MOTT MACDONALD

Explorer Street, Eveleigh NSW 2015

Flood Assessment Report

August 2023

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Mott MacDonald
383 Kent Street
Sydney
NSW 2000
PO Box Q1678
QVB Sydney NSW 1230
Australia

T +61 (0)2 9098 6800
mottmac.com

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Flood Assessment Report

August 2023

Issue and Revision Record

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1 Introduction

1.1 Purpose of Report

This document describes the nature of flooding which impacts the subject site and outlines planning requirements related to flooding that currently apply to Explorer Street, Eveleigh, Sydney. The subject site has an existing residential land use and has potential for a future mixed-use development. This study provides flooding advice which will support the preparation of a rezoning package for the Department of Planning and Environment (DPE).

1.2 The Site

The subject site is identified as shown in Figure 1.1 below, located at Explorer Street, Eveleigh, which is currently occupied by terrace houses. It is located approximately 1.4km southwest of Redfern Station and has an overall area of 1.9 ha. The site is bounded by a rail corridor to the north, Station Place to the east, Explorer Street and Rotary Park to the south, and a car park for the Downer Rail Eveleigh Maintenance Centre to the west. There are two cul-de-sacs, Explorer Street and Aurora Place, which are adjacent to the site. The site is located towards the top of the Munni Street stormwater catchment and is relatively flat, however, it is 4m above the closest local road, Henderson Road, to the south.

Legally, the site is described as being part of Lot 21 in Deposited Plan 835061 as well as Lot 122 in Deposited Plan 1030021. This allotment includes the public housing cluster and park. This proposed development site is owned by NSW Land and Housing Corporation (LAHC).

Figure 1.1: Explorer Street – Site Boundary Location

1.3 Proposed Layout

WMK Architecture and Urbis have proposed a single option for the development of the site. The proposed layout seek to transform the terrace houses into multi-storey apartments as well as an activated park, which consists of the following areas:

- Seating/shelter area.
- Quiet passive public space.
- Private open space.
- An upgrade of the public pocket park (located in the northeast side of the site).

The development option is shown in Figure 1.2 below:

Figure 1.2: Explorer Street – Proposed Layout

Source: Urbis, 28 June 2023

2 Design Controls

The following guidelines and standards relate to civil works as they potentially influence flood behaviour and form the basis of engineering decisions regarding stormwater management and the provision for overland flow.

2.1 Australian Rainfall and Runoff – (2019)

Prepared by the Institution of Engineers, Australian Rainfall, and Runoff – *A Guide to Flood Estimation* was written to provide "Australian designers with the best available information on design flood estimation". It contains procedures for estimating stormwater runoff for a range of catchments and rainfall events as well as design methods for urban stormwater drainage systems. The document has been updated from the previously used 2001 version with a more refined methodology for hydrological analysis based on the latest hydrological data gathered.

According to the document, good water management master planning should consider:

- Hydrological and hydraulic processes.
- Land capabilities.
- Present and future land uses.
- Public attitudes and concerns.
- Environmental matters.
- Costs and finances.
- Legal obligations and other aspects.

2.2 Floodplain Risk Management Guideline: Practical Consideration of Climate Change – Department of Environment and Climate Change (2007)

This guideline is designed to be used in addition to the Floodplain Development Manual (2005) and provides recommendations and methodologies for examining flood risk to developments considering the projected impacts of climate change on sea levels and design rainfall events. The report recommends that sensitivity analysis is undertaken to using 10, 20 and 30% increases to rainfall intensities, with an appropriate level adopted based on the outcomes of this analysis.

2.3 City of Sydney Council Documents

2.3.1 Sydney LEP (2012)

As per Clause 5.21 – Flood Planning of the Sydney LEP (2012) The consent authority must be satisfied that all proposed development adequately protects the safety of property and life, and avoids adverse impacts on stormwater drainage, flood behaviour and the environment. This includes:

- To minimise the flood risk to life and property associated with the use of land; and
- The development will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties.

2.3.2 Sydney Development Control Plan (2012)

An integral part of the master planning process for developments, the Sydney Development Control Plan 2012 provides necessary controls and guidance for redevelopment. The relevant

provisions have been considered regarding the flooding and stormwater elements of the site. Water management requirements include:

- Compliance with Council's A4- Drainage Design;
- Compliance with Council's Interim Floodplain Management System; and
- Adoption of the principles of WSUD (including a water cycle management plan).

2.4 NSW Flood Risk Management Manual (June 2023)

The NSW Government's manual supersedes the previous *Floodplain Development Manual – the Management of Flood Liable Land (2005)* and is concerned with the management of the consequences of flooding as they relate to the human occupation of urban and rural developments. The manual outlines the floodplain risk management process and assigns roles and responsibilities for the various stakeholders.

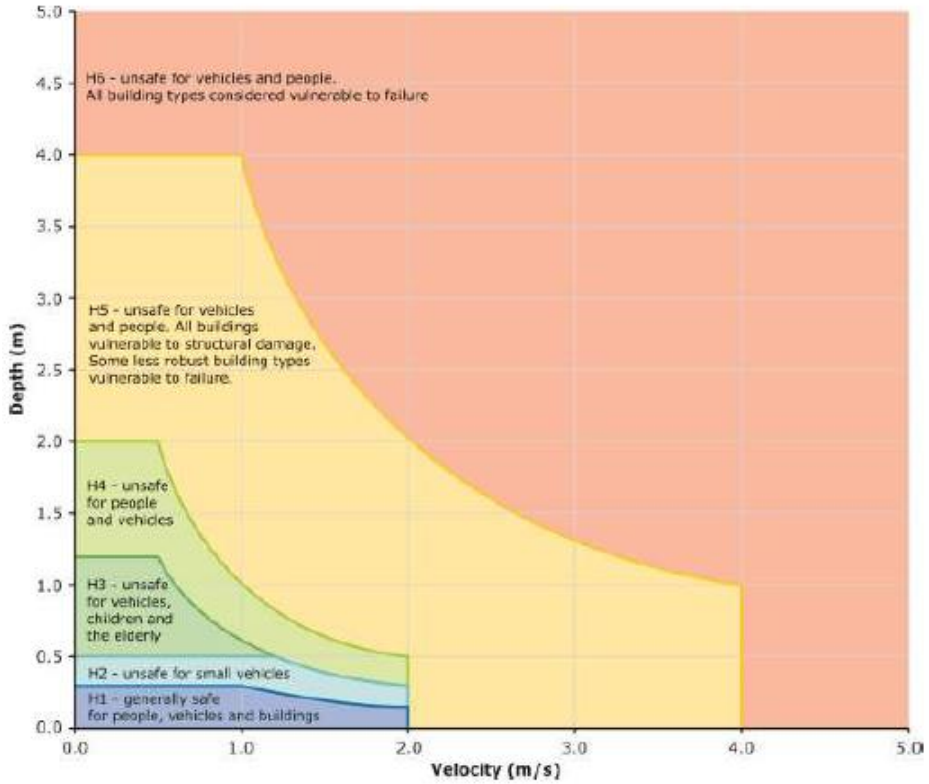
The manual applies to all development and provides additional guidelines for ensuring safe overland flow paths are provided. These guidelines adopt the hazard categorisation which has been developed by Australian Emergency Management Institute in 2014, defining hazard into six categories, shown in Table 1. The classifications relate to the flood vulnerability curves shown in Figure 2.1.

Table 1: Australian Emergency Management Institute – Flood Hazard Classifications (2014)

Hazard Class	Description
H1	Relatively benign flow conditions. No vulnerability constraints.
H2	Unsafe for small vehicles
H3	Unsafe for all vehicles, children and the elderly
H4	Unsafe for people and all vehicles
H5	Unsafe for all people and all vehicles. Buildings require special engineering design and construction
H6	Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure.

Source: Australian Emergency Management Institute (2014)

Figure 2.1: Velocity Depth Relationships – Australian Emergency Management Institute (2014)



Source: Australian Emergency Management Institute (2014)

3 Methodology and Approach

3.1 Data Gap Analysis

Information was gathered to review the existing stormwater infrastructure in the area and the historical approach to the major/minor flow system in the local roads.

Detailed site information including survey and GIS database records were reviewed for incorporation into the ground surface models that form inputs to subsequent technical assessments.

3.2 Modelling Approach

3.2.1 Basis of Flood Model

The Alexandria Canal flood model was used as the basis for this evaluation. The model was developed using TUFLOW in 2020 by WMA Water for City of Sydney and received by Mott MacDonald to use for this flood evaluation.

3.2.2 TUFLOW Software Package

TUFLOW is a one and two-dimensional (1D/2D) hydraulic modelling program that simulates the flow of water across a landscape and through any conveyance structures such as pipes or culverts.

The 2D component of the TUFLOW software package determines overland flow paths by dividing the landscape into a grid of individual cells. The flow of water between cells is then computed repeatedly at regular time steps by solving two-dimensional shallow water equations to estimate the spread and flow of the water. Flows are routed in the direction water that will naturally follow the modelled topography.

The 1D component (called ESTRY) is a separate calculation engine incorporated into TUFLOW to handle flows through structures which cannot be accurately represented with 2d grid cells. ESTRY is a network dynamic flow program suitable for mathematically modelling floods and tides (and/or surges) in a virtually unlimited number of combinations. ESTRY has been developed in conjunction with TUFLOW to resolve complex 1D-2D flows across the floodplain interface.

3.2.3 Modelling Scenarios

TUFLOW models for Explorer Street catchment were based on the following:

- Existing conditions
  - An assessment of the current flooding conditions based on existing survey of the site.
- Design conditions with mitigation measures:
  - An amendment to the existing conditions model was built to incorporate the proposed options as building block-outs

The 1% AEP and the Probable Maximum Flood (PMF) have been assessed as they relate to the flood planning levels for the development. The PMF is the largest flood that could conceivably occur at a location and defines the maximum extent of flood-prone land.

3.3 Planning and Development Advice

The modelling scenarios were reviewed to determine flooding constraints from the existing conditions that provide inputs to the design, comprising overland flow paths, existing stormwater infrastructure and ponded levels that influence design floor levels and access considerations.

The public domain design, grading and stormwater infrastructure was reviewed with the stormwater management design team to identify management of the overland flows and localised ponding to:

- create a better access and amenity for the development and
- improve safety through the public domain areas

Floor level advice was coordinated with the design team regarding the relevant flood planning levels and potential basement entry levels appropriate to the preliminary design options, to ensure that the proposed development satisfied the design controls and relevant guidelines.

4 Flood Evaluation

4.1 Existing Flood Behaviour

The subject site is located towards the upper reaches of the Munni Street catchment. The site itself is relatively flat and is approximately 4m above Henderson Road to the south.

Under existing conditions, the site is prone to flooding with the 1% AEP storm causing inundation across the site. The primary source of this flooding is an overland flow path that originates in the rail corridor to the north. This flow path is constrained by the presence of the existing structures and thus is confined to the backyards of the properties with flood depths up to 1m predicted. There is also an existing detention basin within the Rotary Park. This basin can be seen to be overtopping in the 1% AEP event. The spill occurs at the southern end of the Rotary Park, resulting in a flow path into the intersection of Henderson Road and Monks Lane and flood depths are also observed:

- within the cul-de-sac on Explorer Street of up to 0.3m
- within the cul-de-sac on Aurora Place of up to 0.1m
- along Station Place of depths ranging from 0.1m to 0.3m bounding the eastern edge of the subject site
- up to 0.7m of ponding within the South Sydney Rotary Park Basin

4.2 Flood Planning Requirements

Re-development of the site will require adherence to Council's flood planning controls, including compliance with:

- Sydney Local Environment Plan (LEP) (2012).
- Sydney Development Control Plan (DCP) (2012).
- City of Sydney's Interim Floodplain Management Policy (2014).
- NSW State Government's Flood Prone Land Policy (2005).

Sydney LEP (2012) requires the consent authority to be satisfied that all proposed development adequately protects the safety of property and life, and avoids adverse impacts on stormwater drainage, flood behaviour and the environment. This includes:

- That proposed development will not experience undue flood risk; and
- That existing development will not be adversely flood affected through increased damage or hazard as a result of any new development.

To satisfy Council that the development complies with these requirements a flood study *may* need to be undertaken as part of the Development Application submission in addition to establishing flood planning levels for the development. Council requires the following ancillary development issues to be considered in the assessment of proposed development of flood prone land of residential and industrial/commercial properties (Table 2).

Table 2: Ancillary Flooding Requirements

Development Type/Aspect	Objective	Requirement
Residential properties	• To minimise the damage to residential properties from flooding; and • To minimise risk to human life from the inundation of residential	• The proposed residential building or dwelling must be free from flooding up to and including the 1% AEP flood and must meet the Flood Planning Level Requirements; and

Development Type/Aspect	Objective	Requirement
	properties and to minimise economic cost to the community resulting from flooding.	• The proposed residential building or dwelling should not increase the likelihood of flooding on other developments, properties or infrastructure.
Industrial and Commercial Properties	• To minimise the damage to industrial and commercial properties from flooding; and • To minimise risk to human life from the inundation of industrial and commercial properties and to minimise economic cost to the community resulting from flooding	• The City may consider merits-based approaches presented by the applicant. The proposed industrial or commercial buildings must meet the Flood Planning Level Requirements; and • The proposed industrial or commercial development should not increase the likelihood of flooding on other developments, properties or infrastructure.
Car Parking	• To minimise the damage to motor vehicles from flooding; • To ensure that motor vehicles do not become moving debris during floods, which threaten the integrity or blockage of structures of the safety of people, or damage other property; and • To minimise risk to human life from the inundation of basement and other car park or driveway areas.	• The proposed car park should not increase the risk of vehicle damage by flooding inundation; • The proposed garage or car park should not increase the likelihood of flooding on other developments, properties or infrastructure; • The proposed garage or car park must meet the Flood Planning Level Requirements; and • Open car parking- The minimum surface level of open space car parking subject to inundation should be designed giving regard to vehicle stability in terms of depths and velocity during inundation by flood waters. Where this is not possible, it shall be demonstrated how the objectives will be met.
Filling of Flood Prone Land	• To ensure that any filling of land that is permitted as part of a development consent does not have a negative impact on the floodplain.	• Unless a floodplain risk management plan for the catchment has been adopted, which allows filling to occur, filling for any purpose, including the raising of a building platform in flood-prone areas is not permitted without Council approval. Application for any must be supported by a flood assessment report from a suitably qualified engineer which certifies that the filling will not increase flood affection elsewhere.

Source: Section 5 of Council's *Interim Floodplain Management Policy (2014)*

In addition to the above requirements, the following building floor level requirements are to be met for Industrial/Commercial developments as per Council's *Interim Floodplain Management Policy (2014)*:

Table 3: Flood Planning Levels

Development Type/ Aspect	Objective	Type of Flooding	Flood Planning Level
Residential	Habitable rooms	Mainstream flooding	1% AEP flood level + 0.5m

Development Type/ Aspect	Objective	Type of Flooding	Flood Planning Level
		Local drainage flooding	1% AEP flood level + 0.5m Or Two times the depth of flow with a minimum of 0.3m above the surface if the depth of flow in the 1% AEP flood is less than 0.25m
		Outside flood plain	0.3m above surrounding ground
	Non-habitable rooms such as a laundry or garage (excluding below ground car-parks)	Mainstream or local drainage flooding	1% AEP flood level
Industrial / Commercial	Business	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of the 1% AEP Flood level.
	Residential floors within tourist establishments	Mainstream or local drainage flooding	1% AEP Flood + 0.5m
	Retail Floor Levels	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum 1% AEP flood. The proposal must demonstrate a reasonable balance between flood protection and urban design outcomes for street level activation.
Below-ground garage/car park	Single property owner with not more than 2 spaces.	Mainstream or local drainage flooding	1% AEP flood level + 0.5m

Source: Council's *Interim Floodplain Management Policy (2014)*

5 Hydraulic Modelling

5.1 Flood Model Development

TUFLOW models for Explorer Street catchment were based on the following:

- Existing conditions
  - An assessment of the current flooding conditions based on existing survey of the site.
- Design conditions with mitigation measures:
  - An amendment to the existing conditions model was built to incorporate the proposed options as building block-outs

The 1% AEP and the Probable Maximum Flood (PMF) have been assessed as they relate to the flood planning levels for the development. The PMF is the largest flood that could conceivably occur at a location and defines the maximum extent of flood-prone land.

5.1.1 Digital Terrain Model

Model topography is based on Council provided Airborne Laser Survey (ALS) data, modified where building interference has occurred to ensure the surface is hydraulically correct. Comparisons to ground survey and other LiDAR datasets show that the data used in the TUFLOW model is generally accurate, the model was updated with detailed topographic survey received for the north and east of the site.

5.1.2 Modifications to the existing model

The following updates were made to the received flood model:

- Elevation levels from local topographic survey were used to provide a more accurate surface triangulation than model basis LiDAR to represent the local road profile. Flood levels obtained from the modified TUFLOW model were cross checked with the results provided by the City of Sydney for adjacent areas in the vicinity of the survey supplement and appear to be consistent. This indicates no significant bias is introduced to the model from localised improvements in the definition of overland flow paths.

5.1.3 Critical Storm Duration

The critical duration of the storm for the subject site is between 30 minutes to 60 minutes generally across the majority of the Munni St catchment for the 1% AEP and between 15m and 60 minutes for the PMF event. Maximum envelope results were analysed for the 1% AEP and the PMF.

Results for the 1% AEP storm event have been discussed to provide informed planning decisions and design coordination, and results for the PMF have been discussed to provide insight into flood evacuation.

5.2 Developed Case Flood Model Development

The proposed building footprints were deactivated from the flood model, based on the layout shown in **Figure 1.2** (letter designations for each building have also been provided in the above figures). A deactivated area in TUFLOW means it cannot be used for surface flood flows with flood water having to pass around the deactivated feature. While this is conservative (as no flood water can enter or pass through a building footprint) it gives a maximum estimate for peak

water levels surrounding the properties to guide recommended finished floor levels and evacuation strategies.

5.3 Model Results

5.3.1 Flood Depths

The 1% AEP storm in the design case showed a shift in flow paths and flood depths relative to the existing base case. The removal of impeding structures at the end of Aurora Place allows for the reestablishment of a natural flow path that originates from the northern rail corridor. Flood depth and flood hazard mapping is shown **Appendix A – Flood Maps.** As a result, this option sees flood depth in the following areas:

- Up to 0.5m of ponding impacting Building C to the north
- Up to 0.2m of flood depth along Aurora Place, impacting buildings B and C
- Flood depth along Explorer Street and Station Place that is confined within the roadway
- Up to 0.75m of ponding within the South Sydney Rotary Park Basin

5.3.2 Flood Level Difference (Afflux)

As outlined in Section 5.3.1, the orientation of the proposed structures allows for the reestablishment of a natural flow path through the site. This results in a reduction in flood level along the northern boundary of the site of up to 0.2m as well as a removal of much of the surface water within the eastern portion on the site, classed as “was wet, now dry” in the mapping scheme. This overland flow is instead directed through the open space between Buildings B and C and down Aurora Place. As a result, Aurora Place sees an increase in flood level of up to 0.05m. There is no subsequent flood level difference elsewhere near the subject site. Flood Level maps are shown below in **Appendix A – Flood Maps.**

5.3.3 Flood Hazard

Flood hazard as defined by the Australian Institute of Disaster Resilience can be described by the H1-H6 scale as indicated in Table 1. For the proposed design layout, flood hazard within the site is largely limited to category H1 (Relatively benign flow conditions, no vulnerability constraints), with a small area of H2 (Unsafe for small vehicles) within the pond along the northern boundary. Flooding within the surrounding roadways is all classed as H1. Flood hazard mapping is shown **Appendix A – Flood Maps.**

5.4 Climate Change

To satisfy Sydney LEP’s criteria of consideration of projected effects of climate change, a base multiplied rainfall event is recommended to be run in future revisions of this report. The event modelled will project rainfall patterns for 2050 and 2100. Results are for analysis only and the uncertainty of future flood levels due to climate change, amongst other influences, are accounted for in the building freeboard levels.

6 Design Recommendations

6.1 Flood Planning Levels

As shown in Table 3, the flood planning level for Residential Buildings is to be greater than or equal to the 1% AEP flood level + 500mm freeboard. Whilst the below ground carpark entrances are to be at the greater of the 1% AEP + 500mm or the PMF, whichever is greater.

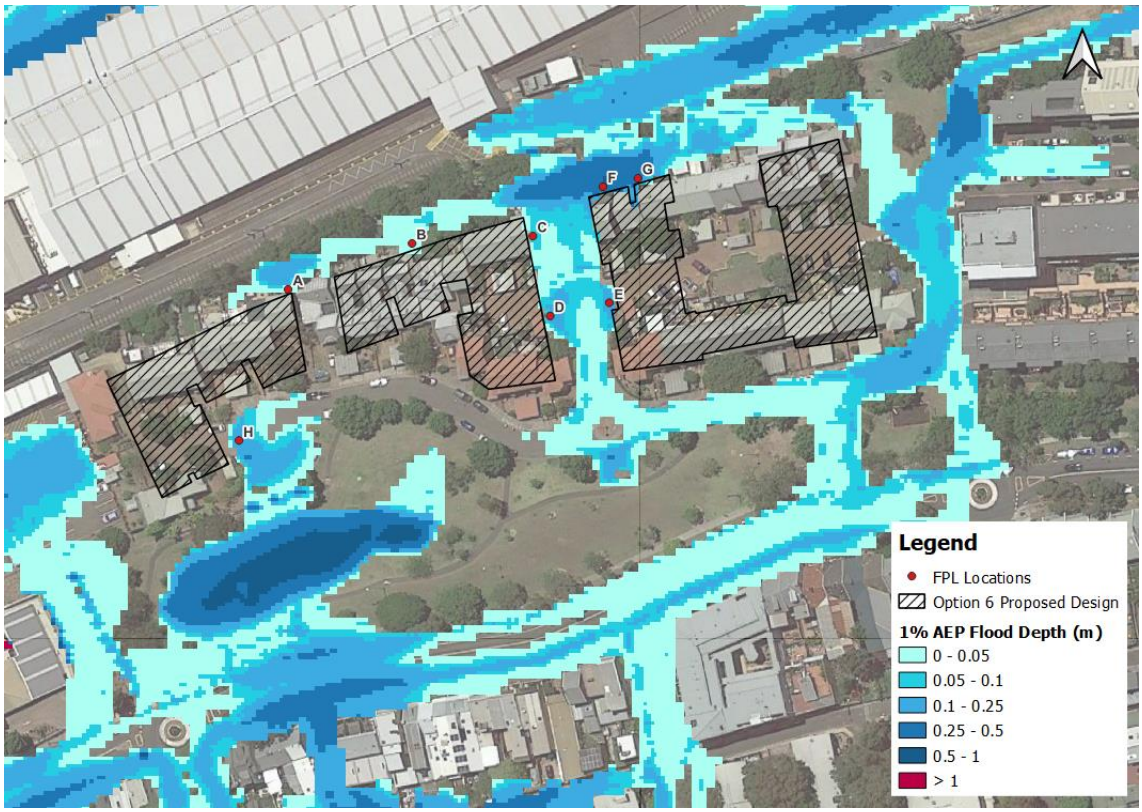
To ensure the 1% AEP plus 500mm freeboard or PMF requirement is met, the following has been proposed for the driveway entrance.

Site specific flood planning levels are listed in Error! Reference source not found.. ID locations shown below in **Figure 6.1.**

Table 4: Site Specific Flood Planning Levels

Location ID	1% AEP Flood Level (m AHD)	PMF Flood Level (m AHD)	Flood Planning Level (FPL) (m AHD)	Governing FPL
A	17.35	17.59	17.85	1% AEP + 0.5m Freeboard.
B	17.99	18.01	18.49	1% AEP + 0.5m Freeboard.
C	18.28	18.34	18.78	1% AEP + 0.5m Freeboard.
D	17.26	17.40	17.76	1% AEP + 0.5m Freeboard.
E	17.24	17.40	17.74	1% AEP + 0.5m Freeboard.
F	18.32	18.41	18.82	1% AEP + 0.5m Freeboard.
G	18.32	18.41	18.82	1% AEP + 0.5m Freeboard.
H	16.64	16.74	17.14	1% AEP + 0.5m Freeboard.

Figure 6.1: Flood Planning Level Locations



6.2 Flood Evacuation Strategy

Assessment of the potential flooding emergency response for all areas of the development has been carried out for the 1% AEP event and PMF to determine appropriate responses in the event of major and extreme flood events. The options available in developing a flood emergency response plan include both evacuation and shelter in place (SIP). These options are assessed for worst case flooding conditions at the site, typically a result of runoff from storms with durations in the range of 15 minutes to 60 minutes.

In assessing the evacuation potential for the site, flood depths and hazard have been examined in the local streets and within routes leading away from the site. Key aspects of the analysis of potential evacuation routes are summarised below:

- Access to the local road network from the site is provided by Progress Road and Station Place. These roads are inundated in worst case flooding conditions to low hazard levels.
- The apparent main access routes from the area include Henderson Road in the eastern and western directions, or south through local roads of Alexandria. There are no vehicular access routes north-east towards Redfern (without returning to Henderson Road).
- Access to surrounding arterial roads involves crossing urban flooding with depths in excess of 1m in PMF events.
- The onset of worst case flooding is rapid, typically less than 60 minutes from the onset of the storm burst resulting in no route planning/preparation time.

Considering the points summarised above, a safe flood evacuation strategy is proposed below:

- Each building will nominate a designated evacuation warden, as per the Sydney CBD Safety Sub Plan, to liaise with relevant authorities and coordinate assembly points in the event of emergency evacuation.
- It is proposed that the onsite safe evacuation point be on Explorer Street as it is free from flood waters in the 1% AEP Event.
- The designated safe evacuation route from the subject site will down Explorer Street, and the westwards along Henderson Road as flood hazard remains relatively low along this route.
- The intent of this route is to evacuate residents to Victoria Park, Camperdown, as this is the closest and most accessible Sydney CBD Evacuation Zone Assembly Area, see **Appendix B.**

Given the lack of warning of the onset of flooding in major flooding events it's likely that building occupants will be reluctant to leave the building in the event of major floods and travel through inundated roads (albeit roads with low flood hazard) to any assembly point off site. The design of the building results in flood free and structurally sound conditions within both structures on site and therefore won't create a situation where a burden is placed on the SES to provide any emergency evacuation. SES discourages the adoption of SIP as a preferred emergency response to flooding.

Options to reduce or eliminate the flood hazard in the vicinity of the project have been considered, with the implications of these local improvements being worsening of flood risk elsewhere, particularly downstream at existing dwellings. It's not recommended to provide flood hazard mitigation in the immediate site vicinity that causes increases in flood hazard to existing populations downstream.

7 Future Design Stages

In future detailed design stages, it is recommended that the following items be addressed as the design stage progresses:

- The position of stormwater pipes, swales and detention tanks is under coordination and is subject to future changes to floor levels, public domain and driveway/road grading, and coordination with utilities. An iteration to this flood assessment will be required once the location and configuration of the stormwater network and any potential design detention storage is finalised.
- Updated flood modelling to reflect design grading and proposed floor and ground levels is to be undertaken. This assessment is to confirm freeboard adequacy and access to evacuation routes through any changes to the design grading.

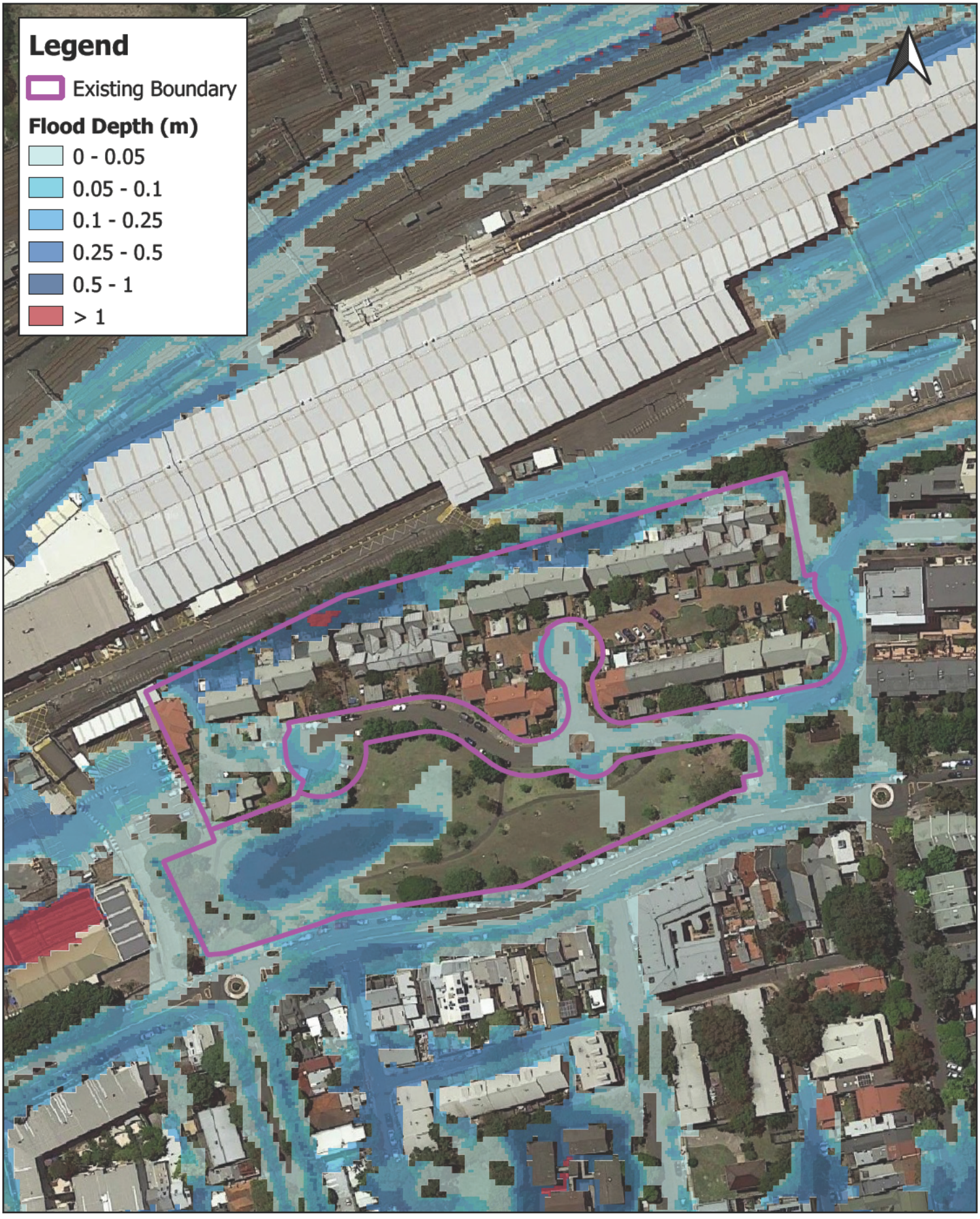
8 Conclusion

This report outlines the requirements to ensure that the construction of the new mixed-use development at Explorer Street, Eveleigh will be safe from flood inundation within the site and not cause excess flooding to its surrounds. The site is currently located in an area of overland flow, with flood depths governed by site topography as it accepts and redirects an incoming flow path from the northern rail corridor. Flood waters drain away from the site to the south towards South Sydney Rotary Park.

An assessment of the flood levels occurring in a developed scenario using the Council approved flood model shows that the site is at medium risk to flooding in both the 1% AEP and PMF. Finished floor levels of both proposed buildings are required to be compliant with the provided FPLs as required by *Flood Risk Management Manual (June 2023)* and Council's *Interim Floodplain Management Policy (2014).*

State Emergency Service (SES) advice is that SIP is not a preferred emergency response to flooding. As such the flood evacuation strategy is detailed in this report, for assembly and potential evacuation to the Sydney CBD Evacuation Zone Assembly Area at Victoria Park, Camperdown. If occupants did remain in place during major and extreme flood events, the development provides the appropriate safety and amenity required such that the SES would not be required to make emergency evacuations.

A. Appendix A – Flood Maps



TITLE

Existing 1% AEP Flood Depth

PROJECT

Explorer St Precinct

MOTT MACDONALD

0 0.05 0.1 km

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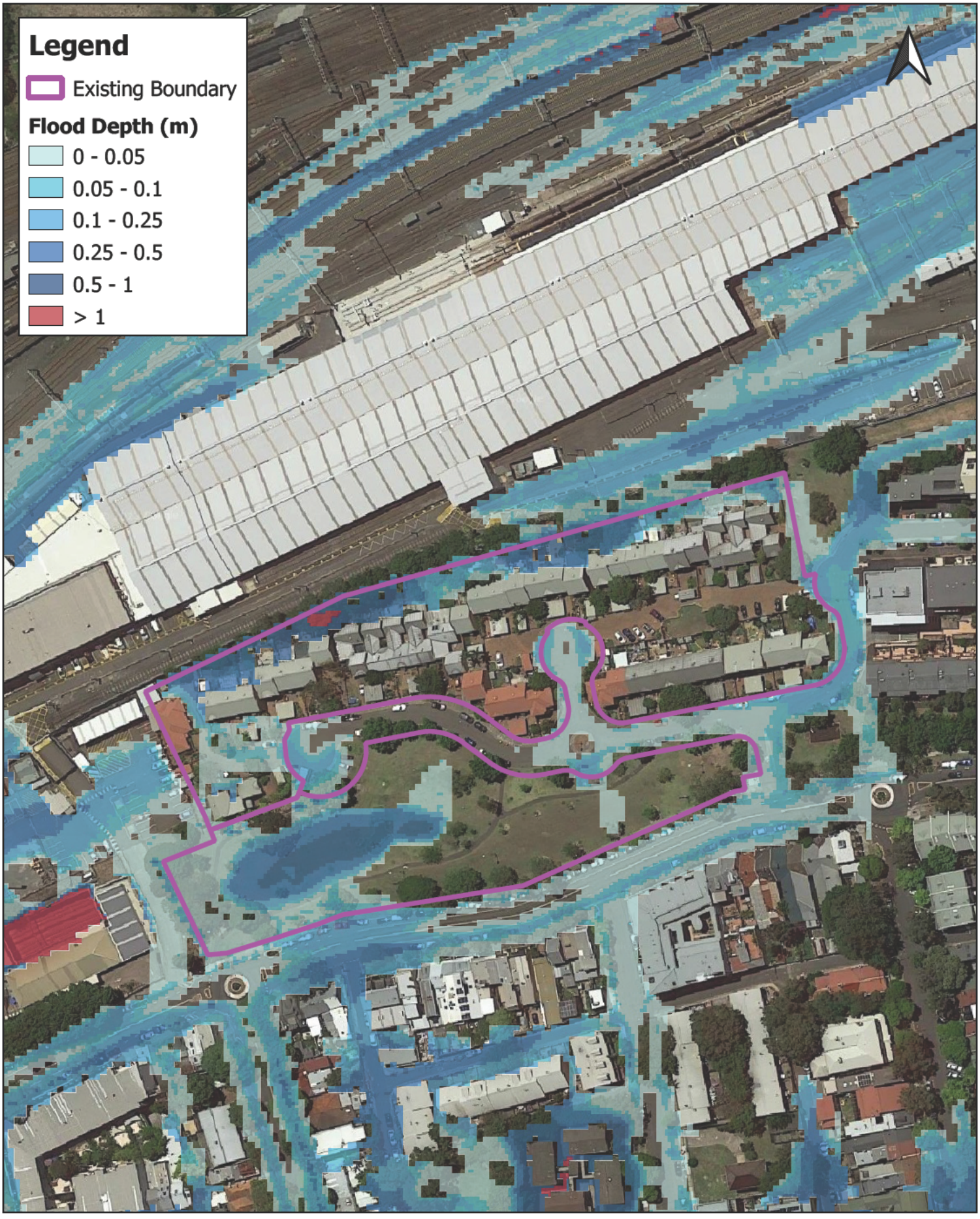

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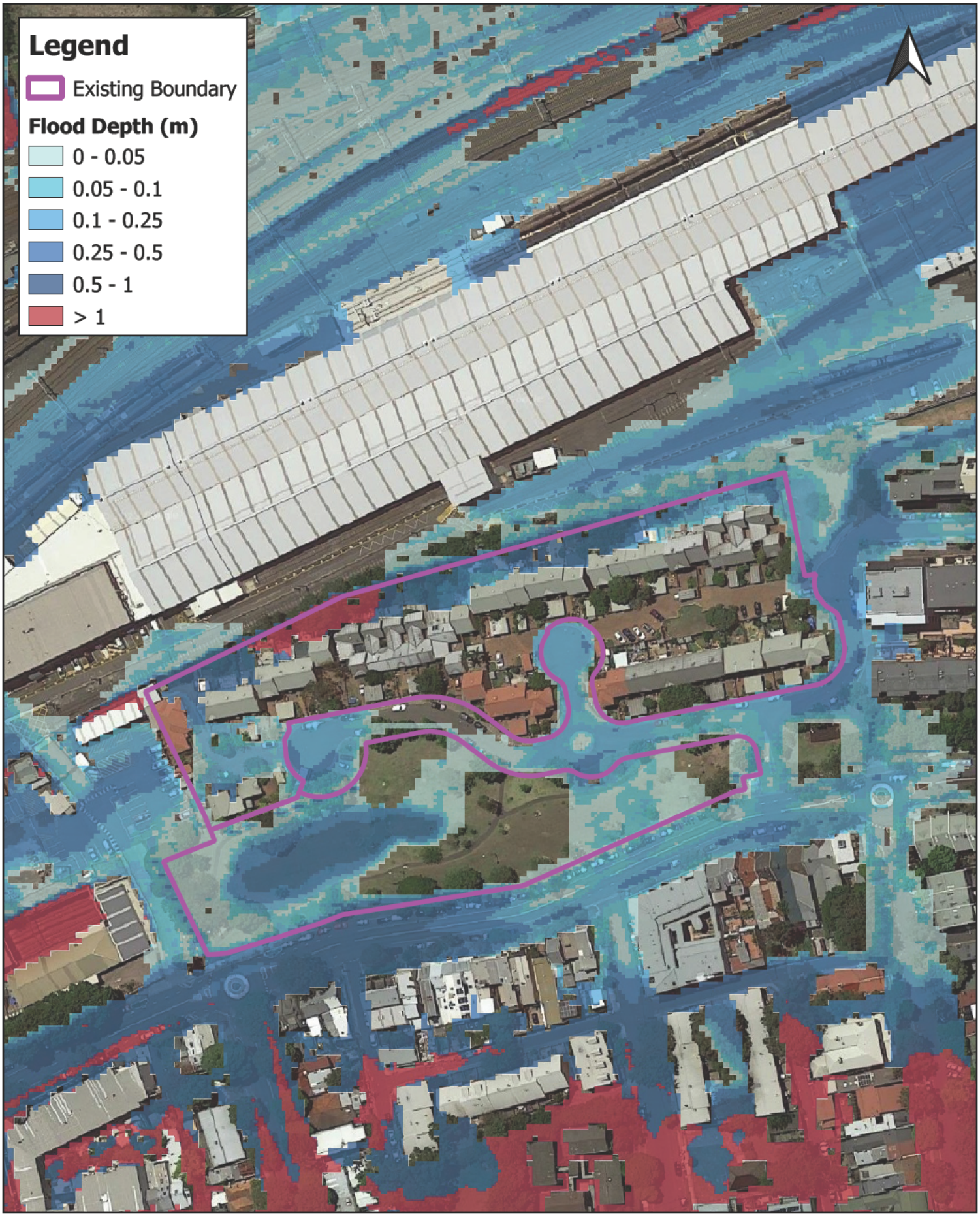

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Existing PMF Flood Depth

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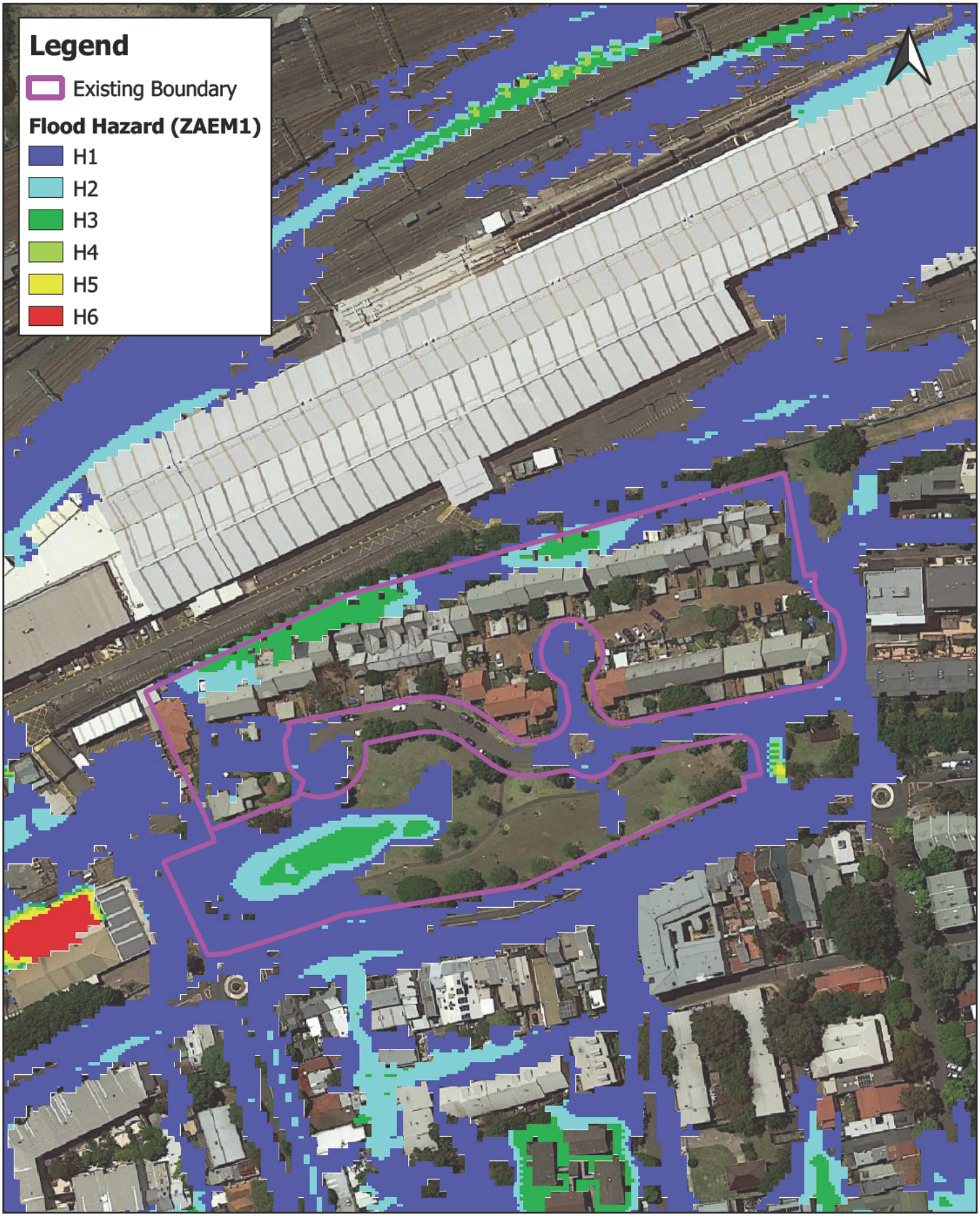

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Existing 1% AEP Flood Hazard

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Explorer St Precinct

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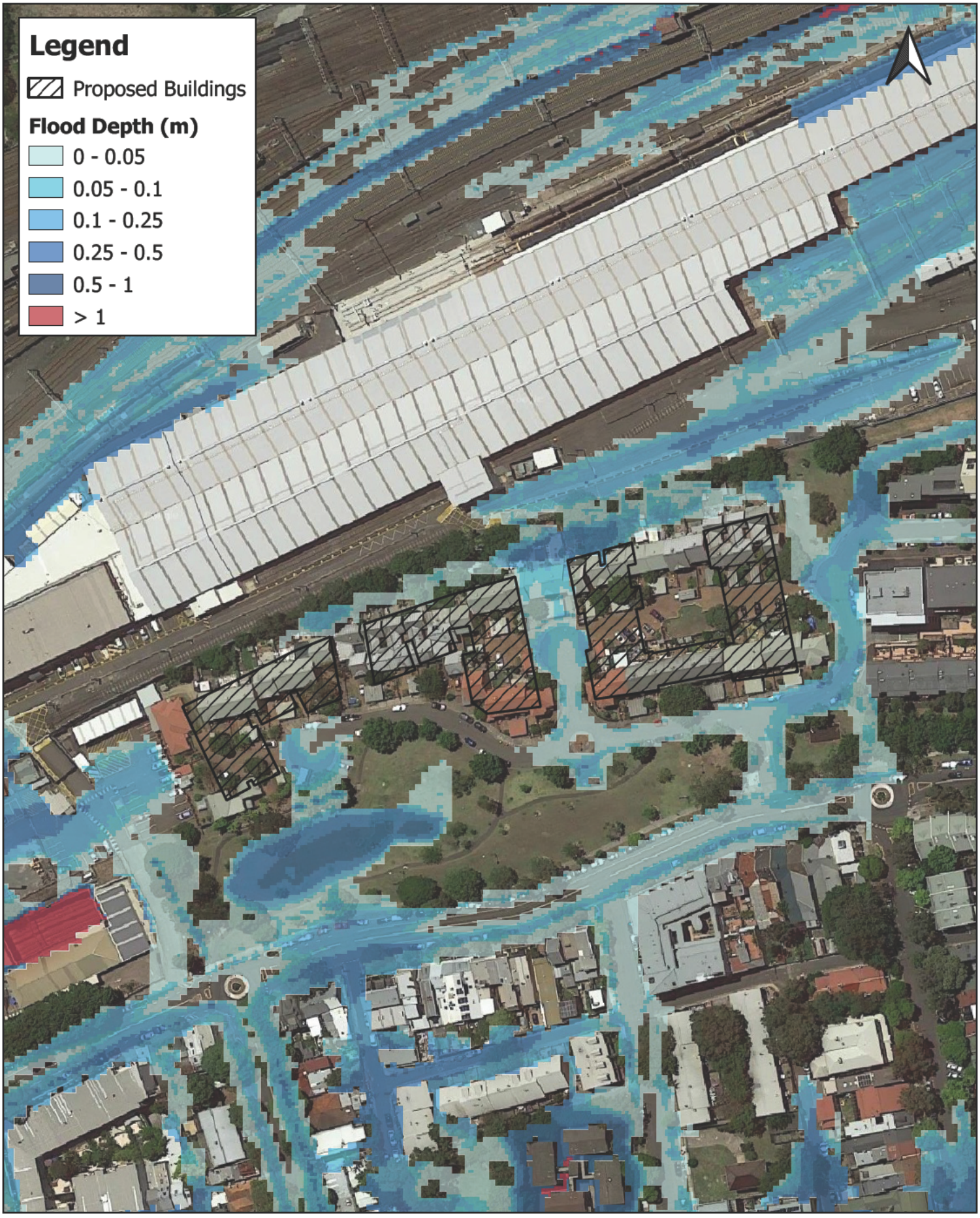

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Design 1% AEP Flood Depth

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Explorer St Precinct

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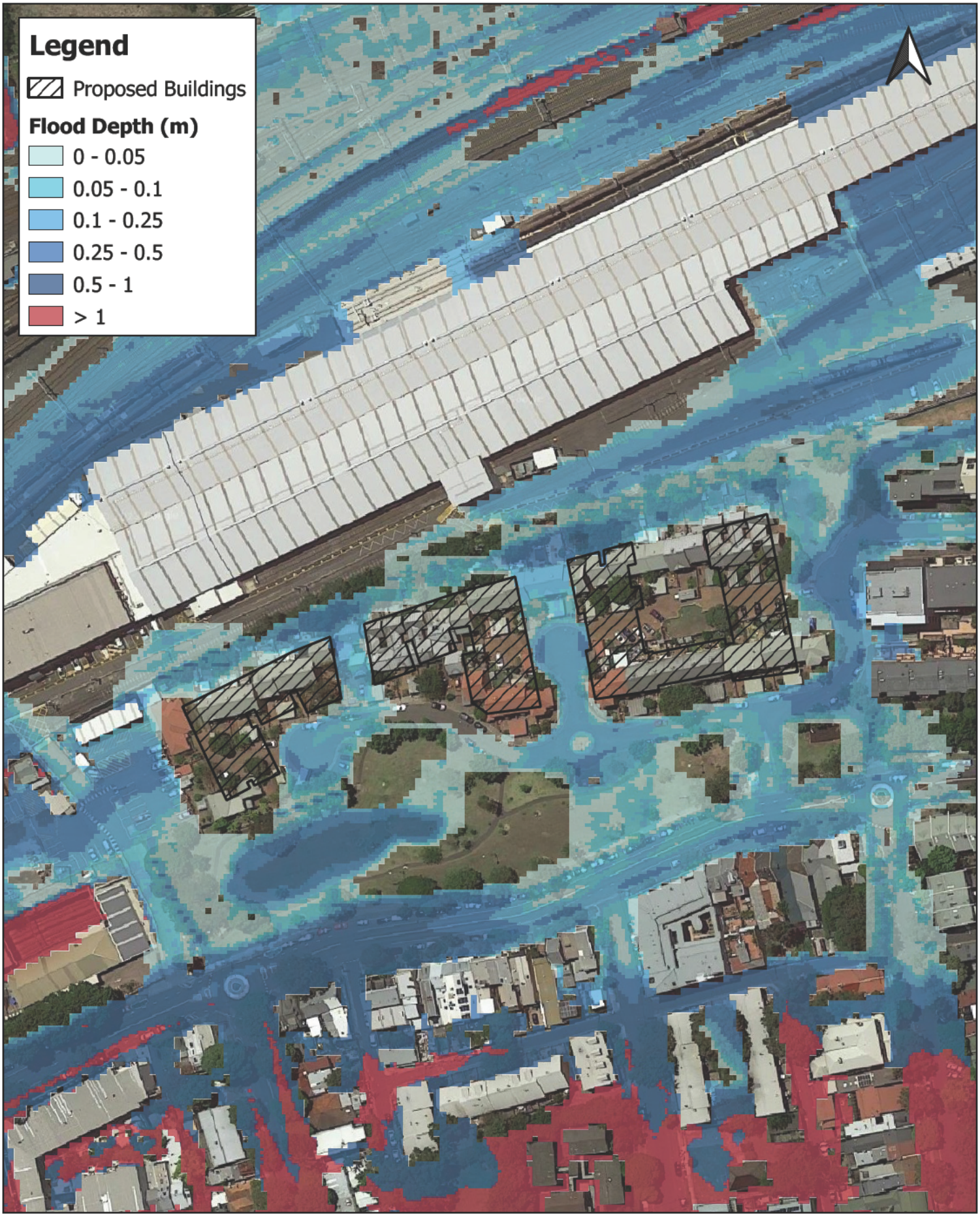

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Design PMF Flood Depth

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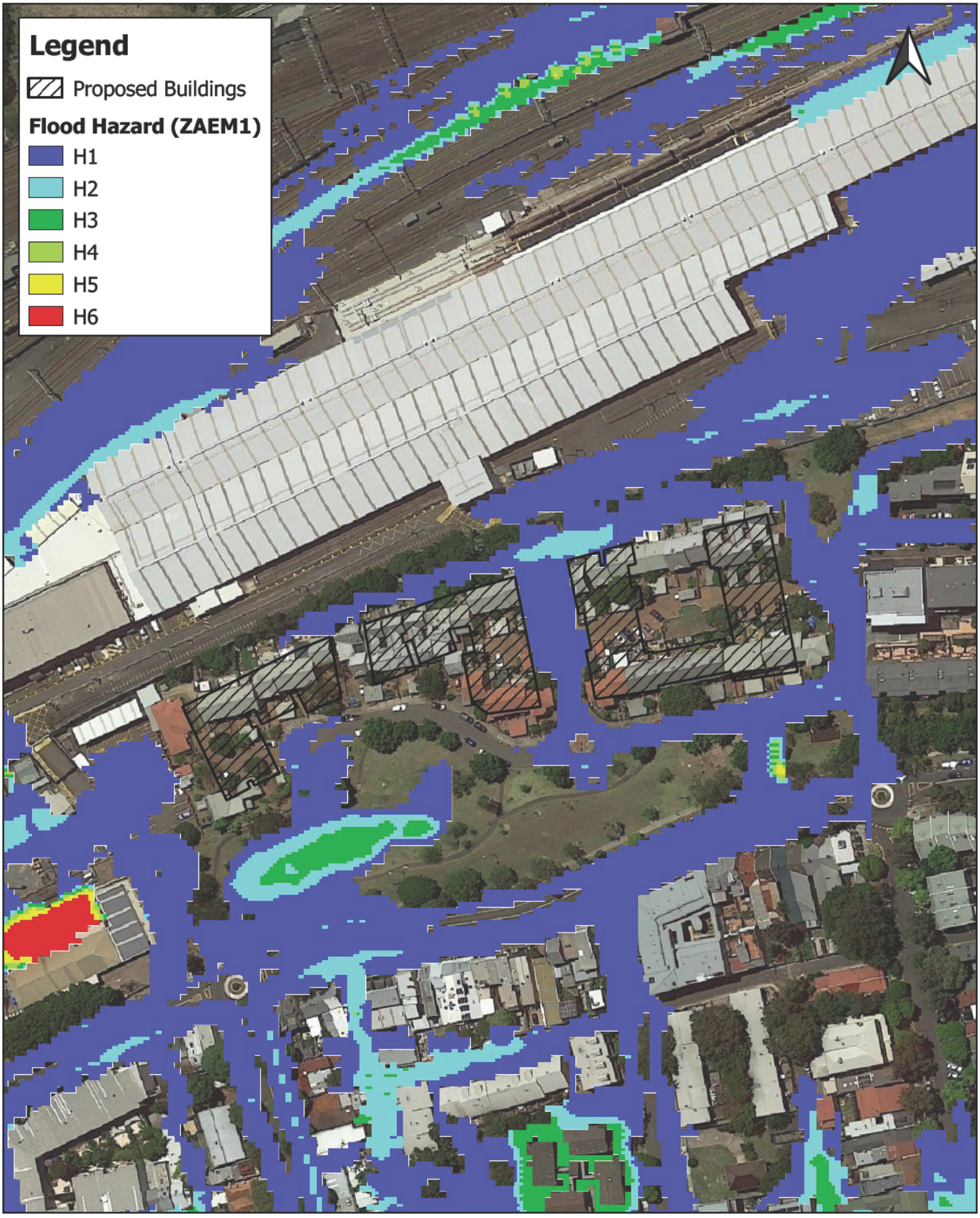


TITLE

Design 1% AEP Flood Hazard

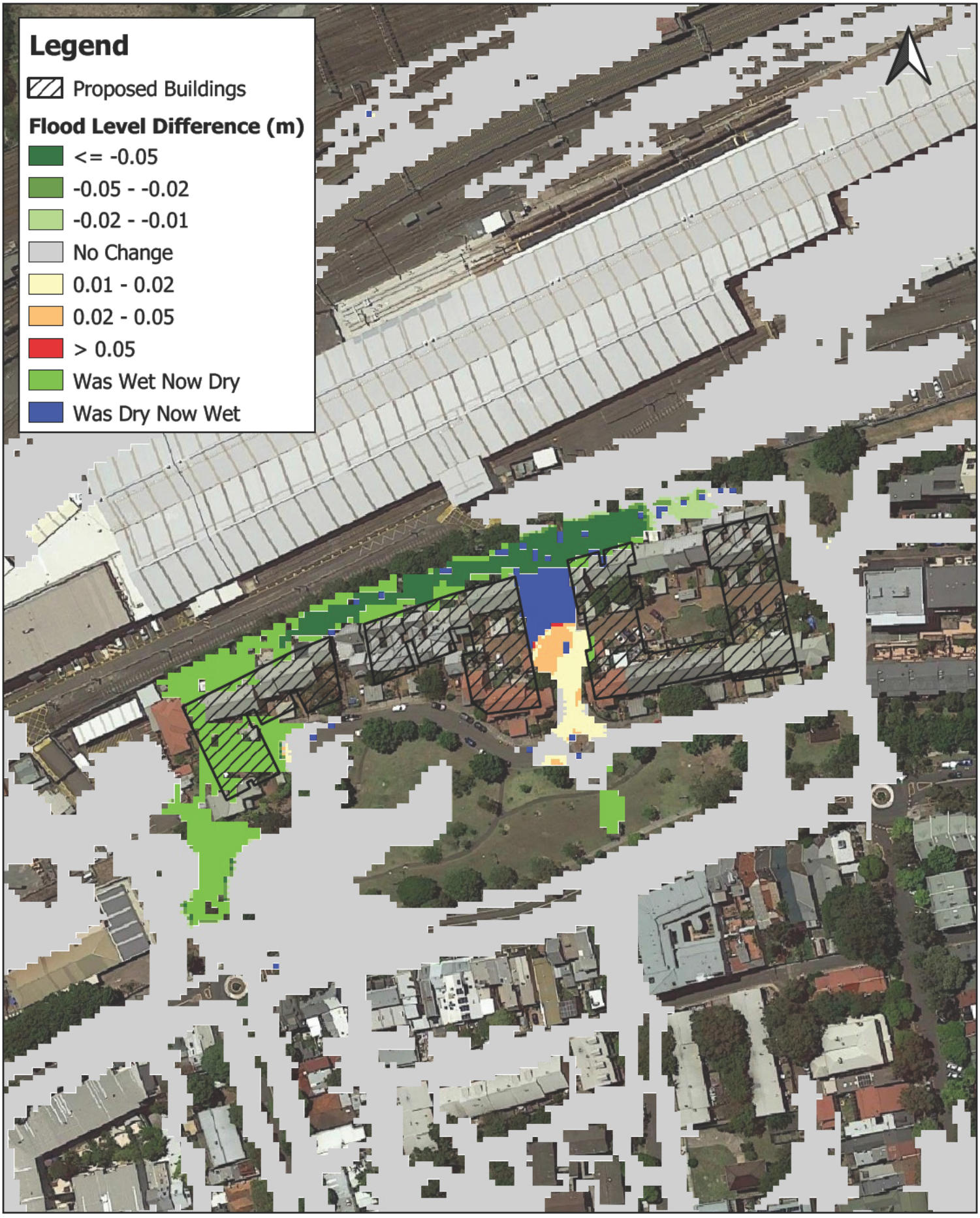
PROJECT

Explorer St Precinct

MOTT MACDONALD

0 0.05 0.1 km

Date	Drawn	Check	Approved	Scale	Rev
31/05/2023	TG	JM	JL	1 : 1600	1



TITLE

Design 1% AEP Flood Level Difference

PROJECT

Explorer St Precinct

MOTT MACDONALD

0 0.05 0.1 km

Date	Drawn	Check	Approved	Scale	Rev
31/05/2023	TG	JM	JL	1 : 1600	1

B. Sydney CBD Safety Sub Plan Assembly Areas