City of Canada Bay

Parramatta Road Corridor Urban Transformation Study (PRCUTS) – Stage 2 Flood Risk Assessment

April 2024

grc HYDRO

Parramatta Road Corridor Urban Transformation Strategy (PRCUTS) Stage 2 Flood Risk Assessment

Report for Public Exhibition

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EXECUTIVE SUMMARY

This report sets out a Flood Risk Assessment undertaken by GRC Hydro on behalf of Canada Bay Council, for the Parramatta Road Corridor Urban Transformation Strategy (PRCUTS) - Stage 2 Precincts. The PRCUTS project consists of a large-scale urban redevelopment of sections of Parramatta Road areas, a major arterial road from the Sydney CBD to Parramatta in Sydney's west. The Flood Risk Assessment is for the Stage 2 Precincts within the Burwood Precinct and the Kings Bay Precinct, in the Canada Bay LGA.

The assessment used a series of previously established hydrologic and hydraulic models to assess flooding in the precincts, which span three catchments that drain to Iron Cove and Hen and Chicken Bay. Models were adjusted and expanded in some areas to reflect current catchment conditions. Design flood behaviour has been assessed with regard to depths and level, flood hazard categories and hydraulic categories, while rate of rise, duration and other factors have also been considered. As an overview, flooding in each of the precincts consisted of:

- Burwood Stage 2 Precincts: Significant overland flow with around 0.3-0.5 m depth in the 1% AEP event through the low point between Coles Street/Parramatta Road, and Coles Street north of Ada Street. Other areas have mostly shallow or negligible overland flow. Area is not affected by creek flooding.
- Kings Bay Stage 2 Precincts: Small western precinct has shallow or negligible overland flow in the 1% AEP, two corners of the precinct are affected by creek flooding (St Lukes Canal) in an extreme event. Eastern precinct has mostly shallow overland flooding, with a flowpath on Parramatta Road, with the easternmost portion affected by Dobroyd Canal flooding. In an extreme flooding, the canal flooding extends to the intersection of Great North Road and Parramatta Road.

The assessment found that proposed redevelopment of the area is generally suitable from a flood risk perspective. Council's DCP and LEP, and relevant state government policies have been considered with respect to development of flood-prone areas. The report sets out relevant planning controls that are currently in the DCP that will manage flood risk, but notes that the area the DCP controls apply to should be expanded. These controls will ensure flood risk is incorporated into the design of new buildings and associated development, and that flooding outside of each precinct is not impacted as a result of the development.

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1. INTRODUCTION

The Parramatta Road Corridor Urban Transformation Strategy (PRCUTS) is a large-scale urban renewal project spanning the Parramatta Road corridor across multiple Sydney Local Government Areas (LGAs), from Granville to Camperdown. The broad objective is to revitalise the corridor and the strategy is comprised of a series of plans, policies and strategies. Councils along the corridor have specific responsibilities for implementing the strategy within specific precincts in each LGA.

In the Canada Bay LGA there are a series of precincts along the corridor, which consist of, from west to east:

- Burwood Precinct (Canada Bay Portion)
- Kings Bay Precinct (Canada Bay Portion)

Each precinct has been further divided into Stage 1 and Stage 2 areas. Stage 1 has been assessed with regards to flooding and the current report is for Stage 2 areas. The Stage 2 areas consist of two sub-areas each. The current study covers four specific areas which are shown on Figure 1:

- Burwood Precinct (Canada Bay Portion) Stage 2 areas (two)
- Kings Bay Precinct (Canada Bay Portion) Stage 2 areas (two)

The four sub-areas are located across four different catchments and are affected by both mainstream and overland flow flooding. The current study assesses design flood behaviour in each area for a range of design flood events, using hydrologic and hydraulic models. The study then models and assesses a high-level schematisation of a future development case, including its impact on flood behaviour. The study then reviews and recommends necessary flood mitigation measures including planning controls.

2. BACKGROUND

2.1 Study Area

The study area consists of four urban areas in Canada Bay LGA, which constitute the Stage 2 precincts. The study area is split across four catchments and the nature of flooding in each is provided below. The area broadly consists of fully-developed medium to high density urban areas with a mix of residential, commercial and industrial land, located in the western portion of Sydney's Inner West. Current urban development dates from the 1800s with Parramatta Road opening in 1811 and the Sydney-Parramatta Railway in 1855.

2.1.1 Exile Bay Catchment

The two Burwood Precinct Stage 2 sub-areas are located in the Exile Bay catchment with the eastern sub-area located half in Exile Bay catchment and half in the St Lukes catchment to the east.

An overview of the catchment features is given below:

- Catchment area: 3.45 km^2
- Watercourses: Saltwater Creek
- Catchment outlet: Exile Bay on Parramatta River

The two areas of interest are located along the north side of Parramatta Road, in the upper southern part of the catchment, and east of Broughton Street along the eastern boundary of the catchment. Flooding at these locations is limited to overland flow, with the catchment's creek and open channels located downstream. The area of interest is not affected by sea level rise associated with climate change.

The previous studies which have been utilised for this catchment are the Exile Bay Flood Study (GRC Hydro on behalf of Canada Bay Council, 2020), the St Lukes, William St and Exile Bay Flood Study (WMAwater, 2019) and the updated model from Parramatta Road Corridor - Flood Risk Assessment For City of Cananda Bay Council (WMAwater, 2020).

2.1.2 St Lukes Catchment

One of the two Kings Bay Precinct Stage 2 sub-areas is located in the St Lukes Catchment, as is half of one of the Burwood Precinct Stage 2 sub-areas (with the other half in Exile Bay catchment).

An overview of the catchment features is given below:

- Catchment area: 2.25 km^2
- Watercourses: St Lukes Canal
- Catchment outlet: Kings Bay on Parramatta River

The two areas of interest are located along the western side of the catchment around Burwood Road, and a small area between Queens Road and Parramatta Road near the catchment's eastern boundary. Flooding at these locations is limited to overland flow, with the catchment's creek and open channels located downstream. The area of interest is not affected by sea level rise associated with climate change.

The previous studies which have been utilised for this catchment are the St Lukes, William St and Exile Bay Flood Study (WMAwater, 2019) and the updated model from Parramatta Road Corridor - Flood Risk Assessment For City of Cananda Bay Council (WMAwater, 2020).

2.1.3 Kings Bay Catchment

One of the two Kings Bay Precinct Stage 2 sub-areas is partially located in the Kings Bay Catchment, (with the other half in Dobroyd Canal catchment).

An overview of the catchment features is given below:

- Catchment area: 1.18 km^2
- Watercourses: Barnwell Park Canal
- Catchment outlet: Kings Bay on Parramatta River

The area of interest is located in the upper catchment around Parramatta Road and Courland Street. Flooding at this location is very limited due to the limited catchment but some shallow overland flow is present. The area of interest is not affected by sea level rise associated with climate change.

The previous studies which have been utilised for this catchment are the St Lukes, William St and Exile Bay Flood Study(WMAwater, 2019) and the updated model from Parramatta Road Corridor - Flood Risk Assessment For City of Cananda Bay Council (WMAwater, 2020).

2.1.4 Dobroyd Canal Catchment

One of the two Kings Bay Precinct Stage 2 sub-areas is partially located in the Dobroyd Canal catchment, (with the other half in Kings Bay catchment).

An overview of the catchment features is given below:

- Catchment area: 8.3 km^2
- Watercourses: Dobroyd Canal also known as Iron Cove Creek
- Catchment outlet: Iron Cove on Parramatta River/Sydney Harbour

The area of interest is located in the lower catchment between Parramatta Road, the western catchment boundary, and Dobroyd Canal. Dobroyd Canal flooding only affects the lowest portions of the area, adjacent to the channel, and the remainder of the area is affected by limited overland flow. The mainstream flooding portion is affected by sea level rise associated with climate change.

The previous studies which have been utilised for this catchment is the Dobroyd Canal and Hawthorne Canal Floodplain Risk Management Study and Plan (WMAwater on behalf of Inner West Council, 2019).

In summary, all four sub-areas are located in small to medium sized urban catchments that drain north to Sydney Harbour. Except for the easternmost sub-area adjacent to Dobroyd Canal, all locations of interest are in the upper catchment outside of the mainstream flood extent, and are affected by overland flow. Some locations of interest have negligible flood affectation as they are located on or adjacent to the catchment boundary.

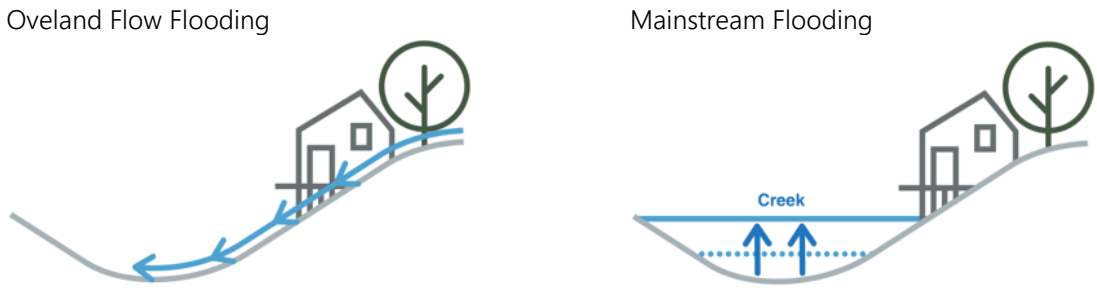
2.2 Flooding Mechanisms

The catchment overviews provided above refer to mainstream and overland flow flooding. These are types of flooding as set out in the NSW Flood Risk Management Manual (2023) and earlier guidelines.

Mainstream flooding occurs from rising water on a defined watercourse causing the watercourse to break its banks and inundate areas that are usually dry. This mechanism typically occurs over a long period of time and generally results in deep, slow moving floodwaters. Image 1 (right hand side) depicts this mechanism. In the Canada Bay LGA, mainstream flooding occurs when either a natural creek or concrete stormwater channel floods the adjacent land.

Overland flow flooding occurs when runoff has not yet reached the creek or channel. In urban areas it most commonly occurs along topographic sags which are typically serviced by a pit and pipe network. When the pipes' capacity is exceeded, above-ground flowpaths form. Overland flow is typically shallower and faster moving than mainstream flooding and occurs with less warning. NSW guidelines note that the two types of flooding can be indistinguishable to people experiencing flooding and that overland flow can cause significant property damage and flood risk, despite not originating from a major watercourse.

Image 1: Flood Mechanisms in the Study Area



3. AVAILABLE DATA

3.1 Overview

The current study utilised a number of data sets in defining and assessing existing flood behaviour in the study area. This data largely consists of previous studies and Council GIS data. The study then assessed future development based on the available draft masterplan for the Stage 2 areas. A summary of each data set is provided below .

3.2 Previous Studies

3.2.1 Exile Bay Flood Study (GRC Hydro, 2020)

The study followed a similar scope to the Powells Creek study and assessed mainstream and overland flow flooding in the portion of the Exile Bay catchment in the Canada Bay LGA (the southern portion is in Burwood LGA). The study used a DRAINS hydrologic model and a TUFLOW hydraulic model, which were verified against two recent historical events in 2018. The study modelled nine design flood events including the 1% AEP and PMF. Hydrologic modelling was based on the ARR2019 methodology and model parameters, including IFD data.

3.2.2 St Lukes, William St and Exile Bay Flood Study (WMAwater, 2019)

The study was undertaken on behalf of Burwood Council and assessed overland flow flooding in the portion of the three catchments in Burwood Council, which was up to Parramatta Road on the northern boundary of the study area. Mainstream flooding is only present in the lower of each catchment, outside of the study area. The study used a DRAINS hydrologic model and TUFLOW hydraulic model, which were verified against two previous studies' design flood estimates. The study modelled six design flood events including the 1% AEP and PMF. Hydrologic modelling was based on the ARR2019 methodology and model parameters, including IFD.

3.2.3 Parramatta Road Corridor - Flood Risk Assessment For City of Cananda Bay Council (WMAwater, 2020)

The study utilised previous models to assess flooding for the PRCUTS Stage 1 Precincts in Canada Bay Council. The Burwood precinct was located in the St Lukes catchment and the Kings Bay precinct was located in the William Street catchment. The study modified the existing model from the 2019 study to capture the areas of interest in more detail, and then assessed design flood mapping and assessment for the 5% AEP, 1% AEP and PMF events. As with the current study, a future development scenario was assessed for the precincts and mitigation measures including planning controls were reviewed and recommended.

3.2.4 Dobroyd Canal and Hawthorne Canal Floodplain Risk Management Study and Plan (WMAwater on behalf of Inner West Council, 2019)

The study carried out a flood risk assessment including assessment of flood risk mitigation measures for the Dobroyd Canal and Hawthorne Canal catchments, which include both mainstream and overland flow. The study followed the earlier flood study including utilising the same models. The study used a DRAINS hydrologic model and TUFLOW hydraulic model, which were verified against

a range of historical events including 1998, 2011 and 2012. Six design events were modelled including the 1% AEP and PMF events. Hydrologic modelling was based on the ARR87 methodology and model parameters, including IFD.

3.3 GIS Data

GIS data was provided by Council and was used to confirm or update model features in the areas of interest. The following data was provided:

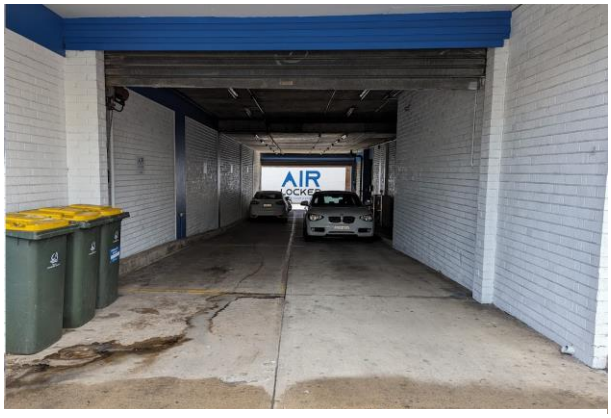
- Council pit and pipe network (drainagepit.shp and drainagepipe.shp)
- Open channels and easements (drainageopenchannel.shp and easement.shp)

3.4 Site Visit

Site visit was undertaken in October 2023 to confirm above-ground features in each of the precinct areas, and to familiarise with the broader catchments. Photos of typical features observed are provided in Image 2 below. Beyond confirming modelled overland flowpaths against the actual topography and built features (kerbs, buildings, etc.) the main utility was adjusting building footprints in the model in the Burwood Stage 2 precinct on Parramatta Road.

Area of overland flow at downstream end of Stanley Street, Burwood Precinct

Overland flowpath through buildings and fences near Parramatta Road, viewed from Coles Street, Burwood Precinct



Potential flowpath through building added to the model, on Parramatta Road, Burwood Precinct

Parramatta Road near Taylor Street, Kings Bay Precinct

Image 2: Selection of photos from site visit

3.5 PRCUTS Masterplans

Masterplans for each of the precincts were provided by Council. The masterplans show a concept building layout that was used to assess a future development scenario. The masterplans are:

- PRCUTS Stage 2 Burwood-Concord Precinct, Master Plan Report (GroupGSA for Canada Bay Council, February 2024)
- PRCUTS Stage 2 Kings Bay Precinct, Master Plan Report (GroupGSA for Canada Bay Council, February 2024)

Although the masterplans propose a comprehensive set of changes to each Precinct, the most pertinent features with regards to flooding are the change in zoning to allow for higher density residential/commercial development, the change in the built environment to replace/expand/reduce current building footprints, and the preservation of roads/open space in areas of significant overland flow. The assessment of the masterplans is presented in Section 5.

4. DESIGN FLOOD BEHAVIOUR

4.1Model Updates

The three models covering the four catchments were updated as part of the study to refine the flood mapping in the areas of interest. The changes are set out in Table 2 and broadly consisted of:

1. The Dobroyd Canal model was largely used as is apart from minor adjustments to the overland flow areas of interest.
2. The St Lukes, William St and Exile Bay model (WMAwater, 2020) was expanded in the Exile Bay catchment and updated to include additional data available from the Exile Bay Flood Study model (GRC Hydro, 2020) as well as additional refinements for the areas of interest.

The models were then re-ran for the design events of interest and the updated results were reviewed.

Table 1: Model Updates

Model	Model Update	Explanation
St Lukes, William Street and Exile Bay	Refined subcatchment definition and additional subcatchments	Subcatchments were slightly more coarsely defined in the area of interest compared to other areas. Subcatchment sizes were refined to a size of approximately 1-2 ha, to produce consistent flood mapping. Additional subcatchments were delineated and added to the hydrologic model for where the model did cover the areas of interest
St Lukes, William Street and Exile Bay	Pit and pipe layer updated	Minor updates were made to pits and pipes to include features shown in the Exile Bay Flood Study model and also the Council GIS dataset.

St Lukes, William Street and Exile Bay	Local inflow layer updated	Local inflow locations were updated to correspond to refined subcatchments
St Lukes, William Street and Exile Bay	Existing Building layer updated	Existing building footprints in the area of interested were refined based on site visit and to add buildings not previously included in the model
St Lukes, William Street and Exile Bay	Road crest breakline layer added	Road crest breaklines were added for the areas of interest
St Lukes, William Street and Exile Bay	1d channel updated	Minor updates were made to channel to include features shown in the Exile Bay Flood Study model
St Lukes, William Street and Exile Bay	Model Boundary Extended	Model downstream boundaries were extended to model Stage 2 precincts in the model
Dobroyd Canal	Local inflow layer updated	The model applied all inflows for the precinct area directly to the canal. The inflow was updated to apply it over the area of overland flow.
Dobroyd Canal	Existing buildings layer updated	Existing building footprints were digitised to include all buildings in the area of interest

4.2 Design Events

The design events of interest were the 5% AEP, 1% AEP and Probable Maximum Flood, representing a range of design flood behaviour. The following design model events were run:

- St Lukes, William Street and Exile Bay
    - 5% AEP 45 minute storm (Storm 1 temporal pattern)
    - 1% AEP 30 minute storm (Storm 4 temporal pattern)
    - PMF 30 minute storm
- Dobroyd Canal
    - 5% AEP 60 storm
    - 1% AEP 60 storm
    - PMF 60 minute storm

The critical duration for each catchment was determined in the previous studies and does not change as a result of the model updates. St Lukes models are based on Australian Rainfall and Runoff 2019 while Dobroyd Canal uses Australian Rainfall and Runoff 1987. Given the Dobroyd Canal area of interest has very minimal catchment, for the developable portion of precinct, the use of ARR87 versus ARR2019 is not estimated to have any significant effect on the assessment or the conclusions reached.

4.2.1 Climate Change

The hydrologic and hydraulic models were adjusted to assess the effect of climate change on design flood behaviour. Climate change is expected to worsen flood risk over time as higher greenhouse gas concentrations lead to increases in high intensity rainfall and sea levels. The assessment used the

IPCC (Intergovernmental Panel on Climate Change) greenhouse gas concentration scenarios and subsequent modelling estimating each scenario's effect on rare rainfall events. There are four IPCC greenhouse gas concentration projections named RCP 2.5, 4.5, 6.0 and 8.5, with the RCP 2.5 being the most optimistic (emissions plateau and then decline) and 8.5 the least optimistic (emissions continue to grow). For the RCP4.5 and 8.5 scenarios, the projected increase in precipitation intensity were obtained from the ARR Data Hub and shown in Table 2 for the 2090 estimate, which were then modelled for the 1% AEP event.

Table 2: Climate Change Factors – Percentage Increase in Rainfall Intensity in 2090

Year	RCP 4.5	RCP 8.5
2090	+9.5 %	+19.7%

Sea level rise as a result of climate change affects the catchment's tailwater conditions at the catchment outlets in Sydney Harbour and can affect flood behaviour in the lower catchment. An estimate of sea level rise is 0.4 m by 2050 and 0.9 m by 2100, as set out in the NSW government Practical Consideration of Climate Change guideline (2007). These sea level rise (SLR) scenarios were modelled for the 1% AEP event.

For each scenario the peak flood levels were then tabulated and compared to the base case (i.e., no climate change), as presented in Section 4.3.3..

4.3 Model Results – Existing Case

4.3.1 Flood Behaviour – Depths and Levels

The models were used to present produce flood mapping for a range of outputs and design events, for the study area. Peak flood depth maps with levels contours for the design events are shown on Figure 6 (5% AEP), Figure 7 (1% AEP) and Figure 8 (PMF) Table 2 summarises design flood levels for a number of locations in the study area. Flood hazard is shown on Figures 9 to 11. The locations in Table 2 are shown on each figure.

Table 3: Design Flood Levels

ID	Location	Ground Level (mAHD)	Peak Flood Level (mAHD) per design event		
			5% AEP	1% AEP	PMF
	Burwood Stage 2 Precinct				
7	Franklyn/Ada St	18.74	18.80	18.80	18.91
8	Ada St near Coles St	13.67	13.89	13.92	14.46
9	Ada St near Lloyd George Ave	14.80	14.87	14.88	15.04
10	Parramatta Road near Philip St	15.09	15.30	15.38	15.89
11	Ada/Melbourne St	17.98	18.01	18.01	18.04
12	Stanley St/Burwood Rd	13.07	13.09	13.09	13.16
13	Burwood Rd/Gipps St	16.13	16.14	16.14	16.19

ID	Location	Ground Level (mAHD)	Peak Flood Level (mAHD) per design event		
			5% AEP	1% AEP	PMF
14	Gipps/Loftus St	6.66	6.68	6.69	6.79
15	Gipps/Broughton	16.47	16.50	16.50	16.54
16	Broughton/Crane St	11.53	11.55	11.55	11.61
17	Stanley St/Broughton St	13.33	13.40	13.41	13.54
18	Burton St/Burwood Rd	18.85	18.94	18.94	18.94
19	Crane St	2.49	2.88	3.01	4.15
	Kings Bay Stage 2 Precinct				
20	Arlington St/Parramatta Rd	8.66	8.80	8.81	8.84
21	Henley Marine Dr	2.79	3.13	3.69	6.04
22	Parramatta Rd near Courland St	19.28	19.29	19.29	19.36
23	Parramatta Rd near Lavendar St	17.10	17.21	17.22	17.22

The flood levels in Table 2 can be used to calculate the equivalent flood depth, for example, the flood depth at location 23 is 0.12 m (17.22 flood level – 17.10 ground level = 0.12 m). The table shows:

- In a relatively common flood such as the 5% AEP, the greatest depths of flooding are at locations 8 and 10 (~0.2 m) where the overland flowpath passes through the precinct, location 21 adjacent to Dobroyd Canal (~0.3 m) and Crane Street (~0.4 m), where runoff accumulates on Crane Street. Most locations however have 0.1 m or less depth.
- In a 1% AEP event, commonly used as the design event, nearly all locations have only 0-0.1 m increase in depth, relative to the 5% AEP. This shows most locations do not scale significantly between flood events. The exception is Henly Marine Drive where the depth is 0.9 m, due to Dobroyd Canal flooding.
- In a PMF event, there is similarly minimal scaling at most locations. Locations 8, 10, 19 and 21 show a significant increase in depth in extreme events.

4.3.2 Flood Behaviour – Flow Rates

Peak flow rates were also tabulated in each precinct in Table 4, with a breakdown of the above-ground and piped flow, in each design event.

Table 4: Peak Flow Rates

		5% AEP (m^3/s)			1% AEP (m^3/s)			PMF (m^3/s)		
	Location, see Image 3,4	Pipes Peak Flow	Overland Peak Flow	Total	Pipes Peak Flow	Overland Peak Flow	Total	Pipes Peak Flow	Overland Peak Flow	Total
Burwood Precinct	A	0.4	2.1	2.5	0.4	2.7	3.2	0.4	15.3	15.7
	B	1.5	4.5	6.0	1.6	6.2	7.8	1.6	36.9	38.5
	C	0.0	0.2	0.2	0.0	0.3	0.3	0.1	1.7	1.7

	D	No pipe	1.5	1.5	No pipes	2.3	2.3	No Pipes	9.0	9.0
Kings Bay Precinct	A	0.1	0.2	0.3	0.1	0.3	0.4	0.2	1.4	1.5
	B	0.1	2.2	2.3	0.2	2.9	3.1	0.3	9.1	9.4

The table shows that as with flood depths, there is minimal scaling between events at most locations, with similar flow in the 5% AEP and 1% AEP events. Locations with relatively small upstream catchments such as locations A, C, D in Burwood and A and B in Kings Bay have around 1-3 m^3/s total flow. Even with small upstream catchment, the majority of flow is above ground, i.e. the pipes are at capacity. Higher flows are at location B, the main flowpath crossing Parramatta Road into the Burwood precinct, which has close to 8 m^3/s peak flow in the 1% AEP, with ~20% of the total flow in the trunk drainage. The flow rates are typical of urban areas with overland flow and are small enough that trunk drainage upgrades would be feasible for mitigating flood risk.

The flow on Dobroyd Canal is not tabulated but would be orders of magnitude greater than the flow rates listed.

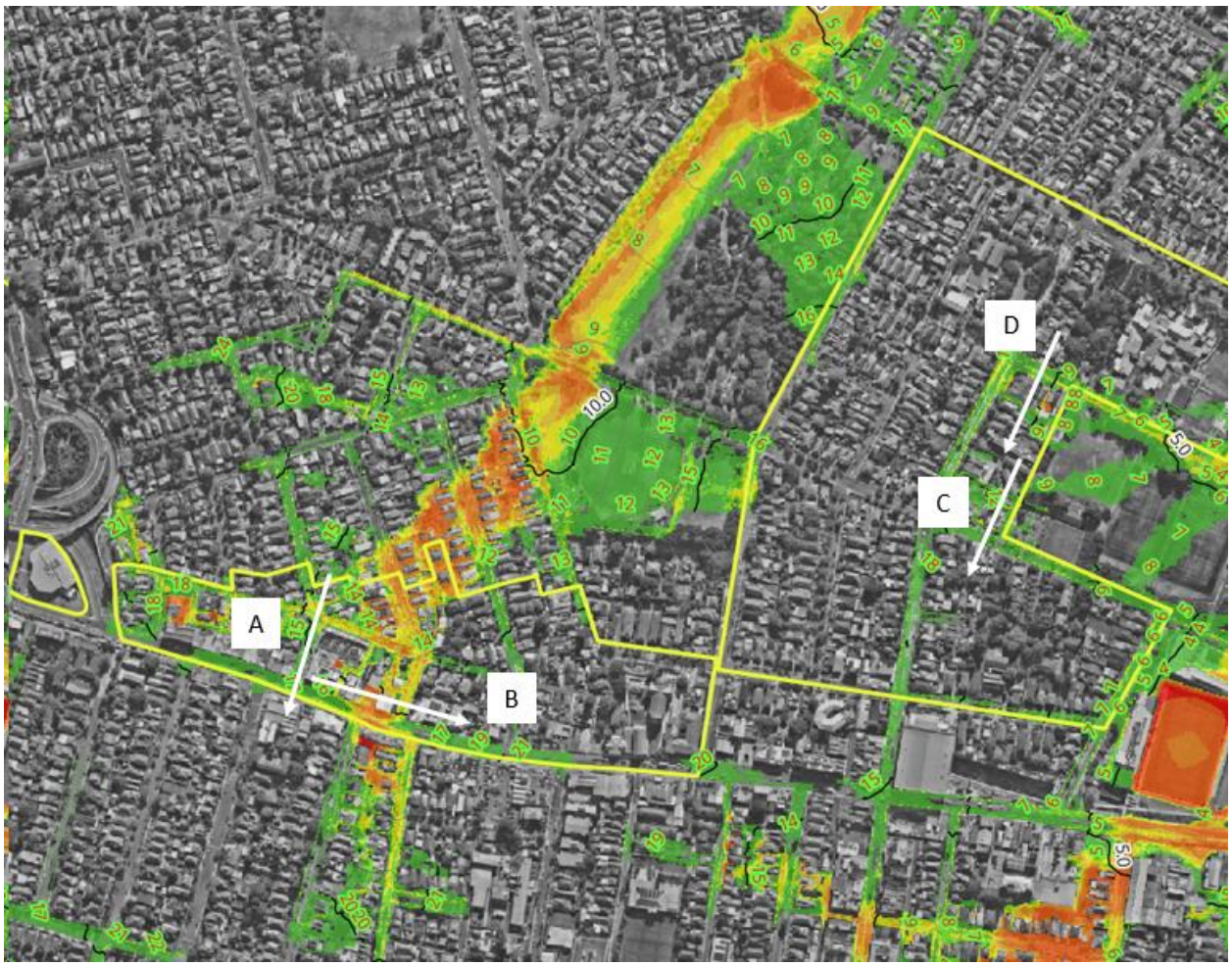


Image 3: Flow Measurement Locations – Burwood Precinct

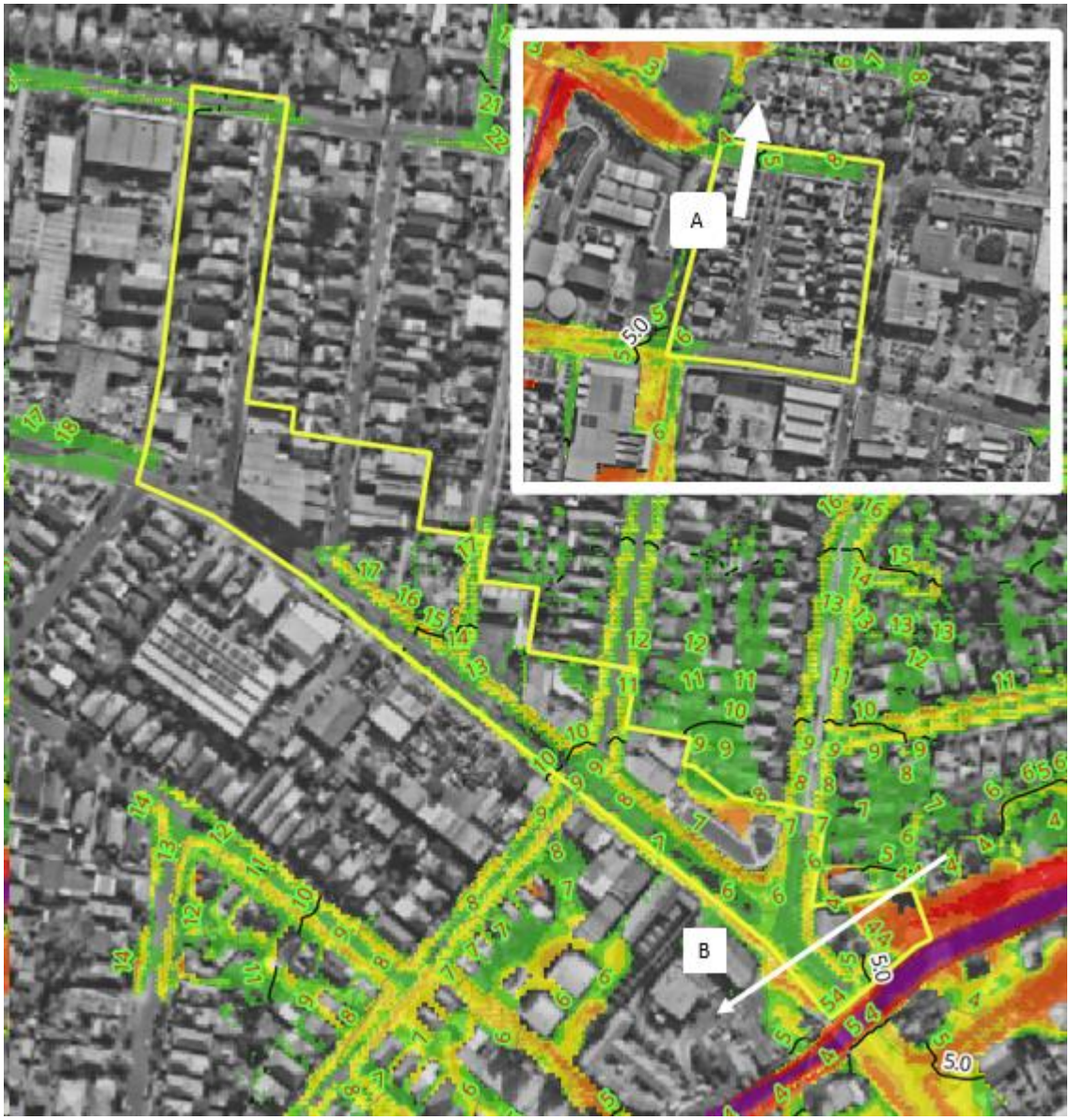


Image 4: Flow Measurement Locations – Kings Bay Precinct

4.3.3 Flood Behaviour – Hazard

Flood hazard mapping has been developed through application of ARR2019 and Australian Emergency Management Institute (AEMI) flood hazard guidelines. The guidelines consider the threat to people, vehicles and buildings based on flood depth and velocity at a specific location. The AEMI flood hazard mapping can be used to assess the flood hazard for site occupants and proposed site usage, as well as for the community surrounding the site.

Chart 1 and Table 5 present the relationship between the velocity and depth of floodwaters and the corresponding classification.

Chart 1: Flood Hazard Curves (Australian Emergency Management Handbook 7)

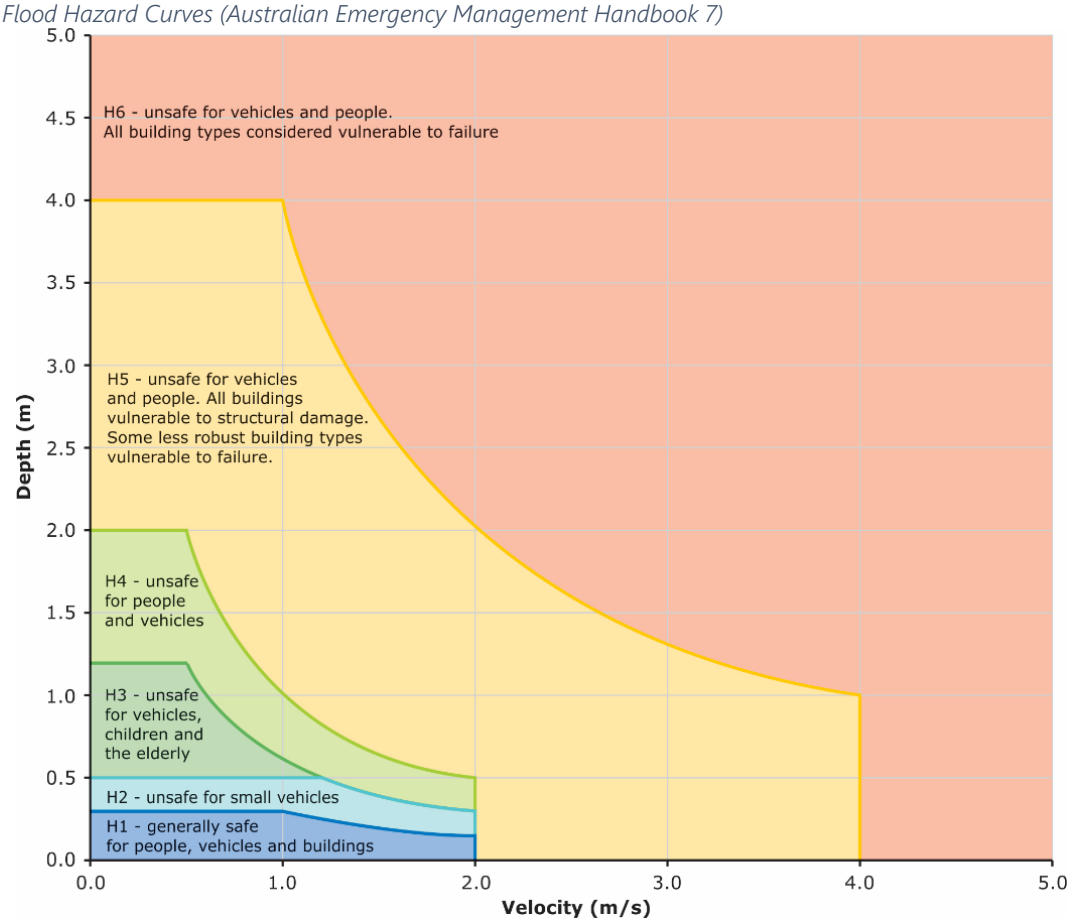


Table 5: Flood Hazard – Vulnerability Thresholds

Hazard Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

The hazard is shown on Figures 9, 10 and 11 for the 5% AEP, 1% AEP and PMF. The figures show the majority of each precinct is only affected by H1 hazard (the lowest level) in most flood events, while roadways in some areas contain higher hazard of around H2-H3. The hazard mapping does not identify any high hazard flowpaths through lots in a 1% AEP event. Further assessment of the flood hazard in each precinct is presented in Section 5.1.

4.3.4 Flood Behaviour – Flood Function/Hydraulic Categories

Flood Function (also referred to as 'Hydraulic Categories') refers to the classification of floodwaters into three categories: floodway/flow conveyance, flood storage and flood fringe. These categories help to describe the nature of flooding across the floodplain and aid planning when assessing

developable areas. According to the Australian Emergency Management Handbook 7, these three categories can be defined as:

- Floodway – the areas where a significant proportion of the floodwaters flow and typically align with defined channels. If these areas are blocked or developed, there will be significant redistribution of flow and increased flood levels across the floodplain. Generally, floodways have deep and/or fast moving floodwaters.
- Flood storage – areas where, during a flood, a significant proportion of floodwaters extend into, water is stored and then recedes after a flood. Significant filing or development in these areas may increase flood levels nearby; and
- Flood fringe – areas that make up the remainder of the flood extent. Development in these areas are unlikely to alter flood behaviour in the surrounding area.

The large majority of flood-affected land in the study area is overland flow, for which the guideline states:

- Defining flood function is complex
- It is important to define a continuous flowpath or floodway once it has formed
- Conveyance and encroachment techniques are difficult to use, and the indicator technique likely more appropriate (this means using depth and velocity, or similar outputs, to estimate areas of flood function)
- Large flood storage areas are not common and may not be present

On this basis, the flood function criteria in the PRCUTS Stage 1 assessment (WMAwater, 2020) using depth, velocity and depth-velocity thresholds has been adopted for the current assessment. The thresholds are as follows:

1. Floodway = Velocity x Depth > 0.25 m^2/s AND Velocity > 0.25 m/s OR Velocity > 1 m/s
2. Flood Storage = Areas that are not floodway, with depth of >0.5 m
3. Flood Fringe = All remaining areas

The flood function is shown on Figure 12, 13 and 14 for the 5% AEP, 1% AEP and PMF.

4.3.5 Flood Risk Precincts

Flood Risk Precincts categorise the flood-affected area into areas of Low, Medium and High Risk. The categories, which are also referred to as Flood Risk Categories in Council's DCP, combine and simplify two outputs: 1% flood hazard and the PMF flood extent. The DCP does not define each category but their definition is generally similar across different LGAs, and for the Stage 2 precincts, the definition used by the Stage 1 flood assessment has been adopted, of:

High Risk: Areas with high hazard (H4-H6) flooding in the 1% AEP event, or with significant evacuation difficulties

Medium Risk: Areas with low hazard (H1-H3) flooding in the 1% AEP event, with no significant evacuation difficulties

Low Risk: Areas not flooded in the 1% AEP but within the PMF flood extent

Risk categories for the Stage 2 precincts are shown on Figure 18. Flood planning controls in the DCP are then set based on the proposed land use and a site's risk precinct.

4.3.6 Flood Planning Area

The Flood Planning Area is traditionally the area to which flood planning controls apply. Following recent NSW Ministerial Directions, flood planning controls more specifically now apply up to the PMF. The Flood Planning Area is still referred to in the policy and guidelines so has been included in this assessment.

The Flood Planning Area (FPA) is typically based on a flood extent equivalent to a flood height 0.5 m above the 1% AEP flood level. In areas of overland flow, this may exaggerate the flood affectation and so often a lot by lot determination is made based on the depth of inundation on each lot in the 1% AEP. Council's Development Control Plan has mapped the FPA and it appears to be based on a lot selection such as selecting lots with 10% of the lot having more than 0.15 m depth. The only precinct with an FPA is the west of the Burwood precincts, which has been shown on Figure 13. The selected lots have shallow depth that is above the threshold (likely to be 0.15 m) and so have been selected.

It is important to note that the FPA does not designate properties with a certain level of flood risk, as lots can have minor affection (e.g. ~0.2 m depth over part of the backyard) and be included in the FPA, or alternatively have very significant affectation (e.g. high hazard flow through the dwelling in frequent floods). Rather than a designation of flood risk, the FPA is simply a determination of where flooding needs to be considered in future development on a particular lot.

The FPA is recommended to be updated in the PRCUTS Stage 2 areas, as described in Section 5.5.

4.4 Model Results – Sensitivity Analysis

Sensitivity analysis describes the sensitivity of model results to changes in the modelling parameters. These parameters include structure blockage, hydraulic roughness and climate change (rainfall increase, and sea level rise). Each parameter is estimated based on the available data, but, due to the complexity of the catchment and flood-producing rainfall, the estimate will involve a series of assumptions and therefore has a degree of uncertainty. The sensitivity analysis therefore qualifies the assumptions by measuring their effect on the modelled flood behaviour. Large changes in the flood behaviour indicates a higher degree of uncertainty in the model results.

The sensitivity is tested by varying each parameter within a reasonable estimate range, and then re-running the hydraulic models (and hydrologic model for losses) to determine the peak flood level results for each scenario, for the 1% AEP event. The sensitivity is then quantified by measuring the impact on the peak flood level at a series of reporting locations.

The parameters tested and the results of the sensitivity analysis are presented below in Table 6 for roughness and blockage, and Table 7 for climate change.

Table 6: Sensitivity Analysis - Roughness and Blockage

ID	Location	Change in 1% AEP flood level			
		Roughness Decreased by 20%	Roughness Increased by 20%	Blockage (pipes) by 20%	Blockage (pipes) by 50%
	Burwood Stage 2 Precinct				
7	Franklyn/Ada St	0.00	0.00	0.00	0.00
8	Ada St near Coles St	0.01	-0.01	0.00	0.01
9	Ada St near Lloyd George Ave	0.01	-0.01	0.00	0.00
10	Parramatta Road near Philip St	0.00	0.00	0.01	0.03
11	Ada/Melbourne St	0.00	0.00	0.00	0.00
12	Stanley St/Burwood Rd	0.00	0.00	0.00	0.00
13	Burwood Rd/Gipps St	-0.01	-0.01	-0.01	-0.01
14	Gipps/Loftus St	0.00	0.00	0.00	0.00
15	Gipps/Broughton	-0.04	-0.05	-0.05	-0.04
16	Broughton/Crane St	0.00	0.00	0.00	0.00
17	Stanley St/Broughton St	0.00	-0.01	0.00	0.00
18	Burton St/Burwood Rd	Not Flooded	Not Flooded	Not Flooded	Not Flooded
19	Crane St	0.00	0.00	0.02	0.05
	Kings Bay Stage 2 Precinct				
20	Arlington St/Parramatta Rd	0.00	-0.01	0.00	0.00
21	Henley Marine Dr	-0.06	0.06	-0.03	-0.06
22	Parramatta Rd near Courland St	0.00	0.00	0.00	0.00
23	Parramatta Rd near Lavendar St	0.00	0.00	0.00	0.00

Table 6 shows that there is very minimal sensitivity to both hydraulic roughness and pipe blockage, with all locations having +-0.05 m change. This is expected given the pipe drainage in the areas conveys a limited portion of the flow, and sensitivity to roughness is typically only where flow velocities are high.

Table 7: Sensitivity Analysis – Climate Change

ID	Location	Change in 1% AEP flood level				
		RF +10%	RF +20%		SLR 0.4m	SLR 0.9m
	Burwood Stage 2 Precinct					
7	Franklyn/Ada St	0.01	0.01		0.00	0.00
8	Ada St near Coles St	0.01	0.03		0.00	0.00
9	Ada St near Lloyd George Ave	0.01	0.01		0.00	0.00
10	Parramatta Road near Philip St	0.03	0.07		0.00	0.00
11	Ada/Melbourne St	0.00	0.00		0.00	0.00
12	Stanley St/Burwood Rd	0.00	0.01		0.00	0.00

13	Burwood Rd/Gipps St	0.00	0.00		0.00	-0.01
14	Gipps/Loftus St	0.00	0.01		0.00	0.00
15	Gipps/Broughton	0.00	0.00		0.00	0.00
16	Broughton/Crane St	0.00	0.00		0.00	0.00
17	Stanley St/Broughton St	0.00	0.01		0.00	0.00
18	Burton St/Burwood Rd	Not Flooded	Not Flooded		Not Flooded	Not Flooded
19	Crane St	0.05	0.09		0.02	0.07
	Kings Bay Stage 2 Precinct					
20	Arlington St/Parramatta Rd	0.00	0.01		0.00	0.00
21	Henley Marine Dr	0.20	0.39		0.05	0.17
22	Parramatta Rd near Courland St	0.00	0.00		0.00	0.00
23	Parramatta Rd near Lavendar St	0.00	0.00		0.00	0.00

The analysis shows climate change will not significantly change flood behaviour or flood risk in the Precincts. Most locations have too small an upstream catchment to allow the increase in rainfall to accumulate to a significant degree, and are far upstream of the interface with tidal flows where sea level rise has an effect. The exception is the location on Henley Marine Drive in the Kings Bay precinct which shows significant sensitivity to rainfall increase, with up to 0.4 m increase in the 1% AEP flood level, and some sensitivity to sea level rise, with 0.2 m increase in flood level under 0.9 m sea level rise. Any development in this area would be recommended to use an increased freeboard when setting design flood levels.

5. FLOOD RISK ASSESSMENT OF PROPOSED REZONING

The proposed rezoning for Stage 2 Precincts of Burwood and Kings Bay is set out in PRCUTS Stage 2 Burwood-Concord Precinct, Master Plan Report, and PRCUTS Stage 2 Kings Bay Precinct, Master Plan Report. The designs set out in the masterplans have been assessed with regard to flooding, specifically to determine:

- The compatibility of the proposed land-uses with the flood hazard of the area. Local and state policies require tailoring a site's land use to fit the flood hazard.
- The impact of the proposed building envelopes on flood risk in the area, and whether any flood impacts require specific mitigation measures.
- The suitability of Council's LGA flood planning controls in mitigating flood risk associated with future development in the precincts, and whether additional planning controls are required.
- The compliance of the proposal with each of the specific requirements of Council policy, specifically the Local Environmental Plan (LEP) and Development Control Plan, and each of the requirements of state government policy, specifically:
    - March 2022 Local Planning Directions
    - Considering flooding in land use planning (guideline) dated July 2021

- Considering flooding in land use planning: guidance and statutory requirements (planning circular) dated July 2021
- NSW Flood Risk Management Manual (2023), which replaces the earlier Floodplain Development Manual

5.1 Flood Hazard Compatibility

A primary consideration in assessing development of flood-affected land is the flood hazard. Flood hazard refers to the threat posed to people, vehicles and buildings in an area of flooding, and is based on the depth and velocity of floodwaters across the range of flood events. Deeper and faster flow has the potential to carry away people or vehicles, causing potential injury, death or financial loss, and similarly, deep and/or fast flow can damage and in some cases destroy buildings. Section 4.3.3 presents the thresholds of depth and velocity that separate the hazard categories from H1 (lowest level) to H6 (highest level).

As set out in Section 4.3.3, flood hazard has been mapped for each of the precincts, for the 5% AEP, 1% AEP and PMF events. An overview of flood hazard at each precinct is presented below.

- The Kings Bay (East) Precinct has low hazard in most areas, except for adjacent to Dobroyd Canal. In the 5% AEP, there is only H1 hazard and very limited areas of H2, with flow consisting of shallow sheet flow. In the 1% AEP event, there is likewise only H1/H2 in the areas of overland flow, while Henley Marine Drive has up to H3 hazard from inundation due to Dobroyd Canal. The PMF hazard is likewise H1 and H2 in the areas of overland flow, while Henley Marine Drive and the end of Parramatta Road within the Precinct have up to H5 due to Dobroyd Canal flooding.
- The Kings Bay (West) Precinct has no high hazard flooding with only H1 in 5% AEP, 1% AEP and PMF, except for a small area of high hazard H4/H5 flooding on the boundary of the precinct in a PMF, with all hazardous flow on the roadway.. Proposed building footprint changes are located upstream of areas of the very shallow overland flow and therefore have no bearing on the flow behaviour. There are likewise no impacts in the 5% AEP and PMF events.
- The Burwood precinct centred on Stanley/Gipps streets also has low hazard. In the 5% AEP and 1% AEP most areas are H1 hazard with very localised sections of H2. In the PMF, there is H5 hazard on Stanley Street, H3 hazard on the eastern edge of Concord High School, and H3/H4 hazard on Crane Street and lots in that area.
- The second Burwood Precinct on Parramatta Road has low hazard in most events including the 1% AEP. In the 5% AEP, there is H1 hazard in most areas, with some H2 on the Coles Street and Ada Street kerbs. In the 1% AEP, there is mostly H2 hazard on Coles Street, with some localised sections of H4 and H5, confined to the roadway. Some lots have areas of H2 otherwise most flow is H1. In the PMF, the main flowpath on Coles Street has H5 hazard as does a section of Ada Street, with adjacent areas having H3 and H4 hazard.

The flood hazard mapping shows none of the four areas have areas of high hazard over lots that would be unsuitable for typical urban land uses such as residential and commercial developments, including high density multi-storey dwellings. Areas of increased hazard, which are mostly H2 and H3 in a 1% AEP, are located on roadways which will be maintained in the proposed case. The only

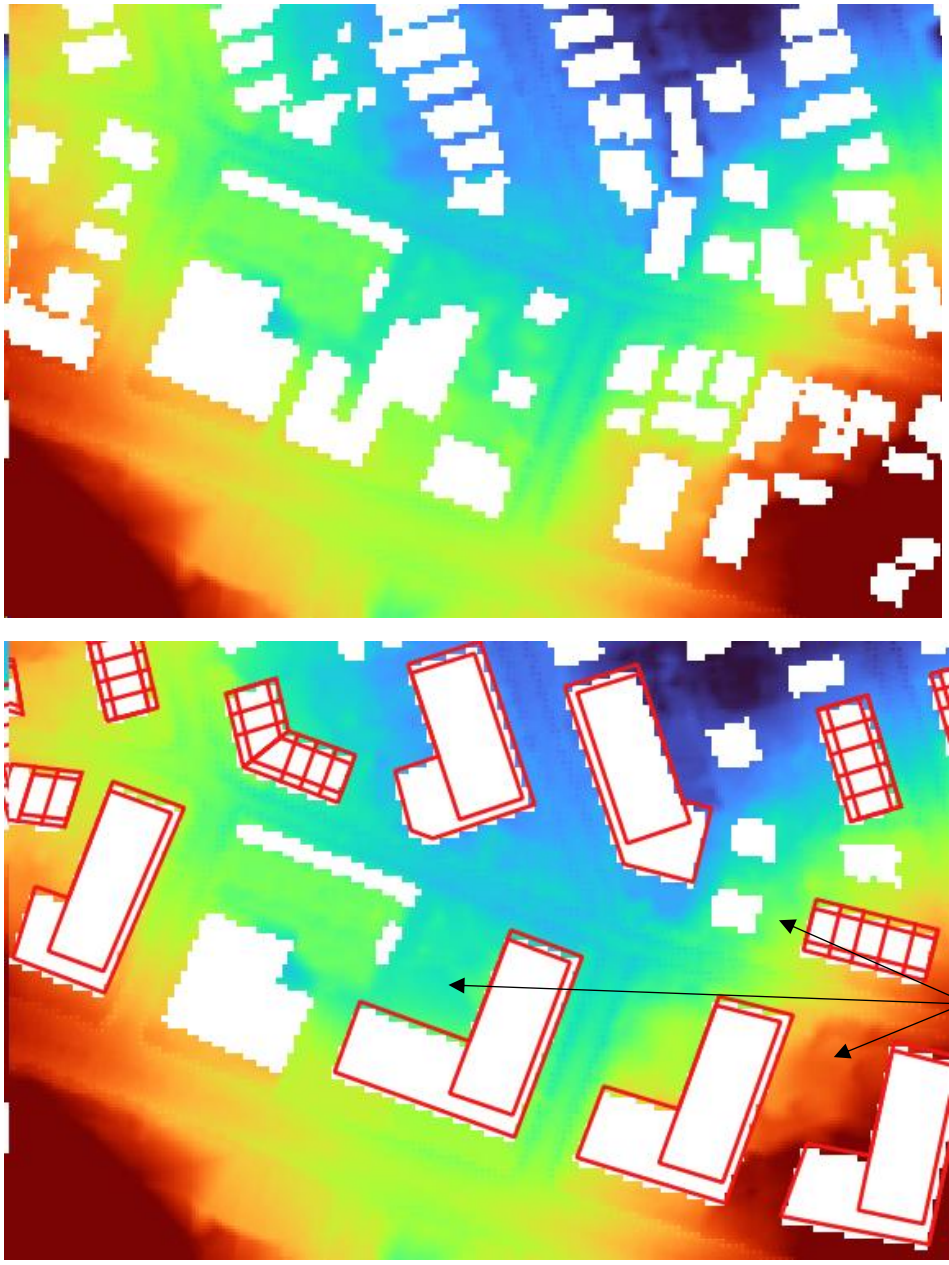
exception is the area directly adjacent to Dobroyd Canal, which has H3 in a 1% AEP and higher hazard in rarer events. This is not proposed for development in the masterplan, with mapping showing open space and zoned RE1 Public Recreation. Further consideration of flood hazard and flood risk is given in Section 5.3 and 5.4

5.2 Hydraulic Modelling Assessment

Hydraulic modelling of the concept-level proposed building footprints was undertaken to quantify the impact of future works on existing flood behaviour. Development in an area affected by flooding is required to assess the magnitude and location of flood impacts, which are changes to the existing flood behaviour that increase flood risk for neighbouring properties.

The assessment is primarily based on the change in flood level under a 1% AEP flood event, and is assessed using the hydraulic models. Changes in ground levels and building extents have the potential to change how overland flowpaths occur and increase the flow and/or flood level at a location either upstream or downstream of the subject site. For example, obstructing a flowpath through the site will tend to increase flood levels upstream, while re-directing or diverting flow can lead to slightly more flow being directed to one area and likewise increasing the flood level. Advice in state guidelines generally indicates an increase of more than 0.01 m in the 1% AEP flood level is considered a significant flood impact (i.e. lesser increases are considered negligible).

The hydraulic modelling assessment was based on the 'existing case' 1% AEP results from the hydraulic model, and then compared to the 1% AEP results of a 'proposed case' model. The 5% AEP and PMF were also modelled to ensure results are similar across different flood events. The proposed case consisted of modifying building footprints in each precinct in accordance with those set out in the relevant masterplans. In a handful of locations this involved converting an area of the model that was 'building' (i.e. impermeable obstruction) to 'ground'. In these cases, the ground levels were interpolated from the surrounding area. An example is shown below in Image 5.



Model Existing Case:

Ground levels shown from high areas (red/brown) to low (blue), white areas are existing buildings

Model Proposed Case

New buildings (red shapes) have changed the modelled building footprints (white areas)

In these areas, which are buildings in the existing case, ground levels have been interpolated from surrounding ground

Image 5: Example of Model Proposed Case

The hydraulic modelling assessment is a concept-level assessment that is only intended to show the broad effects of proposed development, with future stages to further assess the suitability of any proposed works with regards to flood impacts. The modelled proposed case does not include small-scale changes to road and footpath levels, or stormwater pits and pipes, that would be expected to be included in future detailed design stages. The assessment is suitable to show the general impact of the proposed layout and to assess its overall suitability.

The results of the hydraulic modelling assessment are shown in Figure 15 for the 5% AEP, Figure 16 for the 1% AEP and Figure 17 for the PMF. The results for each precinct area, from east to west, are as follows:

- The Kings Bay (East) Precinct has minor flood impacts. The only significant changes is a minor increase in the obstruction of shallow sheet flow due to the building at the Parramatta/Great North Road intersection. The existing building there also obstructs flow. The change in the building footprint results in a minor and localised impact upstream on the adjacent Great North Road property. The very localised nature of the impact indicates the impact is likely to be readily resolved during the future design and assessment of the building at the intersection. Similar impacts are observed in the 5% AEP and PMF.
- The Kings Bay (West) Precinct has no flood impacts. Proposed building footprint changes are located upstream of areas of the very shallow overland flow and therefore have no bearing on the flow behaviour. There are likewise no impacts in the 5% AEP and PMF events.
- The Burwood precinct centred on Stanley/Gipps streets has no significant impacts. The area has only shallow flow through it generally moving east and north-east. There is some marginal impact (yellow area) of around 0.02 m downstream of the precinct but is very localised and no residential areas are affected, only parts of St Lukes Park. Small-scale changes such as this are likely to be readily resolved during the future design and assessment of any buildings in the area. Similar impacts are observed in the 5% AEP and PMF.
- The Burwood precinct along Parramatta Road has significant impacts in the 1% AEP event on property adjacent to the precinct. The two areas of impact are at the edge of two properties at the Philip St/Parramatta Rd intersection, with a flood level increase of 0.02 m, and a larger area spanning a number of Coles Street and Melbourne Street residential properties, with an increase of 0.02-0.05 m. The Parramatta Road impact is caused by the flowpath moving north being slightly more obstructed in the proposed case. The downstream impact is due to a number of small-scale diversions of flow within the precinct that cumulatively result in increased flow on Coles St, and from there it is obstructed by a proposed building footprint, resulting in slightly more flow on private properties downstream of the precinct, with approximately ten affected. A mark-up is provided below showing where flow is being slightly diverted. Similar impacts are observed in the 5% AEP while in the PMF the adverse impacts are largely not present. The impacts are discussed further below.

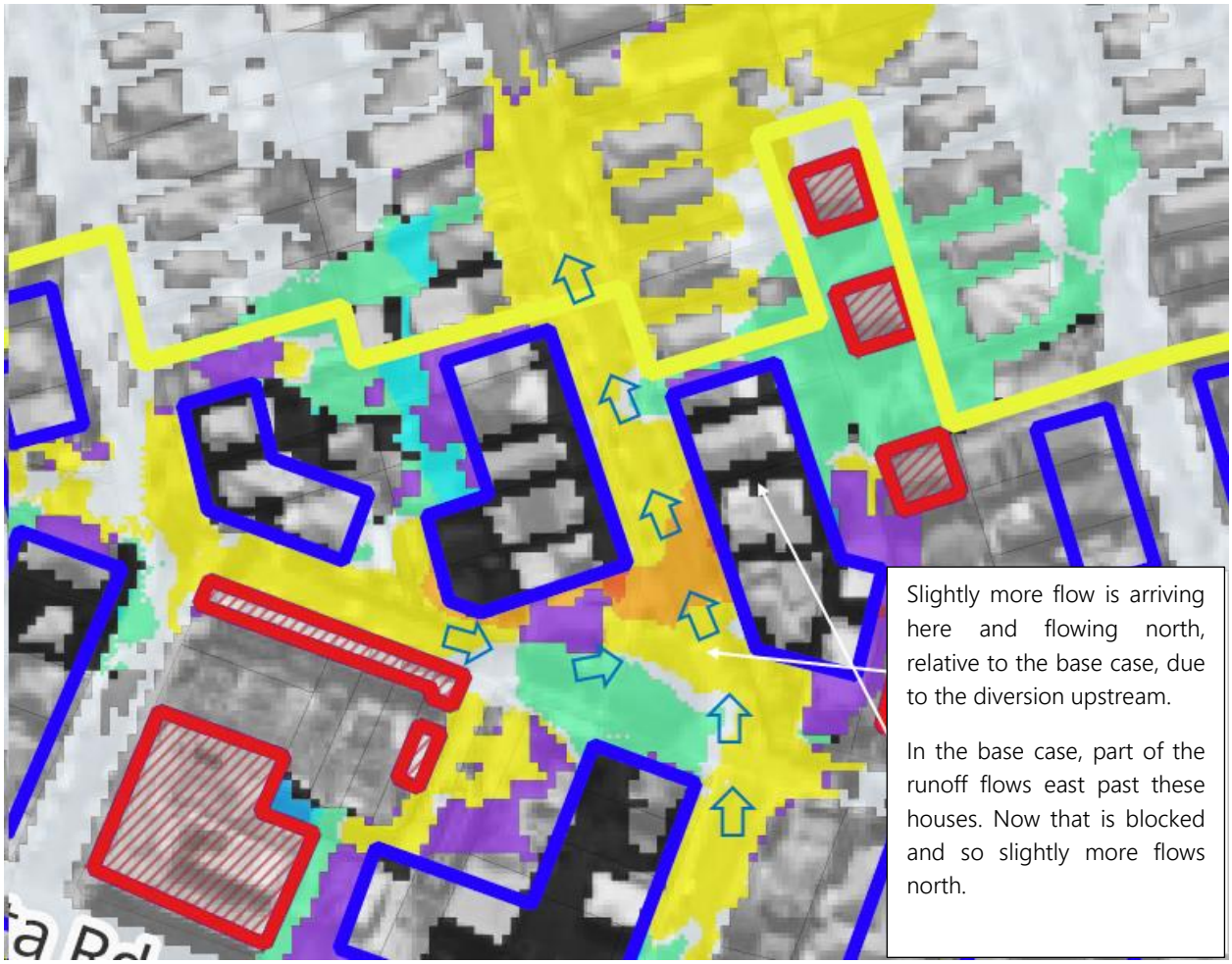


Image 6: Breakdown of change in flow behaviour at Burwood Precinct

In summary, three of the four areas (Kings Bay East, Kings Bay West, Burwood East) have minor or negligible impacts on flood behaviour. The west half of the Burwood Precinct shows some areas of significant increase in flood level in the 1% AEP that would affect multiple properties downstream. The nature of runoff in the area with generally shallow and wide flowpaths means the proposed building footprints result in a series of relatively minor diversions of floodwater that has a cumulative adverse effect in the downstream area, and a small area on Parramatta Road. Given that the current assessment is relatively coarse and that ground levels (i.e. open space, footpath and road levels) around the new buildings are a significant factor, it is recommended to proceed with the building footprints and allow each of the impacts to be fully resolved during subsequent design stages. The current impacts are not acceptable in regards to flood risk, however, they can be resolved at future stages, they are unlikely to require large-scale mitigation works required at masterplan stage, and they do not indicate any specific buildings are inappropriate due to their placement in relation to overland flow. If flood impacts are present when assessing a proposed building (or buildings) and its associated ground level changes, then either the proposed ground levels can be adjusted or the building footprint adjusted and reverted to be closer to what currently exists, in order to resolve the impacts.

An amended scenario has been run for the 1% AEP in the west Burwood precinct that shows minor changes can achieve significant reduction in the flood level impacts. The amended scenario consists of:

- Slightly reducing the building footprint on the east side of Coles Street
- Adding a new 450 mm diameter stormwater pipe along Parramatta Road and Coles Street, connecting to the existing drainage at Coles Street/Ada Street intersection.
- Adjusting proposed ground levels around what is currently 25 Ada Street.

The results are shown on Figure 19. The figure shows significantly less downstream impact, with only five properties now affected (previously ten) while the Parramatta Road impact is largely unaffected. This indicates that relatively minor changes to the ground levels and building footprints can revert some of the small-scale flowpaths to closer to the existing state in order to reduce the flood impact. Alternatively, flood storage tanks, or culvert upgrades, may be considered but are likely to be prohibitively expensive, relative to their benefit and to the alternatives.

5.2.1 On-Site Detention

On-site Detention (OSD) refers to the temporary storage of stormwater flows within a lot in a tank or similar feature. OSD requirements are set out in Council's DCP and are aimed at ensuring new developments do not increase runoff as a result of increased impermeable areas relative to pre-development conditions. The OSD requirements are set out separately to the flood planning controls. However, OSD can influence flood behaviour. OSD controls will likely lead to some benefit regarding flooding in the area, given that there are OSD requirements for sites that already have 80-100% impervious area, as the DCP requires that "Where OSD is required, the permissible site discharge shall be based on a "greenfields" site with an impervious area of 0%.". That is, sites will be required to have OSD that mimics a greenfield site where grass/open space absorbs a percentage of the rainfall. OSD features such as tanks will be incorporated into new buildings and will be included in the flood impact assessment at DA stage.

5.3 Compliance with City of Canada Bay Policy

Development of flood-prone land in the City of Canada Bay LGA must be in accordance with the Local Environmental Plan (2013). The Development Control Plan then contains more specific controls to be followed to ensure compliance with the LEP.

The LEP has two standard clauses related to flooding, 5.21 and 5.22. Clause 5.21 applies to all development on flood-prone land while 5.22 was added in late-2023 to apply additional controls to critical and sensitive land-uses for land between the Flood Planning Area and the PMF flood extent, which are termed Special Flood Considerations. The objectives of the LEP clauses are to:

- Minimise flood risk to life and to property
- Allow development on flood-affected land that is compatible with the area's flood function and behaviour, including climate change
- To avoid adverse or cumulative impacts on flood behaviour and the environment
- to enable the safe occupation and efficient evacuation of people in the event of a flood

The compliance of the masterplan with the LEP is set out in Table 8.

Table 8: LEP Compliance

LEP Planning Control	Compliance Comment
(1) The objectives of this clause are as follows— (a) to minimise the flood risk to life and property associated with the use of land, (b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change, (c) to avoid adverse or cumulative impacts on flood behaviour and the environment, (d) to enable the safe occupation and efficient evacuation of people in the event of a flood.	Rezoning to higher density residential/commercial would meet the LEP objectives, provided that new development follows the applicable flood planning controls. The precincts do not have high flood risk and the flood risk to life and property is readily managed. The flood behaviour consists of shallow overland flow with significant flowpaths forming on some roads in large floods, as typically occurs in an urban area. The only area of mainstream flooding with higher flood risk is recommended to be public open space in the Parramatta Road Strategy. New buildings can be designed to be safely occupied during a flood with evacuation consisting of a shelter in place strategy.
(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development— (a) is compatible with the flood function and behaviour on the land, and (b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and (c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and	a) The flood function consists of flood fringe with some floodway areas on roads, and no flood storage. All future development is only proposed for areas of flood fringe, with existing roads to be maintained under the proposed layout. The flood behaviour consists of shallow overland flow with significant flow forming on some roads in large floods. Flood hazard is low in events up to and including the 1% AEP. b) Flood impact assessment has been carried out using concept-level building footprints. Assessments shows most areas have no adverse impact on flooding, however, in some locations there is a localised adverse impact on other properties. The assessment shows that the future works are generally suitable but will required to be designed to avoid any such flood impacts. This requirement is a flood planning control already in place (see Section 5.5 Recommended Measures

(d) incorporates appropriate measures to manage risk to life in the event of a flood, and (e) 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.	c) Evacuation is not a significant risk factor as the areas have low hazard overland flow. Any new buildings can be designed to be safely occupied during a flood event, with a Shelter In Place evacuation strategy. Emergency access during a 1% AEP flood event will be possible to each of the precincts, through low hazard flooding on roads. d) At the rezoning stage, risk to life measures consist of appropriate zoning based on the flood risk, and ensuring suitable flood planning controls are to be applied. Rezoning is suitable for the area and buildings can be designed to ensure risk to life is managed, see Section 5.5 Recommended Measures. e) The only watercourse in the vicinity of the precincts is Dobroyd Canal, which would not be adversely affected by the proposed building footprints.
(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters— (a) the impact of the development on projected changes to flood behaviour as a result of climate change, (b) the intended design and scale of buildings resulting from the development, (c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood, (d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.	a) Projected changes to flood behaviour as a result of climate change have been assessed, with regards to rainfall increase and sea level rise. Both are shown to have very minimal effect on flood behaviour in the precincts, which are generally well above sea level, and have small upstream catchments that tend to be insensitive to future increases in rainfall intensity. b) The intended design and scale of buildings is, at some locations, a significant increase from what currently exists, with a series of new multistorey buildings. The increase is suitable, from a flood risk perspective. c) See above. d) Building relocation would not be required at the location, given the low flood risk under current and future climate scenarios, and the elevated location. The only low-lying area is the edge of the Kings Bay East precinct, which is proposed as RE1 Public Recreation.
[Clause 5.22] (2) This clause applies to— (a) for sensitive and hazardous development—land between the flood planning area and the probable maximum flood, and (b) for development that is not sensitive and hazardous development—land the consent authority considers to be land that, in the event of a flood, may— (i) cause a particular risk to life, and	a) Sensitive and hazardous development such as aged care, schools and childcare are not proposed as part of the rezoning proposal. b) Land is not present in the precincts that has a particular risk to life or require the evacuation of people. On this basis the clause is not relevant to the PRCUTS Stage 2 project. The clause would be revisited if sensitive or hazardous development is proposed in the future.

(ii) require the evacuation of people or other safety considerations. (3) Development consent must not be granted to development on land to which this clause applies unless the consent authority has considered whether the development— (a) will affect the safe occupation and efficient evacuation of people in the event of a flood, and (b) incorporates appropriate measures to manage risk to life in the event of a flood, and (c) will adversely affect the environment in the event of a flood.	

The table overview shows the proposed rezoning is compliant with the objectives and requirements of the LEP.

Table 9 summarises the Development Control Plan (DCP) flooding section and the project's compliance with it. The DCP contains objectives, design principles and then a matrix of specific planning controls. Many of the DCP controls pertain to building design and so would apply again for the design of any individual building. The assessment of the masterplan is a broader review of compliance and to identify the relevant controls to be applied in the future.

Table 9: DCP Compliance

DCP Section	Compliance Comment
DCP Design Principles D1. Development should not result in any increased risk to human life. D2. The additional economic and social costs which may arise from damage to property from flooding should not be greater than that which can reasonably be managed by the property owner, property occupants and general community. D3. Development should only be permitted where effective warning time is available for the evacuation of an area potentially affected by floods to an area free of risk from flooding. D4. Development should only be permitted where reliable egress is available for the evacuation of an area potentially affected by floods to an area free of risk from flooding. D5. Evacuation should be consistent with any relevant flood evacuation strategy or flood risk management plan where in existence.	D1. The precincts do not have high flood risk and the flood risk to life and property is readily managed. The flood behaviour consists of shallow overland flow with significant flowpaths forming on some roads in large floods, as typically occurs in an urban area. The only area of mainstream flooding with higher flood risk is recommended to be public open space in the Parramatta Road Strategy. New buildings can be designed to be safely occupied during a flood with evacuation consisting of a shelter in place strategy. The current assessment has found that following the DCP applicable flood planning controls will ensure there is no increased risk to human life. D2. Economic and social costs arising from damage to property would be expected to significantly decrease as development occurs and buildings are designed to be at or above

D6. Development should not adversely increase the potential flood affectation on other development or properties, either individually or in combination with similar developments(s) that are likely to occur within the same catchment. D7. Developments must make allowances for motor vehicles to be relocated to an area with substantially less risk from flooding within an effective warning time. D8. Developments must provide an evacuation plan detailing procedures that would be in place for an emergency (such as warning systems, signage or evacuation drills). D9. Flood mitigation measures associated with new developments should not result in significant impacts upon the amenity of an area by way of unacceptable overshadowing of adjoining properties, privacy impacts (eg. by unsympathetic house raising), alienation of otherwise usable open space or by being incompatible with the streetscape or character of the locality (including heritage). D10. Raised structures shall be designed to cater for the forces of floodwaters. An Engineer's Certificate will be required for the structural design. D11. Development is to be compatible with any relevant Floodplain Risk Management Study, Floodplain Risk Management Plan, Flood Studies, or Sub-Catchment Management Plan. D12. Development must not divert flood waters, nor interfere with floodwater storage or the natural function of waterways. D13. Filling of land up to the Probable Maximum Flood (PMF) must not adversely impact upon flood behaviour. This must be demonstrated by appropriate modelling. D14. Development must consider the impact of flooding resulting from local overland flooding whether it is a result of Local Drainage or Major Drainage. D15. Where hydraulic flood modelling is required, flow hazard categories should be identified and adequately addressed in the design of the development. D16. Council strongly discourages basement car parks on properties within the floodplain. Where site conditions require a basement car park on a property within the floodplain, development applications must provide a detailed hydraulic flood study and design demonstrating that the proposed basement car park has been protected from all flooding up to and including the PMF event. An adequate emergency response and	the flood planning level. Use of the FPL will ensure minimal flood damage that can be reasonably managed by the property owner and general community. D3 -D5. Evacuation of the area is not required during a flood, given the low flood risk. Emergency access will be possible in a 1% AEP event with low hazard on most roads. D6 and D12. Flood impact assessment has been carried out using concept-level building footprints. Assessments shows most areas have no adverse impact on flooding, however, in some locations there is a localised adverse impact on other properties. The assessment shows that the future works are generally suitable but will required to be designed to avoid any such flood impacts. Impacts can be resolved via changes to the building design, as necessary. This requirement is a flood planning control already in place (see Section 5.5 Recommended Measures D7. Flooding would occur with little to no warning in the area. However, the precincts have generally low flood risk and any basement car parking would have protection against flooding. D8. This is readily achievable as part of design and occupation of new buildings. D9. Any specific mitigation measures can avoid these impacts. Overshadowing, privacy, alienation of open space and compatibility with the streetscape have all been considered as part of the masterplan. D10. No raised structures are proposed D11. Development is assessed to be compatible with the three relevant flood studies. D13: The effect of filling has been included in the impact assessment. No broadscale filling is proposed as the area has shallow flooding in the design event. D14: The impact assessment has considered local overland flooding. D15: Flow hazard categories have been assessed in Section 5.1

evacuation plan must also be provided where basement car parks are proposed in the floodplain.	D16: Any future basement car parks could be designed to be protected against PMF flooding, given the relatively shallow depth of the PMF. The basement car parking requirements would be incorporated into the design of any buildings.
DCP Planning Controls for Residential Development in Medium Risk Precincts [Medium has been chosen but slightly different controls apply to Low and High Risk Precincts, however, there are no lots with High Risk proposed for new buildings, and Low Risk areas have the same or lesser controls]. 1. Floor level: Habitable floor levels to be equal to or greater than the 100 year ARI flood level plus freeboard. A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable floor area is elevated more than 1.5m above finished ground level, confirming that the subfloor space is not to be enclosed. 2. Building components: All structures to have flood compatible building components below the 100 year ARI flood level plus freeboard. 3. Structural Soundness. An Engineer's report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year ARI flood level plus freeboard. 4. Flood Affectation: An Engineer's report is required to demonstrate how and certify that the development will not increase flood affectation elsewhere, having regard to: a) loss of flood storage; b) changes in flood levels, flows and velocities caused by alterations to flood flows; and c) the cumulate impact of multiple potential developments in the vicinity. 5. Car Parking and Driveway Access The minimum surface level of open parking spaces or carports shall be as high as practical, but no lower than 0.1m below the 100 year ARI flood level. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 100 year ARI flood level. Garages capable of accommodating more than 3 motor vehicles on land zoned for urban purposes, or enclosed car parking, must be protected from inundation by floods equal to or greater than the 100 year ARI flood. Ramp levels to be no lower than 0.5m above the 100 year ARI flood level.	1. Floor levels for all new buildings will be required to be set at or above the site's FPL. This will be incorporated in the design stage. See Section 5.5 on recommended FPL. 2. This is readily achievable and can be incorporated in the design stage of each new building. 3. As above 4. A concept-level flood assessment has shown that future development is generally acceptable with regards to flood impacts, however, flood impacts are possible in certain areas and will have to be assessed at the design stage. 5. Car parking and driveway access requirements are readily achievable and will be incorporated into the design stage of each new building. 6. A shelter in place strategy in new buildings will provide a suitable evacuation area. In most locations the ground floor will be above the PMF level, however, in some instances evacuation of the ground floor may be needed to the first floor or above. A shelter in place strategy will ensure occupants are not venturing out on to flooded roads and will ensure no additional reliance on the SES or others. 7. A Site Emergency Response Flood Plan can be prepared on an as-needed basis but is not expected to be required for most new buildings. Requirements for storage of goods and materials are readily achievable and will be incorporated into the design stage of each new building.

The level of the driveway providing access between the road and parking spaces shall be no lower than 0.2m below the 100 year ARI flood level. Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 100 year ARI flood. Enclosed underground car parks shall have all potential water entry points protected from the PMF. The intent of this requirement is to mitigate the creation of life threatening circumstances and very high economic loss such as may occur with the complete inundation of an underground car park. Council may consider relaxation of this requirement if it can be shown by modelling that the catchment characteristics are such that the maximum depth of inundation is less than 300mm. Because of the particular catchment characteristics of the Concord West Precinct, an additional requirement within that precinct is for habitable floor levels to be at a minimum of RL 3.0m AHD. 6. Evacuation Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (eg. second storey) or off site. Applicant is to demonstrate the development is consistent with any relevant flood evacuation strategy or similar plan. Adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel. 7. Management and Design Site Emergency Response Flood Plan required where the site is affected by the 100 year ARI flood level (except for single dwelling-houses). Applicant is to demonstrate that area is available to store goods above the 100 year flood level plus freeboard. No storage of materials below the 100 year ARI flood level.	

The masterplans are assessed to be in accordance with the design principles in the DCP, with regards to flooding. The relevant planning controls relating to building design are discussed in more detail in Section 5.5.

5.4 Compliance with NSW Policy

Management of flood risk is overseen by the state government in conjunction with local governments, with the state government providing technical guidelines for understanding and

managing flood risk. These guidelines are collected in the NSW Flood Risk Management Manual (2023) which has superseded the earlier Floodplain Development Manual (2005). The overarching legislation is the NSW Environmental Planning and Assessment Act 1979 (EP&A Act), which tasks Councils with implementing the NSW government's flood prone land policy, with the objectives:

(a) to 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

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

The policy has requirements prohibiting development in areas of floodway, ensuring development does not adversely impact others, and requirements for development of the FPA. These requirements are then set out in the LEP clauses (see previous report section).

In addition to the two guidelines and overarching policy, three recent policies have been released with specific direction on flooding and land use planning including rezoning. These are:

- Considering flooding in land use planning: guidance and statutory requirements (planning circular) dated July 2021
- Considering flooding in land use planning (guideline) dated July 2021
- March 2022 Local Planning Directions

The first guidance sets out the various statutory requirements including the new LEP clauses (assessed above), and the two other guidelines above.

The second is a 9 page guideline for Councils on how to consider flooding in land use planning, which instructs Councils to:

- Consider flood function, flood hazard, extent and flooding behaviour for the full range of flood events, and risk to life
- Recommends Councils produce a Flood Planning Area for their LGA
- Use a freeboard of 0.5 m when setting Flood Planning Levels, or a lower freeboard in some cases where the consequences of flooding are lower
- Consider Special Flood Considerations (of which the details are set out in LEP Clause 5.22, which was only adopted into LEPs in late 2023).
- Map areas of flooding as part of the assessment

These considerations have all been included in the current assessment.

Lastly, March 2022 Local Planning Directions requirements are set out below in Table 10.

Table 10: March 2022 Local Planning Directions

Planning Directions	Compliance Comment
A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005 (including	Consideration of a range of flood events up to the PMF, including flood hazard and flood function classification, has been undertaken. Further, site access and the potential for isolation and emergency vehicle access issues are considered. The analysis and

the Guideline on Development Controls on Low Flood Risk Areas).	findings are consistent with the objectives of the Floodplain Development Manual 2005 and newer Flood Risk Management Manual.
A planning proposal must not rezone land within the flood planning areas from Special Use, Special Purpose, Recreation, Rural or Environmental Protection Zones to a Residential, Business, Industrial, Special Use or Special Purpose Zone.	One precinct area (west Burwood) has a flood planning area. This area is zoned Complex Area, Productivity Support and Medium Density Residential. So no rezoning from the five prohibited zonings is proposed.
A planning proposal must not contain provisions that apply to the flood planning areas which: permit development in floodway areas, permit development that will result in significant flood impacts to other properties, permit a significant increase in the development of that land, are likely to result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services, or permit development to be carried out without development consent except for the purposes of agriculture (not including dams, drainage canals, levees, buildings or structures in floodways or high hazard areas), roads or exempt development.	-The large majority of the precincts' area are flood fringe, with only localised instances of floodway confined to the roadway, due to slightly deeper and higher velocity flow. - Flood impact assessment has been carried out using concept-level building footprints. Assessments shows most areas have no adverse impact on flooding, however, in some locations there is a localised adverse impact on other properties. The assessment shows that the future works are generally suitable but will required to be designed to avoid any such flood impacts. This requirement is a flood planning control already in place (see Section 5.5 Recommended Measures -the masterplans involve a significant increase in the development of one area that is currently a Flood Planning Area, in the west of the two Burwood precincts. The FPA designation is due to 1% AEP depths of around 0.2-0.3 m on part of some lots, which is H1-H2 hazard in the 1% AEP and flood fringe. Given the low flood risk and the opportunity to significantly reduce flood risk in the precinct via the design of new buildings in the area, the increase in density is considered to be entirely suitable. -No increase in government spending on mitigation, infrastructure or services would be expected. -Development consent would be required for new buildings in the precincts via the DA process.
A planning proposal must not impose flood related development controls above the residential flood planning level for residential development on land, unless a relevant planning authority provides adequate justification for those controls to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General). For the purposes of a planning proposal, a relevant planning authority must not determine a flood planning level that is inconsistent with the Floodplain Development Manual 2005 (including the Guideline on Development Controls on Low Flood Risk Areas) unless a relevant planning authority provides adequate justification for the	Flood-related development controls above the residential FPL are not proposed. The recommended FPL is provided in Section 5.5 and is consistent with the Floodplain Development Manual and newer Flood Risk Management Manual.

proposed departure from that Manual to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).	

The assessment finds that the re-zoning is not fully compliant with the planning directions, as they prohibit changes to a Flood Planning Area that results in "*significant increase in the development of that land*". Based on GRC Hydro's assessment of flooding and flood risk within the Burwood precinct, the FPA in this area does not correlate to any significant flood risk and future development would be readily designed that ensures protection against flooding and for some lots, reduces the flood risk from what currently exists.

The planning directions do make some allowance for inconsistency with the above requirements, stating that a proposal can be inconsistent if the planning authority is satisfied that "*the planning proposal is supported by a flood and risk impact 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*". The current assessment clearly sets out the low risk at the site with regards to design flood depths, velocities, hazard, flood function, evacuation and also scaling between the 1% AEP and extreme events, and sensitivity to blockage and climate change. On this basis we would seek the consent of the planning authority that rezoning of the Flood Planning Area is permitted under the planning directions.

5.5 Recommended Measures including Flood Planning Controls

The current assessment has found that rezoning in each of the Stage 2 precincts is broadly suitable in relation to the area's flood behaviour, but has identified various requirements that must be met in subsequent stages in the design of new buildings and associated development. These requirements are captured by the LEP and DCP flood planning controls, which have been recently updated and are assessed to comprehensively manage flood risk. However, currently the DCP controls only apply to lots in the mapped FPA in the DCP, which is limited to a portion of the lots in the west of the two Burwood areas. It is recommended that the FPA be updated to expand the applicability of the controls to all lots with Medium or High Risk Category (as shown on Figure 18 and similarly mapped as part of the Stage 1 assessment).

Once the FPA is expanded to cover these additional lots, the assessment identifies the most important controls being:

- Flood impact assessment is to be carried out to ensure no increase in flood risk on adjoining areas as a result of new development. Assessment of the concept building footprints shows flood impacts may occur if this is not incorporated into the design.
- Use of Flood Planning Levels for new development, see below.

Flood Planning Levels (FPLs) are one of the primary mitigation controls that will ensure new development in each of the precincts is sufficiently protected against flooding. The FPL is a level at any new building entrance that the floor level is required to be at or above to be sufficiently protected

from ingress of floodwaters. The level varies depending on the flood level (flood levels will typically vary within a site), the proposed land use (e.g. residential floors require more protection than a ground level carport) and the type of flooding, with mainstream/creek flooding requiring a higher freeboard than shallow overland flooding. These considerations are all captured in the table of FPLs in Council's DCP, reproduced below.

Table 11: FPL Table in DCP Section SW25

Freeboard requirements above 1% AEP water surface level				
Finished Floor Level (B)	Adopted Flood planning area	Overland flow path identified by Council as "Minor"	Overland flow paths other than ones identified by Council as "Minor	Mainstream flooding
Residential – Habitable rooms	As per the adopted Plan	300mm	500mm	500mm
Residential – Non-habitable rooms	As per the adopted Plan	300mm	300mm	500mm
Commercial or Industrial – All internal areas	As per the adopted Plan	300mm	500mm	500mm
Carport open on 3 or 4 sides (At Ground Level)	As per the adopted Plan	150mm*	150mm	300mm
Entrance to Basement	As per the adopted Plan	300mm*	Difference between the 100-yr ARI Level and the PMF Level	Difference between the 100-yr ARI Level and the PMF Level
Critical Infrastructure	As per the adopted Plan	300mm	Difference between the 100-yr ARI Level and the PMF Level	Difference between the 100-yr ARI Level and the PMF Level

* **Note**: At Council's discretion, may be reduced

The DCP does not define when a flowpath is categorised as "Minor". Flood mapping as part of the current assessment shows several areas that have shallow flooding in a range of flood events, and would be considered Minor by GRC Hydro. Our recommendation for the use of FPLs in the precincts is:

- Use the DCP FPL table for setting FPLs in each precinct.
- As the only area of mainstream flooding, adjacent to Dobroyd Canal, is proposed as recreation space, the final column of Mainstream flooding FPLs would not apply
- New buildings with, or directly adjacent to, High Risk Precinct in the Stage 2 precincts are recommended to use the second last column, i.e. 0.5 m freeboard for habitable rooms in residential areas, 0.5 m for commercial areas, etc.

- New buildings in other areas, with Medium or Low Risk Category, as shown on Figure 18, should be considered as Minor overland flowpaths and use the third-last column in setting FPLs, i.e. 0.3 m for habitable rooms in residential areas, 0.3 m for commercial areas, etc.

As discussed above, the DCP does not appear to require that buildings outside of the current FPA apply a FPL. The recommendation to expand the FPA to all areas with a Medium or High flood risk category will ensure all lots with a degree of flood risk are sufficiently protected.

The other DCP controls regarding use of flood compatible materials, structural soundness, car parking and evacuation are also important in managing flood risk. Table 12 lists each of the controls in the Medium Flood Risk Category and provides advice on applying the controls to new development in each precinct.

Table 12: Advice on application of DCP Planning Controls

DCP Planning Controls for Residential Development in Medium Risk Precincts	Advice on Application
[Medium has been chosen but slightly different controls apply to Low and High Risk Precincts, however, there are no lots with High Risk proposed for new buildings, and Low Risk areas have the same or lesser controls]. 1. Floor level: Habitable floor levels to be equal to or greater than the 100 year ARI flood level plus freeboard. A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable floor area is elevated more than 1.5m above finished ground level, confirming that the subfloor space is not to be enclosed.	Advice on the recommended FPLs is provided above this table. 1% AEP flood depths and levels can be read from the mapping provided in this report. The required FPL of buildings in all areas, and in particular the Burwood precinct on Parramatta Road, should be considered early in the building design process. Building entrances cannot sit flush with the footpath level in most locations and will require some level of step up or ramp. Floor levels for all new buildings will be required to be set at or above the site's FPL. This will be incorporated in the design stage. See Section 5.5 on recommended FPL. This is readily achievable and can be incorporated in the design stage of each new building. As above A concept-level flood assessment has shown that future development is generally acceptable with regards to flood impacts, however, flood impacts are possible in certain areas and will have to be assessed at the design stage. Car parking and driveway access requirements are readily achievable

	and will be incorporated into the design stage of each new building.
2. Building components: All structures to have flood compatible building components below the 100 year ARI flood level plus freeboard.	Flood compatible building components include common building materials with an example list in City of Sydney's Interim Floodplain Management Policy.
3. Structural Soundness. An Engineer's report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year ARI flood level plus freeboard.	Structural engineer's advice and report is required. To be confirmed by a structural engineer, but modelling generally indicates that the forces of floodwater in each precinct are unlikely to require additional structural design features than what would otherwise be required.
4. Flood Affectation: An Engineer's report is required to demonstrate how and certify that the development will not increase flood affectation elsewhere, having regard to: a) loss of flood storage; b) changes in flood levels, flows and velocities caused by alterations to flood flows; and c) the cumulate impact of multiple potential developments in the vicinity.	Flood impacts should be considered early in the design process where a flowpath may be blocked or diverted by a new building and associated works. Several building footprints particularly in the west of the two Burwood precincts show potential for flood impacts. Building footprints may have to be reduced or otherwise adjusted, if impacts are still present once proposed ground levels and building footprint are modelled.
5. Car Parking and Driveway Access The minimum surface level of open parking spaces or carports shall be as high as practical, but no lower than 0.1m below the 100 year ARI flood level. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 100 year ARI flood level. Garages capable of accommodating more than 3 motor vehicles on land zoned for urban purposes, or enclosed car parking, must be protected from inundation by floods equal to or greater than the 100 year ARI flood. Ramp levels to be no lower than 0.5m above the 100 year ARI flood level. The level of the driveway providing access between the road and parking spaces shall be no lower than 0.2m below the 100 year ARI flood level. Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 100 year ARI flood. Enclosed underground car parks shall have all potential water entry points protected from the PMF. The intent of this requirement is to mitigate the creation of life threatening circumstances and very high economic loss such as may occur with the complete inundation of an underground car park. Council may consider relaxation of this requirement if it can be shown by modelling that the catchment characteristics are such that the maximum depth of	Car parking requirements particularly for basement car parks should be considered early in the building design process. Basement car parks in flood affected areas are generally discouraged by Council. For some sites, locating the entrance away from the areas of deepest flooding will simplify the design requirements.

inundation is less than 300mm. Because of the particular catchment characteristics of the Concord West Precinct, an additional requirement within that precinct is for habitable floor levels to be at a minimum of RL 3.0m AHD.	
6. Evacuation Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (eg. second storey) or off site. Applicant is to demonstrate the development is consistent with any relevant flood evacuation strategy or similar plan. Adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel.	Evacuation requirements are likely to be straightforward if a shelter-in-place strategy is followed. Additional effort will be required for any new buildings where the PMF level is above the ground floor. See Section 4.3.1 for PMF and 1% AEP levels.
7. Management and Design Site Emergency Response Flood Plan required where the site is affected by the 100 year ARI flood level (except for single dwelling-houses). Applicant is to demonstrate that area is available to store goods above the 100 year flood level plus freeboard. No storage of materials below the 100 year ARI flood level.	A Site Emergency Response Flood Plan may be required in some instances but is not likely to be a factor in the initial design of the building. Any new buildings that potentially involve storage of goods and materials in an area below the Flood Planning Level should consider higher storage areas in the design of the building.

In summary the recommendations are:

- Ensure all new development in the Stage 2 precincts with Medium/High Risk Category on the lot follows the applicable DCP controls based on the risk category and proposed land use.
- Flood assessments to be undertaken at DA stage of individual or multiple buildings can build on the advice offered in this section in Table 12. As set out in the table, certain requirements should be considered early in the design process of new buildings.
- Amend the FPA to expand the flood planning controls application to beyond just the current FPA map. The new FPA should include all lots with Medium and High Risk Precincts. The same approach was followed for the Stage 1 precincts.

6.CONCLUSIONS

Assessment of flood risk in relation to the Stage 2 Precincts of the PRCUTS project in the Canada Bay Council area has been carried. The assessment has used the available hydrologic and hydraulic models to assess flood risk in each of the catchments.

The assessment found that proposed redevelopment of the area is generally suitable from a flood risk perspective. Council's DCP and LEP, and relevant state government policies have been considered with respect to development of flood-prone areas. The report sets out relevant planning controls that are currently in the DCP that will manage flood risk, but notes that the FPA should be expanded. These controls will ensure flood risk is incorporated into the design of new buildings and associated development, and that flooding outside of each precinct is not impacted as a result of the development.

7.REFERENCES

1. Exile Bay Flood Study – GRC Hydro, 2020

2. St Lukes, William St and Exile Bay Flood Study – WMAwater, 2019

3. Parramatta Road Corridor – Flood Risk Assessment for City of Canada Bay Council – WMAwater, 2020

4. Dobroyd Canal and Hawthorne Canal Floodplain Risk Management Study and Plan – WMAwater, 2020

5. PRCUTS Stage 2 Burwood-Concord Precinct, Master Plan Report (GroupGSA for Canada Bay Council, February 2024)

6. PRCUTS Stage 2 Kings Bay Precinct, Master Plan Report (GroupGSA for Canada Bay Council, February 2024)

7. Australian Rainfall and Runoff 2019 – Commonwealth of Australia

8. Flood Risk Management Manual - NSW Government, 2023

9. Australian Disaster Resilience Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia, 2017, Australian Institute for Disaster Resilience.

APPENDIX A

Glossary of Key Terminology (Reference: Floodplain Development Manual 2005)

annual exceedance probability (AEP)	the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. Eg, if a peak flood discharge of 500 m3/s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a 500 m3/s or larger events occurring in any one year (see ARI).
Australian Height Datum (AHD)	a common national surface level datum approximately corresponding to mean sea level.
average annual damage (AAD)	depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time.
average recurrence interval (ARI)	the long-term average number of years between the occurrence of a flood as big as or larger than the selected event. For example, floods with a discharge as great as or greater than the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.
catchment	the land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
consent authority	the council, government agency or person having the function to determine a development application for land use under the EP&A Act. The consent authority is most often the council, however legislation or an EPI may specify a Minister or public authority (other than a council), or the Director General of DIPNR, as having the function to determine an application.
development	is defined in Part 4 of the EP&A Act infill development: refers to the development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as minimum floor levels may be imposed on infill development new development: refers to development of a completely different nature to that associated with the former land use. Eg, the urban subdivision of an area previously used for rural purposes. New developments involve re-zoning and typically require major extensions of existing urban services, such as roads, water supply, sewerage and electric power. redevelopment: refers to rebuilding in an area. Eg, as urban areas age, it may become necessary to demolish and reconstruct buildings on a

	relatively large scale. Redevelopment generally does not require either re-zoning or major extensions to urban services.
disaster plan (DISPLAN)	a step by step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations, with the object of ensuring the coordinated response by all agencies having responsibilities and functions in emergencies.
discharge	the rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).
effective warning time	the time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.
emergency management	a range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
flash flooding	flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.
flood	relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage (refer Section C6) before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
flood awareness	Awareness is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.
flood education	flood education seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.
flood fringe areas	the remaining area of flood prone land after floodway and flood storage areas have been defined.
flood liable land	is synonymous with flood prone land (ie) land susceptible to flooding by the PMF event. Note that the term flood liable land covers the whole floodplain, not just that part below the FPL (see flood planning area).

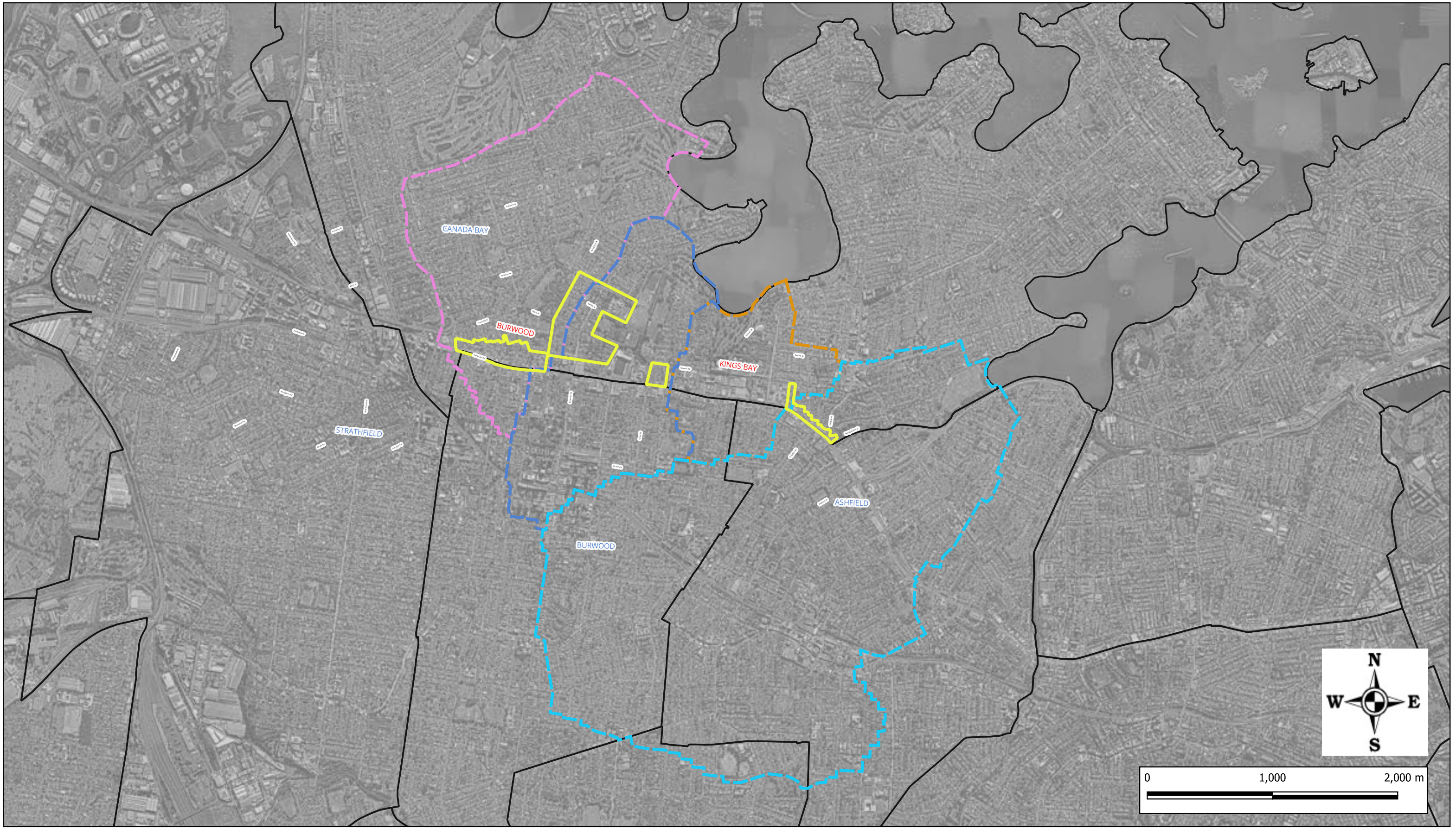
flood mitigation standard	the average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding.
floodplain	area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
floodplain risk management options	the measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.
floodplain risk management plan	a management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
flood plan (local)	A sub-plan of a disaster plan that deals specifically with flooding. They can exist at state, division and local levels. Local flood plans are prepared under the leadership of the SES.
flood planning area	the area of land below the FPL and thus subject to flood related development controls. The concept of flood planning area generally supersedes the "flood liable land" concept in the 1986 Manual.
flood planning levels (FPLs)	are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans. FPLs supersede the "standard flood event" in the 1986 manual.
flood proofing	a combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.
flood prone land	land susceptible to flooding by the PMF event. Flood prone land is synonymous with flood liable land.
flood readiness	Readiness is an ability to react within the effective warning time.
flood risk	potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below: existing flood risk: the risk a community is exposed to as a result of its location on the floodplain. future flood risk: the risk a community may be exposed to as a result of new development on the floodplain. continuing flood risk: the risk a community is exposed to after floodplain risk management measures have been implemented. For a town

	protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
flood storage areas	those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
floodway areas	those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
freeboard	provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. (See Section K5). Freeboard is included in the flood planning level.
habitable room	in a residential situation: a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom. in an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
hazard	a source of potential harm or a situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community.
hydraulics	term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.
hydrograph	a graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
hydrology	term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
local overland flooding	inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
local drainage	smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.

mainstream flooding	inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
major drainage	councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purposes of this manual major drainage involves: • the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or • water depths generally in excess of 0.3m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; and/or • major overland flowpaths through developed areas outside of defined drainage reserves; and/or • the potential to affect a number of buildings along the major flow path.
mathematical/computer models	the mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.
merit approach	the merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State's rivers and floodplains. The merit approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into council plans, policy, and EPIs. At a site specific level, it involves consideration of the best way of conditioning development allowable under the floodplain risk management plan, local flood risk management policy and EPIs.
minor, moderate and major flooding	both the SES and the BoM use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood: minor flooding: causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded. moderate flooding: low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered.

	major flooding: appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.
modification measures	measures that modify either the flood, the property or the response to flooding.
peak discharge	the maximum discharge occurring during a flood event.
probable maximum flood	the PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation works and controlling development, up to and including the PMF event should be addressed in a floodplain risk management study.
probable maximum precipitation	the PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.
probability	a statistical measure of the expected chance of flooding (see AEP).
risk	chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
runoff	the amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
stage	equivalent to water level (both measured with reference to a specified datum).
stage hydrograph	a graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum.
survey plan	a plan prepared by a registered surveyor.
water surface profile	a graph showing the flood stage at any given location along a watercourse at a particular time.

FIGURES



Precinct
LGA Boundary

Exile Bay Catchment
St Lukes Catchment
William Street Catchment
Dobroyd Canal Catchment

TITLE: **Study Area and PRCUTS Precinct**

PROJECT: **PRCUTS Flood Assessment**

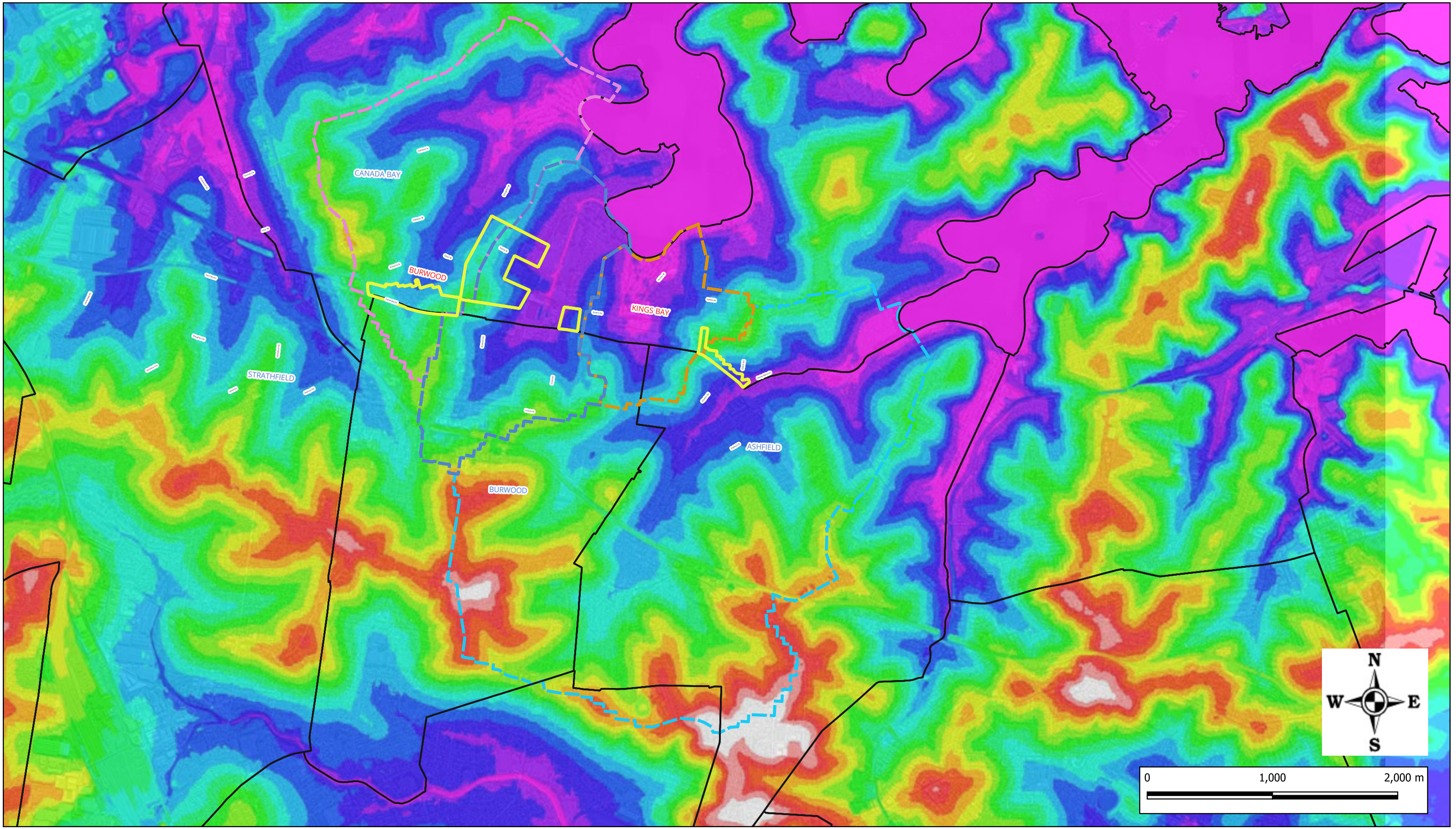
PROJECT No. **230074**

DATE: **03-2024**

SCALE: **1:28,000**

FIGURE No. **01**

grc HYDRO



Cadastre
Precinct
LGA Boundary

Ground Elevation (mAHD)

<= 2.4	16.0 - 19.4	36.4 - 39.8
2.4 - 5.8	19.4 - 22.8	39.8 - 43.2
5.8 - 9.2	22.8 - 26.2	43.2 - 46.6
9.2 - 12.6	26.2 - 29.6	> 46.6
12.6 - 16.0	29.6 - 33.0	
	33.0 - 36.4	

TITLE: **Digital Elevation Model**

PROJECT: **PRCUTS Flood Assessment**

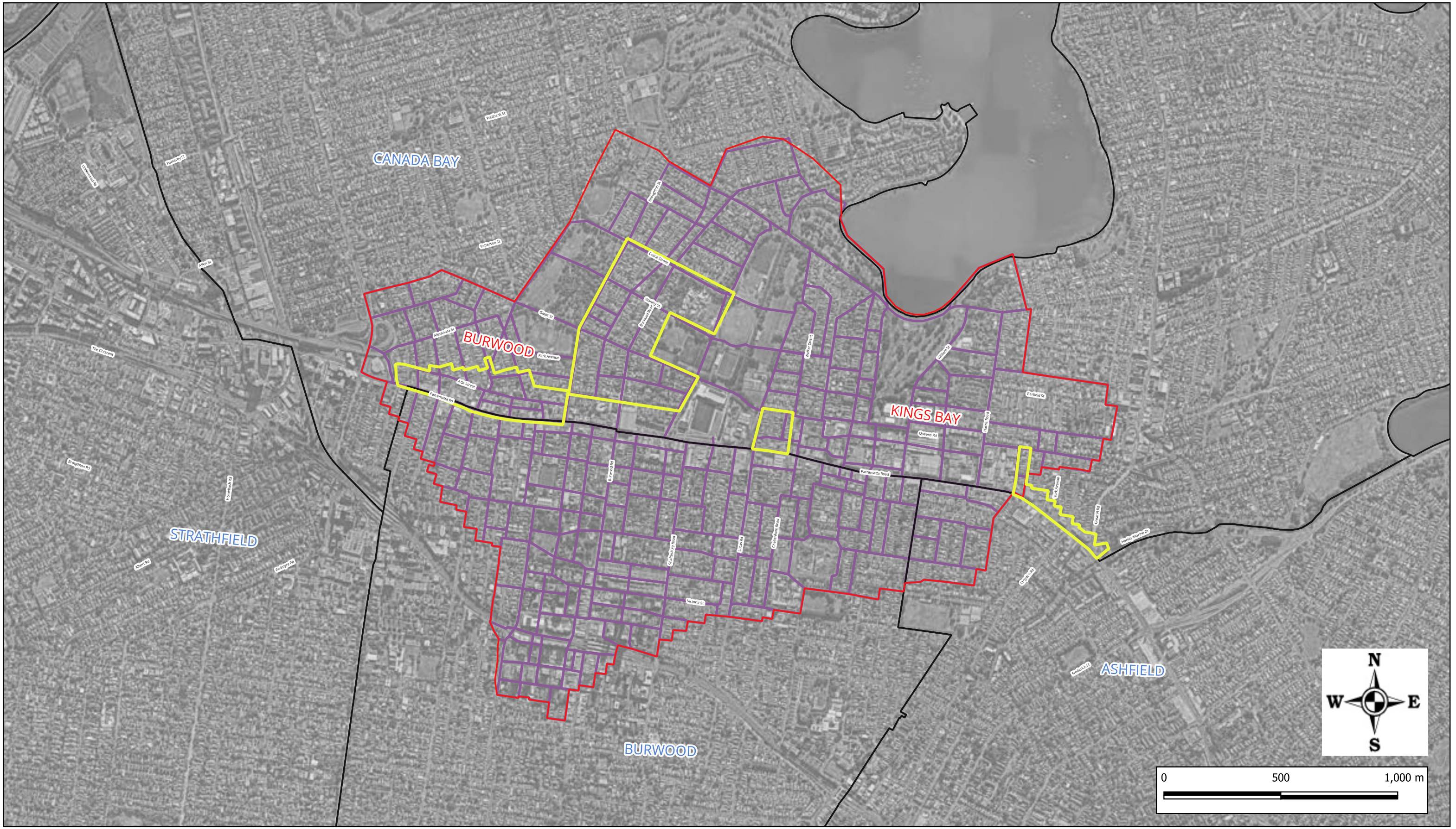
PROJECT No. **230074**

DATE: **03-2024**

SCALE: **1:28,000**

FIGURE No. **2**

grc HYDRO



- Precinct
- LGA Boundary
- Hydraulic Model Boundary
- Hydrologic Subcatchments

TITLE: **Subcatchment Deliniation - St Lukes**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:15,000**	FIGURE No.	**3A**

grc HYDRO

Precinct
LGA Boundary
Hydraulic Model Boundary

TITLE: **Subcatchment Delineation - Dobroyd Canal**

PROJECT: **PRCUTS Flood Assessment**

PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:18,000**

FIGURE No. **3B**

grc HYDRO

Precinct
LGA Boundary
Hydraulic Model Boundary
Buildings
Catchment Inflows
Stormwater Pits
Stormwater Pipes
Kerbs

TITLE: **Hydraulic Model Schematisation - St Lukes**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:15,000**	FIGURE No.	**4A**

Precinct	Hydraulic Model Boundary
LGA Boundary	Buildings
	Catchment Inflows
	Stormwater Pits
	Stormwater Pipes
	Kerbs

TITLE: **Hydraulic Model Schematisation - St Lukes**

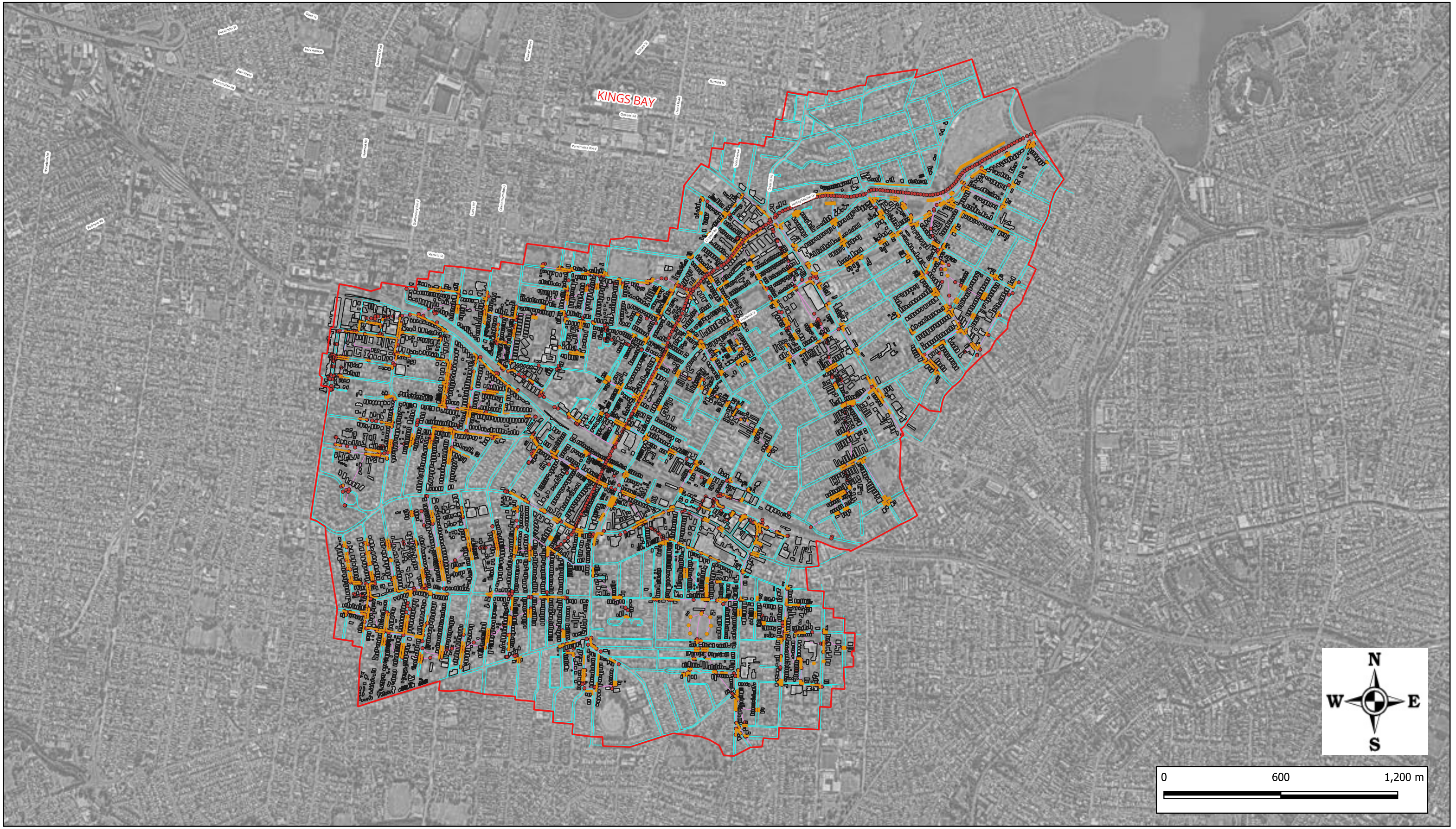
PROJECT: **PRCUTS Flood Assessment**

PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:15,000**

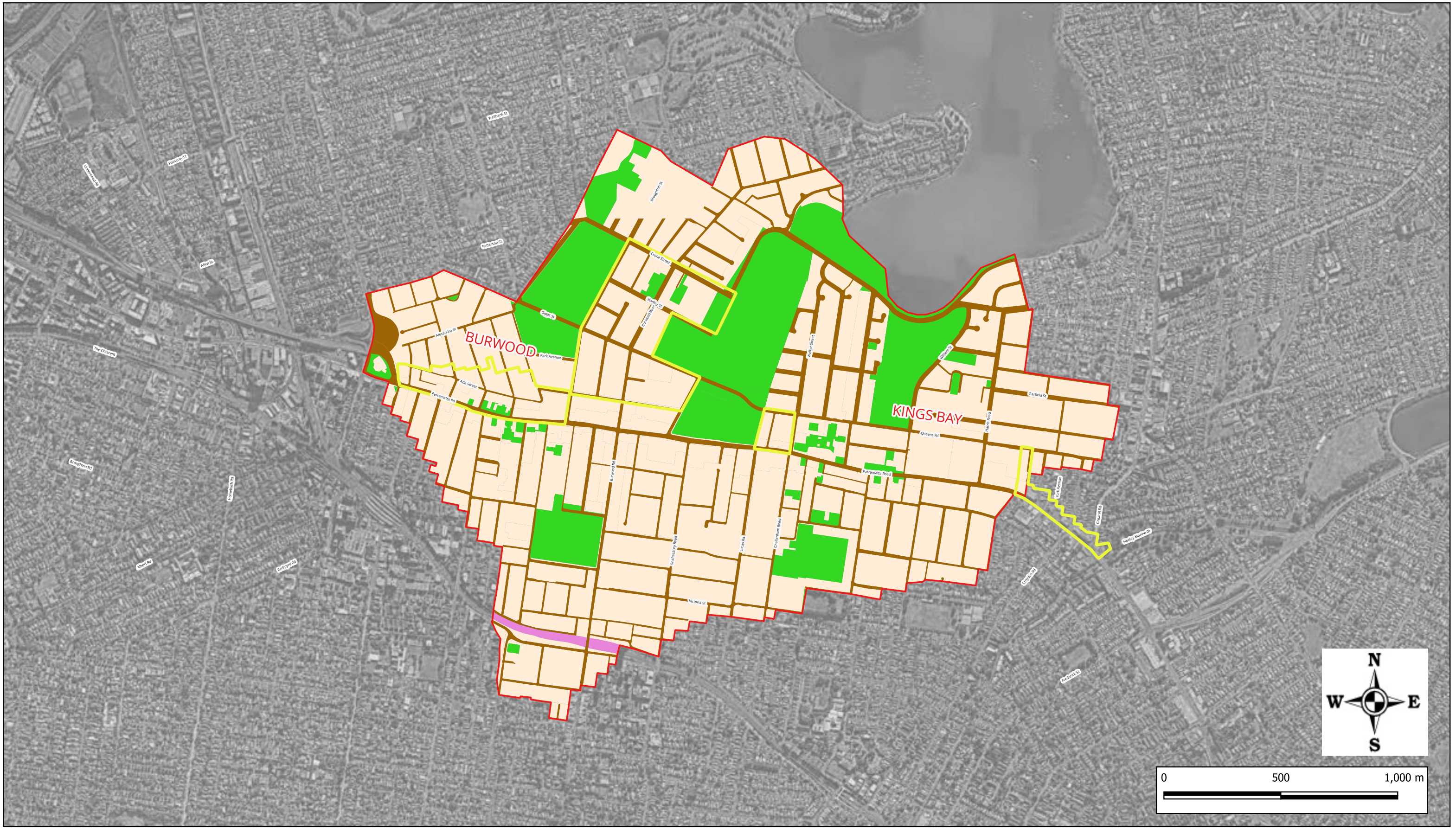
FIGURE No. **4A**



- Precinct
- LGA Boundary
- Hydraulic Model Boundary
- Buildings
- Catchment Inflows
- Stormwater Pits
- Stormwater Pipes
- Kerbs

TITLE: **Hydraulic Model Schematisation - Dobroyd Canal**		
PROJECT: **PRCUTS Flood Assessment**		PROJECT No. **230074**
DATE: **04-2024**	SCALE: **1:18,000**	FIGURE No. **4B**

grc HYDRO



Precinct
LGA Boundary
Hydraulic Model Boundary

Railway (Manning's Value: 0.05)
Open Space (Manning's Value: 0.03)
Properties (Manning's Value: 0.05)
Roads (Manning's Value: 0.02)
Light Vegetation (Manning's Value: 0.03)

TITLE: **Hydraulic Model Roughness - St Lukes**

PROJECT: **PRCUTS Flood Assessment**

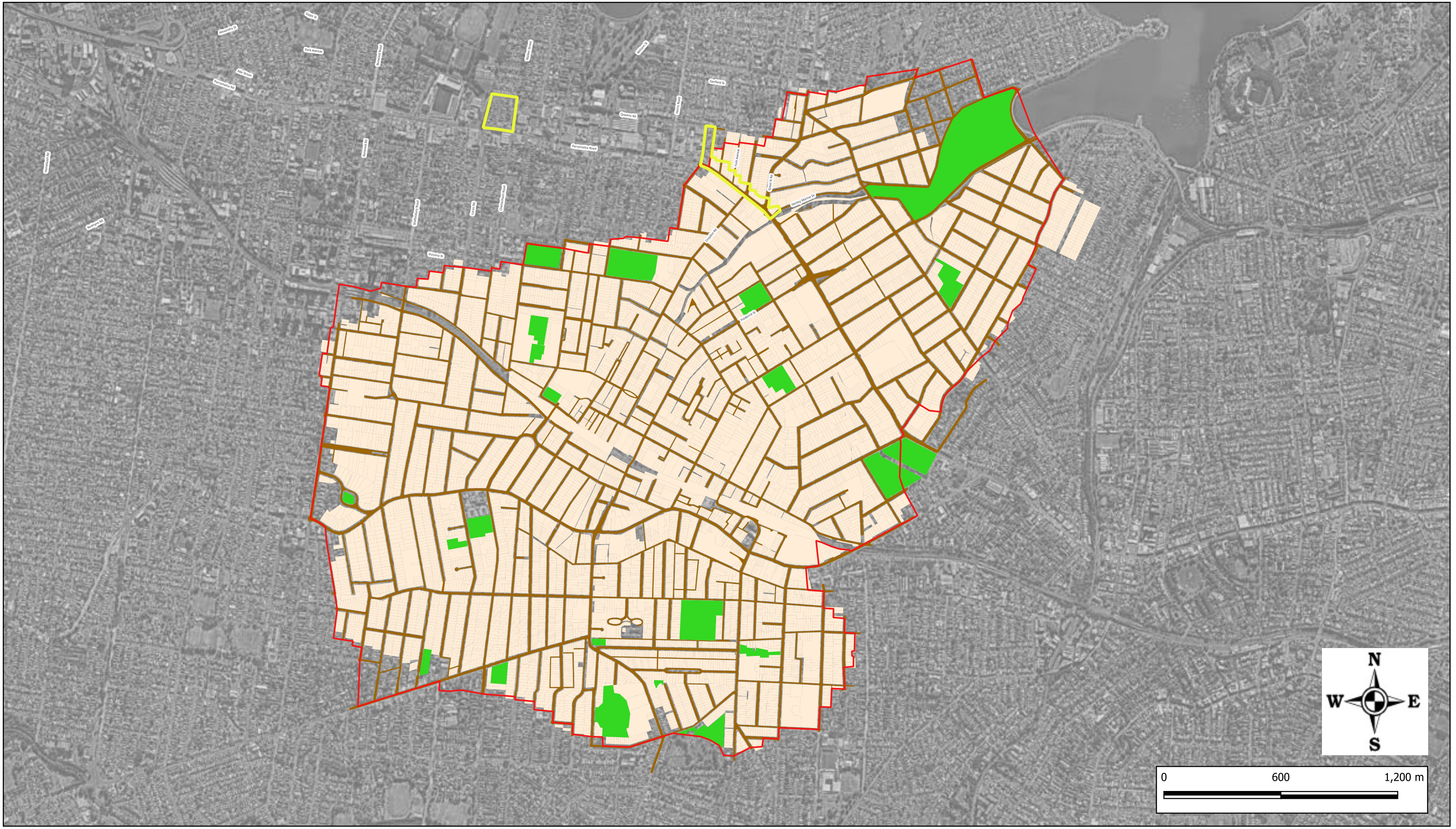
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:15,000**

FIGURE No. **5A**

grc HYDRO



Precinct
LGA Boundary
Hydraulic Model Boundary

Properties (Manning's Value: 0.05)
Roads (Manning's Value: 0.02)
Light Vegetation (Manning's Value: 0.03)

TITLE: **Hydraulic Model Roughness - Dobroyd Canal**

PROJECT: **PRCUTS Flood Assessment**

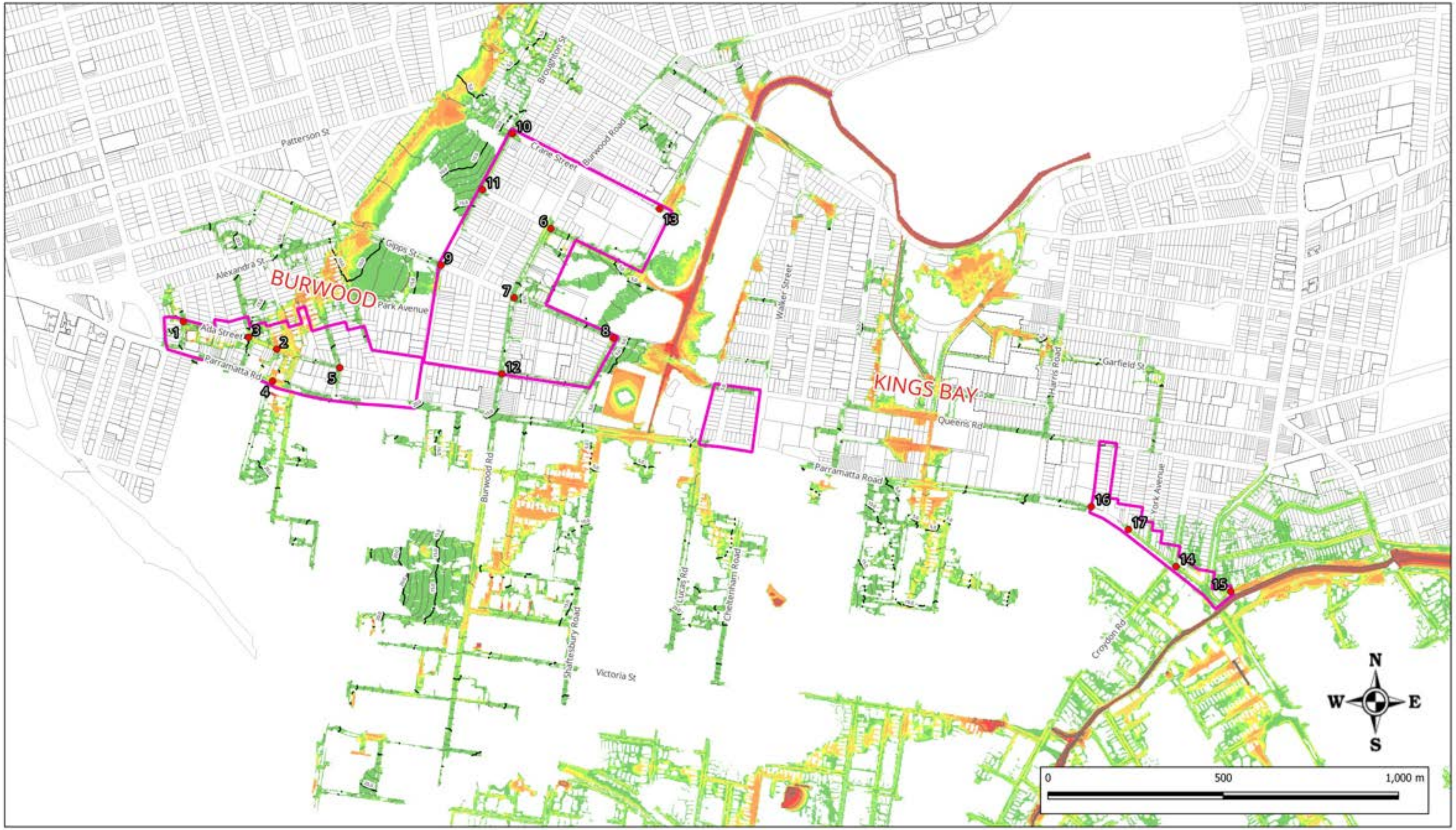
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:18,000**

FIGURE No. **5B**

grc HYDRO



Cadastre
Precinct
Sensitivity Analysis Points

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
> 2.0

Major Flood Level Contour (Spacing = 5 m)
Minor Flood Level Contour (Spacing = 1 m)

TITLE: **5% AEP Peak Flood Depths and Levels**

PROJECT: **PRCUTS Flood Assessment**

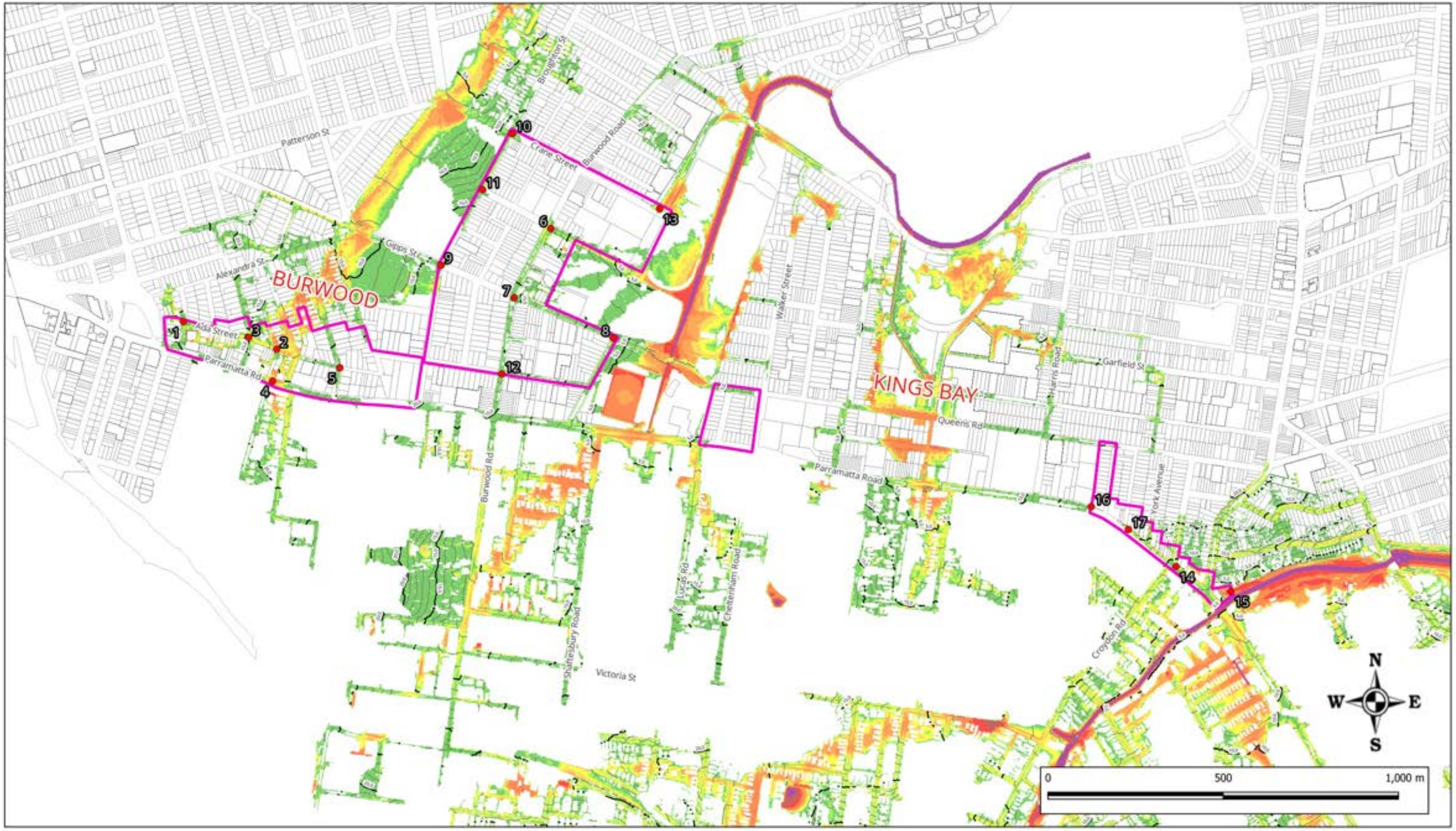
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:10,000**

FIGURE No. **6**

grc HYDRO



Cadastre
Precinct
Sensitivity Analysis Points

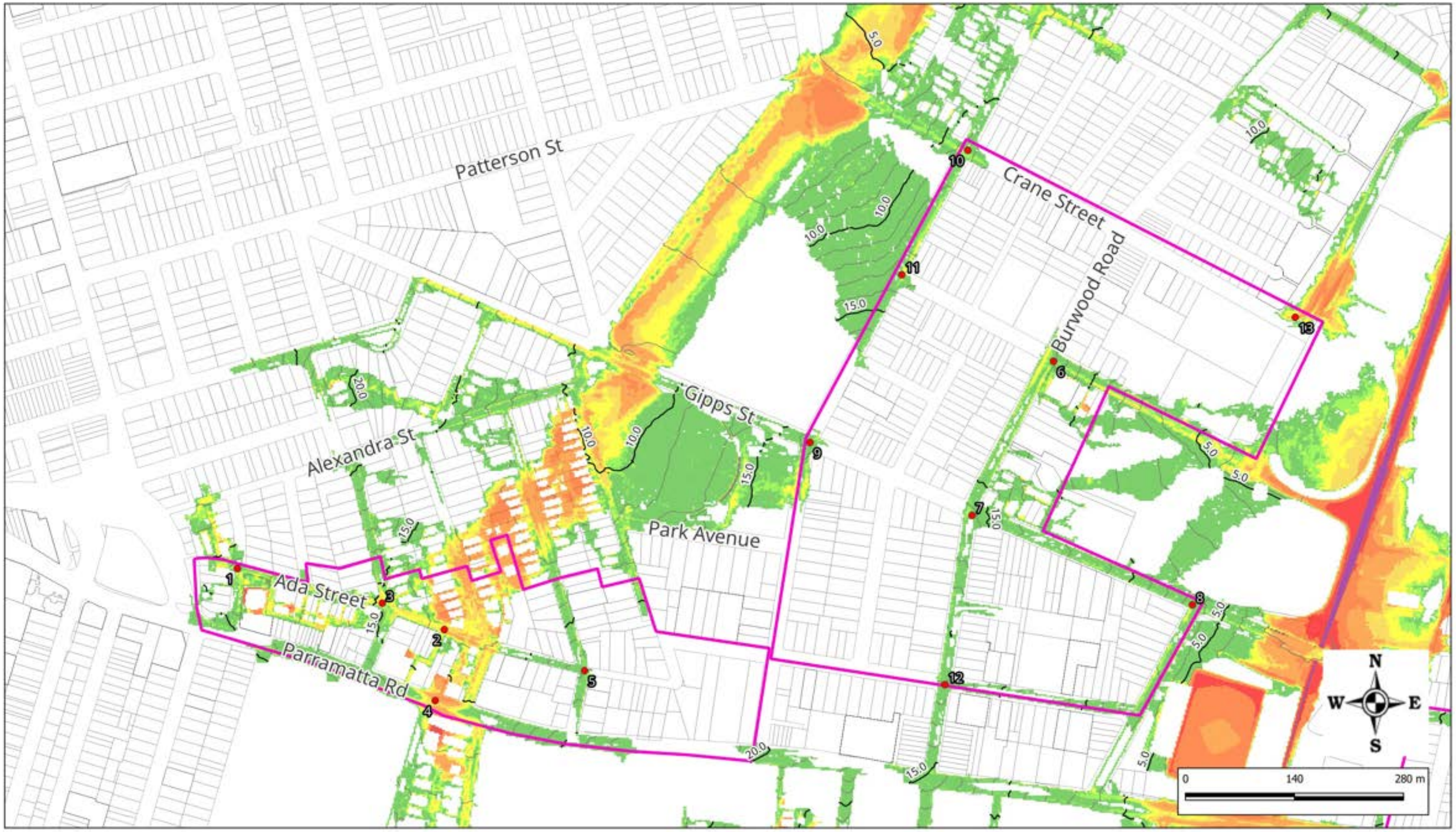
Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
> 2.0

Major Flood Level Contour (Spacing = 5 m)
Minor Flood Level Contour (Spacing = 1 m)

TITLE: **1% AEP Peak Flood Depths and Levels**

PROJECT: **PRCUTS Flood Assessment**
PROJECT No. **230074**
DATE: **04-2024**
SCALE: **1:10,000**
FIGURE No. **7**

grc HYDRO



Cadastre
Precinct
Sensitivity Analysis Points

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
> 2.0

Major Flood Level Contour (Spacing = 5 m)
Minor Flood Level Contour (Spacing = 1 m)

TITLE: **1% AEP Peak Flood Depths and Levels - Burwood Precinct**

PROJECT: **PRCUTS Flood Assessment**
PROJECT No. **230074**
DATE: **04-2024**
SCALE: **1:4,500**
FIGURE No. **7A**

grc HYDRO

Cadastre
Precinct
Sensitivity Analysis Points

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
> 2.0

Major Flood Level Contour (Spacing = 5 m)
Minor Flood Level Contour (Spacing = 1 m)

TITLE: **1% AEP Peak Flood Depths and Levels - Kings Bay (West) Precinct**

PROJECT: **PRCUTS Flood Assessment**

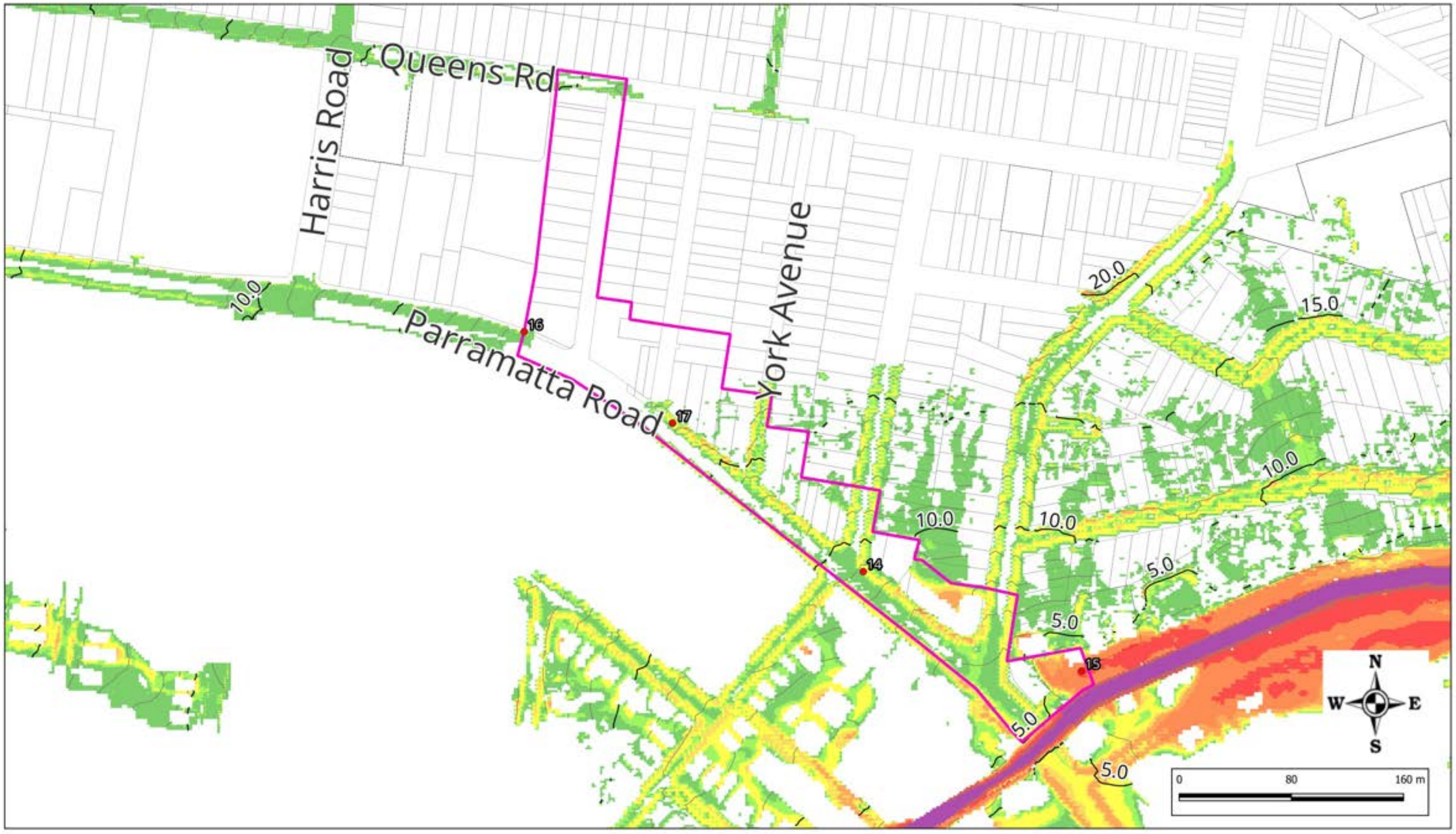
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:1,600**

FIGURE No. **7B**

grc HYDRO



Cadastre
Precinct
Sensitivity Analysis Points

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
> 2.0

Major Flood Level Contour (Spacing = 5 m)
Minor Flood Level Contour (Spacing = 1 m)

TITLE: **1% AEP Peak Flood Depths and Levels - Kings Bay (East) Precinct**

PROJECT: **PRCUTS Flood Assessment**

PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:2,500**

FIGURE No. **7C**

grc HYDRO

Cadastre
Precinct
Sensitivity Analysis Points

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
> 2.0

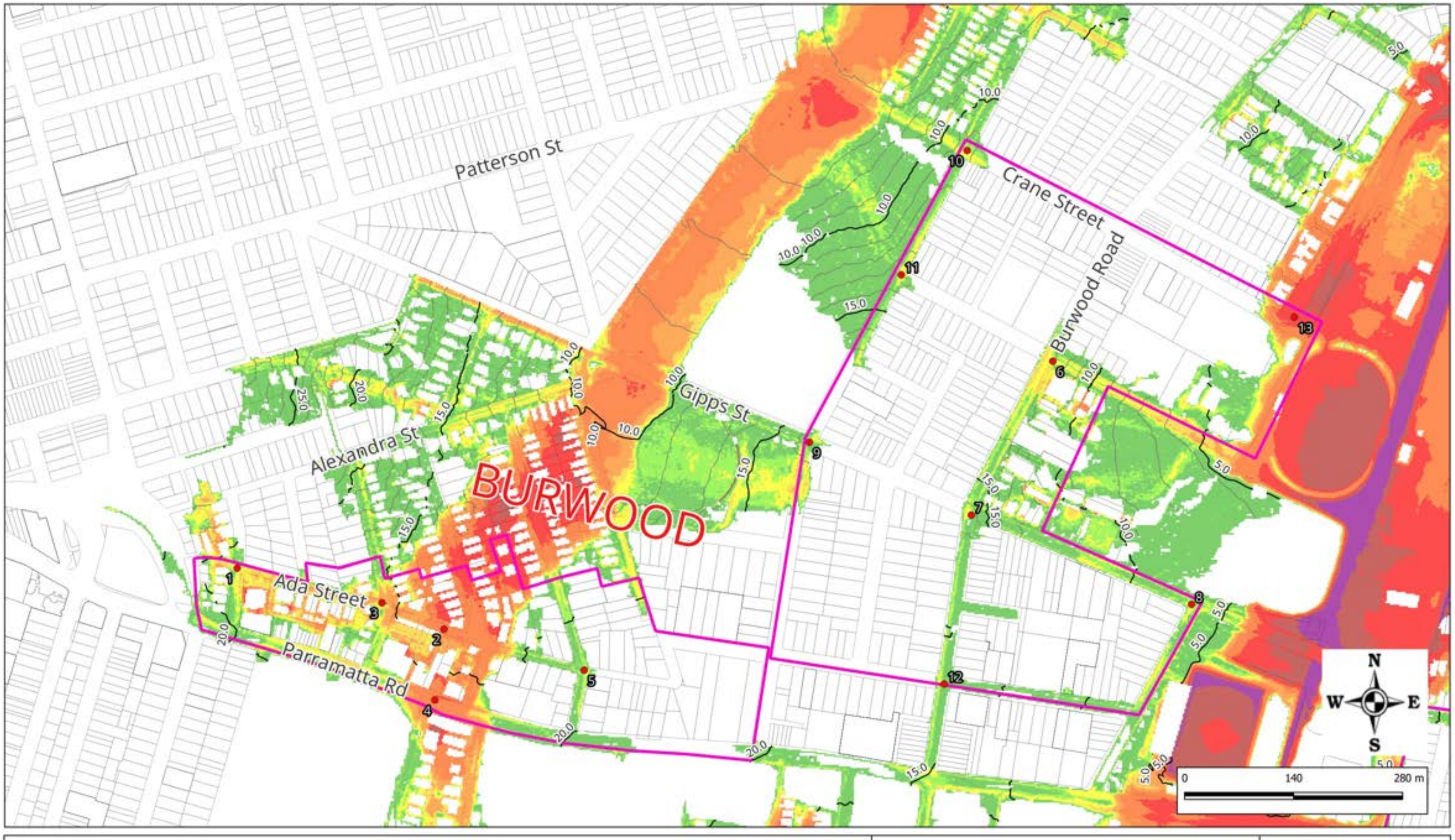
Major Flood Level Contour (Spacing = 5 m)
Minor Flood Level Contour (Spacing = 1 m)

TITLE: **PMF Flood Depth and Level**

PROJECT: **PRCUTS Flood Assessment** | PROJECT No. **230074**

DATE: **04-2024** | SCALE: **1:10,000** | FIGURE No. **8**

grc HYDRO



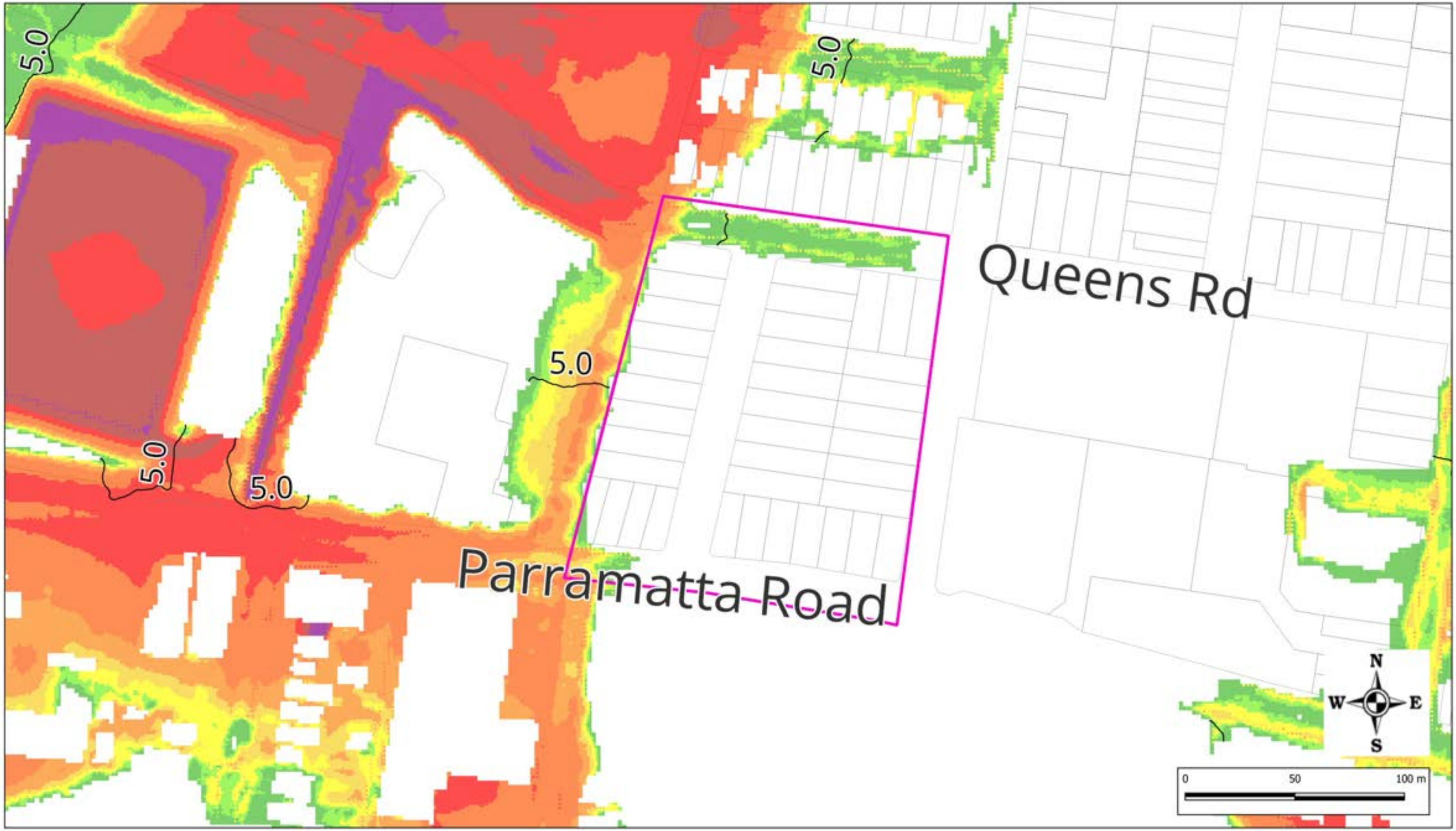
Cadastre
Precinct
Sensitivity Analysis Points

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
> 2.0

Major Flood Level Contour (Spacing = 5 m)
Minor Flood Level Contour (Spacing = 1 m)

TITLE: **PMF Peak Flood Depths and Levels - Burwood Precinct**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:4,500**	FIGURE No.	**8A**

grc HYDRO



Cadastre
Precinct
Sensitivity Analysis Points

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
> 2.0

Major Flood Level Contour (Spacing = 5 m)
Minor Flood Level Contour (Spacing = 1 m)

TITLE: **PMF Peak Flood Depths and Levels - Kings Bay (West) Precinct**

PROJECT: **PRCUTS Flood Assessment**

PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:1,600**

FIGURE No. **8B**

grc HYDRO

Cadastre
Precinct
Sensitivity Analysis Points

Flood Depth (m)
0 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
> 2.0

Major Flood Level Contour (Spacing = 5 m)
Minor Flood Level Contour (Spacing = 1 m)

TITLE: **PMF Peak Flood Depths and Levels - Kings Bay (East) Precinct**

PROJECT: **PRCUTS Flood Assessment**

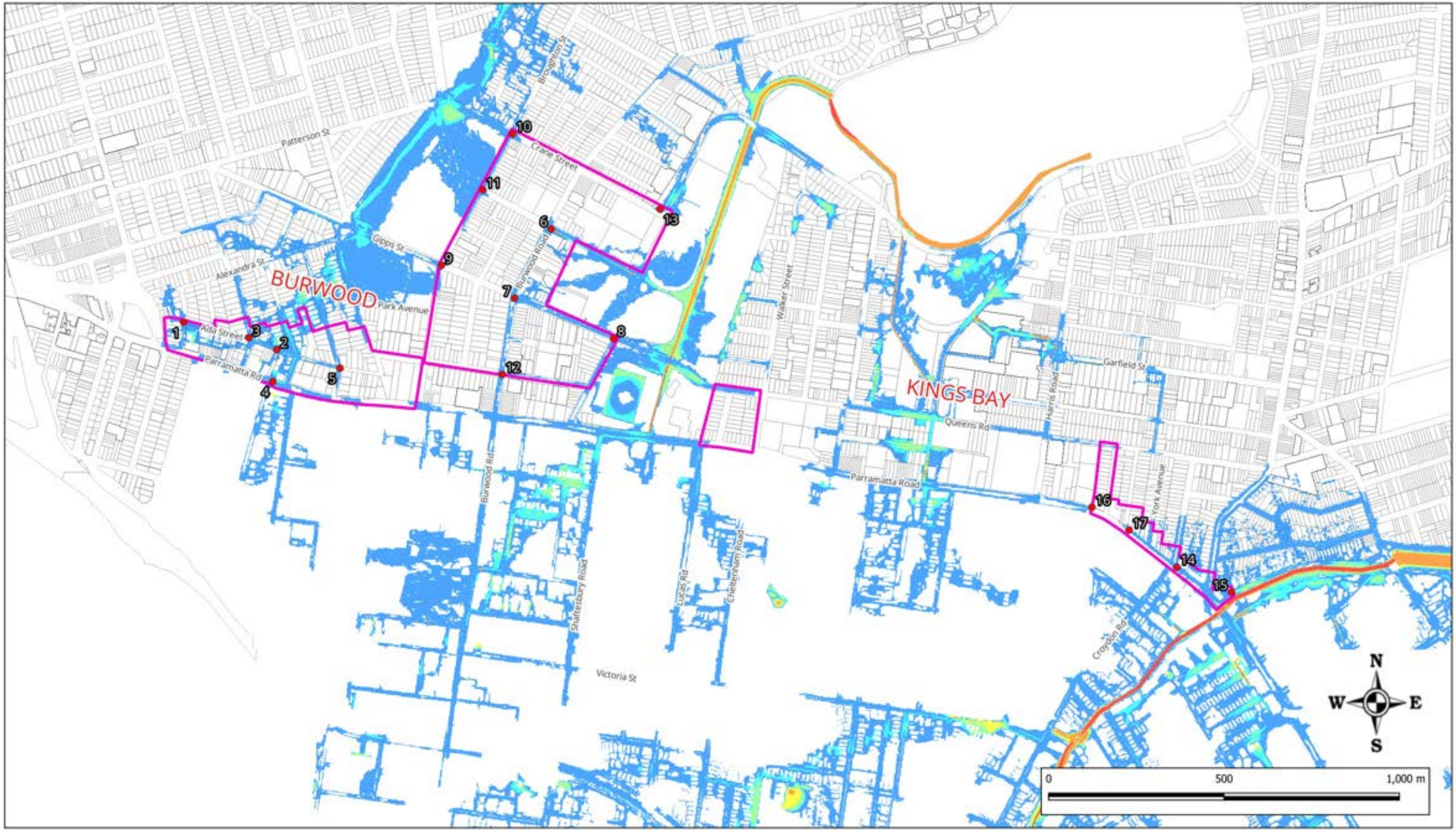
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:2,500**

FIGURE No. **8C**

grc HYDRO

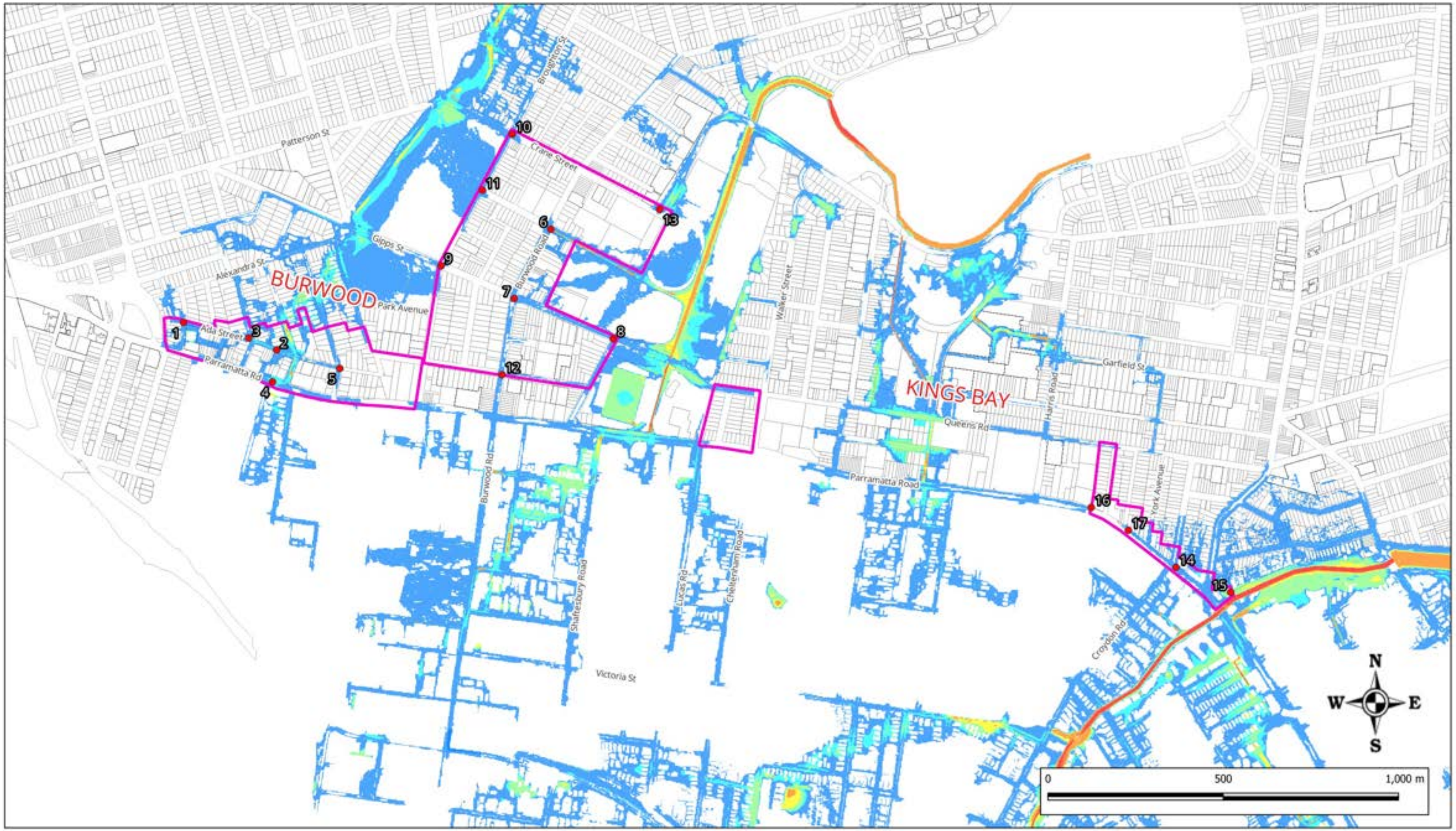


Cadastre
Precinct
Sensitivity Analysis Points

Hydraulic Hazard
H1
H2
H3
H4
H5
H6

TITLE: **5% AEP Hydraulic Hazard**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:10,000**	FIGURE No.	**9**

grc HYDRO



Cadastre
Precinct
Sensitivity Analysis Points

Hydraulic Hazard
H1
H2
H3
H4
H5
H6

TITLE: **1% AEP Hydraulic Hazard**

PROJECT: **PRCUTS Flood Assessment**

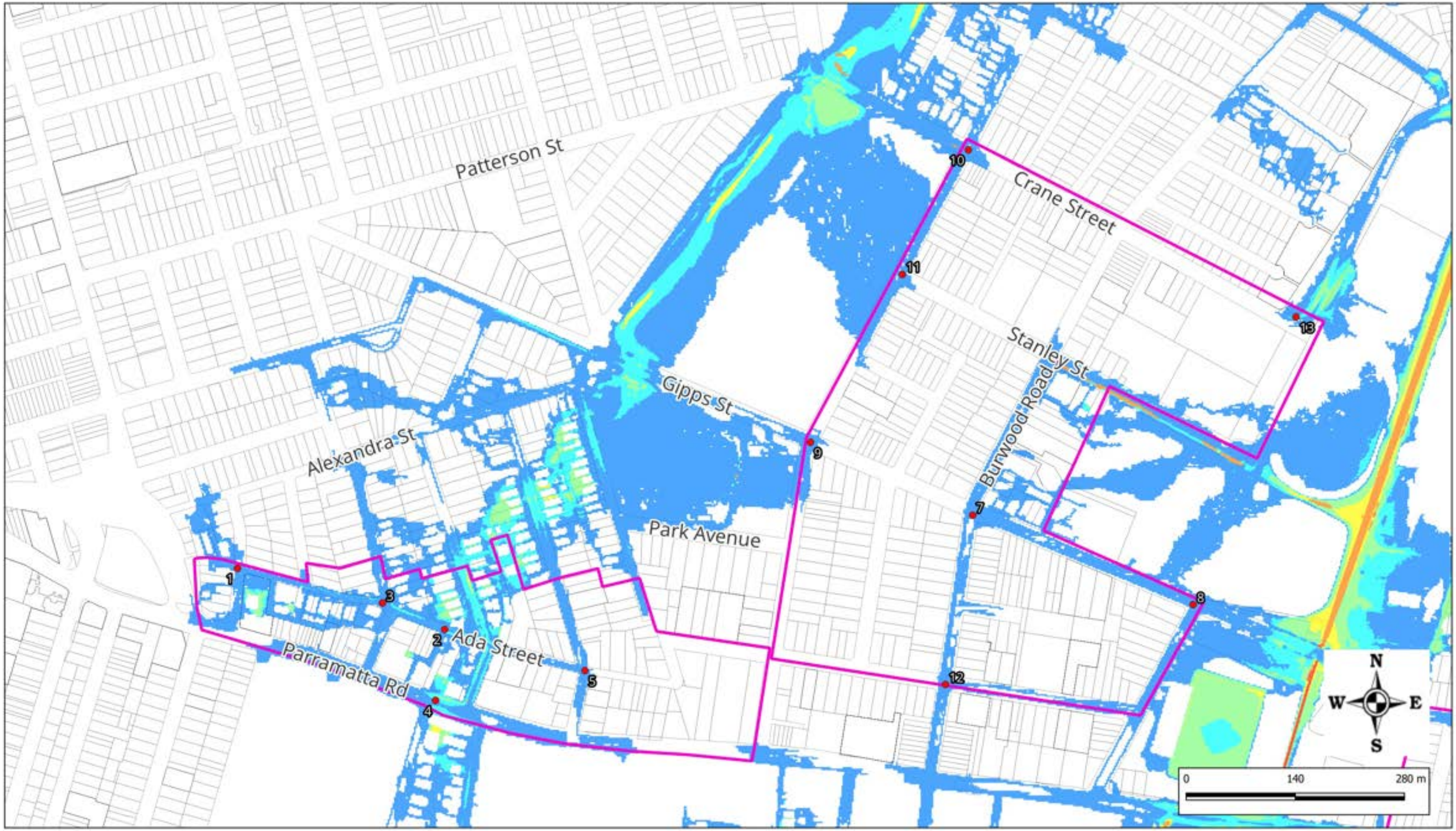
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:10,000**

FIGURE No. **10**

grc HYDRO



Cadastre
Precinct
Sensitivity Analysis Points

Hydraulic Hazard
H1
H2
H3
H4
H5
H6

TITLE: **1% AEP Hydraulic Hazard - Burwood Precinct**

PROJECT: **PRCUTS Flood Assessment**

PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:4,500**

FIGURE No. **10A**

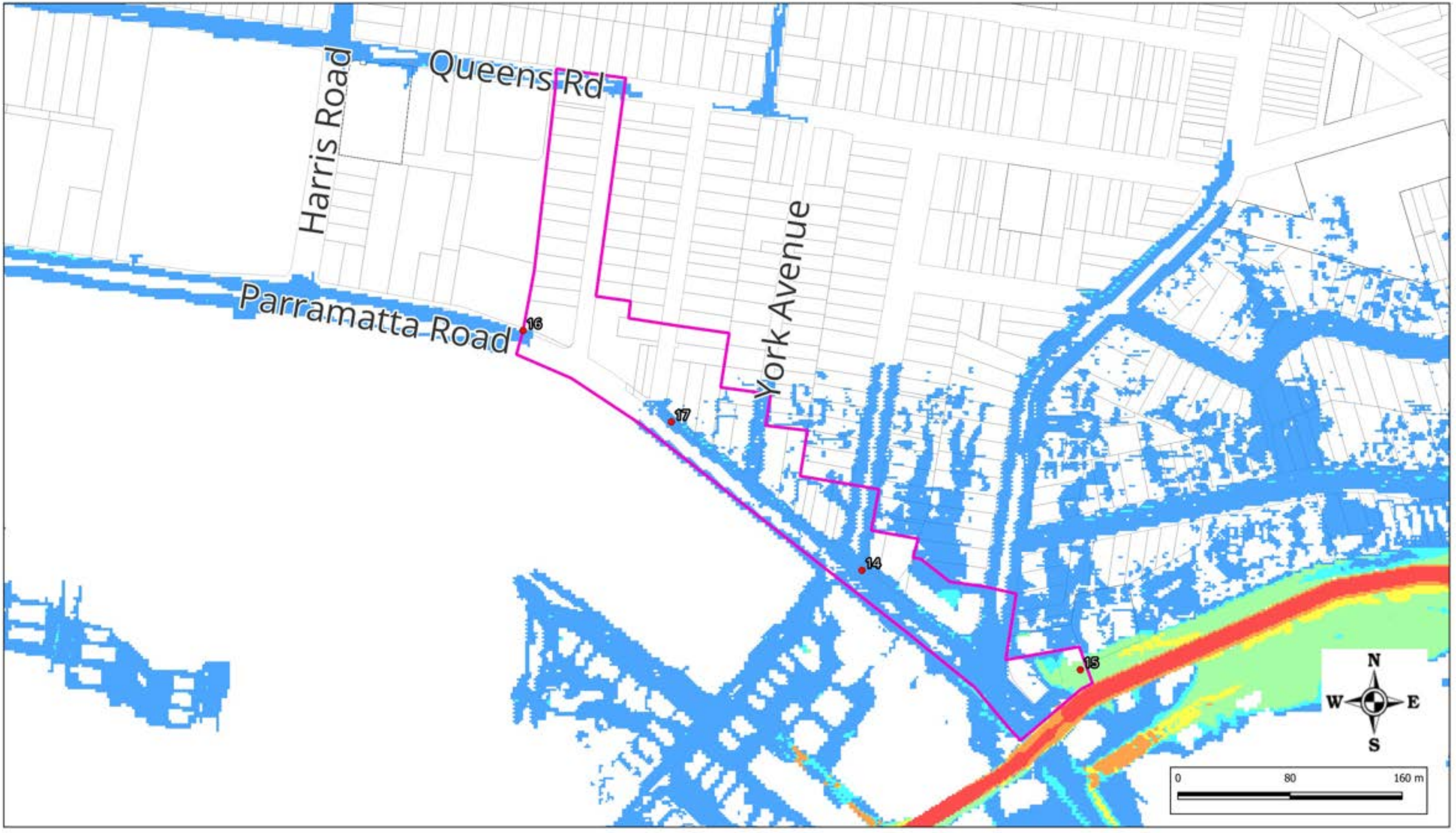
grc HYDRO

Cadastre
Precinct
Sensitivity Analysis Points

Hydraulic Hazard
H1
H2
H3
H4
H5
H6

TITLE: **1% AEP Hydraulic Hazard - Kings Bay (West) Precinct**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:1,600**	FIGURE No.	**10B**

grc HYDRO



Cadastre
Precinct
Sensitivity Analysis Points

Hydraulic Hazard
H1
H2
H3
H4
H5
H6

TITLE: **1% AEP Hydraulic Hazard - Kings Bay (East) Precinct**

PROJECT: **PRCUTS Flood Assessment**

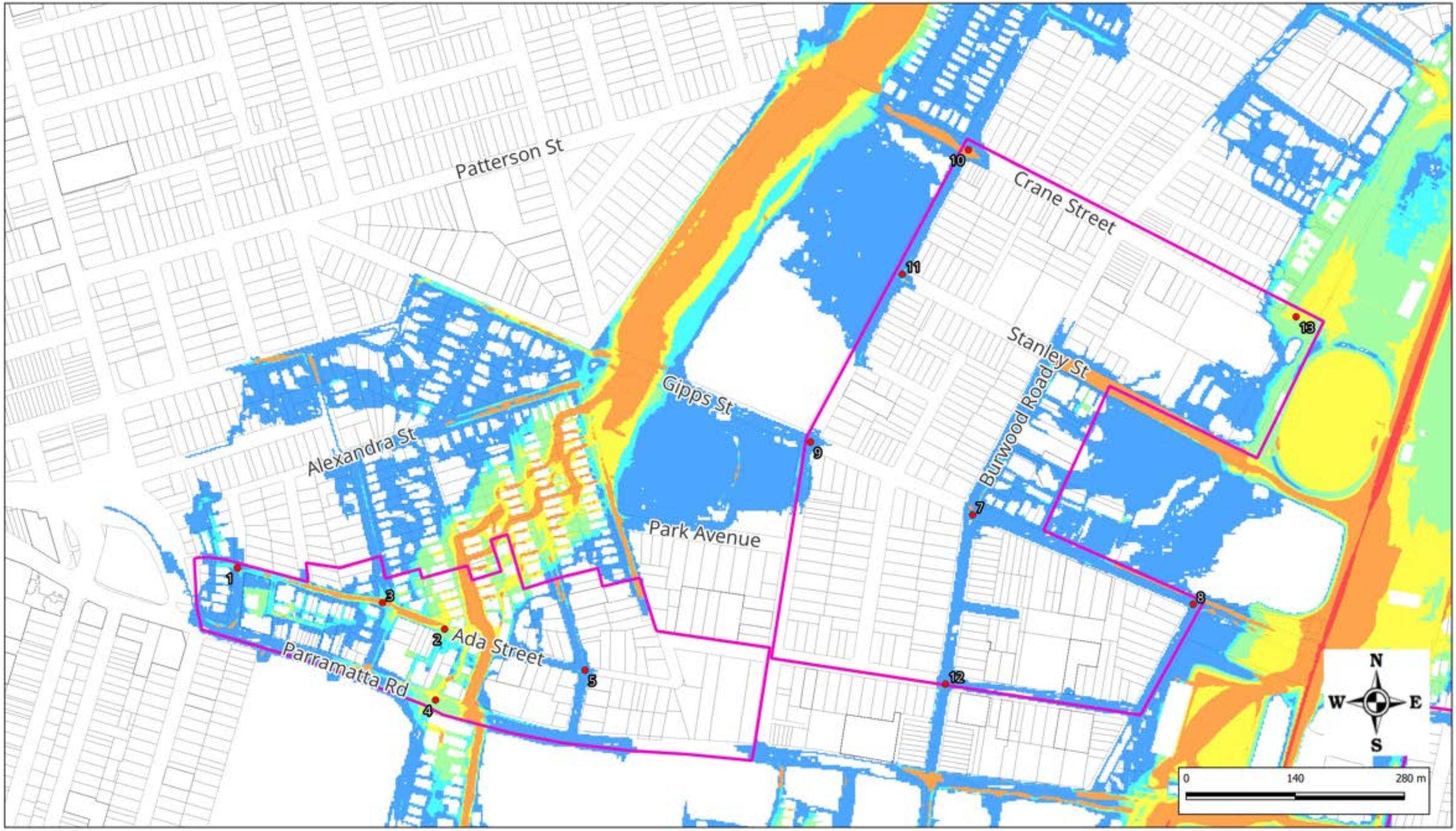
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:2,500**

FIGURE No. **10C**

grc HYDRO



Cadastre
Precinct
Sensitivity Analysis Points

Hydraulic Hazard
H1
H2
H3
H4
H5
H6

TITLE: **PMF Hydraulic Hazard - Burwood Precinct**

PROJECT: **PRCUTS Flood Assessment**

PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:4,500**

FIGURE No. **11A**

grc HYDRO

Cadastre
Precinct
Sensitivity Analysis Points

Hydraulic Hazard
H1
H2
H3
H4
H5
H6

TITLE: **PMF Hydraulic Hazard - Kings Bay (West) Precinct**

PROJECT: **PRCUTS Flood Assessment**

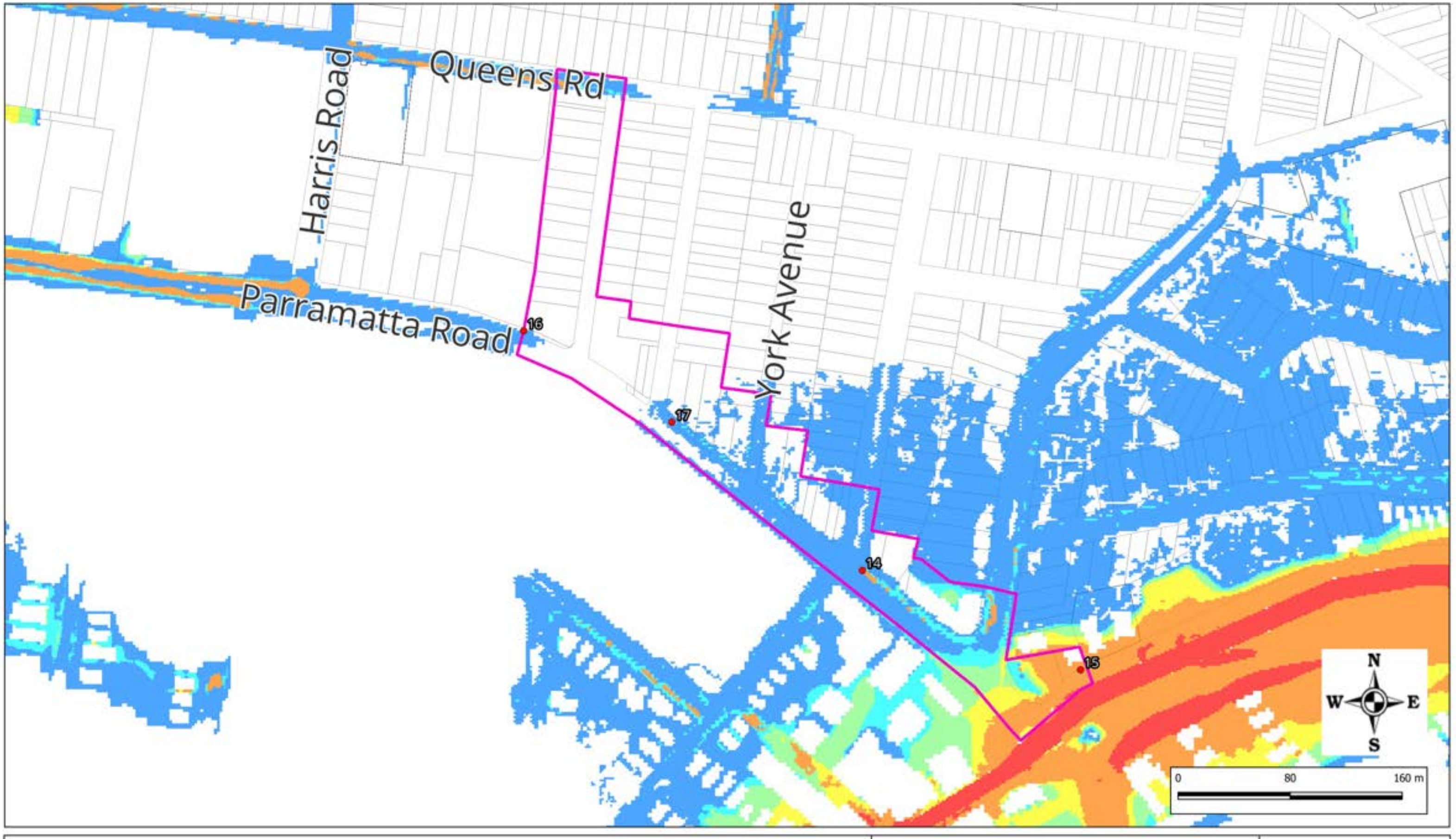
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:1,600**

FIGURE No. **11B**

grc HYDRO



Cadastre
Precinct
Sensitivity Analysis Points

Hydraulic Hazard
H1
H2
H3
H4
H5
H6

TITLE: **PMF Hydraulic Hazard - Kings Bay (East) Precinct**

PROJECT: **PRCUTS Flood Assessment**

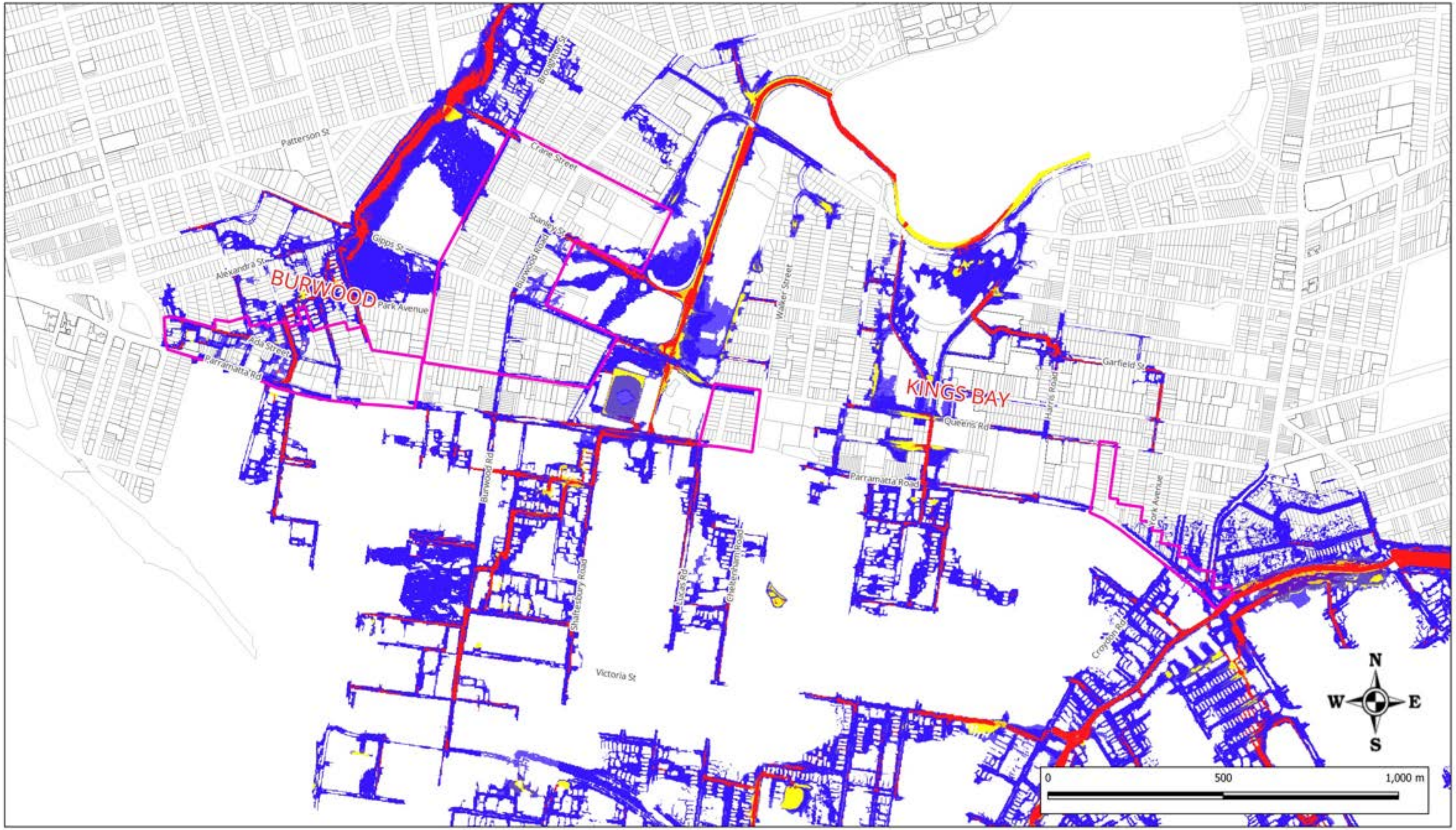
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:2,500**

FIGURE No. **11C**

grc HYDRO



Cadastre

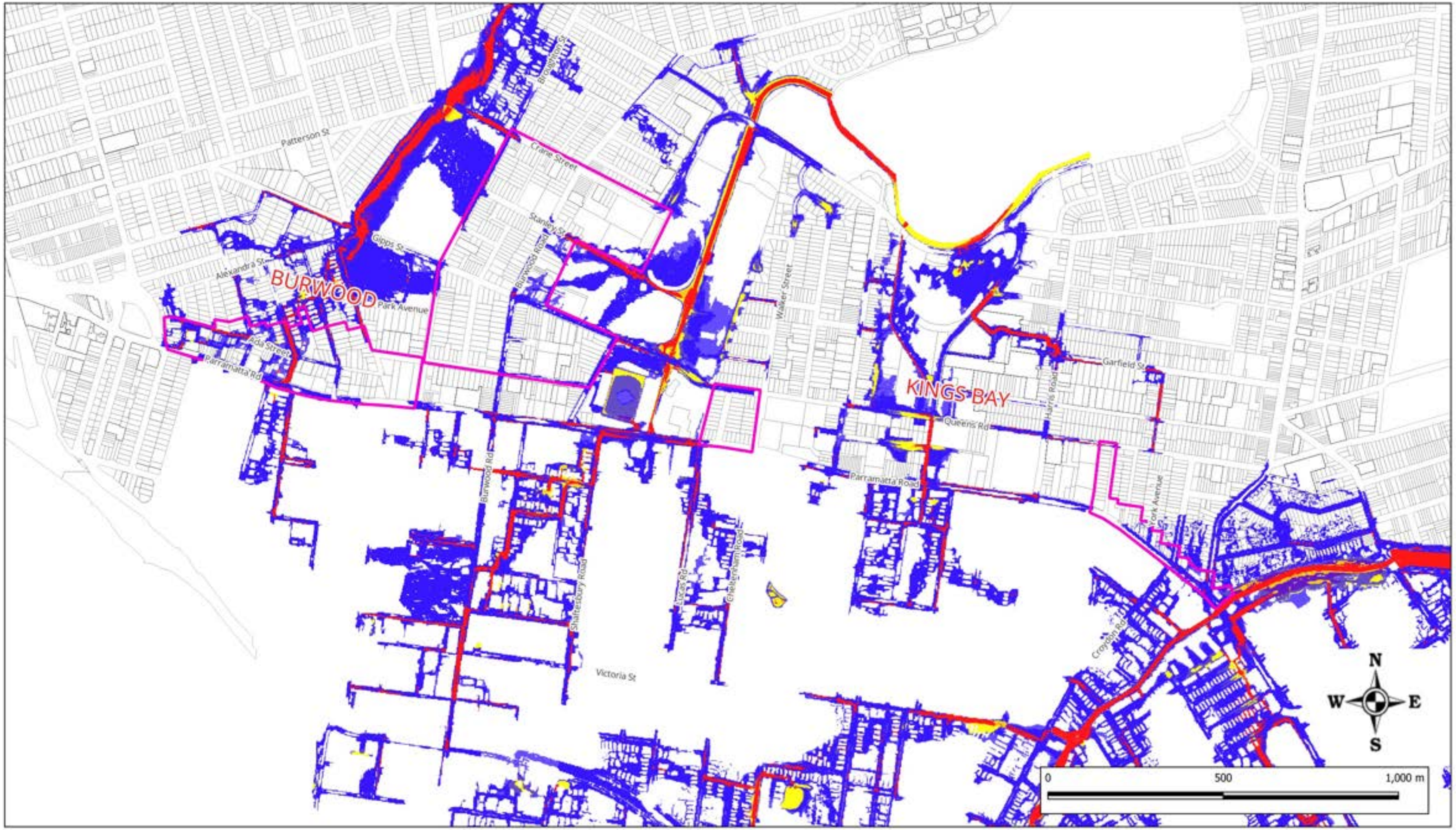
Precinct

Hydraulic Categorisation

- Floodway
- Flood Storage
- Flood Fringe

TITLE: **5% AEP Hydraulic Categorisation**		
PROJECT: **PRCUTS Flood Assessment**		PROJECT No. **230074**
DATE: **04-2024**	SCALE: **1:10,000**	FIGURE No. **12**

grc HYDRO



Cadastre

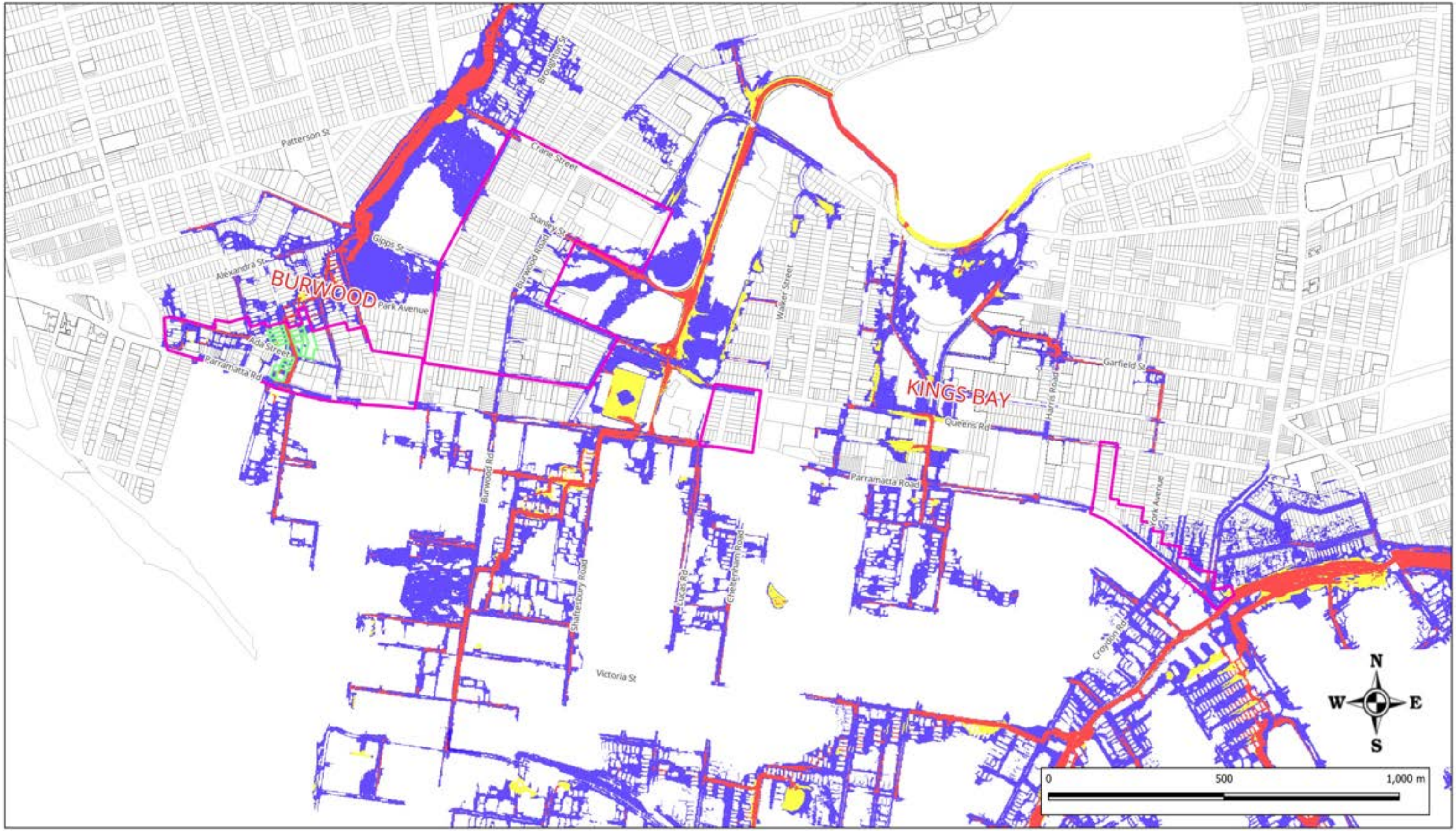
Precinct

Hydraulic Categorisation

- Floodway
- Flood Storage
- Flood Fringe

TITLE: **5% AEP Hydraulic Categorisation**		
PROJECT: **PRCUTS Flood Assessment**		PROJECT No. **230074**
DATE: **04-2024**	SCALE: **1:10,000**	FIGURE No. **12**

grc HYDRO

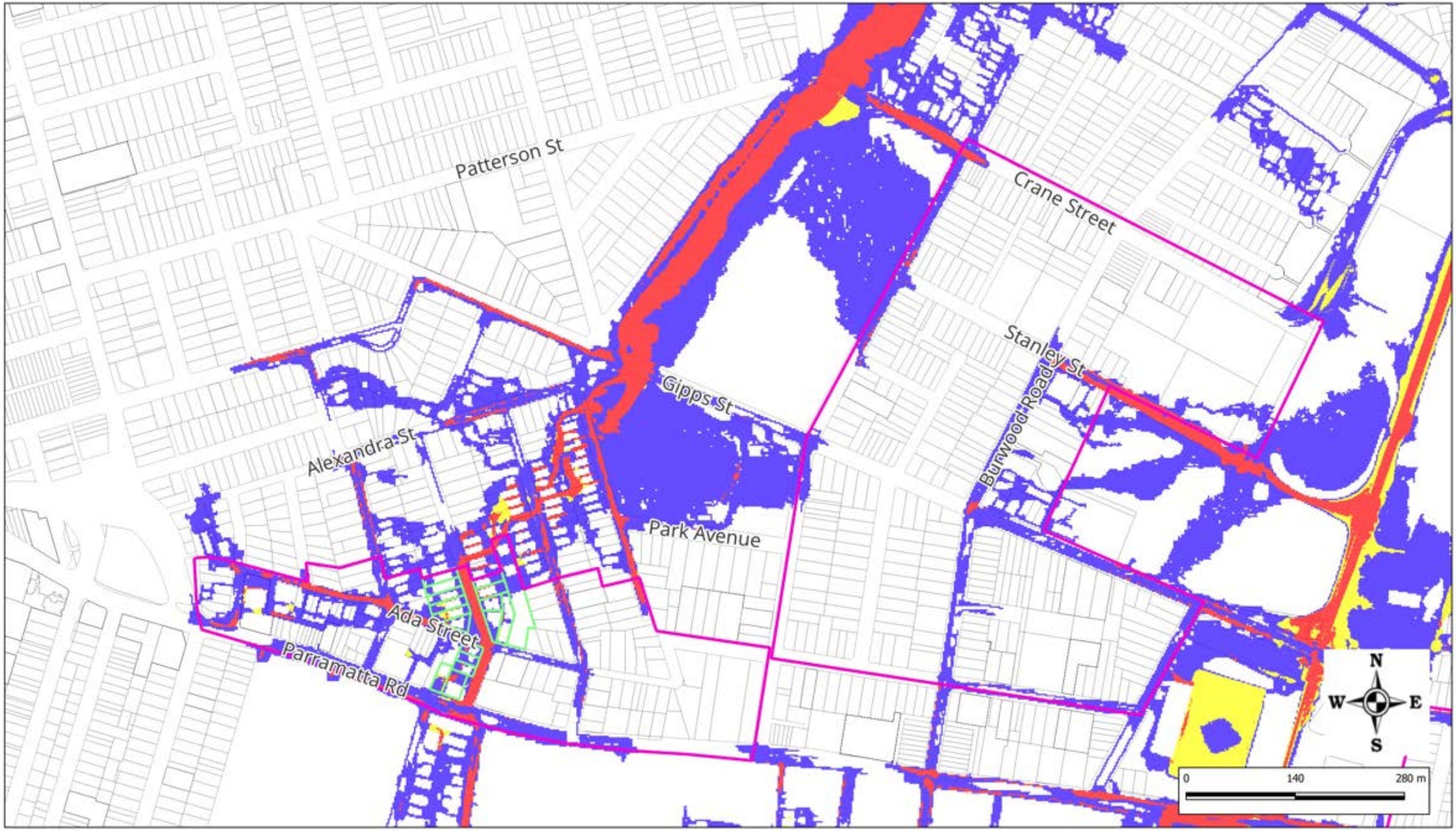


Cadastre
Precinct
Flood Planning Area (within precincts)

Hydraulic Categorisation
Floodway
Flood Storage
Flood Fringe

TITLE: **1% AEP Hydraulic Categorisation and Flood Planning Area**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:10,000**	FIGURE No.	**13**

grc HYDRO



Cadastre
Precinct
Flood Planning Area (within precincts)

Hydraulic Categorisation
Floodway
Flood Storage
Flood Fringe

TITLE: **1% AEP Hydraulic Categorisation and Flood Planning Area - Burwood Precinct**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:4,500**	FIGURE No.	**13A**

grc HYDRO

Cadastre
Precinct

Hydraulic Categorisation
Floodway
Flood Storage
Flood Fringe

TITLE: **1% AEP Hydraulic Categorisation - Kings Bay (West) Precinct**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:1,600**	FIGURE No.	**13B**

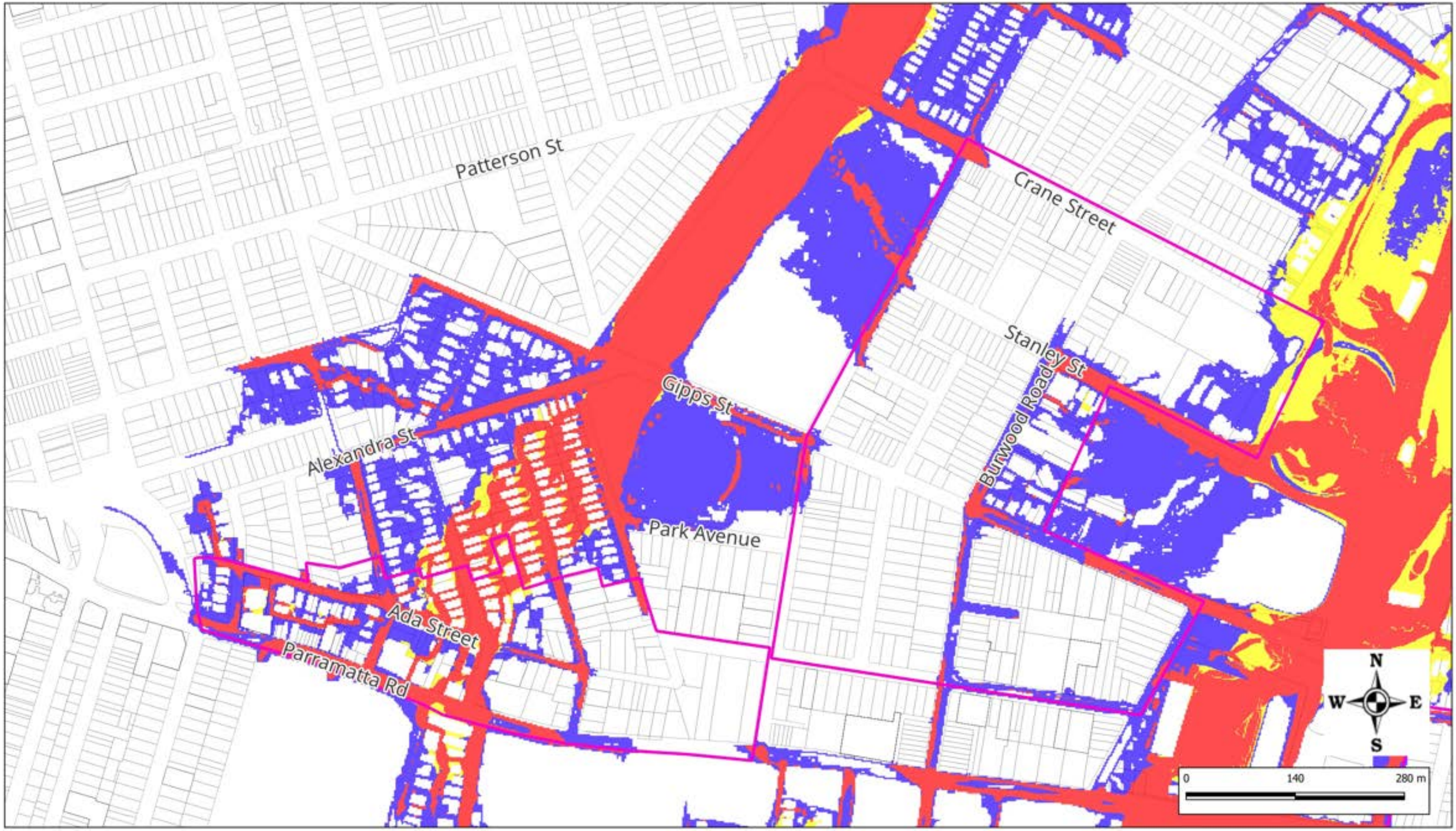
grc HYDRO

Cadastre
Precinct

Hydraulic Categorisation
Floodway
Flood Storage
Flood Fringe

TITLE: **1% AEP Hydraulic Categorisation - Kings Bay (East) Precinct**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:2,500**	FIGURE No.	**13C**

grc HYDRO



Cadastre

Precinct

Hydraulic Categorisation

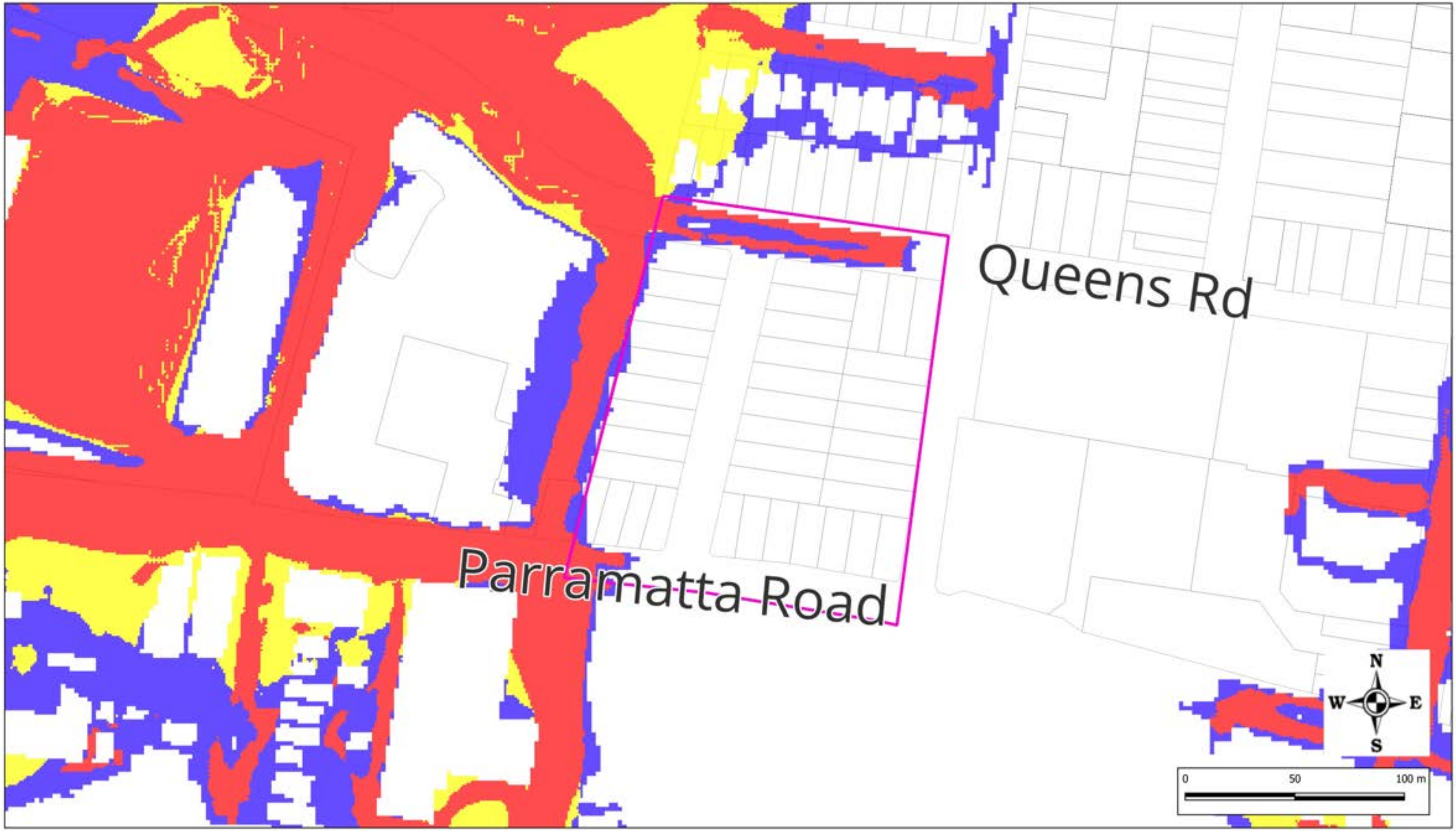
Floodway

Flood Storage

Flood Fringe

TITLE: **PMF Hydraulic Categorisation - Burwood Precinct**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:4,500**	FIGURE No.	**14A**

grc HYDRO

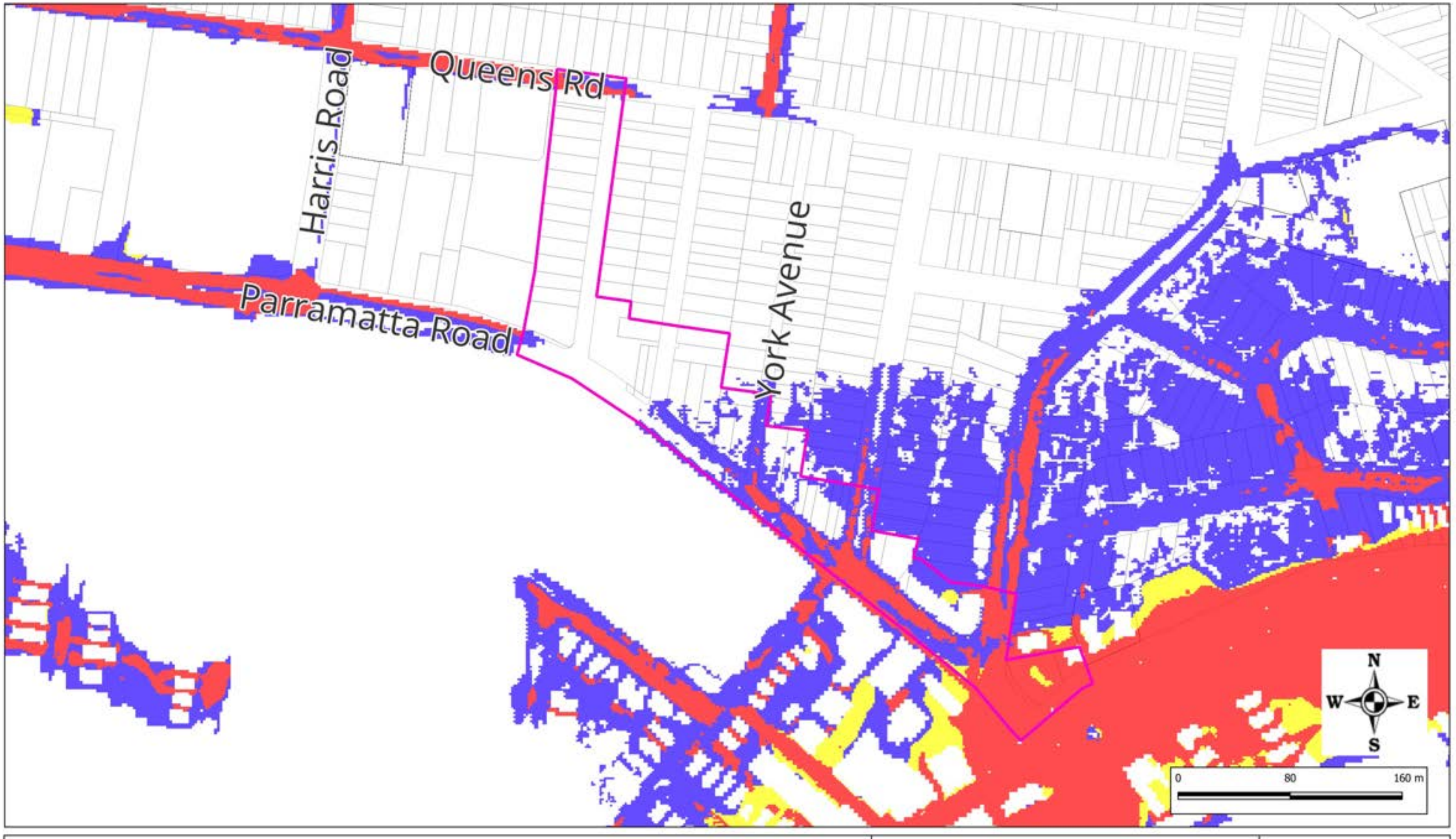


Cadastre
Precinct

Hydraulic Categorisation
Floodway
Flood Storage
Flood Fringe

TITLE: **PMF Hydraulic Categorisation - Kings Bay (West) Precinct**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:1,600**	FIGURE No.	**14B**

grc HYDRO

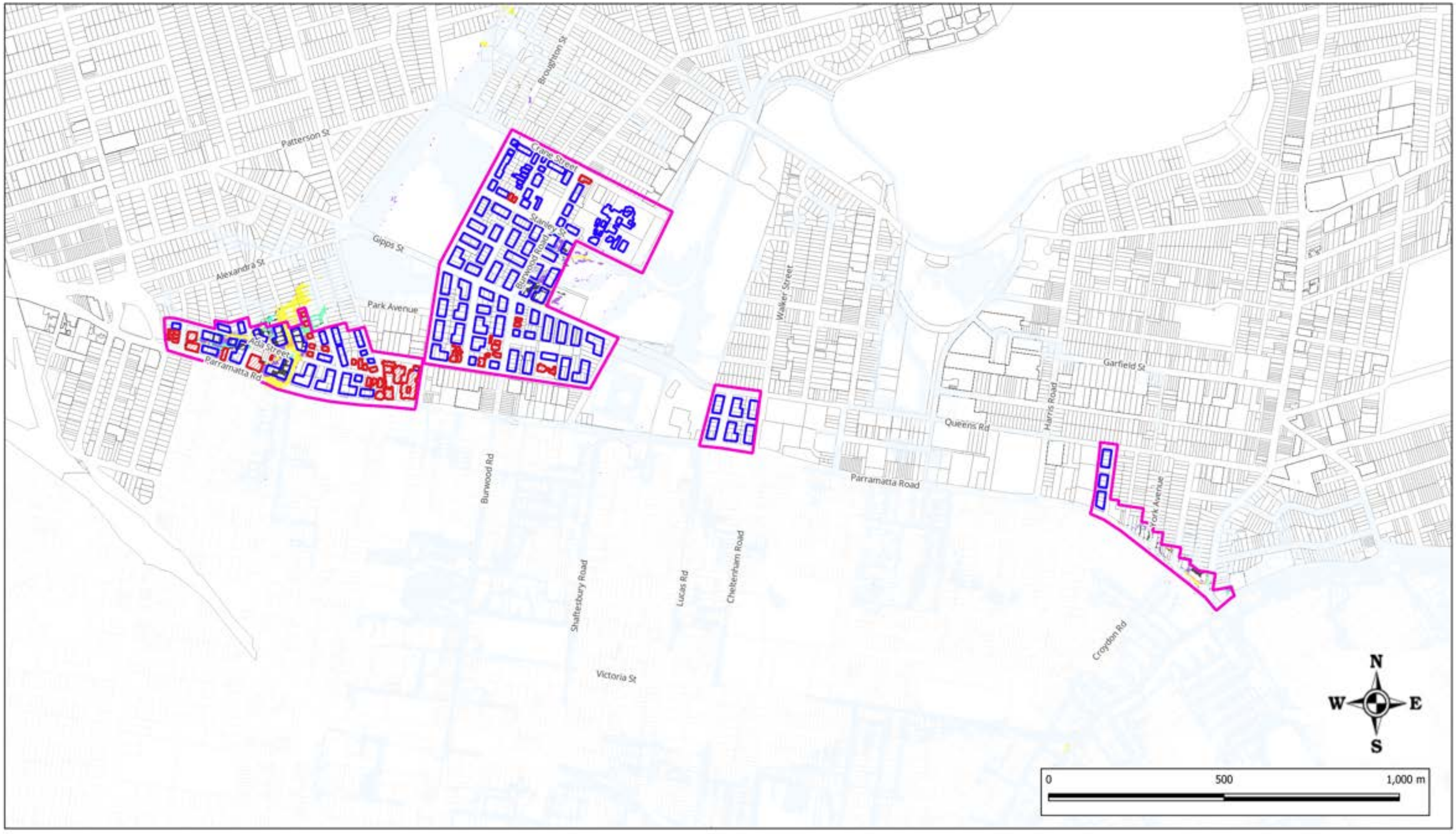


Cadastre
Precinct

Hydraulic Categorisation
Floodway
Flood Storage
Flood Fringe

TITLE: **PMF Hydraulic Categorisation - Kings Bay (East) Precinct**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:2,500**	FIGURE No.	**14C**

grc HYDRO



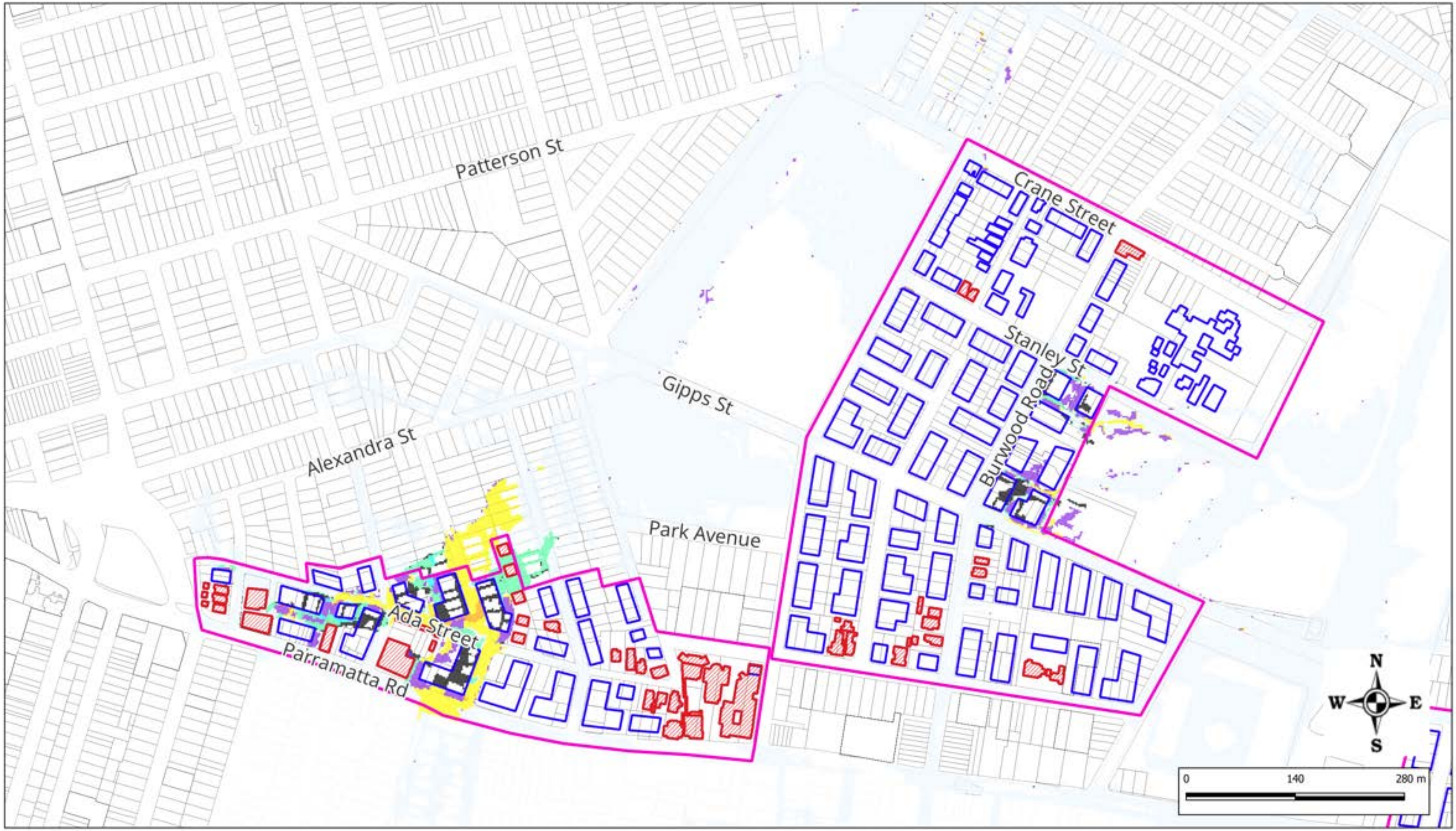
Cadastre
Precinct
Existing Buildings Retained
Proposed Buildings

Impact (m)

< -0.3	0.01 to 0.1
-0.3 to -0.2	0.1 to 0.2
-0.2 to -0.1	0.2 to 0.3
-0.1 to -0.01	> 0.3
No Impact	No Longer Flooded
	Newly Flooded

TITLE: **Change in Peak Flood Levels Proposed Development vs Existing 5% AEP**		
PROJECT: **PRCUTS Flood Assessment**		PROJECT No. **230074**
DATE: **04-2024**	SCALE: **1:10,000**	FIGURE No. **15**

grc HYDRO



Cadastre
Precinct
Existing Buildings Retained
Proposed Buildings

Impact (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded

TITLE: **Change in Peak Flood Levels Proposed Development vs Existing 5% AEP - Burwood Precinct**

PROJECT: **PRCUTS Flood Assessment**

PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:4,500**

FIGURE No. **15A**

grc HYDRO

Queens Rd

Parramatta Road

N
W E
S

0 50 100 m

Cadastre
Precinct
Existing Buildings Retained
Proposed Buildings

Impact (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded

TITLE: **Change in Peak Flood Levels Proposed Development vs Existing 5% AEP - Kings Bay (West) Precinct**

PROJECT: **PRCUTS Flood Assessment**

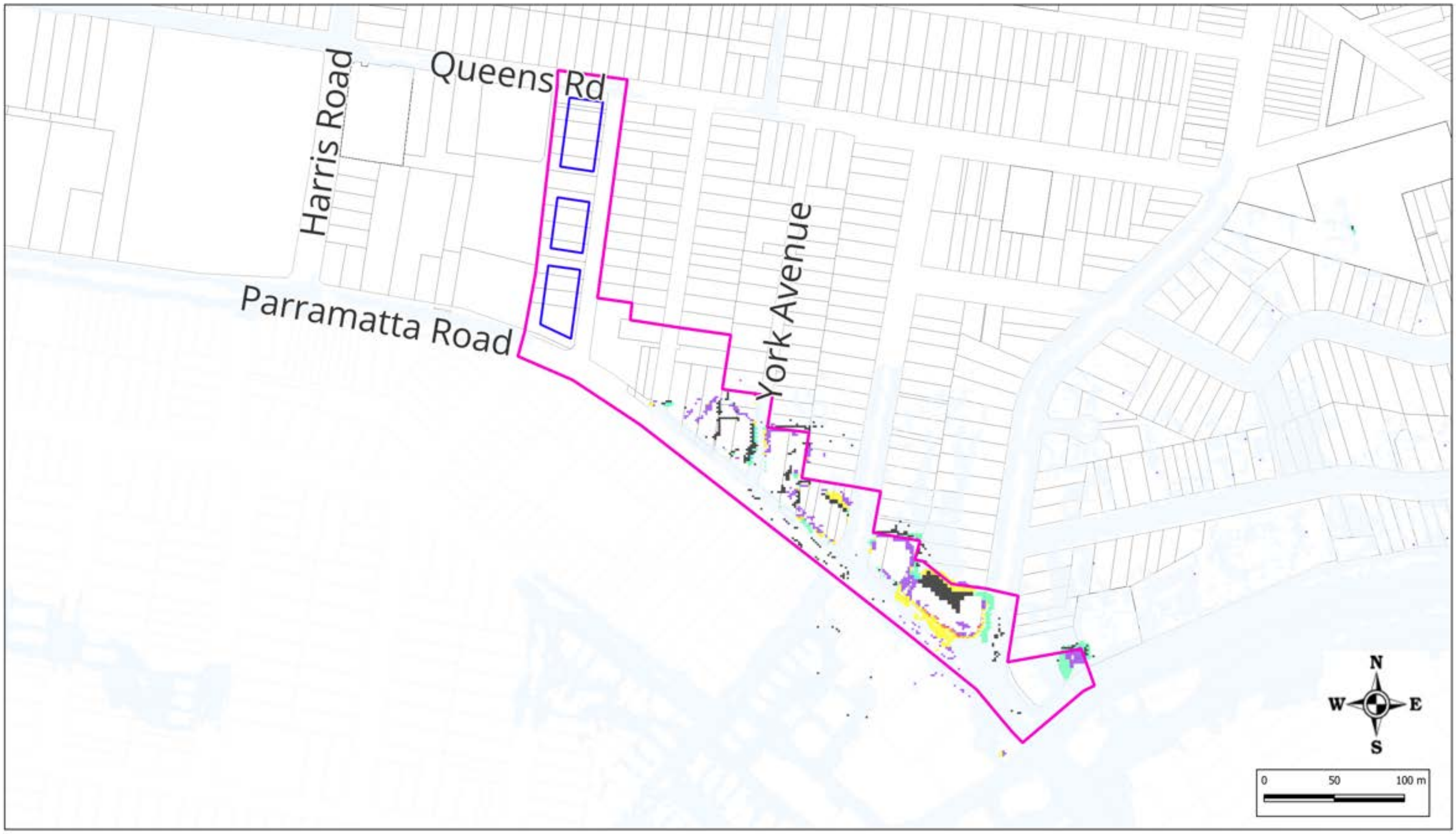
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:1,600**

FIGURE No. **15B**

grc HYDRO



Cadastre
Precinct
Existing Buildings Retained
Proposed Buildings

Impact (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded

TITLE: **Change in Peak Flood Levels Proposed Development vs Existing 5% AEP - Kings Bay (East) Precinct**

PROJECT: **PRCUTS Flood Assessment**

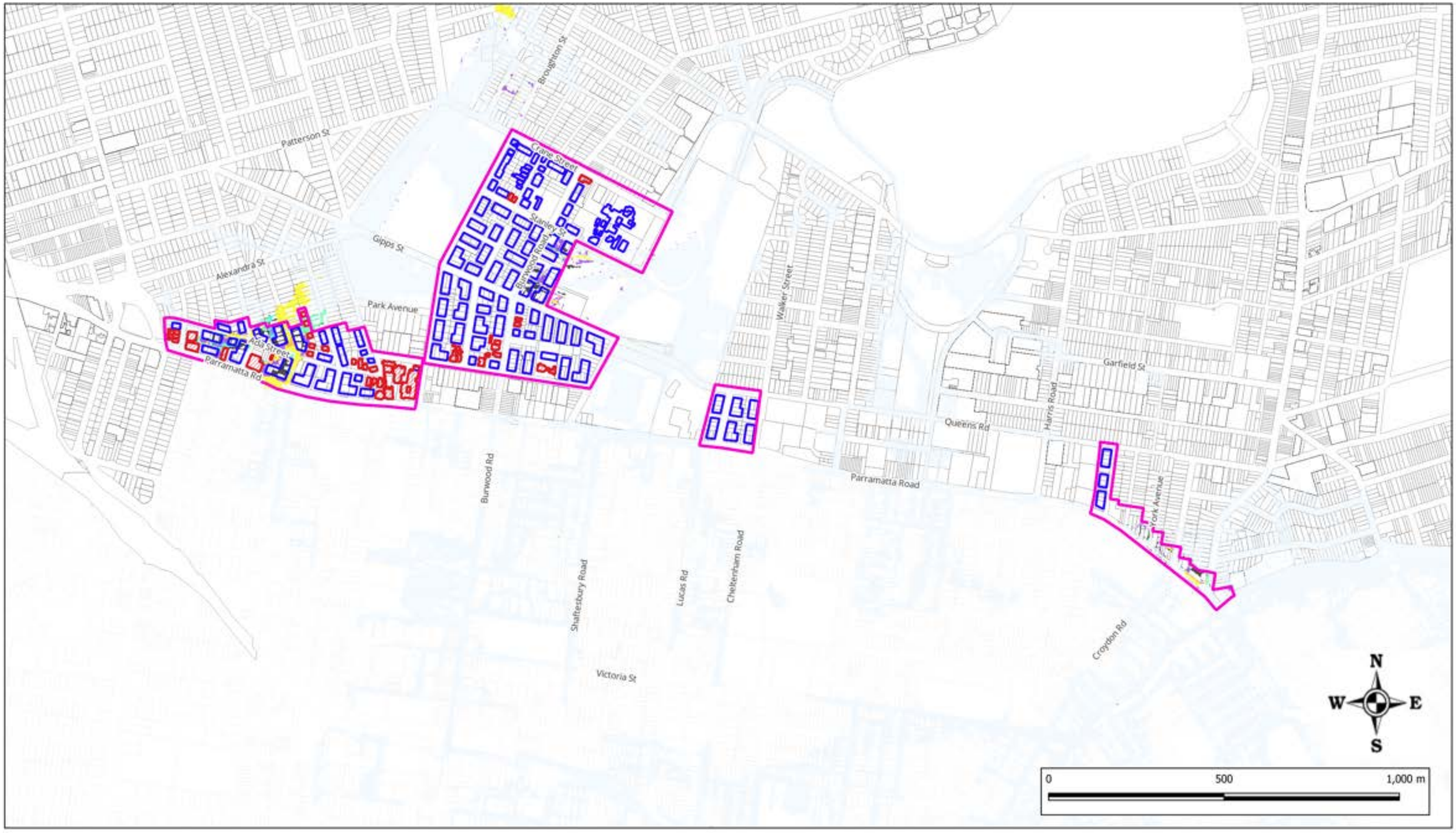
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:2,500**

FIGURE No. **15C**

grc HYDRO



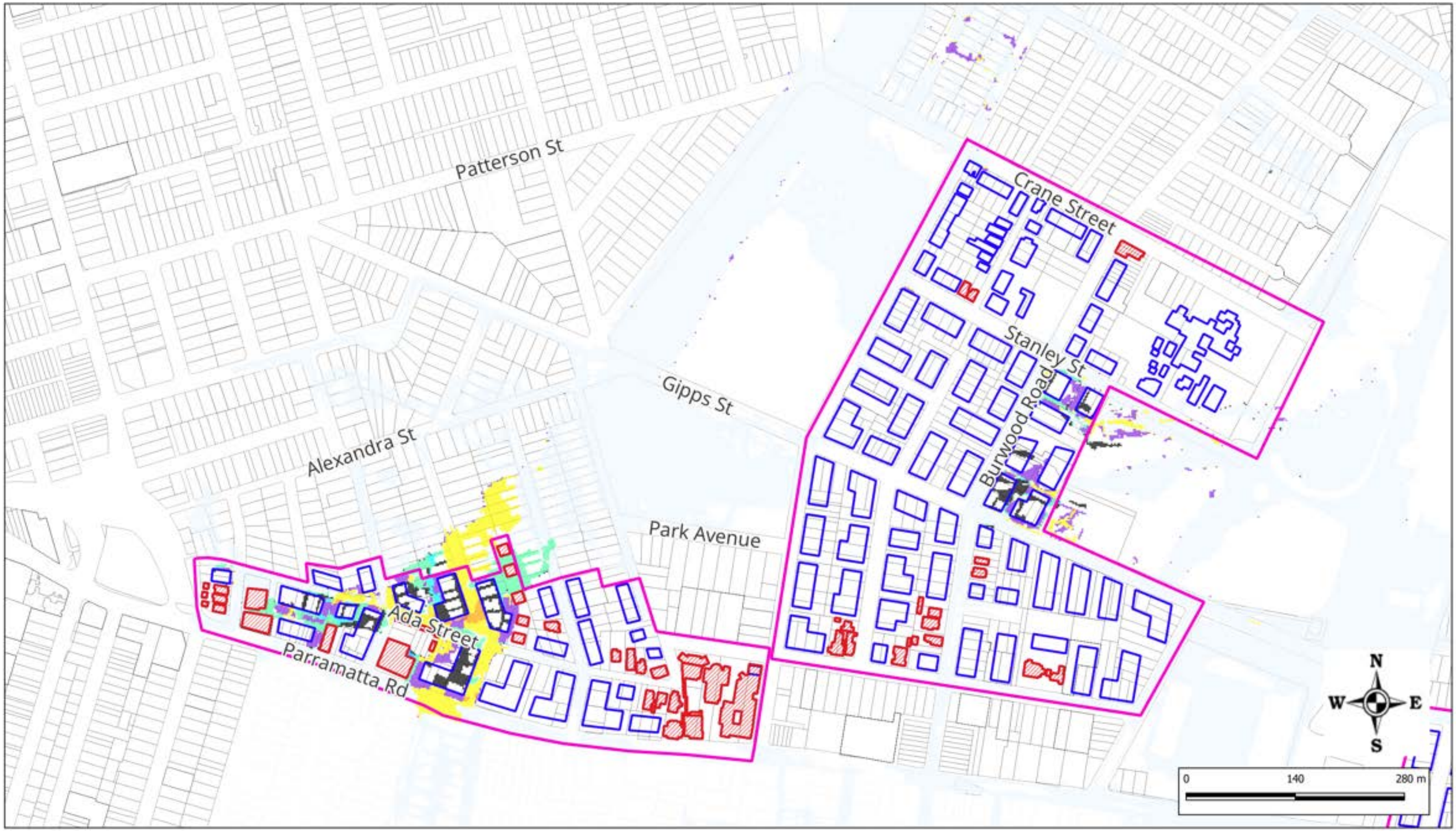
Cadastre
Precinct
Existing Buildings Retained
Proposed Buildings

Impact (m)

< -0.3	0.01 to 0.1
-0.3 to -0.2	0.1 to 0.2
-0.2 to -0.1	0.2 to 0.3
-0.1 to -0.01	> 0.3
No Impact	No Longer Flooded
	Newly Flooded

TITLE: **Change in Peak Flood Levels Proposed Development vs Existing 1% AEP**		
PROJECT: **PRCUTS Flood Assessment**		PROJECT No. **230074**
DATE: **04-2024**	SCALE: **1:10,000**	FIGURE No. **16**

grc HYDRO



Cadastre
Precinct
Existing Buildings Retained
Proposed Buildings

Impact (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded

TITLE: **Change in Peak Flood Levels Proposed Development vs Existing 1% AEP - Burwood Precinct**

PROJECT: **PRCUTS Flood Assessment**

PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:4,500**

FIGURE No. **16A**

grc HYDRO

Queens Rd

Parramatta Road

N

W E

S

0 50 100 m

Cadastre
Precinct
Existing Buildings Retained
Proposed Buildings

Impact (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded

TITLE: **Change in Peak Flood Levels Proposed Development vs Existing 1% AEP - Kings Bay (West) Precinct**

PROJECT: **PRCUTS Flood Assessment**

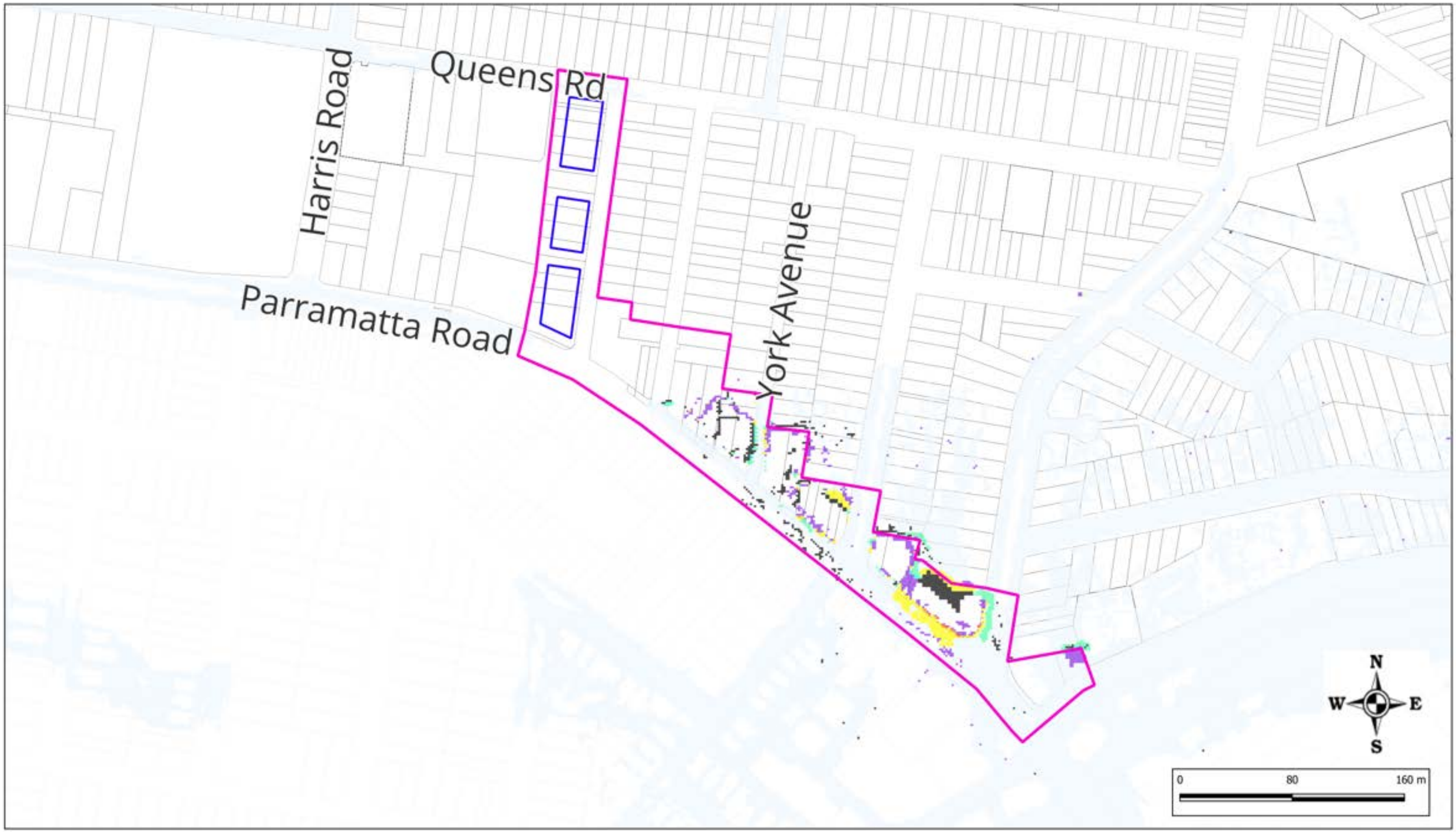
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:1,600**

FIGURE No. **16B**

grc HYDRO



Cadastre
Precinct
Existing Buildings Retained
Proposed Buildings

Impact (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded

TITLE: **Change in Peak Flood Levels Proposed Development vs Existing 1% AEP - Kings Bay (East) Precinct**

PROJECT: **PRCUTS Flood Assessment**

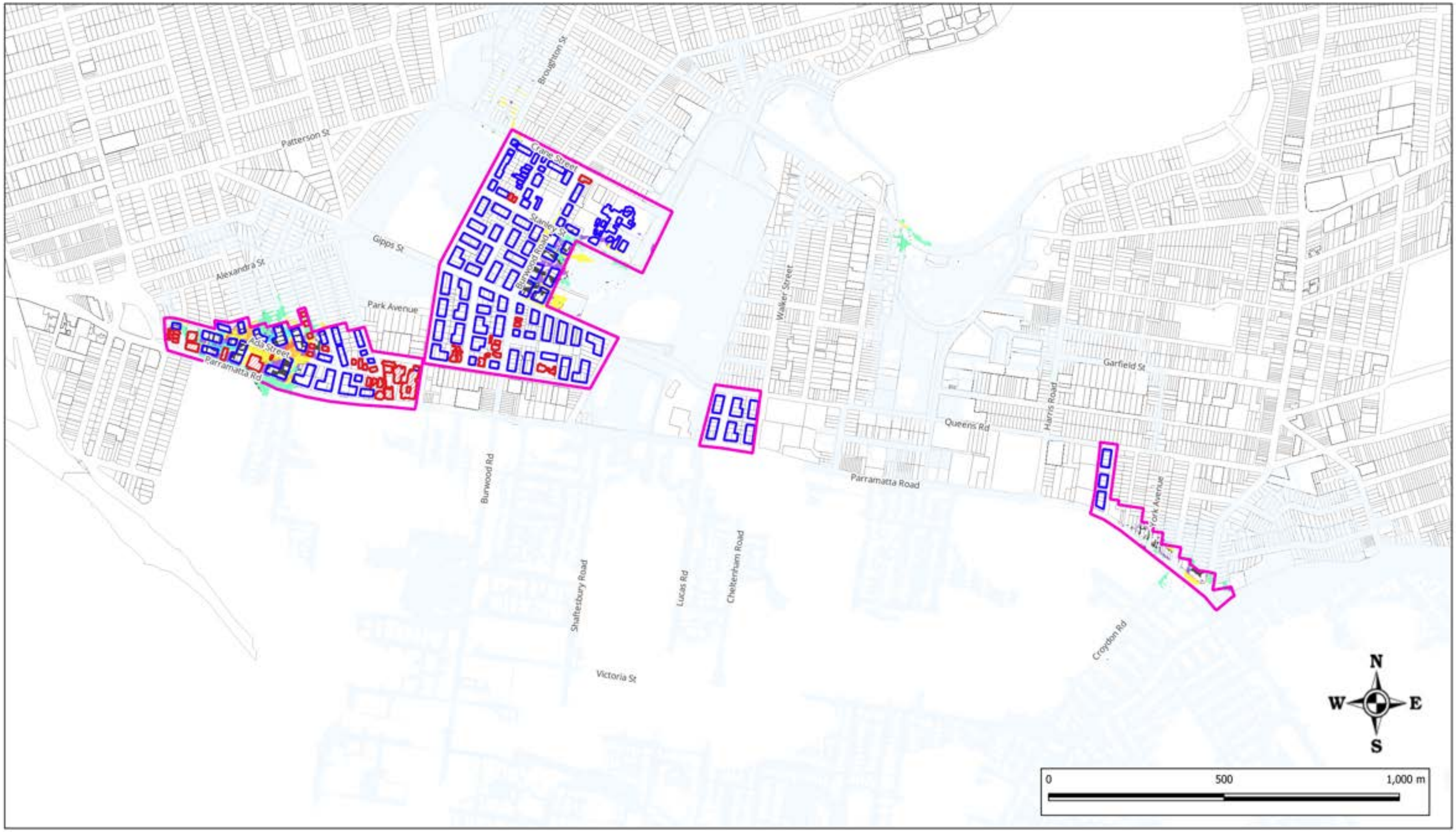
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:2,500**

FIGURE No. **16C**

grc HYDRO



Cadastre
Precinct
Existing Buildings Retained
Proposed Buildings

Impact (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded

TITLE: **Change in Peak Flood Levels Proposed Development vs Existing PMF**

PROJECT: **PRCUTS Flood Assessment**

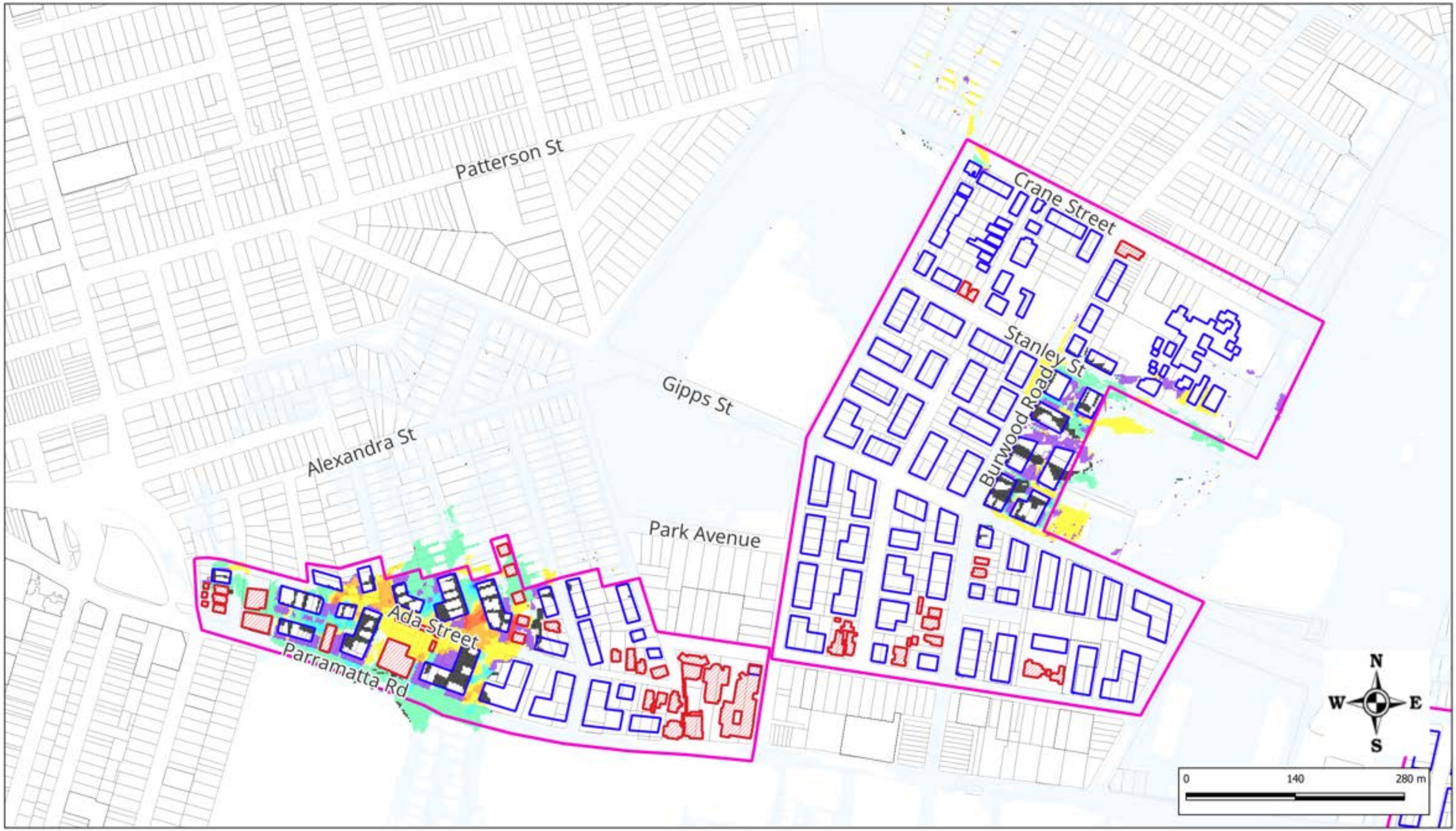
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:10,000**

FIGURE No. **17**

grc HYDRO



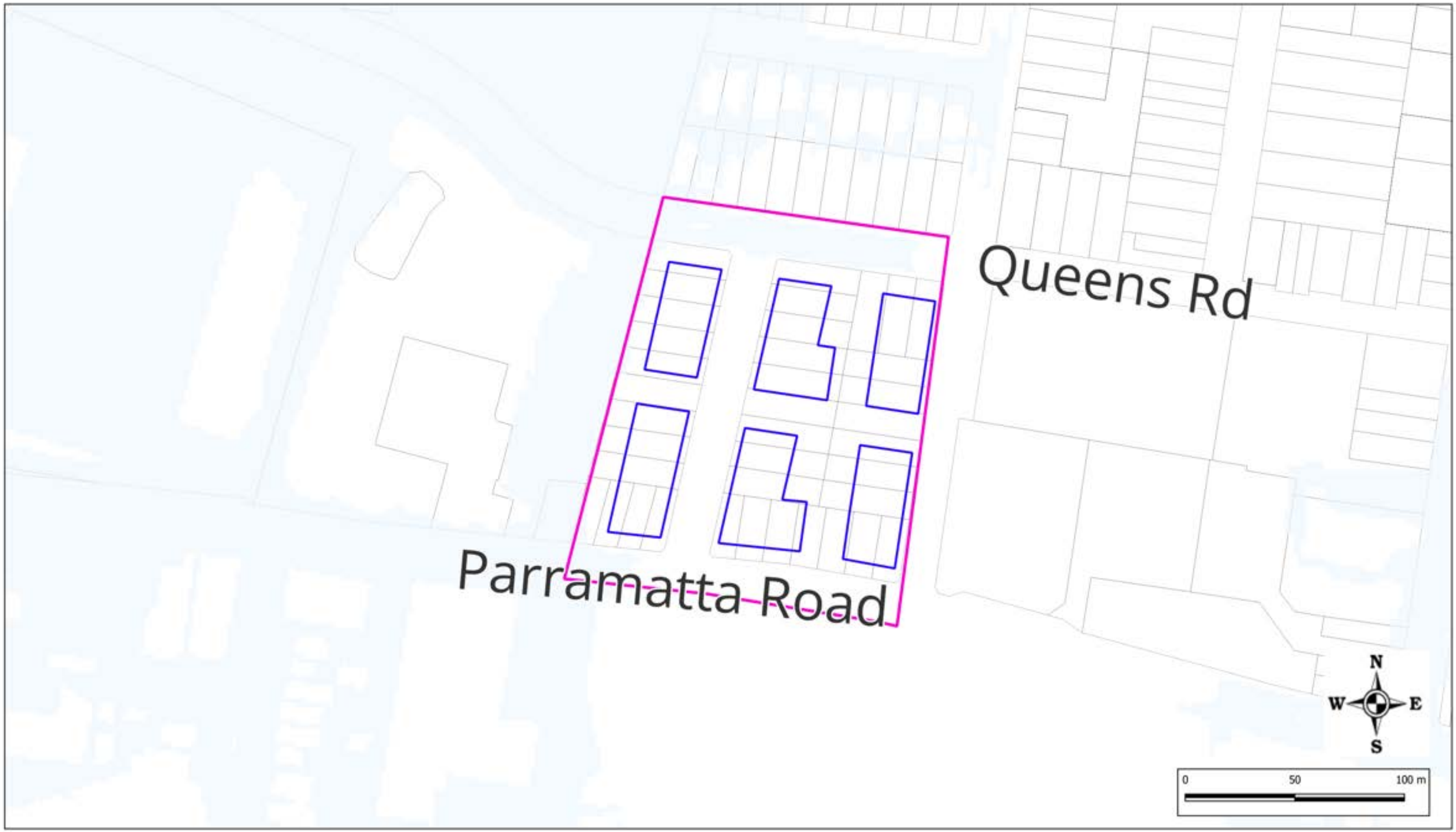
Cadastre
Precinct
Existing Buildings Retained
Proposed Buildings

Impact (m)

- < -0.3
- -0.3 to -0.2
- -0.2 to -0.1
- -0.1 to -0.01
- No Impact
- 0.01 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- > 0.3
- No Longer Flooded
- Newly Flooded

TITLE: **Change in Peak Flood Levels Proposed Development vs Existing PMF - Burwood Precinct**			
PROJECT: **PRCUTS Flood Assessment**		PROJECT No.	**230074**
DATE: **04-2024**	SCALE: **1:4,500**	FIGURE No.	**17A**

grc HYDRO



Cadastre
Precinct
Existing Buildings Retained
Proposed Buildings

Impact (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded

TITLE: **Change in Peak Flood Levels Proposed Development vs Existing PMF - Kings Bay (West) Precinct**

PROJECT: **PRCUTS Flood Assessment**

PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:1,600**

FIGURE No. **17B**

grc HYDRO

Harris Road

Queens Rd

Parramatta Road

York Avenue

N

W E

S

0 80 160 m

Cadastre
Precinct
Existing Buildings Retained
Proposed Buildings

Impact (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
No Longer Flooded
Newly Flooded

TITLE: **Change in Peak Flood Levels Proposed Development vs Existing PMF - Kings Bay (East) Precinct**

PROJECT: **PRCUTS Flood Assessment**

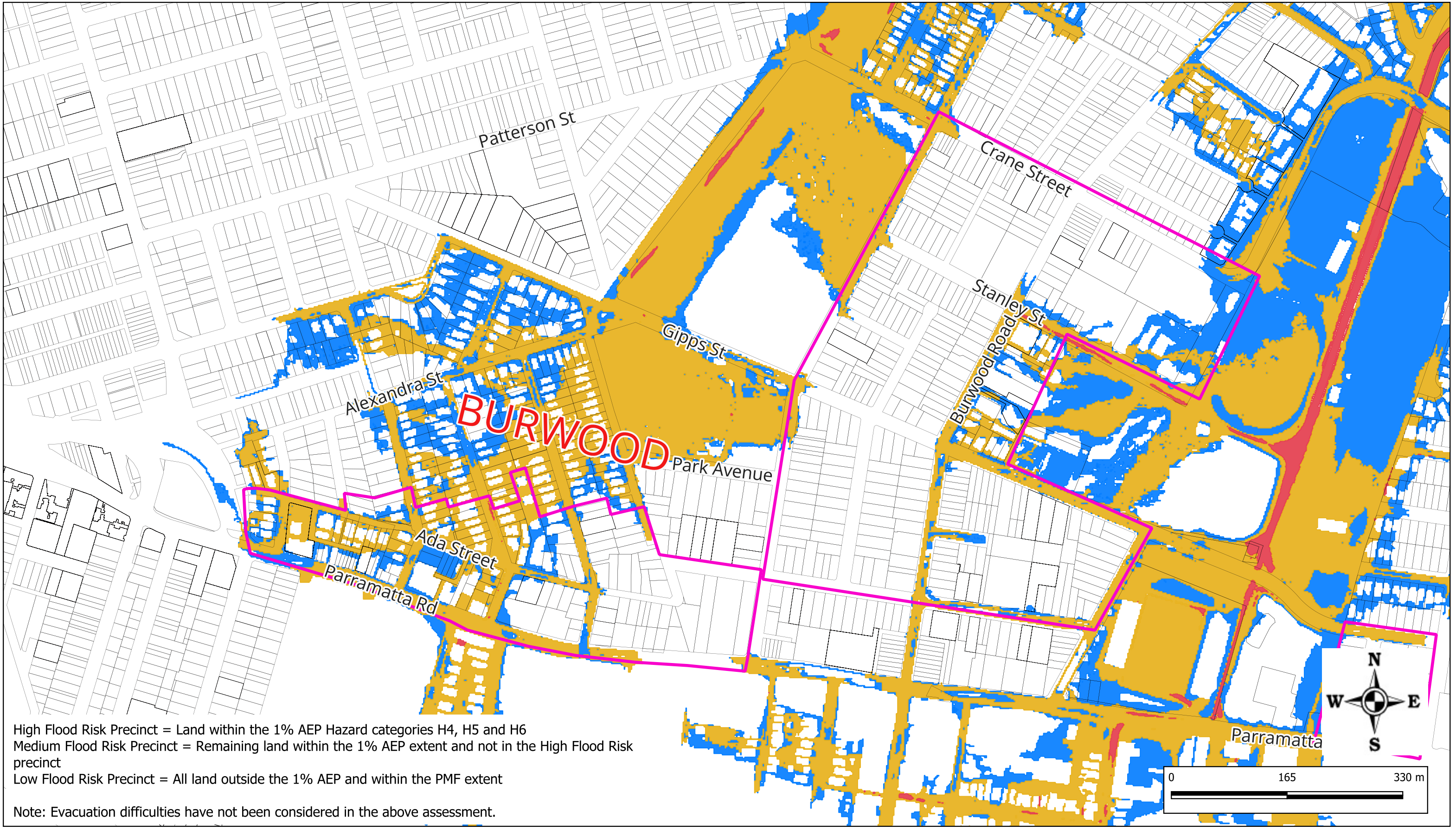
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:2,500**

FIGURE No. **17C**

grc HYDRO



High Flood Risk Precinct = Land within the 1% AEP Hazard categories H4, H5 and H6
Medium Flood Risk Precinct = Remaining land within the 1% AEP extent and not in the High Flood Risk precinct
Low Flood Risk Precinct = All land outside the 1% AEP and within the PMF extent

Note: Evacuation difficulties have not been considered in the above assessment.

Cadastre
Precinct
High Flood Risk Precinct
Medium Flood Risk Precinct
Low Flood Risk Precinct

TITLE: **Flood Risk Precincts - Burwood Precinct**

PROJECT: **PRCUTS Flood Assessment**

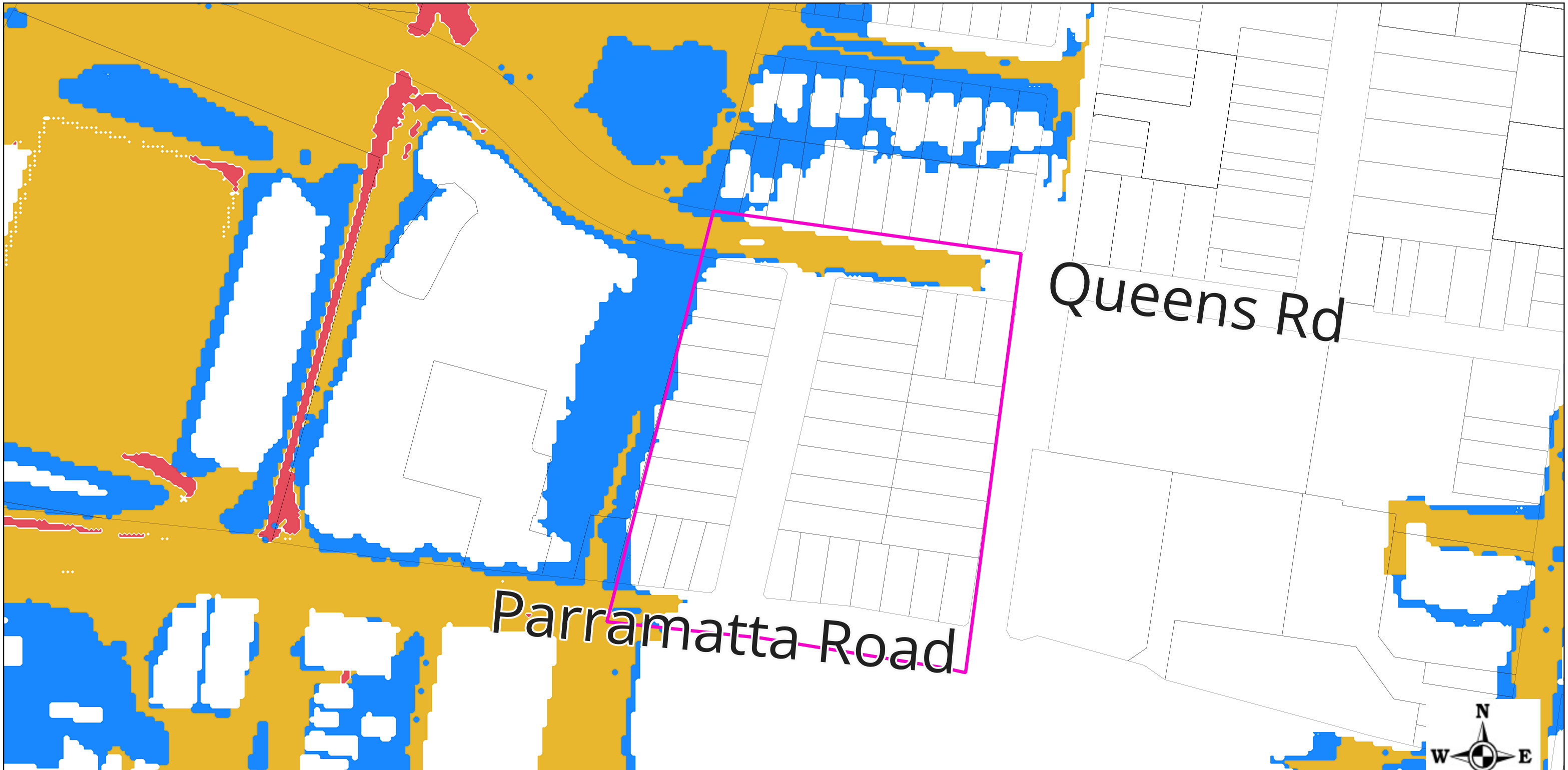
PROJECT No. **230074**

DATE: **04-2024**

SCALE: **1:5,000**

FIGURE No. **18A**

grc HYDRO



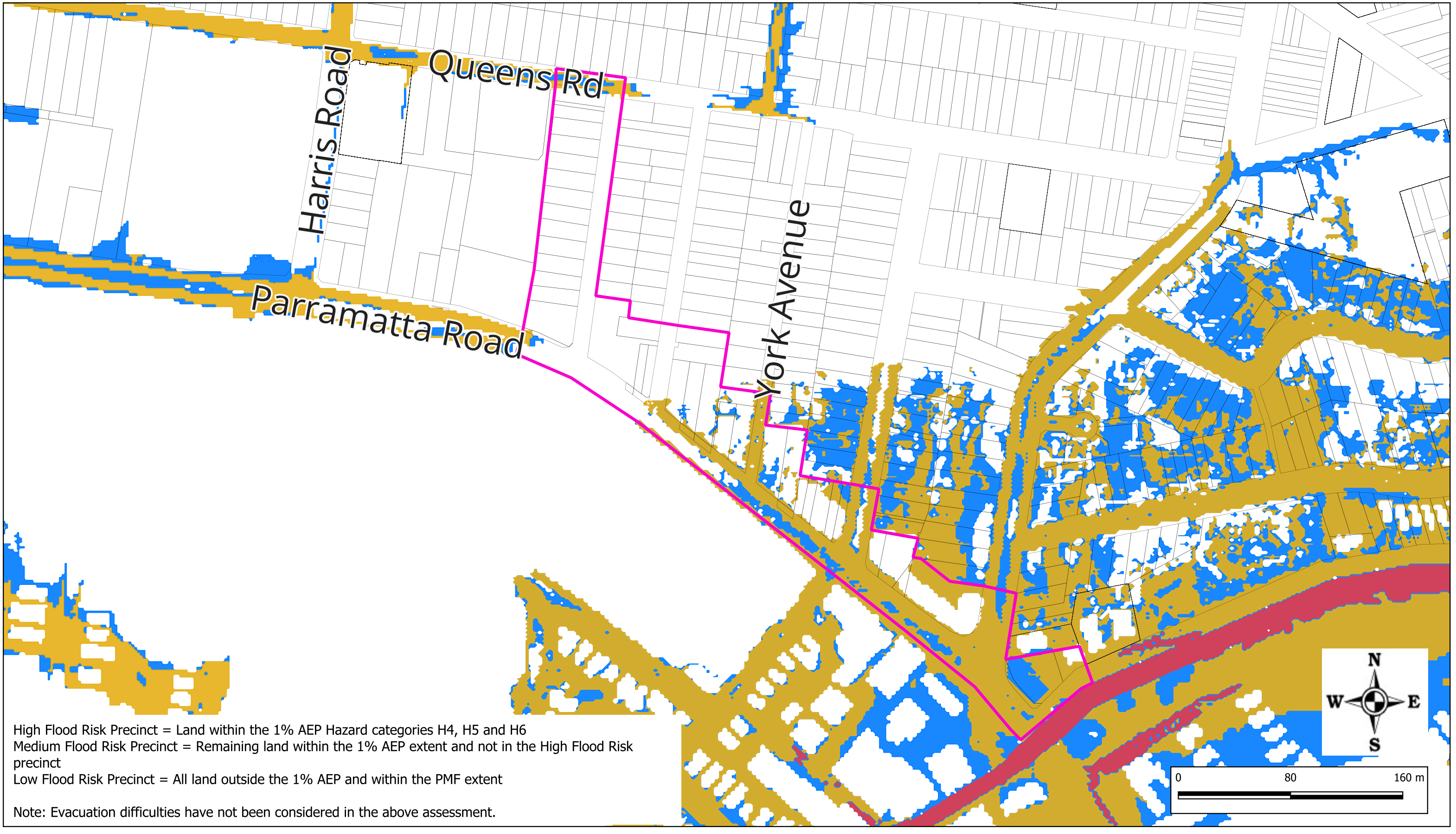
High Flood Risk Precinct = Land within the 1% AEP Hazard categories H4, H5 and H6
Medium Flood Risk Precinct = Remaining land within the 1% AEP extent and not in the High Flood Risk precinct
Low Flood Risk Precinct = All land outside the 1% AEP and within the PMF extent

Note: Evacuation difficulties have not been considered in the above assessment.

- Cadastre
- Precinct
- High Flood Risk Precinct
- Medium Flood Risk Precinct
- Low Flood Risk Precinct

TITLE: **Flood Risk Precincts - Kings Bay (West) Precinct**		
PROJECT: **PRCUTS Flood Assessment**		PROJECT No. **230074**
DATE: **04-2024**	SCALE: **1:1,600**	FIGURE No. **18B**

grc HYDRO



High Flood Risk Precinct = Land within the 1% AEP Hazard categories H4, H5 and H6
Medium Flood Risk Precinct = Remaining land within the 1% AEP extent and not in the High Flood Risk precinct
Low Flood Risk Precinct = All land outside the 1% AEP and within the PMF extent

Note: Evacuation difficulties have not been considered in the above assessment.

Cadastre
Precinct
High Flood Risk Precinct
Medium Flood Risk Precinct
Low Flood Risk Precinct

TITLE: **Flood Risk Precincts - Kings Bay (East) Precinct**		
PROJECT: **PRCUTS Flood Assessment**		PROJECT No. **230074**
DATE: **04-2024**	SCALE: **1:2,500**	FIGURE No. **18C**

grc HYDRO