

**GLENMORE PARK EAST
PLANNING PROPOSAL**

**FLOOD RISK AND SURFACE WATER
MANAGEMENT STRATEGY**

SEPTEMBER 2023

FOREWORD

The Planning Proposal (**PP**) seeks to rezone a 47.95-hectare (ha) parcel of land bounded by the recently upgraded The Northern Road to the east, Glenmore Parkway to the north, Bradley Street to the south and the existing Glenmore Park neighbourhood to the west. The precinct is within the Penrith Local Government Area (**LGA**) and the land subject to this PP is described as **Glenmore Park East**.

The precinct is located 10km to the north of the new 24-hour Western Sydney International Airport and 5km south of the Penrith CBD and is centrally located within the Western Parkland City. The precinct is surrounded by the existing the stages of the Glenmore Park Estate (stages 1-3), Penrith Golf Course to the north, the state led Orchard Hills master planned precinct to the east and the Defence Establishment Orchard Hills to the southeast. The precinct is approximately 1km south of the M4 freeway and approximately 5km west of the new Orchard Hills Metro Station which is currently under construction.

Glenmore Park East will contribute to the long-term housing targets of Penrith and the broader Western Parkland City and will contribute to increased housing supply in the short to medium term which is a key priority of the Premier and the NSW Government. The precinct has also been identified as being 'urban capable' and the proponent (Nergl Developments Pty Ltd) is responding to this capability and government priority through the provision of much needed diversity in housing in the Glenmore Park area and to support future local employment within the Western Parkland City, tapping into the new opportunities that will emerge through the delivery of the Western Sydney Aerotropolis. In doing so, the precinct will achieve its vision of *live, work, play*.

The proponent applied to the Department of Planning and Environment in January 2023 for the PP to be considered under the pilot State Assessed Planning Proposal (**SAPP**) program. From more than 100 applications across NSW, DPE selected this precinct as one of five (5) to be assessed through the SAPP pilot program. In being selected for this pilot program, DPE was satisfied that the proposal:

- demonstrated public benefit through housing supply and alignment with state policies and land use strategies
- contributed to affordable and social housing outcomes
- offered a pathway to the delivery of housing in the short term
- has adequate infrastructure available or that funding is committed for critical infrastructure

Whilst there has been differing views over the last 20 years about how the precinct should be developed, the growth and evolution of the Western Parkland City confirms that the precinct is a logical urban inclusion in the Penrith Local Environmental Plan 2010 (**PLEP 2010**) whilst being a contemporary gateway to the Penrith LGA.

The Proposal

The precinct is currently zoned C4 Environmental Living (44.93 hectares), R2 Low Density Residential (225 square meters), SP2 Infrastructure (113 square meters) and RE1 Public Recreation (2.98 hectares) under the PLEP 2010. Land within the precinct is currently utilised for rural residential lifestyle properties, with part of the precinct having been approved for a 17-lot rural residential subdivision in 2005.

The proposed Master Plan provides for approximately 1,710 new homes, offering a diverse range of housing options to meet the needs of a changing community. These new homes include approximately 242 traditional detached homes (with an average site area of 320 square meters), 182 smaller attached terraces (with an average site area of 240 square meters), and 1,286 (1, 2 and 3 bedroom) apartments (with an average size of 90 square meters). The proposal also commits to providing a minimum of 5% affordable housing on the site, in collaboration with a Community Housing Provider, surpassing Penrith City Council's target of 3% affordable housing applied in other locations.

Furthermore, the proposed Master Plan accommodates a range of non-residential uses in the precinct, including mixed-use retail spaces, childcare facilities, medical services, food and beverage establishments, a fresh food market, specialty shops, restaurants and cafes, entertainment venues, offices, and a hotel for short-term accommodation supporting visitors and the requirements of nearby defence industry partners. This diverse range of services and amenities aims to meet the needs of both residents and visitors to the precinct.

The precinct will also feature 14.425 hectares of public open space (including bushland and riparian corridors), 1.02 hectares of communal open space and 2.935 hectares of avoided land¹ which is to be partly utilised for flooding, drainage and landscape purposes. In all, these areas total 18.38ha which represents more than 38.3% of the site. The location of parks and open space areas has been thoughtfully chosen to enhance the existing natural landscape, such as hilltops and creek lines, and to preserve significant bushland areas, providing the highest level of amenity for future residents. Additionally, the precinct proposes significant open space embellishments including a commitment to the provision of a public swimming pool, two (2) public tennis courts and high-end play facilities.

The precinct is connected through a series of pathways and cycleways with the integration of public transport at its core, reducing the reliance on private cars and promoting sustainable transportation options. This focus on urban sustainability is not limited to transport alone and will be a core consideration for buildings within the precinct.

Having regard to the proposed Master Plan detailed above, the PP seeks to change the areas zoned C4 Environmental Living and SP2 Infrastructure to a combination of the following zones:

- R2 – Low Density Residential
- R3 – Medium Density Residential
- MU1 – Mixed Use
- E1 – Local Centre
- SP2 - Infrastructure
- RE1 – Public Recreation
- C2 – Environmental Conservation

The PP also proposes the introduction of various controls and provisions, including minimum lot sizes, building height restrictions, consideration of scenic and landscape values, maximum lot yield, additional permitted uses, urban release area designation, and flexible boundaries between certain zones, to ensure that the statutory framework is in place to deliver the proposed Master Plan.

¹ As identified and defined in the Cumberland Plain Conservation Plan

Vision

Glenmore Park East is the welcoming gateway for residents and visitors moving between Western Sydney Airport and the Penrith Local Government Area. This sustainable and liveable precinct fosters an inclusive and engaged community, whilst providing new housing choices that cater for the needs of a diverse and growing Western Parkland City. Glenmore Park East proudly embraces its ties to the land, its biodiversity, and its stunning vistas of the Blue Mountains.

The urban areas within this precinct will be seamlessly connected through an array of public open spaces and vibrant community amenities that are easily accessible by walking or cycling. Notably, a district-scale hilltop park will serve as a central attraction, welcoming people of all ages.

Residents will have the convenience of working near their homes or opting for efficient public transportation options to reach destinations including the Western Sydney Airport, Penrith, or nearby jobs, ensuring that the precinct offers a genuine 20-minute neighbourhood. All these objectives will be realized by adhering to the core principles of Live, Work, Play.

Live: Diversity in housing options is a central aspect of the precinct's Live principle. It encompasses a wide array of housing choices, such as single-family homes, townhouses, apartments, senior-friendly housing, and mixed-use developments. These options are carefully designed to cater to the diverse needs and preferences of future residents in Penrith. The aim is to offer housing that is not only affordable but also aesthetically appealing, nurturing a strong sense of community and belonging among its residents.

Work: Under the Work principle, the precinct incorporates areas for home offices, co-working spaces, and local enterprises that bolster the Glenmore Park East neighbourhood. This urban framework allows residents easy access to workspaces and jobs right within the community, reducing the reliance on cars and long commutes. Additionally, the precinct will feature an Eat Street, which will provide essential amenities akin to those found in a thriving and evolving city, catering to the needs of local residents and visitors to the precinct.

Play: Under the Play principle, the precinct offers dynamic public spaces and communal gathering spots to encourage social engagement and inclusiveness. It is designed to offer a wide range of recreational and leisure activities, including parks, playgrounds, walking and cycling trails, fitness centres, a public swimming pool, and two public tennis courts. Moreover, there will be local convenience retail and dining options to ensure that residents can enjoy a high level of urban amenities right within the precinct. This comprehensive approach aims to promote an active and vibrant lifestyle for all residents.

The Glenmore Park East Master Plan achieves the vision through sustainable transportation, connectivity, and community development.

Location and Connectivity: Glenmore Park East's strategic location makes it accessible to both the Western Sydney Airport and the Penrith CBD. It is also adjacent to Orchard Hills and benefits from a new Metro system connecting Western Sydney to Sydney City. This connectivity is essential for the area's growth and accessibility.

Sustainable Transportation: The precinct prioritises walking, cycling, and public transport, which aligns with Council's sustainability goals. Promoting these modes of transportation will reduce dependence on cars and help create a more environmentally friendly community.

Street Design: Streets are designed to be perpendicular to the contours of the land. This design not only creates an attractive public domain but also minimises the impact of housing in sloping land. The intention is to create a visually appealing and walkable neighbourhood.

Block Layout: The layout of the blocks is designed to maximise permeability through a network of streets, paths, and building separation. This layout encourages easy access to key destinations, such as The Northern Road (with bus stops) and open space areas including the new 2ha Hilltop Park.

Mixed-Use Development: The Northern Road frontage is envisioned as a mixed-use area with active ground floor uses including (but not limited to) hotel, medical facilities, child care, entertainment, fresh food market, and apartments above. This mixed-use approach will contribute to a vibrant streetscape and offer convenience to residents. A walkable and bike-friendly environment encourages residents to shop, dine, and work close to home.

Eat Street: The Eat Street serves as food and beverage destination for members of the community and visitors. The area is designed for mixed-use development, including shops, restaurants, and apartments, creating a focal point for the community.

Housing Diversity: The vision emphasises the importance of housing diversity, with a mix of housing types and price points. This approach aims to create a well-rounded community that accommodates a range of residents and lifestyles.

Natural Environment: The plan acknowledges the significance of natural watercourses and drainage channels, advocating for their retention, celebration, or enhancement. This approach aligns with principles of biodiversity and sustainable landscaping. The precinct also recognises and retains significant areas of Cumberland Plain woodland which is embedded as a key element of the design.

Open Space: The vision aims to optimise open space, making it multipurpose and accessible for various activities. The Transgrid easement which passes through the site and connects the precinct to the wider Glenmore Park community, is identified as an opportunity for informal sports fields, urban agriculture, and cycleways.

Community Engagement: The plan encourages development that engages and links with riparian zones and natural habitats. It envisions community gardens to provide fresh produce and shared paths for residents and visitors to enjoy nature, culture and artistic expression.

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NOTE ON FLOOD FREQUENCY

The frequency of floods is generally referred to in terms of their Annual Exceedance Probability (**AEP**) or Average Recurrence Interval (**ARI**). For example, for a flood magnitude having 5% AEP, there is a 5% probability that there will be floods of greater magnitude each year. As another example, for a flood having a 5 year ARI, there will be floods of equal or greater magnitude once in 5 years on average. The approximate correspondence between these two systems is:

Annual Exceedance Probability (AEP) (%)	Average Recurrence Interval (ARI) (years)
0.2	500
0.5	200
1	100
2	50
5	20
10	10
20	5

The report also refers to the Probable Maximum Flood (**PMF**). This flood occurs as a result of the Probable Maximum Precipitation (**PMP**). The PMP is the result of the optimum combination of the available moisture in the atmosphere and the efficiency of the storm mechanism as regards rainfall production. The PMP is used to estimate PMF discharges using a model which simulates the conversion of rainfall to runoff. The PMF is defined as the limiting value of floods that could reasonably be expected to occur. It is an extremely rare flood, generally considered to have a return period greater than 1 in 10⁶ years.

ABBREVIATIONS

AEP	Annual Exceedance Probability (%)
ARI	Average Recurrence Interval (years)
ARR	Australian Rainfall and Runoff (Ball et al, 2019)
DECC	Department of Environment and Climate Change
DPE	Department of Planning and Environment
FDM	Flood Risk Management Manual (NSW Government, 2005)
FPL	Flood Planning Level
FRMM	Flood Risk Management Manual (NSW Government, 2023)
FR&SWMS	Flood Risk and Surface Water Management Strategy
PMF	Probable Maximum Flood
RCP	Representative Concentration Pathways
TfNSW	Transport for NSW
TN	Total Nitrogen
TSS	Total Suspended Solids
TP	Total Phosphorus
VRZ	Vegetation Retention Zone
WSUD	Water Sensitive Urban Design

EXECUTIVE SUMMARY

This report describes the characteristics of the upper Surveyors Creek catchment within which Glenmore Park East is located, as well as the nature of flooding in its vicinity for storms ranging between 50% (1 in 2) and 1% (1 in 100) Annual Exceedance Probability (**AEP**), as well as the Probable Maximum Flood (**PMF**).

Due to time constraints associated with the pilot State Assessed Planning Proposal (**SAPP**) program and the need to obtain access to flood modelling data that are associated with the recently upgraded section of The Northern Road, the findings of a flood risk assessment that formed part of the draft Environmental Impact Statement for the road upgrade project have been relied upon for describing the nature of flooding in the vicinity of Glenmore Park East under pre- and post-developed conditions. The results of the earlier flood risk assessment have also been relied upon for assessing the flood risk associated with future development within Glenmore Park East.

Precinct-specific DRAINS, MUSIC and HEC-RAS models have been developed as part of the present investigation to size the various surface water management related components of Glenmore Park East. Recommendations have also been made for the inclusion of measures in the precinct-specific Development Control Plan which are aimed at managing flood risk in the northern portion of Glenmore Park East.

The flood risk and surface water management strategy that is set out in this report has been developed in accordance with relevant local and state government guidelines and requirements. This includes the provision of a minimum 30 metre wide (on average) vegetation retention zone either side of the unnamed watercourse which runs through the northern portion of Glenmore Park East, as well as consideration of the risks posed by the occurrence of very rare and extreme floods on future occupiers of the floodplain. Consideration has also been given to the potential impact that future climate change and also the potential failure of an embankment associated with an existing flood retarding basin could have on flood behaviour in Glenmore Park East.

1 INTRODUCTION

1.1 Background

This report sets out the flood risk and surface water management strategy for Glenmore Park East, the location of which is shown on **Figure 1.1**.

While precinct-specific computer models (DRAINS, MUSIC and HEC-RAS) have been developed to support the development of the surface water management strategy for Glenmore Park East, due to time constraints associated with the pilot State Assessed Planning Proposal (**SAPP**) program and the need to obtain access to flood modelling data that are associated with the recently upgraded section of The Northern Road, there was insufficient time available to develop a precinct-specific hydraulic model (TUFLOW) that could be used to undertake a detailed assessment of the flood risk in Glenmore Park East. As a result, the development of the flood risk management strategy for Glenmore Park East has relied upon the findings of a flood risk assessment that formed part of the draft Environmental Impact Statement that was prepared by Transport for NSW (**TfNSW**) for The Northern Road upgrade project (TfNSW, 2017).

The flood risk and surface water management strategy for Glenmore Park East has been developed in accordance with relevant local and state government guidelines and requirements.

1.2 Layout of Report

Chapter 2 contains a brief description of the existing environment as it relates to flooding and surface water management. This includes a description of the catchment which contributes to flow in an unnamed watercourse which runs through the northern portion of Glenmore Park East, the key features of the recently upgraded section of The Northern Road and the nature of flooding for design storms with Annual Exceedance probabilities (**AEPs**) of 50% (1 in 2), 10% (1 in 10) and 1% (1 in 100), as well as the Probable Maximum Flood (**PMF**)

Chapter 3 contains a brief description of development that is proposed within Glenmore Park East.

Chapter 4 deals with the assessment of the future flood risk and provides recommendations managing this risk within Glenmore Park East. This chapter also deals with the requirements to manage both the quantity and quality of stormwater runoff originating from the developed parts of Glenmore Park East.

Chapter 5 contains a list of references.

The following appendices are also included in the report:

- **Appendix A**, which contains a copy of the Master Plan for Glenmore Park East.
- **Appendix B**, which contains a copy of the Zoning Map for Glenmore Park East.
- **Appendix C** contains figures showing the sub-catchments which comprise the Pre- and Post-GPE DRAINS models.

Figures referred in **Chapters 1 to 4** of this report can be found after **Chapter 5** of the report.

2 EXISTING ENVIRONMENT

2.1 Catchment Description

Glenmore Park East is located in the upper reaches of the Surveyors Creek catchment, noting that Surveyors Creek is a tributary of Peach Tree Creek, the main arm of which joins the Nepean River downstream of Penrith Weir (refer **Figure 1.1**).

While the Surveyors Creek catchment is largely urbanised, the portion that contributes runoff to the unnamed tributary that runs through Glenmore Park East (referred to herein as “Unnamed Tributary of Surveyors Creek”) is generally rural in nature.

Figure 2.1 shows the layout of the existing stormwater drainage system in the vicinity of Glenmore Park East, as well as the extent of the catchments that contribute runoff to the existing transverse drainage that are located along The Northern Road and Glenmore Parkway in its vicinity.²

A large portion of the catchment that contributes runoff to the Unnamed Tributary of Surveyors Creek where it runs through Glenmore Park East comprises the Commonwealth Defence Establishment Orchard Hills which is located on the eastern side of The Northern Road. While the remainder of the catchment on the western side of The Northern Road generally comprises large-lot rural and semi-rural residential type development, it is noted that development is presently planned in the catchment which contributes to existing transverse drainage structure PXD2 as part of Glenmore Park Stage 3.

Elevated transmission lines run in an east-west direction through the northern portion of Glenmore Park East within about a 110 metre wide easement.

2.2 The Northern Road Upgrade

The Northern Road was recently upgraded by TfNSW from two to four lanes. A short length of Glenmore Parkway either side of The Northern Road was also upgraded as part of the road works.

The primary intent of the drainage design for the upgrade works was to provide a 1% AEP level of protection to both The Northern Road and Glenmore Parkway where they run through the catchment of The Unnamed Tributary of Surveyors Creek, while maintaining as close as was practical existing flooding patterns in private property. This required the construction of a number of large transverse drainage structures, the locations of which are shown on **Figure 2.1**. A large flood retarding basin, the location of which is also shown on **Figure 2.1**, was also constructed on the eastern side of The Northern Road. The flood retarding basin was designed to mitigate the impact that the road widening would otherwise have had on flood behaviour along the Unnamed Tributary of Surveyors Creek.

While a small portion of the land comprising Glenmore Park East at its southern end contributes to flow in the pavement drainage system of Bradley Street and ultimately The Northern Road, the majority of the surface runoff that originates from the southern portion of Glenmore Park East contributes to flow in a grassed lined channel which was constructed along the western side of the road corridor. The grass line channel, which was sized to convey flows generated by the adjacent

² Note that the location and naming convention of the existing transverse drainage that are shown along The Northern Road and Glenmore Parkway have been taken from TfNSW, 2017.

rural catchment for all storms up to 1% AEP in intensity, runs in a northerly direction where it joins the main arm of the Unnamed Tributary of Surveyors Creek immediately downstream of transverse drainage structure PXD4. Seven access driveways presently cross the grass lined channel along its length.

2.3 Unnamed Tributary of Surveyors Creek

Under the Strahler system for classifying watercourses, the Unnamed Tributary of Surveyors Creek is a 3rd order stream where it runs through Glenmore Park East.³ Both the inbank and overbank area of the watercourse have been highly modified in the vicinity of Glenmore Park East. These include:

- its realignment on the eastern side of The Northern Road as part of the abovementioned road works;
- its deepening immediately south (upstream) of the transmission easement within Glenmore Park East to form a permanent waterbody;
- the filling of its overbank area in a number of properties that are located between the transmission easement and Glenmore Parkway; and
- the creation of a series of permanent ponds and the conversion of its overbank area into fairways and greens within the Penrith Golf and Recreation Club which is located on the northern (downstream) side of Glenmore Parkway.

In addition to the above, it is noted that the inbank area of the watercourse is almost indistinguishable where it runs through the transmission easement, with a portion of the area observed to be in a highly disturbed state.

Five private access driveways presently cross the Unnamed Tributary of Surveyors Creek where it runs through Glenmore Park East, two of which are located on the southern (upstream) side and three on the northern (downstream) side of the transmission easement. The access driveways are typically low level in nature and comprise either pipe/culvert or single span bridge crossings.

2.4 Description of Existing Flood Behaviour

While Penrith City Council has completed a flood study for the Peach Tree Creek and Lower Surveyors Creek catchments (Catchment Simulation Solutions, 2019), it does not define the nature of flooding in the upper reaches of the latter mentioned creek system in the vicinity of Glenmore Park East.

Lyall & Associates prepared a flood risk assessment for the proposed upgrade of The Northern Road where it runs to the east of Glenmore Park East as part of TfNSW, 2017. The assessment involved the development of hydrologic (DRAINS) and hydraulic (TUFLOW) models that were used to define the nature of flooding in the vicinity of the road corridor under both pre- and post-road upgrade conditions.

³ Refer **Figure 2.1**, which shows the location of 1st, 2nd and 3rd streams in the vicinity of Glenmore Park East.

As mentioned in **Section 1.1** of this report, it has been necessary to rely on the information that is presented in TfNSW, 2017 for describing flood behaviour under present day conditions, noting that a Consistency Check was undertaken during the detailed design phase of the road upgrade to confirm that it was in accordance with the environmental documents (i.e. that flooding patterns resulting from the design of the road upgrade were consistent with those set out in TfNSW, 2017).

Figures 2.2 shows the indicative extent and depth of inundation in the vicinity of Glenmore Park East for a design storm with an AEP of 50%. Similar information is shown on **Figures 2.3, 2.4** and **2.5** for design storms with AEPs of 10% and 1%, as well as the PMF. The key features of flooding where the Unnamed Tributary of Surveyors Creek runs through Glenmore Park East are as follows:

- i. While flow is generally confined to the inbank area of the watercourse immediately south (upstream) of the transmission easement during a 50% AEP storm event, floodwater is forced to pond over a relatively large area within the transmission easement due to the indistinct nature of the watercourse coupled with the blocking effects of one of the downstream access driveways.
- ii. While floodwater extends onto the eastern and western overbank of the watercourse immediately north (downstream) of the transmission easement, the filling of land further to the north confines flow to the inbank area and western overbank closer to Glenmore Parkway.
- iii. While depths of flow in the inbank area of the watercourse generally exceeds one metre along most of its length during storms as frequent as 50% AEP, depths of inundation on its overbank area are generally relatively shallow and do not exceed about 0.6 metres during storms up to 1% AEP in intensity. The primary exception is within the transmission easement, where the blocking effects of the access driveway that is located on its northern (downstream) side cause floodwater to pond to depths approaching one metre.
- iv. The grass lined channel which runs along the western side of The Northern Road and controls surface runoff from the southern portion of the land comprising Glenmore park East has a hydrologic standard of about 1% AEP, with only relatively minor depths of inundation shown to extend outside the road corridor.
- v. Overtopping of The Northern Road will occur during a PMF event, with flow generally discharging in a northerly direction toward the major sag in the road which is located about 150 metres to the south of its intersection with Glenmore Parkway.
- vi. The depth of flow internal to Glenmore Park East would exceed one metre during a PMF event and extend over a maximum width of about 250 metres, noting that floodwater would generally be confined to its north-eastern portion.

The following chapter of this report deals with the management of the flood risk as it relates to development within Glenmore Park East.

3 PROPOSED DEVELOPMENT

As set out in the Forward of this report, the PP seeks to change the areas zoned C4 Environmental Living and SP2 Infrastructure to a combination of the following zones:

- *R2 – Low Density Residential*
- *R3 – Medium Density Residential*
- *MU1 – Mixed Use*
- *E1 – Local Centre*
- *SP2 - Infrastructure*
- *RE1 – Public Recreation*
- *C2 – Environmental Conservation*

Appendix A of this report contains a copy of the Master Plan which shows the location of the various land use types, while **Appendix B** contains a figure showing the proposed zoning for Glenmore Park East.

The Master Plan provides for approximately 1,710 new homes, comprising approximately 242 traditional detached homes, 182 smaller attached terraces and 1,286 (1, 2 and 3 bedroom) apartments. The proposal also commits to providing a minimum of 5% affordable housing on the site.

The Master Plan also accommodates a range of non-residential uses in the precinct, including mixed-use retail spaces, childcare facilities, medical services, food and beverage establishments, a fresh food market, specialty shops, restaurants and cafes, entertainment venues, offices, and a hotel for short-term accommodation supporting visitors and the requirements of nearby defence industry partners.

The precinct will also feature about 14 hectares of public open space (including bushland and riparian corridors), about one hectare of communal open space and about three hectares of avoided land⁴ which is to be partly utilised for flooding, drainage and landscape purposes.

A single road connection to The Northern Road will replace the seven existing access driveways that presently cross the grass lined channel which runs along the western side of corridor, while a new access driveway crossing of the Unnamed Tributary of Surveyors Creek north (downstream) of the transmission easement will replace the five existing driveway crossings. The new access driveway will permit vehicular and pedestrian access to apartment type development that will be located in the north-east corner of Glenmore Park East.

The existing channel which runs from the outlet of transverse drainage structure PXD6 to the main arm of the Unnamed Tributary of Surveyors Creek will also be partially enclosed as part of the proposed development.

⁴ As identified and defined in the *Cumberland Plain Conservation Plan*.

4 FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY

4.1 General

This chapter of the report sets out the flood risk and surface water management strategy (**the FR&SWMS**) that has been developed for Glenmore Park East. When developing the FR&SWMS, consideration has been given to the guidelines and requirements contained in the following documents:

- *NSW Flood Prone Land Policy*
- *Floodplain Management Manual* (NSW Government, 2005) (**FDM 2005**)
- *Penrith Local Environmental Plan 2010*
- *Design Guidelines for Engineering Works for Subdivisions and Developments* (Penrith City Council, 2013)
- *Penrith City Council Development Control Plan 2014*
- *Australian Rainfall and Runoff* (Ball et al, 2019) (**ARR 2019**)
- *Considering Flooding in Land Use Planning Guideline* (NSW Government, 2021)
- *WSUD Technical Guidelines* (Penrith City Council, 2020)
- *Controlled Activities – Guidelines for Riparian Corridors on Waterfront Land* (DPE, 2022)
- *Flood Risk Management Manual – The Policy and Manual for the Management of Flood Liable Land* (NSW Government, 2023a) (**FRMM 2023**)
- *Understanding and Managing Flood Risk – Flood Risk Management Guideline FB01* (NSW Government, 2023b) (**Flood Risk Management Guideline FB01**)
- *Stormwater Drainage Guidelines for Building Developments* (Penrith City Council Policy No. ES 002)
- *Water Sensitive Urban Design (WSUD) Policy* (Penrith City Council Policy No. EH 003)

The key principles that guided the development of the FR&SWMS were as follows:

- i. Land upon which development is to be located must lie at or above the peak 1% AEP flood level plus 0.5 metres freeboard (denoted herein as the Flood Planning Level (**FPL**)).
- ii. Peak flows in the receiving drainage lines are to be no greater than occur under present day conditions for all storms up to 1% AEP in intensity. This is to be achieved through the provision of appropriately size and located stormwater detention basins.
- iii. Peak flood levels are not to be increased by more than 0.1 metres in other development or properties.
- iv. The hydrologic standard of the transverse drainage along the adjacent sections of The Northern Road and Glenmore Parkway is not to be reduced.
- v. The development is to achieve the following pollutant load reduction targets through the provision of appropriately sized and located Water Sensitive Urban Design (**WSUD**) measures:
 - 90% reduction in the post development mean annual load total gross pollutant (greater than 5mm);

- 85% reduction in the post development mean annual load of Total Suspended Solids (**TSS**);
 - 60% reduction in the post development mean annual load of Total Phosphorus (**TP**);
 - 45% reduction in the post development mean annual load of Total Nitrogen (**TN**);
 - 90% Free Oils and Grease with no visible discharge.
- vi. Outside of the BASIX requirements, further reductions in the volume of surface runoff are to be achieved through the provision of permanent ponds which will maximise evaporation and transpiration losses.
- vii. A 30 metre (on average) wide Vegetation Retention Zone (**VRZ**) is to be provided either side of the inbank area of the Unnamed Tributary of Surveyors Creek, noting it is a 3rd Order stream under the Strahler system for classifying watercourses.
- viii. Fill material that has been placed on the overbank area of the Unnamed Tributary of Surveyors Creek within the extent of the VRZ will be removed.

The following sections of this chapter provide background to the development of the FR&SWMS for Glenmore Park East. When reading the following sections of this report, reference should be made to **Figure 4.1** which shows the key features of the FR&SWMS for Glenmore Park East.

4.2 Flood Risk Management

4.2.1. Current Climatic Conditions

As mentioned in **Section 1.1** of this report, the assessment of the future flood risk in Glenmore Park East has relied upon information that is presented in TfNSW, 2017. To this end, the Master Plan contained in **Appendix A** of this report was laid over several figures that formed part of TfNSW, 2017.

Figures 4.2, 4.3, 4.4 and 4.5 (2 sheets each) show the indicate extent and depth of inundation relative to the Master Plan for design storms with intensities of 50%, 10% and 1%, as well as the PMF, noting that the depth and extent of inundation shown on these figures is the same as that shown on **Figures 2.2 to 2.5**. **Figure 4.6** shows the provisional flood hazard for the 1% AEP based on the definition that is set out in FDM 2005.

The key flood risk related aspects of the Master Plan are as follows:

- i. The majority of the land that is proposed to be zoned for development lies outside the extent of the 1% AEP flood, resulting in only fringe areas that are located to the north (downstream) of the transmission easement needing to be raised to the FPL.
- ii. High hazard areas are generally confined to the inbank area of the Unnamed Tributary of Surveyors Creek and therefore do not extend into areas that have been zoned to permit residential or commercial type development.
- iii. The minor nature of the fill required to raise finished surface levels to the FPL would not increase peak 1% AEP flood levels in adjacent property or development by more than 0.1 metres. To the contrary, the removal of fill material that has historically be placed in the VRZ to the north (downstream) of the transmission easement is likely to result in a net reduction in peak flood levels on the floodplain.

- iv. While the PMF would inundate development that is proposed on the western side of the Unnamed Tributary of Surveyors Creek, it is limited to a relatively narrow strip of land which will comprise a mixture of *R2 – Low Density Residential*, *R3 – Median Density Residential* and *MU1 – Mixed Use type development*. In all cases, the land to the west, along with the east-west running roads are rising off the floodplain.
- v. While Penrith City Council opted out of adopting clause 5.22 – *Special flood considerations* when the NSW Government mandated the update of *Penrith LEP 2010* to include clause 5.21 – *Flood planning* in July 2021, in practice the density of development would be significantly increased in the north-eastern corner of Glenmore Park East, where depending on finished surface levels, depths of inundation could exceed 1 metre during a PMF event.

In order to manage the flood risk in this area during very rare and extreme flood events, it is recommended that the Development Control Plan for Glenmore Park East require that habitable floor levels associated with the proposed apartment type development be set on the first floor above the PMF level, with the ground floor level used for either covered or enclosed car parking. This will ensure that should the occupants find that they are not able to walk the short distance to the flood free land that is located at the intersection of The Northern Road and Glenmore Parkway, then they can shelter in place for the relatively short period of time that the area is subject to flooding.
- vi. Further to the above, while Penrith City Council only requires transverse drainage structures under local roads to have a minimum hydrologic standard of 10% AEP, it is recommended that the new access driveway that will cross the Unnamed Tributary of Surveyors Creek to the north (downstream) of the transmission easement incorporate a minimum hydrologic standard of 5% AEP given that vehicular access/egress to/from the aforementioned apartment type development would be cut during rarer flood events. It is also recommended that bollards featuring depth markers be provided along both sides of the driveway where it crosses the floodplain.

4.2.2. Potential Future Climatic Conditions

In regards the potential impacts of future climate change on flood behaviour in the vicinity of Glenmore Park East, the *ARR Data Hub* and ARR 2019 give the following interim climate change factors for Representative Concentration Pathways (RCPs) of 4.5 and 8.5 in the years 2050 and 2090:

Year	RCP 4.5	RCP 8.5
2050	6.4%	9.0%
2090	9.5%	19.7%

The 0.5% and 0.2% AEP events are typically in the order of 15% and 30% more rainfall than the current 1% AEP flood event respectively, although the actual difference varies with location. *Flood Risk Management Guideline FB01* considers these events to provide reasonable proxies for the scale of change to the 1% AEP event for changes to flood-producing rainfall events under RCP 4.5 and RCP 8.5 at 2090 respectively, with the 0.5% AEP event also similar to RCP 8.5 between 2050 and 2060. *Flood Risk Management Guideline FB01* also considers that these events can be used for understanding the scale of impacts of change on flood behaviour and the community in the 1% AEP for these scenarios and time periods.

TfNSW, 2017 assessed the impact that 10% and 30% increases in 1% AEP rainfall intensities would have on flood behaviour in the vicinity of The Northern Road where it runs to the east of Glenmore Park East. To assess the impact that potential climate change could have on flood behaviour in Glenmore Park East, the Master Plan was laid over the figures from TfNSW, 2017 which show the impact that a 10% and 30% increase in 1% AEP rainfall intensities would have on flood behaviour (refer **Figures 4.7** and **4.8**, respectively).

The key finding of the assessment is that increases in 1% AEP rainfall intensities of up to 30% would only have a relatively minor impact on peak flood levels on the floodplain of the Unnamed Tributary of Surveyors Creek where it runs through Glenmore Park East, which in turn does not translate to a significant increase in the extent of inundation.

4.2.3. Potential Basin Embankment Failure

TfNSW, 2017 assessed the impact that the potential failure of the relatively large flood retarding basin that formed part of The Northern Road upgrade project would have on flood behaviour. Similar to the approach adopted for assessing the potential impacts of future climate change on Glenmore Park East, the Master Plan was laid over the figure from TfNSW, 2017 which shows the impact that a potential failure of the basin embankment would have on flood behaviour (refer **Figure 4.9**).

By inspection of **Figure 4.9**, while peak 1% AEP flood levels would be increased on the eastern (upstream) side of The Northern Road by almost 0.5 metres, the increase in peak 1% AEP flood levels on the western (downstream) side of The Northern Road within Glenmore Park East does not exceed 0.1 metres, with only a minor increase in the extent of inundation.

4.3 Surface Water Management

4.3.1. Water Quantity

In order to assess the stormwater detention basin requirements for Glenmore Park East, it was necessary to develop DRAINS models representing both pre-development (**Pre-GPE DRAINS Model**) and post-development (**Post-GPE DRAINS Model**) conditions. **Appendix C** of this report contains two figures showing the sub-catchments comprising the Pre- and Post-GPE DRAINS models, noting that the fraction impervious adopted for newly developed areas was as per the values set out in Table 3 in Section 3.5 of Penrith City Council, 2013.

The Pre- and Post-GPE DRAINS models were run for design storms with AEPs of 50%, 10% and 1% based on the ensemble approach prescribed in ARR 2019, noting that initial and continuing loss values of 15 millimetres and 2.5 millimetres per hour were respectively adopted for design estimation purposes.⁵ By comparison of the peak flows set out in **Table 4.1** at the end of this chapter, the Pre-GPE DRAINS Model generates peak flows which are comparable with those derived as part of TfNSW, 2017.

Four stormwater detention basins were incorporated in the Post-GPE DRAINS Model at locations matching those on **Figure 4.1**. Their size and outlet arrangement were then adjusted until peak flows in the receiving drainage lines were no greater than under pre-Glenmore Park East conditions for design storms with AEPs of 50%, 10% and 1%, noting that a maximum depth of inundation of 1.5 metres during a 1% AEP storm event was adopted for preliminary sizing purposes.

⁵ These rainfall loss values are consistent with those adopted as part of TfNSW, 2017.

Table 4.1 sets out the post-Glenmore Park East peak flows for design storms with AEPs of 50%, 10% and 1% at key locations in the receiving drainage lines, while **Table 4.2** sets out the surface area and storage volume requirements for the four stormwater detention basins, noting that the following criteria were adopted for deriving their total surface area:

- A height to crest of 2 metres, which includes provision for freeboard to the adopted top operating water level of 1.5 metres.
- Side slopes of 1(Vertical):6(Horizontal) over the bottom 1.2 metres and side slopes of 1(Vertical):1(Horizontal) over the top 0.8 metres, noting the former represents a grassed batter and the latter a sandstone block type retaining structure.⁶

By comparison with the values set out in **Table 4.1**, development within Glenmore Park East would not increase peak flows in the receiving drainage lines for storms ranging between 50% and 1% in intensity.

4.3.2. Water Quality

The WSUD requirements for Glenmore Park East were assessed using a MUSIC model that was developed as part of the present investigation (**GPE MUSIC Model**). Penrith City Council's MUSIC-*link* was used to create the base model, the structure of which was then updated to reflect the proposed land uses within Glenmore Park East.

The strategy for reducing the pollutant load which would otherwise discharge to the receiving drainage lines involves the provision of GPTs at all piped outlets and the incorporation of biofiltration measures within the base of the four proposed stormwater detention basins. While nominal GPT sizes were adopted for preliminary assessment purposes, the biofiltration requirements were assessed based on a maximum extended detention depth of 0.3 metres and a filter media layer thickness of 0.8 metres.

Figure 4.1 shows the location the GPTs and biofiltration measures which form the surface water management strategy for Glenmore Park East, as well as the extent of the catchments which contribute to flow in each, while **Table 4.2** at the end of this chapter sets out the biofiltration surface area requirements within the four stormwater detention basins. **Table 4.3** at the end of this chapter summarises the percentage reduction in gross pollutants, TSS, TP and TN that is achieved by the proposed GPTs and biofiltration measures.

4.3.3. Proposed Grass Lined Swales and Designated Overland Flow Paths

The FR&SWMS includes provision for grass lined swales which would intercept surface runoff which is not captured by the new pit and pipe drainage system and divert it into Basins GPE-B1 and GPE_B2. Designated overland flow paths would also be provided along the western side of the riparian corridor which would intercept overland flow discharging toward the watercourse from upslope developed areas and divert it to Basins GPE-B3 and GPE-B4.

HEC-RAS models were developed of the grass lined swales which would run along the eastern boundary of Glenmore Park East upslope of Basins GPE-B1 and GPE-B2. The models were used to confirm that a sufficiently wide corridor has been provided in this area to convey peak flows which would otherwise discharge to the road corridor of The Northern Road for all storm up to 1% AEP in intensity and divert it to the aforementioned stormwater detention basins.

⁶ As the volume requirements for the stormwater detention basins were derived assuming vertical sides, the adoption of sloping sides for computing their footprint will allow for the 15% of additional storage volume that is required by Penrith City Council to account for losses associated with landscaping.

TABLE 4.1
COMPARISON OF PEAK FLOWS
MAIN ARM OF UNNAMED TRIBUTARY OF SURVEYORS CREEK
(m³/s)

Location	TfNSW, 2017			Present Investigation					
	Pre-Glenmore Park East Conditions			Post-Glenmore Park East Conditions					
	50% AEP	10% AEP	1% AEP	50% AEP	10% AEP	1% AEP	50% AEP	10% AEP	1% AEP
Northern (downstream) boundary of transmission easement	8.1	14.4	25.5	5.8	14.4	29.8	5.8	13.8	26.9
Immediately downstream of Glenmore Parkway	9.6	17.5	30.7	7.7	18.7	37.1	7.4	17.0	34.3

TABLE 4.2
SUMMARY OF SURFACE WATER MANAGEMENT MEASURES

Catchment ID	Catchment Area (ha)	GPT (Yes/No)	Biofiltration (Yes/No)	Stormwater Detention (Yes/No)	Biofiltration Surface Area (m ²)	Stormwater Detention Surface Area (m ²)		Minimum Stormwater Detention Volume Requirement ⁽¹⁾ (m ³)	Estimated Cost of Biofiltration and Stormwater Detention Basin Requirements
						At Invert Level	At Crest Level		
GPE-C_B1	5.0	Yes	Yes	Yes	400	700	2100	2800	\$475,000
GPE-C_B2	13.4	Yes	Yes	Yes	800	3500	6500	9800	\$1,295,000
GPE-C_B3	11.9	Yes	Yes	Yes	700	2750	5400	8000	\$1,090,000
GPE-C_B4	6.5	Yes	Yes	Yes	400	500	1700	2200	\$415,000
GPE-C_B5	0.6	Yes	No	No	-	-	-	-	-
GPE-C_B6	1.4	Yes	No	No	-	-	-	-	-

1. Includes additional 15% storage volume to offset loss due to landscaping.
2. Based on an estimated \$400/m² for biofiltration and \$150/m² for stormwater detention.

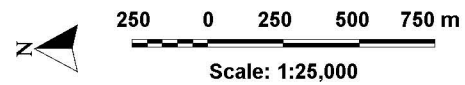
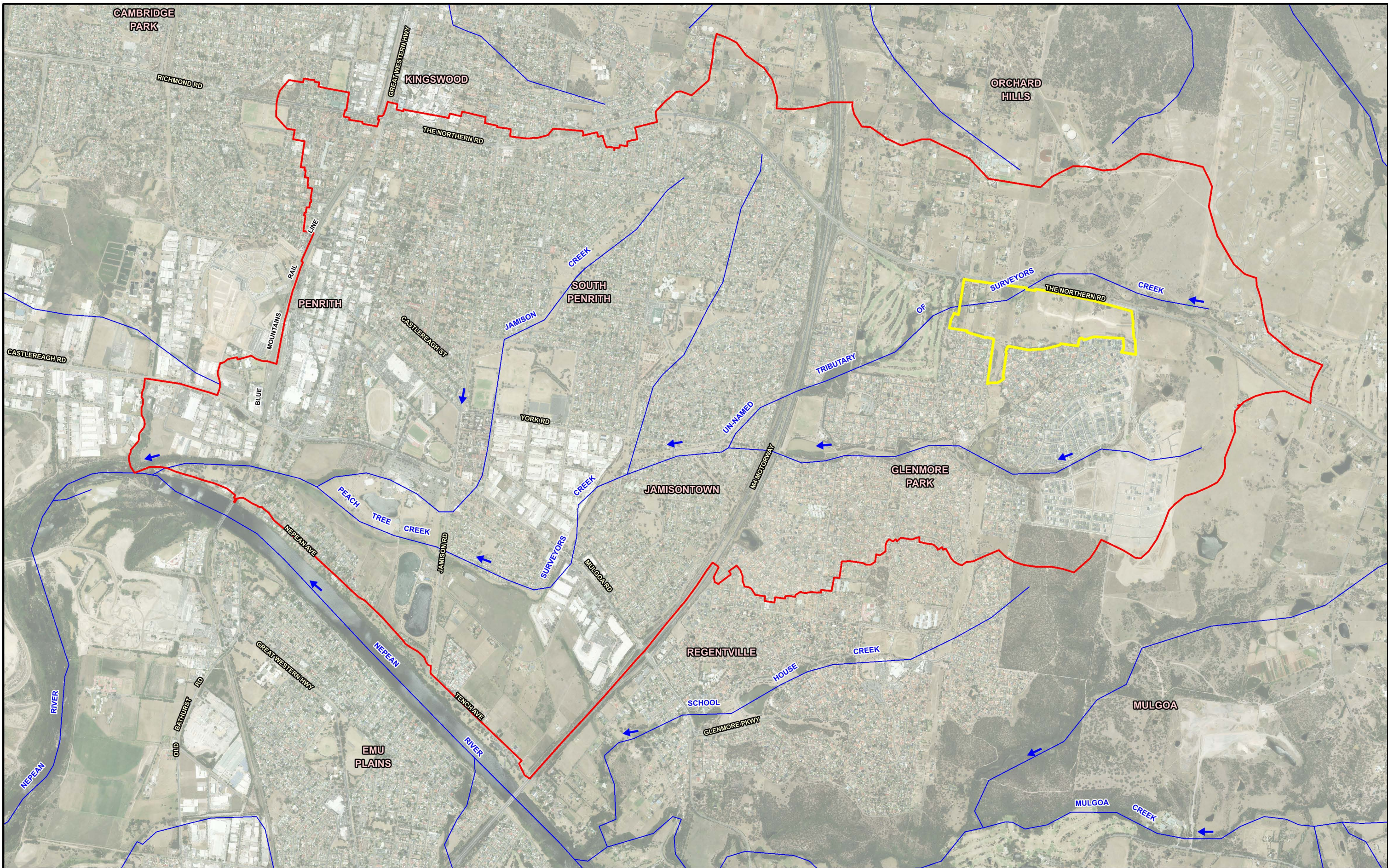
TABLE 4.3
POLLUTANT LOAD REDUCTIONS ACHIEVED BY PROPOSED SURFACE WATER MANAGEMENT STRATEGY

Catchment ID	Gross Pollutants		Total Suspended Solids		Total Phosphorus		Total Nitrogen	
	Source Load (kg/year)	Percentage Reduction	Source Load (kg/year)	Percentage Reduction	Source Load (kg/year)	Percentage Reduction	Source Load (kg/year)	Percentage Reduction
GPE-C_B1	769	100	4780	94.5	7.56	69.8	56.1	49.4
GPE-C_B2	2060	100	12600	93.8	20.3	68.1	153	47
GPE-C_B3	1540	100	8610	94.6	13.8	70.2	103	50.7
GPE-C_B4	982	100	6040	93	9.68	67.2	72.1	43.1
GPE-C_B5	78.9	100	456	70	0.73	30	5.46	0
GPE-C_B6	208	100	1260	70	2.05	30	15	0
Total	5638	100	33746	92.7	54.1	66.7	405	45.2
Targets	-	90	-	85	-	60	-	45

5 REFERENCES

- Ball et al, 2019. ***“Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia”***
- Catchment Simulation Solutions, 2019. ***“Peach Tree and Lower Surveyors Creeks Flood Study”***
- Department of Planning and Environment, 2022. ***“Controlled Activities – Guidelines for Riparian Corridors on Waterfront Land”***
- TfNSW. 2017. ***“The Northern Road Upgrade - Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park - Draft Environmental Impact Statement”***
- NSW Government, 2005. ***“Floodplain Development Manual – The Management of Flood Liable Land”***.
- NSW Government, 2021. ***“Considering Flooding in Land Use Planning Guideline”***
- NSW Government, 2023a. ***“Flood Risk Management Manual – The Policy and Manual for the Management of Flood Liable Land”***
- NSW Government, 2023b. ***“Understanding and Managing Flood Risk – Flood Risk Management Guideline FB01”***
- Penrith City Council, 2013. ***“Design Guidelines for Engineering Works for Subdivisions and Developments”***
- Penrith City Council, 2020. ***“WSUD Technical Guidelines”***

FIGURES

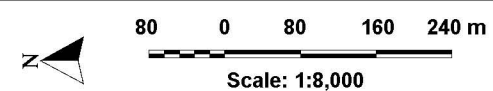
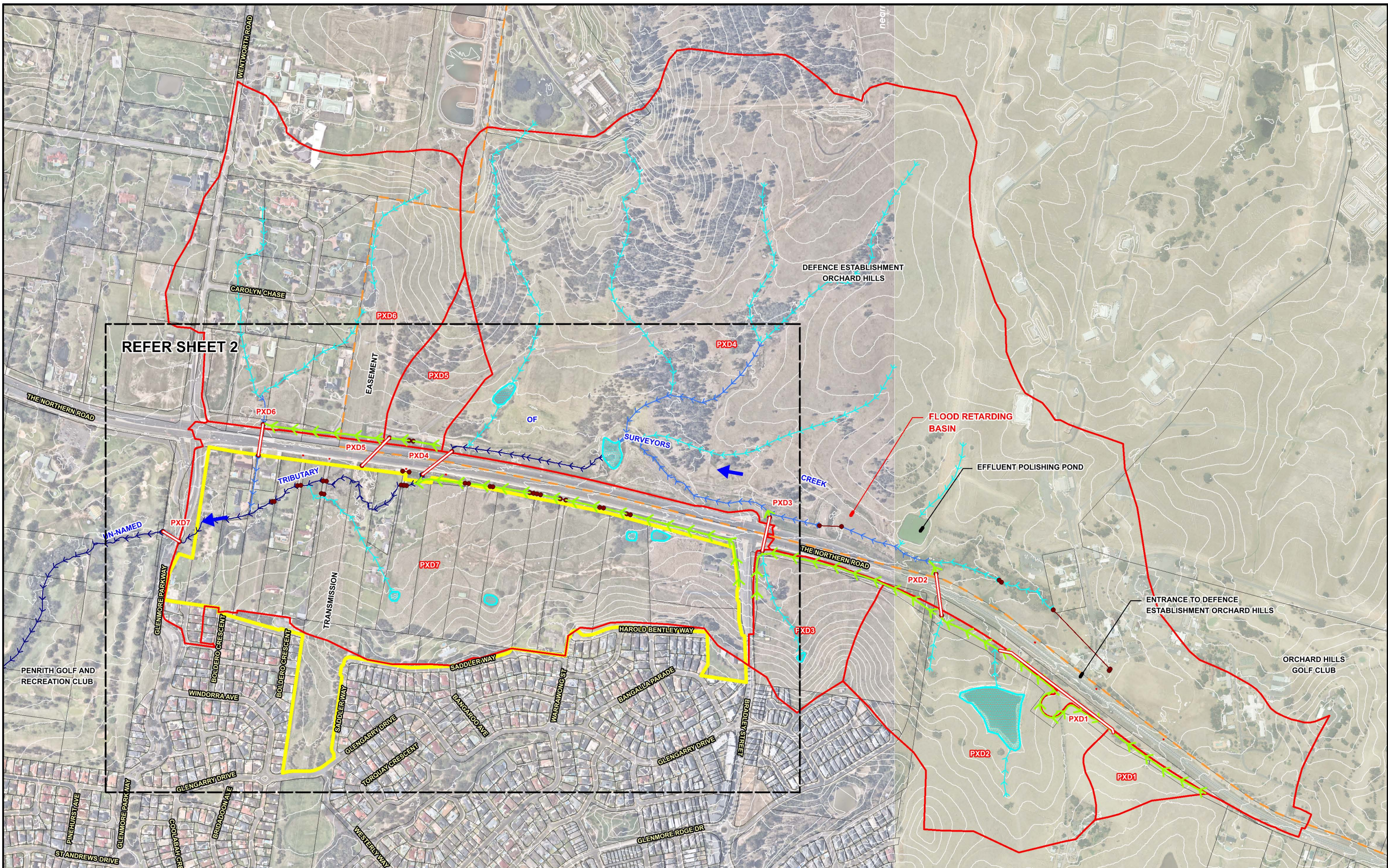


LEGEND

- Surveyors Creek and Peach Tree Creek Catchment Boundary
- Glenmore Park East Boundary

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

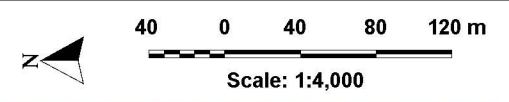
Figure 1.1



LEGEND	
	Existing Minor Drainage Structure in Study Catchment
	Existing Major Drainage Structure and Identifier in Study Catchment
	1st Order Stream
	2nd Order Stream
	3rd Order Stream
	Extent of Catchment Draining into Existing Transverse Drainage Structure and Identifier
	Defence Establishment Orchard Hills Boundary
	Existing Dam in Study Catchment
	Glenmore Park East Boundary
	Existing Grass Lined Channel

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 2.1
(Sheet 1 of 2)
EXISTING DRAINAGE SYSTEM IN THE VICINITY OF GLENMORE PARK EAST



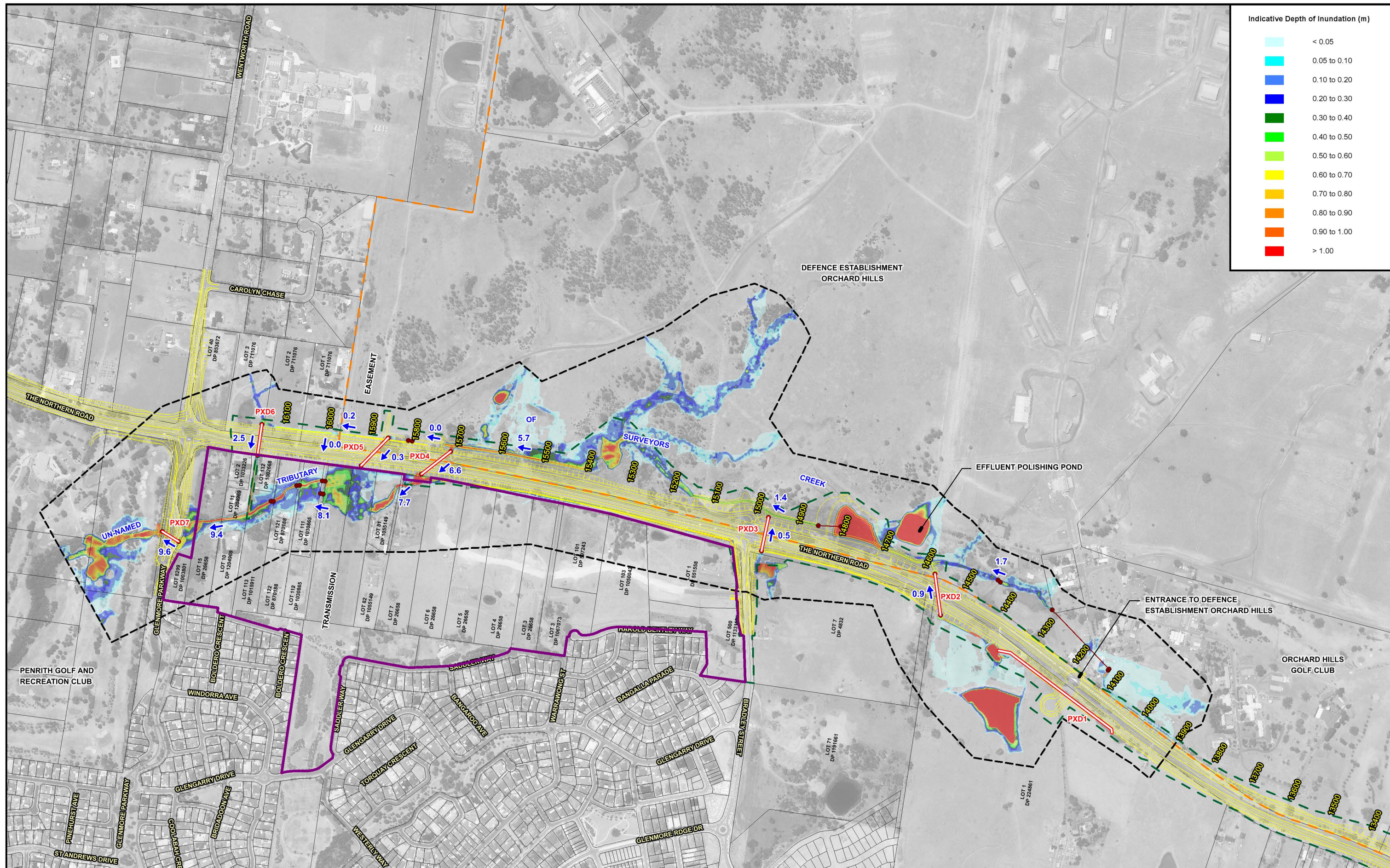
LEGEND	
	Existing Minor Drainage Structure in Study Catchment
	Existing Major Drainage Structure and Identifier in Study Catchment
	1st Order Stream
	2nd Order Stream
	3rd Order Stream

	Extent of Catchment Draining into Existing Transverse Drainage Structure and Identifier
	Defence Establishment Orchard Hills Boundary
	Existing Dam in Study Catchment
	Glenmore Park East Boundary
	Existing Grass Lined Channel

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 2.1
(Sheet 2 of 2)

EXISTING DRAINAGE SYSTEM IN THE VICINITY OF GLENMORE PARK EAST



Indicative Depth of Inundation (m)

< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00



- Modelled Stormwater Drainage Network
- Two-Dimensional Model Extent
- Defence Establishment Orchard Hills Boundary
- TNR5 Project Boundary

- LEGEND**
- Design Strings
 - Proposed Transverse Drainage Structure and Identifier
 - Design Road Control String and Chainage
 - Glenmore Park East Boundary

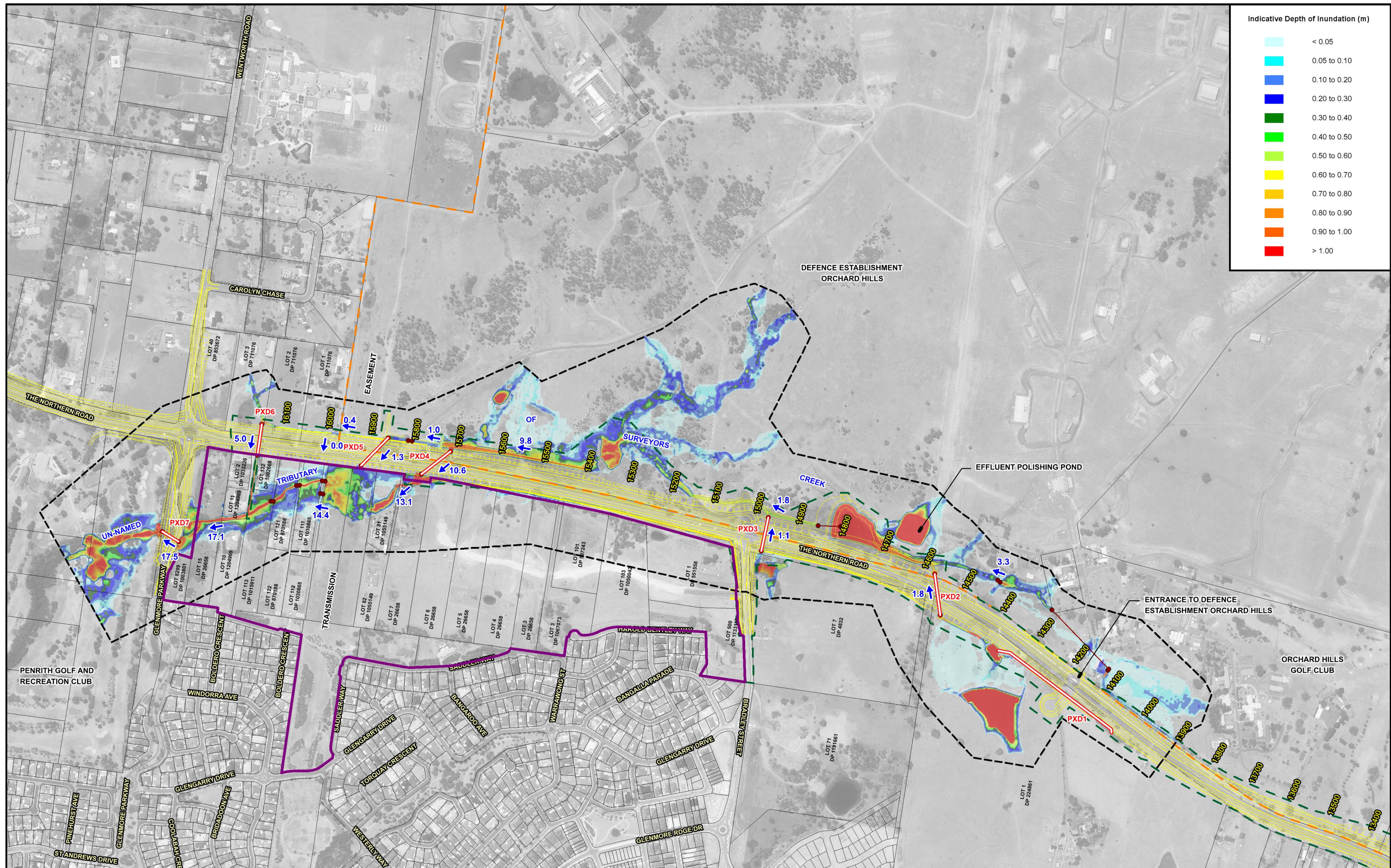
Peak Flow (m³/s)

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 2.2

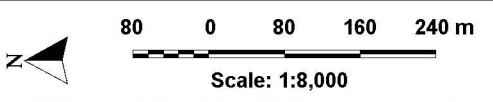
INDICATIVE EXTENT AND DEPTH OF INUNDATION
IN VICINITY OF GLENMORE PARK EAST - PRESENT DAY CONDITIONS - 50% AEP





Indicative Depth of Inundation (m)

<math>< 0.05</math>
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00



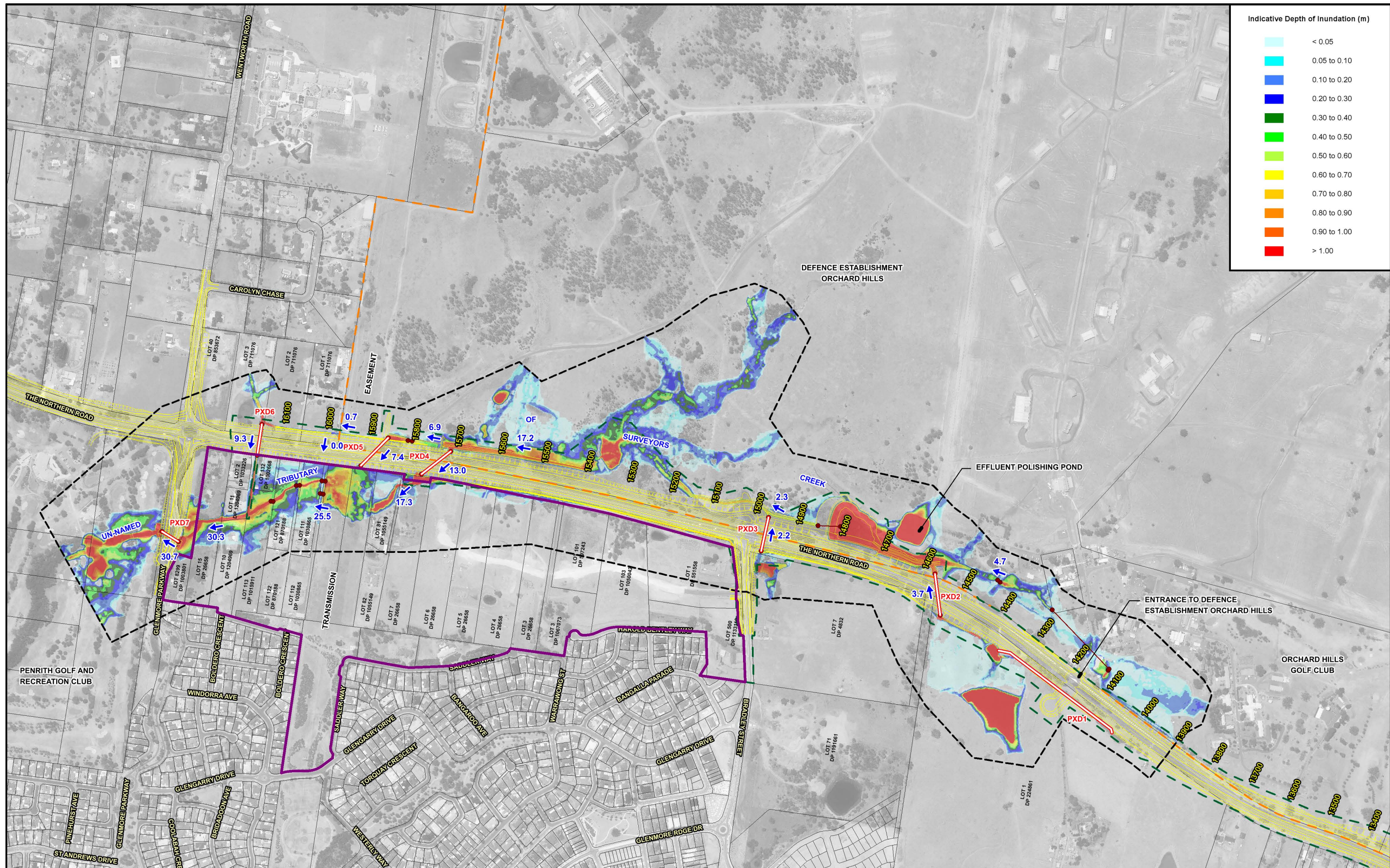
- LEGEND**
- Modelled Stormwater Drainage Network
 - Two-Dimensional Model Extent
 - Defence Establishment Orchard Hills Boundary
 - TNR5 Project Boundary
 - Design Strings
 - Proposed Transverse Drainage Structure and Identifier
 - Design Road Control String and Chainage
 - Glenmore Park East Boundary
 - Peak Flow (m³/s)

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 2.3

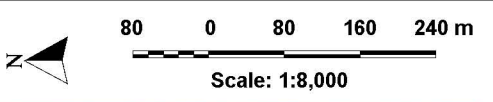
INDICATIVE EXTENT AND DEPTH OF INUNDATION
IN VICINITY OF GLENMORE PARK EAST - PRESENT DAY CONDITIONS - 10% AEP





Indicative Depth of Inundation (m)

< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00



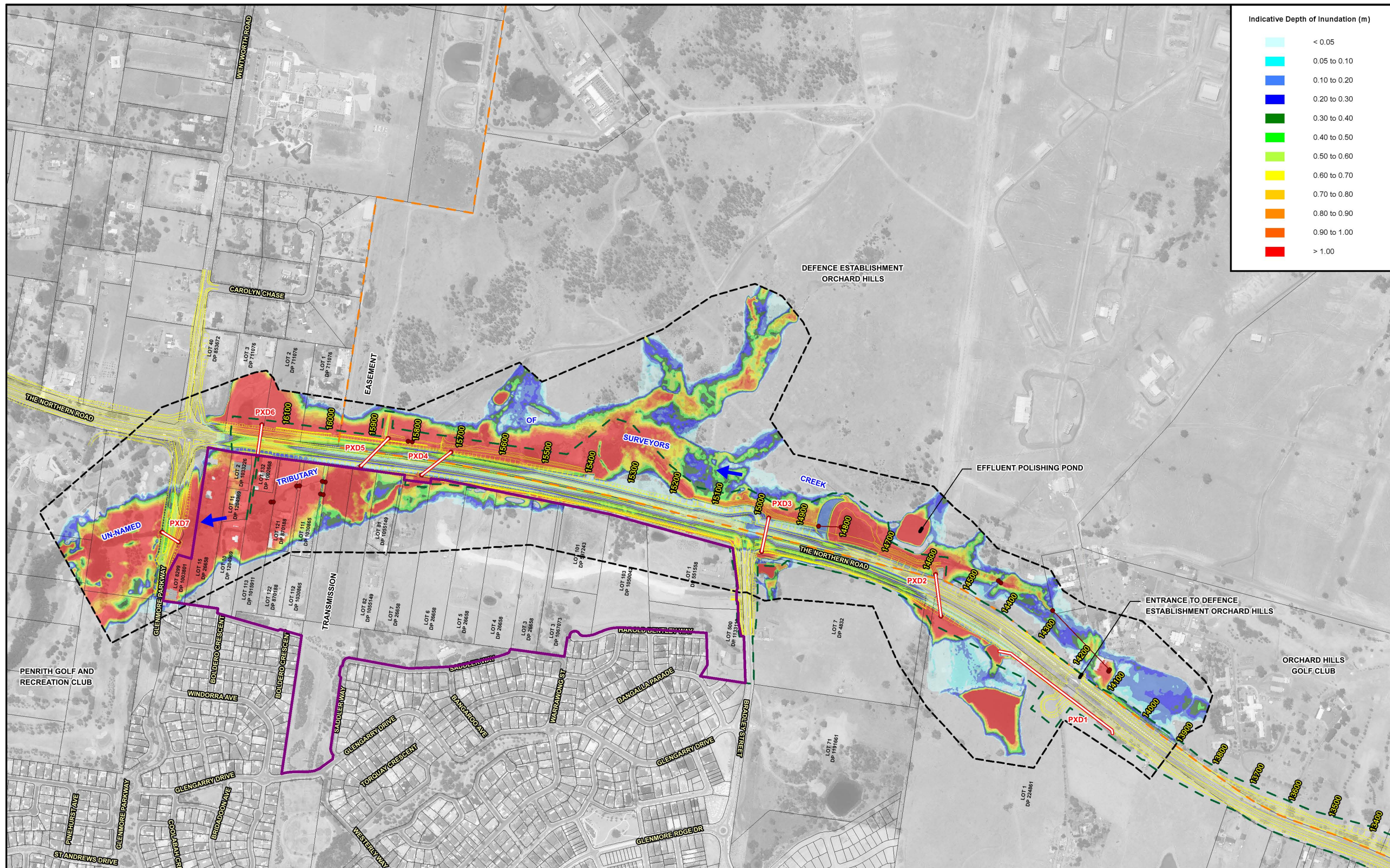
- LEGEND**
- Modelled Stormwater Drainage Network
 - Two-Dimensional Model Extent
 - Defence Establishment Orchard Hills Boundary
 - TNR5 Project Boundary
 - Design Strings
 - Proposed Transverse Drainage Structure and Identifier
 - Design Road Control String and Chainage
 - Glenmore Park East Boundary
 - Peak Flow (m/s)

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 2.4

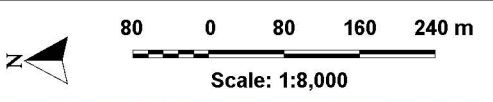
INDICATIVE EXTENT AND DEPTH OF INUNDATION
IN VICINITY OF GLENMORE PARK EAST - PRESENT DAY CONDITIONS - 1% AEP





Indicative Depth of Inundation (m)

< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00



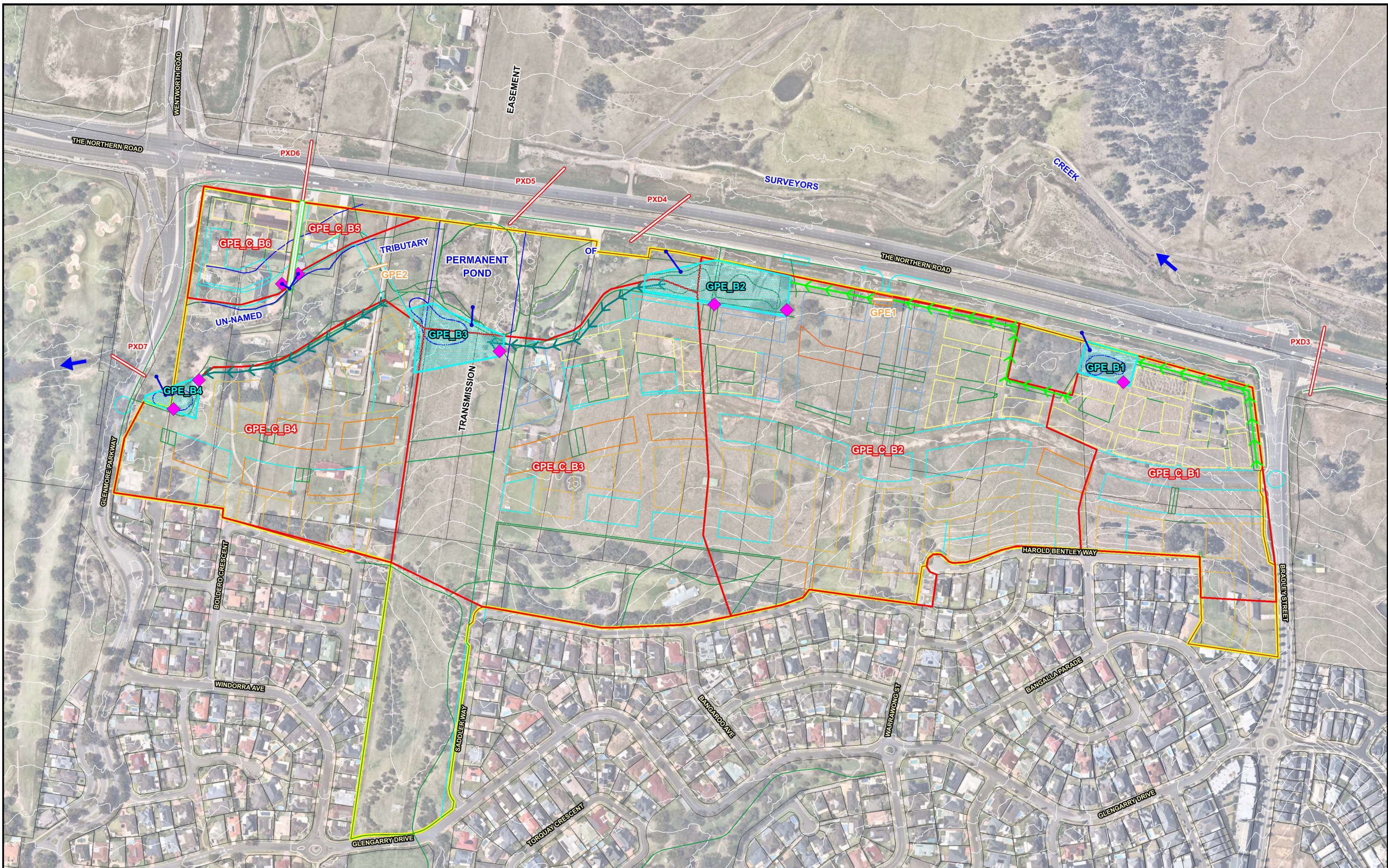
- LEGEND**
- Modelled Stormwater Drainage Network
 - Two-Dimensional Model Extent
 - Defence Establishment Orchard Hills Boundary
 - TNR5 Project Boundary
 - Design Strings
 - Proposed Transverse Drainage Structure and Identifier
 - Design Road Control String and Chainage
 - Glenmore Park East Boundary

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 2.5

INDICATIVE EXTENT AND DEPTH OF INUNDATION
IN VICINITY OF GLENMORE PARK EAST - PRESENT DAY CONDITIONS - PMF





40 0 40 80 120 m
Scale: 1:4,000

Glenmore Park East Boundary

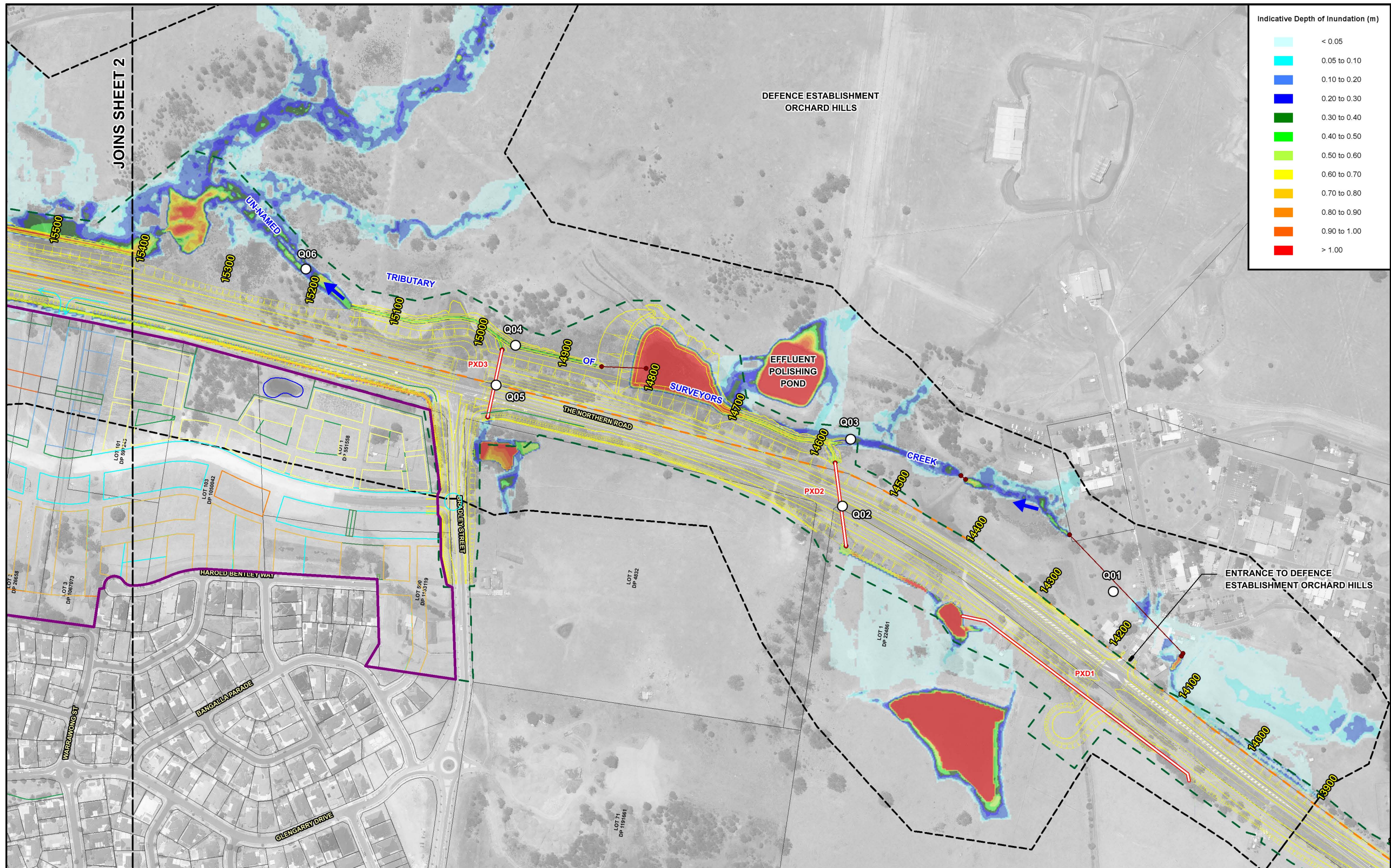
- LEGEND**
- **PXD1** Existing Major Drainage Structure and Identifier
 - **GPE1** Proposed Major Drainage Structure and Identifier
 - Grass Swale
 - Designated Overland Flow Path
 - Enclosed Reach of Channel

- GPE_C_B1 Extent of Catchment Draining to Defined Outlet Location and Identifier
- GPE_B1 Combined Biofiltration and OSD Basin and Identifier
- ◆ GPT

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 4.1

FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY
FOR GLENMORE PARK EAST



Indicative Depth of Inundation (m)	
< 0.05	Lightest Cyan
0.05 to 0.10	Cyan
0.10 to 0.20	Blue
0.20 to 0.30	Dark Blue
0.30 to 0.40	Green
0.40 to 0.50	Bright Green
0.50 to 0.60	Yellow-Green
0.60 to 0.70	Yellow
0.70 to 0.80	Orange-Yellow
0.80 to 0.90	Orange
0.90 to 1.00	Dark Orange
> 1.00	Red



- Modelled Stormwater Drainage Network
- Two-Dimensional Model Extent
- Defence Establishment Orchard Hills Boundary
- TNR5 Project Boundary

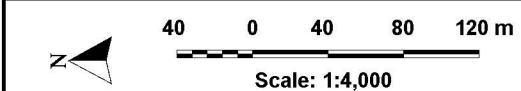
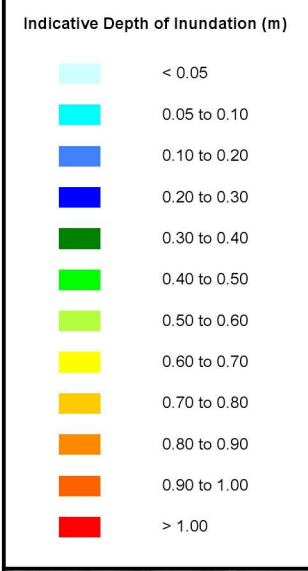
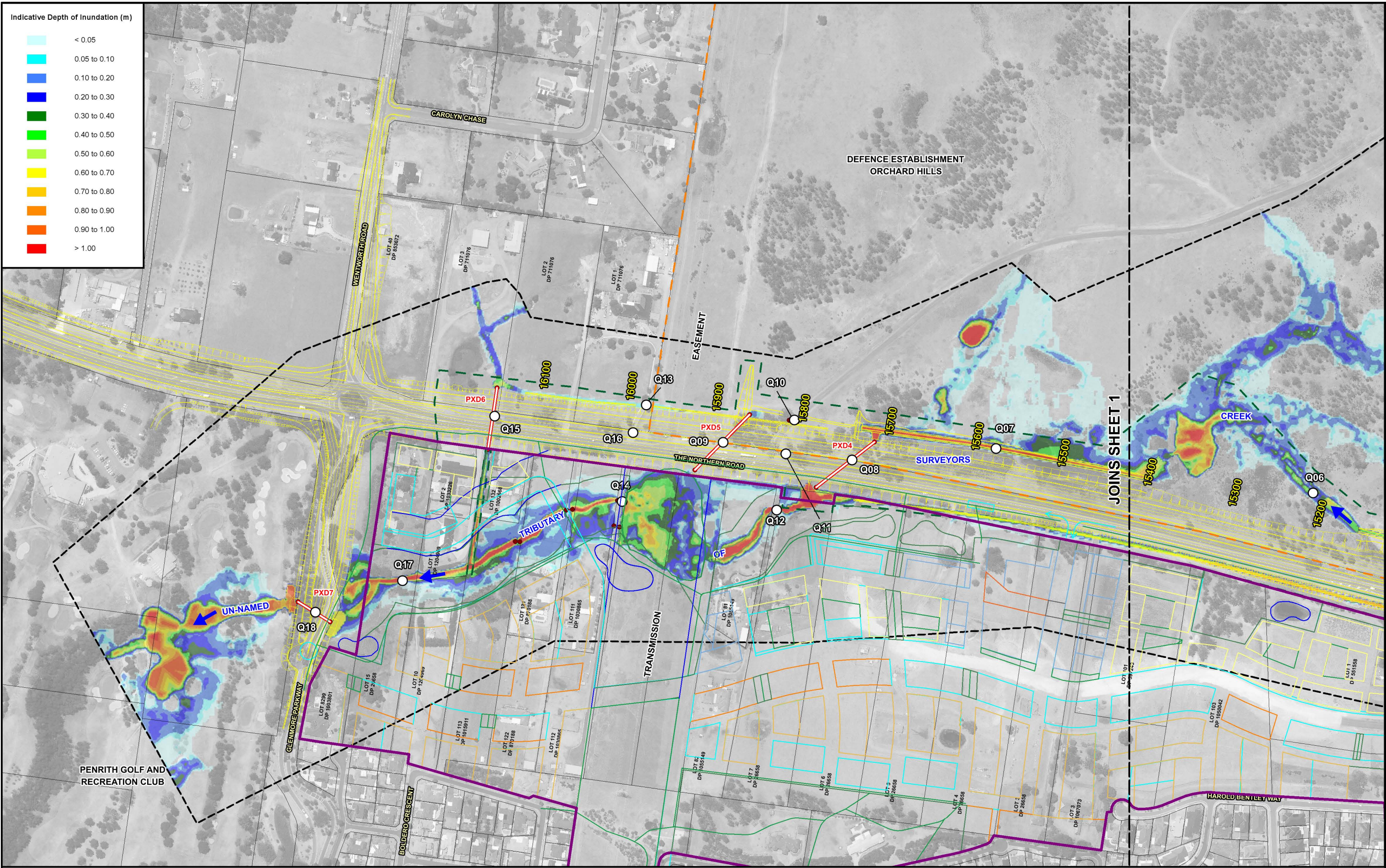
- LEGEND**
- Design Strings
 - Proposed Transverse Drainage Structure and Identifier
 - Design Road Control String and Chainage
 - Glenmore Park East Boundary

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 4.2
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION RELATIVE TO
PROPOSED DEVELOPMENT IN GLENMORE PARK EAST - 50% AEP





- Modelled Stormwater Drainage Network
- Two-Dimensional Model Extent
- Defence Establishment Orchard Hills Boundary
- TNR5 Project Boundary

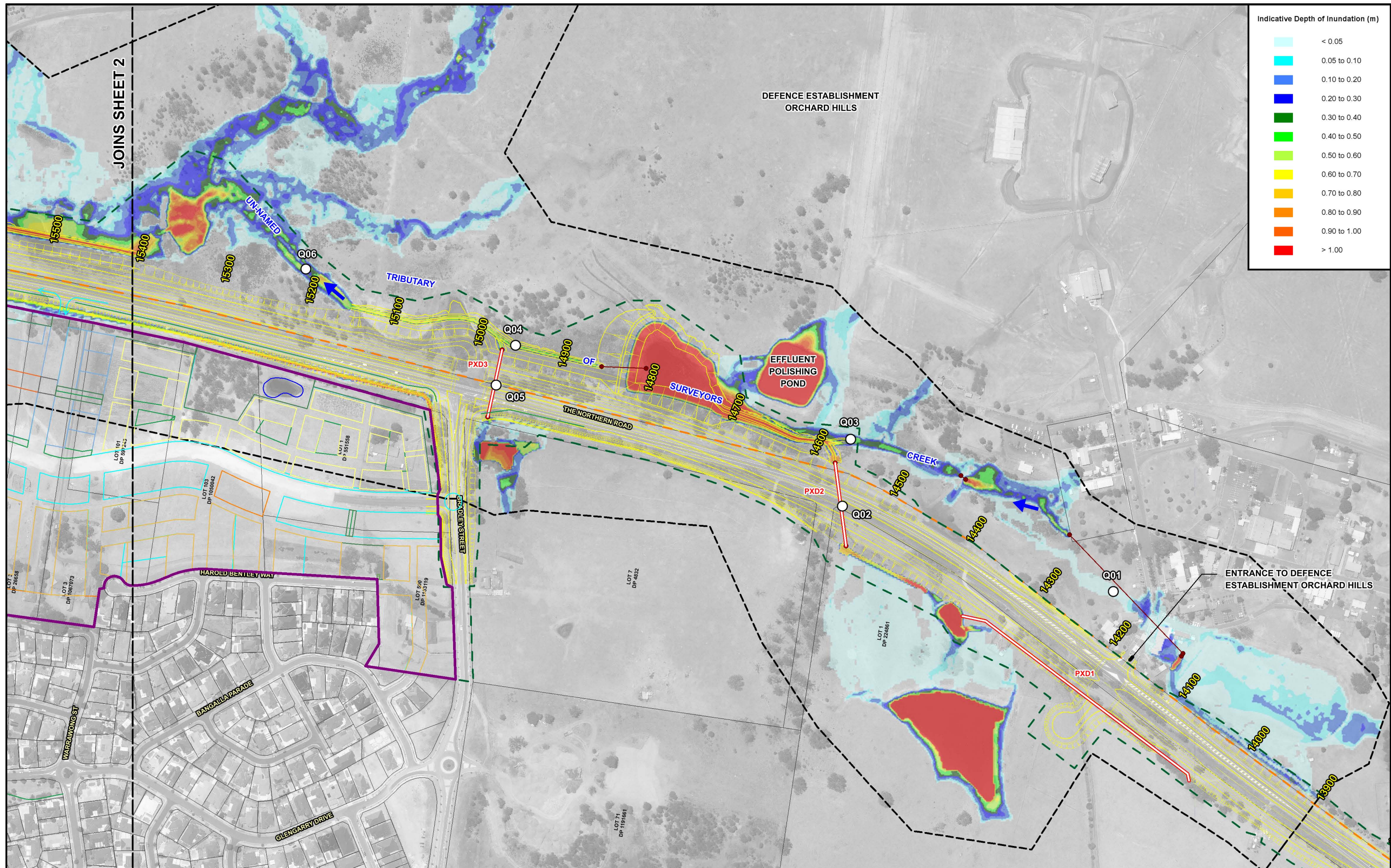
- LEGEND
- Design Strings
 - Proposed Transverse Drainage Structure and Identifier (PXD4)
 - Design Road Control String and Chainage (15400, 15500)
 - Glenmore Park East Boundary

GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY

Figure 4.2
(Sheet 2 of 2)

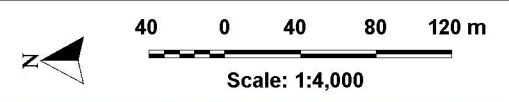
INDICATIVE EXTENT AND DEPTH OF INUNDATION RELATIVE TO PROPOSED DEVELOPMENT IN GLENMORE PARK EAST - 50% AEP





Indicative Depth of Inundation (m)

< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00



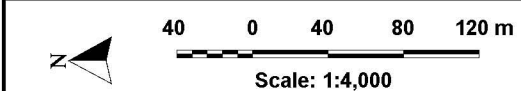
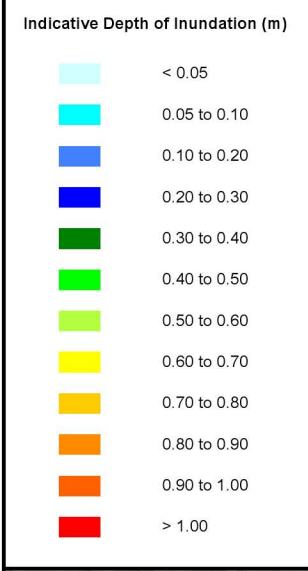
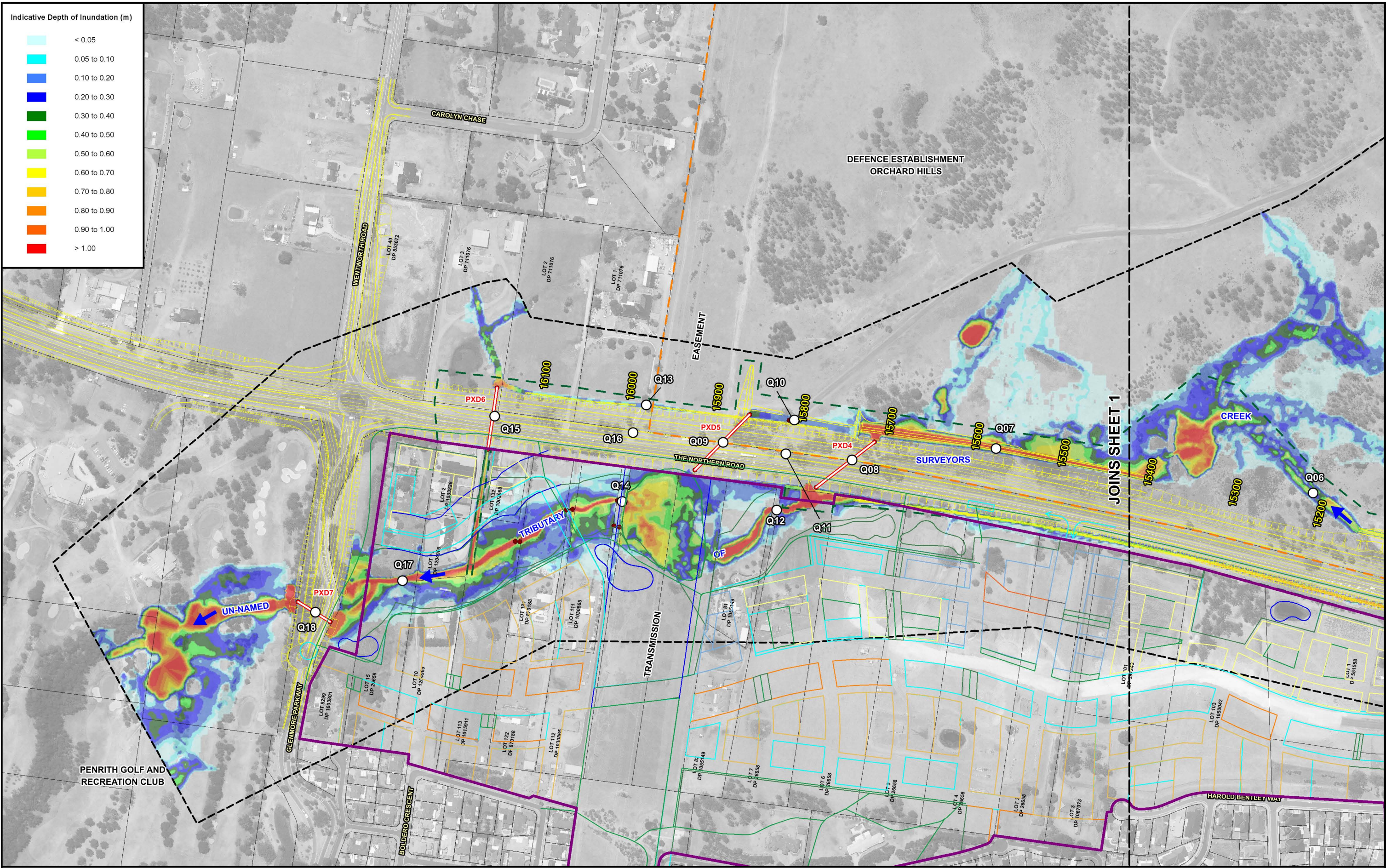
- Modelled Stormwater Drainage Network
- Two-Dimensional Model Extent
- Defence Establishment Orchard Hills Boundary
- TNR5 Project Boundary

- LEGEND**
- Design Strings
 - Proposed Transverse Drainage Structure and Identifier
 - Design Road Control String and Chainage
 - Glenmore Park East Boundary

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 4.3
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION RELATIVE TO PROPOSED DEVELOPMENT IN GLENMORE PARK EAST - 10% AEP



- Modelled Stormwater Drainage Network
- Two-Dimensional Model Extent
- Defence Establishment Orchard Hills Boundary
- TNR5 Project Boundary

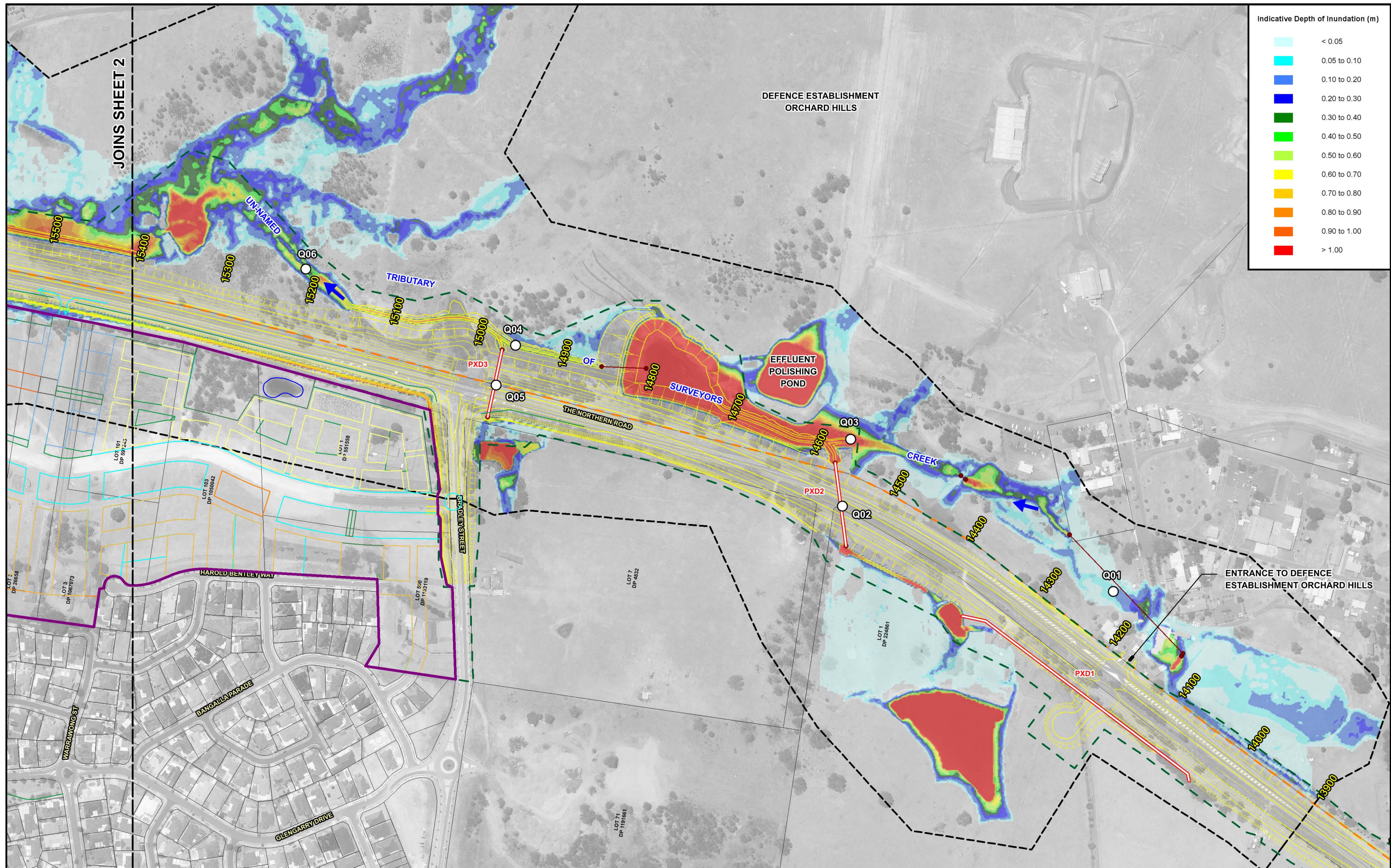
- LEGEND
- Design Strings
 - Proposed Transverse Drainage Structure and Identifier (PXD4)
 - Design Road Control String and Chainage (15400, 15500)
 - Glenmore Park East Boundary

GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY

Figure 4.3
(Sheet 2 of 2)

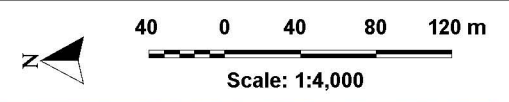
INDICATIVE EXTENT AND DEPTH OF INUNDATION RELATIVE TO PROPOSED DEVELOPMENT IN GLENMORE PARK EAST - 10% AEP





Indicative Depth of Inundation (m)

< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00



- Modelled Stormwater Drainage Network
- Two-Dimensional Model Extent
- Defence Establishment Orchard Hills Boundary
- TNR5 Project Boundary

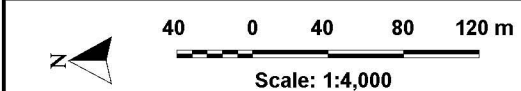
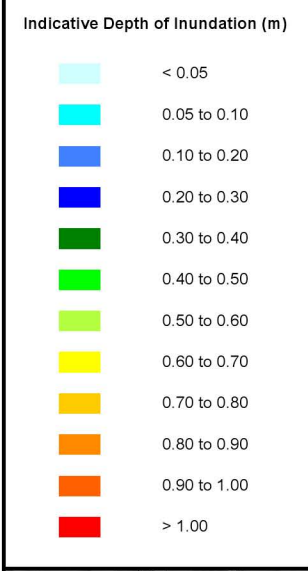
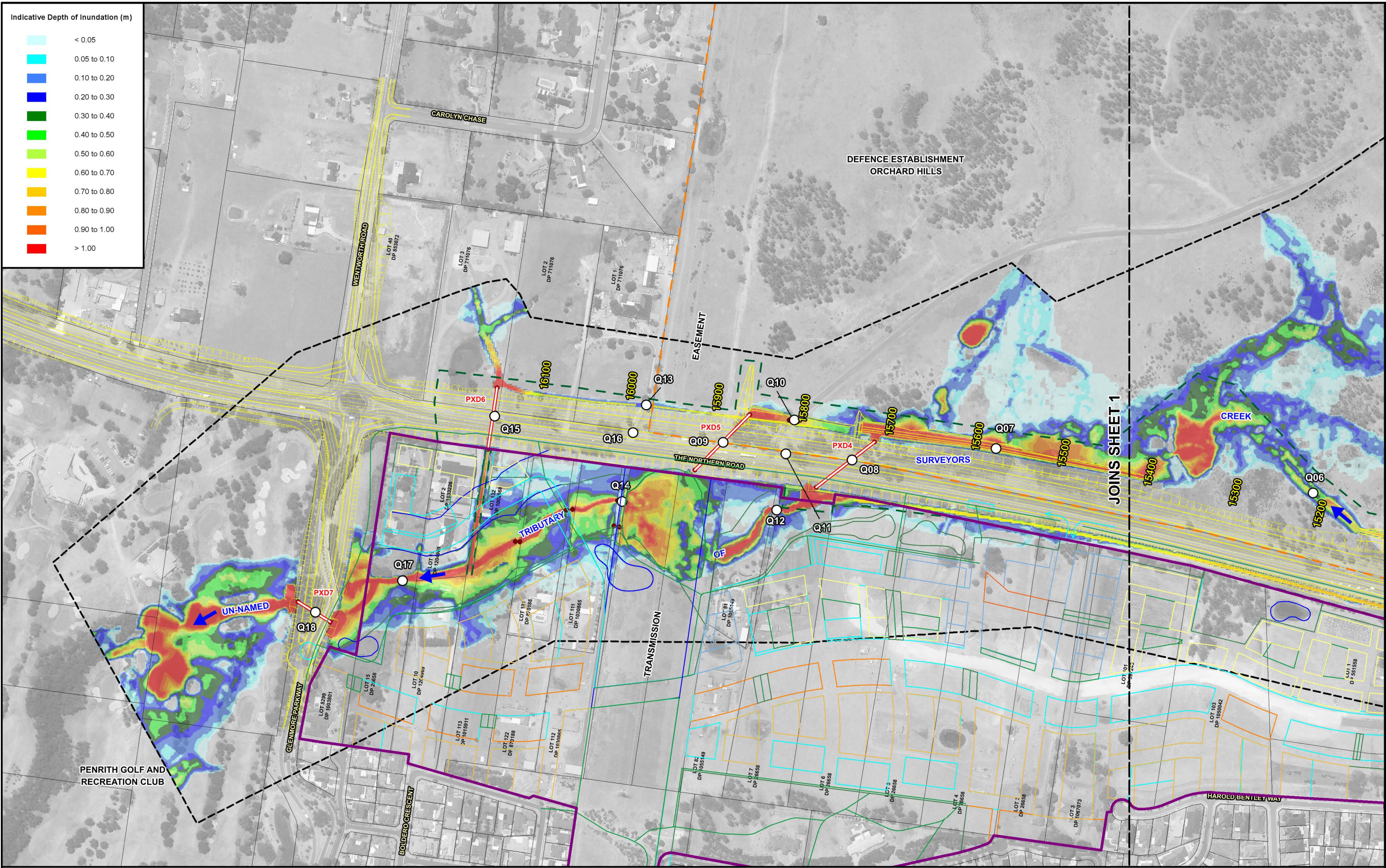
- LEGEND**
- Design Strings
 - Proposed Transverse Drainage Structure and Identifier
 - Design Road Control String and Chainage
 - Glenmore Park East Boundary

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 4.4
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION RELATIVE TO PROPOSED DEVELOPMENT IN GLENMORE PARK EAST - 1% AEP





- Modelled Stormwater Drainage Network
- Two-Dimensional Model Extent
- Defence Establishment Orchard Hills Boundary
- TNR5 Project Boundary

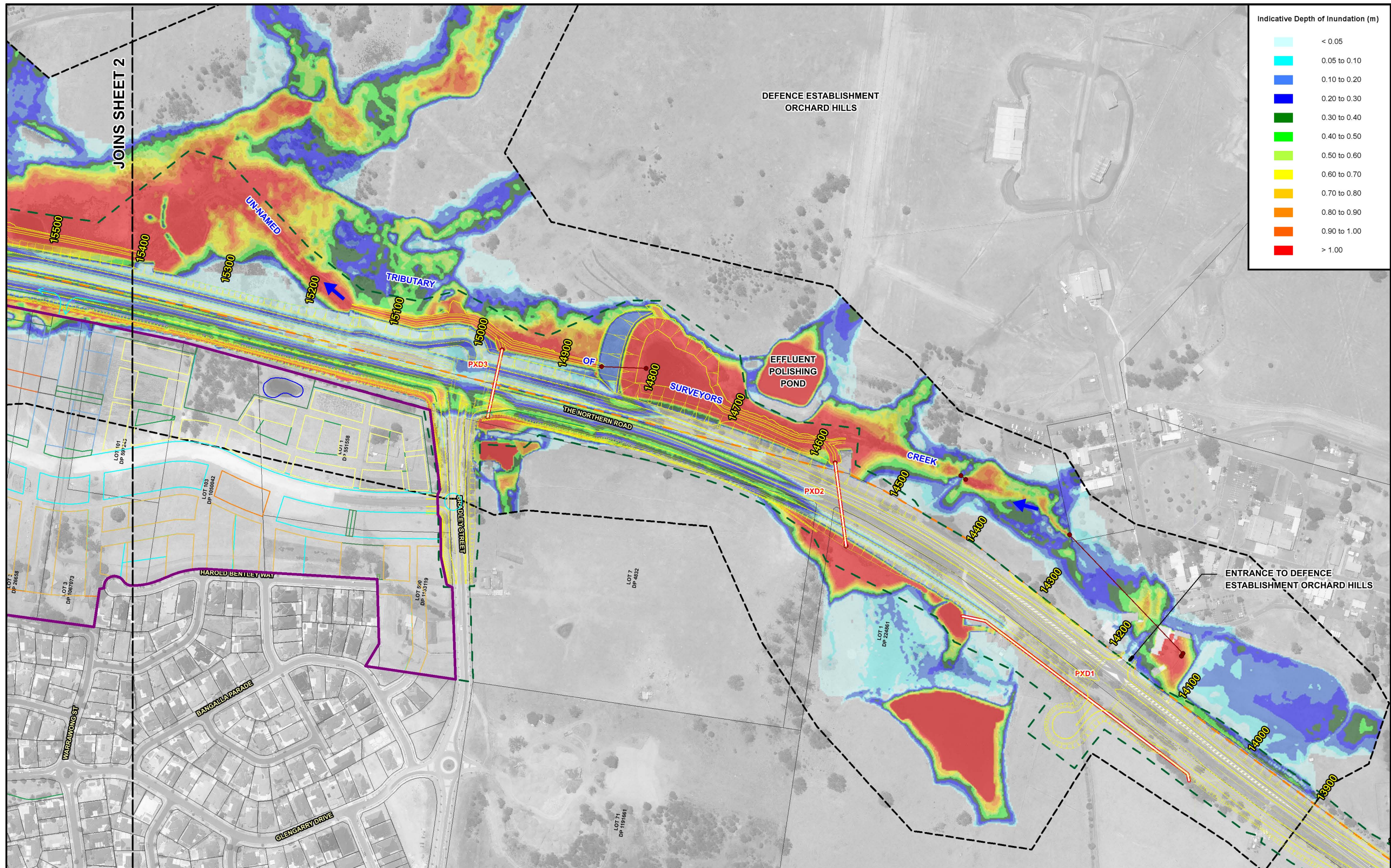
- LEGEND
- Design Strings
 - Proposed Transverse Drainage Structure and Identifier
 - Design Road Control String and Chainage
 - Glenmore Park East Boundary

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 4.4
(Sheet 2 of 2)

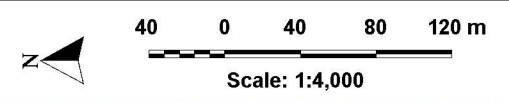
INDICATIVE EXTENT AND DEPTH OF INUNDATION RELATIVE TO PROPOSED DEVELOPMENT IN GLENMORE PARK EAST - 1% AEP





Indicative Depth of Inundation (m)

< 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.30
0.30 to 0.40
0.40 to 0.50
0.50 to 0.60
0.60 to 0.70
0.70 to 0.80
0.80 to 0.90
0.90 to 1.00
> 1.00



- Modelled Stormwater Drainage Network
- Two-Dimensional Model Extent
- Defence Establishment Orchard Hills Boundary
- TNR5 Project Boundary

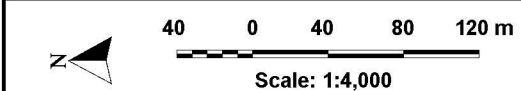
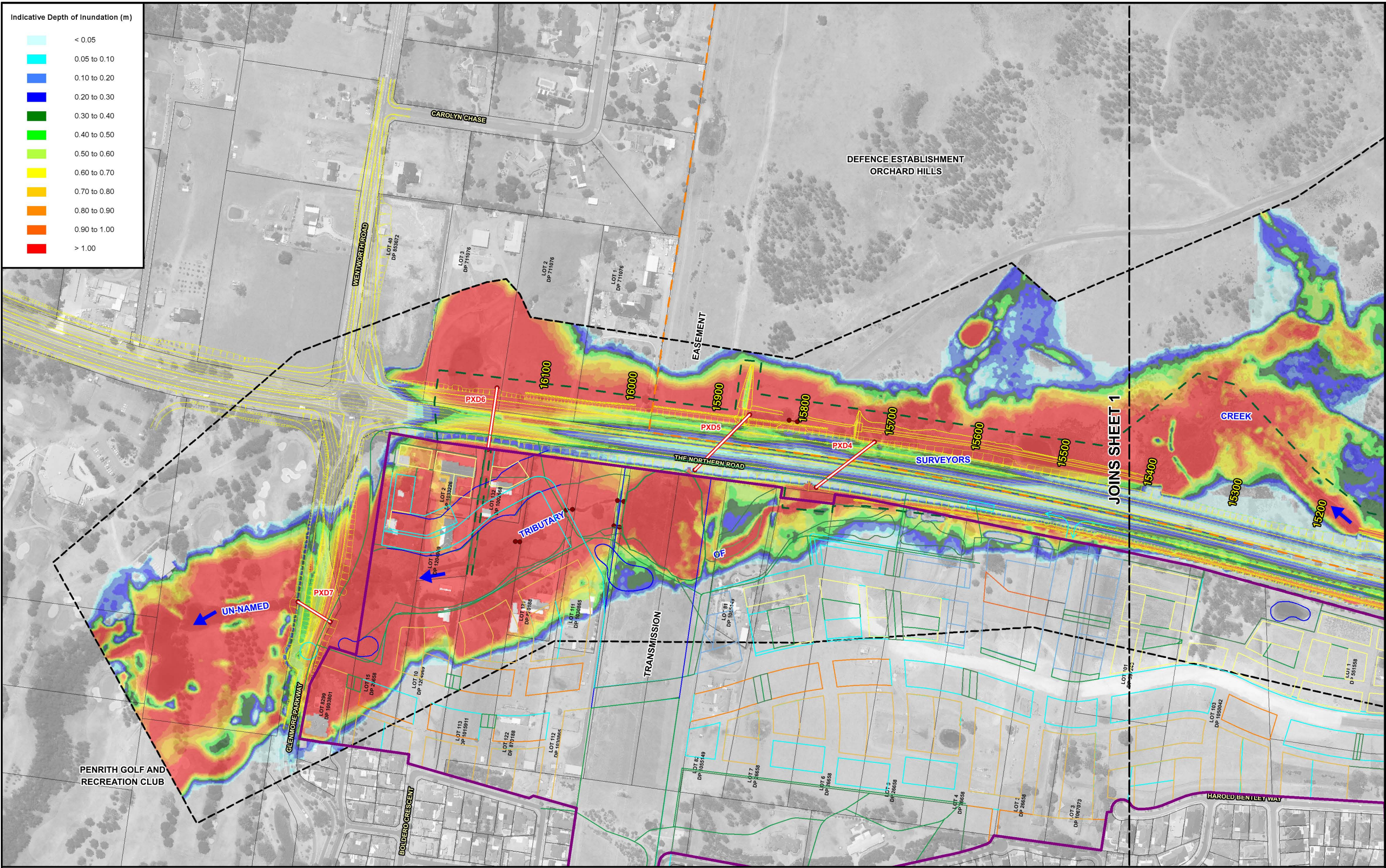
- LEGEND**
- Design Strings
 - Proposed Transverse Drainage Structure and Identifier
 - Design Road Control String and Chainage
 - Glenmore Park East Boundary





**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**


Figure 4.5
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION RELATIVE TO PROPOSED DEVELOPMENT IN GLENMORE PARK EAST - PMF





-  Modelled Stormwater Drainage Network
-  Two-Dimensional Model Extent
-  Defence Establishment Orchard Hills Boundary
-  TNR5 Project Boundary

- LEGEND**
-  Design Strings
 -  Proposed Transverse Drainage Structure and Identifier
 -  Design Road Control String and Chainage
 -  Glenmore Park East Boundary

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 4.5
(Sheet 2 of 2)

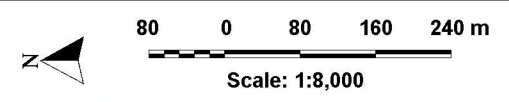
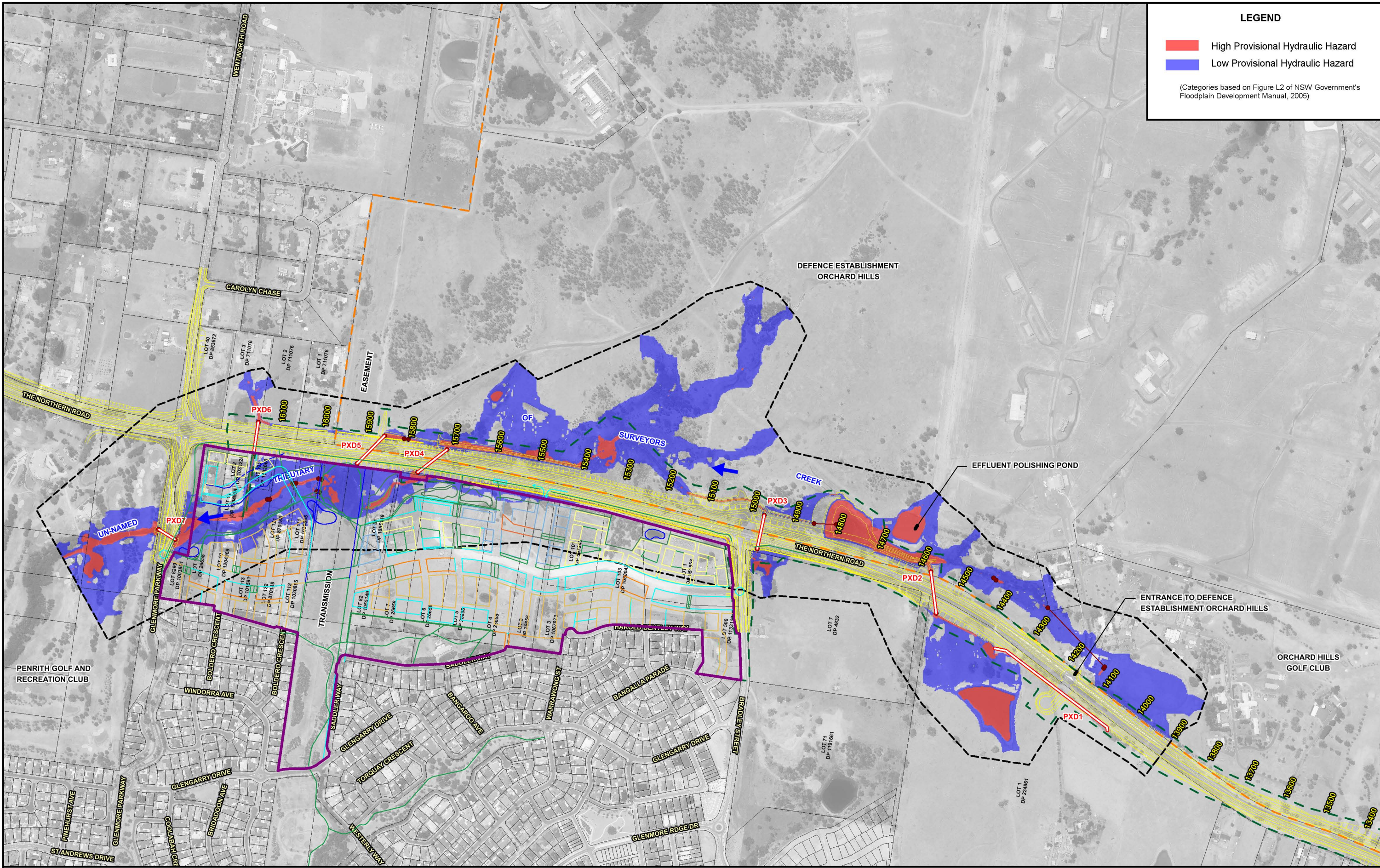
INDICATIVE EXTENT AND DEPTH OF INUNDATION RELATIVE TO PROPOSED DEVELOPMENT IN GLENMORE PARK EAST - PMF

LEGEND

High Provisional Hydraulic Hazard

Low Provisional Hydraulic Hazard

(Categories based on Figure L2 of NSW Government's Floodplain Development Manual, 2005)



- Modelled Stormwater Drainage Network
- Two-Dimensional Model Extent
- Defence Establishment Orchard Hills Boundary
- TNR5 Project Boundary

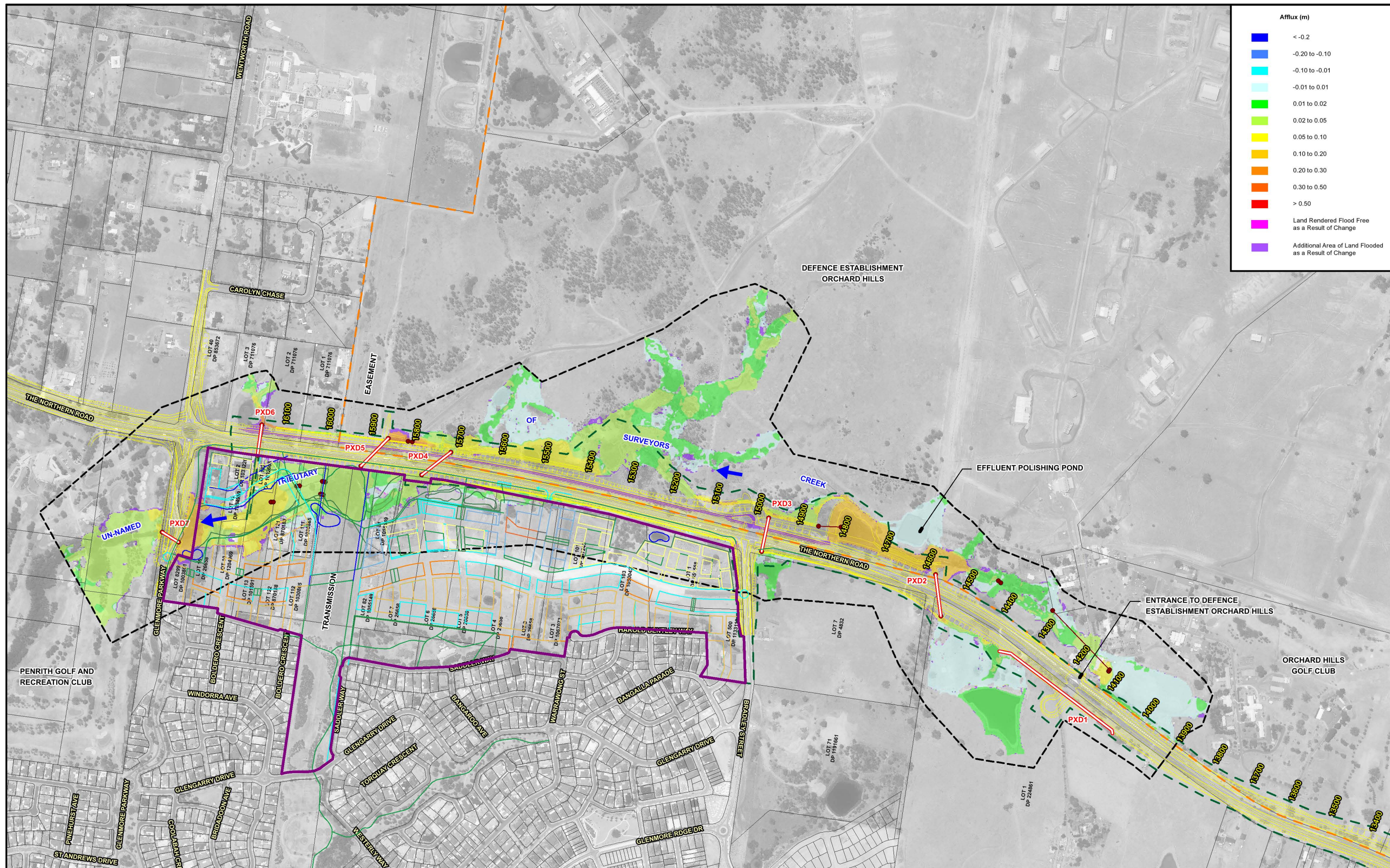
- LEGEND**
- Design Strings
 - Glenmore Park East Boundary
 - Proposed Transverse Drainage Structure and Identifier
 - Design Road Control String and Chainage

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 4.6

PROVISIONAL FLOOD HAZARD RELATIVE TO PROPOSED DEVELOPMENT
IN GLENMORE PARK EAST - 1% AEP





Afflux (m)	
Dark Blue	< -0.2
Blue	-0.20 to -0.10
Cyan	-0.10 to -0.01
Light Cyan	-0.01 to 0.01
Green	0.01 to 0.02
Light Green	0.02 to 0.05
Yellow	0.05 to 0.10
Orange	0.10 to 0.20
Red-Orange	0.20 to 0.30
Red	0.30 to 0.50
Pink	Land Rendered Flood Free as a Result of Change
Purple	Additional Area of Land Flooded as a Result of Change



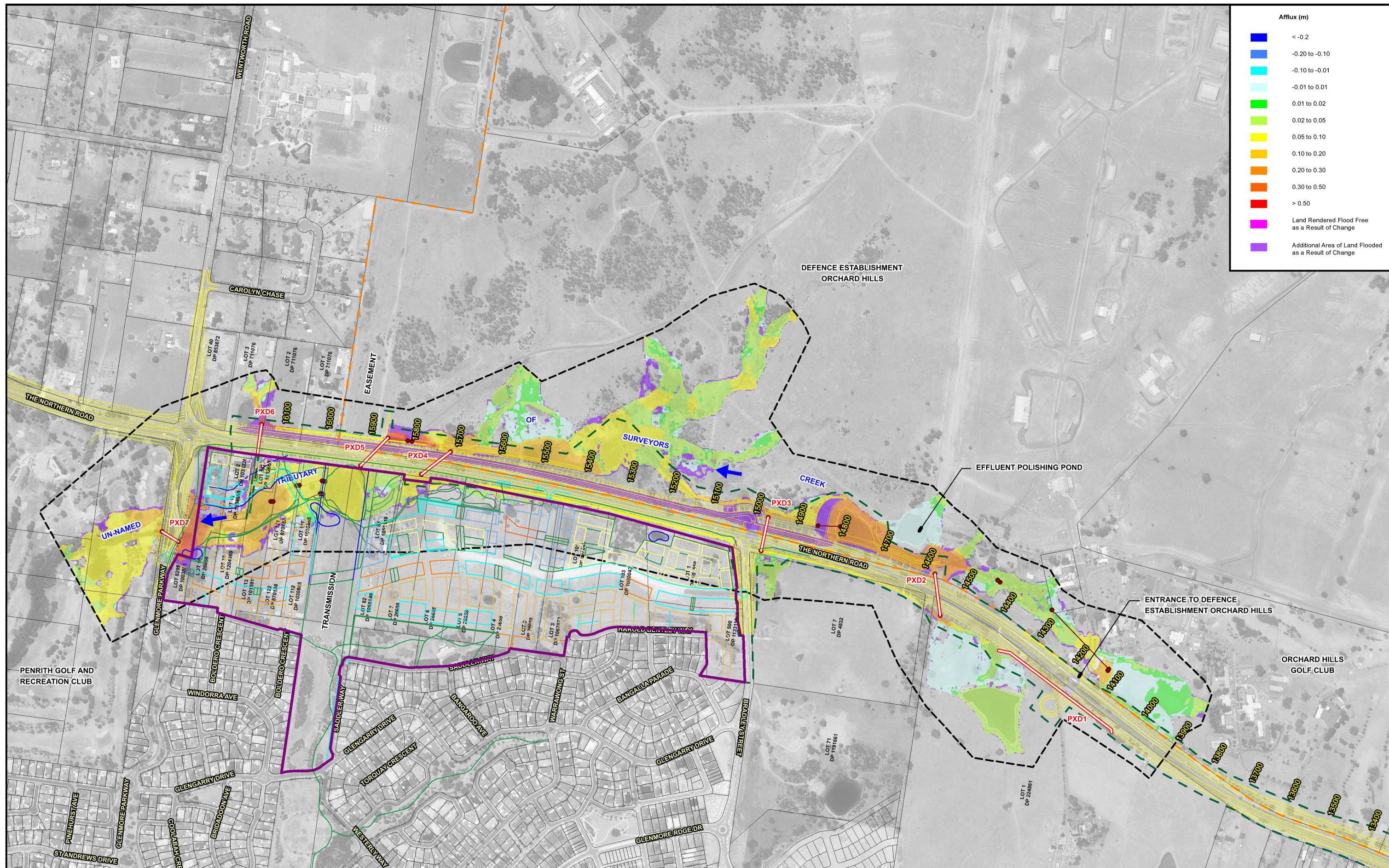
LEGEND	
	Modelled Stormwater Drainage Network
	Two-Dimensional Model Extent
	Defence Establishment Orchard Hills Boundary
	TNR5 Project Boundary
	Design Strings
	Glenmore Park East Boundary
	Proposed Transverse Drainage Structure and Identifier
	Design Road Control String and Chainage

GLENMORE PARK EAST PLANNING PROPOSAL FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY

Figure 4.7

IMPACT OF 10% INCREASE IN DESIGN RAINFALL INTENSITIES ON FLOOD BEHAVIOUR
RELATIVE TO PROPOSED DEVELOPMENT IN GLENMORE PARK EAST - 1% AEP





Afflux (m)	
Blue	<math><-0.2</math>
Light Blue	-0.20 to -0.10
Cyan	-0.10 to -0.01
Light Green	-0.01 to 0.01
Green	0.01 to 0.02
Light Yellow	0.02 to 0.05
Yellow	0.05 to 0.10
Orange	0.10 to 0.20
Dark Orange	0.20 to 0.30
Red	0.30 to 0.50
Red	> 0.50
Magenta	Land Rendered Flood Free as a Result of Change
Purple	Additional Area of Land Flooded as a Result of Change



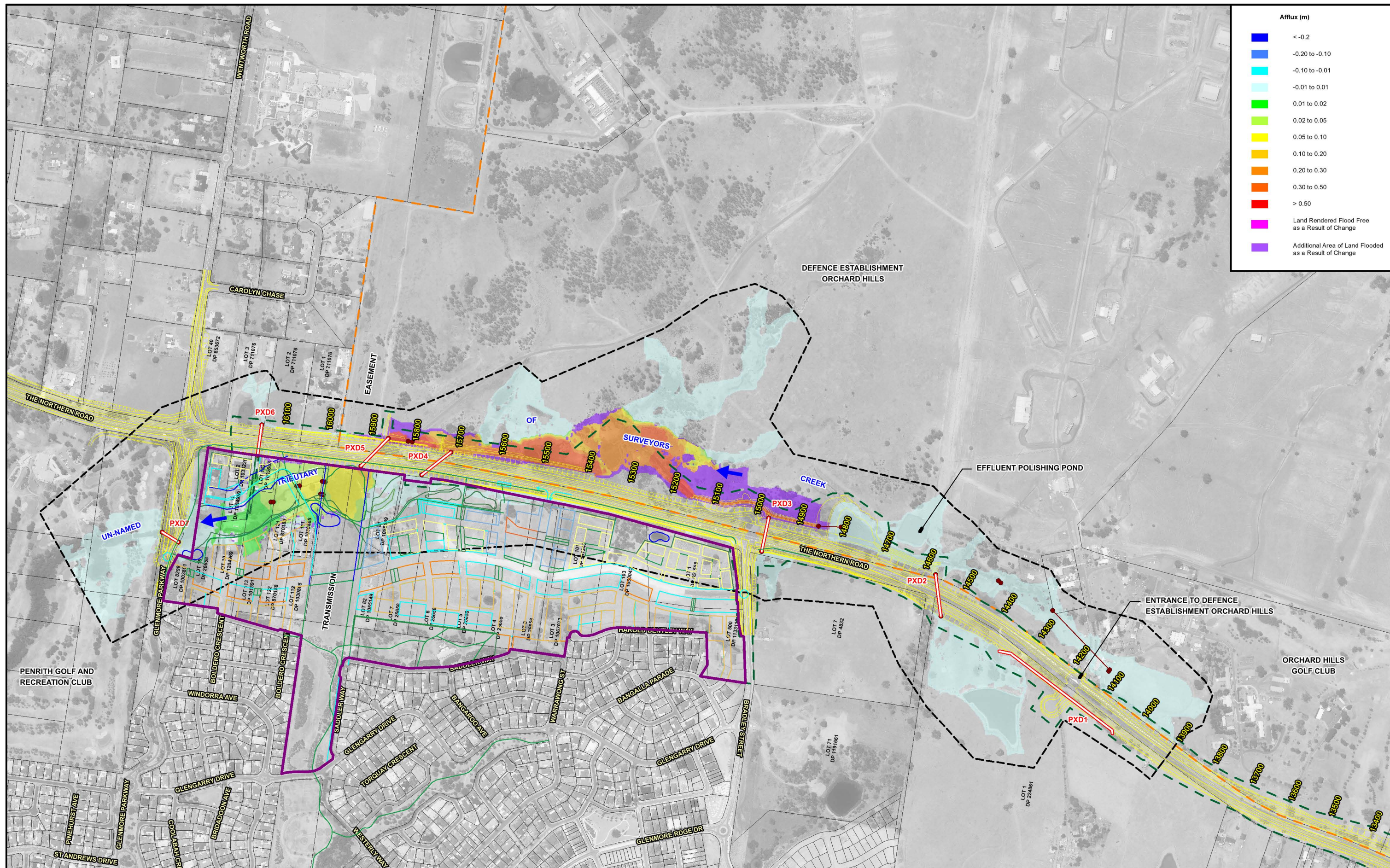
LEGEND	
	Modelled Stormwater Drainage Network
	Two-Dimensional Model Extent
	Defence Establishment Orchard Hills Boundary
	TNR5 Project Boundary
	Design Strings
	Glenmore Park East Boundary
	Proposed Transverse Drainage Structure and Identifier
	Design Road Control String and Chainage

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

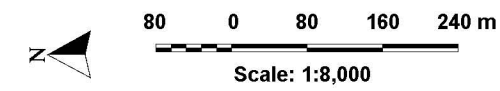
Figure 4.8

IMPACT OF 30% INCREASE IN DESIGN RAINFALL INTENSITIES ON FLOOD BEHAVIOUR
RELATIVE TO PROPOSED DEVELOPMENT IN GLENMORE PARK EAST - 1% AEP





Afflux (m)	
Blue	<math><-0.2</math>
Light Blue	-0.20 to -0.10
Cyan	-0.10 to -0.01
Light Green	-0.01 to 0.01
Green	0.01 to 0.02
Light Yellow	0.02 to 0.05
Yellow	0.05 to 0.10
Orange	0.10 to 0.20
Dark Orange	0.20 to 0.30
Red	0.30 to 0.50
Pink	> 0.50
Light Purple	Land Rendered Flood Free as a Result of Change
Dark Purple	Additional Area of Land Flooded as a Result of Change



LEGEND	
	Modelled Stormwater Drainage Network
	Two-Dimensional Model Extent
	Defence Establishment Orchard Hills Boundary
	TNR5 Project Boundary
	Design Strings
	Glenmore Park East Boundary
	Proposed Transverse Drainage Structure and Identifier
	Design Road Control String and Chainage

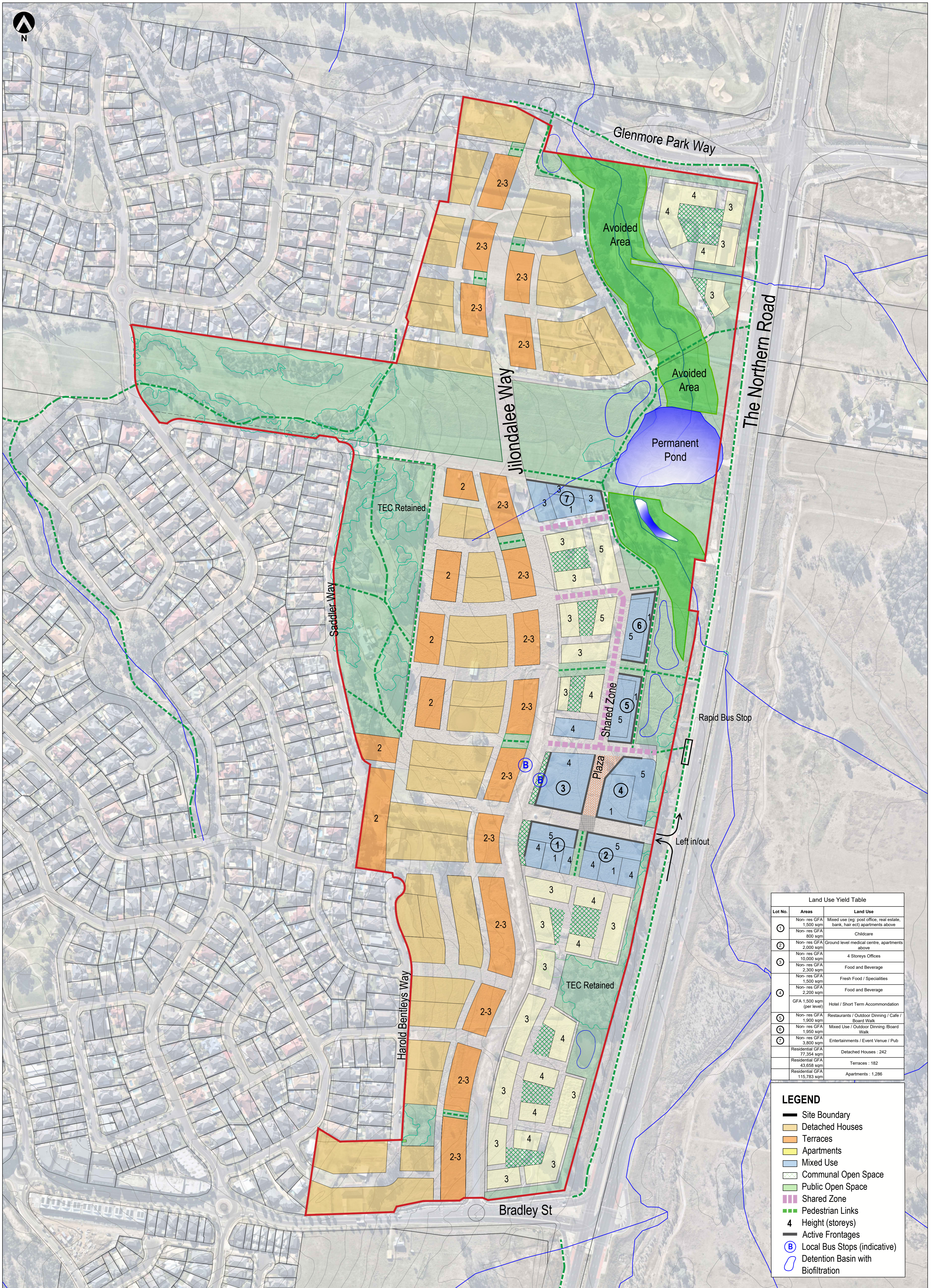
**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure 4.9

IMPACT OF BASIN EMBANKMENT FAILURE ON FLOOD BEHAVIOUR
RELATIVE TO PROPOSED DEVELOPMENT IN GLENMORE PARK EAST - 1% AEP



APPENDIX A
GLENMORE PARK EAST MASTER PLAN












Land Use Yield Table		
Lot No.	Areas	Land Use
①	Non-res GFA 1,500 sqm	Mixed use (eg: post office, real estate, bank, hair ect) apartments above
	Non-res GFA 800 sqm	Childcare
②	Non-res GFA 2,000 sqm	Ground level medical centre, apartments above
③	Non-res GFA 10,000 sqm	4 Storeys Offices
	Non-res GFA 2,300 sqm	Food and Beverage
④	Non-res GFA 1,500 sqm	Fresh Food / Specialities
	Non-res GFA 2,200 sqm	Food and Beverage
⑤	GFA 1,500 sqm (per level)	Hotel / Short Term Accommodation
	Non-res GFA 1,900 sqm	Restaurants / Outdoor Dining / Cafe / Board Walk
⑥	Non-res GFA 1,950 sqm	Mixed Use / Outdoor Dining / Board Walk
⑦	Non-res GFA 3,800 sqm	Entertainments / Event Venue / Pub
	Residential GFA 77,354 sqm	Detached Houses : 242
	Residential GFA 43,658 sqm	Terraces : 182
	Residential GFA 115,765 sqm	Apartments : 1,286

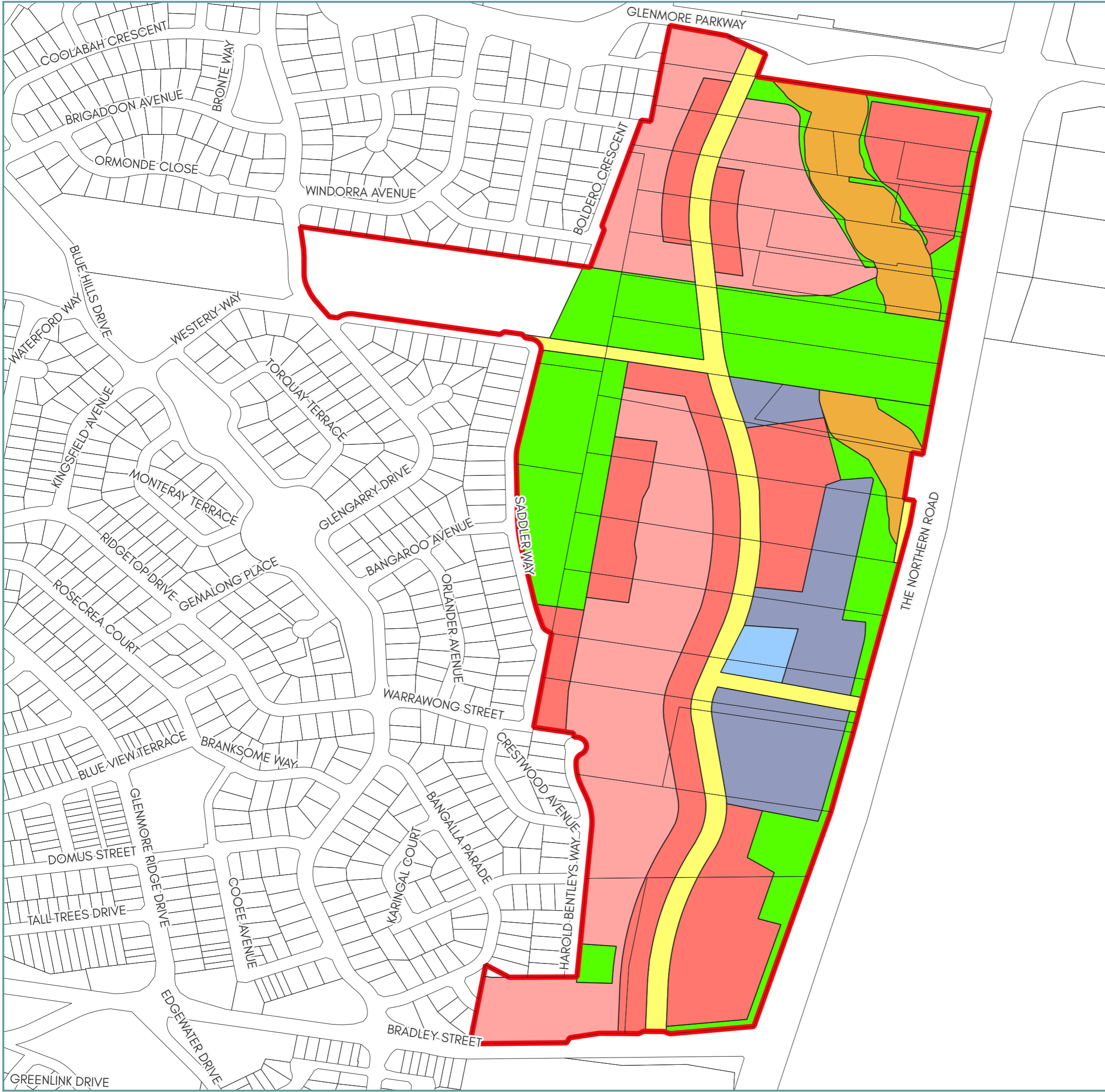
LEGEND	
	Site Boundary
	Detached Houses
	Terraces
	Apartments
	Mixed Use
	Communal Open Space
	Public Open Space
	Shared Zone
	Pedestrian Links
	Height (storeys)
	Active Frontages
	Local Bus Stops (indicative)
	Detention Basin with Biofiltration

APPENDIX B
GLENMORE PARK EAST ZONING MAP

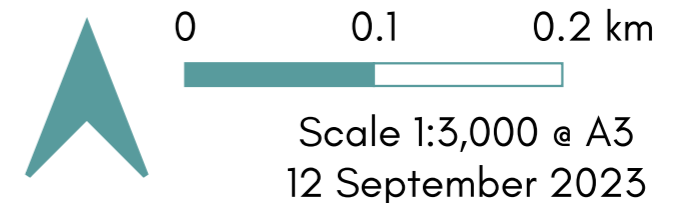
State Assessed Planning Proposal Pathway
 Nergl Developments Pty Ltd
 2013-2113 The Northern Road, Glenmore Park &
 1-29 Bradley Street, Glenmore Park

Legend

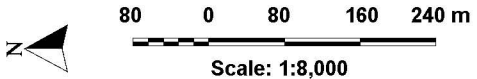
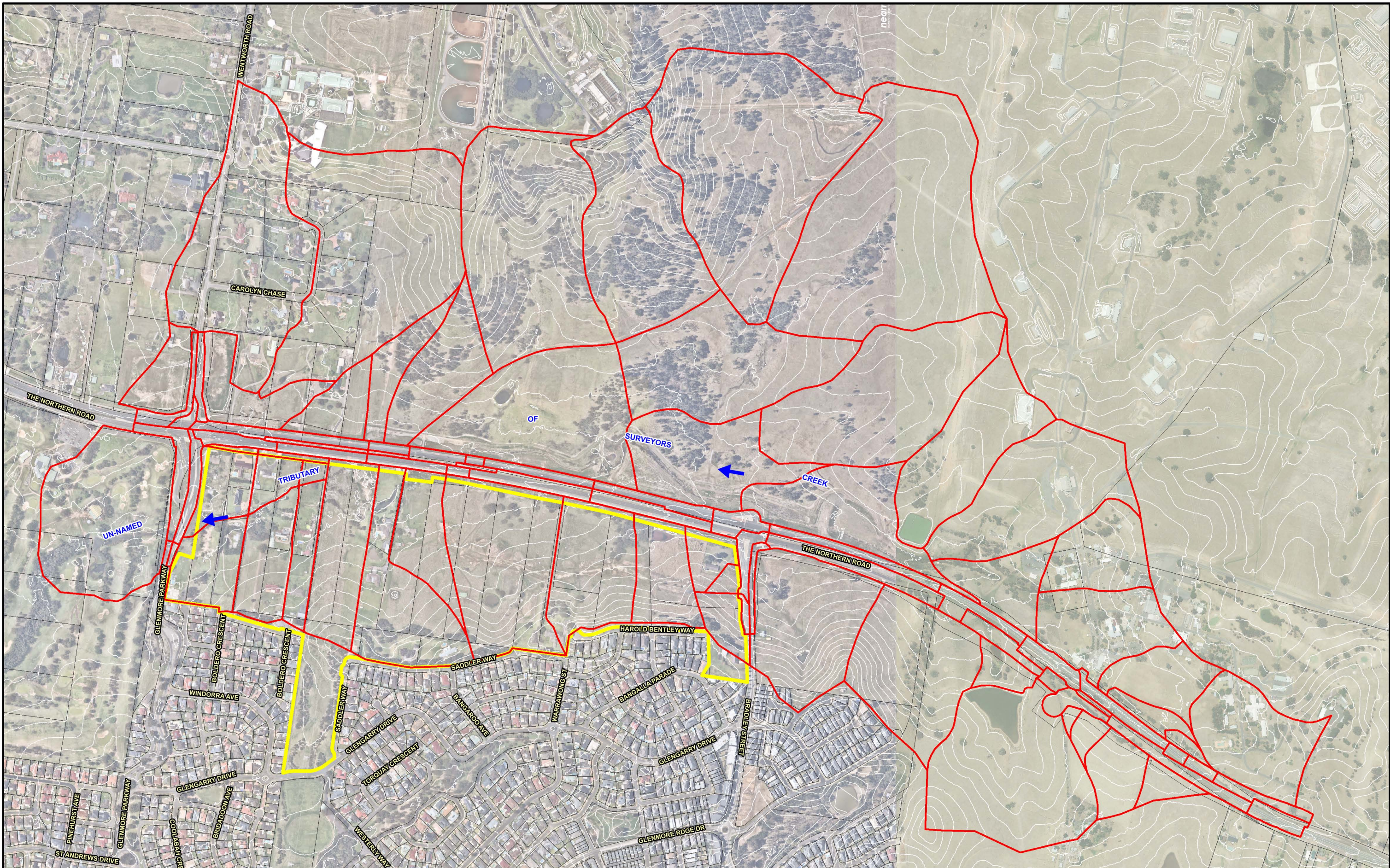
- Cadastre - Penrith - 03082023 
- Master Plan
- Master Plan Area 
- Proposed Zoning
- Proposed Zone - E1 
- Proposed Zone - MU1 
- Proposed Zone - R2 
- Proposed Zone - R3 
- Proposed Zone - RE1 
- Proposed Zone - C2 
- Proposed Zone - SP2 



PLEP2010 - Proposed Zoning



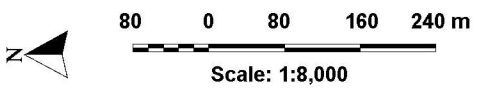
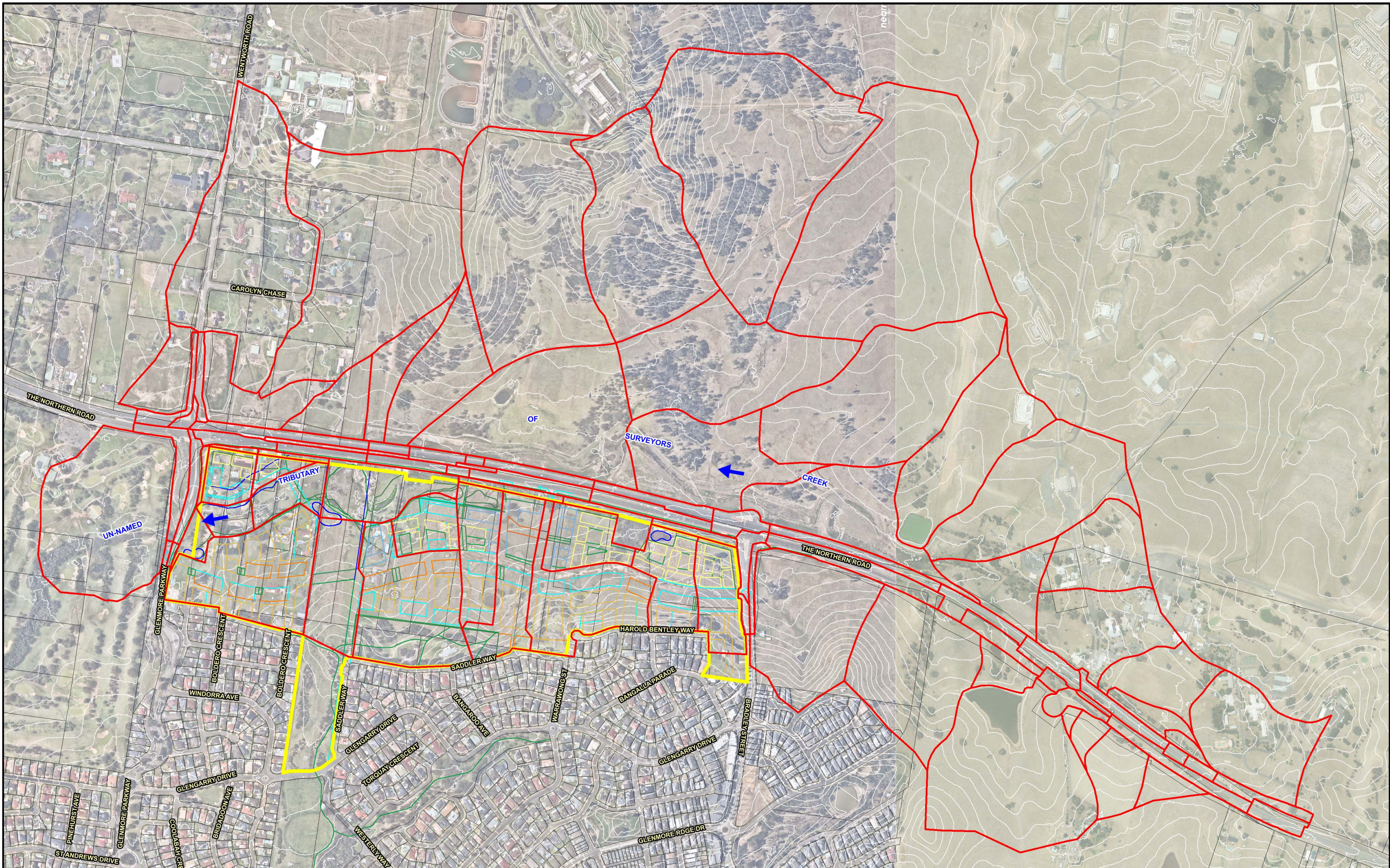
APPENDIX C
FIGURES SHOWING SUB-CATCHMENTS COMPRISING PRE-AND
POST-GPE DRAINS MODELS



- LEGEND**
- Sub-Catchment Boundary
 - Glenmore Park East Boundary

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure C1



- LEGEND**
- Sub-Catchment Boundary
 - Glenmore Park East Boundary

**GLENMORE PARK EAST PLANNING PROPOSAL
FLOOD RISK AND SURFACE WATER MANAGEMENT STRATEGY**

Figure C2