.76	0.77	1440	4150	0.91	0.92	1440	4150	1.83	1.89	180	3982	2.46	2.53	120	3944	3	3.06	120	3913
30.02	2.09	2.11	1440	4150	2.54	2.72	720	4102	4.88	5.31	270	4017	6.47	6.43	120	3913	7.97	7.89	120	3901
30.03	5.43	5.24	1440	4150	6.67	7.04	720	4102	12.68	14	270	4018	16.3	16.07	120	3901	20.11	20.13	120	3901
30.04	5.65	5.44	1440	4150	6.98	7.31	720	4102	13.13	14.56	270	4016	16.65	16.46	120	3901	20.53	20.56	120	3901
31.01	0.44	0.45	1440	4155	0.53	0.54	1440	4155	1.05	1.11	180	3982	1.44	1.44	120	3913	1.76	1.77	90	3915
32.01	1.21	1.35	1440	4154	1.49	1.61	1440	4158	3	3.05	180	3982	3.7	3.58	120	3901	4.63	4.59	120	3901
32.02	2.88	3.2	1440	4158	3.5	3.79	1440	4158	7.02	7.07	180	3982	8.78	8.68	120	3901	10.98	10.96	120	3901
33.01	1.07	1.11	1440	4158	1.3	1.31	1440	4158	2.64	2.67	180	3982	3.37	3.5	120	3944	4.19	4.28	120	3944
34.01	0.27	0.3	1440	4155	0.32	0.35	1440	4155	0.68	0.67	120	3955	0.94	0.9	120	3901	1.19	1.18	60	3883

Subcatchment ID	2% AEP				1% AEP				1 in 200				1 in 500				PMF			
	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern
1.01	6.75	7.55	360	3862	7.93	7.96	180	3966	9.2	9.18	180	3966	9.2	9.18	180	3966	120.89	120.89	90	5
1.02	24.12	23.45	360	4025	28.29	31.07	360	3862	32.53	35.63	360	3862	32.53	35.63	360	3862	414.66	414.66	90	5
1.03	26.92	26.57	360	4025	31.41	30.27	360	4025	36	34.37	360	4025	36	34.37	360	4025	447.27	447.27	120	6
1.04	32.48	32.54	360	4025	37.96	37	360	4025	43.31	41.89	360	4025	43.31	41.89	360	4025	527.42	527.42	150	7
1.05	46.43	45.74	360	4025	54.14	52.12	360	4025	61.68	59.12	360	4025	61.68	59.12	360	4025	700.5	700.5	150	7
1.06	49.52	49.51	360	4025	57.76	56.52	360	4025	65.77	64.11	360	4025	65.77	64.11	360	4025	741.15	741.15	180	8
1.07	50.97	51.29	360	4025	59.46	58.52	360	4025	67.79	68.14	270	3992	67.79	68.14	270	3992	765.55	765.55	180	8
1.08	54.8	55.41	360	4025	64.49	64.13	720	3962	73.48	73.04	270	3991	73.48	73.04	270	3991	839.22	839.22	240	9
1.09	71.18	72.7	360	4025	83.41	83.87	360	4025	95.1	95.46	360	4025	95.1	95.46	360	4025	1037.8	1037.8	240	9
1.10	71.79	73.37	360	4025	84.08	84.6	360	4025	95.86	96.36	360	4025	95.86	96.36	360	4025	1046.7	1046.7	240	9
1.11	73.07	74.63	360	4025	85.51	86.16	360	4025	97.55	98.09	360	4025	97.55	98.09	360	4025	1061.3	1061.3	240	9
1.12	73.8	75.35	360	4025	86.37	86.95	360	4025	98.5	98.97	360	4025	98.5	98.97	360	4025	1069.7	1069.7	240	9
1.13	74.36	75.82	360	4025	87.03	87.48	360	4025	99.23	99.54	360	4025	99.23	99.54	360	4025	1075.5	1075.5	240	9
1.14	94.52	95.06	360	4025	109.9	109.45	360	4025	125.21	124.48	360	4025	125.21	124.48	360	4025	1284.6	1284.6	240	9
2.01	5.99	5.89	360	4025	7.08	6.77	360	4025	8.17	9.06	360	3862	8.17	9.06	360	3862	109.55	109.55	90	5
2.02	16.24	15.84	360	4025	19.1	21.06	360	3862	22	24.2	360	3862	22	24.2	360	3862	288.99	288.99	90	5
3.01	5.96	5.75	360	4025	7.03	7.79	360	3862	8.09	8.95	360	3862	8.09	8.95	360	3862	108.69	108.69	90	5
3.02	8.77	8.49	360	4025	10.3	11.38	360	3862	11.85	13.04	360	3862	11.85	13.04	360	3862	158.69	158.69	90	5
4.01	3.24	3.25	60	3876	3.91	3.93	60	3876	4.58	4.6	60	3876	4.58	4.6	60	3876	47.27	47.27	45	3
5.01	7.89	7.88	90	3874	9.46	9.38	90	3874	11.06	10.89	90	3874	11.06	10.89	90	3874	134	134	60	4
6.01	6.37	6.47	180	3964	7.62	7.55	90	3794	8.93	8.81	90	3794	8.93	8.81	90	3794	104.83	104.83	60	4
6.02	9.46	9.64	180	3964	11.26	11.14	90	3874	13.16	12.94	90	3874	13.16	12.94	90	3874	153.42	153.42	60	4
6.03	14.68	15.09	360	4024	17.24	17.28	360	3862	19.77	19.6	360	3862	19.77	19.6	360	3862	230.62	230.62	90	5
7.01	2.66	2.67	90	3874	3.19	3.17	90	3874	3.73	3.68	90	3874	3.73	3.68	90	3874	43.15	43.15	60	4
8.01	2.7	2.65	60	3847	3.2	3.14	60	3876	3.71	3.72	45	3845	3.71	3.72	45	3845	38.35	38.35	45	3
9.01	5.13	5.17	60	3872	6.2	6.15	60	3876	7.28	7.22	60	3876	7.28	7.22	60	3876	85.01	85.01	45	3
10.01	3.1	3.05	90	3874	3.66	3.67	60	3872	4.33	4.32	60	3876	4.33	4.32	60	3876	56.75	56.75	45	3
11.01	1.02	1.08	45	3844	1.21	1.19	30	3815	1.43	1.42	30	3815	1.43	1.42	30	3815	13.83	13.83	15	1
11.02	1.55	1.59	45	3844	1.85	1.91	45	3844	2.13	2.22	45	3844	2.13	2.22	45	3844	21.69	21.69	30	2
11.03	1.89	1.97	45	3844	2.25	2.21	45	3717	2.6	2.56	45	3717	2.6	2.56	45	3717	26.52	26.52	45	3
11.04	2.27	2.32	45	3844	2.72	2.75	45	3844	3.14	3.18	45	3844	3.14	3.18	45	3844	32.44	32.44	45	3
11.05	2.5	2.54	60	3819	2.98	3.02	45	3844	3.44	3.49	45	3844	3.44	3.49	45	3844	35.65	35.65	45	3
11.06	2.67	2.66	60	3871	3.15	3.21	45	3844	3.64	3.6	45	3717	3.64	3.6	45	3717	38.14	38.14	60	4
12.01	0.23	0.23	20	3703	0.27	0.28	20	3753	0.32	0.32	20	3753	0.32	0.32	20	3753	2.73	2.73	15	1
13.01	0.22	0.22	30	3815	0.27	0.27	30	3815	0.32	0.32	30	3815	0.32	0.32	30	3815	3.51	3.51	15	1
14.01	2.91	2.87	60	3847	3.46	3.41	60	3876	4.02	3.98	60	3876	4.02	3.98	60	3876	45.69	45.69	30	2
14.02	5.68	5.7	60	3873	6.74	7.02	45	3844	7.88	8.19	45	3844	7.88	8.19	45	3844	87.27	87.27	45	3
14.03	5.85	5.86	60	3819	6.92	7.02	60	3819	8.05	8.32	45	3844	8.05	8.32	45	3844	90.71	90.71	45	3
14.04	6.04	6.1	60	3819	7.15	7.14	60	3871	8.3	8.39	60	3871	8.3	8.39	60	3871	94.24	94.24	45	3
14.05	7.84	7.91	60	3871	9.25	9.38	60	3875	10.7	10.76	60	3875	10.7	10.76	60	3875	123.22	123.22	60	4
14.06	8.39	8.43	60	3871	9.91	9.98	60	3819	11.44	11.46	60	3819	11.44	11.46	60	3819	131.78	131.78	60	4
14.07	8.52	8.53	360	3862	10.04	10.08	60	3819	11.59	11.57	60	3819	11.59	11.57	60	3819	134.4	134.4	90	5
14.08	8.54	8.55	360	3862	10.04	10.09	60	3819	11.59	11.57	60	3819	11.59	11.57	60	3819	134.79	134.79	90	5
14.09	8.61	8.63	360	3862	10.11	10.14	60	3819	11.66	11.63	60	3819	11.66	11.63	60	3819	136.27	136.27	90	5
15.01	1.84	1.81	45	3845	2.22	2.36	45	3844	2.59	2.73	45	3844	2.59	2.73	45	3844	26.37	26.37	30	2
16.01	0.33	0.35	25	3704	0.4	0.41	20	3691	0.48	0.48	20	3703	0.48	0.48	20	3703	4.77	4.77	15	1
17.01	0.68	0.71	45	3844	0.82	0.79	30	3815	0.96	0.96	30	3815	0.96	0.96	30	3815	10.65	10.65	15	1
17.02	2.59	2.55	45	3845	3.13	3.05	45	3717	3.64	3.54	45	3717	3.64	3.54	45	3717	43.22	43.22	30	2
18.01	1.64	1.64	45	3845	1.98	1.97	45	3845	2.33	2.27	45	3845	2.33	2.27	45	3845	28.22	28.22	30	2
19.01	0.71	0.7	30	3815	0.86	0.87	30	3815	1.01	1.04	25	3704	1.01	1.04	25	3704	11.17	11.17	15	1
20.01	0	0	1440	2520	0	0	1440	2520	0	0	1440	2520	0	0	1440	2520	0	0	15	1
21.01	0.9	0.9	45	3845	1.09	1.08	45	3845	1.28	1.24	45	3845	1.28	1.24	45	3845	15.35	15.35	30	2
22.01	7.47	7.57	180	3964	8.94	8.87	90	3874	10.47	10.32	90	3874	10.47	10.32	90	3874	124.78	124.78	60	4
22.02	18.72	19.4	180	3964	22.15	22.37	180	3964	25.47	25.1	90	3794	25.47	25.1	90	3794	320.32	320.32	90	5
22.03	22.8	22.59	360	4024	26.63	27.56	360	3862	30.53	31.23	360	3862	30.53	31.23	360	3862	378.99	378.99	90	5
22.04	25.91	26.28	360	4024	30.11	31.37	360	3862	34.4	35.53	360	3862	34.4	35.53	360	3862	418.78	418.78	90	5
23.01	6.56	6.64	180	3965	7.84	7.96	180	3964	9.05	8.99	90	3874	9.05	8.99	90	3874	121.91	121.91	60	4
24.01	4.62	4.59	60	3873	5.55	5.54	45	3845	6.51	6.44	45	3845	6.51	6.44	45	3845	64.45	64.45	30	2
25.01	4.97	4.93	60	3876	5.92	5.88	60	3876	6.88	6.87	60	3876	6.88	6.87	60	3876	69.5	69.5	45	3
26.01	3.37	3.33	60	3873	3.98	3.94	60	3876	4.67	4.68	45	3845	4.67	4.68	45	3845	46.26	46.26	45	3
27.01	2.08	2.09	180	3965	2.48	2.5	180	3964	2.88	2.86	90	3874	2.88	2.86	90	3874	39.38	39.38	60	4
28.01	2.01	1.98	60	3847	2.4	2.37	60	3876	2.8	2.76	60	3876	2.8	2.76	60	3876	31.05	31.05	45	3
29.01	4.58	4.52	60	3873	5.42	5.43	45	3845	6.38	6.38	45	3845	6.38	6.38	45	3845	60.88	60.88	30	2
30.01	3.71	3.72	60	3876	4.48	4.49	60	3876	5.25	5.26	60	3876	5.25	5.26	60	3876	59.31	59.31	45	3
30.02	9.38	9.54	90	3890	11.15	11.02	90	3902	12.94	13.03	90	3902	12.94	13.03	90	3902	159.48	159.48	90	5
30.03	24.46	25.31	360	3862	28.98	29.12	270	3683	33.2	34.46	270	3683	33.2	34.46	270	3683	407.83	407.83	90	5
30.04	25.34	23.75	270	3994	29.99	29.54	270	3683	34.32	34.91	270	3683	34.32	34.91	270	3683	416.43	416.43	90	5
31.01	2.22	2.18	60	3847	2.64	2.59	60	3876	3.06	3.02	60	3876	3.06	3.02	60	3876	34.09	34.09	30	2
32.01	5.88	5.84	180	3965	7.03	6.97	90	3794	8.25	8.15	90	3794	8.25	8.15	90	3794	97.24	97.24	60	4
32.02	13.6	13.41	90	3907	16.18	15.92	90	3794	18.83	18.65	90	3794	18.83	18.65	90	3794	223.39	223.39	90	5
33.01	5.25	5.18	90	3907	6.2	6.06	90	3794	7.2	7.07	90	3794	7.2	7.07	90	3794	83.41	83.41	45	3
34.01	1.42	1.43	45	3845	1.73	1.71	45	3845	2.03	1.98	45	3845	2.03	1.98	45	3845	18.84	18.84	30	2

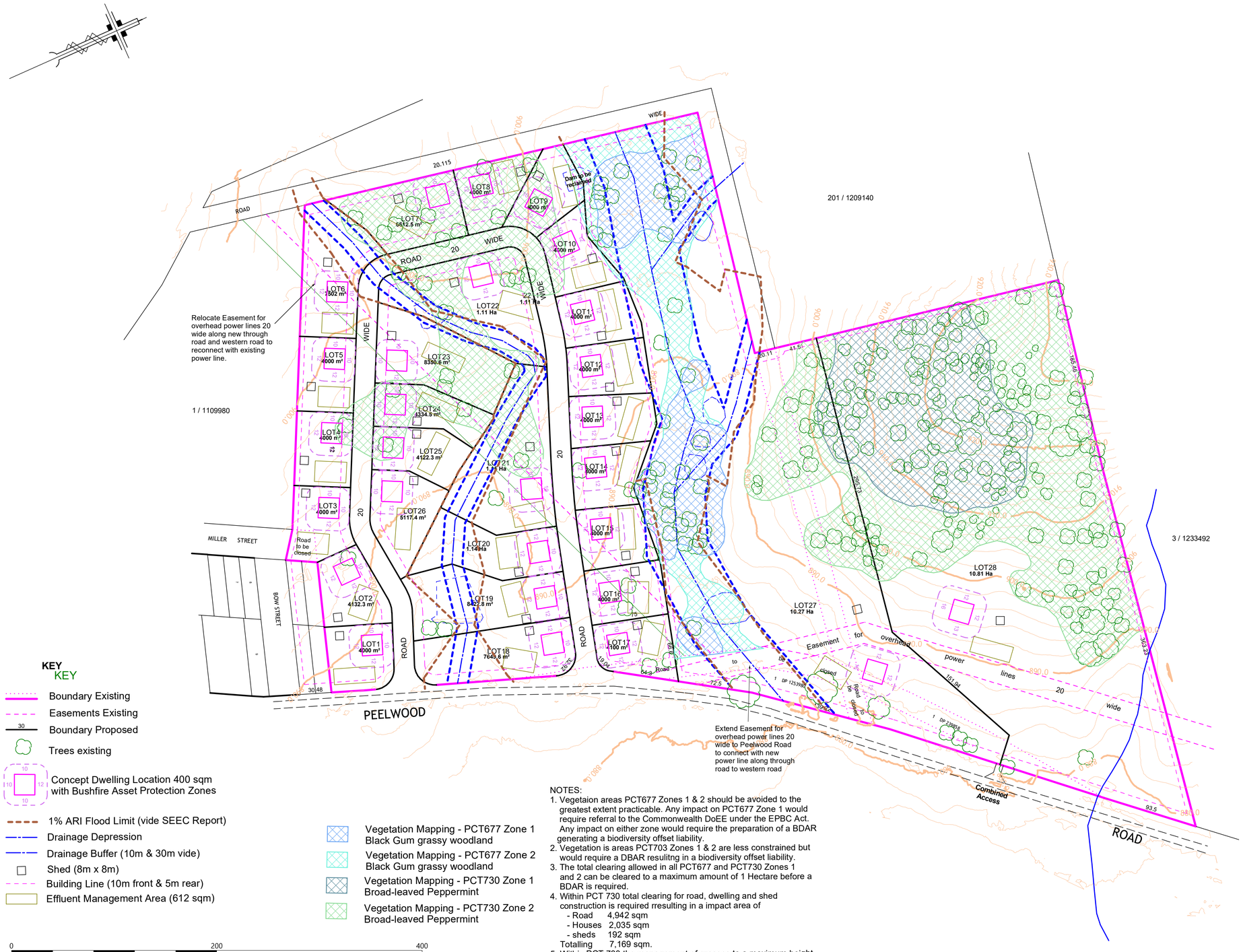
APPENDIX E
BLOCKAGE ASSESSMENT

STRUCTURE BLOCKAGE ASSESSMENT

Peelwood Road, Laggan Flood Assessment

Structure ID	Roadway		Structure Type	Structure Dimensions			Land Use Across Upstream Catchment	Max. L10 (m)	Control Dimension	Main Stream Slope (%)	Debris Availability (L, M, H)	Debris Mobility (L, M, H)	Debris Transportability (L, M, H)	Debris Potential	Debris Potential at Structure	Adjustment for AEP			Design Blockage Level		
				Dia/Width /Span	Height	Cells / Spans										AEP >5%	AEP 5%-0.5%	AEP < 0.5%	AEP >5%	AEP 5%-0.5%	AEP < 0.5%
ExCulv_Culv3	Peelwood Rd	C	Pipe Culvert	0.45	0	2	95% Grass, 5% Trees	0.50	W<L	2.94	L	M	M	**LMM**	Low	Low	Low	Medium	25%	25%	50%
ExCSS01	Woodhouselee Road	C	Pipe Culvert	0.75	0	4	95% Grass, 5% Trees	0.50	L<W<3L	2.34	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%
ExCSS02	Laggan-Taralga Road	R	Box Culvert	3	2.1	3	95% Grass, 5% Trees	0.50	W>3L	2.18	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	0%
ExCSS04	Peelwood Rd	C	Pipe Culvert	0.45	0	2	95% Grass, 5% Trees	0.50	W<L	3.13	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%
ExCSS06	Redground Heights Road	C	Pipe Culvert	0.375	0	1	95% Grass, 5% Trees	0.50	W<L	3.97	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%
ExCSS07	Woodhouselee Road	C	Pipe Culvert	0.75	0	2	95% Grass, 5% Trees	0.50	L<W<3L	2.39	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%
ExCSS06a	Redground Heights Road	C	Pipe Culvert	0.45	0	1	95% Grass, 5% Trees	0.50	W<L	4.91	L	M	H	**LMH**	Medium	Low	Medium	High	25%	50%	100%
ExCSS06b	Redground Heights Road	C	Pipe Culvert	0.6	0	1	95% Grass, 5% Trees	0.50	L<W<3L	2.94	L	M	M	**LMM**	Low	Low	Low	Medium	0%	0%	10%
CSS01_culv1	Peelwood Rd	C	Pipe Culvert	1.05	0	3	95% Grass, 5% Trees	0.50	L<W<3L	4.16	L	M	H	**LMH**	Low	Low	Low	Medium	0%	0%	10%
CSS02_Culv2	Peelwood Rd	C	Pipe Culvert	1.05	0	0	95% Grass, 5% Trees	0.50	L<W<3L	4.19	L	M	H	**LMH**	Low	Low	Low	Medium	0%	0%	10%
CSS_DEV01	Proposed Internal Road	R	Box Culvert	2.4	0.75	6	95% Grass, 5% Trees	0.50	W>3L	3.8	L	M	H	**LMH**	Low	Low	Low	Medium	0%	0%	0%

APPENDIX F
CONCEPT DESIGN



NOTES:

1. Vegetaion areas PCT677 Zones 1 & 2 should be avoided to the greatest extent practicable. Any impact on PCT677 Zone 1 would require referral to the Commonwealth DoEE under the EPBC Act. Any impact on either zone would require the preparation of a BDAR generating a biodiversity offset liability.
2. Vegetation is areas PCT703 Zones 1 & 2 are less constrained but would require a DBAR resulitng in a biodiversity offset liability.
3. The total clearing allowed in all PCT677 and PCT730 Zones 1 and 2 can be cleared to a maximum amount of 1 Hectare before a BDAR is required.
4. Within PCT 730 total clearing for road, dwelling and shed construction is required rresulting in a impact area of
   - Road 4,942 sqm
   - Houses 2,035 sqm
   - sheds 192 sqm

   Totalling 7,169 sqm.
5. Within PCT 730 the management of grasses to a maximum height of 100mm is required within Asset Protection Zones resulting in the management of 4,950 sqm (not needing the removal of any tree).

Issue	Amendment	Date
I	Adjusted Bldg APZ's to match Bushfire Report	29/11/2023
H	Adjusted waterway buffers	13/10/2023
G	Amend Design for Flooding	23/2/2023

Surveyed : Southern Cross Consulting Sjurveyors
Designed : R Mowle
Drawn : K Allen
Checked : R Mowle
Datum : AHD
Laterals Ref : 1820

SCALE
1:2000

Sheet No.	No. of Sheets	Sheet size
4	4	A1

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Sheet Subject
SUBDIVISION AND DEVELOPMENT PLAN

UPPER LACHLAN SHIRE COUNCIL

PROPOSED REZONING AND POTENTIAL SUBDIVISION

LOT 2 DP 1233492, LOT 1 DP 239858, LOT1 DP 1253980 AND ROADS PROPOSED TO BE CLOSED

APPENDIX G
XP-RAFTS SUBCATCHMENT OUTPUTS FOR POST-DEVELOPMENT CONDITIONS

Post Development XP-RAFTS Outputs

Subcatchment ID	63.2% AEP				50% AEP				20% AEP			
	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern
1.01	1.33	1.47	720	4097	1.7	1.92	720	4102	3.25	3.12	270	4014
1.02	4.72	5.08	720	4097	6.09	6.82	720	4102	11.37	10.95	270	4014
1.03	5.35	5.66	720	4097	6.9	7.69	720	4102	12.8	12.65	270	4014
1.04	6.91	7.63	720	4097	8.85	10.08	720	4102	15.94	15.92	720	4102
1.05	10.41	11.54	720	4097	13.12	14.81	720	4102	23.43	23.97	270	4016
1.06	11.4	12.71	720	4097	14.33	15.92	720	4102	25.46	26.03	270	4016
1.07	11.9	13.4	720	4097	14.95	16.38	720	4102	26.51	27.12	270	4016
1.08	13.04	14.42	720	4102	16.33	17.61	720	4102	28.71	29.61	270	4016
1.09	16.8	18.76	720	4102	20.99	22.96	720	4102	36.96	37.63	270	4016
1.10	16.95	18.92	720	4102	21.17	23.13	720	4102	37.26	37.95	270	4016
1.11	17.25	19.26	720	4102	21.53	23.52	720	4102	37.86	38.53	270	4016
1.12	17.44	19.44	720	4102	21.76	23.7	720	4102	38.19	38.86	270	4016
1.13	17.58	19.55	720	4102	21.93	23.82	720	4102	38.42	39.12	270	4016
1.14	21.75	23.86	720	4102	27.08	28.87	720	4102	47.84	47.33	270	4016
2.01	1.12	1.18	720	4097	1.48	1.68	720	4097	2.79	2.81	360	4046
2.02	3.11	3.33	720	4097	4.05	4.58	720	4102	7.6	7.57	360	4046
3.01	1.14	1.22	720	4097	1.49	1.68	720	4102	2.8	2.72	270	4014
3.02	1.68	1.82	720	4097	2.19	2.47	720	4102	4.12	3.98	270	4014
4.01	0.67	0.67	1440	4150	0.8	0.81	1440	4150	1.6	1.65	180	3982
5.01	1.63	1.8	1440	4158	1.99	2.13	1440	4158	4.04	4.12	180	3982
6.01	1.32	1.46	1440	4158	1.61	1.74	1440	4158	3.25	3.3	180	3982
6.02	1.97	2.19	1440	4158	2.4	2.6	1440	4158	4.87	4.97	180	3982
6.03	3.2	3.06	1440	4150	3.87	4.09	720	4102	7.53	7.67	180	3982
7.01	0.55	0.61	1440	4158	0.67	0.72	1440	4158	1.37	1.39	180	3982
8.01	0.54	0.55	1440	4155	0.64	0.66	1440	4155	1.26	1.35	180	3982
9.01	1.06	1.06	1440	4150	1.27	1.27	1440	4150	2.57	2.64	180	3982
10.01	0.64	0.64	1440	4158	0.77	0.75	1440	4158	1.56	1.59	180	3982
11.01	0.18	0.19	720	4093	0.21	0.23	720	4093	0.47	0.49	120	3956
11.02	0.29	0.3	720	4093	0.35	0.35	720	4093	0.74	0.77	120	3956
11.03	0.37	0.37	720	4100	0.44	0.43	720	4100	0.88	0.9	120	3956
11.04	0.47	0.52	1440	4154	0.55	0.56	720	4100	1.08	1.08	120	3955
11.05	0.53	0.58	1440	4155	0.62	0.64	720	4100	1.21	1.22	120	3955
11.06	0.58	0.63	1440	4155	0.68	0.7	720	4100	1.32	1.34	120	3955
12.01	0.03	0.03	180	3985	0.04	0.04	180	3985	0.1	0.1	120	3952
13.01	0.05	0.05	10	3714	0.06	0.06	10	3714	0.12	0.12	120	3956
14.01	0.58	0.59	1440	4155	0.69	0.7	1440	4155	1.38	1.46	180	3982
14.02	1.16	1.21	1440	4155	1.39	1.42	720	4102	2.81	2.86	120	3955
14.03	1.22	1.25	1440	4155	1.46	1.5	720	4102	2.92	2.98	120	3955
14.04	1.28	1.29	1440	4155	1.53	1.59	720	4102	3.02	3.09	120	3955
14.05	1.74	1.76	1440	4155	2.07	2.18	720	4102	4	4.12	120	3956
14.06	1.91	1.92	1440	4155	2.27	2.39	720	4102	4.32	4.38	120	3956
14.07	1.96	1.96	1440	4155	2.33	2.46	720	4102	4.4	4.66	270	4021
14.08	1.96	1.96	1440	4155	2.34	2.47	720	4102	4.41	4.66	270	4021
14.09	1.98	1.98	1440	4155	2.37	2.5	720	4102	4.46	4.71	270	4021
15.01	0.33	0.37	1440	4154	0.4	0.41	540	4076	0.85	0.9	120	3956
16.01	0.05	0.05	720	4097	0.07	0.07	180	3979	0.15	0.16	120	3952
17.01	0.12	0.13	720	4097	0.14	0.16	720	4093	0.31	0.33	120	3956
17.02	0.49	0.54	1440	4154	0.58	0.58	720	4100	1.23	1.2	120	3955
18.01	0.32	0.35	1440	4155	0.37	0.41	1440	4155	0.78	0.77	120	3955
19.01	0.12	0.12	720	4097	0.14	0.14	720	4097	0.33	0.33	120	3956
20.01	0	0	1440	4149	0	0	1440	4149	0	0	1440	4149
21.01	0.17	0.19	1440	4154	0.2	0.2	540	4075	0.43	0.42	120	3955
22.01	1.55	1.72	1440	4158	1.89	2.04	1440	4158	3.82	3.89	180	3982
22.02	3.97	4.42	1440	4154	4.86	5.18	720	4102	9.66	9.8	180	3982
22.03	4.91	4.64	1440	4150	5.95	6.37	720	4102	11.68	11.86	180	3982
22.04	5.64	5.43	1440	4150	6.85	7.31	720	4102	13.15	13.77	270	4018
23.01	1.34	1.47	1440	4154	1.66	1.84	720	4102	3.3	3.34	270	4016
24.01	0.9	0.97	1440	4155	1.05	1.14	1440	4155	2.18	2.18	120	3955
25.01	1	1	1440	4155	1.19	1.2	1440	4155	2.36	2.49	180	3982
26.01	0.67	0.69	1440	4155	0.79	0.82	1440	4155	1.58	1.61	120	3955
27.01	0.43	0.47	1440	4154	0.53	0.58	720	4102	1.05	1.04	180	3985
28.01	0.41	0.4	1440	4155	0.49	0.48	1440	4155	0.97	1.01	180	3982
29.01	0.9	0.95	1440	4155	1.06	1.13	1440	4155	2.15	2.17	120	3955
30.01	0.76	0.77	1440	4150	0.91	0.92	1440	4150	1.83	1.89	180	3982
30.02	2.09	2.11	1440	4150	2.54	2.72	720	4102	4.88	5.31	270	4017
30.03	5.43	5.24	1440	4150	6.67	7.04	720	4102	12.68	14	270	4018
30.04	5.65	5.44	1440	4150	6.98	7.31	720	4102	13.13	14.56	270	4016
31.01	0.44	0.45	1440	4155	0.53	0.54	1440	4155	1.05	1.11	180	3982
32.01	1.21	1.35	1440	4154	1.49	1.61	1440	4158	3	3.05	180	3982
32.02	2.88	3.2	1440	4158	3.5	3.79	1440	4158	7.02	7.07	180	3982
33.01	1.07	1.11	1440	4158	1.3	1.31	1440	4158	2.64	2.67	180	3982
34.01	0.27	0.3	1440	4155	0.32	0.35	1440	4155	0.68	0.67	120	3955

Subcatchment ID	10% AEP				5% AEP				2% AEP				1% AEP			
	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern
1.01	4.26	4.26	360	4034	5.17	5.11	360	4033	6.75	7.55	360	3862	7.93	7.96	180	3966
1.02	15.15	15.08	360	4040	18.41	18.6	360	4034	24.12	23.45	360	4025	28.29	31.07	360	3862
1.03	16.98	17.03	360	4040	20.54	20.29	360	4034	26.92	26.57	360	4025	31.41	30.27	360	4025
1.04	20.84	21.45	540	4059	25.19	25.58	540	4059	32.48	32.54	360	4025	37.96	37	360	4025
1.05	30.2	30.19	540	4059	36.38	36.21	540	4059	46.43	45.74	360	4025	54.14	52.12	360	4025
1.06	32.66	32.58	360	4033	39.26	39.17	540	4059	49.52	49.51	360	4025	57.76	56.52	360	4025
1.07	33.85	33.82	540	4059	40.74	40.58	540	4059	50.95	51.23	360	4025	59.44	58.45	360	4025
1.08	36.65	37.59	360	4033	44.07	44.96	540	4059	54.77	55.35	360	4025	64.4	64	720	3962
1.09	47.62	48.35	360	4033	57.03	57.06	360	4034	71.05	72.57	360	4025	83.26	83.72	360	4025
1.10	48.03	48.91	360	4033	57.51	57.4	360	4034	71.66	73.23	360	4025	83.95	84.47	360	4025
1.11	48.85	49.82	360	4033	58.53	58.21	360	4034	72.93	74.52	360	4025	85.4	86.04	360	4025
1.12	49.33	50.4	360	4033	59.09	58.57	360	4034	73.68	75.25	360	4025	86.22	86.85	360	4025
1.13	49.68	50.84	360	4033	59.49	58.79	360	4034	74.24	75.73	360	4025	86.88	87.38	360	4025
1.14	61.81	61.51	360	4033	73.87	74.1	360	4033	94.53	95.12	360	4025	109.88	109.52	360	4025
2.01	3.75	3.8	540	4065	4.57	4.57	360	4040	5.99	5.89	360	4025	7.08	6.77	360	4025
2.02	10.15	10.2	360	4040	12.39	12.34	360	4034	16.24	15.84	360	4025	19.1	21.06	360	3862
3.01	3.73	3.73	360	4040	4.56	4.52	360	4034	5.96	5.75	360	4025	7.03	7.79	360	3862
3.02	5.51	5.49	360	4040	6.72	6.69	360	4034	8.77	8.49	360	4025	10.3	11.38	360	3862
4.01	2.15	2.21	120	3944	2.63	2.67	120	3913	3.24	3.25	60	3876	3.91	3.93	60	3876
5.01	4.96	4.85	120	3901	6.21	6.19	120	3901	7.89	7.88	90	3874	9.46	9.38	90	3874
6.01	4.01	3.89	120	3901	5.02	4.98	120	3901	6.37	6.47	180	3964	7.62	7.55	90	3794
6.02	5.98	5.84	540	4060	7.47	7.39	120	3901	9.46	9.64	180	3964	11.26	11.14	90	3874
6.03	9.56	9.74	120	3913	11.83	12.02	120	3913	14.68	15.09	360	4024	17.24	17.28	360	3862
7.01	1.67	1.64	120	3901	2.09	2.09	120	3901	2.66	2.67	90	3874	3.19	3.17	90	3874
8.01	1.74	1.75	120	3913	2.14	2.15	90	3915	2.7	2.65	60	3847	3.2	3.14	60	3876
9.01	3.36	3.4	120	3944	4.13	4.25	120	3913	5.13	5.17	60	3872	6.2	6.15	60	3876
10.01	2	2.04	120	3944	2.47	2.51	120	3944	3.1	3.05	90	3874	3.66	3.67	60	3872
11.01	0.67	0.67	60	3884	0.83	0.85	60	3884	1.02	1.08	45	3844	1.21	1.19	30	3815
11.02	1.02	1.06	90	3915	1.25	1.29	60	3887	1.55	1.59	45	3844	1.85	1.91	45	3844
11.03	1.24	1.29	90	3915	1.49	1.48	90	3918	1.82	1.89	45	3844	2.18	2.15	45	3717
11.04	1.5	1.55	120	3901	1.79	1.92	120	3901	2.18	2.18	60	3875	2.57	2.55	45	3842
11.05	1.66	1.69	120	3901	1.97	1.92	120	3913	2.44	2.45	60	3871	2.85	2.87	60	3877
11.06	1.79	1.79	120	3913	2.13	2.1	120	3913	2.65	2.65	60	3819	3.09	3.09	60	3877
12.01	0.15	0.15	30	3828	0.19	0.19	30	3828	0.23	0.23	20	3703	0.27	0.28	20	3753
13.01	0.16	0.17	60	3888	0.2	0.21	30	3824	0.25	0.26	30	3815	0.31	0.31	20	3703
14.01	1.89	1.91	120	3913	2.32	2.33	90	3915	2.91	2.87	60	3847	3.46	3.41	60	3876
14.02	3.89	3.78	120	3913	4.7	4.73	120	3901	5.68	5.7	60	3873	6.74	7.02	45	3844
14.03	4.03	3.97	120	3913	4.87	4.9	120	3901	5.85	5.86	60	3819	6.92	7.02	60	3819
14.04	4.18	4.15	120	3913	5.03	5.11	120	3901	5.99	6.06	60	3819	7.1	7.1	60	3871
14.05	5.56	5.59	120	3913	6.69	6.68	120	3913	7.76	7.83	60	3871	9.15	9.31	60	3875
14.06	6.02	6.08	120	3913	7.23	7.23	120	3901	8.32	8.32	360	4023	9.78	9.88	60	3819
14.07	6.13	6.19	120	3913	7.36	7.42	120	3901	8.46	8.47	360	3862	9.88	9.96	60	3819
14.08	6.14	6.2	120	3913	7.37	7.44	120	3913	8.47	8.47	360	4023	9.89	9.96	60	3819
14.09	6.19	6.26	120	3913	7.45	7.51	120	3913	8.54	8.54	360	4023	9.95	10.01	60	3819
15.01	1.22	1.21	60	3883	1.52	1.51	60	3884	1.84	1.81	45	3845	2.22	2.36	45	3844
16.01	0.21	0.21	60	3882	0.27	0.28	30	3825	0.33	0.35	25	3704	0.4	0.41	20	3691
17.01	0.45	0.45	60	3884	0.56	0.56	60	3884	0.68	0.71	45	3844	0.82	0.79	30	3815
17.02	1.72	1.71	120	3901	2.13	2.13	60	3883	2.59	2.55	45	3845	3.13	3.05	45	3717
18.01	1.08	1.02	120	3901	1.36	1.34	60	3883	1.64	1.64	45	3845	1.98	1.97	45	3845
19.01	0.47	0.47	60	3884	0.56	0.56	60	3888	0.71	0.7	30	3815	0.86	0.87	30	3815
20.01	0	0	1440	2625	0	0	1440	2625	0	0	1440	2520	0	0	1440	2520
21.01	0.6	0.6	60	3883	0.76	0.75	60	3883	0.92	0.92	45	3845	1.11	1.09	45	3845
22.01	4.69	4.62	540	4060	5.87	5.83	120	3901	7.47	7.57	180	3964	8.94	8.87	90	3874
22.02	12	11.67	540	4060	14.8	14.76	120	3901	18.72	19.4	180	3964	22.15	22.37	180	3964
22.03	14.59	14	540	4063	17.99	18.34	120	3913	22.8	22.59	360	4024	26.63	27.56	360	3862
22.04	16.51	15.88	540	4060	20.31	20.61	120	3913	25.91	26.28	360	4024	30.11	31.37	360	3862
23.01	4.15	4.2	180	3969	5.01	4.91	120	3901	6.56	6.64	180	3965	7.84	7.96	180	3964
24.01	3.03	2.87	120	3913	3.79	3.78	60	3883	4.62	4.59	60	3873	5.55	5.54	45	3845
25.01	3.25	3.28	120	3913	3.98	4.02	90	3915	4.97	4.93	60	3876	5.92	5.88	60	3876
26.01	2.2	2.17	120	3913	2.69	2.71	90	3915	3.37	3.33	60	3873	3.98	3.94	60	3876
27.01	1.31	1.33	180	3969	1.59	1.57	120	3901	2.08	2.09	180	3965	2.48	2.5	180	3964
28.01	1.31	1.34	120	3913	1.6	1.61	90	3915	2.01	1.98	60	3847	2.4	2.37	60	3876
29.01	2.99	2.91	120	3913	3.67	3.69	60	3883	4.58	4.52	60	3873	5.42	5.43	45	3845
30.01	2.46	2.53	120	3944	3	3.06	120	3913	3.71	3.72	60	3876	4.48	4.49	60	3876
30.02	6.47	6.43	120	3913	7.97	7.89	120	3901	9.38	9.54	90	3890	11.15	11.02	90	3902
30.03	16.3	16.07	120	3901	20.11	20.13	120	3901	24.46	25.31	360	3862	28.98	29.12	270	3683
30.04	16.65	16.46	120	3901	20.53	20.56	120	3901	25.34	23.75	270	3994	29.99	29.54	270	3683
31.01	1.44	1.44	120	3913	1.76	1.77	90	3915	2.22	2.18	60	3847	2.64	2.59	60	3876
32.01	3.7	3.58	120	3901	4.63	4.59	120	3901	5.88	5.84	180	3965	7.03	6.97	90	3794
32.02	8.78	8.68	120	3901	10.98	10.96	120	3901	13.6	13.41	90	3907	16.18	15.92	90	3794
33.01	3.37	3.5	120	3944	4.19	4.28	120	3944	5.25	5.18	90	3907	6.2	6.06	90	3794
34.01	0.94	0.9	120	3901	1.19	1.18	60	3883	1.42	1.43	45	3845	1.73	1.71	45	3845

Subcatchment ID	1 in 200				1 in 500				PMF			
	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern	Average Discharge (m3/s)	Critical Discharge (m3/s)	Critical Duration (mins)	Critical Temporal Pattern
1.01	9.2	9.18	180	3966	10.92	10.92	180	3965	120.89	120.89	90	5
1.02	32.53	35.63	360	3862	38.28	41.71	360	3862	414.66	414.66	90	5
1.03	36	34.37	360	4025	42.18	46.23	360	3862	447.27	447.27	120	6
1.04	43.31	41.89	360	4025	50.84	50.88	270	3991	527.42	527.42	150	7
1.05	61.68	59.12	360	4025	71.74	77.6	360	3862	700.5	700.5	150	7
1.06	65.77	64.11	360	4025	76.58	75.33	270	3992	741.15	741.15	180	8
1.07	67.75	68.05	270	3992	79.31	79.71	270	3992	765.18	765.18	180	8
1.08	73.39	73.03	270	3991	85.82	85.84	270	3991	838.68	838.68	240	9
1.09	94.94	95.3	360	4025	110.61	110.79	360	4025	1037.6	1037.6	240	9
1.10	95.7	96.22	360	4025	111.53	111.87	360	4025	1046.4	1046.4	240	9
1.11	97.39	97.97	360	4025	113.48	113.86	360	4025	1061	1061	240	9
1.12	98.33	98.86	360	4025	114.54	114.84	360	4025	1069.5	1069.5	240	9
1.13	99.07	99.43	360	4025	115.39	115.47	360	4025	1075.3	1075.3	240	9
1.14	125.18	124.54	360	4025	145.65	144.57	360	4025	1284.6	1284.6	240	9
2.01	8.17	9.06	360	3862	9.64	10.66	360	3862	109.55	109.55	90	5
2.02	22	24.2	360	3862	25.93	28.37	360	3862	288.99	288.99	90	5
3.01	8.09	8.95	360	3862	9.54	9.54	180	3966	108.69	108.69	90	5
3.02	11.85	13.04	360	3862	14	14.1	180	3966	158.69	158.69	90	5
4.01	4.58	4.6	60	3876	5.47	5.5	60	3876	47.27	47.27	45	3
5.01	11.06	10.89	90	3874	13.21	12.96	90	3794	134	134	60	4
6.01	8.93	8.81	90	3794	10.69	10.54	90	3794	104.83	104.83	60	4
6.02	13.16	12.94	90	3874	15.72	15.4	90	3794	153.42	153.42	60	4
6.03	19.77	19.6	360	3862	23.19	22.96	360	4023	230.62	230.62	90	5
7.01	3.73	3.68	90	3874	4.45	4.36	90	3794	43.15	43.15	60	4
8.01	3.71	3.72	45	3845	4.51	4.5	45	3845	38.35	38.35	45	3
9.01	7.28	7.22	60	3876	8.72	8.63	60	3876	85.01	85.01	45	3
10.01	4.33	4.32	60	3876	5.23	5.22	60	3876	56.75	56.75	45	3
11.01	1.43	1.42	30	3815	1.74	1.74	30	3815	13.83	13.83	15	1
11.02	2.13	2.22	45	3844	2.53	2.51	45	3842	21.69	21.69	30	2
11.03	2.53	2.51	45	3717	3.02	3.07	45	3844	26.24	26.24	45	3
11.04	2.99	2.97	45	3842	3.56	3.55	45	3842	31.75	31.75	45	3
11.05	3.27	3.27	60	3877	3.86	3.86	45	3826	34.74	34.74	45	3
11.06	3.54	3.54	60	3877	4.15	4.14	60	3877	37.44	37.44	60	4
12.01	0.32	0.32	20	3753	0.37	0.37	20	3753	2.73	2.73	15	1
13.01	0.36	0.37	20	3703	0.44	0.44	20	3703	3.75	3.75	15	1
14.01	4.02	3.98	60	3876	4.87	4.87	45	3845	45.69	45.69	30	2
14.02	7.88	8.19	45	3844	9.46	9.8	45	3844	87.27	87.27	45	3
14.03	8.05	8.32	45	3844	9.65	9.94	45	3844	90.71	90.71	45	3
14.04	8.24	8.34	60	3871	9.83	10.05	45	3844	93.75	93.75	45	3
14.05	10.58	10.6	60	3875	12.51	12.55	60	3875	122.71	122.71	60	4
14.06	11.31	11.35	60	3819	13.35	13.29	60	3819	131.12	131.12	60	4
14.07	11.42	11.43	60	3819	13.47	13.38	60	3819	134.09	134.09	90	5
14.08	11.42	11.43	60	3819	13.47	13.38	60	3819	134.46	134.46	90	5
14.09	11.49	11.49	60	3819	13.56	13.76	60	3877	135.91	135.91	90	5
15.01	2.59	2.73	45	3844	3.11	3.07	30	3815	26.37	26.37	30	2
16.01	0.48	0.48	20	3703	0.57	0.58	20	3703	4.77	4.77	15	1
17.01	0.96	0.96	30	3815	1.17	1.18	30	3815	10.65	10.65	15	1
17.02	3.64	3.54	45	3717	4.35	4.23	45	3717	43.22	43.22	30	2
18.01	2.33	2.27	45	3845	2.81	2.97	45	3844	28.22	28.22	30	2
19.01	1.01	1.04	25	3704	1.21	1.24	25	3704	11.17	11.17	15	1
20.01	0	0	1440	2520	0	0	15	3716	0	0	15	1
21.01	1.3	1.38	45	3844	1.56	1.65	45	3844	15.43	15.43	30	2
22.01	10.47	10.32	90	3874	12.53	12.32	90	3794	124.78	124.78	60	4
22.02	25.47	25.1	90	3794	30.46	30.66	90	3794	320.32	320.32	90	5
22.03	30.53	31.23	360	3862	35.78	36.13	360	3862	378.99	378.99	90	5
22.04	34.4	35.53	360	3862	40.19	41.08	360	3862	418.78	418.78	90	5
23.01	9.05	8.99	90	3874	10.92	10.82	90	3794	121.91	121.91	60	4
24.01	6.51	6.44	45	3845	7.87	7.66	45	3845	64.45	64.45	30	2
25.01	6.88	6.87	60	3876	8.32	8.33	45	3845	69.5	69.5	45	3
26.01	4.67	4.68	45	3845	5.66	5.64	45	3845	46.26	46.26	45	3
27.01	2.88	2.86	90	3874	3.46	3.42	90	3874	39.38	39.38	60	4
28.01	2.8	2.76	60	3876	3.35	3.35	45	3845	31.05	31.05	45	3
29.01	6.38	6.38	45	3845	7.72	7.65	45	3845	60.88	60.88	30	2
30.01	5.25	5.26	60	3876	6.26	6.29	60	3876	59.31	59.31	45	3
30.02	12.94	13.03	90	3902	15.35	15.44	90	3905	159.48	159.48	90	5
30.03	33.2	34.46	270	3683	39.2	40.99	90	3794	407.83	407.83	90	5
30.04	34.32	34.91	270	3683	40.14	42.26	270	3683	416.43	416.43	90	5
31.01	3.06	3.02	60	3876	3.71	3.71	45	3845	34.09	34.09	30	2
32.01	8.25	8.15	90	3794	9.88	9.74	90	3794	97.24	97.24	60	4
32.02	18.83	18.65	90	3794	22.51	22.72	90	3794	223.39	223.39	90	5
33.01	7.2	7.07	90	3794	8.72	8.69	60	3847	83.41	83.41	45	3
34.01	2.03	1.98	45	3845	2.45	2.6	45	3844	18.84	18.84	30	2