INNER WEST

Council's Alternate Approach for New Housing in the Inner West

APPENDIX 6

Flood Impact and Risk Assessment for Housing Investigation Area Stage 1

May 2025

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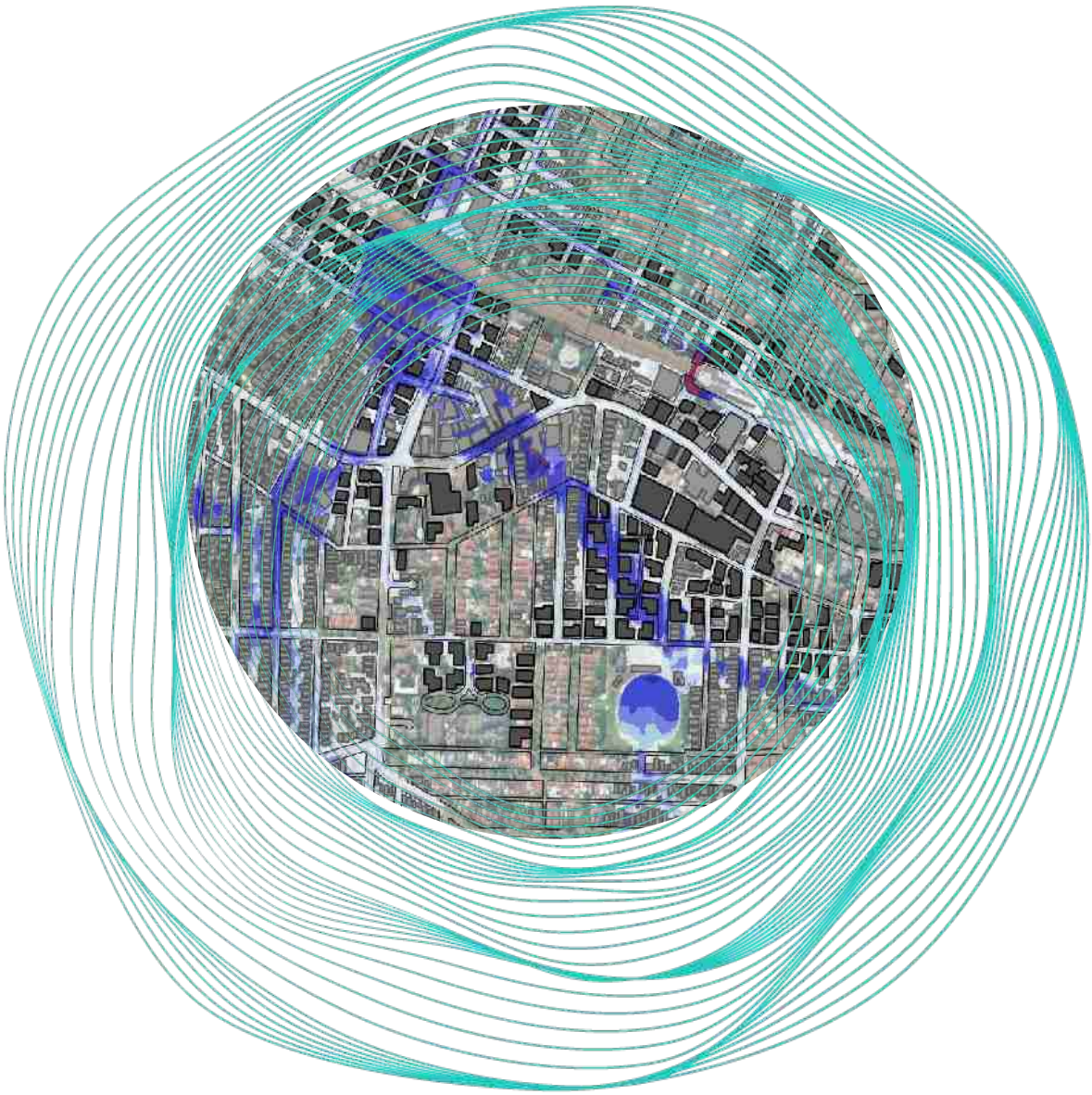
INNER WEST COUNCIL

Inner West Housing Investigation Area Master Plans

Flood Impact and Risk Assessment



May 2025

rp311015-00653lt250512 Inner West Housing FIRA.docx

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Project No. 311015-00653: Inner West Housing Flood Impact and Risk Assessment

Rev	Description	Author	Reviewer	Approver	Revision Date
A	Draft for Internal Review	**LT** L To	**WH** W Honour		7/04/2025
0	Draft Issued for Client Review	**LT** L To	**WH** W Honour		8/04/2025
1	Final Draft Report	**LT** L To	**WJH** W Honour		23/04/2025
2	Final Report	**LT** L To	**WJH / CRT** W Honour / C Thomas	Chris Thomas	12/05/2025

Level 19 420 George Street
Sydney NSW 2000
Australia

Worley Services Pty Ltd

ABN 61 001 279 812

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Executive Summary

Background

The inner west suburbs of Ashfield, Croydon, Dulwich Hill and Marrickville have been identified by the NSW Government as Transport Oriented Development (TOD) locations. The preparation of master plans for these areas is required to demonstrate delivery of TOD objectives and to contribute to meeting a housing target of 7,800 constructed dwellings across the Inner West local government area (LGA) by June 2029. The TOD program has delivered new controls to facilitate additional housing within a 400-metre radius of the train stations at Ashfield, Croydon, Dulwich Hill and Marrickville. Council has also undertaken an alternate place-based planning approach that incorporates a broader area than that covered by the TOD program.

Stage 1 of the master planning program for the Inner West Housing Investigation aims to promote well-located and well-designed housing uplift in each of the suburbs listed above. The master planning program is to consider two study areas, namely the Ashfield / Croydon study area and the Dulwich Hill / Marrickville study area.

The studies completed by Council indicate that several locations within the Ashfield / Croydon and Dulwich Hill / Marrickville study areas could be affected by flooding. Therefore, any proposed densification of built form or redevelopment would need to allow for appropriate management of flooding. In recognition of this, Council engaged Worley Consulting to undertake a Flood Impact and Risk Assessment (**FIRA**) for a number of potential uplift scenarios which are representative of the proposed planning controls for the two study areas.

Flood Modelling of Uplift Scenarios

The FIRA investigated the potential for 32 uplift scenarios to affect existing flooding patterns and flood risk in the study areas (refer **Figure 8-1** to **Figure 8-3**). It was found that seven (7) of the uplift locations (Sites O, T, X, Z, CC, DD and FF) may lead to some adverse flood impacts in neighbouring properties or in a railway corridor, however, these impacts are minor and localised. It is envisaged that the development design can be refined at the development application stage to minimise / avoid these adverse impacts. The remaining 25 uplift locations are not predicted to have any material adverse impacts on existing flood behaviour and flood risk.

Consultation with the relevant rail authorities is also recommended as part of future design stages for developments which are predicted to lead to some minor adverse impacts in the railway corridor (Sites X, Z, DD and FF). Some of the development areas are predicted to lead to notable increases in flood levels within the development site (e.g., Sites C, H and W). These increases need to be managed through on-site mitigation measures.

Accordingly, the nominated proposed planning controls for the 32 uplift locations, as represented by the indicative building footprints, can proceed subject to compliance with the development controls and flood planning recommendations outlined below.

These potential uplift scenarios are not expected to lead to any material adverse off-site flood impacts, or otherwise are predicted to lead to some minor flood impacts which could be managed through design refinements and/or the implementation of on-site mitigation measures.

For other flood-affected locations in the study areas, iterative testing has concluded that additional uplift is not appropriate at this stage due to the potential for significant adverse flood impacts or high flood risk. (refer **Section 8.2**). Further detailed assessment and/or identification of suitable mitigation measures are required before uplift is identified in those locations.

Flood Modification Measures and Proposed Drainage Works

Several flood modification measures were recommended in the Dobroyd Canal, Hawthorne Canal, Marrickville Valley and Cooks River Floodplain Risk Management Plans. A number of relevant drainage works items in the Inner West Local Infrastructure Contributions Plan 2023 are also proposed for the Ashfield / Croydon and Dulwich Hill / Marrickville study areas. However, these flood modification measures / drainage works items either provide limited benefit in reducing the existing flood risk in the study areas and/or would involve significant cost and disruption to implement.

Climate Change Analysis

This FIRA has assessed a climate change sensitivity scenario which applies a 30% increase in existing 1% AEP rainfall intensities. This climate change scenario is expected to lead to flood level increases typically between 0.2 to 0.3 metres along most overland flow paths. However, flood levels are predicted to increase by up to 0.7 metres in the vicinity of Heighway Avenue to the south of the T2 railway line in the Ashfield study area.

Flood Planning Advice and Recommendations

A number of recommendations to manage the flood risk for new developments in the area were also provided.

a. Floor levels for habitable spaces and basement entries at locations affected by H1 to H2 hazard during the 1% AEP event should be set at or above the Flood Planning Level (FPL). Basement entries at locations affected by H3 hazard or higher during the 1% AEP event should be set above the peak PMF level or FPL, whichever is the higher. Consideration should also be given to locating basement entries above the PMF level in areas of high hazard in the PMF.

b. Parts of new / re-purposed buildings which are located below the Flood Planning Level should be constructed using flood compatible materials.

c. On-site detention should be considered in accordance with Council's planning controls and engineering guidelines.

d. Further design refinement is required at Sites O, T, X, Z, CC, DD and FF to minimise the predicted adverse off-site impacts. This could comprise the refinement of building footprints or the implementation of local flood mitigation measures.

e. Development at Sites C, H and W should include on-site mitigation measures to manage the expected increases in flood depths within these development areas.

f. Sensitive land uses such as hospitals, aged care, childcare, schools and emergency services should be located outside the PMF extent.

g. Reliable off-site evacuation is considered unlikely and impractical for the majority of the Ashfield / Croydon and Dulwich Hill / Marrickville study areas given that these areas are affected by flash flooding and due to the absence of a catchment-specific flash flood warning system. Therefore, Shelter-in-Place (SIP) is recommended as the preferred flood emergency response strategy for developments affected by flooding in the uplift locations.

h. SIP at the proposed uplift locations aligns with the objectives and criteria outlined in the NSW Government's '*Shelter-in-place guideline for flash flooding*' (DPHI, 2024). Off-site evacuation would result in a greater risk to life.

i. The Bureau of Meteorology's FLARE resource should be used to investigate the feasibility of developing a tailored flash flood warning system for the two study areas.

j. Several proposed uplift locations would be affected by H5 to H6 flood hazard during the PMF. These

areas are listed in **Section 9.2.3**. Specialist structural engineering design of building that are proposed in these areas is required to ensure that the buildings are able to withstand the force of floodwaters in events up to and including the PMF.

k. New developments should provide floor area above the peak PMF level to facilitate a Shelter-in-Place (SIP) emergency response option, given the low likelihood of achieving reliable off-site evacuation. This is particularly important at uplift locations which are affected by high PMF flood depths (e.g. higher than 1.5 metres), such as parts of sites B, C, D, H, O, P, Q, T, U, W, CC and DD. These sites may require habitable spaces to be located on the first or second floor of the building (i.e., not the ground floor level). Further detail is provided in **Section 9.2.4**. The time required for residents to vertically evacuate to higher floors should be assessed with reference to the predicted rate of rise of floodwaters in a PMF.

l. The Flood Planning Level (FPL) for a number of uplift locations could adopt a freeboard less than 0.5 metres above the peak 1% AEP flood level. This is because the peak PMF levels at these locations are typically less than 0.3 metres higher than peak 1% AEP flood levels. These locations are listed in **Section 9.3.1**.

m. As noted above, the assessed climate change scenario is expected to lead to an increase in 1% AEP flood levels of up to 0.7 metres in areas to the south of the T2 railway near Heighway Avenue. This flood level increase is greater than the freeboard of 0.5 metres which is adopted by ADCP 2016 and the MDCP 2011 for defining the Flood Planning Level. Accordingly, Council should consider revising the freeboard applicable to new developments in areas such as Heighway Avenue, as part of future flood risk management activities.

n. Ground level activation (i.e., entries to buildings or basements) should be provided in areas of shallowest flood depth to minimise filling or steps / ramps, according to the floor level and basement entry requirements specified in the ADCP 2016 and the MDCP 2011. Suitable locations are discussed in **Section 9.3.3**.

o. A detailed Flood Impact and Risk Assessment (FIRA) should be completed in support of any Development Applications (DA) for new developments or areas of redevelopment in flood affected parts of the uplift locations. The detailed FIRA should:

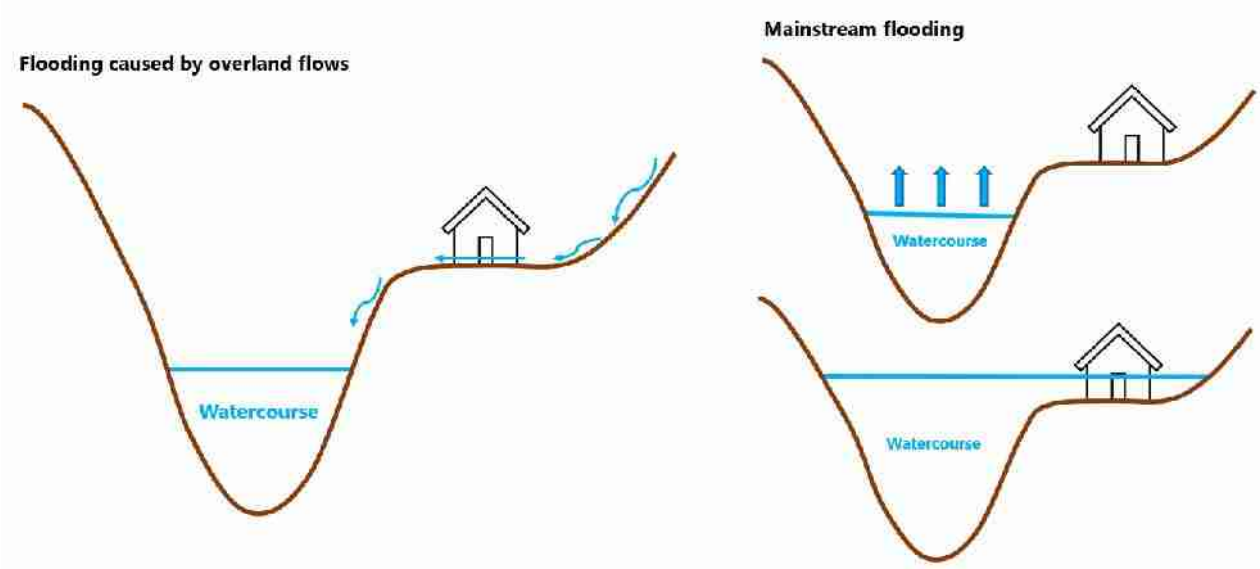
- assess the flood impacts of the final building design to meet the criteria specified in the ADCP 2016 and MDCP 2011;
- address flood risk issues and emergency response, accounting for the proposed uses of the site and the number and demographic of future occupants once these details are available;
- address how SIP will be used as part of the site's emergency management response, including actions before, during and after the SIP period;
- address how SIP will be communicated to occupants and visitors of the building and how this communication will be maintained for the life of the development; and,
- provide an understanding of secondary risks and how the proponent proposes to manage these risks (e.g., building fire, medical emergencies, health and wellbeing) during a flood emergency.

1. Introduction

The inner west suburbs of Ashfield, Croydon, Dulwich Hill and Marrickville have been identified by the NSW Government as Transport Oriented Development (TOD) locations. The preparation of master plans for these areas is required to demonstrate delivery of TOD objectives and to contribute to meeting a housing target of 7,800 constructed dwellings across the Inner West local government area (LGA) by June 2029. The TOD program has delivered new controls to facilitate additional housing within a 400-metre radius of the train stations at Ashfield, Croydon, Dulwich Hill and Marrickville. Council has also undertaken an alternate place-based planning approach that incorporates a broader area than that covered by the TOD program.

Stage 1 of the master planning program for the Inner West Housing Investigation aims to promote well-located and well-designed housing uplift in each of the suburbs listed above. The master planning program is to consider two study areas, namely the Ashfield / Croydon study area (refer **Figure 1-1**) and the Dulwich Hill / Marrickville study area (refer **Figure 1-2**).

Council has previously completed flood studies and floodplain risk management studies and plans (**FRMSPs**) in the vicinity of the two study areas. These studies have investigated both mainstream flooding and overland flow flooding. Mainstream flooding results from water rising out of a defined watercourse and overtopping the banks of the watercourse. Conversely, overland flow is typically characterised by runoff flowing towards and entering a defined watercourse. The difference between mainstream flooding and overland flow flooding is illustrated graphically below.



The previously completed flood studies and FRMSPs cover the entirety of the Ashfield / Croydon study area as well as the majority of the Dulwich Hill / Marrickville study area. The Ashfield / Croydon study area can be affected by mainstream flooding of Dobroyd Canal and Hawthorne Canal, as well as overland flows which drain towards these channels. The extent of the Dobroyd Canal and Hawthorne Canal catchments relative to the Ashfield / Croydon study area is shown in **Figure 1-1**.

Parts of the Dulwich Hill / Marrickville study area can be affected by mainstream flooding of Hawthorne Canal and the Cooks River. The Dulwich Hill / Marrickville study area is also located within the Marrickville Valley and Marrickville South overland flow catchments. The Marrickville Valley overland flow catchment generally drains to the east towards the T3 Bankstown train line near Sydenham, while the Marrickville South overland flow catchment drains southward towards the Cooks River. The extent of the Hawthorne Canal,

Marrickville Valley, Marrickville South and Cooks River catchments relative to the Dulwich Hill / Marrickville study area is shown in **Figure 1-2**.

It is noted that the Marrickville South overland flow catchment overlaps with areas which could be inundated by mainstream flooding of the Cooks River. That is, the low-lying parts of the Marrickville South overland flow catchment could be affected by both mainstream flooding of the Cooks River and by overland flow paths which drain in a southerly direction towards the river.

Council has completed a FRMSP for the Marrickville Valley overland flow catchment as well as mainstream flooding of the Cooks River. It is understood there is a FRMSP scheduled to investigate overland flows in the Marrickville South catchment, however it is not expected to be finalised until 2026.

The studies completed by Council indicate that several locations within the Ashfield / Croydon and Dulwich Hill / Marrickville study areas could be affected by flooding. Therefore, any proposed densification of built form or redevelopment would need to allow for appropriate management of flooding.

In recognition of this, Council engaged Worley Consulting to undertake a Flood Impact and Risk Assessment (**FIRA**) for a number of potential uplift scenarios which are representative of the proposed planning controls for the two study areas. The FIRA is to investigate the potential for the uplift scenarios to affect existing flooding patterns and flood risk in the study areas.

This report documents the findings of the FIRA and also provides a number of recommendations to manage the flood risk for new developments in the area.

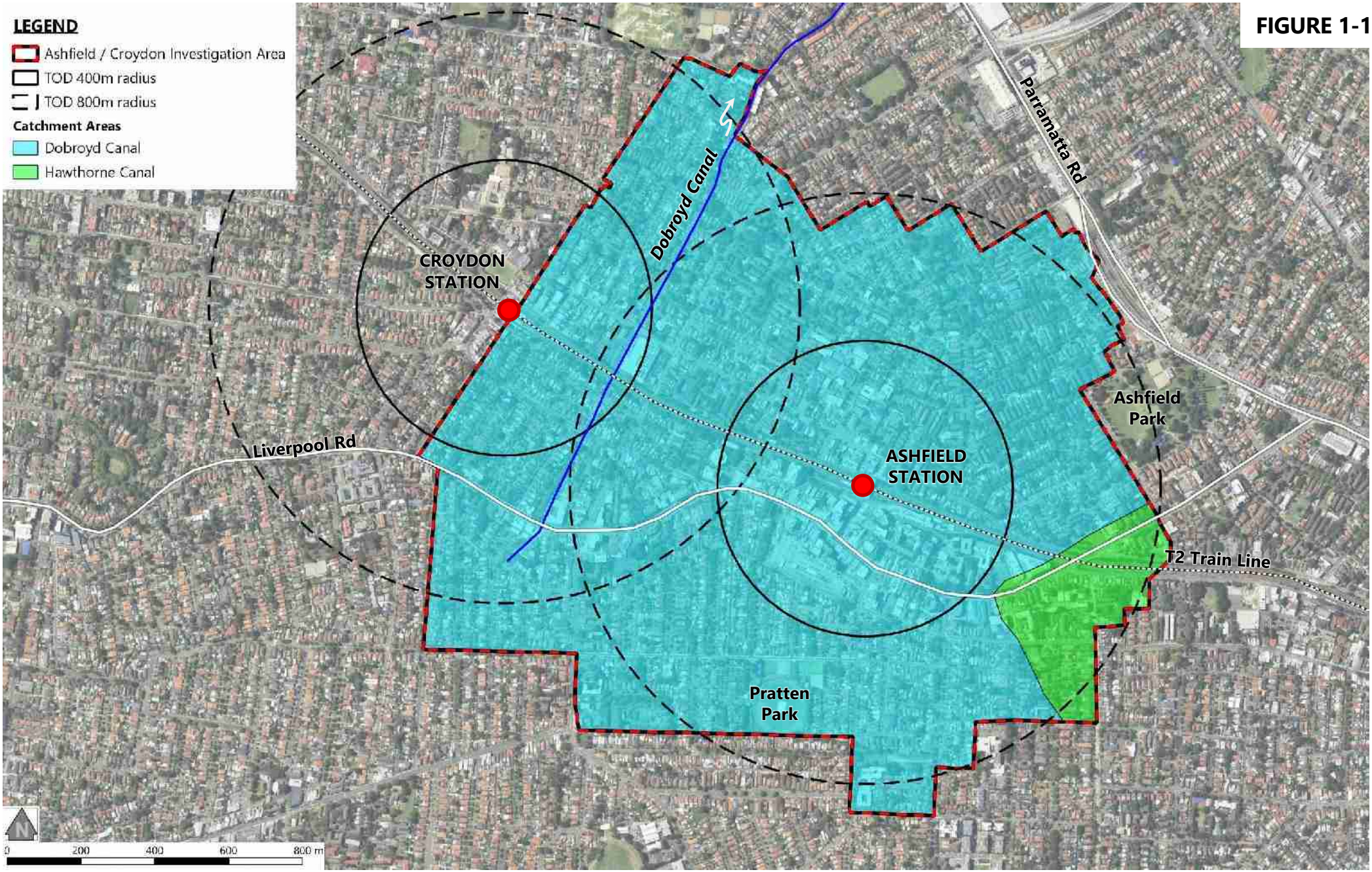


FIGURE 1-1

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ASHFIELD / CROYDON INVESTIGATION AREA

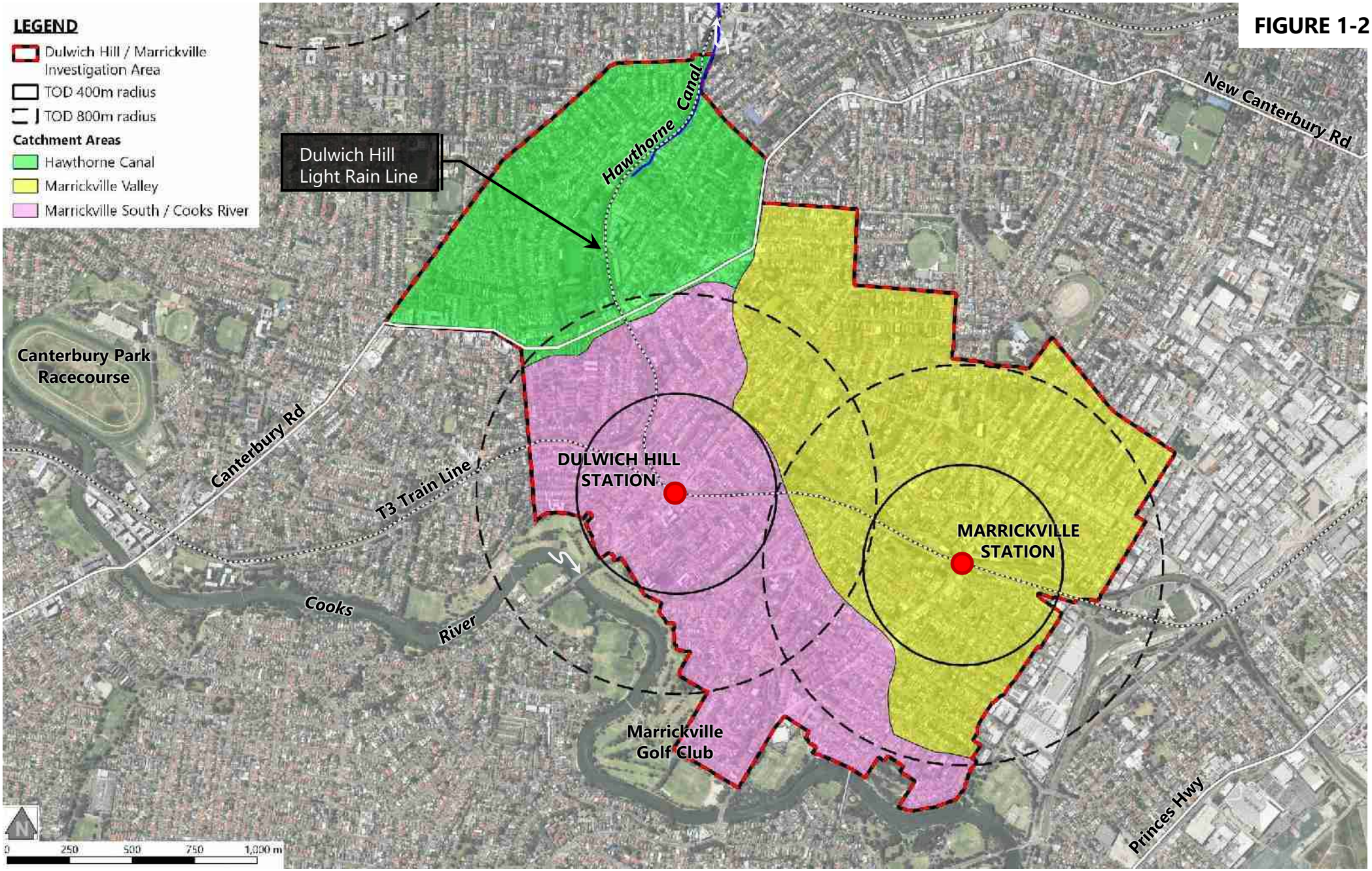

FIGURE 1-2

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DULWICH HILL / MARRICKVILLE INVESTIGATION AREA

2. Background

2.1 Site Description

The suburbs of Ashfield, Croydon, Dulwich Hill and Marrickville are located in the inner west of the Sydney Metropolitan Area to the south-west of the Sydney Central Business District (CBD). These suburbs comprise primarily residential properties, with some pockets of commercial land use located near train stations and main roads. The study areas are highly urbanised with minimal areas of open space outside dedicated road reserves.

The Ashfield and Croydon train stations are located along the T2 Inner West & Leppington train line, while the Dulwich Hill and Marrickville train stations are located along the T3 Bankstown train line. These train lines run from east to west through the respective study areas. Additionally, the Dulwich Hill light rail runs in a northerly direction from the Dulwich Hill train station towards Leichhardt.

Dobroyd Canal is the major watercourse in the vicinity of the Ashfield / Croydon study area and generally flows from south to north near the western boundary of the study area. The watercourse starts near the intersection of Norton Street and Carshalton Street and comprises an open concrete-lined channel which discharges into Iron Cove along the Parramatta River about 2 kilometres downstream of the study area. The majority of the Ashfield / Croydon study area falls within the Dobroyd Canal catchment (refer **Figure 1-1**).

Hawthorne Canal is a major watercourse located near Dulwich Hill and Summer Hill. It is also an open concrete-lined channel which flows from south to north, discharging into Iron Cove Creek about 2.7 kilometres to the north of the Dulwich Hill / Marrickville area. The channel starts near Pigott Street and Hoskins Park and generally follows the alignment of the Dulwich Hill light rail line. A small portion of the Ashfield / Croydon study area falls within the Hawthorne Canal catchment (refer **Figure 1-1**), while the northern section of the Dulwich Hill / Marrickville study area drains towards the Hawthorne Canal (refer **Figure 1-2**).

A large portion of the Dulwich Hill / Marrickville study area falls within the Marrickville Valley catchment, which comprises several overland flow paths that typically drain eastward towards low-lying land in the vicinity of the Marrickville industrial area. The southern portion of the Dulwich Hill / Marrickville study area is affected by overland flows within the Marrickville South catchment as well as flooding along the Cooks River.

2.2 Previous Flood Studies

Flood behaviour in the Dobroyd Canal, Hawthorne Canal, Marrickville Valley and Cooks River catchments has previously been investigated in flood studies and floodplain risk management studies and plans (FRMSP) undertaken by Inner West Council as part of the NSW Government's floodplain management program. It is noted that there is a flood study and risk management plan scheduled for the Marrickville South overland flows catchment, which is not expected to be finalised until 2026. In lieu of a detailed flood study, Worley Consulting has developed a basic TUFLOW model of the area to provide a preliminary understanding of overland flow behaviour in the Marrickville South catchment (refer **Section 5**).

A summary of previous completed flood studies relevant to the two study areas is provided in the following.

Dobroyd Canal and Hawthorne Canal Floodplain Risk Management Study and Plan (WMAwater 2020)

- The FRMSP builds on the understanding of flood behaviour that was established in the Dobroyd Canal Flood Study (WMAwater, 2014) and the Hawthorne Canal Flood Study (WMAwater, 2015).

- The flood models developed for the 2014 and 2015 flood studies were revised and updated as part of the FRMSP. The updated flood models were used to simulate a range of design events.
- The critical storm duration for both the Dobroyd and Hawthorne Canal catchments was determined to be 1 hour for the range of design events.
- The FRMSP identified that the Dobroyd Canal catchment has a more severe flood affectation than the Hawthorne Canal catchment, with approximately double the number of properties expected to be inundated for any given design flood event.
- A number of areas of notable flood risk were identified, including Heighway Avenue in Croydon as well as the Brown Street / Bland Street underpass beneath the T2 railway line at Ashfield.

Marrickville Valley Floodplain Risk Management Study and Plan (Cardno, 2017)

- The FRMSP builds on the understanding of flood behaviour that was established in the Marrickville Valley Flood Study (WMAwater, 2013).
- The flood models developed for the 2013 flood study were revised and updated as part of the FRMSP. The updated flood models were used to simulate a range of design events.
- The 1 hour storm duration was found to be critical for the Probable Maximum Flood (PMF), while the 2 hour storm duration was found to be critical for smaller events such as the 10% and 1% Annual Exceedance Probability (AEP) events.
- The updated flood model results were used to identify areas of notable flood risk which includes the T3 railway line near Marrickville Station as well as some surrounding streets such as Byrnes Street, Crawford Place and Hollands Avenue.

Cooks River Floodplain Risk Management Study and Plan (WMAwater, 2015)

- The FRMSP builds on the understanding of flood behaviour established by the Cooks River Flood Study (MWH & PB, 2009). The flood model results generated in the 2009 flood study were used to assess flood damages and options to reduce flood risk.
- The 2 hour storm duration was found to be critical for the Cooks River catchment for the full range of design events.

It is noted that the flood modelling completed in the three FRMSPs listed above adopted rainfall data and techniques from *Australian Rainfall and Runoff 1987* (ARR 1987. This is understandable because the updated version of *Australian Rainfall and Runoff 2019* (ARR 2019) had not been released at the time these studies commenced and/or were published.

Given that the critical storm duration was determined to be between 1 and 2 hours for the Dobroyd Canal, Hawthorne Canal, Marrickville Valley and Cooks River catchments, each of the studies identified flash flooding to be a notable factor when accounting for flood emergency response issues.

Each of the FRMSPs summarised above also completed a detailed assessment of potential mitigation measures to reduce the existing flood risk. These assessments included the investigation of flood modification, property modification and response modification measures. A number of measures were then recommended for implementation via a benefit-cost and multi-criteria analysis. The recommended and other flood modification measures were assessed for their relevance to the Ashfield / Croydon and Dulwich Hill / Marrickville study areas (refer **Section 7**).

3. Data Collection and Review

The following data was collected and reviewed by Worley Consulting in the preparation of this flood impact and risk assessment.

3.1 Flood Model Files

Flood model data and output files relevant to the two study areas were provided by Council, including:

- DRAINS hydrologic models for the Dobroyd Canal, Hawthorne Canal and Marrickville Valley catchments.
- 1D/2D TUFLOW hydraulic models for the Dobroyd Canal, Hawthorne Canal, Marrickville Valley and Cooks River catchments, including topographic data, building footprints, representation of major drainage channels and the stormwater pit and pipe network and hydraulic roughness delineation.
- Raw TUFLOW model results.
- GIS grids for processed TUFLOW model results.

3.2 GIS Data

Council provided the following GIS data:

- The boundaries of the Ashfield / Croydon study area and the Dulwich Hill / Marrickville study area.
- Drainage catchment boundaries.
- Lots tagged as flood affected by overland flow or the PMF.
- Layers representing the TOD 400-metre and 800-metre radii from the four train stations.

4. Existing Flood Planning Controls

4.1 Inner West Local Environmental Plan 2022

The Inner West Local Environmental Plan 2022 (IWLEP 2022) is the statutory planning instrument that establishes the permissible and/or prohibited forms of development and land use within the Inner West LGA.

Flood planning for properties within the Flood Planning Area (**FPA**) is addressed in Clause 5.21 of the IWLEP 2022. Council has also opted to include Clause 5.22 from the Standard Instrument into IWLEP 2022. Clause 5.22 applies to land between the FPA and the Probable Maximum Flood (**PMF**).

The objectives of Clause 5.21 are:

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; and,

d. to enable the safe occupation and efficient evacuation of people in the event of a flood.

Clause 5.22 expands on these objectives to add the need:

e. to protect the operational capacity of emergency response facilities and critical infrastructure during flood events; and,

f. to avoid adverse effects of hazardous development on the environment during flood events.

The remainder of Clause 5.21 is reproduced below.

> *2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development—*
>
> *a. is compatible with the flood function and behaviour on the land, and*
>
> *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*
>
> *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 riverbanks or watercourses.*

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.

4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.

5) In this clause –

***Considering Flooding in Land Use Planning Guideline** means the Considering Flooding in Land Use Planning Guideline published on the Department's website on 14 July 2021.*

***Flood Planning Area** has the same meaning as it has in the Flood Risk Management Manual.*

***Floodplain Development Manual** means the Flood Risk Management Manual (ISBN 978-1-923076-17-4) published by the NSW Government in June 2023.*

The remainder of the special flood considerations from Clause 5.22 are reproduced below.

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

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.

4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.

5) In this clause—

***Considering Flooding in Land Use Planning Guideline** – see clause 5.21(5).*

***Flood Planning Area** – see clause 5.21(5).*

***Flood Risk Management Manual** – see clause 5.21(5).*

***Probable maximum flood** has the same meaning as in the Flood Risk Management Manual.*

***Sensitive and hazardous development** means development for the following purposes –*

(a) boarding houses, (b) caravan parks, (c) correctional centres, (d) early education and care facilities, (e) eco-tourist facilities, (f) educational establishments, (g) emergency services facilities, (h) group homes, (i) hazardous industries, (j) hazardous storage establishments, (k) hospitals, (l) hostels, (m) information and education facilities, (n) respite day care centres, (o) seniors housing, (p) sewerage systems, (q) tourist and visitor accommodation, (r) water supply systems.

4.2 Development Control Plans

Inner West Council was formed in May 2016 from the merger of the former Ashfield, Leichhardt and Marrickville Councils. Development Control Plans (DCPs) from the previous Councils are still applicable to the two study areas. In particular, the Ashfield DCP (2016) and the Marrickville DCP (2011) provide flood-related planning controls to the Ashfield / Croydon study area and the Dulwich Hill / Marrickville study area, respectively.

Flood-related planning controls for new developments are found in Chapter A Part 3 of the Ashfield DCP (ADCP 2016) as well as Section 2.22.5 of the Marrickville DCP (MDCP 2011). A summary of the key controls found in these two policies is provided in **Table 4-1**.

Table 4-1 Relevant flood-related planning controls

Requirement / Development Control	Relevant Section of ADCP 2016	Relevant Section of MDCP 2011
A Flood Risk Management Report is required for applications that are identified as flood control lots or as flood liable land.	Clause DS1.1 to DS1.4	Clause C1
Floor levels for residential developments are to be at or above the 1% AEP flood level plus 0.5 metres, with some select exceptions regarding minor alterations, affectation by minor overland flow and Heritage/Conservation constraints. Portions of buildings below the 1% AEP flood level plus 0.5 metres must be constructed from flood compatible materials.	Clauses DS2.1, DS2.2	Clauses C5, C6
Floor levels for non-residential developments to be at or above the 1% AEP flood level plus 0.5 metres, or to be constructed from flood-proofed to the 1% AEP flood level plus 0.5 metres where raising the floor level may be impractical. Floor levels for additions to existing buildings may be approved below the Flood Planning Level if the applicant can demonstrate that all practical measures will be taken to prevent or minimise the impact of flooding.	Clause DS5.1	Clauses C13, C15
Flood-free access must be provided where practicable for both new residential and non-residential developments.	Clause DS2.3, DS5.2	Clauses C7, C14
Development consent for change of use of an existing building with floor levels below the 1% AEP flood level will only be given where there is no foreseeable risk of pollution associated with the proposed use of the building, and consideration will be given to whether the proposed development would result in increased flood risk with respect to the proposed use and risk of pollution.	Clauses DS7.1, DS7.2	Clauses C17, C18
Filling of floodways or high flood hazard areas within the Flood Planning Area may only be considered where the filling does not lead to adverse impacts in surrounding properties (a range of controls apply including limiting flood level increases to 10 mm or less).	Clause DS9.1	Clause C21

Requirement / Development Control	Relevant Section of ADCP 2016	Relevant Section of MDCP 2011
Flood prone land must have a site emergency response flood plan, adequate flood warning systems, signage for evacuation and reliable access to an area of refuge above the PMF.	Clauses DS10.1 to DS10.3	Clauses C22-24
Floor levels of new enclosed garages, open car park areas and carports must be at or above the 1% AEP flood level plus 200 mm. In extenuating circumstances, consideration may be given to a lower floor level, being the highest practical level but no lower than 180 mm below the 1% AEP flood level	Clauses DS11.1, DS11.2	Clauses C25-26
Basement carparking for properties affected by Low flood hazard must have all access and potential water entry points above the Flood Planning Level. Further considerations would apply for basement carparking in properties affected by High flood hazard (refer note).	Clause DS11.3	Clause C27

5. Preliminary Marrickville South Flood Model

The southern portion of the Dulwich Hill / Marrickville study area falls within the Marrickville South catchment. This catchment is affected by mainstream flooding of the Cooks River as well as overland flows. The Cooks River Floodplain Risk Management Study and Plan (WMAwater, 2015) provides a detailed understanding of flood behaviour along the Cooks River. However, the overland flow behaviour within the Marrickville South catchment has not been investigated to date.

It is understood there is a flood study and risk management plan scheduled to investigate overland flows in the Marrickville South catchment, however, it is not expected to be finalised until 2026. In lieu of a detailed flood study, Worley Consulting has developed a preliminary TUFLOW model of the area to provide a high-level understanding of overland flow behaviour in the Marrickville South catchment.

5.1 Modelling Approach and Assumptions

Key details on the development of this preliminary TUFLOW model are provided in the following.

- The topography within the TUFLOW model domain is defined by 1-metre LiDAR data obtained from the online ELVIS portal, which was captured in May 2020 and is the latest data available.
- The TUFLOW model domain was delineated by following the ridgelines captured in the 2020 1-metre LiDAR grid. The TUFLOW model extent is shown in **Figure 5-1**.
- The model domain was delineated into areas of different hydraulic roughness, including material types for open space, water bodies, roads / hardstands, railway corridors, residential blocks and commercial / industrial blocks.
- The 1-hour storm was assumed to be the critical duration storm for all design events, given that the hydrologic analyses completed for the nearby Hawthorne Canal, Marrickville Valley and Cooks River catchments determined that critical storm durations were typically between 1 and 2 hours.
- Design rainfall depths for the 1-hour storm duration was obtained from ARR 1987 IFD data from the Bureau of Meteorology, to achieve consistency with other nearby studies for Hawthorne Canal, Marrickville Valley and the Cooks River.
- The TUFLOW model adopted the direct rainfall (rainfall on grid) approach to allow for the natural resolution of overland flow paths.
- A suitably low tailwater level was adopted along the Cooks River to allow better definition of overland flow paths in the vicinity of the river.
- The raw TUFLOW model results were filtered to remove areas of benign flooding or localised minor ponding. The filtering criteria applied is described in the following:
    - *Depth ≥ 0.15 m*

      This criterion removes flood depths shallower than 0.15 m which are generally considered quite benign.
    - *Velocity x Depth ≥ 0.025 m^2/s*

      This criterion was used to include depths shallower than 0.15 m where some flow conveyance is evident which may:
      - *Occur near-bank along creeks and waterways;*
      - *Form part of overland flood flow paths;*

  - *Form important linkages between deeper areas of flooding and their source.*
- *Mapping of these shallower flows can be important as:*
  - *It provides a better understanding of flood behaviour;*
  - *Obstruction of such flows may have adverse flood impacts;*
  - *It provides confidence that discrete 'ponds' of inundation removed by the following mapping criterion are not associated with broader flood flowpaths.*
- *Area of inundation ≥ 100 m2*

  This criterion removes discrete areas of inundation with an area of less than 100 m^2. Such areas are generally expected to be related to local ponding in ground depressions rather than significant flood flowpaths.

5.2 Model Purpose and Limitations

The purpose of the preliminary TUFLOW model is to identify the location of overland flow paths and the location of potential flooding hotspots in the Marrickville South catchment. Given the simplified modelling approach and assumptions in rainfall data, the extent, depth, level and velocity of floodwaters are indicative only.

The model is intended to provide high-level indicative information on flood behaviour only and should not supplant the flood study and flood risk management study and plan which is scheduled for this area.

The results of the modelling should not be relied upon for flood planning purposes or emergency response management.

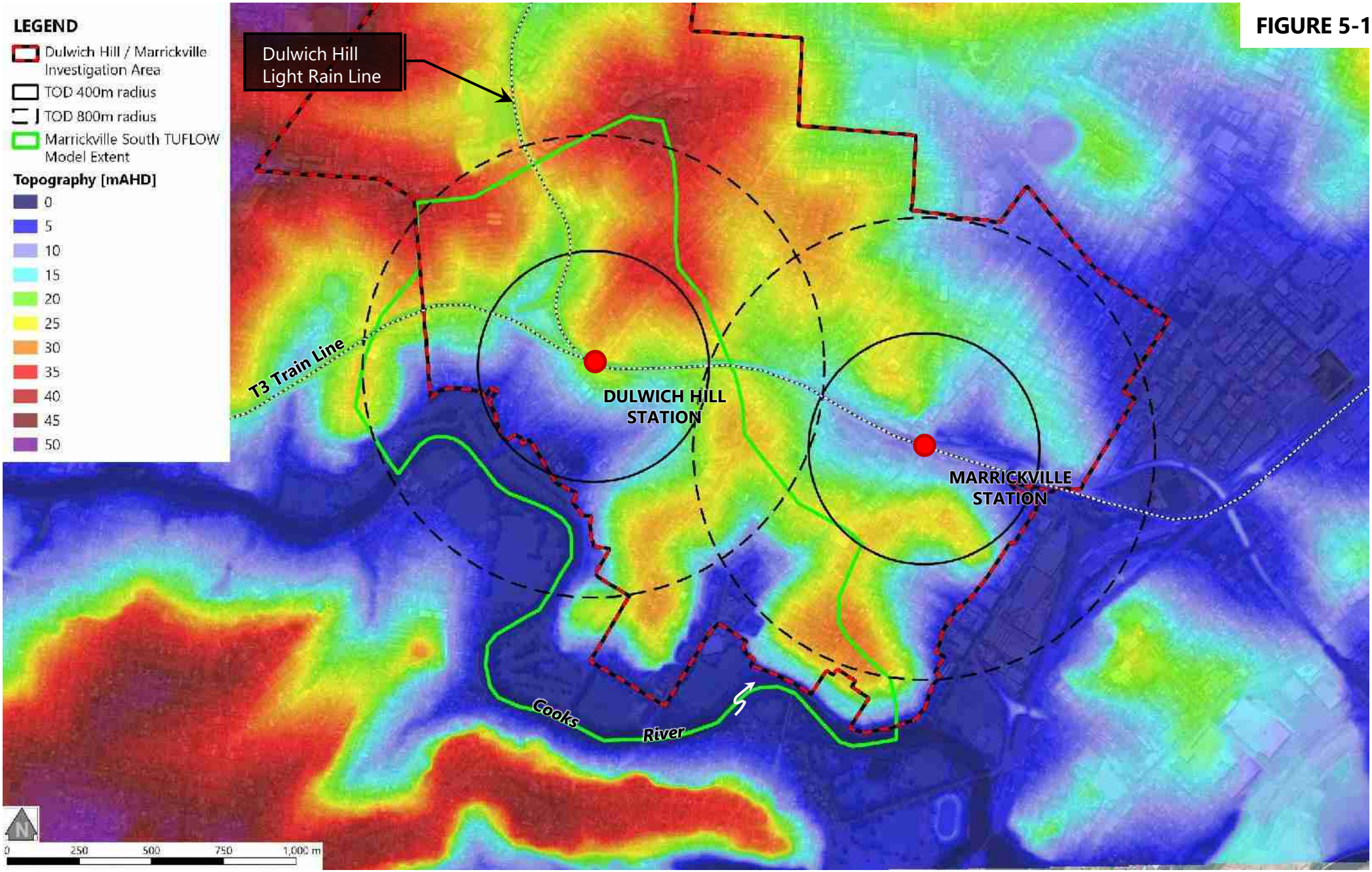

FIGURE 5-1

Prepared by:

worley consulting

MARRICKVILLE SOUTH TUFLOW MODEL EXTENT

6. Existing Conditions Flood Modelling

6.1 Adopted Approach

The existing TUFLOW flood models developed for the Dobroyd Canal, Hawthorne Canal, Marrickville Valley and Cooks River studies were used without alteration to establish flood behaviour in the Ashfield / Croydon and Dulwich Hill / Marrickville study areas under existing conditions. The preliminary TUFLOW model developed by Worley Consulting was used to approximate overland flow behaviour in the Marrickville South catchment within the Dulwich Hill / Marrickville study area.

As noted previously, the existing studies have adopted hydrologic data and techniques from ARR 1987. Accordingly, Worley Consulting has also adopted ARR 1987 for to achieve consistency with the finalised flood studies. In line with the existing studies, the 1-hour storm was adopted as the critical duration storm for the Dobroyd Canal, Hawthorne Canal and Marrickville South overland flow catchments, while the 2-hour storm was adopted as the critical duration storm for the Cooks River catchment.

The 1-hour storm was also adopted as the critical duration storm for the PMF event in the Marrickville Valley catchment, while the 2-hour storm was adopted as the critical duration storm for all other design events within the Marrickville Valley catchment.

6.2 Flood Model Results

The TUFLOW models were used to simulate the 1% AEP flood as well as the Probable Maximum Flood (PMF) for existing conditions within the Ashfield / Croydon and Dulwich Hill / Marrickville study areas. Flood mapping for existing development conditions is included in the following figures:

- Appendix A, Figure A1 to Figure A8 – 1% AEP flood mapping for Ashfield / Croydon.
- Appendix B, Figure B1 to Figure B8 – 1% AEP flood mapping for Dulwich Hill / Marrickville.
- Appendix C, Figure C1 to Figure C8 – PMF mapping for Ashfield / Croydon.
- Appendix D, Figure D1 to Figure D8 – PMF mapping for Dulwich Hill / Marrickville.

The flood mapping outlined above also includes flood hazard mapping. Flood hazard provides a measure of the potential risk to life, well-being and property posed by a flood event. ARR 2019 presents a set of hazard curves which assess the vulnerability of people, vehicles and buildings to flooding based on the velocity and depth of flood flows. These curves have been adopted to define flood hazard in this study and are reproduced in **Figure 6-1**, however noting that the rainfall data and methods of ARR 2019 have not been adopted for the flood modelling (refer **Section 6.1**).

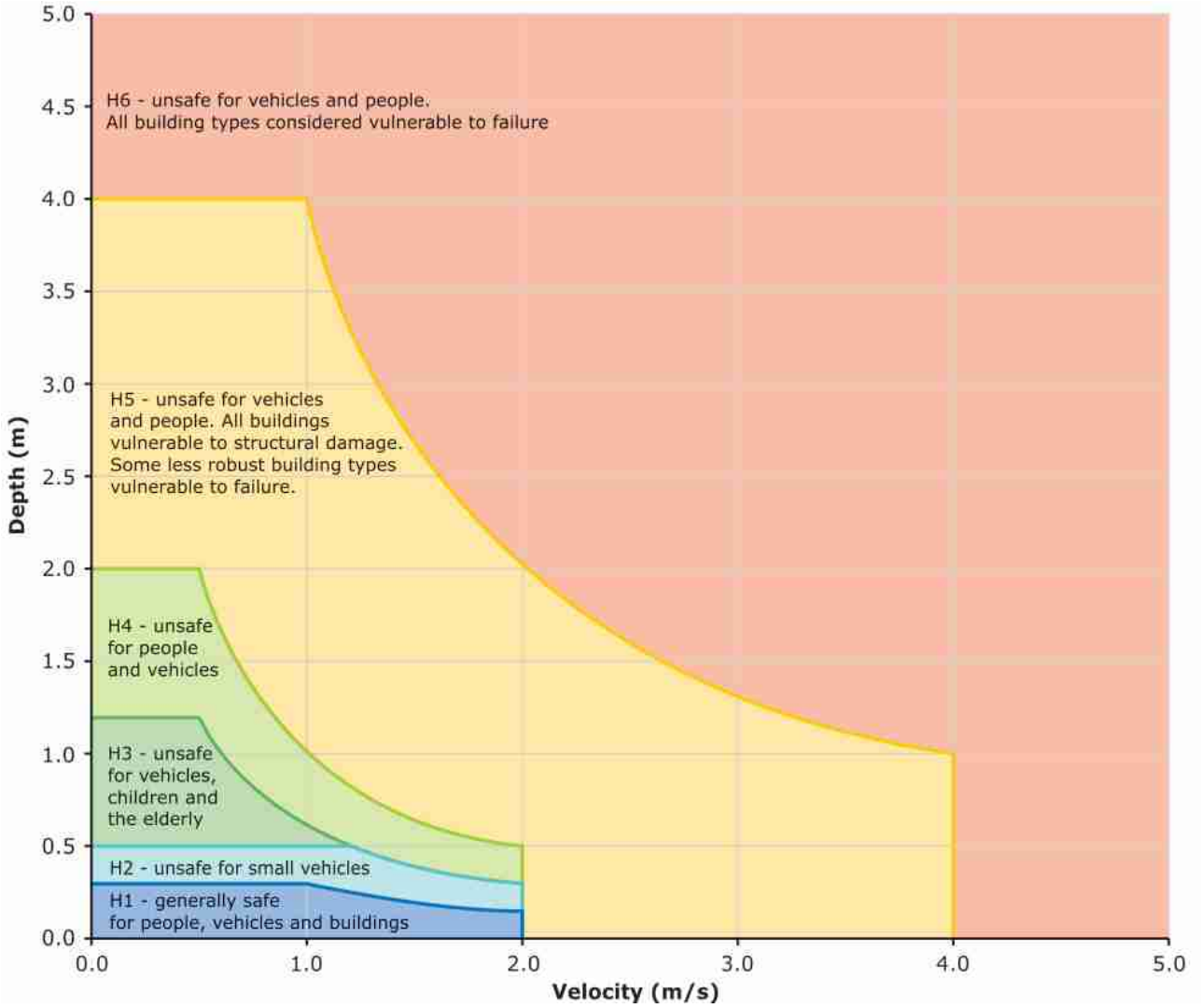

Figure 6-1 ARR 2019 Flood Hazard Curves

6.2.1 Ashfield / Croydon Flooding "Hotspots"

The flood model results for existing conditions indicate a number of areas which are particularly flood prone within the Ashfield / Croydon study area:

- Sections of Heighway Avenue and Thomas Street in Croydon adjacent to Dobroyd Canal are affected by high flood depths due to floodwaters "backing up" against the T2 railway line. Several properties along Heighway Avenue are affected by H4 hazard during the 1% AEP event. During the PMF event, a significant area between the railway line and Liverpool Road is affected by H5 to H6 hazard. Floodwaters are also expected to discharge through the Frederick Street railway underpass leading to large portions of the street being affected by H5 to H6 hazard during the PMF.
- Downstream (north) of the railway line, areas of high flood hazard are generally confined to the Dobroyd Canal channel, however, several streets in the vicinity of the channel are expected to be affected by high flood hazard during the PMF.
- The depth of flooding in the Bland Street / Brown Street railway underpass is expected to exceed 2 metres during the 1% AEP event, leading to a H5 hazard category. To the west of this area, there is an overland flow path which generally follows Elizabeth Street towards Frederick Street before discharging into the Dobroyd Canal.

- Other significant flow paths in this study area include:
  - Flows travelling from Queen Street and Pratten Park in a north-westerly direction towards Dobroyd Canal near Heighway Avenue and Thomas Street.
  - A flow path which originates in the vicinity of Carshalton Street and drains northwards into Dobroyd Canal.
  - Flows which travel in a westerly direction towards Dobroyd Canal to the north of the railway line, passing through Charlotte Street, Bland Street and Alt Street.

Some uplift was initially identified in the vicinity of these flood prone areas. However, these uplift scenarios were subsequently deemed unsuitable for further consideration at this stage as development in these areas would likely lead to significant adverse flood impacts or are located in areas of high flood risk. Further details about these uplift locations are provided in **Section 8.2**.

6.2.2 Dulwich Hill / Marrickville Flooding "Hotspots"

The flood model results for existing conditions indicate that a number of areas are particularly flood prone within the Dulwich Hill / Marrickville study area.

- The railway corridor in the vicinity of Marrickville Station is affected by H4 to H5 flood hazards during the 1% AEP event, with some areas adjacent to the railway affected by significant flood depths including McNeilly Park (up to 0.9 metres) and the intersection of Byrnes Street and O'Hara Street (greater than 2 metres).
- Several streets adjacent to the open concrete channel which runs parallel and south of Sydenham Road (referred to in previous flood studies as the Western Channel) are affected by H3 flood hazards arising from flood depths of between 0.6 and 0.9 metres during the 1% AEP event. Affected streets within the Dulwich Hill / Marrickville study area include Carew Lane, Malakoff Street, Convent Lane, Despointes Street, Peace Lane, Le Clos Lane and Silver Street. During the PMF, significant areas in the vicinity of the Western Channel are affected by H4 to H5 hazard, while Sydenham Road is affected by H6 flood hazard.
- Flooding of the Cooks River is expected to inundate some residential areas in the southern part of the Dulwich Hill / Marrickville study area, including properties near the intersection of Riverside Crescent and Dibble Avenue and also near the intersection of Wharf Street and Illawarra Road.
- Areas of high flood hazard are typically confined to the Hawthorne Canal channel in the northern part of the Dulwich Hill / Marrickville study area, although some floodwaters are expected to spill out of the canal leading to H4 flood hazards in some areas of Hoskins Park and the western end of Pigott Street during the 1% AEP event.
- The preliminary TUFLOW model developed for the Marrickville South overland flows catchment identified two notable flow paths which drain towards the Cooks River:
  - Overland flows are predicted to travel southward through the Terrace Road railway underpass before travelling through several properties along Ewart Street, Balfour Street and Tennyson Street and discharging into the golf course. Peak 1% AEP flood depths reach up to 0.9 metres in some sections of this flow path, with some areas of H4 to H5 hazard between Ewart Street and Tennyson Street.
  - A second flow path originates at the western end of Albermarle Street and travels in a south-westerly direction through School Parade, Wicks Avenue, Ewart Street, Dibble Avenue and Riverside Crescent. This drainage issue was also discussed briefly in the Cooks River Floodplain Risk Management Study and Plan (WMAwater, 2015). Flood hazards are generally H3 or less along this flow path in the 1% AEP event except within the Dibble Avenue waterhole.

- The Marrickville South preliminary model also identified areas of ponding against the light rail embankment near the Dulwich Hill Skate Park. Some properties at the southern end of MacArthur Parade and Hercules Street could be affected by runoff ponding against the railway embankment.

7. Review of Mitigation Measures and Proposed Drainage Works

The Floodplain Risk Management Studies (FRMS) completed for the Dobroyd Canal, Hawthorne Canal, Marrickville Valley and Cooks River catchments investigated an extensive list of possible flood modification measures to reduce the flood risk across the two study areas. This included consideration of flood protection levees, detention basins, drainage upgrades and diversion channels.

Several measures were not recommended for implementation due to either limited benefits in reducing the impact of flooding, a low benefit-cost ratio or other factors which were identified during a multi-criteria assessment. The recommended measures for implementation are documented in the respective Floodplain Risk Management Plans (FRMP).

Some of the flood modification measures were also included in the *Inner West Local Infrastructure Contributions Plan 2023* (GLN Planning, 2023). These measures comprise drainage works which are expected to be delivered by 2036.

Worley Consulting has undertaken a review of the flood modification measures recommended in the Dobroyd Canal, Hawthorne Canal, Marrickville Valley and Cooks River FRMPs, as well as the relevant drainage works items in the *Inner West Local Infrastructure Contributions Plan 2023*.

The measures relevant to the Ashfield / Croydon and Dulwich Hill / Marrickville study areas have been reviewed and are presented in the following sections. Several of the recommended modification measures or drainage works fall outside of the study areas, or else have insignificant benefits in very localised areas which were not considered worthwhile for further investigation for the purposes of this report.

7.1 Pratten Park and Arthur St Detention Basins [Croydon]

7.1.1 Overview

This option comprises the construction of an underground detention basin in Pratten Park as well as beneath the tennis courts at the corner of Arthur Street and Rose Street. The purpose of the detention basins is to attenuate the flows in the overland flow path thereby reducing the peak depth of flooding down to Dobroyd Canal near Heighway Avenue.

This measure was identified as measure FM0703 in the Dobroyd Canal and Hawthorne Canal Floodplain Risk Management Study and Plan (WMAwater, 2020) as well as item 190 in the Inner West Local Infrastructure Contributions Plan 2023. The layout of the option and the predicted flood impacts during the 1% AEP event has been extracted from Figure A25 of the Dobroyd Canal and Hawthorne Canal Floodplain Risk Management Study and Plan (WMAwater, 2020) and shown in **Figure 7-1** below.

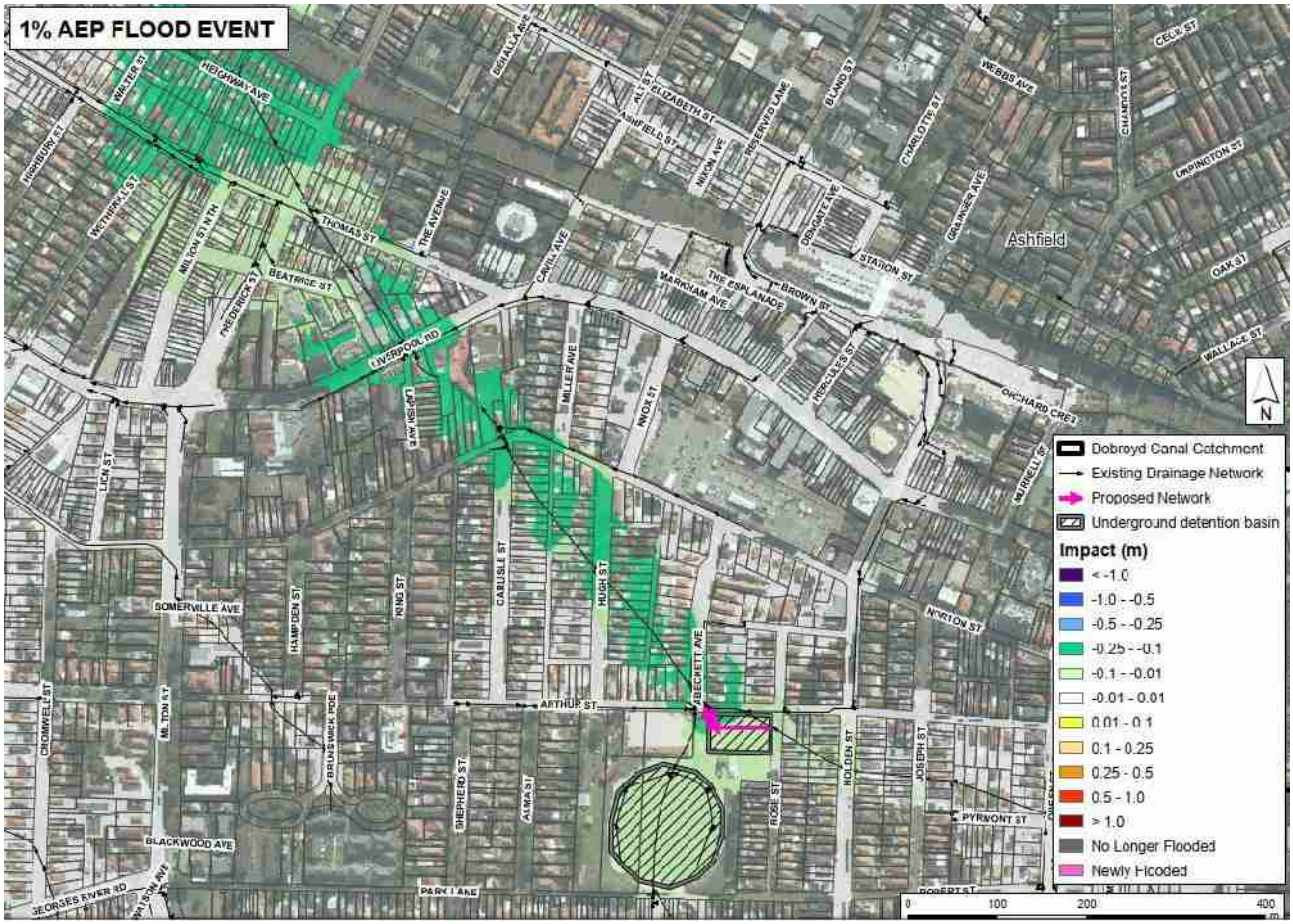

Figure 7-1 Layout of Pratten Park / Arthur Street detention basins [source: WMAwater, 2020]

7.1.2 Expected Flood Impacts

As shown in **Figure 7-1**, the installation of the detention basins results in widespread flood level decreases along the overland flow path which runs from Pratten Park towards Dobroyd Canal at Heighway Avenue. The 2020 FRMS report notes that this proposed mitigation measure is expected to decrease flood levels by 0.1 metres along the overland flow path and by 0.15 metres in the vicinity of Liverpool Road and Heighway Avenue.

It is noted that this option is only able to provide a minor benefit in reducing the existing flood depths along the overland flow path and near Heighway Avenue during the 1% AEP event. A flood level decrease of 0.1 metres is expected to decrease flood depths from 0.7 metres to 0.6 metres along the overland flow path, while a flood level decrease of 0.15 metres near Heighway Avenue would decrease flood depths from 1.3 to 1.1 metres. The depth of flooding is still significant in these areas.

Notwithstanding this, the 2020 FRMS report further notes that this mitigation measure will have significant benefits in decreasing the number of properties which are flooded above floor level for a range of design events. For example, the implementation of this measure is expected to reduce the number of properties flooded above floor level from 136 to 92 during the 10% AEP event. The number of properties flooded above floor level will be reduced from 410 to 366 during the 1% AEP event.

7.1.3 Additional Considerations

The implementation of this mitigation measure is expected to cost $16.9M according to the *Inner West Local Infrastructure Contributions Plan 2023*. However, the 2020 FRMS report notes that other factors would require

consideration, including land acquisition given that the tennis courts are privately owned. In addition, it was noted that Pratten Park and Thirning Villa are listed as Council heritage items and therefore, heritage impacts would need to be accounted for during the design and construction of the detention basins.

7.2 Dobroyd Canal Capacity Upgrade at Railway [Croydon]

7.2.1 Overview

This option comprises the quadruplication of the Dobroyd Canal culverts beneath the T2 railway line downstream (north) of Heighway Avenue at Croydon. This mitigation measure aims to alleviate the significant flood risk at Heighway Avenue, which is affected by floodwaters backing up against the railway embankment.

This measure was identified as measure FM0108 in the *Dobroyd Canal and Hawthorne Canal Floodplain Risk Management Study and Plan* (WMAwater, 2020). The layout of the option and the predicted flood impacts during the 1% AEP event has been extracted from Diagram A6 in Appendix C of the *Dobroyd Canal and Hawthorne Canal Floodplain Risk Management Study and Plan* (WMAwater, 2020) and shown in **Figure 7-2**.

It is noted that this option in its current arrangement was not recommended for implementation due to the significant downstream adverse flood impacts.

7.2.2 Expected Flood Impacts

As shown in **Figure 7-2**, this mitigation measure results in flood level decreases of up to 0.5 metres in the vicinity of Heighway Avenue. This would serve to decrease the existing depth of flooding from 1.5 metres to about 1.0 metre. The 2020 FRMSP notes that the implementation of this measure would remove above-floor inundation at 21 properties upstream (south) of the railway.

However, there are significant adverse flood impacts downstream (north) of the railway. Flood levels along Dobroyd Parade are predicted to increase by up to 0.25 metres during the 1% AEP event and also leads to above-floor inundation at 13 properties which were previously not inundated during this event.

7.2.3 Additional Considerations

Following discussions with Council staff, it is Worley Consulting's understanding that further optimisation of this mitigation measure was not able to be investigated during the 2020 FRMSP. Council staff note that the adverse flood impacts downstream of the railway could be minimised through the construction of a detention basin beneath the existing open-air carpark at the Ashfield Aquatic Centre.

The optimisation of this mitigation measure, through the construction of a detention basin downstream of the railway, or otherwise, could have notable benefits in decreasing the flood risk in the vicinity of Heighway Avenue. This mitigation measure should be investigated at a later stage to explore the possibility of reducing flood risk at Heighway Avenue without leading to adverse flood impacts in downstream areas.

It is noted that this mitigation measure would require collaboration with Sydney Trains and Sydney Water.

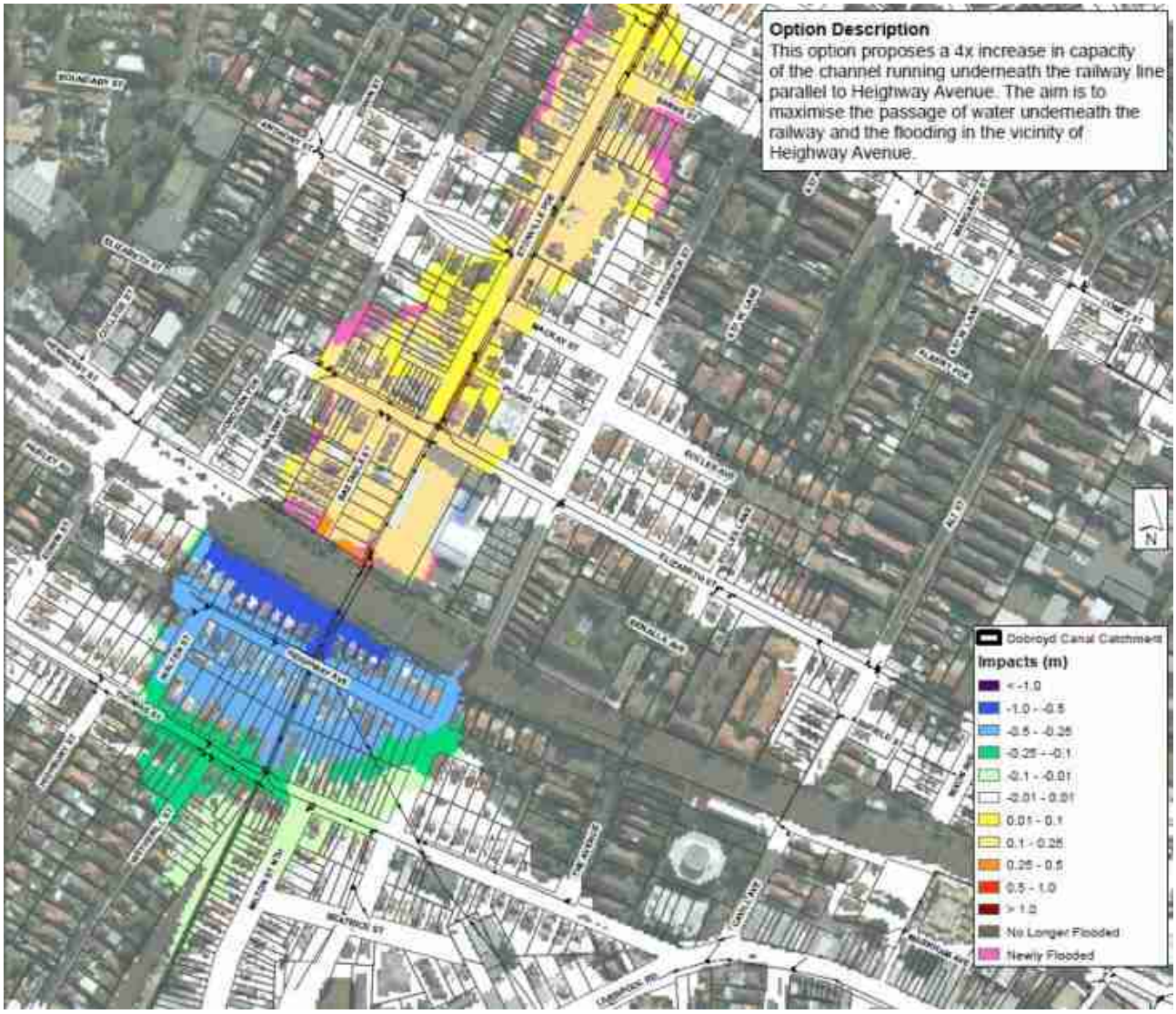

Figure 7-2 Layout of Dobroyd Canal capacity upgrade at railway line [source: WMAwater, 2020]

7.3 Hawthorne Canal Capacity Upgrade at Old Canterbury Road / Fred Street [Marrickville]

7.3.1 Overview

Hawthorne Canal is an open concrete-lined channel which drains northwards out of the Dulwich Hill / Marrickville study area near Fred Street and Old Canterbury Road. The open channel passes through a culvert beneath the light rail immediately upstream of Fred Street and passes through another culvert under Old Canterbury Road. This option comprises tripling the pipe capacity of Hawthorne Canal beneath Old Canterbury Road.

This measure was identified as measure FM0802 in the *Dobroyd Canal and Hawthorne Canal Floodplain Risk Management Study and Plan* (WMAwater, 2020). The layout of the option and the predicted flood impacts during the 1% AEP event has been extracted from Figure B30 of the *Dobroyd Canal and Hawthorne Canal Floodplain Risk Management Study and Plan* (WMAwater, 2020) and shown in **Figure 7-3** below.

7.3.2 Expected Flood Impacts

As shown in **Figure 7-3**, increasing the capacity of the Hawthorne Canal culverts results in flood level decreases upstream (south) of Old Canterbury Road by up to 1 metre, at the expense of increasing flood levels downstream of the road by up to 0.5 metres.

This mitigation measure results in the elimination of over floor inundation for four properties along Fred Street during the 1% AEP event. The 2020 FRMS notes that this measure was considered worthwhile given the elimination of over floor inundation at these four properties, but should be considered only in the event that Old Canterbury Road is upgraded in the future.

This mitigation measure results in some localised flood benefits in a localised area at the northern corner of the Dulwich Hill / Marrickville study area. Given the very localised benefits, downstream adverse impacts and the location outside of the 800-metre radius from Dulwich Hill train station, this measure was not considered further for the Dulwich Hill master planning process.

7.3.3 Additional Considerations

A cost estimate for this option was not provided in the 2020 FRMS, although the report notes that there is likely to be a significant cost associated with this mitigation measure. The 2020 FRMS also notes that there would likely be design and construction challenges, potential land acquisition costs and negotiation with other stakeholders given that Old Canterbury Road is not owned by Council. Additionally, the flood level increases downstream of Old Canterbury Road are of concern and require further management and investigation.

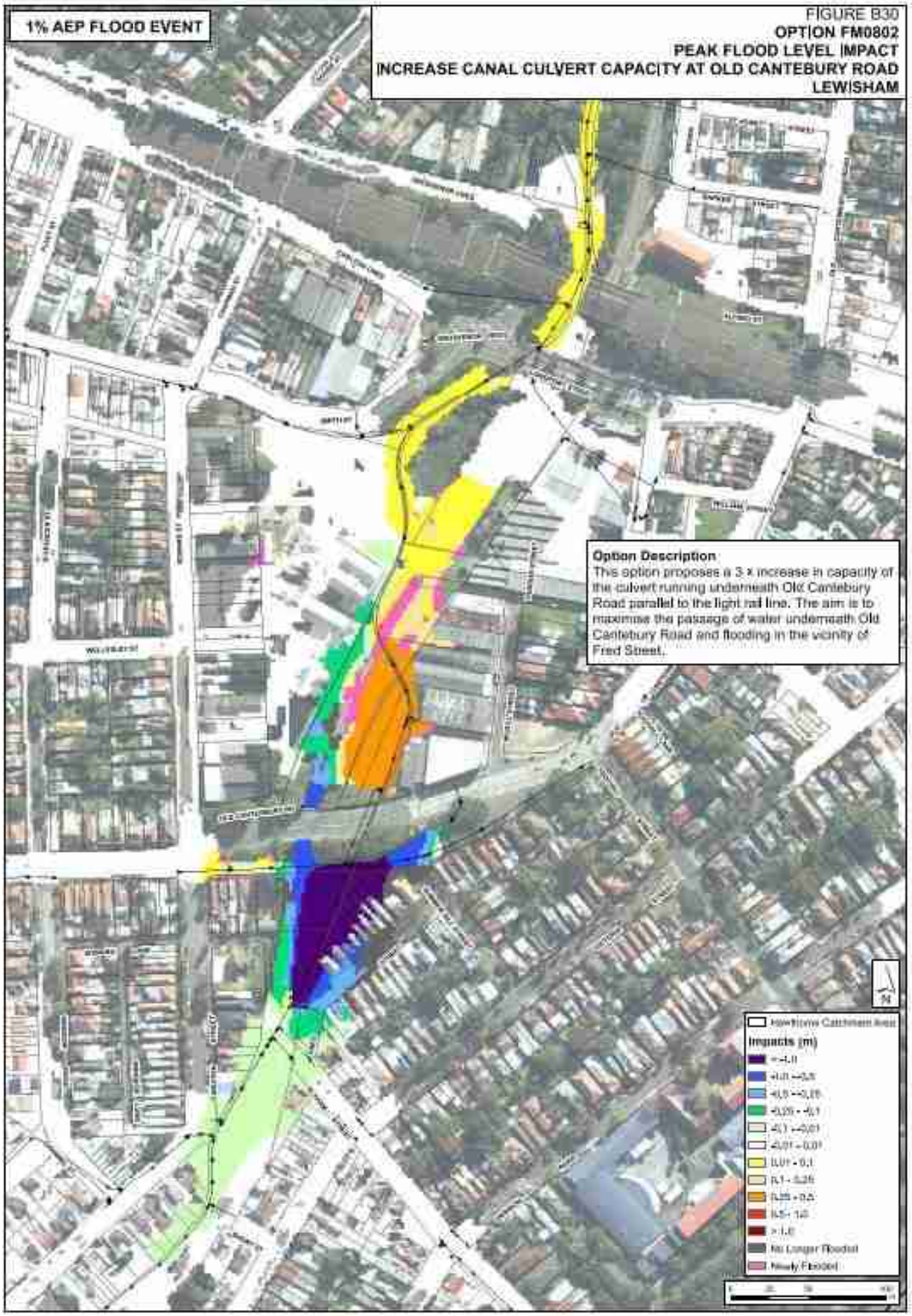

Figure 7-3 Layout of Hawthorne Canal capacity upgrade [source: WMAwater, 2020]

7.4 Drainage Upgrades near Western Channel between Convent Ln and Silver St [Marrickville]

7.4.1 Overview

This option comprises the upgrade of the existing stormwater network along Despointes Street, Convent Lane, Peace Lane, Le Clos Lane, Illawarra Road and Silver Street. The proposed upgrade includes increasing the pipe diameters from 300 mm / 450 mm to 600 mm as well as installing additional inlet pits to alleviate flooding in these streets.

This measure was identified as measure FM3.4 in the *Marrickville Valley Floodplain Risk Management Plan* (Cardno, 2017) as well as item 194 in the *Inner West Local Infrastructure Contributions Plan 2023*. The layout of the option and the predicted flood impacts during the 1% AEP event has been extracted from Appendix A of the 2017 FRMP and shown in **Figure 7-4** below.

7.4.2 Expected Flood Impacts

As shown in **Figure 7-4**, increasing the stormwater network capacity in this area results in flood level decreases of up to 0.3 metres in the subject streets during the 1% AEP event. Flood levels along Sydenham Road are also decreased by up to 0.15 metres. However, flood levels within the Western Channel and several properties downstream of the channel between Garners Lane and Frampton Avenue are increased by up to 0.6 metres.

Flood level decreases of between 0.2 to 0.3 metres in Despointes Street, Convent Lane, Peace Lane and Illawarra Road would represent notable reductions in the existing depth of flooding in those streets. The residual depth of flooding in these streets would be around 0.5 metres or less.

However, the increase in flood levels at several residential properties between Garners Lane and Frampton Avenue is unfavourable. The 2017 FRMP notes that flood levels could increase by up to 0.6 metres during the 1% AEP event, which is considered a significant increase. No further commentary was provided on this adverse flood impact in the 2017 FRMP report.

Given the significant adverse impacts (albeit in a localised area), this mitigation measure is not recommended for implementation as part of the Marrickville master planning process without further investigation into potential actions to minimise the adverse impact.

7.4.3 Estimated Cost

The implementation of this mitigation measure is expected to cost $0.6M according to the *Inner West Local Infrastructure Contributions Plan 2023*.

Figure 7-4 Layout of Western Channel drainage upgrades [source: Cardno, 2017]

7.5 Arthur Street Drainage Upgrades [Marrickville]

7.5.1 Overview

This option comprises the installation of a new 900 mm diameter pipe to connect to the existing stormwater network in the vicinity of Arthur Street and the Malakoff Tunnel. A new 600 mm diameter pipe along Robert Street is also proposed to connect to the existing stormwater network beneath Arthur Street.

This measure was identified as measure FM8.1 and FM8.2 in the *Marrickville Valley Floodplain Risk Management Plan* (Cardno, 2017). The layout of the option and the predicted flood impacts during the 1% AEP event has been extracted from Appendix A of the FRMP and is shown in **Figure 7-5** below.

7.5.2 Expected Flood Impacts

As shown in **Figure 7-5**, increasing the capacity of the stormwater network in the vicinity of Arthur Street is expected to lead to widespread decreases in flood level of up to 0.1 metres in the vicinity of the T3 railway line as well as Marrickville Station. Flood levels in the industrial area to the south of the T3 railway line are also expected to decrease by up to 0.1 metres.

However, the 2017 FRMP model results also indicate that flood levels are predicted to increase by up to 0.1 metres in widespread areas to the north of the T3 railway line in the vicinity of Sydenham Road and the Western Channel as well as industrial areas in the vicinity of Sydenham Road.

A flood level decrease of up to 0.1 metres is not expected to materially reduce the existing flood risk in the vicinity of the T3 railway line and Marrickville Station, given that peak flood depths during the 1% AEP event typically range from 0.8 to 1.5 metres in this area.

Given the minimal benefit in reducing existing flood depths and the predicted flood level increases elsewhere, this mitigation measure is not recommended for further consideration as part of the Marrickville master planning process.

7.5.3 Estimated Cost

The implementation of this mitigation measure is expected to cost $340,000 according to the *Marrickville Valley Floodplain Risk Management Plan* (Cardno, 2017).

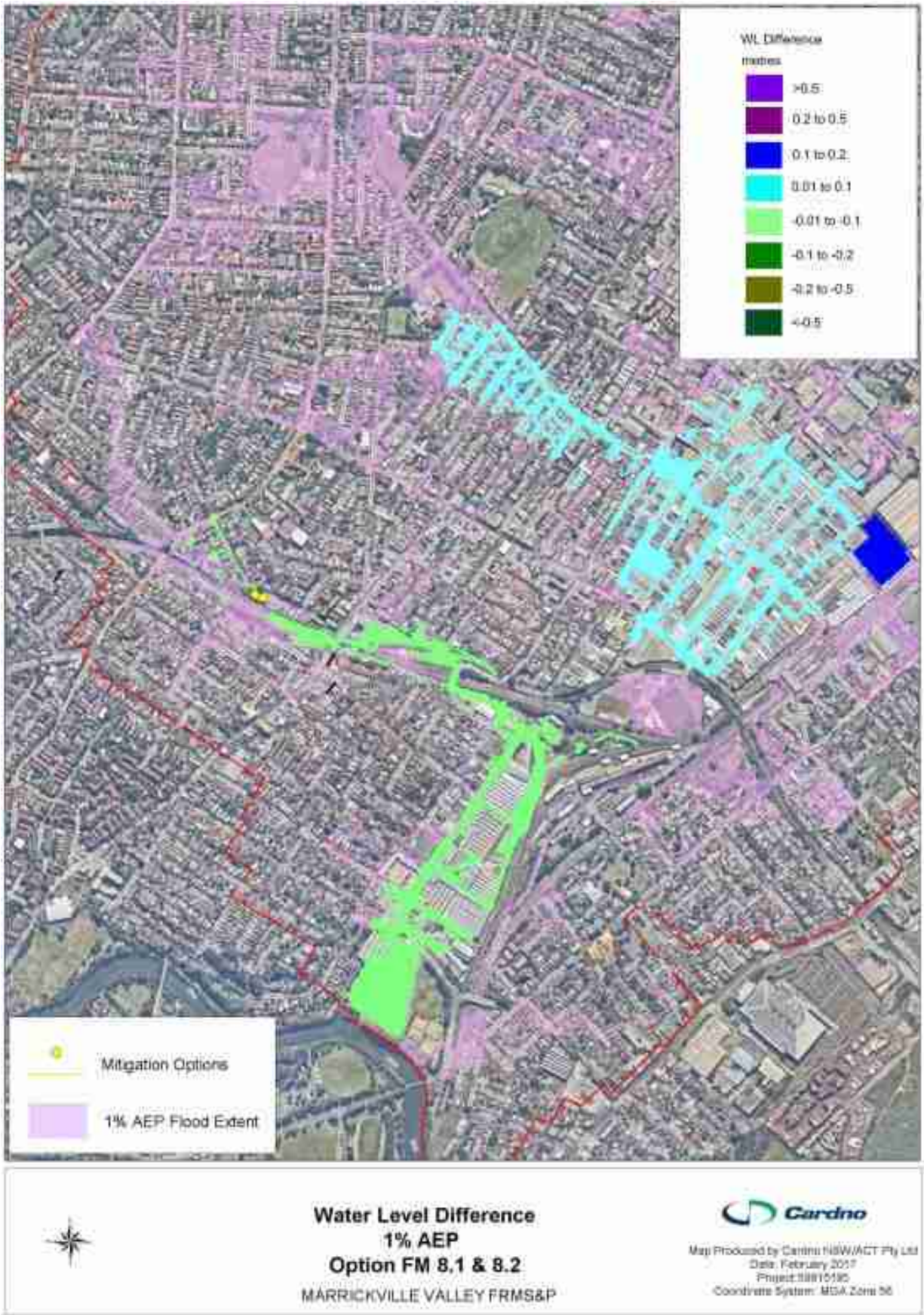

Figure 7-5 Layout of Arthur Street drainage upgrades [source: Cardno, 2017]

7.6 Hollands Avenue Drainage Upgrades and McNeilly Park Detention Basin [Marrickville]

7.6.1 Overview

This option comprises the installation of a new 1050 mm diameter pipe beneath Harney Street, Pine Street and Hollands Avenue to divert flows from Marrickville Road to Livingstone Road. A detention basin is also proposed beneath McNeilly Park with a storage capacity of 8000 m^3, which will connect to Malakoff Tunnel via a new 450 mm pipe. New stormwater inlet pits will also be installed along Marrickville Road, Pine Street and Hollands Avenue.

This measure was identified as measure FM8.3 in the *Marrickville Valley Floodplain Risk Management Plan* (Cardno, 2017). The layout of the option and the predicted flood impacts during the 1% AEP event has been extracted from Appendix A of the FRMP and is shown in **Figure 7-6** below.

7.6.2 Expected Flood Impacts

As shown in **Figure 7-6**, the proposed works is expected to lead to widespread decreases in flood level of up to 0.1 metres in the vicinity of the Hollands Avenue flow path as well as the T3 railway line and Marrickville Station.

Similar to the previous mitigation measure (refer **Section 7.5**), a flood level decrease of up to 0.1 metres is not expected to materially reduce the existing flood risk in the vicinity of the T3 railway line and Marrickville Station, given that peak flood depths during the 1% AEP event typically range from 0.8 to 1.5 metres in this area.

However, this flood level decrease is expected to have greater benefits in overland flow paths to the north of the T3 railway line including Hollands Avenue as well as properties inundated along Crawford Place. The existing depth of flooding in some of these areas is relatively low (0.2 to 0.4 metres) and a reduction of 0.1 metres could be considered a more notable decrease.

Given the benefits in reducing the depth of flooding in some overland flow areas, this mitigation measure could be considered as part of the Marrickville master planning process, however, it is noted that this measure is expensive and could be challenging to implement (refer below).

7.6.3 Additional Considerations

The implementation of this mitigation measure is expected to cost $3.6M according to the *Marrickville Valley Floodplain Risk Management Plan* (Cardno, 2017). It is also noted that the benefit-cost ratio for this option was low (0.19) and the multi-criteria analysis also yielded an overall rank of 'Poor'. Accordingly, it was recommended as a low priority mitigation measure in the 2017 FRMP.

Whilst not discussed in the 2017 FRMP, it is expected that the construction of this measure would lead to significant disruptions along several streets including Harney Street, Pine Street, Hollands Avenue and the railway corridor while the new stormwater pits and pipes are installed.

Figure 7-6 Layout of Hollands Avenue drainage upgrades and McNeilly Park detention basin [source: Cardno, 2017]

7.7 Marrickville Road Drainage Upgrades [Marrickville]

7.7.1 Overview

This option comprises the installation of new 450 mm and 600 mm diameter pipes with additional inlet pits near the Livingstone Road / Marrickville Road intersection, as well as a new 900 mm pipe running beneath Marrickville Road between Livingstone Road and Petersham Road. East of Petersham Road, the new 900 mm pipe will transition into a new 1500 mm diameter pipe to divert flows into a small 100 m^3 detention basin. This detention basin then connects to the existing Malakoff Tunnel.

This measure was identified as measure FM9.1 in the *Marrickville Valley Floodplain Risk Management Plan* (Cardno, 2017). The layout of the option and the predicted flood impacts during the 1% AEP event has been extracted from Appendix A of the FRMP and is shown in **Figure 7-7** below.

7.7.2 Expected Flood Impacts

As shown in **Figure 7-7**, the proposed works are expected to lead to flood level decreases of up to 0.1 metres during the 1% AEP event along Marrickville Road between Livingstone Road and Malakoff Street as well as along Livingstone Road, Lilydale Street, Petersham Road and Depot Lane. A flood level decrease of 0.1 metres during the 1% AEP event is a significant reduction given that the existing flood depths in these areas are typically less than 0.3 metres. This mitigation measure has benefit in more frequent flood events in eliminating flooding along some of these streets.

However, the implementation of this mitigation measure is expected to lead to flood level increases of up to 0.06 metres during the 1% AEP event along the Western Channel and nearby streets such as Malakoff Street, Convent Lane, Despointes Street and Peace Lane. Flood level increases of about 0.02 metres are also predicted to occur in the industrial area to the east.

Given that the area of adverse impact covers a significantly larger than the area of benefit (compare blue shaded areas with green shaded areas in **Figure 7-7**), this mitigation measure was not considered further as part of the master planning process.

7.7.3 Additional Considerations

The implementation of this mitigation measure is expected to cost $2.4M according to the *Marrickville Valley Floodplain Risk Management Plan* (Cardno, 2017). It is also noted that the benefit-cost ratio for this option was low (0.11) and the multi-criteria analysis also yielded an overall rank of 'Poor'. Accordingly, it was recommended as a low priority mitigation measure in the 2017 FRMP.

Whilst not discussed in the 2017 FRMP, it is expected that construction of this measure would lead to significant disruptions along Marrickville Road.

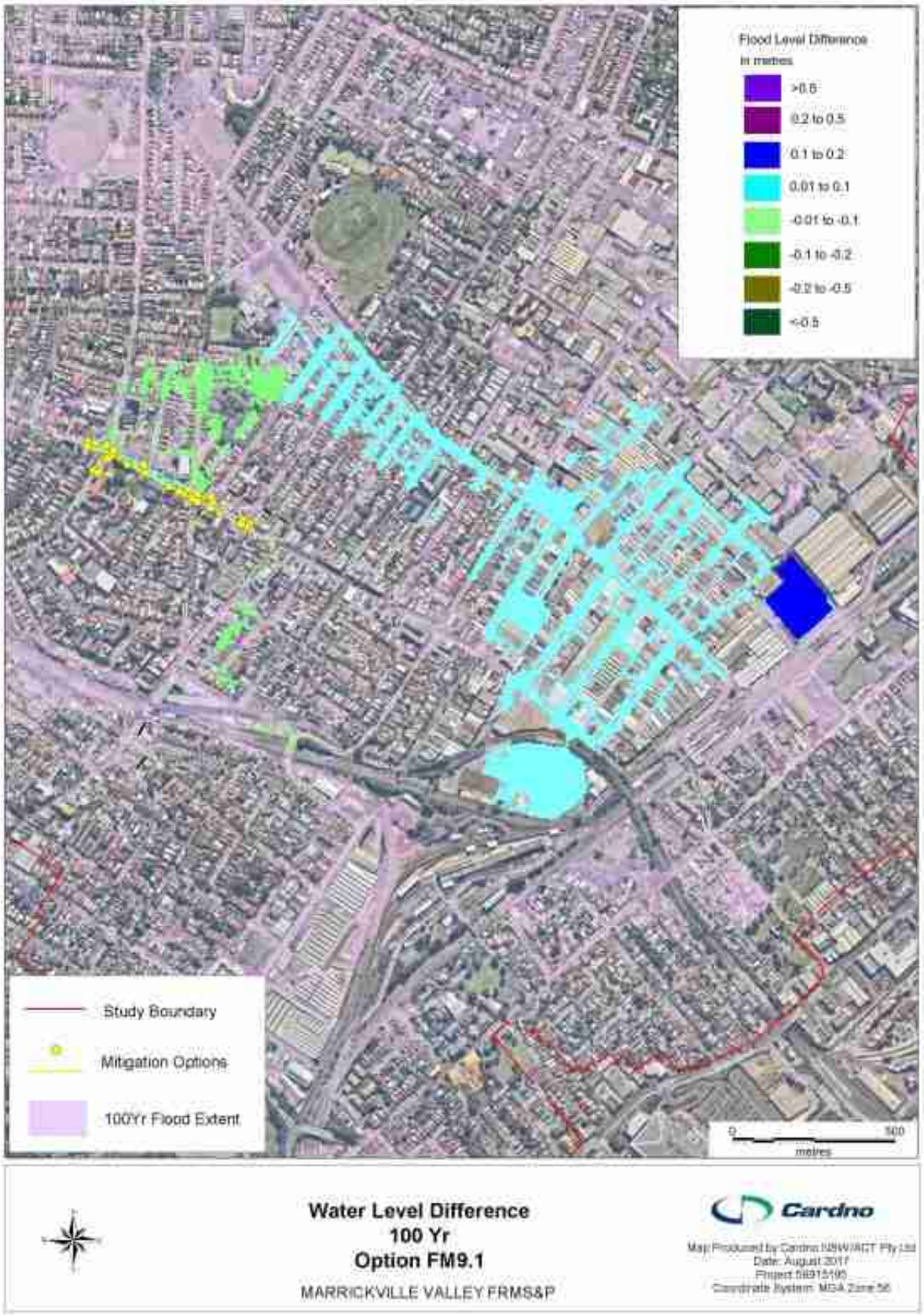

Figure 7-7 Layout of Marrickville Road drainage upgrades [source: Cardno, 2017]

7.8 Cary St, Premier St and Renwick St Drainage Upgrades [Marrickville]

7.8.1 Overview

This option comprises the installation of new 750 mm diameter pipes and inlet pits along Renwick Street, Cary Street and Premier Street to capture additional overland flows to discharge into the Western Channel.

This measure was identified as measure FM12.1 and FM12.2 in the *Marrickville Valley Floodplain Risk Management Plan* (Cardno, 2017) as well as item 195 in the *Inner West Local Infrastructure Contributions Plan 2023*. The layout of the option and the predicted flood impacts during the 1% AEP event has been extracted from Appendix A of the FRMP and is shown in **Figure 7-8** below.

7.8.2 Expected Flood Impacts

As shown in **Figure 7-8**, the proposed works is expected to lead to localised minor benefits along Renwick Street. Flood levels along the Renwick Street road reserve are expected to reduce by 0.08 metres during the 1% AEP event. The 2017 FRMP notes that this mitigation measure is predicted to lead to minor increases in flood levels along the Western Channel between Renwick Street and Cary Street as well as a flood level increase of 0.04 metres in some properties along Renwick Street.

The benefits associated with this mitigation measure are minor and localised to a 150-metre stretch of the Renwick Street road reserve at the eastern boundary of the Dulwich Hill / Marrickville study area. Given the limited flood benefit and potential flood level increases at some properties, this mitigation measure was not considered further for the purposes of this report.

7.8.3 Additional Considerations

The implementation of this mitigation measure is expected to cost $0.6M according to the *Inner West Local Infrastructure Contributions Plan 2023*. However, it is noted that the cost for this measure according to the *Marrickville Valley Floodplain Risk Management Plan* (Cardno, 2017) was estimated to be $2.0M. The cost for this mitigation measure should be reviewed and updated as part of future studies.

Figure 7-8 Layout of Cary Street, Premier Street and Cary Street drainage upgrades [source: Cardno, 2017]

7.9 Cooks River FRMSP Outcomes

The *Cooks River Floodplain Risk Management Study and Plan* (WMAwater, 2015) reviewed a range of potential flood modification options to reduce the impact of flooding in the Cooks River floodplain. However, following an options assessment process, the FRMSP did not recommend the implementation of any flood modification measures.

Instead, the FRMSP recommended further investigation into a levee in the Riverside Crescent area within Marrickville Golf Course as well as stormwater network upgrades near the Riverside Crescent / Dibble Avenue intersection.

7.9.1 Riverside Crescent Levee

The FRMSP noted that the construction of a levee within Marrickville Golf Course would be expensive and highly disruptive. The study concluded that it was a low priority option due to a likely low benefit-cost ratio as well as potential issues with draining water from behind the levee. The study also noted that there could be opposition from the golf club as well as nearby residents.

This mitigation measure was not considered further for the purposes of this report given the lack of a detailed investigation into the feasibility of the levee as well as the likely high costs and disruptive nature of the levee.

7.9.2 Drainage at Riverside Crescent / Dibble Avenue

The FRMSP noted that the Riverside Crescent / Dibble Avenue intersection is regularly inundated by local overland runoff flowing towards the river but did not provide any suggestions for mitigation measures. A high-level recommendation was provided to further investigate stormwater network upgrades or management of the overland flow path.

This flow path was also identified in the preliminary TUFLOW model developed for the Marrickville South overland flows catchment (refer **Section 5**). It is expected that this area would be further investigated in the flood study and floodplain risk management study which is scheduled for the Marrickville South catchment.

8. Flood Modelling of Uplift Scenarios

In order to assess whether Council's master planning would result in an acceptable/unacceptable level of flood impacts and flood risk, a number of uplift scenarios were provided to Worley for testing in the TUFLOW flood models. 32 locations were included in this assessment, which are all locations where new planning controls are proposed within or in the vicinity of identified flood-affected areas.

The uplift scenarios were provided to Worley in the form of indicative building footprints which represent proposed planning controls. It is noted that these footprints are indicative only, as alternative development schemes may come forward which could meet the proposed planning controls and also adequately address potential flood impact and risk issues.

Worley completed a flood impact and risk assessment for these uplift scenarios to assess the predicted impacts on the existing flood risk and flood behaviour in the two study areas. The impact assessment was completed using the TUFLOW flood models developed for the Dobroyd Canal, Hawthorne Canal, Marrickville Valley and Cooks River studies (refer **Section 2.2** and **Section 3.1**) as well as the newly developed preliminary TUFLOW model for the Marrickville South overland flows catchment (refer **Section 5**). These models were modified to incorporate the indicative building footprints associated with the uplift scenarios.

A description of each uplift scenario and the predicted impacts on existing flood risk and flood behaviour is provided in the following.

8.1 Overview of Uplift Locations

The location of the 32 proposed uplift scenarios for the Ashfield / Croydon and Dulwich Hill / Marrickville study areas are shown in **Figure 8-1** to **Figure 8-3**. A summary of the uplift locations is provided in **Table 8-1** with the Ashfield/Croydon study area noted as AC, and the Dulwich Hill/Marrickville study area as DM.

Table 8-1 Summary of Proposed Uplift Locations

Location ID	Study Area	Figure Reference	Description
A	AC	Fig 8-1	New developments on either side of Edwin St between Kenilworth St to the north and Anthony St to the south.
B	AC	Fig 8-1	New developments on northern and southern side of Elizabeth St to the west of Dobroyd Canal, between Edwin St to the west and Bastable St to the east.
C	AC	Fig 8-1	New developments along Etonville Pde and Frederick St between Elizabeth St to the south and John St to the north. Many buildings located adjacent to the Dobroyd Canal open concrete-lined channel.
D	AC	Fig 8-1	New developments near intersection of Heighway Ave and Edwin St to the south of the railway line.
E	AC	Fig 8-1	New development on the eastern side of the Frederick St / Hedger Ave intersection.
F	AC	Fig 8-1	New development on the western side of Alt St to the north of the Albert Pde intersection.

Location ID	Study Area	Figure Reference	Description
G	AC	Fig 8-1	New developments along Charlotte St near Bland St intersection and new developments near the Chandos St / Julia St intersection.
H	AC	Fig 8-1	New developments in Curt St cul-de-sac.
I	AC	Fig 8-1	New development on the corner of Cecil St and Loftus St.
J	AC	Fig 8-1	New developments on the western side of Ashfield Park.
K	AC	Fig 8-1	New developments along Charlotte St near intersection with Webbs Ave.
L	AC	Fig 8-1	New developments along northern and southern sides of Elizabeth St between Frederick St to the west and Nixon Ave to the east.
M	AC	Fig 8-1	New developments near intersection of Chandos St and Orpington St.
N	AC	Fig 8-1	New developments along northern and southern sides of Elizabeth St between Bland St to the west, Wallace St to the east.
O	AC	Fig 8-2	New developments on eastern side of Frederick St near Thomas St intersection.
P	AC	Fig 8-2	New developments between the Dobroyd Canal channel and Frederick St between Liverpool Rd to the south and Thomas St to the north.
Q	AC	Fig 8-2	New developments on the south-western corner of the Milton St / Liverpool Rd intersection.
R	AC	Fig 8-2	New developments to the south of Liverpool Rd, east of Milton St and west of Lapish Ave.
S	AC	Fig 8-2	New developments south of Arthur St and west of Shepherd St.
T	AC	Fig 8-2	New developments at the southern end of Carlisle St and western side of Hugh St.
U	AC	Fig 8-2	New developments bound by Norton St to the north, A'Beckett Ave to the east, Arthur St to the south and Hugh St to the west.
V	AC	Fig 8-2	New developments in Ashfield CBD surrounding Liverpool Road, north of Norton St and south of the railway line.
W	AC	Fig 8-2	New developments bound by Norton St to the north, A'Beckett Ave to the west, Arthur St to the south, Holden St to the east.
X	AC	Fig 8-2	New developments south of Norton St, east of Holden St and west of Queen St.

Location ID	Study Area	Figure Reference	Description
Y	AC	Fig 8-2	New developments bound by Liverpool Rd to the north, Victoria St to the east, Arthur St to the south and Queen St to the west.
Z	AC	Fig 8-2	New developments between Victoria St and Prospect Road near Liverpool Rd to the south of the railway line.
AA	AC	Fig 8-2	New developments at intersection of Victoria St and Robert St.
BB	AC	Fig 8-2	New developments between Bruce St and Pembroke St near Liverpool Rd to the north of the railway line.
CC	DM	Fig 8-3	New developments on the eastern side of Windsor Rd between Terry Rd and Davis St.
DD	DM	Fig 8-3	New developments on land bound by Macarthur Pde, Blackwood Ln and the light rail.
EE	DM	Fig 8-3	New developments on the south-eastern corner of the Livingstone Rd and Stanley St intersection.
FF	DM	Fig 8-3	New developments along the eastern and southern boundary of McNeilly Park south of the railway line.

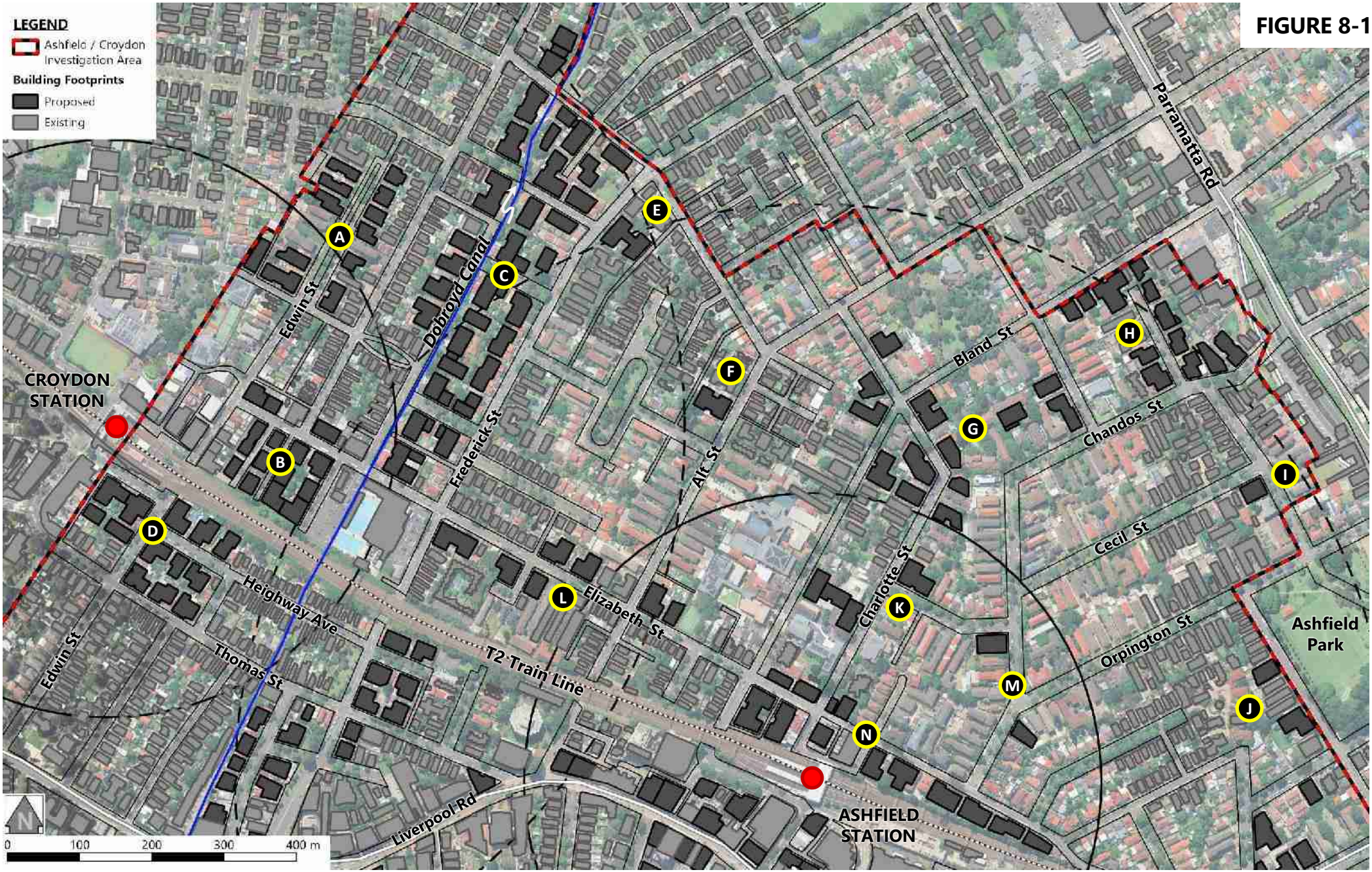

FIGURE 8-1

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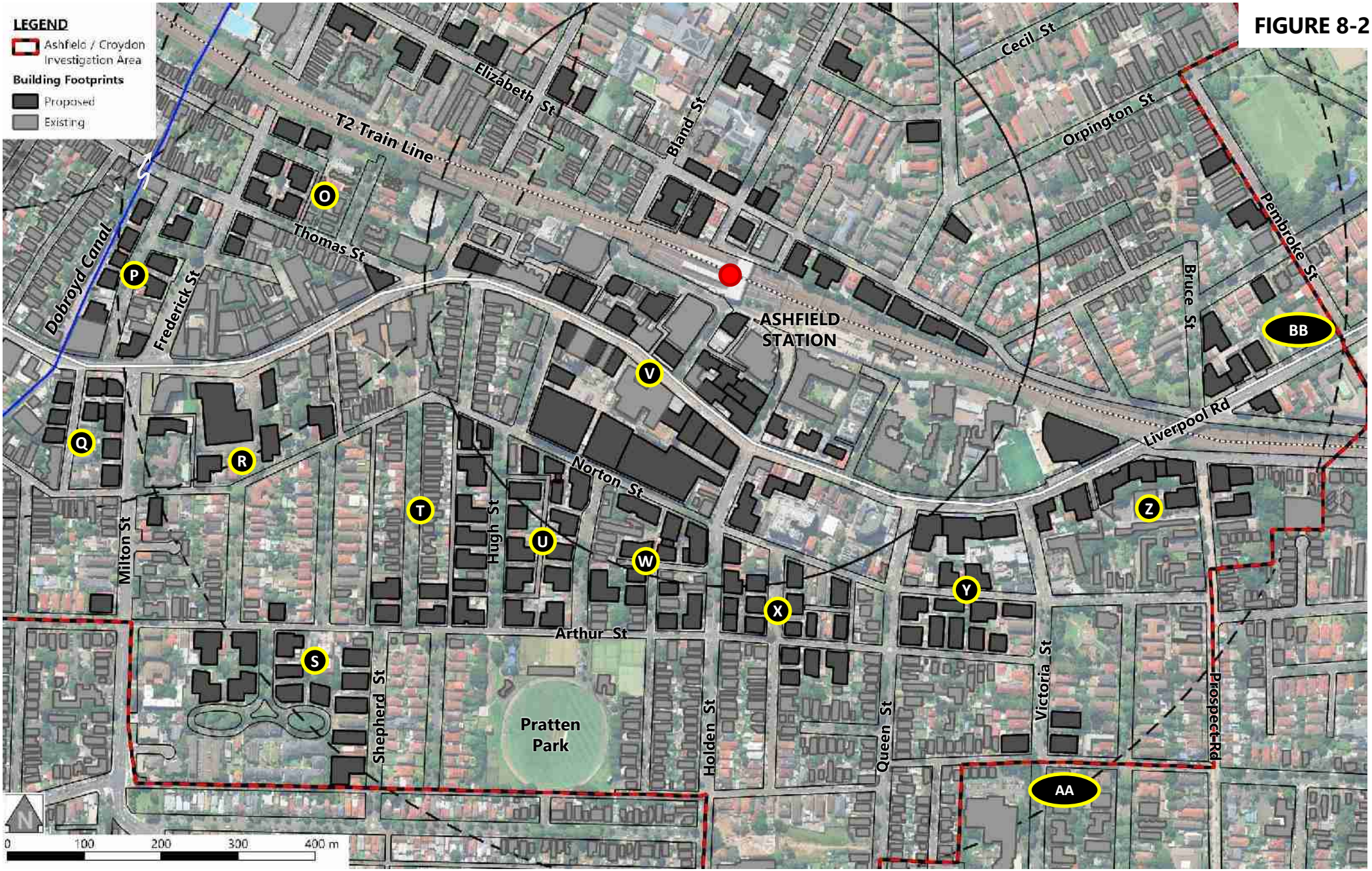
PROPOSED REDEVELOPMENT LOCATIONS AT ASHFIELD AND CROYDON [NORTH]

FIGURE 8-2



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PROPOSED REDEVELOPMENT LOCATIONS AT ASHFIELD AND CROYDON [SOUTH]

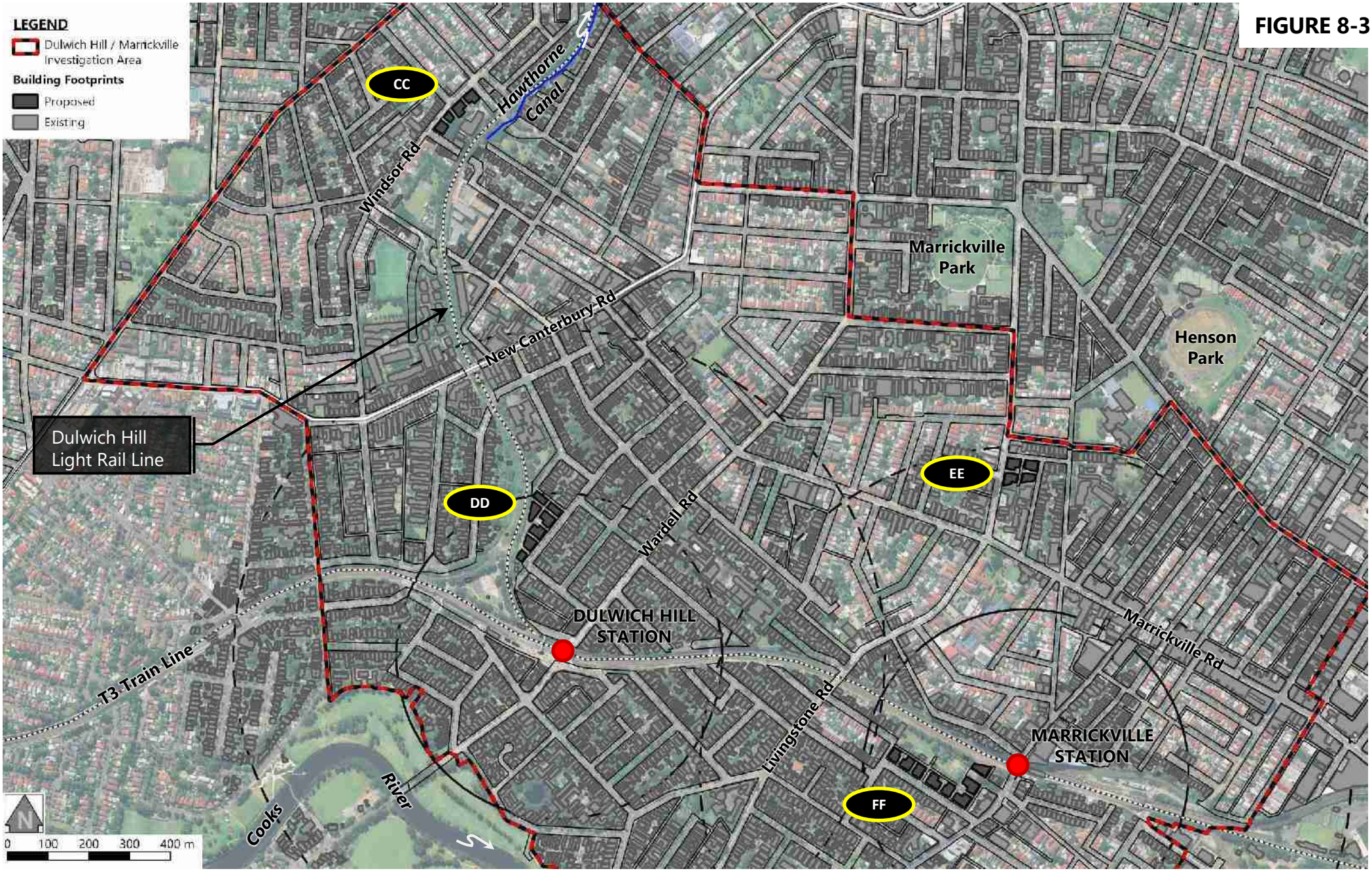

FIGURE 8-3

Prepared by:

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PROPOSED REDEVELOPMENT LOCATIONS AT DULWICH HILL AND MARRICKVILLE

8.2 Unsuitable Uplift Locations

A number of uplift locations which are additional to the 32 locations summarised in **Table 8-1** were previously assessed by Worley through iterative preliminary testing in the TUFLOW flood models. These additional uplift locations were found to be unsuitable for further consideration at this stage due to unacceptable adverse off-site flood impacts or were otherwise situated in areas of high flood risk.

The uplift locations which were considered unsuitable at this stage include the following ten areas (refer **Figure 8-4** and **Figure 8-5**):

1. Residential lots located to the south-east and south-west of the Holden Street / Arthur Street intersection in the Ashfield / Croydon study area. Development in these areas is likely to result in notable adverse off-site flood impacts to existing properties to the south of this area.

2. The lot on the south-eastern corner of the Frederick Street / Beatrice Street intersection in the Ashfield / Croydon study area. Development in this area is likely to result in notable adverse off-site flood impacts to existing properties to the south of this area.

3. The lot on the northern side of Norton Street between Lapish Avenue and Miller Avenue in the Ashfield / Croydon study area. Development in this area is likely to result in notable adverse off-site flood impacts to existing properties to the south and east of this area.

4. Residential lots to the south of Elizabeth Street between Bland Street and Alt Street in the Ashfield / Croydon study area. Development in this area is likely to result in notable adverse off-site flood impacts to existing properties to the west as well as significant increases in the depth of flooding in Nixon Avenue.

5. Residential lots to the north and south of Comet Street to the east of Alt Street in the Ashfield / Croydon study area. Development in this area is likely to result in notable adverse off-site flood impacts to existing properties to the south of this area.

6. Residential lots at 36-42 Bland Street in the Ashfield / Croydon study area. Development in this area is likely to result in an increase in the flood hazard along Bland Street.

7. Residential lots at 54-56 Charlotte Street in the Ashfield / Croydon study area. Development in this area is likely to result in notable adverse off-site flood impacts to existing properties to the north and south.

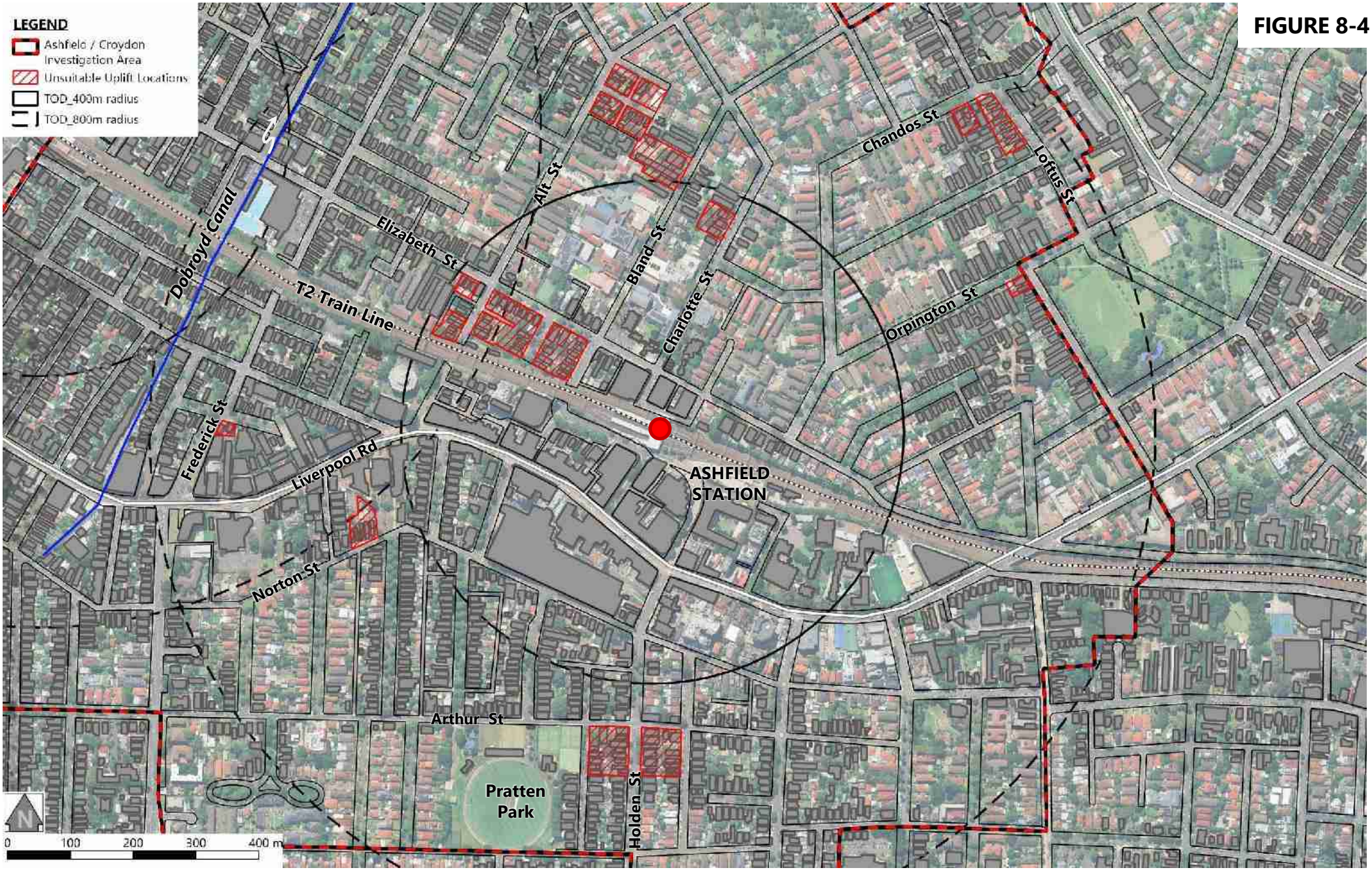
8. Residential lots on the south-western corner of the Chandos Street / Loftus Street intersection in the Ashfield / Croydon study area. Development in this area is likely to result in notable adverse off-site flood impacts to existing properties to the south and west.

9. The lot on the south-western corner of the Orpington Street / Pembroke Street intersection in the Ashfield / Croydon study area. Development in this area is likely to result in notable adverse off-site flood impacts to existing properties to the west and south.

10. Residential lots bound by Ewart Street to the north, Riverside Crescent to the east, Tennyson Street to the south and Ness Avenue to the west in the Dulwich Hill / Marrickville study area. Development in this study area is likely to lead to notable increases in the depth of flooding at Ewart Street and should be confirmed by a more detailed flood model as part of a formal Floodplain Risk Management Study for the Marrickville South area.

Further assessment of significantly altered building footprint configurations, reduced uplift extent and/or suitable flood mitigation measures would be required at the above locations before uplift could be considered.

FIGURE 8-4



Prepared by:

worley consulting

UNSUITABLE LOCATIONS FOR UPLIFT IN THE ASHFIELD / CROYDON STUDY AREA

FIGURE 8-5

Prepared by:

worley consulting

UNSUITABLE LOCATIONS FOR UPLIFT IN THE DULWICH HILL / MARRICKVILLE STUDY AREA

8.3 Overview of Flood Mapping and Impact Mapping

A summary of flood mapping which shows the predicted post-development flood behaviour as well as flood impacts is provided in **Table 8-2**.

Table 8-2 Summary of Post-Development Flood Mapping and Flood Impact Mapping

Appendix	Study Area	Figure Reference	Description
A	Ashfield / Croydon	Fig A9 to Fig A16 Fig A17 to Fig A20	1% AEP post-development flood mapping 1% AEP flood impact mapping
B	Dulwich Hill / Marrickville	Fig B9 to Fig B16 Fig B17 to Fig B20	1% AEP post-development flood mapping 1% AEP flood impact mapping
C	Ashfield / Croydon	Fig C9 to Fig C16 Fig C17 to Fig C20	PMF post-development flood mapping PMF impact mapping
D	Dulwich Hill / Marrickville	Fig D9 to Fig D16 Fig D17 to Fig D20	PMF post-development flood mapping PMF impact mapping

The impact of the uplift scenarios is demonstrated in the flood level and flood hazard difference mapping included in **Appendix A** to **Appendix D**. The difference maps were created by comparing peak flood level and flood hazard estimates from the results of simulations undertaken for existing and post-development scenarios.

This effectively creates a contour map of predicted changes in peak flood levels (*i.e., increases and decreases*) and allows visual assessment of the impact of each uplift scenario on existing peak flood levels. Increases in peak flood levels are represented in different shades of yellow and red, while decreases are represented as shades of blue. The white shading indicates changes in peak flood levels that are between +/- 0.02 metres, which represents the threshold of flood impacts that are considered material for the purposes of this broadscale assessment, particularly given the indicative nature of the proposed building footprints.

The impact of each uplift scenario on the existing flood risk can also be assessed through the comparison of flood hazard mapping for both existing conditions and post-development conditions. Mapping of the change in flood hazard category has also been prepared for each option.

8.4 Predicted Flood Behaviour & Flood Impacts

An overview of the predicted flood behaviour and potential flood impacts at each uplift location is provided in the following. In some instances, redevelopment under proposed planning controls is expected to lead to minor adverse flood impacts. At this stage, it is expected that these adverse impacts can be minimised / avoided at a later stage of the development design, through the implementation of on-site management measures or refinement of the proposed building footprints. The recommended management measures for developments which are predicted to have minor adverse flood impacts have been underlined in the following sections.

For the purposes of this Flood Impact Assessment (FIA), all 32 uplift locations are assumed to be fully redeveloped per the indicative building footprints. The predicted impacts may change depending on the timing and extent of development take-up in these locations.

8.4.1 Uplift Location A (Ashfield / Croydon)

This proposed uplift location would remain generally flood-free up to and including the Probable Maximum Flood (PMF) with the exception of the building footprint on the eastern corner of the Edwin Street / Anthony Street intersection. This building footprint would be affected by an overland flow path which flows eastward along Anthony Street towards Dobroyd Canal.

The majority of high hazard flows are confined to the Anthony Street road corridor. The proposed building footprint on the eastern corner of the Edwin Street / Anthony Street intersection would be inundated by low hazard (H1 to H2) floodwaters in events up to and including the PMF. The proposed uplift is not expected to lead to any material changes to the existing flood levels or flood hazards in the vicinity of the site for events up to and including the PMF.

Figure 8-6 Flood extents near Uplift Location A

8.4.2 Uplift Location B (Ashfield / Croydon)

This proposed uplift location is affected by low hazard in events up to and including the 1% AEP event, with areas of H3 flood hazard confined to the road corridors of Bastable St and Elizabeth St. Flood hazard at this location increases during the PMF, with the eastern portion of the development affected by H3 flood hazard. Flood hazard along Elizabeth St and Bastable St is increased to H4 and H5.

The proposed uplift is not expected to lead to any adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in the vicinity of the site in events up to and including the 1% AEP event. This development is predicted to result in some increases of up to 0.05 metres to existing PMF levels in adjacent lots to the east, although these impacts are considered immaterial given the existing high flood depths (up to 1.5 metres) as well as the low likelihood of the PMF event.

The proposed uplift is also expected to increase the PMF hazard from H4 to H5 in a localised area within the Croydon Road and Elizabeth Street road corridors, near the intersection of the two streets. This increase in PMF hazard will not materially impact on the ability of emergency services to respond to a flood event given that the flood hazard in these roads already leads to conditions which are impassable for emergency vehicles under existing conditions.

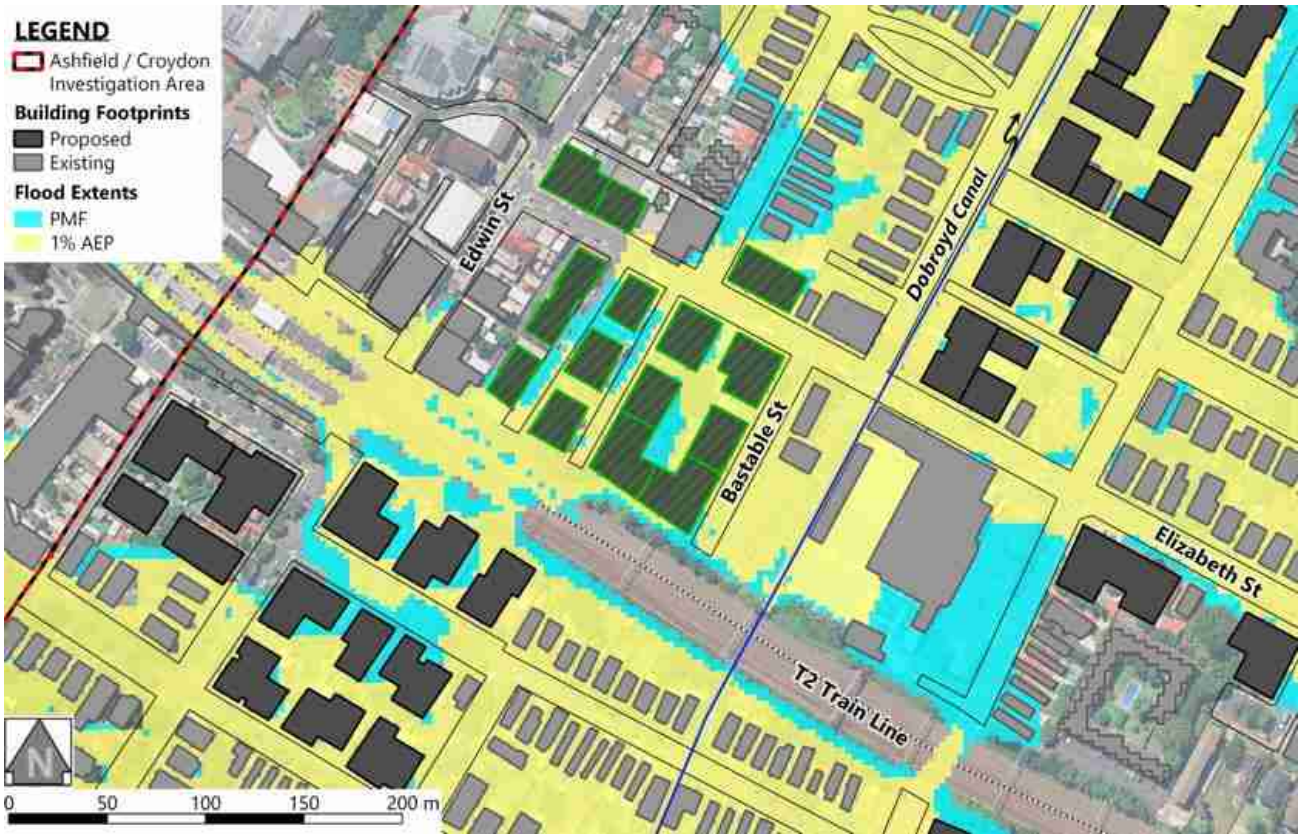


Figure 8-7 Flood extents near Uplift Location B

8.4.3 Uplift Location C (Ashfield / Croydon)

The proposed uplift location is situated on either side of the Dobroyd Canal open concrete channel. The majority of these developments are expected to be inundated during the 1% AEP event. It is noted that the flood hazard within the development lots are generally low (H1 to H2) in events up to and including the 1% AEP event. Areas of high flood hazard are localised and typically confined to the Dobroyd Canal channel and some areas within the Etonville Parade and Hedger Avenue road corridors.

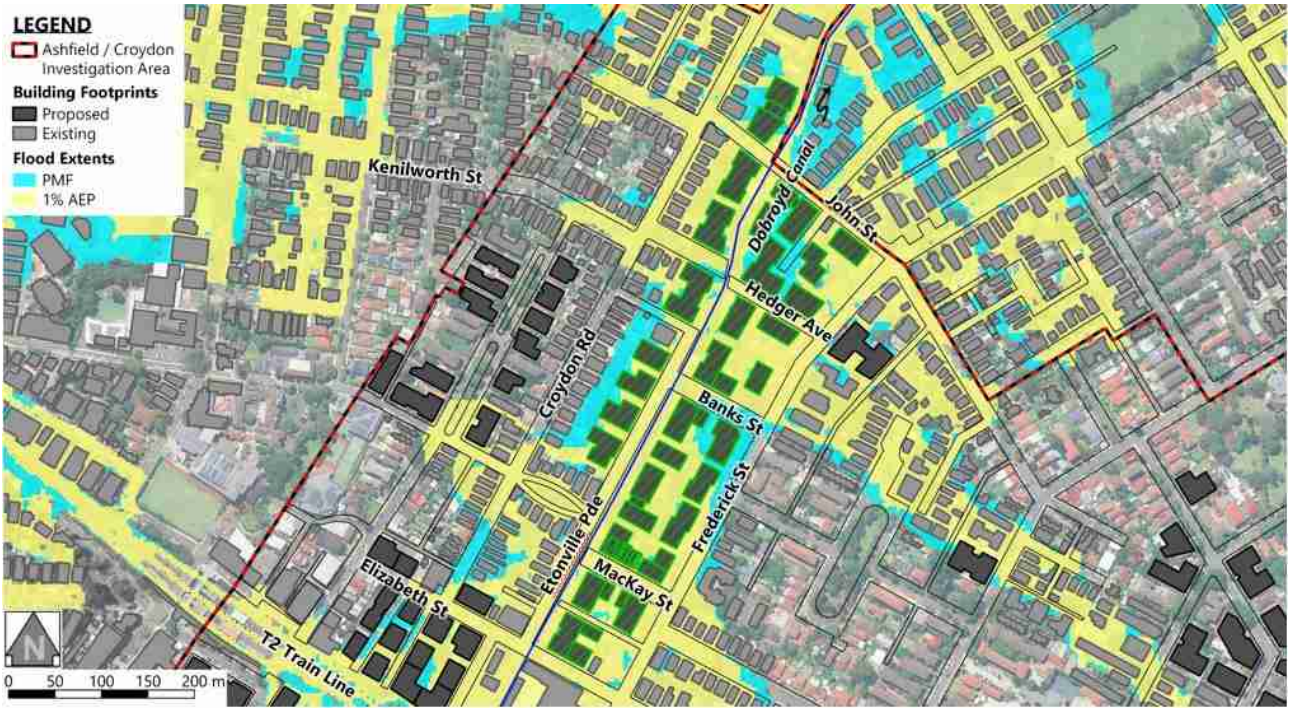


Figure 8-8 Flood extents near Uplift Location C

The flood model results predict a notable increase in flood hazard at the proposed uplift location during the PMF. Development lots are affected by H4 to H5 flood hazard, with some areas of H6 flood hazard within the Etonville Parade road corridor and the immediate vicinity of the Dobroyd Canal channel. The high PMF hazard within development lots is attributed to depths of flooding typically between 1 and 1.5 metres and flow velocities typically between 0.6 and 1.2 m/s.

This proposed uplift is not expected to lead to any adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in the vicinity of the site in events up to and including the 1% AEP event. However, there are some notable increases to flood levels within the proposed development lots on the southern side of Hedger Avenue. Flood levels are predicted to increase by up to 0.2 metres during the 1% AEP event in these development lots. <u>This notable increase in flood levels should be managed through the implementation of on-site mitigation measures at the development application stage</u>.

The proposed uplift is predicted to lead to flood level increases of about 0.2 metres along the length of the development area during the PMF. The uplift is also predicted to lead to some areas of increased PMF hazard within the development lots as well as along Etonville Parade and Frederick Street. The increased flood hazard along Etonville Parade and Frederick Street will not materially impact on the ability of emergency services to respond to a flood event given that the flood hazard in these roads already leads to conditions which are impassable for emergency vehicles under existing conditions (H3+ hazard). It is also recommended that new or redeveloped buildings incorporate elements of structural design to ensure stability in areas of high flood hazard.

The predicted PMF level impact is not considered a factor which precludes the viability of the proposed uplift given that the PMF event is not typically used as the design flood event for flood impact assessments due to the rarity of the event. Additionally, increases in PMF hazard will not materially impact on potential flood emergency response procedures and high PMF hazard within development lots could be mitigated through the incorporation of sound structural design. Careful consideration will need to be given to the design of entrances to buildings and any basement carparking.

8.4.4 Uplift Location D (Ashfield / Croydon)

Significant areas to the south of the railway line along Heighway Avenue and Thomas Street in the vicinity of Dobroyd Canal is affected by H3 to H4 flood hazard during the 1% AEP event. The H3 to H4 flood hazard is attributed to high flood depths (typically between 0.8 and 1.5 metres) which is caused by floodwaters backing-up against the railway embankment.

The proposed uplift would be located towards the western end of Heighway Avenue and Thomas Street generally outside of the areas of H3 to H4 flood hazard. The easternmost building footprint on the northern side of Heighway Avenue is located on the fringes of H3 flood hazard, with flood model results showing that flood depths reach up to 0.8 metres against the eastern edge of this building footprint. Otherwise, all other proposed developments are affected by low flood hazard (H1) during the 1% AEP event.

Figure 8-9 Flood extents near Uplift Location D

During the PMF, the depth of flooding and extent of areas affected by high flood hazard increases significantly. The eastern development lots are typically affected by H4 to H5 flood hazard. PMF depths in these eastern development lots are typically between 2 and 4 metres. It is noted that proposed development lots to the west of Edwin Street would be flood-free in events up to and including the PMF.

The proposed uplift is not expected to lead to any adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in the vicinity of the site for all events up to and including the 1% AEP event. The uplift is predicted to result in some increases of up to 0.05 metres to existing PMF levels in adjacent lots to the east and south, although these impacts are considered immaterial given the existing high flood depths (in excess of 2 metres) as well as the low likelihood of the PMF event. Uplift in this area is not expected to lead to any changes in the existing PMF hazard.

8.4.5 Uplift Location E (Ashfield / Croydon)

This proposed uplift location is located near an overland flow path which flows in a westerly direction towards Dobroyd Canal. The site is affected by low flood hazard (H1) in events up to and including the 1% AEP event. During the PMF event, the southern edge of the development is affected by some localised high hazard (H3 to H5) arising from high flow velocities of up to 2.3 m/s and flood depths of up to 0.6 metres.

The proposed uplift is not expected to lead to any adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in the vicinity of the site in events up to and including the 1% AEP event.

The proposed uplift is predicted to lead to flood level increases of about 0.15 metres in the adjacent property to the south during the PMF. It is noted that the uplift is not expected to lead to any material impacts to the existing PMF hazard in the vicinity of the development. The flood hazard in the neighbouring building to the south as well as the Frederick Street road corridor generally remains low (H2), with small, isolated areas of H3 hazard.

The predicted PMF level impact is not considered a factor which precludes the viability of the proposed uplift given that the PMF event is not typically used as the design flood event for flood impact assessments. Additionally, the uplift does not lead to any significant changes to the PMF hazard in the adjacent property or the adjacent roadway.

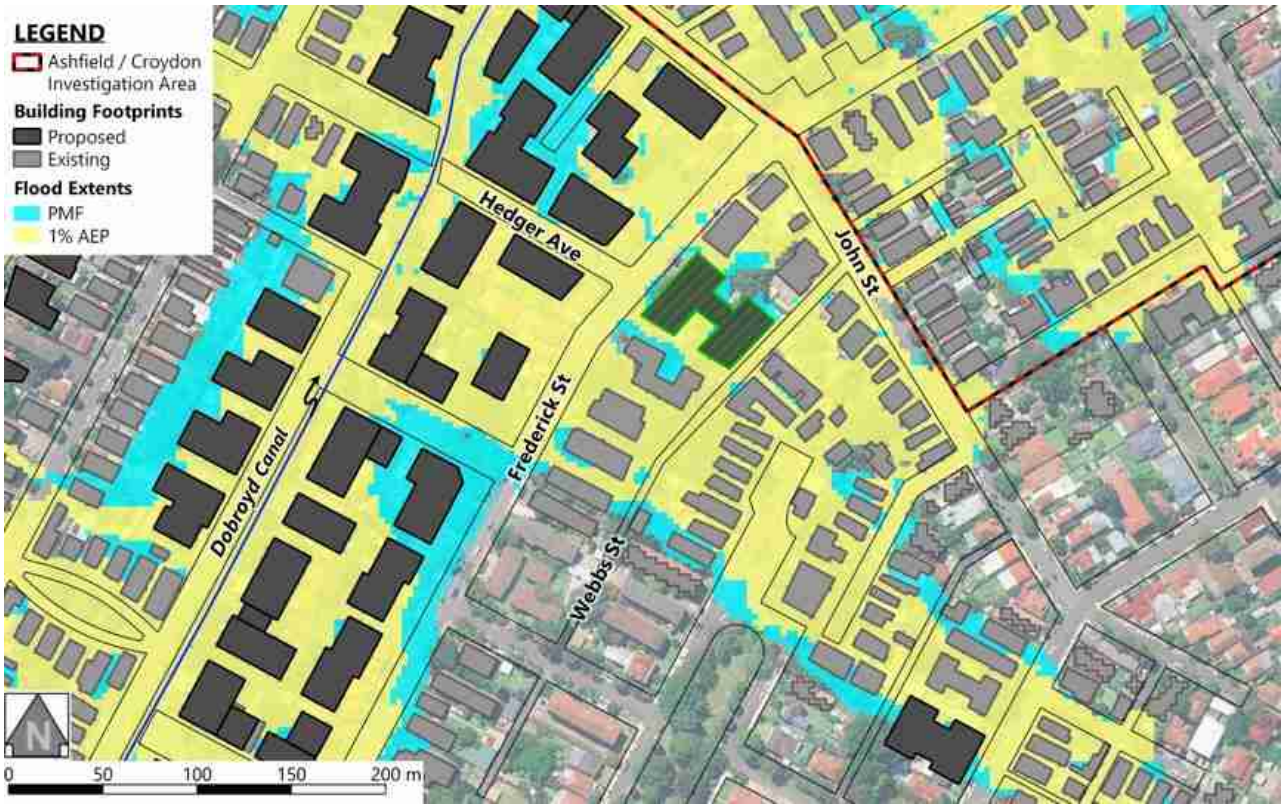


Figure 8-10 Flood extents near Uplift Location E

8.4.6 Uplift Location F (Ashfield / Croydon)

This proposed uplift location is located near an overland flow path which flows in a westerly direction towards Dobroyd Canal. The site is affected by low flood hazards (H1 to H2) in events up to and including the 1% AEP event. During the PMF event, the northern edge of the development is affected by some localised high hazards (H3 to H5) arising from high flow velocities of up to 2.1 m/s and flood depths of up to 0.8 metres.

This proposed uplift is not expected to lead to any adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in the vicinity of the site in events up to and including the 1% AEP event.

The proposed uplift is predicted to lead to flood level increases of about 0.14 metres in the adjacent property to the north-west during the PMF. It is noted that the uplift is not expected to lead to any material impacts to the existing PMF hazard in the vicinity of the uplift area. The flood hazard increases from H3 to H4 in a small localised area in the neighbouring property to the north-west, while the flood hazard remains at H3 in the Alt Street road corridor adjacent to the proposed uplift area.

The predicted PMF level impact is not considered a factor which precludes the viability of the proposed uplift given that the PMF event is not typically used as the design flood event for flood impact assessments. Additionally, the uplift does not lead to any significant changes to the PMF hazard in the adjacent property or the adjacent roadway.

Figure 8-11 Flood extents near Uplift Location F

8.4.7 Uplift Location G (Ashfield / Croydon)

The proposed uplift location is not affected by flooding in events up to and including the Probable Maximum Flood (PMF). Accordingly, the uplift is not expected to impact on existing flood behaviour.

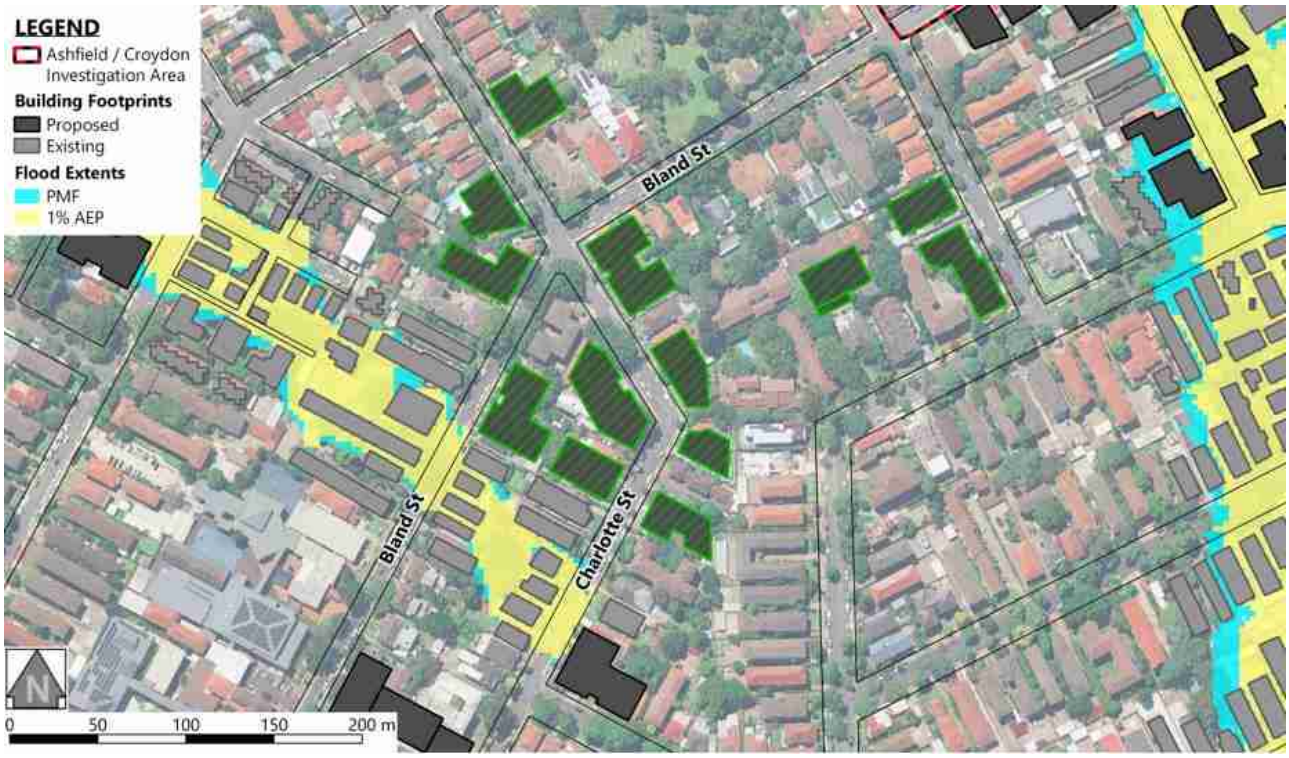


Figure 8-12 Flood extents near Uplift Location G

8.4.8 Uplift Location H (Ashfield / Croydon)

This proposed uplift location is located along an overland flow path which flows in a northerly direction towards Dobroyd Canal. The site is typically affected by low flood hazards (H1 to H2) during the 1% AEP event, except for some localised areas of H3 to H4 hazard which are typically located in small gaps between building footprints which are affected by high flow velocities. During the PMF event, much of the site is affected by H5 flood hazards.

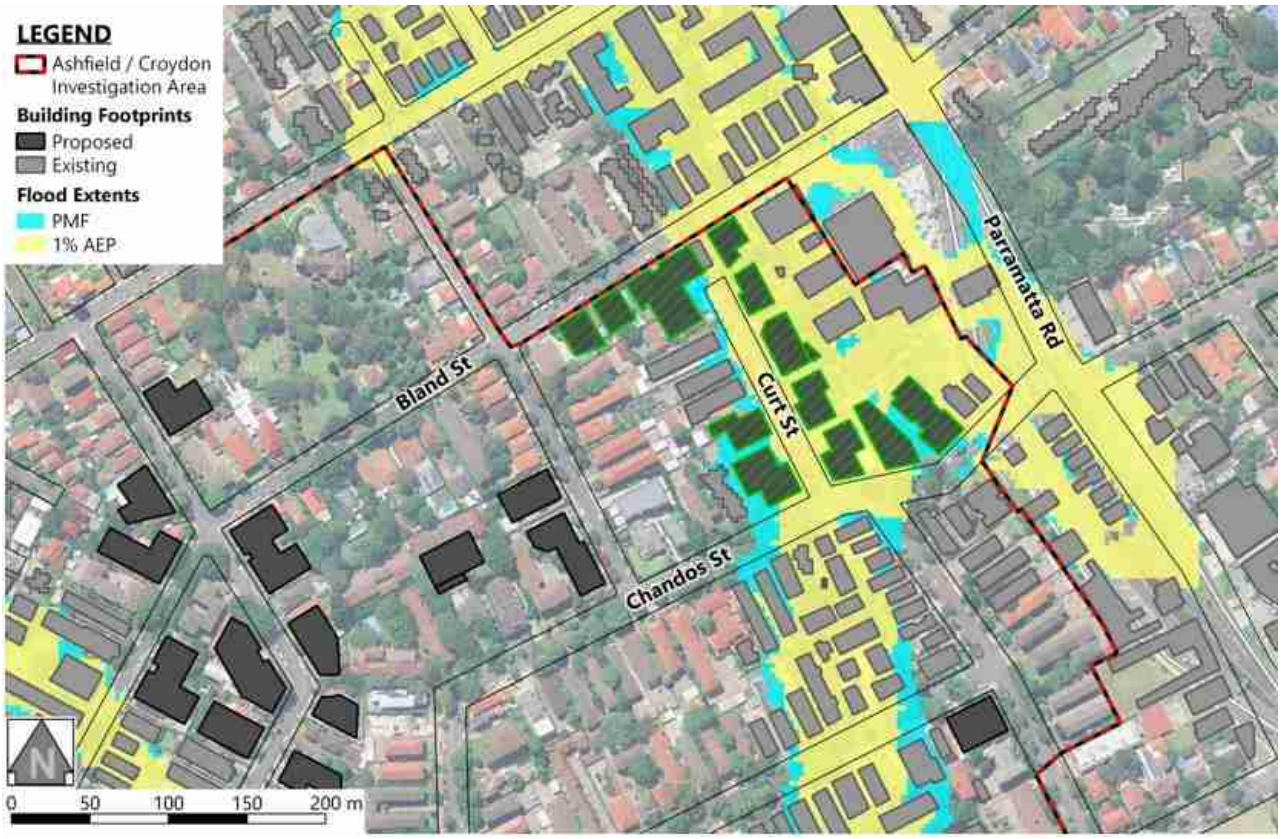


Figure 8-13 Flood extents near Uplift Location H

This proposed uplift is not expected to lead to any adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in the vicinity of the site in events up to and including the 1% AEP event. Some localised areas of flood level increases are predicted in areas within the development lots which are to be managed by on-site mitigation measures or refinement of building footprints at the development application stage.

The proposed uplift is predicted to lead to localised flood level increases of up to 0.17 metres during the PMF in some adjacent properties and within the Curt Street road corridor. It is noted that the uplift is not expected to lead to any material impacts to the existing PMF hazard in the vicinity of the development area.

The predicted PMF level impact is not considered a factor which precludes the viability of the proposed uplift given that the PMF event is not typically used as the design flood event for flood impact assessments. Additionally, the uplift does not lead to any significant changes to the PMF hazard in adjacent properties or road corridors.

8.4.9 Uplift Location I (Ashfield / Croydon)

The proposed uplift location is not affected by flooding in events up to and including the Probable Maximum Flood (PMF). Accordingly, the uplift is not expected to impact on existing flood behaviour.

Figure 8-14 Flood extents near Uplift Location I

8.4.10 Uplift Location J (Ashfield / Croydon)

This proposed uplift location is near an overland flow path which flows in a northerly direction towards Dobroyd Canal. The site is typically affected by low flood hazards (H1) in events up to and including the PMF event.

Figure 8-15 Flood extents near Uplift Location J

This proposed uplift is not expected to lead to any notable adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in events up to and including the PMF, except for a small localised area which is newly inundated under post-development conditions. It is noted that this newly inundated area affects only yards and open spaces and does not impact against existing building footprints. Additionally, flood depths in this newly inundated area are very low (<0.02 metres) in events up to and including the PMF.

8.4.11 Uplift Location K (Ashfield / Croydon)

This proposed uplift location is not affected by flooding in events up to and including the Probable Maximum Flood (PMF). Accordingly, this uplift is not expected to impact on existing flood behaviour.

Figure 8-16 Flood extents near Uplift Location K

8.4.12 Uplift Location L (Ashfield / Croydon)

This proposed uplift location is affected by low hazard (H1 to H2) flooding in events up to and including the 1% AEP event, with areas of higher flood hazard confined to the Elizabeth Street road corridor. Flood hazard at this location increases during the PMF, with some proposed development lots affected by H3 flood hazards. Similar to the more frequent design events, areas of high flood hazard (H5) are confined to the Elizabeth Street road corridor.

The proposed uplift is not expected to lead to any adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in the vicinity of the site in events up to and including the 1% AEP event. The uplift is predicted to result in some localised increases of up to 0.11 metres in existing PMF levels in the Elizabeth Street road corridor.

It is noted that these flood level increases do not lead to increases to the existing PMF hazard along Elizabeth Street. PMF hazard along Elizabeth Street is predicted to be H5 under both existing and post-development conditions. Accordingly, there is no impact on potential emergency response strategies given that Elizabeth Street would not be trafficable during the PMF.

Figure 8-17 Flood extents near Uplift Location L

8.4.13 Uplift Location M (Ashfield / Croydon)

The proposed uplift location is not affected by flooding in events up to and including the Probable Maximum Flood (PMF). Accordingly, the proposed uplift is not expected to impact on existing flood behaviour.

Figure 8-18 Flood extents near Uplift Location M

8.4.14 Uplift Location N (Ashfield / Croydon)

This site is located to the east of the Bland Street railway underpass. The Bland Street railway underpass is affected by high flood depths as floodwaters pond in the low point in the road to depths exceeding 3 metres during the 1% AEP event.

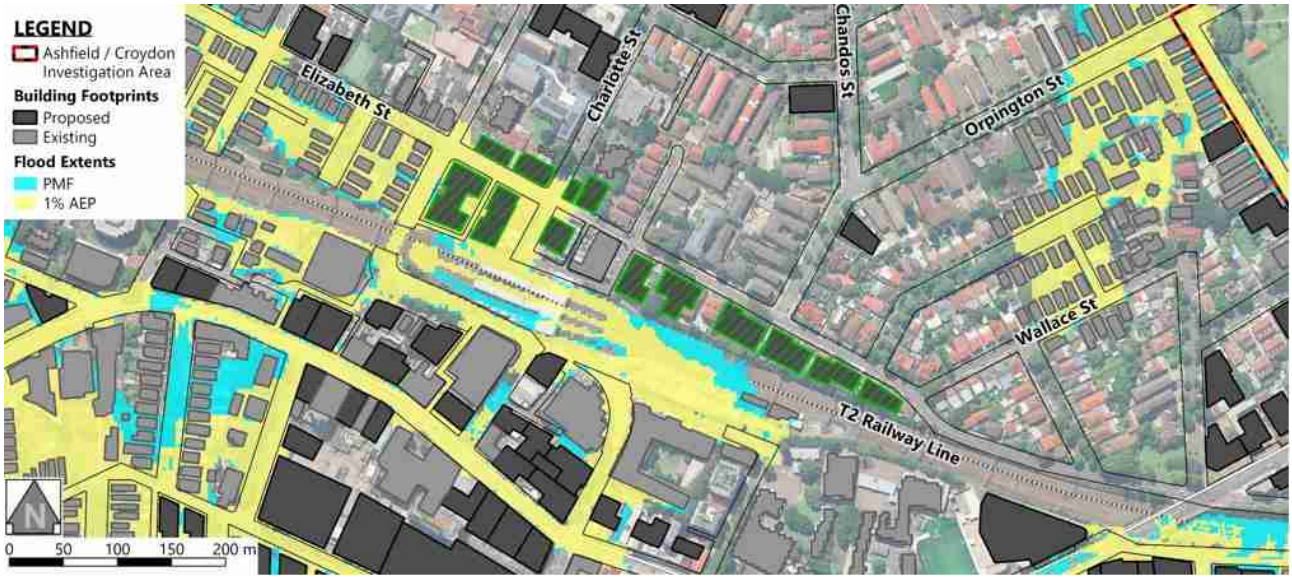


Figure 8-19 Flood extents near Uplift Location N

However, it is noted that the uplift location is located on land above the peak PMF level of ponding in the Bland Street railway underpass. Notwithstanding, this proposed uplift location is affected by overland flows which drain westward towards the railway underpass.

The majority of the development area is expected to be flood free in events up to and including the PMF, in areas to the east of Charlotte Street. The proposed uplift is not expected to lead to any adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in the vicinity of the site in events up to and including the PMF.

8.4.15 Uplift Location O (Ashfield / Croydon)

This site is located along a major overland flow path which runs in a north-westerly direction towards Dobroyd Canal near Heighway Avenue. The development lots are affected by low flood hazards (H1 to H2) in events up to and including the 1% AEP event, with areas of higher flood hazard confined to the Thomas Street and Frederick Street road corridors.

Figure 8-20 Flood extents near Uplift Location O

A higher flood hazard is expected in the vicinity of the proposed uplift location during the PMF. The site is affected by H5 flood hazard, with a small area of H6 flood hazard in the development lot between Heighway Avenue to the north and Thomas Street to the south. These high flood hazards are attributed to PMF depths in excess of 3 metres across this development site, with some localised areas of H6 flood hazard attributed to localised high velocities in combination with the high flood depths. These significant flood depths are caused by floodwaters backing-up on the southern side of the railway line.

During the 1% AEP event, the proposed uplift is expected to lead to some areas of flood level increases of up to 0.09 metres in the Thomas Street roadway to the east of Frederick Street, as well as some flood level increases of up to 0.1 metres in an existing property on the southern side of Thomas Street. It is noted that these impacts are localised and could be minimised / removed through further refined design of the development and/or the implementation of on-site management measures at the development application stage.

The proposed uplift is also expected to result in some localised increases in the existing 1% AEP flood hazard along Thomas Street to the east of Frederick Street. The uplift is expected to lead to increased areas of H4

flood hazard in Thomas Street as more flows are directed westward along the street. However, it is noted that Thomas Street is already affected by some areas of H4 to H5 hazard in areas to the east of the proposed uplift location under existing conditions.

Further refinement of the building footprint design is required to minimise or remove the localised flood level and flood hazard impacts.

8.4.16 Uplift Location P (Ashfield / Croydon)

This site is located on the eastern side of Dobroyd Canal which runs in a northerly direction towards and through the railway embankment. The development lots are affected by low flood hazard (H1 to H2) in events up to and including the 1% AEP event, with areas of higher flood hazard confined to the Dobroyd Canal open channel and the Milton Street North and Beatrice Street road corridors.

A higher flood hazard is expected in the vicinity of this proposed uplift location during the PMF. The site is affected by H5 flood hazard, with areas of H6 flood hazard confined to the Dobroyd Canal channel and the Milton Street North road corridor.

The proposed uplift is not expected to lead to any adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in the vicinity of the site in events up to and including the 1% AEP event. This development is predicted to result in some increases of up to 0.25 metres in existing PMF levels in the Dobroyd Canal channel and adjacent lots to the west. These impacts are considered largely immaterial given the existing high flood depths (up to 3.5 metres) as well as the low likelihood of the PMF event. It is noted that the uplift is not expected to lead to any material changes in the existing PMF hazard.

It is noted that some existing buildings on the south-western corner of the Frederick Street / Thomas Street intersection are proposed to be removed as part of a proposed widening of Frederick Street. This is expected to lead to a minor localised flood level increase of up to 0.05 metres in an existing property on the north-western corner of the Frederick Street / Thomas Street intersection during the 1% AEP event. This off-site impact is attributed to the removal of existing buildings as part of the Frederick Street road widening and is not attributed to the proposed uplift at Site P.

Figure 8-21 Flood extents near Uplift Location P

8.4.17 Uplift Location Q (Ashfield / Croydon)

This site is located on the eastern side of Dobroyd Canal which runs in a northerly direction towards and through the railway embankment. The development lots are affected by low flood hazards (H1 to H2) events up to and including the 1% AEP event, with areas of higher flood hazard confined to the Dobroyd Canal open channel.

A higher flood hazard is expected in the vicinity of this proposed uplift location during the PMF. The westernmost building footprints are affected by H4 to H5 flood hazard, but the easternmost building footprints (i.e., adjacent to Milton Street) are affected by low flood hazard (typically H1 to H2).

The proposed uplift is not expected to lead to any adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in the vicinity of the site in events up to and including the 1% AEP event. The uplift is predicted to result in some increases of up to 0.04 metres in existing PMF levels in the Dobroyd Canal channel and adjacent lots to the west, although these impacts are considered immaterial given the existing high flood depths (up to 1.7 metres) as well as the low likelihood of the PMF event. It is noted that the proposed uplift is not expected to lead to any material changes in the existing PMF hazard.

Figure 8-22 Flood extents near Uplift Location Q

8.4.18 Uplift Location R (Ashfield / Croydon)

This proposed uplift location is generally flood-free up to and including the Probable Maximum Flood (PMF) with the exception of the two easternmost building footprints, which are inundated during the PMF only. These building footprints are affected by an overland flow path which flows in a north-westerly direction towards Dobroyd Canal.

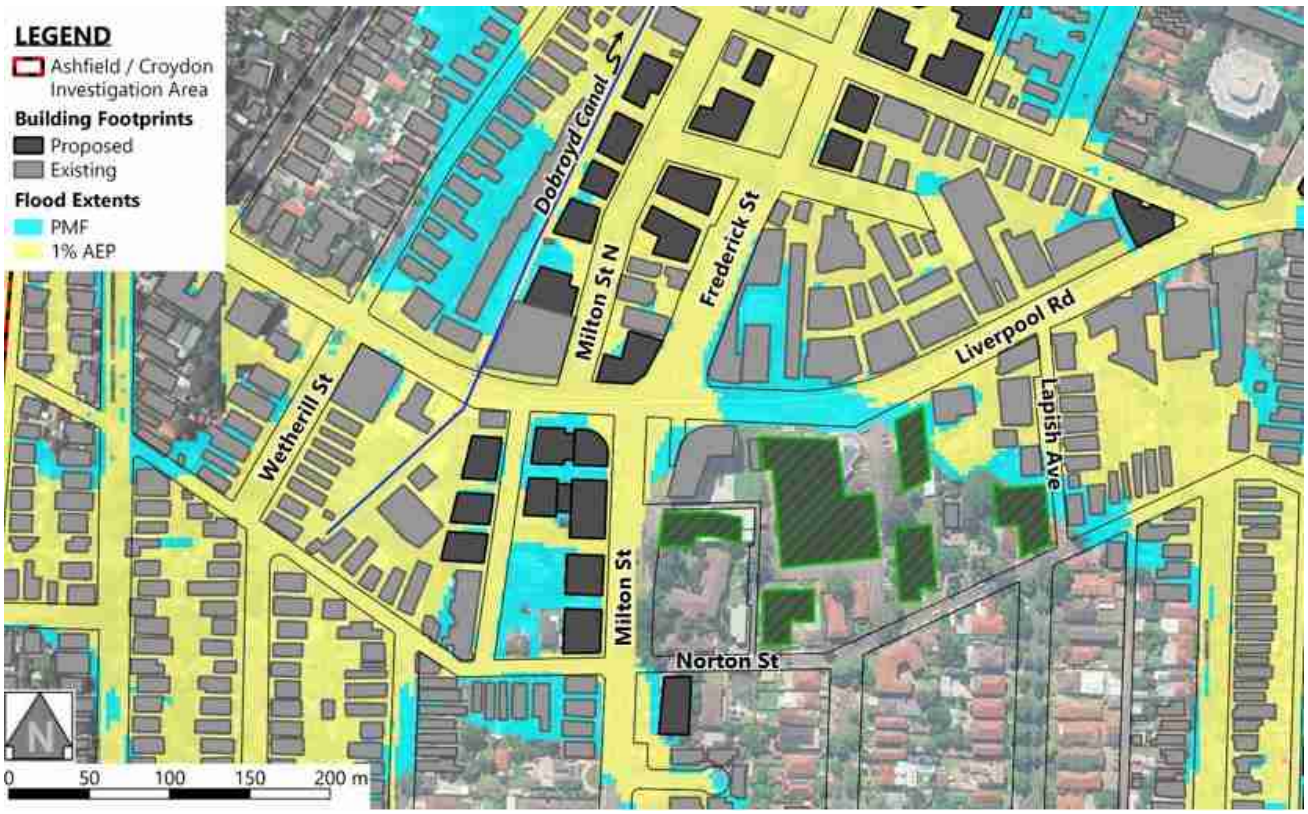


Figure 8-23 Flood extents near **Uplift Location** R

During the PMF, these two building footprints are typically affected by H1 to H3 flood hazard. High PMF hazard is confined to Liverpool Road to the north of the uplift location or in areas to the east of the uplift location. The proposed uplift is not expected to lead to any adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in the vicinity of the site in events up to and including the PMF.

8.4.19 Uplift Location S (Ashfield / Croydon)

This site is located at the upper reaches of an overland flow path which runs in a north-westerly direction towards Dobroyd Canal near Liverpool Rd. The development lots are generally affected by low flood hazards (H1 to H2) in events up to and including the PMF event, with areas of higher flood hazard confined to the Arthur Street road corridor.

Development lots on the eastern side of Brunswick Parade remain flood-free in events up to and including the PMF.

The proposed uplift is not expected to lead to any adverse off-site flood impacts (i.e., increases to existing flood levels or flood hazards) in the vicinity of the site in events up to and including the 1% AEP event.

During the PMF, the uplift is predicted to lead to a localised flood level increase of up to 0.18 metres in Brunswick Parade immediately east of indicative building footprints on the west side of the road. This does not manifest as any material increase to the flood hazard along Brunswick Parade. Additionally, there are no adverse flood impacts in any adjacent properties.

The predicted PMF level impact is not considered a factor which precludes the viability of the proposed uplift given that the PMF event is not typically used as the design flood event for flood impact assessments. Additionally, the uplift does not lead to any notable changes to the PMF hazard in adjacent properties or road corridors.

Figure 8-24 Flood extents near Uplift Location S

8.4.20 Uplift Location T (Ashfield / Croydon)

This site is located along a major overland flow path which runs in a north-westerly direction towards Dobroyd Canal near Thomas Street and Heighway Avenue. This major overland flow path affects several proposed buildings at the northern end of the development area. Some of the proposed buildings in this area are affected by H4 / H5 flood hazard during the 1% AEP event and primarily H5 hazard during the PMF event. Otherwise, buildings towards the southern end of this development area are affected by low flood hazards (H1) in events up to and including the PMF.

The proposed uplift is expected to lead to a flood level increase of up to 0.04 metres during the 1% AEP event in some adjacent lots on the eastern side of Carlisle Avenue. However, these impacts are very localised and only affect two existing buildings. Notwithstanding this, these impacts should be mitigated through refinement of the building design or implementation of on-site management measures at the development application stage. These on-site management measures should also be implemented to reduce some predicted flood level increases within the development lots.

The uplift is not expected to lead to any notable changes to the existing flood hazard in the vicinity of the development in events up to and including the PMF.

Figure 8-25 Flood extents near Uplift Location T

8.4.21 Uplift Location U (Ashfield / Croydon)

This site is also located along the major overland flow path which runs in a north-westerly direction towards Dobroyd Canal near Thomas Street and Heighway Avenue. This major overland flow path affects several indicative building footprints in the middle of the development area. Some of the indicative building footprints in this area are affected by H4 / H5 flood hazard during the 1% AEP event and primarily H5 hazard during the PMF event. Otherwise, building footprints at the northern and southern ends of this development area are affected by low flood hazards (H1 to H2) in events up to and including the PMF.

During the 1% AEP event, the proposed uplift is expected to lead to localised flood level increases of up to 0.06 metres and 0.21 metres in the A'Beckett Avenue and Hugh Street road corridors, respectively. It is noted that these flood level increases are not expected to have any material impacts on flood hazard in these roads. Both roads are already not trafficable under existing conditions due to H4 to H5 flood hazard during the 1% AEP event. Similar impacts are predicted for the PMF event.

Figure 8-26 Flood extents near Uplift Location U

8.4.22 Uplift Location V (Ashfield / Croydon)

This site is the main commercial area of Ashfield, which is located north of the major overland flow path which runs in a north-westerly direction towards Dobroyd Canal near Thomas Street and Heighway Avenue.

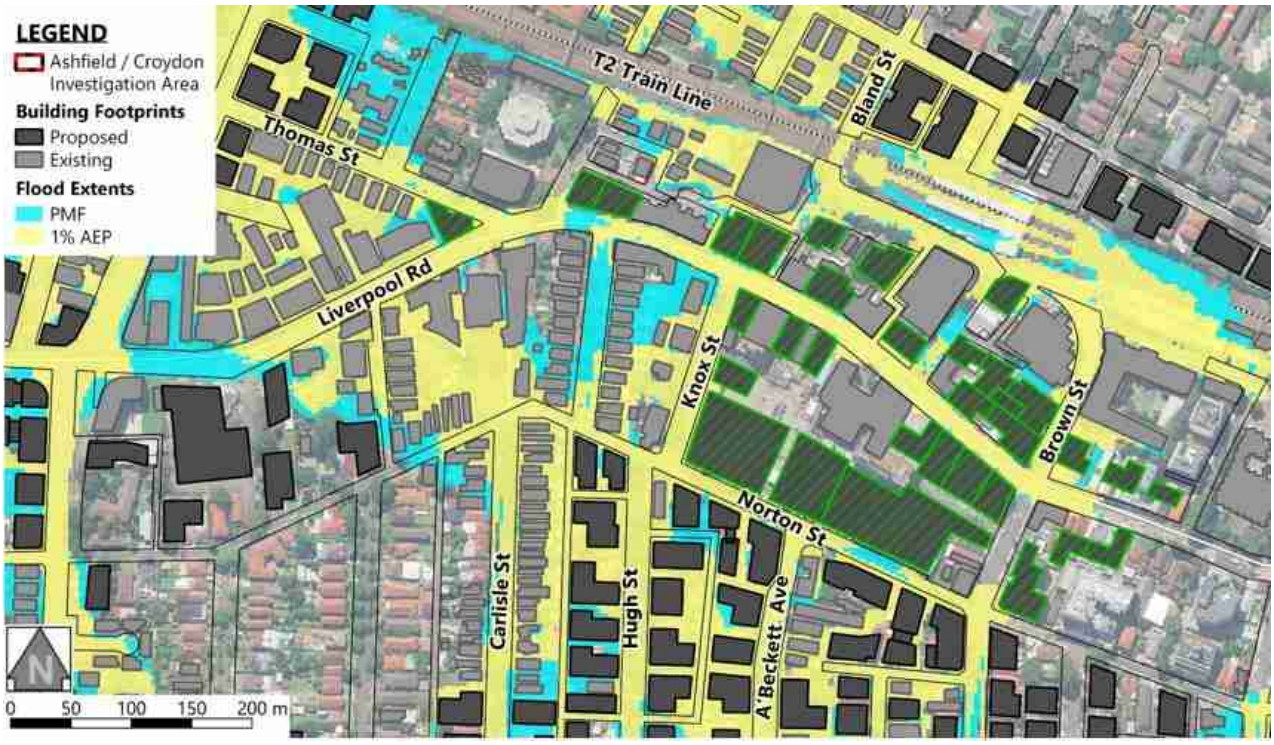


Figure 8-27 Flood extents near Uplift Location V

Flood hazards within proposed development lots remain low (H1 to H2) in all events up to and including the PMF. Areas of higher flood hazard are confined to the Liverpool Road and Bland Street road corridors.

The predicted uplift is not expected to lead to any adverse off-site impacts (i.e., increases to flood levels or flood hazards) for all events up to and including the PMF.

8.4.23 Uplift Location W (Ashfield / Croydon)

This site is located north of and near the major overland flow path which runs in a north-westerly direction towards Dobroyd Canal near Thomas Street and Heighway Avenue. Flood hazards remain low (H1 to H2) at the development lots for events up to and including the 1% AEP flood. The building footprint at the south-western corner of the development area is affected by primarily H3 flood hazard during the PMF, with some H5 flooding against the southern edge of the building footprint.

The proposed uplift is expected to lead to some increases to flood levels and flood hazards in the kerb and gutter of Arthur Street to the south during the 1% AEP event. It is noted that these increases occur in a small localised area and are not expected to impact on the existing properties on the opposite side of Arthur Street. There are also some significant flood level increases within the development lot at the building footprint in the south-western corner of the development area. Flood levels are predicted to increase by up to 0.5 metres during the 1% AEP event against the side of this building footprint. These on-site impacts should be managed through the refinement of building footprints or the implementation of on-site mitigation measures at the development application stage.

The proposed uplift is expected to lead to an increase in PMF levels of up to 0.05 metres in some existing adjacent properties to the south. It is noted that the uplift does not lead to any increases to the existing PMF hazard. The predicted PMF level impact is not considered a factor which precludes the viability of the proposed uplift given that the PMF event is not typically used as the design flood event for flood impact assessments. Additionally, the uplift is not expected to lead to any material changes to the existing PMF hazard.

Figure 8-28 Flood extents near Uplift Location W

8.4.24 Uplift Location X (Ashfield / Croydon)

This site is located north of and near the major overland flow path which runs in a north-westerly direction towards Dobroyd Canal near Thomas Street and Heighway Avenue. Flood hazards remain low (H1) across the majority of the development area for events up to and including the PMF. The building footprint at the southern edge of the development area can be affected by H2 to H3 flood hazard during the 1% AEP event. The flood hazard category in this area is H3 to H5 during the PMF.

The proposed uplift is generally not expected to lead to any adverse off-site impacts with the exception of some newly inundated areas in parts of two existing properties on the south-western corner of the Arthur Street / Joseph Street intersection. The depth of flooding in these areas is generally 0.03 metres or less during the 1% AEP event, with some very localised areas inundated to depths up to 0.07 metres. These areas are already inundated under existing conditions during the PMF.

It is expected that this localised adverse off-site impact can be mitigated through the refinement of building footprints at Site X at the development application stage.

Figure 8-29 Flood extents near Uplift Location X

8.4.25 Uplift Location Y (Ashfield / Croydon)

This proposed uplift location remains generally flood-free in events up to and including the PMF. Floodwaters are generally confined to the Queen Street and Arthur Street road corridors. Flooding along these roads is categorised as H1 hazard in events up to and including the PMF. The proposed uplift is not expected to lead to any adverse off-site impacts (i.e., increases to flood levels or flood hazards) for events up to and including the PMF.

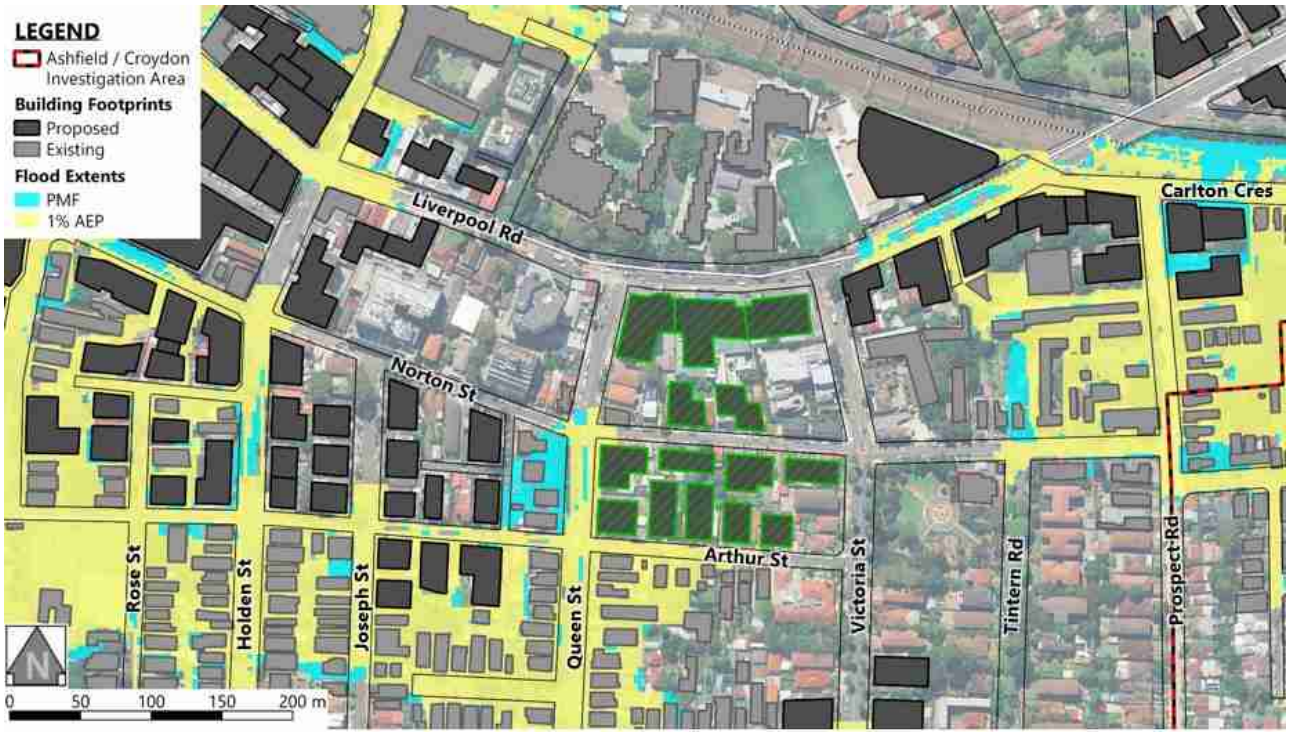


Figure 8-30 Flood extents near Uplift Location Y

8.4.26 Uplift Location Z (Ashfield / Croydon)

The development lots are generally affected by low hazard flooding (H1) in events up to and including the PMF. Similarly, the surrounding streets of Liverpool Road, Prospect Road and Carlton Crescent are also generally affected by low hazard flooding aside from localised areas of H5 hazard in the PMF.

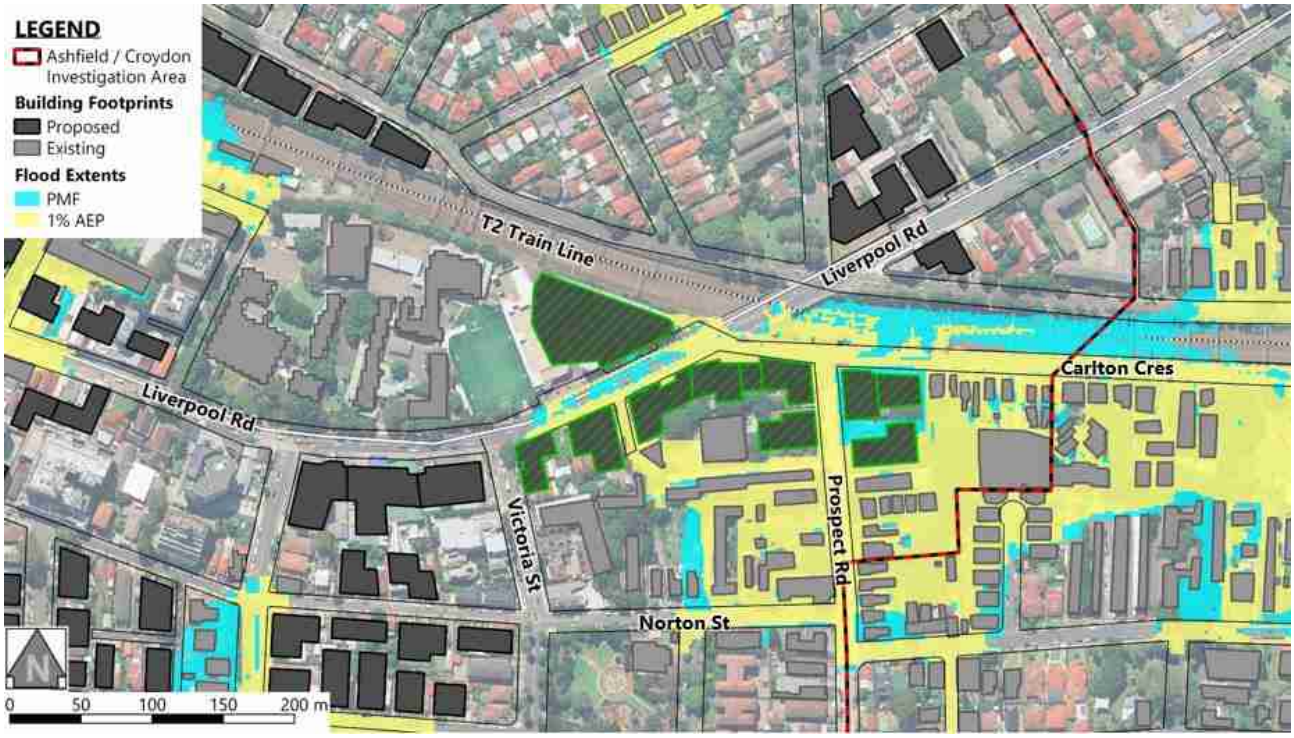


Figure 8-31 Flood extents near Uplift Location Z

The proposed uplift is not expected to lead to any adverse off-site impacts (i.e., increases to flood levels or flood hazards) for events up to and including the 1% AEP event, with the exception of a localised area within the railway corridor to the north of the uplift location which is newly inundated during the 1% AEP event. Peak 1% AEP flood depths in this area are typically around 0.04 metres, while the flood hazard is predominantly H1. However, it is noted that sections of the railway to the west of this newly inundated area are already flooded under existing conditions to greater depths. Therefore, the newly inundated area is not expected to materially impact on the operational capacity of the railway network during a 1% AEP event.

During the PMF, there are significant areas of the railway corridor to the north of the uplift location which are newly inundated. However, flooding of the railway corridor during the PMF is relatively benign. Flood hazard categories are typically H1, with shallow flood depths (typically less than 0.2 metres) and low flow velocities (typically less than 0.5 m/s).

Similar to the 1% AEP impacts, the PMF impacts within the railway corridor are considered immaterial given that other areas of the railway corridor are already affected by higher flood hazards. For example, the full width of the railway corridor is inundated by H1/H2 floodwaters at Ashfield and Croydon Stations under existing conditions. Therefore, the PMF impacts are not expected to materially impact on the operational capacity of the railway network during the PMF event.

Notwithstanding this, consultation with the relevant rail authority at the development application stage is recommended as part of further design and assessment of proposed building footprints.

During the PMF, the uplift is also expected to lead to localised increases of up to 0.12 metres in the southern-most lane of Carlton Crescent. The flood hazard is also expected to increase to H5 in this small area due to localised increases to flow velocity. PMF depths remain relatively low and typically do not exceed 0.25 metres in this area.

This off-site impact is not expected to have any significant consequences on emergency response given that the area is localised and can be avoided by emergency vehicles by taking a short detour through Prospect Road and Norton Street. However, there is opportunity at later design stages to reduce or remove this impact.

8.4.27 Uplift Location AA (Ashfield / Croydon)

This uplift location remains generally flood-free except the southern edges of the southern-most building footprints, which are affected by low hazard (H1) floodwaters in events up to and including the PMF. The flood hazard along Robert Street to the south of the development also generally remains between H1 and H2 in events up to and including the 1% AEP event. During the PMF, there are some localised areas of H4 to H5 flood hazard in Robert Street to the south-west of the development due to localised high flow velocities.

The proposed uplift is not expected to lead to any adverse off-site impacts (i.e., increases to flood levels or flood hazards) for events up to and including the PMF.

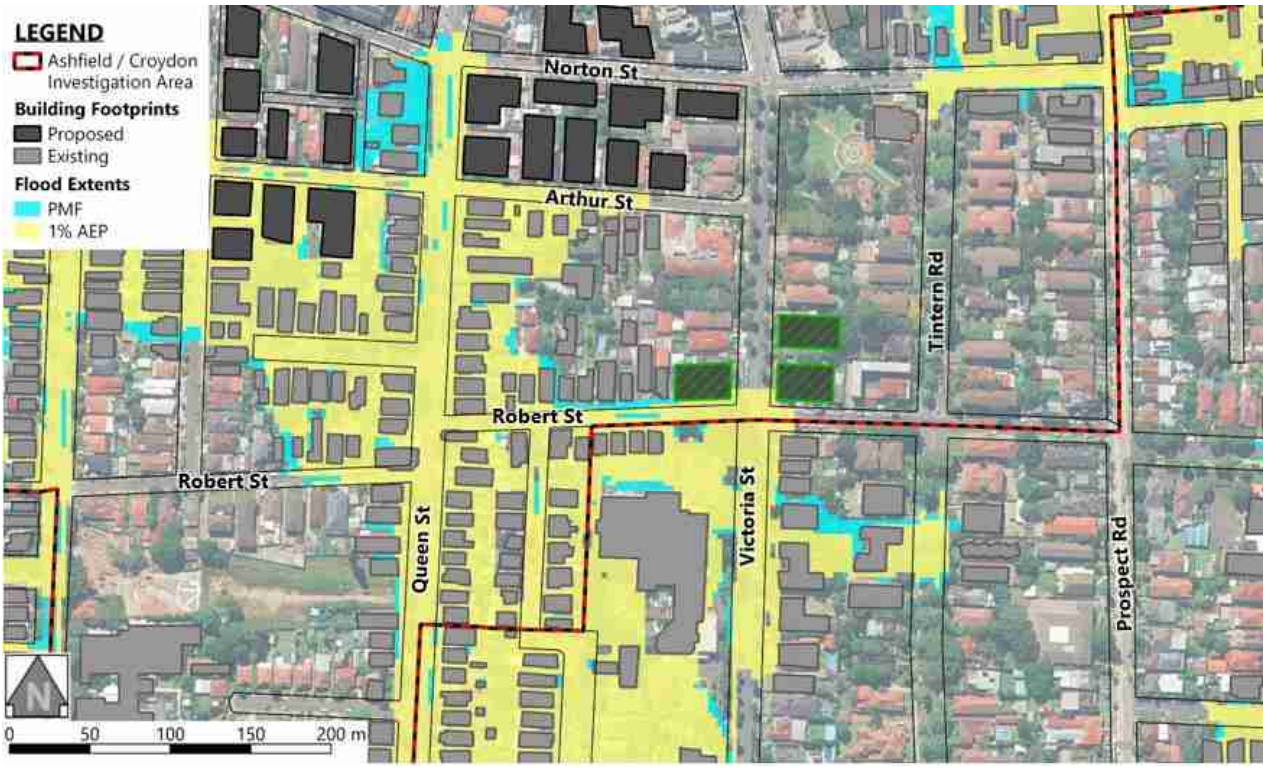


Figure 8-32 Flood extents near **Uplift Location** A**A**

8.4.28 Uplift Location BB (Ashfield / Croydon)

This proposed uplift location is not affected by flooding in events up to and including the PMF. Accordingly, uplift in this area is not expected to impact on existing flood behaviour.

Figure 8-33 Flood extents near Uplift Location BB

8.4.29 Uplift Location CC (Dulwich Hill / Marrickville)

This uplift location is located along an overland flow path which drains in a south-easterly direction towards Hawthorne Canal. The development lots are generally affected by H2 to H3 flood hazard during the 1% AEP event, with small areas of H5 flood hazard between building footprints due to localised high flow velocities.

During the PMF, the building footprints are typically affected by H4 to H5 flood hazard with the exception of the eastern-most building footprint, which is affected by low flood hazard (typically H1 to H2).

The proposed uplift is predicted to increase 1% AEP flood levels by about 0.05 metres across parts of Windsor Road to the north, as well as in some localised parts of the existing properties on the opposite side of Windsor Road. Flood level increases are predicted to be up to 0.19 metres during the PMF.

It is noted that the proposed uplift is not expected to lead to any changes to the existing flood hazards in off-site areas for events up to and including the 1% AEP event. During the PMF, there are localised minor increases to the flood hazard along Windsor Road. However, this is not expected to materially impact on emergency response and potential evacuation routes given that this road is already cut off by H4 to H5 floodwaters under existing conditions.

Refinement of building footprints at the development application stage is recommended to minimise / remove the adverse off-site flood level impacts described above.

Figure 8-34 Flood extents near Uplift Location CC

8.4.30 Uplift Location DD (Dulwich Hill / Marrickville)

Parts of this uplift location are affected by floodwaters ponding against the light rail embankment to the west. The two southernmost building footprints are affected by H3 to H4 flood hazard during the 1% AEP event due to relatively high flood depths. Otherwise, development lots to the north are typically affected by lower flood hazard (H1 to H2). During the PMF, the building footprints immediately adjacent to the railway line are affected by H4 to H5 flood hazard, which is also caused by floodwaters ponding against the light rail embankment.

Figure 8-35 Flood extents near Uplift Location DD

During the 1% AEP event, the proposed uplift is predicted to lead to some downstream flood level increases of up to 0.05 metres in the residential lots south of Ewart Street (south of the T3 train line). These flood level increases are attributed to the increased gap in building footprints which allows ponded water along Macarthur Parade to more readily spill towards the light rail line, resulting in increased runoff along the downstream overland flow path which runs south towards the Cooks River.

It is anticipated that this adverse impact could readily be minimised / removed through reducing the gap between proposed building footprints along MacArthur Parade at the development application stage.

The proposed uplift is also expected to lead to some flood level increases within the railway corridor, however, this only occurs against the railway embankments. There are no adverse flood impacts along the railway tracks for events up to and including the PMF. Notwithstanding this, consultation with the relevant rail authority at the development application stage is recommended as part of further design and assessment of proposed buildings.

The proposed uplift is not expected to lead to any increases to existing flood hazard categories for events up to and including the PMF.

Finally, it is noted that flood modelling in this area was undertaken using the preliminary Marrickville South TUFLOW model. Flood behaviour in the vicinity of this development should be confirmed by a more detailed flood model (for example, once the FRMS scheduled for this area is completed).

8.4.31 Uplift Location EE (Dulwich Hill / Marrickville)

The proposed uplift is generally affected by low flood hazards (H1 to H2) in events up to and including the 1% AEP event, except for small areas of H5 hazard which are attributed to localised high velocities in between the indicative building footprints. Peak flood depths in these areas are generally less than 0.3 metres during the 1% AEP event and less than 0.5 metres during the PMF.

Figure 8-36 Flood extents near Uplift Location EE

During the 1% AEP event, the proposed uplift is predicted to increase flood levels along a localised section of Livingstone Road by up to 0.04 metres. It is noted that this flood level increase does not lead to any increases to the existing flood hazard category.

During the PMF, the uplift is expected to increase PMF levels along Livingstone Road by up to 0.15 metres. It is noted that this flood level increase also does not lead to any material impacts to the existing flood hazard categories along the road. The PMF hazard category along Livingstone Road to the south of the development is predicted to be H5 under both existing and post-development conditions.

8.4.32 Uplift Location FF (Dulwich Hill / Marrickville)

The proposed uplift location is located near an overland flow path which flows from west to east along the T3 railway line. Most of the high hazard flows are confined to the roads and laneways in the vicinity of the development lots, with some localised areas of H5 flood hazard attributed to high flow velocities. The peak depth of flooding is relatively shallow and is typically less than 0.3 metres during the 1% AEP event and less than 0.5 metres during the PMF.

The proposed uplift is expected to lead to some localised increases in peak flood levels at McNeilly Park and the railway corridor to the north. Otherwise, it is noted that the development is not expected to lead to adverse flood impacts (i.e., increases to flood levels or flood hazards) in neighbouring properties or road corridors in events up to and including the PMF.

It is expected that the minor impacts in the railway corridor could be mitigated through the refinement of the footprint of the northernmost building at this uplift location at the development application stage.

Figure 8-37 Flood extents near Uplift Location FF

9. Flood Planning Advice

9.1 Existing Flood-Related Development Controls

The following development controls should be taken into consideration as part of any proposal for redevelopment or the construction of new buildings, in accordance with the Ashfield and Marrickville Development Control Plans (ADCP 2016 and MDCP 2011).

- It is noted that the 'Flood Planning Level' is defined as the peak 1% AEP flood level plus a freeboard of 500 mm in accordance with the ADCP 2016 and the MDCP 2011. The 'Flood Planning Area' refers to land which is located below the Flood Planning Level.
- Floor levels should be at or above the Flood Planning Level. Considerations on adopting an alternative freeboard at select locations are discussed in **Section 9.3.1** and **Section 9.3.2**.
- Parts of the development which are located below the Flood Planning Level should be constructed from flood compatible materials.
- Basement entry locations in uplift locations affected by H1 to H2 flood hazard during the 1% AEP event should be above the Flood Planning Level. Basement entry locations in uplift locations affected by H3 flood hazard or above during the 1% AEP event should be above the peak PMF level or the FPL, whichever is higher.
- Consider on-site detention requirements in accordance with Council's planning controls and engineering guide
- Ensure that development in floodways or high hazard areas do not result in adverse impacts in surrounding properties.

The flood-related objectives of the Inner West Local Environment Plan 2022 (IWLEP 2022) specified in Clause 5.21 and 5.22 should also be considered. Redevelopment and densification should aim to:

- Minimise flood risk to life and property (e.g., avoid population densification in areas of high flood hazard, prepare site-specific flood emergency response plans).
- Avoid adverse impacts on flood behaviour (e.g., aim to minimise flood level or flow velocity increases to other properties).
- Be compatible with the existing flood function and behaviour (e.g. preserve existing flow paths).
- Enable the safe occupation and efficient evacuation of people in the event of a flood (e.g. prepare site-specific flood emergency response plans including available evacuation routes, inclusion of floor levels above the peak PMF level for safe vertical evacuation).

Additionally, sensitive land uses such as hospitals, aged care, childcare, schools and emergency services should be located outside of the PMF extent.

9.2 Flood Emergency Response Considerations

Key flood emergency response considerations relevant to the Ashfield / Croydon and Dulwich Hill / Marrickville study areas are summarised in the following.

9.2.1 Evacuation

- Both study areas are affected by flash flooding which is characterised by rapid changes in the velocity and depth of floodwaters. Flash flooding is defined as flooding that occurs within six hours or less of flood-producing rainfall.
- The Bureau of Meteorology has developed a Flash Flood Advisory Resource (**FLARE**) which assists relevant agencies such as local councils to design, implement and manage "fit-for-purpose" flood warning systems. FLARE includes a website and advisory service for registered users. Council could explore obtaining access to FLARE and could investigate the feasibility of developing a tailored flash flood warning system for the different flash flood catchments in the two study areas.
- Flooding typically occurs within 60 minutes from the onset of rainfall. Given the lack of a tailored flash flood warning system for the study areas, the minimal warning time available means that State Emergency Services (SES) assisted evacuation is not practical.
- For self-evacuation to be considered feasible, the evacuation strategy would need to be developed based on a suitable flood warning system which uses flood forecasting methods. However, frequent evacuation that is triggered by a flood warning system but where only minor flooding occurs, can lead to a situation where warnings are eventually ignored. Furthermore, the lead time of warnings based on rainfall predictions is unlikely to provide sufficient time to enact evacuation from the precinct. Evacuation which occurs too late could be more dangerous than staying put, as residents may be endangered by walking / driving through floodwaters.
- Therefore, given that both SES-assisted evacuation and self-evacuation are not practical, **off-site evacuation is not an acceptable flood emergency response** for the two study areas.

9.2.2 Shelter-in-Place

- The flood modelling and analysis completed for this investigation indicates that the duration inundation along all tributaries will be less than 12 hours. Therefore, shelter-in-Place (**SIP**) is the recommended emergency response strategy for new developments that are proposed under the Stage 1 master planning process.
- The NSW Department of Planning, Housing and Infrastructure (**DPHI**) recently released a guideline document titled, '*Shelter-in-place guideline for flash flooding*' (2025). This document provides guidance for the assessment of whether SIP is an appropriate emergency response strategy for particular development types and sites. **Table 9-1** provides a summary of how developments for the 32 identified uplift locations would align with the objectives of, and criteria set out, in the SIP guideline.
- Locations nominated for shelter-in-place would need to consider the structural stability of the building with reference to the flood hazard as well as the capacity to provide a refuge above the PMF level for residents to shelter while waiting for floodwaters to recede. This would likely require a mezzanine level or a first floor to be constructed where the existing floor level of a building is below the level of the PMF.
- Shelter-in-Place locations, and obtaining access to these locations, should not rely on access to electricity and should also have clearly marked internal access for all people on site. Items for self-sufficiency (such as drinking water, food, medical kits, fire extinguishers, radios etc.) should be stored and regularly maintained in these locations.
- Notwithstanding the points made above, the Australian Fire and Emergency Service Authorities Council (AFAC) notes that Shelter-in-Place is not low risk. Risks to consider include the ability of elderly, disabled and young residents to reach higher parts of the residence, difficulties in servicing medical emergencies and the unpredictability of behaviour under stress; e.g., residents changing their minds and deciding to evacuate when floodwaters enter their dwelling.

- It should also be noted that it is Worley Consulting's recent experience that the SES is not supportive of new developments that rely on Shelter-in-Place as justification for development approval.
- Flood awareness programs are an effective way of educating residents of the flood risk in their area. The development and implementation of a flood awareness program is likely to improve the capacity of residents to respond in a flood emergency, thereby reducing the risk to life and flood damages.
- Site-specific emergency response plans should be considered for new multi-unit developments. It is Worley Consulting's experience that any site-specific emergency response plans would need to consider the practicality of implementation, which can depend on the scale of development; e.g., it is more likely for a plan to be effective for a large commercial building which has a building manager trained as a Flood Warden, compared to relying on residents in individual houses to enact their own property-specific plan. Site specific emergency response plans are not recommended as an emergency response strategy for individual houses.

Table 9-1 Assessment of the SIP strategy for proposed uplift locations

#	SIP Consideration*	Assessment of Stage 1 Inner West Housing uplift locations
1	Does SIP align with existing emergency management strategies for the area, as determined through the flood risk management process and by the NSW SES?	Previously completed flood risk management studies for Dobroyd Canal, Hawthorne Canal, Marrickville Valley and the Cooks River have identified that off-site evacuation is challenging given the rapid catchment response times (typically 1-2 hours) and the lack of a catchment-specific flash flood warning system. These studies note that SIP is a safer emergency response strategy.
2	Has evacuation off-site (the primary emergency management strategy) been investigated and determined to be unachievable?	The discussion in **Section 9.2.1** demonstrates that off-site evacuation is not practical in the study area, given the rapid catchment response and the lack of a catchment-specific flash flood warning system.
3	Does the development include medical centres, emergency service and community facilities, and sensitive and hazardous land uses, some of which may not be suitable for SIP?	Sensitive land-uses are recommended to be located outside of the PMF extent (**refer Section 9.1)**
4	SIP for greenfield development is not supported.	The developments are not greenfield developments.
5	Are there existing government developed flood warning systems that give advanced detailed forecasts of flash flooding to allow sufficient time to evacuate to the proposed refuge locations?	There are no existing government developed flood warning systems that give advanced detailed forecasts of flash flooding to allow sufficient time to evacuate to the proposed refuge locations.
6	Can the community effectively be informed of the risks associated with the emergency management strategy?	Yes, this can be implemented through community flood awareness programs and through printed material to be distributed to residents who will be living in these new buildings.
7	The FIRA should include detailed assessment of evacuation off-site (the primary emergency management strategy) to determine that evacuation off-site is not achievable.	The discussion in **Section 9.2.1** demonstrates that off-site evacuation is not practical in the study area, given the rapid catchment response and the lack of a catchment-specific flash flood warning system.

#	SIP Consideration*	Assessment of Stage 1 Inner West Housing uplift locations
8	The FIRA should include the flood behaviour at the site, with consideration of climate change and assessment of the potential maximum duration of isolation up to and including the PMF to identify that: a. Flash flooding is the only flood risk present at the site, whether it be from overland flooding, local creek or riverine flooding; and b. The flooding occurs within less than 6 hours from the commencement of the causative rain and the duration of SIP due to isolation by floodwaters is less than 12 hours from the commencement of rainfall; and c. The development is not subject to high hazard flooding (e.g. floodways, high hazard H5 of H6 areas) or surrounding roadways are not subject to high hazard flooding.	The flood modelling adopted for this study is based on existing floodplain risk management studies which have been completed under the NSW Floodplain Management Program. These flood models indicate that both study areas are affected by flash flooding where flooding occurs within less than 6 hours from the commencement of the causative rain and are not affected by flooding which lasts for longer than 12 hours. Item 8c can be considered inconsistent with the rationale behind the need for a SIP strategy given that off-site evacuation would be more plausible under low hazard conditions at the site and in surrounding roads. SIP would be expected to lead to a safer outcome for buildings in high hazard conditions, as residents would be protected from high hazard floodwaters in their homes, provided that the buildings are designed to withstand the force of PMF waters. Recommendations for uplift locations which require specialist structural engineering design input for this purpose are provided in **Section 9.2.3**.
9	a. How will SIP be used as part of the site's emergency management response, including actions before, during and after the SIP period? b. How will SIP be communicated to occupants and visitors of the building and how will this communication be maintained for the life of the development?	As per the SIP guidelines, these items are to be addressed as part of a site-specific FIRA once the consent authority considers that SIP is an appropriate emergency response strategy. These items are included as recommendations for future site-specific FIRAs (refer **Section 10.2**).
10	Provide an understanding of the secondary risks and how the proponent proposes they will be managed. This should include medical emergencies, building fire, health and wellbeing.	

**Source: Shelter-in-place Guideline for flash flooding (NSW DPHI, 2024) pages 4-6*

9.2.3 Structural Stability

As noted in **Section 9.2.1**, reliable off-site evacuation is impractical in both the Ashfield / Croydon and Dulwich Hill / Marrickville study areas due to the nature of flash flooding in these catchments. Accordingly, Shelter-in-Place is the only viable emergency response strategy.

The adoption of Shelter-in-Place requires that the building be structurally sound in events up to and including the PMF. Buildings which are proposed on sites which are classified as being exposed to H5 or H6 flood hazard during the PMF would be vulnerable to structural damage or failure (AIDR, 2017). Therefore, any proposals to site buildings in areas categorised as having H5 or H6 flood hazard will require specialist structural engineering design input to ensure that the building is able to withstand the force of floodwaters.

Part or all of the following uplift locations are predicted to be affected by H5 to H6 flood hazard during the PMF and would require specialist structural engineering input during the design of development proposed for these sites.

- Site B
- Site C
- Site D
- Site F
- Site H
- Site O
- Site P
- Site Q
- Site T
- Site U
- Site W
- Site X
- Site CC
- Site DD
- Site EE
- Site FF

9.2.4 Habitable Floor Levels

As noted in the ADCP 2016 and the MDCP 2011, floor levels should be set at or above the Flood Planning Level (FPL), which is the peak 1% AEP flood level plus a freeboard of 0.5 metres for both the Ashfield / Croydon and Dulwich Hill / Marrickville study areas. However, given that developments will likely rely on a Shelter-in-Place flood emergency response strategy as opposed to evacuation to off-site locations, it is recommended that habitable floor levels be set at or above the peak PMF level in areas affected by high flood hazard during the PMF; i.e., where the PMF flood hazard is H3 and above.

In this regard, it is recognised that some development areas are affected by high PMF depths (e.g., greater than 1.5 metres), such as parts of sites B, C, D, H, O, P, Q, T, U, W, CC and DD and therefore, may require all habitable spaces to be located on the first floor of the building; i.e., the ground floor would be reserved for non-habitable uses.

Many proposed building footprints at sites D, O and P, are affected by peak PMF depths in excess of 2.7 metres due to floodwaters backing-up behind (to the south of) the T2 railway. A height of 2.7 metres is equivalent to a typical floor height for most modern building construction. Therefore, floodwaters would be expected to enter the first floor of these buildings at the peak of the PMF if a standard floor height is adopted.

Accordingly, proposed new developments at sites D, O and P should consider adopting a higher floor height for the ground floor or otherwise nominate suitable habitable spaces on the second floor or higher areas of the buildings.

Further design of developments must assess the time required for vertical evacuation against the rate of rise of PMF floodwaters, to ensure occupants can evacuate safely to floors above the PMF level and avoid getting trapped in ground floor premises.

9.3 Further Flood Planning Considerations

9.3.1 Flood Planning Levels

As noted previously, the ADCP 2016 and the MDCP 2011 define the Flood Planning Level (FPL) is defined as the peak 1% AEP flood level plus a freeboard of 0.5 metres. However, there are several uplift locations where peak PMF levels are less than 300mm above the peak 1% AEP flood level. Therefore, floodwaters will never reach the level of the FPL at these locations.

It is recommended that a FPL corresponding to a reduced freeboard of 300 mm above the 1% AEP peak flood level be adopted for ground floor activations and basement entry locations at these locations. Elsewhere, a FPL based on the 1% AEP flood level plus a freeboard of 500 mm should be the limiting control.

Uplift locations where the peak PMF levels are higher than peak 1% AEP flood levels by 300 mm or less (across the whole area) include:

- Site A
- Site E
- Site G (flood-free in PMF)
- Site I (flood-free in PMF)
- Site J
- Site K
- Site M (flood-free in PMF)
- Site N
- Site S
- Site V
- Site Y
- Site Z
- Site AA
- Site BB (flood-free in PMF)

9.3.2 Climate Change Considerations

In August 2024 an update of the Climate Change Considerations chapter of *Australian Rainfall and Runoff 2019* (Book 1 Chapter 6) was published by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) and Engineers Australia.

The chapter provides up-to-date guidance aligned with the latest relevant science as detailed in the Sixth Assessment Report published by the Intergovernmental Panel on Climate Change (IPCC, 2023). This includes new estimates of increased rainfall intensity under a range of climate change scenarios which are referred to as Shared Socioeconomic Pathways, or SSPs. The new estimates of rainfall intensity are typically higher than those presented in the original ARR chapter.

A climate change sensitivity assessment has been completed which applied an increase in 1% AEP rainfall intensity of 30% which is approximately equivalent to the following scenarios referred to in the updated guideline.

- A medium-term climate change scenario (2060) for the high range SSP5-8.5 emissions scenario.
- A long-term climate change scenario (2100) for the medium range SSP2-4.5 emissions scenario.

The impacts of climate change are demonstrated in the flood level difference mapping shown in **Figure 9-1** and **Figure 9-2**. The flood level difference mapping shows that an increase in rainfall intensity of 30% leads to flood level increases of between 0.2 to 0.3 metres along most overland flow paths. However, flood levels are predicted to increase by up to 0.7 metres in the area to the south of the T2 railway near Heighway Avenue .

This flood level increase is greater than the freeboard of 0.5 metres which is currently specified in the ADCP 2016 and the MDCP 2011 for defining the flood planning level. Accordingly, Council should consider revising the freeboard applicable to new developments in areas such as Heighway Avenue, as part of future flood risk management activities.

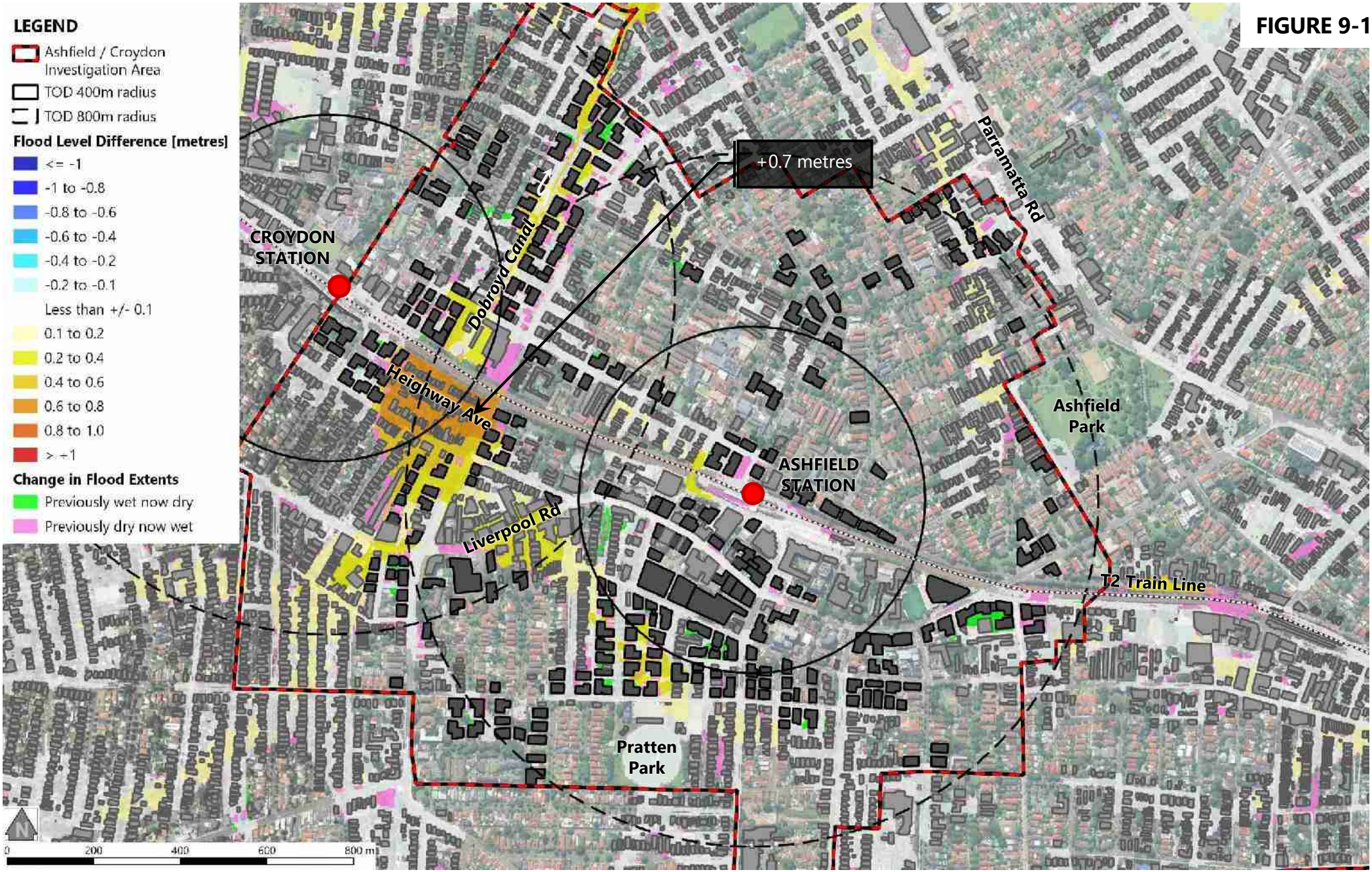


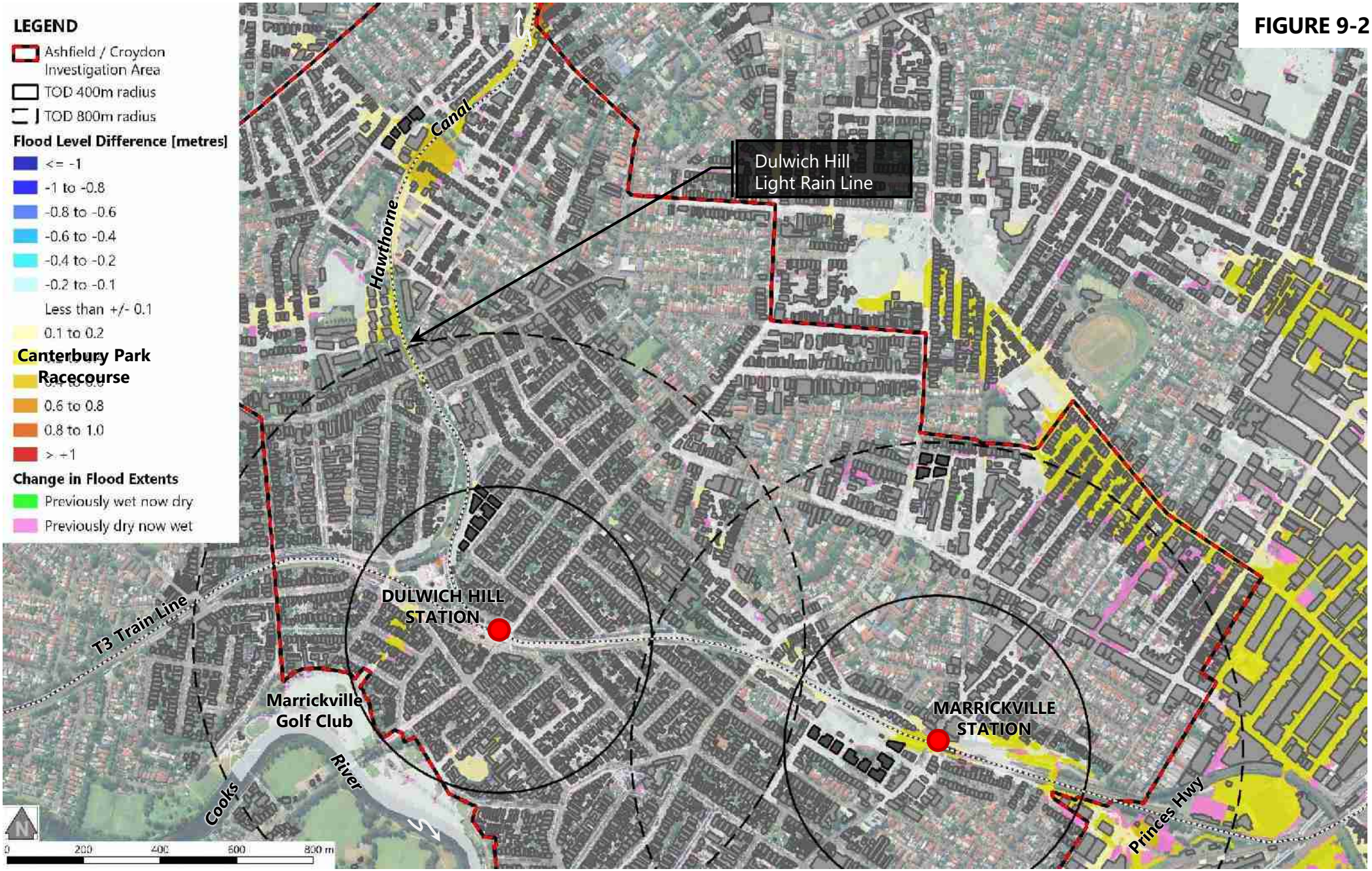
FIGURE 9-1

Prepared by:

worley consulting

PREDICTED CHANGES IN PEAK FLOOD LEVELS DUE TO A 30% INCREASE IN RAINFALL INTENSITY [ASHFIELD / CROYDON]

FIGURE 9-2



Prepared by:

worley consulting

PREDICTED CHANGES IN PEAK FLOOD LEVELS DUE TO A 30% INCREASE IN RAINFALL INTENSITY [DULWICH HILL / MARRICKVILLE]

9.3.3 Ground Level Activation

Pedestrian and basement entries should be located in areas where the flooding is shallowest to facilitate efficient ground level activation without requiring excessive filling or steps / ramps, while also reducing the potential for significant inflows during flooding.

Potentially feasible locations for each of the developments are outlined in the following. Notwithstanding, development at these locations will need to comply with the floor level and basement entry level requirements specified in the ADCP 2016 and the MDCP 2011 which are summarised in **Section 9.1**. The assessment of each uplift location included general recommendations which would be subject to the nature and extent of the finalised uplift footprint and building configuration at each location.

- Uplift Location A: Most locations would be suitable, particularly in flood-free areas of the development area. For buildings near the corner of the Edwin Street / Anthony Street intersection, entries should be located towards the northern end of the buildings where the depth of flooding would be shallowest.
- Uplift Location B: Ground level activations along Bastable Street and Elizabeth Street would be difficult given that peak 1% AEP flood depths are about 0.8 metres. Entries should be located along Railway Street or Hordern Parade where the depth of flooding is shallower (typically less than 0.3 metres during the 1% AEP event).
- Uplift Location C: Ground level activations along Frederick Street would be more practical given that the depth of flooding during the 1% AEP event is typically less than 0.3 metres. In contrast, peak 1% AEP flood depths along Etonville Parade are expected to reach up to 0.8 metres. Similarly, entries along John Street (away from Dobroyd Canal), Banks Street, MacKay Street and Pound Lane would be more suitable than along Hedger Avenue. Peak 1% AEP flood depths along Hedger Avenue typically exceed 0.3 metres, whereas the depth of flooding along the other streets is typically shallower than 0.3 metres.
- Uplift Location D: Entries along Edwin Street to the west of the development area are considered the most suitable locations for ground floor activations, given that flood depths are low and are expected to be less than 0.4 metres during the PMF. Ground level activations along Heighway Avenue and Thomas Street would also be possible given that flood depths are generally less than 0.3 metres during the 1% AEP event. However, basement entries along Heighway Avenue or Thomas Street should be avoided if possible given that the peak depth of flooding increases significantly during the PMF. The depth of flooding along these streets during the PMF is typically greater than 1.5 metres and increases to 3.5 metres towards the eastern end of the development area.
- Uplift Location E: Ground level activations along either Frederick Street or Webbs St would be suitable given that the peak depth of flooding remains less than 0.3 metres in events up to and including the PMF.
- Uplift Location F: Entries along Alt Street should be located towards the southern end of the development where the depth of flooding is shallowest.
- Uplift Location G: This uplift location remains flood-free during events up to and including the PMF. Therefore, there are no flood-related constraints regarding ground level activations.
- Uplift Location H: The most suitable locations for entries are along Bland Street to the west of Curt Street or along Chandos Street to the east of Loftus Street, which is flood-free in events up to and including the PMF. However, this location would only service five of the proposed buildings. Most other buildings would require entries along Curt Street. Flood depths along Curt Street are relatively uniform, with depths of about 0.4 metres and 0.8 metres during the 1% AEP and PMF events, respectively.
- Uplift Location I: This uplift location would remain flood-free in events up to and including the PMF. Therefore, there are no flood-related constraints regarding ground level activations.

- Uplift Location J: The only possible locations for entries to this uplift location are along Pembroke Street. The depth of flooding along Pembroke Street is about 0.2 metres and 0.4 metres during the 1% AEP and PMF events, respectively.
- Uplift Location K: This uplift location would remain flood-free in events up to and including the PMF, although it is noted that a section of Charlotte Street adjacent to the eastern building is predicted to be inundated during all design events tested. Therefore, ground level activations would be more suitable along Webbs Avenue, which remains flood-free in events up to and including the PMF.
- Uplift Location L: The most suitable locations for entries to buildings in this uplift location are along Frederick Street south of Elizabeth Street and to the north and east of the Alt Street / Elizabeth Street intersection. Entries in the Benalla Avenue cul-de-sac would also be suitable as this location is flood-free during the PMF. The depth of flooding along Elizabeth Street is relatively uniform, with depths of about 0.4 metres and 0.7 metres during the 1% AEP event and the PMF, respectively.
- Uplift Location M: This uplift location remains flood-free in events up to and including the PMF. Therefore, there are no flood-related constraints regarding ground level activations.
- Uplift Location N: The development lots to the east of Grainger Avenue / Wood Street remain flood-free in events up to and including the PMF. Therefore, there are no flood-related constraints regarding ground level activations in these areas. The section of Elizabeth Street to the east of Bland Street is only affected by shallow flood depths during the PMF (typically less than 0.2 metres) and accordingly ground level activations in these areas would also be appropriate. Entries along Bland Street should be avoided given the high flood depths in the vicinity of the Bland Street railway underpass.
- Uplift Location O: Entries along Heighway Avenue to the east of Frederick Street are considered the most suitable locations for ground floor activations, given that this area is either flood-free or affected by shallow flood depths during the 1% AEP event. The depth of flooding along Thomas Street, Frederick Street and Beatrice Street is relatively uniform during the 1% AEP event, typically varying between 0.4 and 0.5 metres. However, basement entries in this development area should be avoided given the peak depth of flooding increases significantly during the PMF. The depth of flooding along these streets during the PMF is typically greater than 2 metres.
- Uplift Location P: The shallowest flood depths in the vicinity of this uplift location are along Frederick Street to the south of Beatrice Street. Peak 1% AEP flood depths in this area are typically less than 0.2 metres. Beatrice Street, Thomas Street and Milton Street North are affected by depths of between 0.5 and 0.8 metres during the 1% AEP event. Basement entries should be avoided in this development area given that the peak depth of flooding increases significantly during the PMF. The depth of flooding along these streets during the PMF is typically greater than 2 metres.
- Uplift Location Q: The most suitable entry locations for buildings in this uplift location are located along Milton Street to the south of Milton Lane, where peak PMF depths are less than 0.4 metres. Basement entries along the northern half of Lion and Milton Streets should be avoided if possible given that these locations are affected by peak PMF depths in excess of 1 metre. It is noted that peak 1% AEP flood depths along Lion Street and Milton Street are shallow and are typically less than 0.2 metres.
- Uplift Location R: The most suitable entry locations for buildings in this uplift location are along Milton Lane, Milton Street south of Milton Lane and Norton Street. These streets are generally flood-free or are affected by shallow PMF depths typically less than 0.4 metres. Entries along Liverpool Road should be avoided given that PMF depths are about 1 metre along this road.
- Uplift Location S: Flooding at this site is relatively benign in events up to and including the PMF. Peak PMF depths are typically less than 0.4 metres. The most ideal locations for entries would be along the area of Brunswick Parade which runs in an east-west direction as this area is not inundated during events up to and including the PMF.

- Uplift Location T: Ground level activations at the southern end of Carlisle Street and Hugh Street would be suitable as peak PMF depths in these areas are typically less than 0.2 metres. Ground level activations along the southern half of the laneway between Carlisle Street and Hugh Street would also be suitable given the shallow PMF depths. Basement entries along the northern half of Hugh Street and the laneway should be avoided if possible given that peak PMF depths are typically greater than 1 metre in these areas.
- Uplift Location U: The most suitable locations for ground level activations are at the southern end of Hugh Street, along Norton Street or the northern half of A'Beckett Avenue given that peak PMF depths are typically less than 0.2 metres in these areas. Basement entries along the northern half of Hugh Street and the southern half of A'Beckett Avenue should be avoided if possible given that peak PMF depths are typically greater than 1 metre in these areas.
- Uplift Location V: Ground level activations along any of the surrounding streets would generally be suitable given that peak PMF depths along these streets are typically less than 0.2 metres and hazard is low, aside from near the Bland Street underpass. Entries along Brown Street are the least ideal given the higher depths of flooding in this street.
- Uplift Location W: The most suitable locations for ground level activations are along Rose Street, Holden Street and Norton Street where the peak PMF depths are typically less than 0.2 metres. Basement entries along the southern half of A'Beckett Avenue should be avoided given that peak PMF depths are typically greater than 1 metre in this area.
- Uplift Location X: The most ideal locations for ground level activations are along Norton Street, the northern half of Joseph Street and Amy Street, which are flood-free in events up to and including the PMF. Entries along Holden Street and Arthur Street may also be suitable given that peak PMF depths are typically less than 0.2 metres in these areas. Ground level activations along Joseph Street south of Arthur Street are the least suitable as this location can be affected by peak PMF depths between 0.7 and 1 metre.
- Uplift Location Y: Ground level activations along any of the surrounding streets would generally be suitable given these streets are either flood-free during the PMF or are affected by shallow PMF depths typically less than 0.2 metres.
- Uplift Location Z: The most suitable locations for ground level activations are along Liverpool Road, Prospect Road and Nottle Street where the peak PMF depths are typically less than 0.2 metres. Entries along Carlton Crescent may also be suitable; however, it is noted that peak PMF depths can reach up to 0.5 metres in a localised area.
- Uplift Location AA: Ground level activations along any of the surrounding streets would generally be suitable given these streets are either flood-free during the PMF or are affected by shallow PMF depths typically less than 0.2 metres.
- Uplift Location BB: This uplift location remains flood-free in events up to and including the PMF. Therefore, there are no flood-related constraints regarding ground level activations.
- Uplift Location CC: The most suitable entry locations would be along Terry Road or along Windsor Road near the Davis Street intersection, where peak PMF depths are typically less than 0.2 metres. Basement entries along Windsor Road near the middle of the uplift location (to the south-west of the Windsor Road / Hampstead Road intersection) are not recommended as the direction of flow would result in floodwaters discharging directly into the basements. Peak flood depths in this area reach up to 0.7 and 1.4 metres during the 1% AEP event and the PMF, respectively.
- Uplift Location DD: Ground level activations along MacArthur Parade and Blackwood Lane would generally be suitable given that the peak PMF depths in these streets are typically less than 0.2 metres.

- Uplift Location EE: The most suitable entry locations would be along Stanley Street where the peak PMF depths are typically less than 0.2 metres. Entries along Livingstone Road, Hospital Lane and Lilydale Street would be less suitable as PMF depths reach up to 0.8 metres at these locations. Peak 1% AEP depths along these streets range from 0.4 to 0.6 metres.
- Uplift Location FF: The most suitable entry locations would be along the eastern half of Greenbank Street where peak PMF depths are typically less than 0.2 metres. Otherwise, the depth of flooding at the western end of this uplift location is relatively uniform. Peak flood depths in this area are typically 0.3 to 0.4 metres during the 1% AEP event and typically 0.4 to 0.6 metres during the PMF.

10. Conclusions and Recommendations

The inner west suburbs of Ashfield, Croydon, Dulwich Hill and Marrickville, have been identified by the NSW Government as Transport Oriented Development (TOD) locations. The preparation of master plans for these areas is required to demonstrate delivery of TOD objectives and to contribute to meeting a housing target of 7,800 constructed dwellings across the Inner West local government area (LGA) by June 2029. Stage 1 of the master planning program has delivered new controls that will facilitate additional housing within a 400-metre radius of the train stations at Ashfield, Croydon, Dulwich Hill and Marrickville. The Inner West Council has also undertaken an alternate place-based planning approach that incorporates a broader area than the area covered by the TOD program.

Flash flooding in the catchments that drain through these suburbs was identified as a key concern in previous flood studies undertaken by Council and the NSW Government. Accordingly, the master planning program needs to allow for appropriate management of flooding in areas where increased housing densification is proposed.

Worley Consulting, acting in concert with Inner West Council, has considered the flood impact and flood risk issues that could arise at a range of locations where increased housing density is proposed. This has involved adoption and application of the TUFLOW flood models developed for the *Dobroyd Canal and Hawthorne Canal Floodplain Risk Management Study and Plan* (WMAwater, 2020), the *Marrickville Valley Floodplain Risk Management Study and Plan* (Cardno, 2017) and the *Cooks River Floodplain Risk Management Study and Plan* (WMAwater, 2015).

Additionally, Worley Consulting has developed a preliminary model of the Marrickville South catchment due to the absence of a detailed flood study for that area. While there is a flood study and risk management plan scheduled to investigate overland flows in the Marrickville South catchment, these studies are not expected to be completed until late 2026.

10.1 Conclusions

The flood models were used to investigate the potential for uplift scenarios to impact on the existing flood behaviour and flood risk within the study areas. The key outcomes from the flood impact assessment are provided in the following.

1. A total of 32 areas were nominated for re-development or densification across the Ashfield / Croydon and Dulwich Hill / Marrickville study areas. A detailed description of the predicted flood behaviour and flood impacts of each proposed development area is provided in **Section 8.4**.

2. Many of the development areas are not predicted to lead to material adverse off-site impacts. However, the uplift scenarios for 7 of the development areas (e.g., Sites O, T, X, Z, CC, DD and FF) will lead to some minor adverse impacts on neighbouring properties or along a nearby railway corridor. Investigation of the off-site impacts at these locations suggests that the development design can be refined at each location at the development application stage to avoid these adverse impacts or reduce them to acceptable levels.

3. Developments which are predicted to lead to some minor adverse impacts in the railway corridor (e.g. Sites X, Z, DD and FF) should also include consultation with the relevant rail authorities as part of future design stages.

4. Some of the development areas are predicted to lead to notable increases in flood levels within the development site (e.g., Sites C, H and W). These increases will need to be reduced by incorporating on-site mitigation measures.

5. A number of uplift locations which are additional to the 32 nominated areas were previously assessed by Worley Consulting through iterative preliminary testing in the TUFLOW flood models. These additional uplift locations were found to be unsuitable for further consideration at this stage due to unacceptable adverse off-site flood impacts or were otherwise situated in areas of high flood risk (refer **Section 8.2**). Further detailed assessment of significantly reduced uplift extent, altered building footprint configurations and/or suitable flood mitigation measures would be required before uplift can be considered at those locations.

6. Several flood modification measures were recommended in the floodplain risk management plans for the Dobroyd Canal, Hawthorne Canal, Marrickville Valley and Cooks River catchments. A number of relevant drainage works items detailed in the *Inner West Local Infrastructure Contributions Plan 2023* are also proposed for the Ashfield / Croydon and Dulwich Hill / Marrickville study areas. A detailed commentary on the expected benefits and the viability of these options is presented in **Section 7**.

7. The flood modification measures / drainage works items discussed in **Section 7** either provide limited benefit in reducing the existing flood risk in the study areas and/or would involve significant cost and disruption to implement.

8. This FIRA has assessed a climate change sensitivity scenario which applies a 30% increase in existing 1% AEP rainfall intensities. This climate change scenario is expected to lead to flood level increases typically between 0.2 to 0.3 metres along most overland flow paths. However, flood levels are predicted to increase by up to 0.7 metres in the vicinity of Heighway Avenue to the south of the T2 railway line in the Ashfield study area.

In light of the findings documented above, the nominated proposed planning controls for the 32 uplift locations, as represented by the indicative building footprints, can proceed subject to compliance with the development controls and flood planning recommendations outlined below.

These potential uplift scenarios are not expected to lead to any material adverse off-site flood impacts, or otherwise are predicted to lead to some minor flood impacts which could be managed through design refinements and/or the implementation of on-site mitigation measures.

10.2 Recommendations

Based on the findings of the flood modelling investigations and the flood-related controls outlined in the *Inner West Local Environment Plan 2022* (IWLEP 2022), the *Ashfield Development Control Plan 2016* (ADCP 2016) and the *Marrickville Development Control Plan 2011* (MDCP 2011), the following recommendations are provided for consideration in the Inner West Housing master planning process:

g. Floor levels for habitable spaces and basement entries at locations affected by H1 to H2 hazard during the 1% AEP event should be set at or above the Flood Planning Level (FPL). Basement entries at locations affected by H3 hazard or higher during the 1% AEP event should be set above the peak PMF level or FPL, whichever is the higher. Consideration should also be given to locating basement entries above the PMF level in areas of high hazard in the PMF.

h. Parts of new / re-purposed buildings which are located below the Flood Planning Level should be constructed using flood compatible materials.

i. On-site detention should be considered in accordance with Council's planning controls and engineering guidelines.

j. Further design refinement is required at Sites O, T, X, Z, CC, DD and FF to minimise the predicted adverse off-site impacts. This could comprise the refinement of building footprints or the implementation of local flood mitigation measures.

k. Development at Sites C, H and W should include on-site mitigation measures to manage the expected increases in flood depths within these development areas.

l. Sensitive land uses such as hospitals, aged care, childcare, schools and emergency services should be located outside the PMF extent.

m. Reliable off-site evacuation is considered unlikely and impractical for the majority of the Ashfield / Croydon and Dulwich Hill / Marrickville study areas given that these areas are affected by flash flooding and due to the absence of a catchment-specific flash flood warning system. Therefore, Shelter-in-Place (SIP) is recommended as the preferred flood emergency response strategy for developments affected by flooding in the uplift locations.

n. SIP at the proposed uplift locations aligns with the objectives and criteria outlined in the NSW Government's '*Shelter-in-place guideline for flash flooding*' (DPHI, 2024). Off-site evacuation would result in a greater risk to life.

o. The Bureau of Meteorology's FLARE resource should be used to investigate the feasibility of developing a tailored flash flood warning system for the two study areas.

p. Several proposed uplift locations would be affected by H5 to H6 flood hazard during the PMF. These areas are listed in **Section 9.2.3**. Specialist structural engineering design of building that are proposed in these areas is required to ensure that the buildings are able to withstand the force of floodwaters in events up to and including the PMF.

q. New developments should provide floor area above the peak PMF level to facilitate a Shelter-in-Place (SIP) emergency response option, given the low likelihood of achieving reliable off-site evacuation. This is particularly important at uplift locations which are affected by high PMF flood depths (e.g. higher than 1.5 metres), such as parts of sites B, C, D, H, O, P, Q, T, U, W, CC and DD. These sites may require habitable spaces to be located on the first or second floor of the building (i.e., not the ground floor level). Further detail is provided in **Section 9.2.4**. The time required for residents to vertically evacuate to higher floors should be assessed with reference to the predicted rate of rise of floodwaters in a PMF.

r. The Flood Planning Level (FPL) for a number of uplift locations could adopt a freeboard less than 0.5 metres above the peak 1% AEP flood level. This is because the peak PMF levels at these locations are typically less than 0.3 metres higher than peak 1% AEP flood levels. These locations are listed in **Section 9.3.1**.

s. As noted above, the assessed climate change scenario is expected to lead to an increase in 1% AEP flood levels of up to 0.7 metres in areas to the south of the T2 railway near Heighway Avenue. This flood level increase is greater than the freeboard of 0.5 metres which is adopted by ADCP 2016 and the MDCP 2011 for defining the Flood Planning Level. Accordingly, Council should consider revising the freeboard applicable to new developments in areas such as Heighway Avenue, as part of future flood risk management activities.

t. Ground level activation (i.e., entries to buildings or basements) should be provided in areas of shallowest flood depth to minimise filling or steps / ramps, according to the floor level and basement entry requirements specified in the ADCP 2016 and the MDCP 2011. Suitable locations are discussed in **Section 9.3.3**.

u. A detailed Flood Impact and Risk Assessment (FIRA) should be completed in support of any Development Applications (DA) for new developments or areas of redevelopment in flood affected parts of the uplift locations. The detailed FIRA should:

- assess the flood impacts of the final building design to meet the criteria specified in the ADCP 2016 and MDCP 2011;
- address flood risk issues and emergency response, accounting for the proposed uses of the site

and the number and demographic of future occupants once these details are available;

- address how SIP will be used as part of the site's emergency management response, including actions before, during and after the SIP period;
- address how SIP will be communicated to occupants and visitors of the building and how this communication will be maintained for the life of the development; and,
- provide an understanding of secondary risks and how the proponent proposes to manage these risks (e.g., building fire, medical emergencies, health and wellbeing) during a flood emergency.

11. References

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- NSW Department of Planning, Housing and Infrastructure (2024), '*Shelter-in-place guideline for flash flooding*'.
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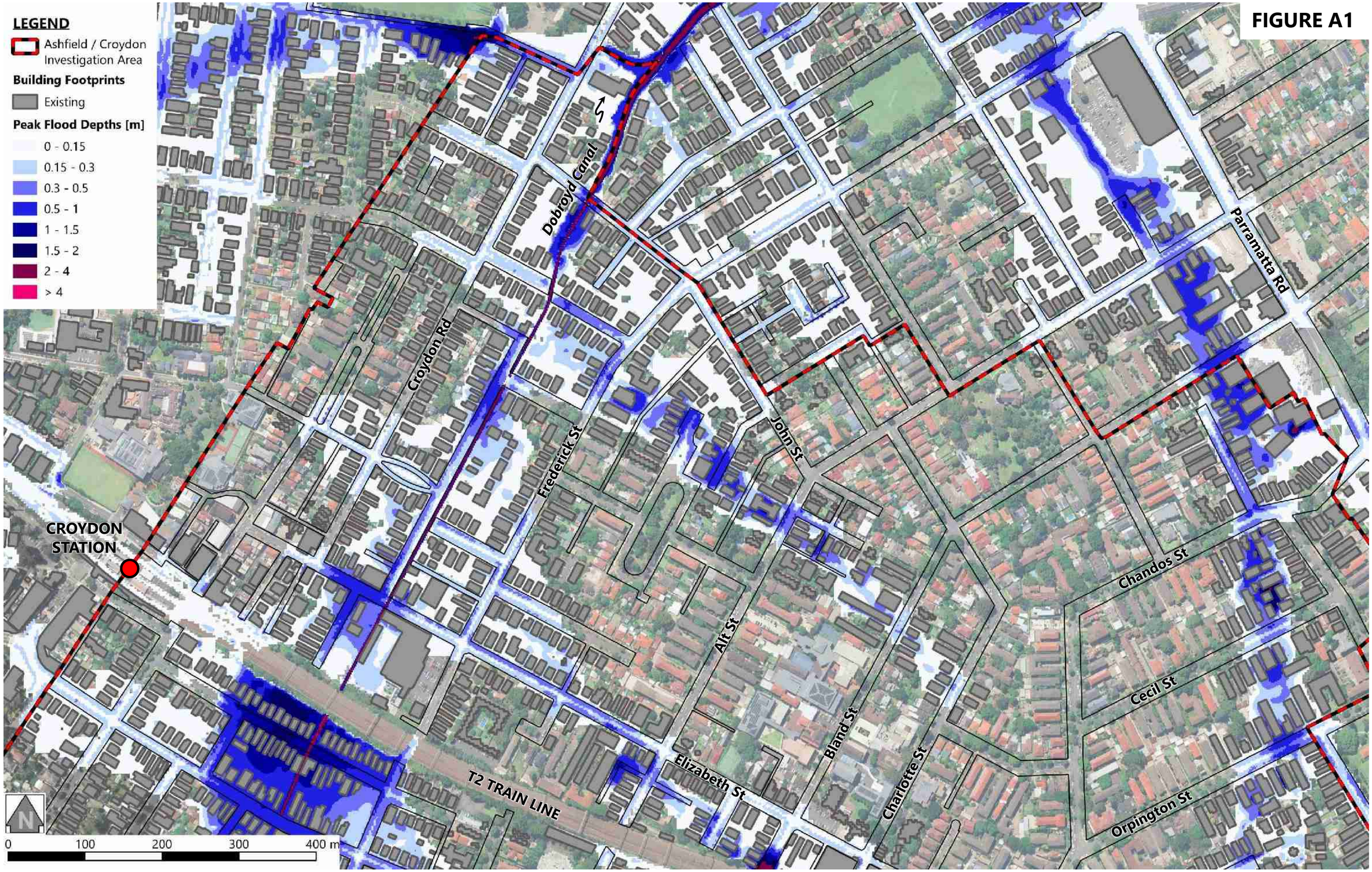
- WMAwater (2015), '*Hawthorne Canal Flood Study*', prepared for Ashfield Council, Burwood Council and Sydney Water Corporation.
- WMAwater (2015), '*Cooks River Floodplain Risk Management Study and Plan*', prepared for Marrickville Council.
- WMAwater (2020), '*Dobroyd Canal and Hawthorne Canal Floodplain Risk Management Study and Plan*', prepared for Inner West Council.

Appendix A. 1% AEP Flood Mapping [Ashfield / Croydon]

FIGURE A1



Prepared by:
worley consulting

PEAK 1% AEP FLOOD DEPTHS FOR EXISTING CONDITIONS [ASHFIELD / CROYDON - NORTH]

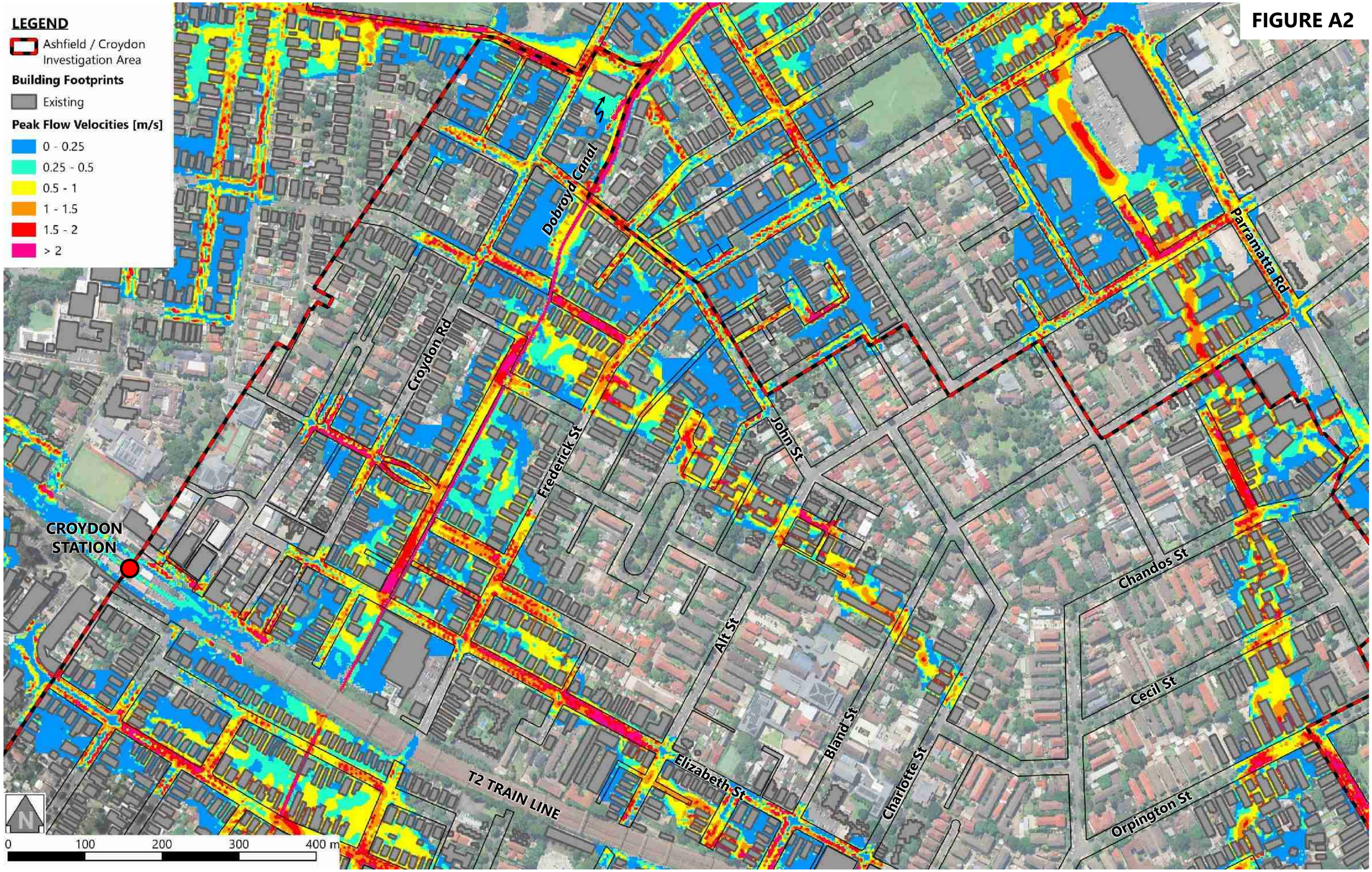


FIGURE A2

Prepared by:
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PEAK 1% AEP FLOW VELOCITIES FOR EXISTING CONDITIONS [ASHFIELD / CROYDON - NORTH]

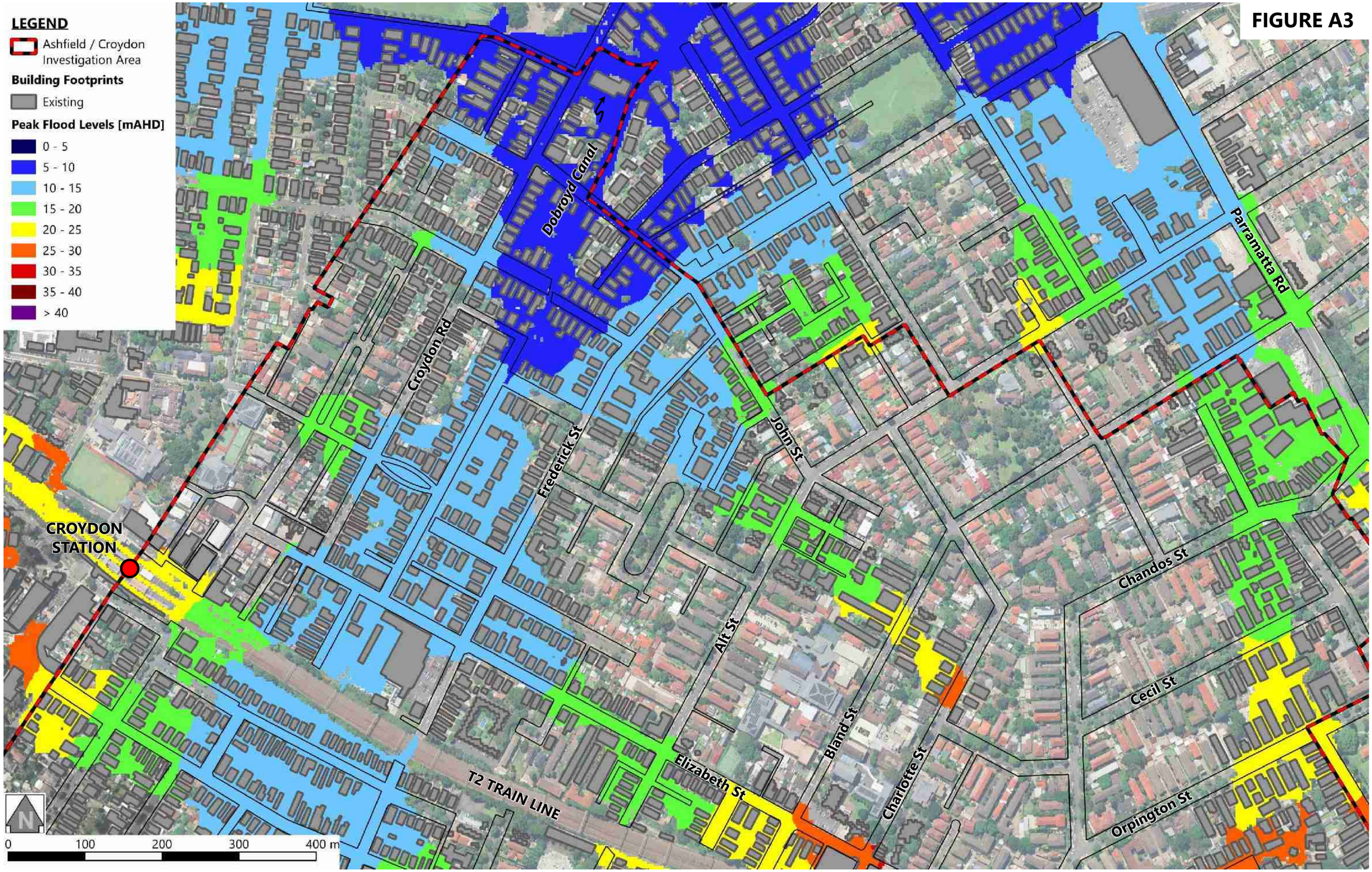
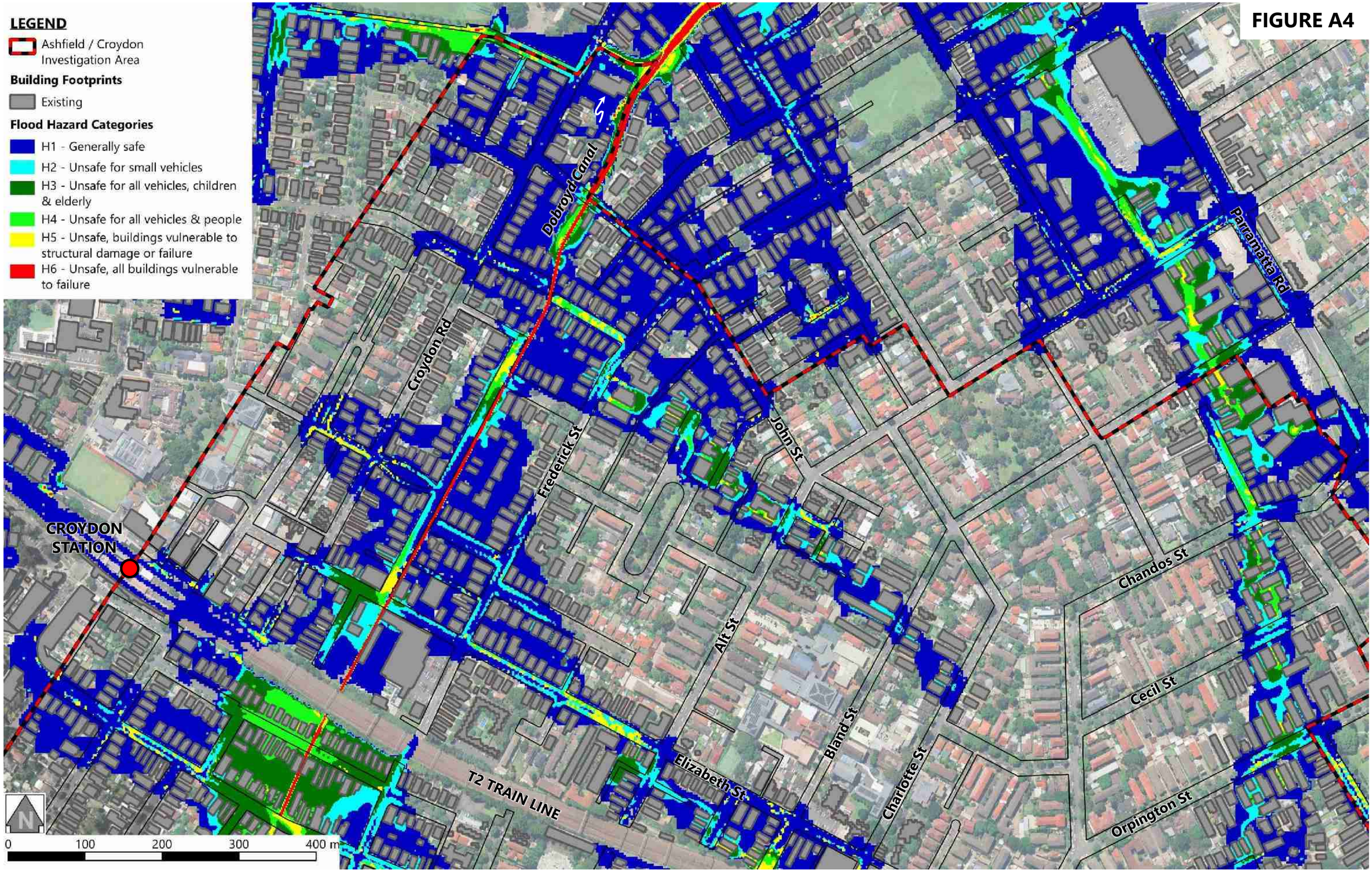


FIGURE A3

Prepared by:
worley consulting

PEAK 1% AEP FLOOD LEVELS FOR EXISTING CONDITIONS [ASHFIELD / CROYDON - NORTH]

FIGURE A4



Prepared by:
worley consulting

PEAK 1% AEP FLOOD HAZARD CATEGORIES FOR EXISTING CONDITIONS [ASHFIELD / CROYDON - NORTH]

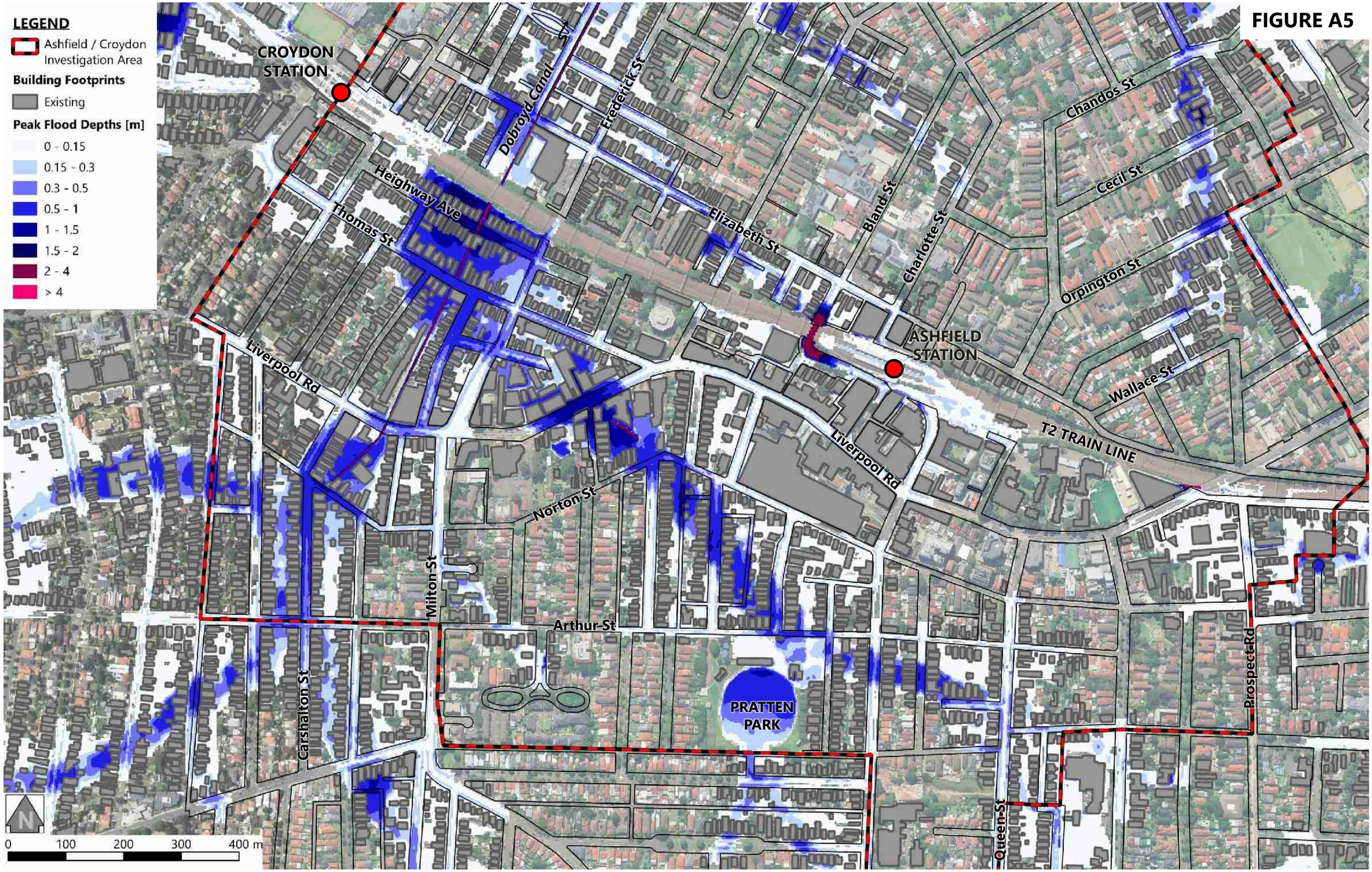


FIGURE A5

Prepared by:
worley consulting

PEAK 1% AEP FLOOD DEPTHS FOR EXISTING CONDITIONS [ASHFIELD / CROYDON - SOUTH]

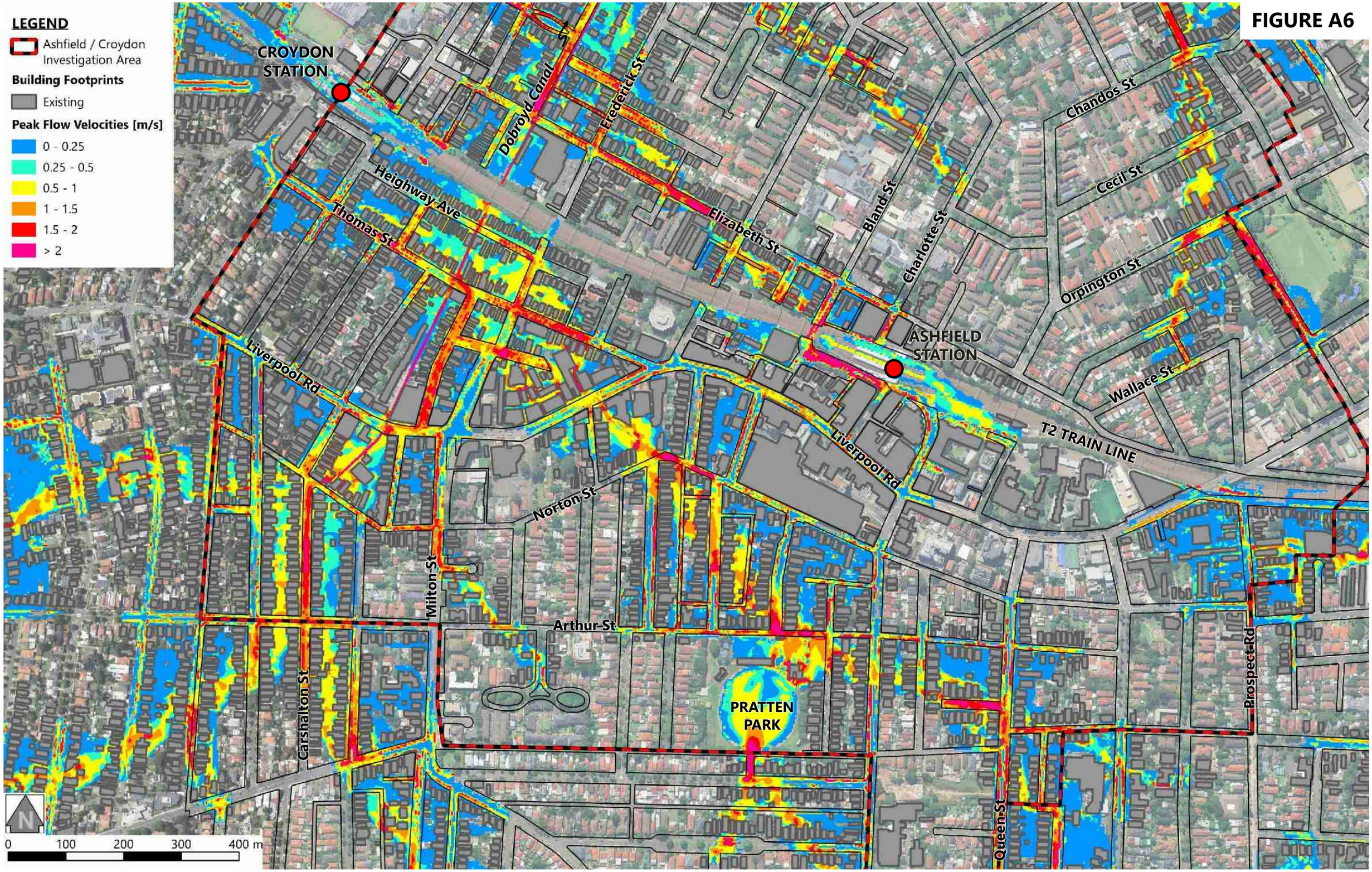


FIGURE A6

Prepared by:
worley consulting

PEAK 1% AEP FLOW VELOCITIES FOR EXISTING CONDITIONS [ASHFIELD / CROYDON - SOUTH]

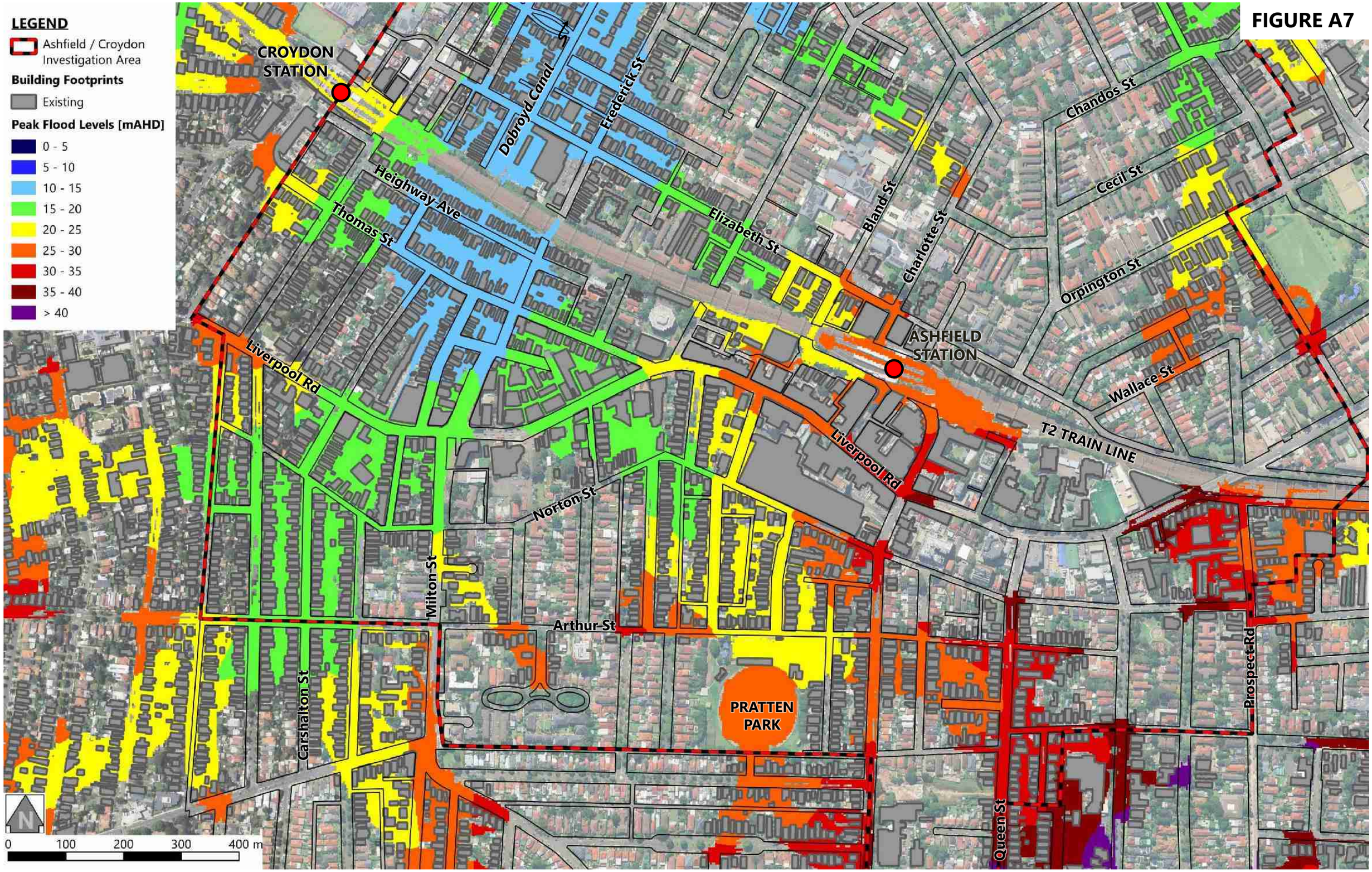
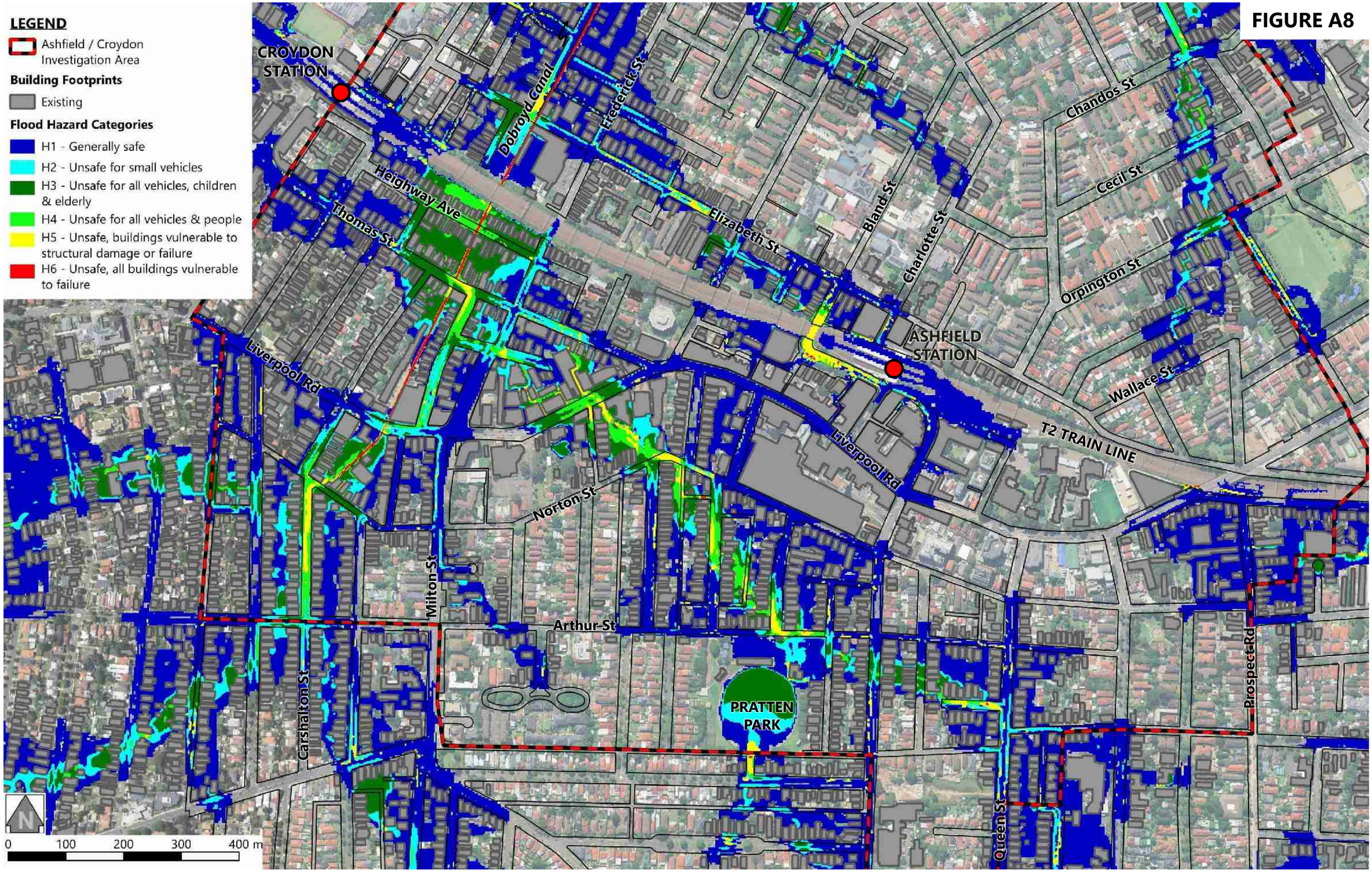


FIGURE A7

Prepared by:
worley consulting

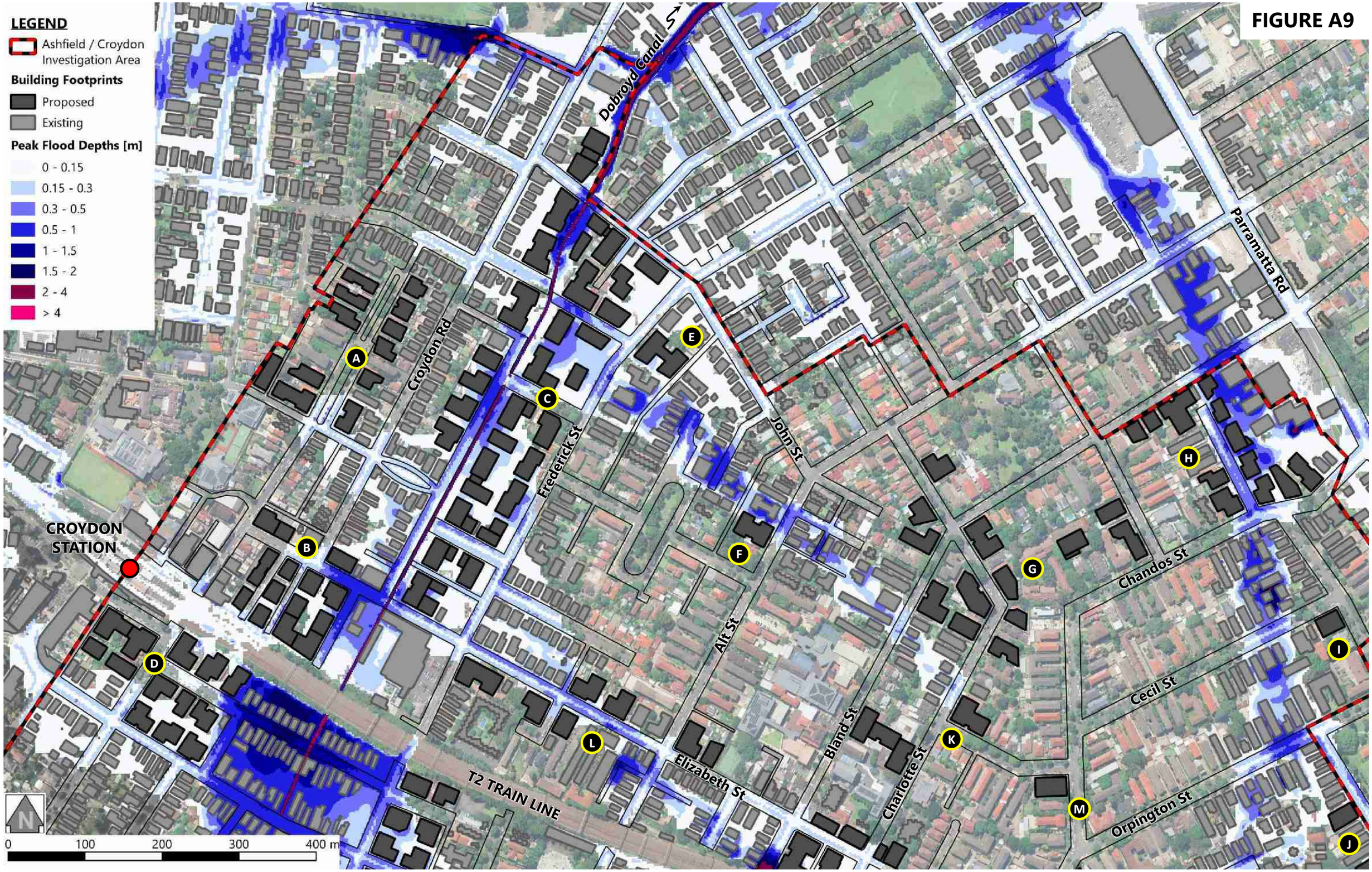
PEAK 1% AEP FLOOD LEVELS FOR EXISTING CONDITIONS [ASHFIELD / CROYDON - SOUTH]

FIGURE A8



Prepared by:
worley consulting

PEAK 1% AEP FLOOD HAZARD CATEGORIES FOR EXISTING CONDITIONS [ASHFIELD / CROYDON - SOUTH]



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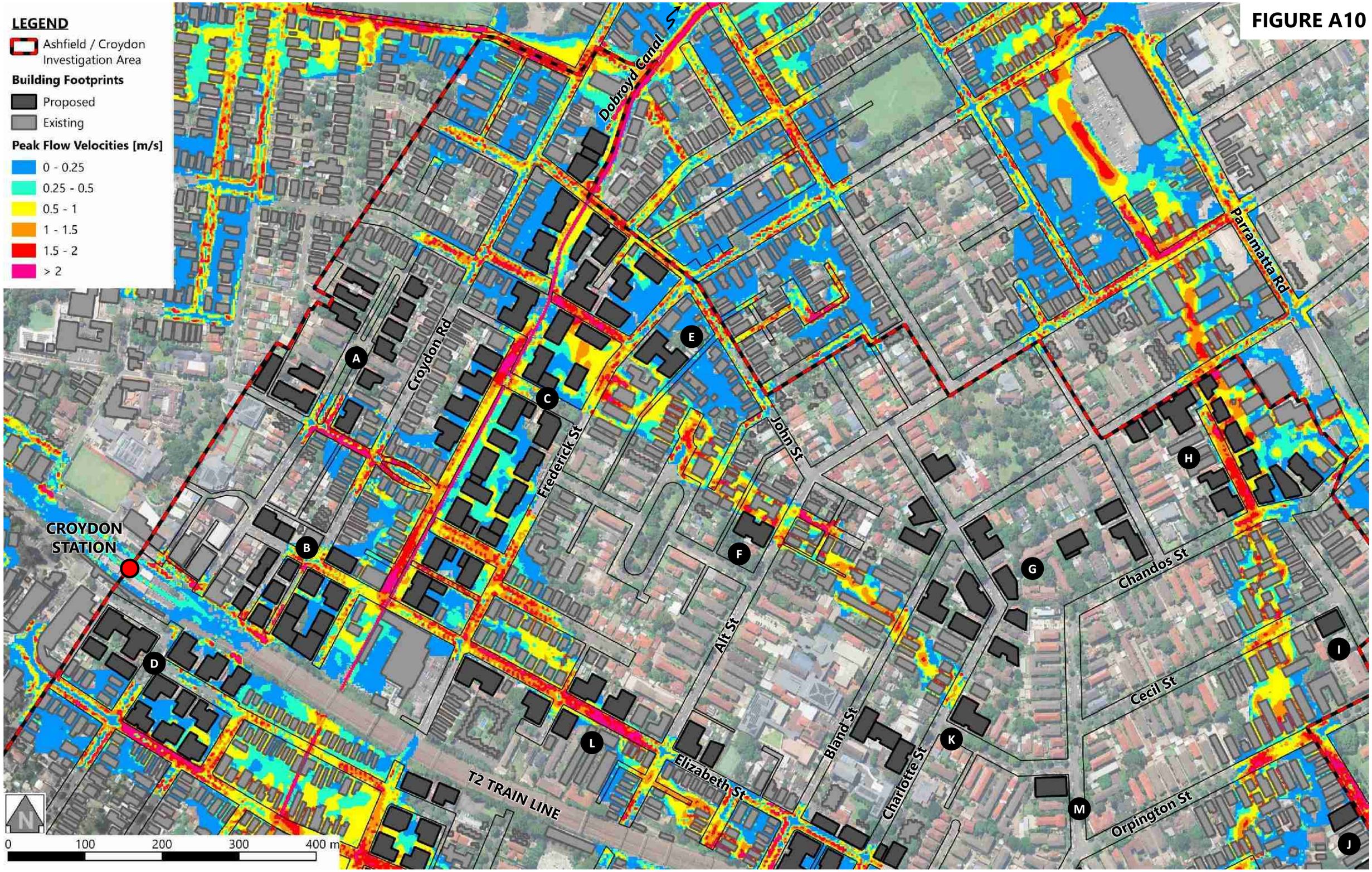
PEAK 1% AEP FLOOD DEPTHS FOR POST-DEVELOPMENT CONDITIONS [ASHFIELD / CROYDON - NORTH]

FIGURE A10



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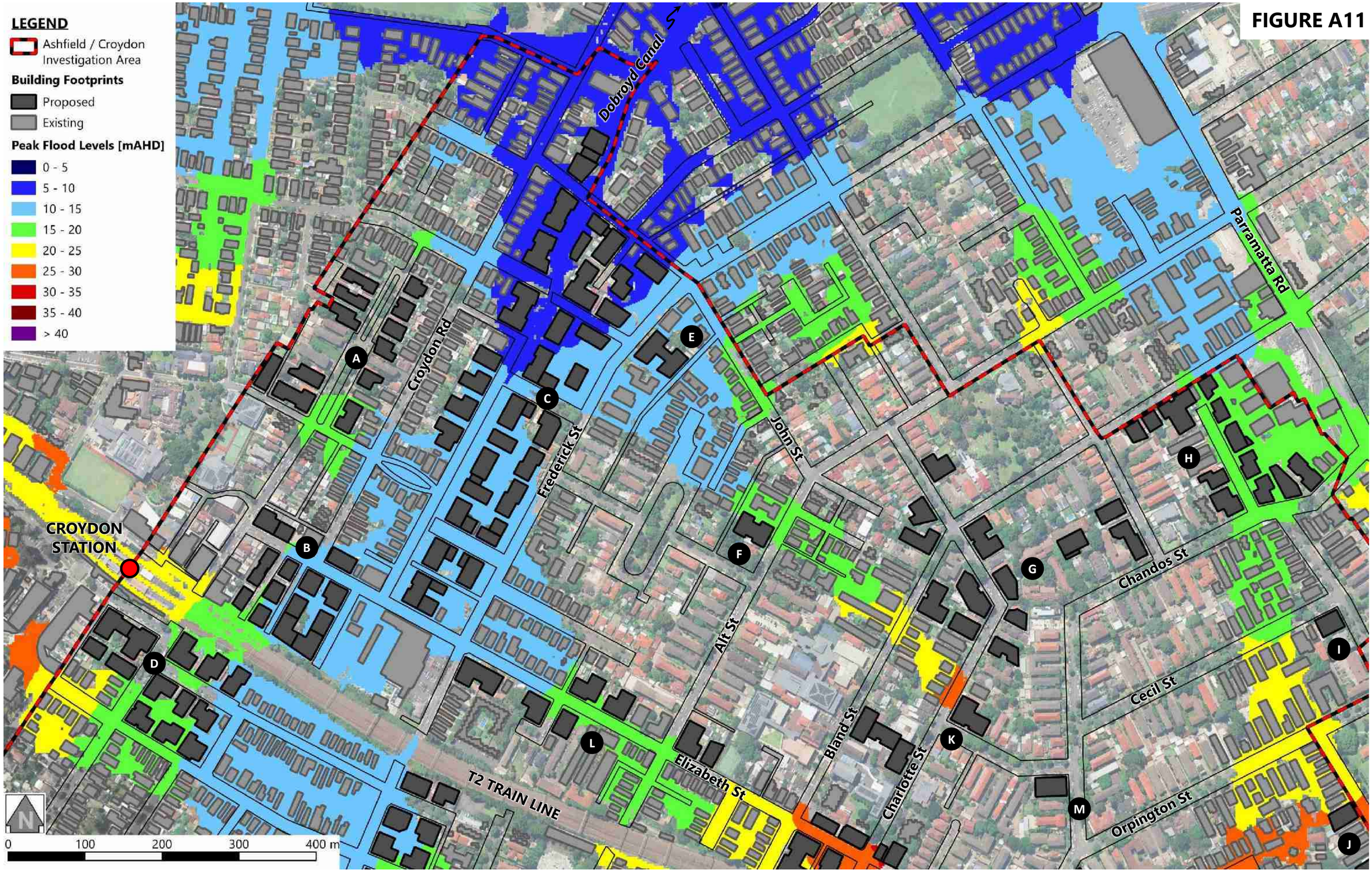
worley consulting

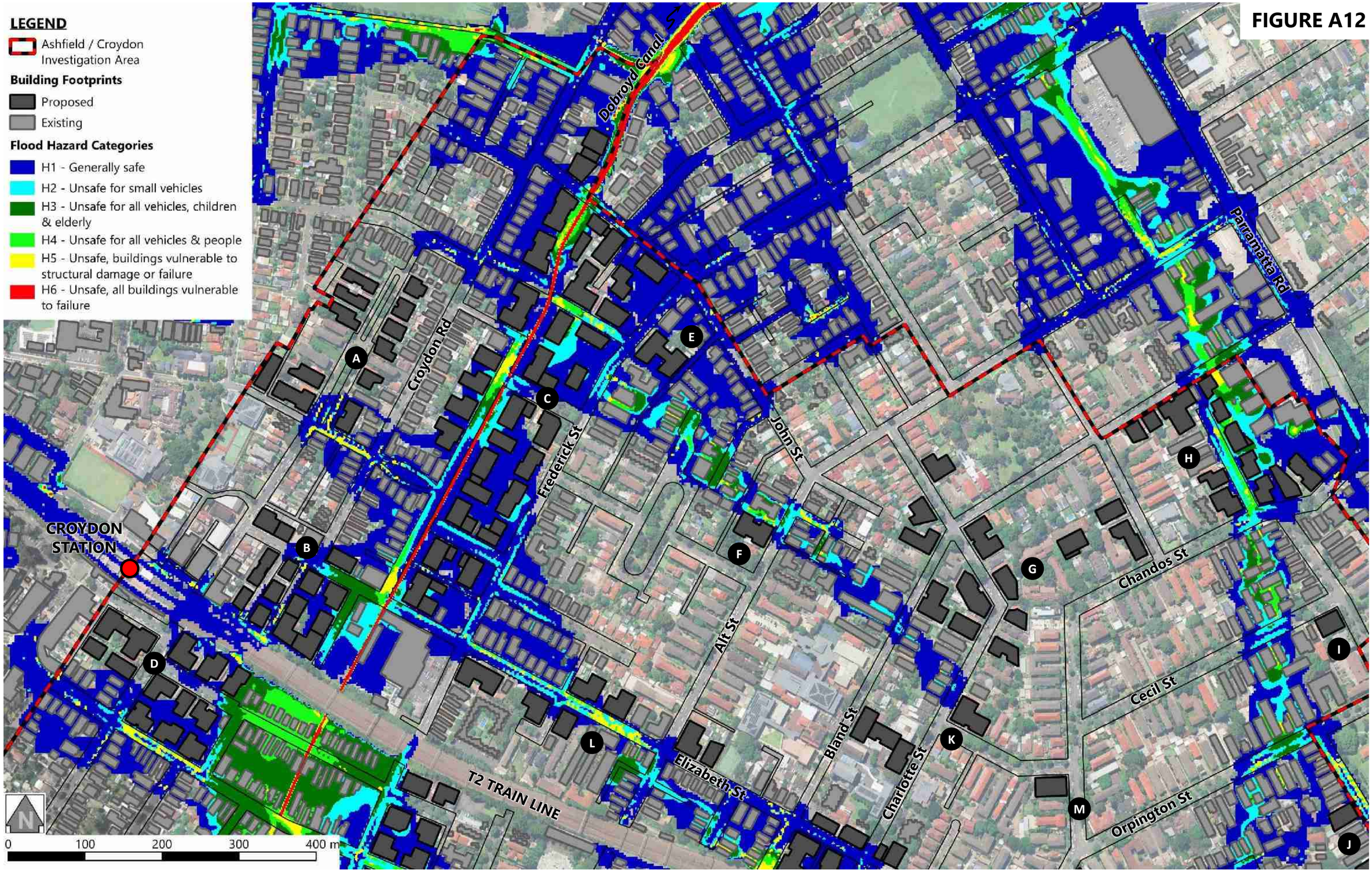
PEAK 1% AEP FLOW VELOCITIES FOR POST-DEVELOPMENT CONDITIONS [ASHFIELD / CROYDON - NORTH]



Prepared by:
worley consulting

PEAK 1% AEP FLOOD LEVELS FOR POST-DEVELOPMENT CONDITIONS [ASHFIELD / CROYDON - NORTH]

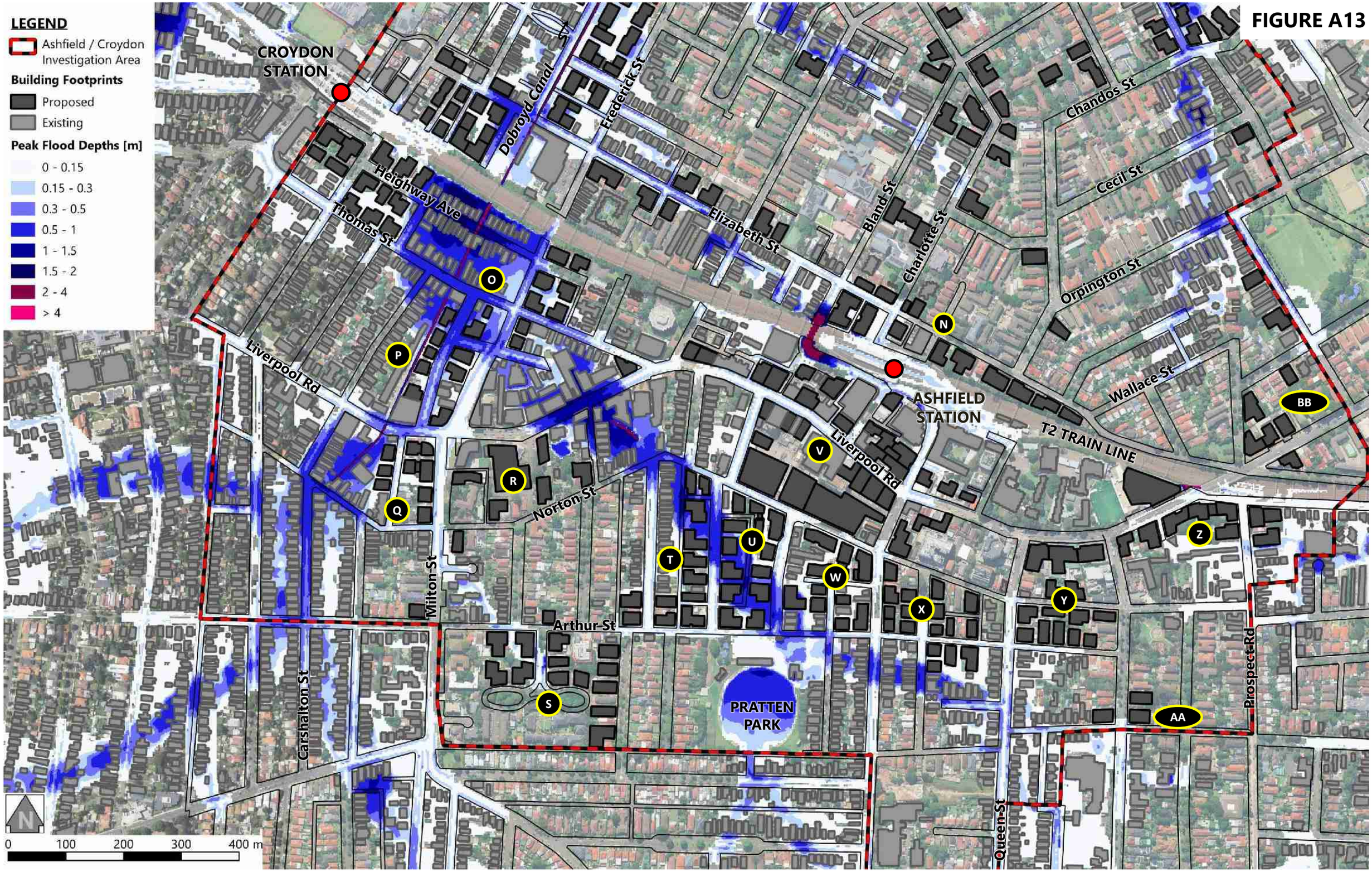
FIGURE A12



Prepared by:
worley consulting

PEAK 1% AEP FLOOD HAZARD CATEGORIES FOR POST-DEVELOPMENT CONDITIONS [ASHFIELD / CROYDON - NORTH]

FIGURE A13



Prepared by:

worley consulting

PEAK 1% AEP FLOOD DEPTHS FOR POST-DEVELOPMENT CONDITIONS [ASHFIELD / CROYDON - SOUTH]

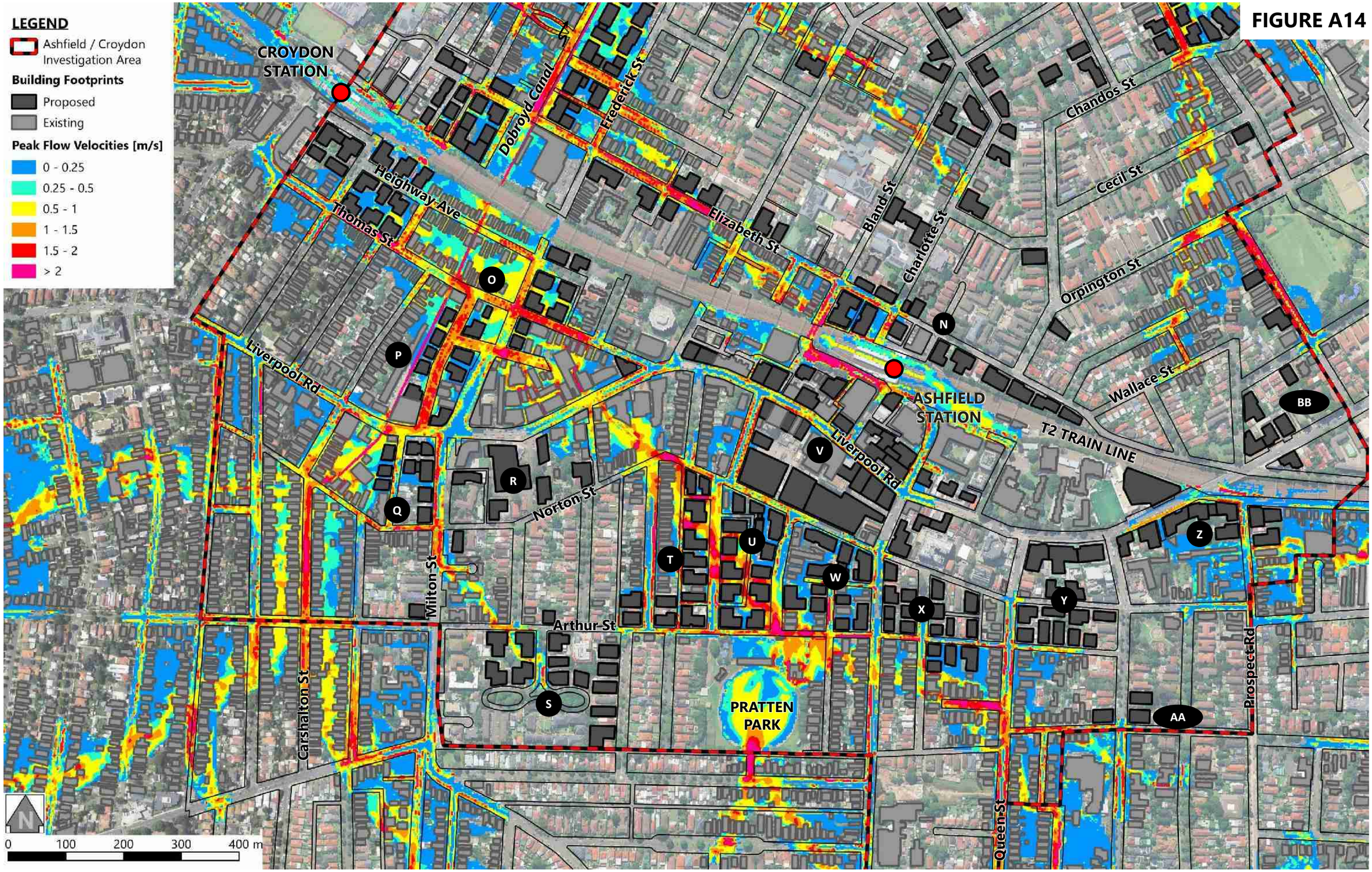


FIGURE A14

Prepared by:
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PEAK 1% AEP FLOW VELOCITIES FOR POST-DEVELOPMENT CONDITIONS [ASHFIELD / CROYDON - SOUTH]

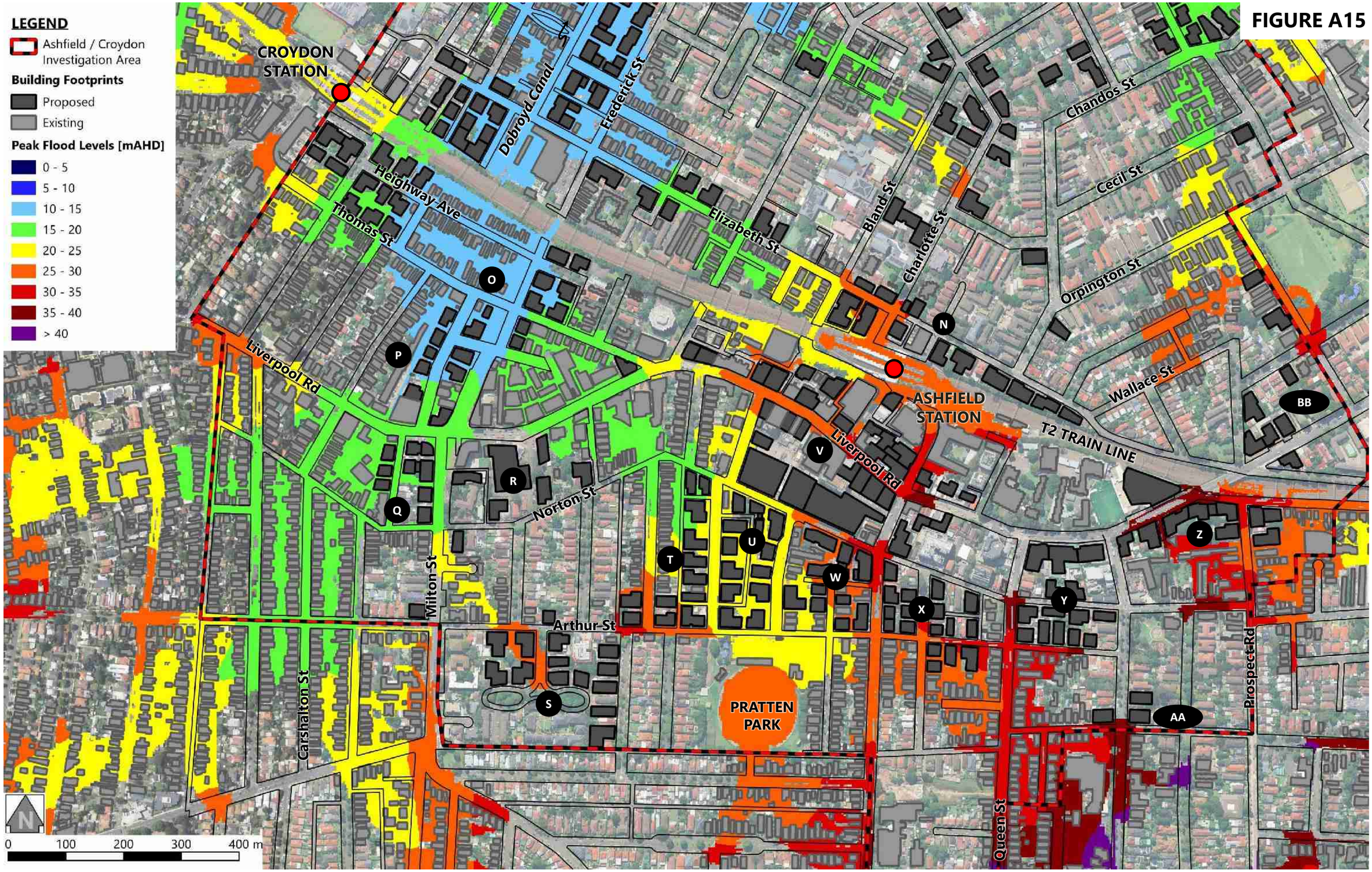

FIGURE A15

Prepared by:
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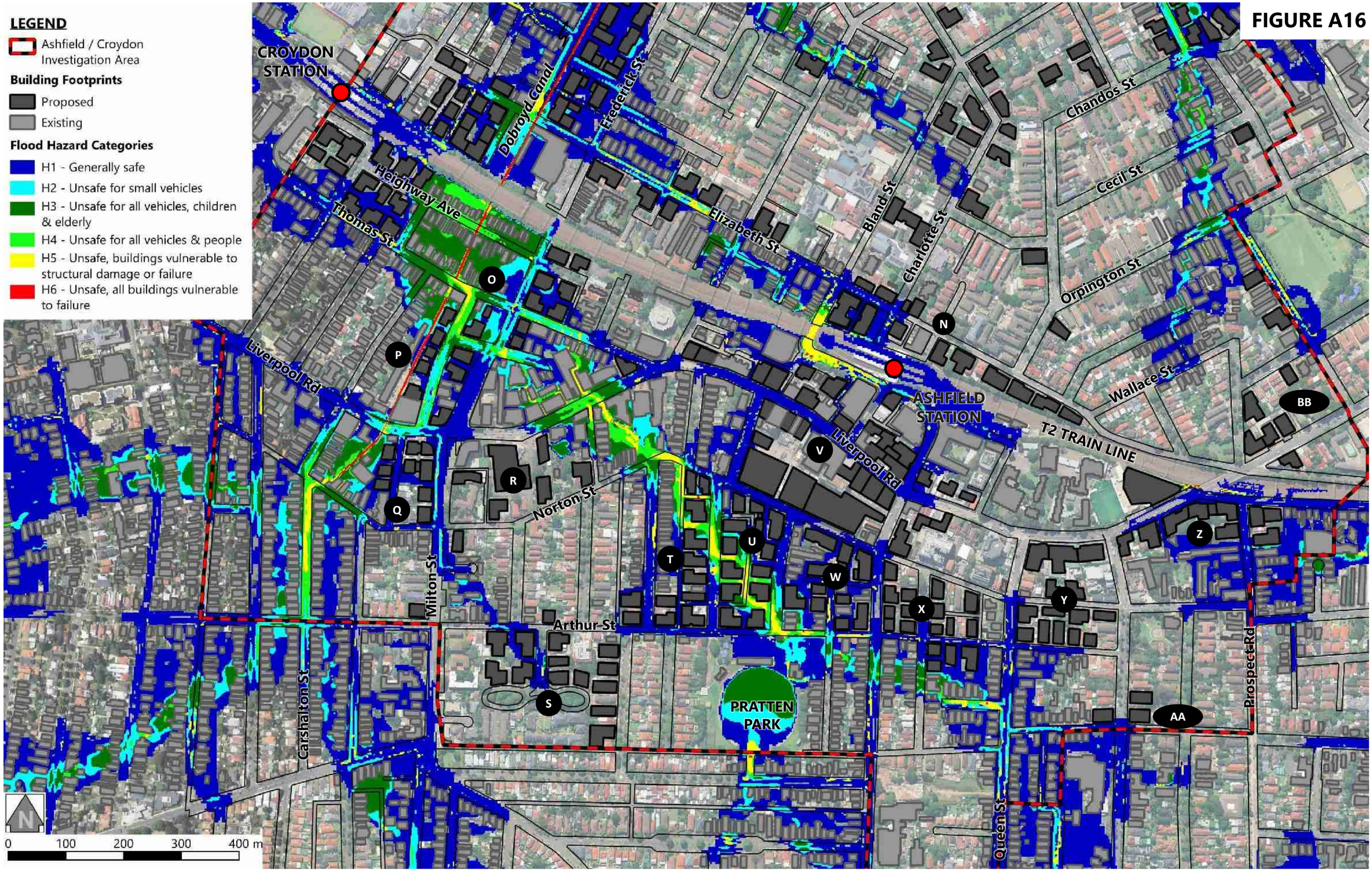
PEAK 1% AEP FLOOD LEVELS FOR POST-DEVELOPMENT CONDITIONS [ASHFIELD / CROYDON - SOUTH]

FIGURE A16



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worley consulting

PEAK 1% AEP FLOOD HAZARD CATEGORIES FOR POST-DEVELOPMENT CONDITIONS [ASHFIELD / CROYDON - SOUTH]

FIGURE A17

Prepared by:
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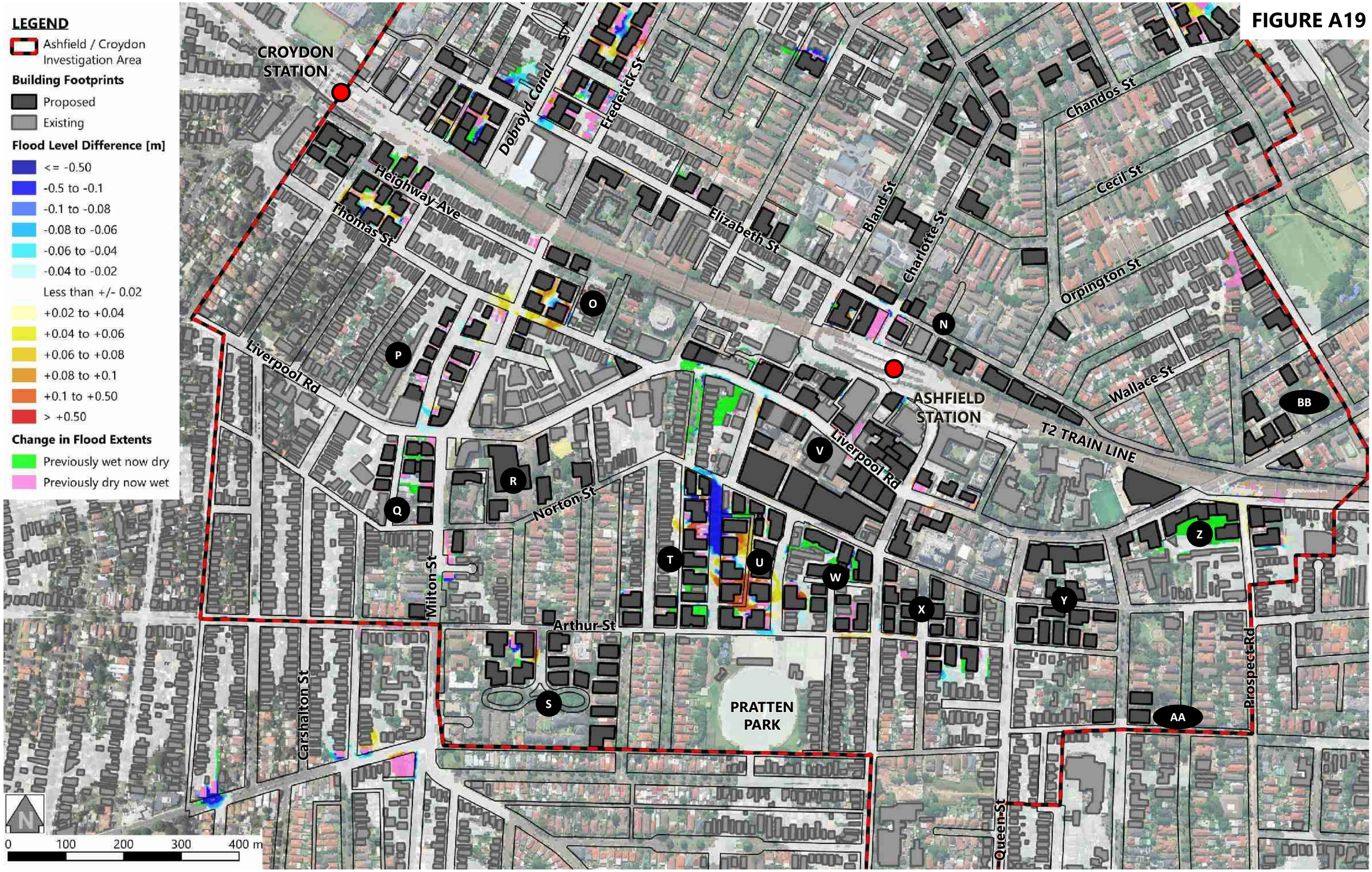
DIFFERENCE IN PEAK 1% AEP FLOOD LEVELS [ASHFIELD / CROYDON - NORTH]

FIGURE A18

Prepared by:
worley consulting

DIFFERENCE IN 1% AEP FLOOD HAZARD CATEGORIES [ASHFIELD / CROYDON - NORTH]

FIGURE A19

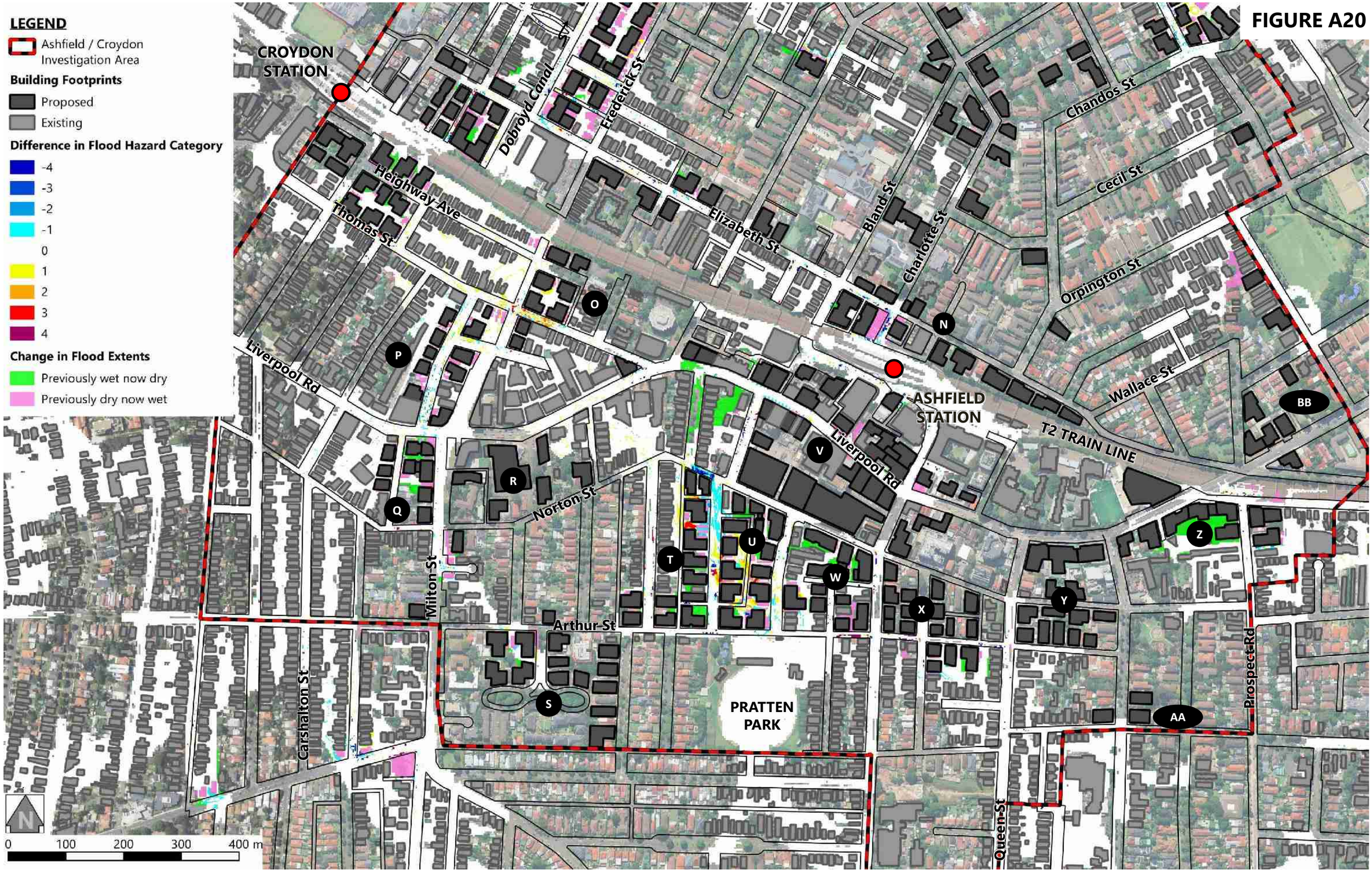


Prepared by:

worley consulting

DIFFERENCE IN PEAK 1% AEP FLOOD LEVELS [ASHFIELD / CROYDON - SOUTH]

FIGURE A20

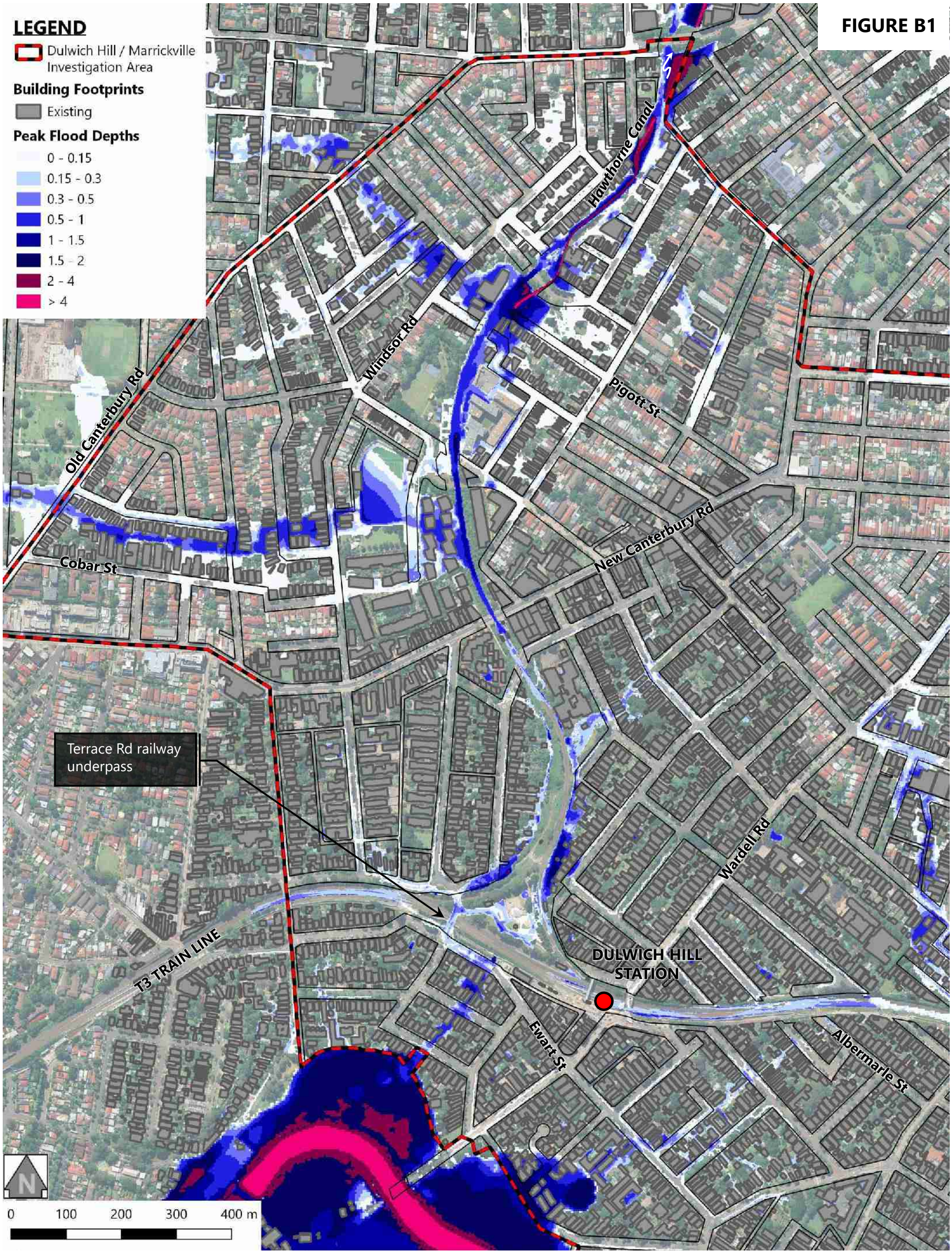


Prepared by:

worley consulting

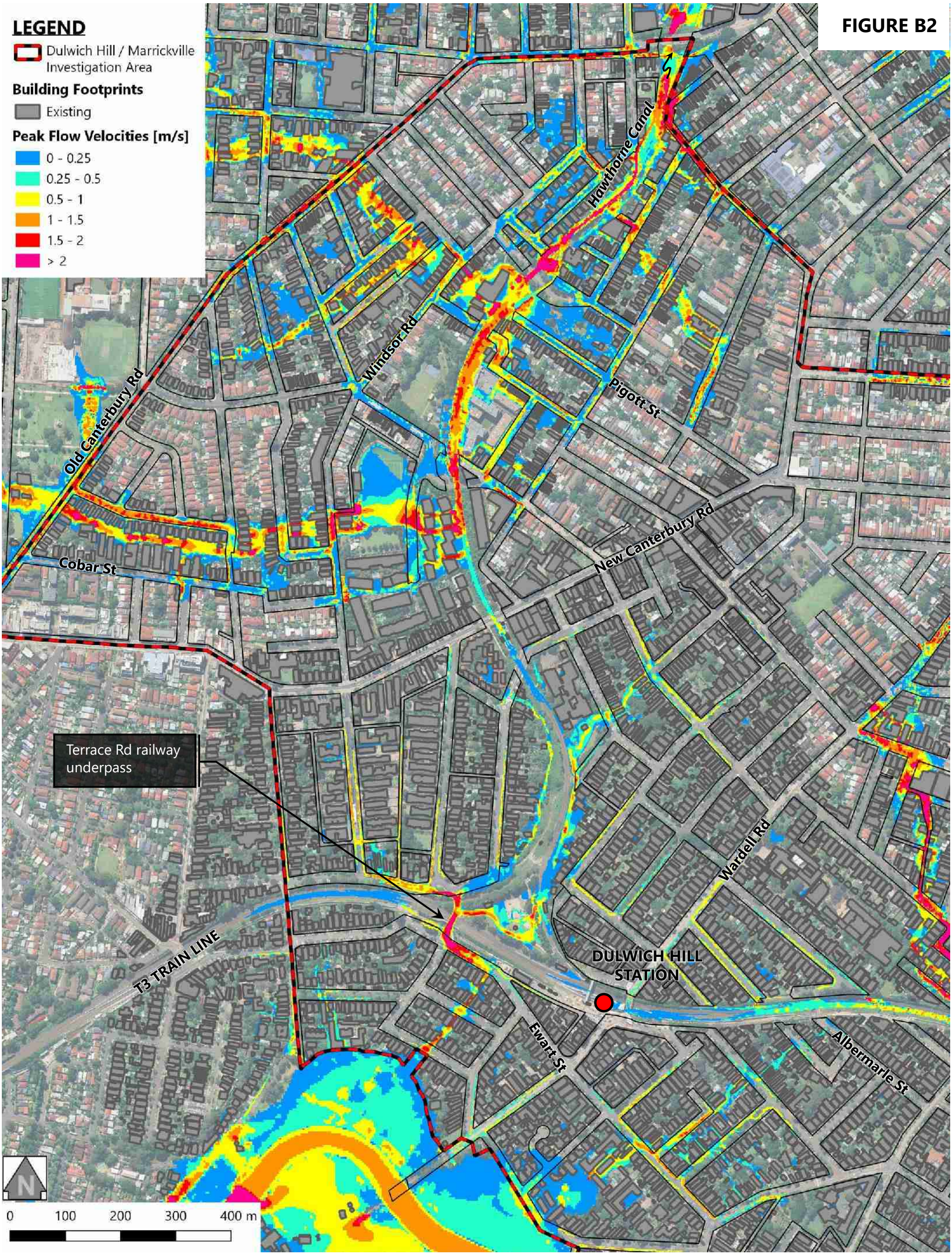
DIFFERENCE IN 1% AEP FLOOD HAZARD CATEGORIES [ASHFIELD / CROYDON - SOUTH]

Appendix B. 1% AEP Flood Mapping [Dulwich Hill / Marrickville]



Prepared by:
worley consulting

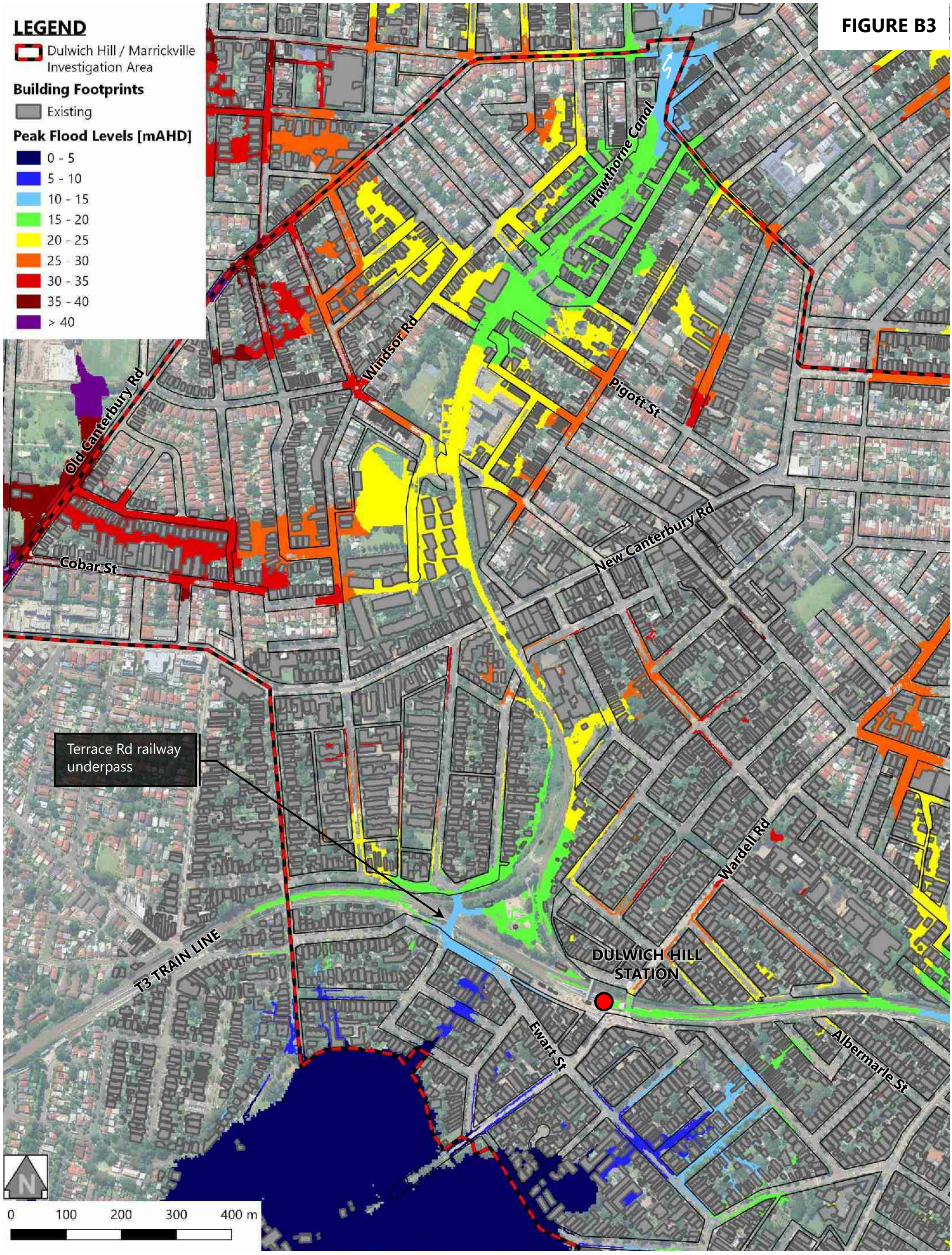
PEAK 1% AEP FLOOD DEPTHS FOR EXISTING CONDITIONS [DULWICH HILL / MARRICKVILLE - WEST]



Prepared by:

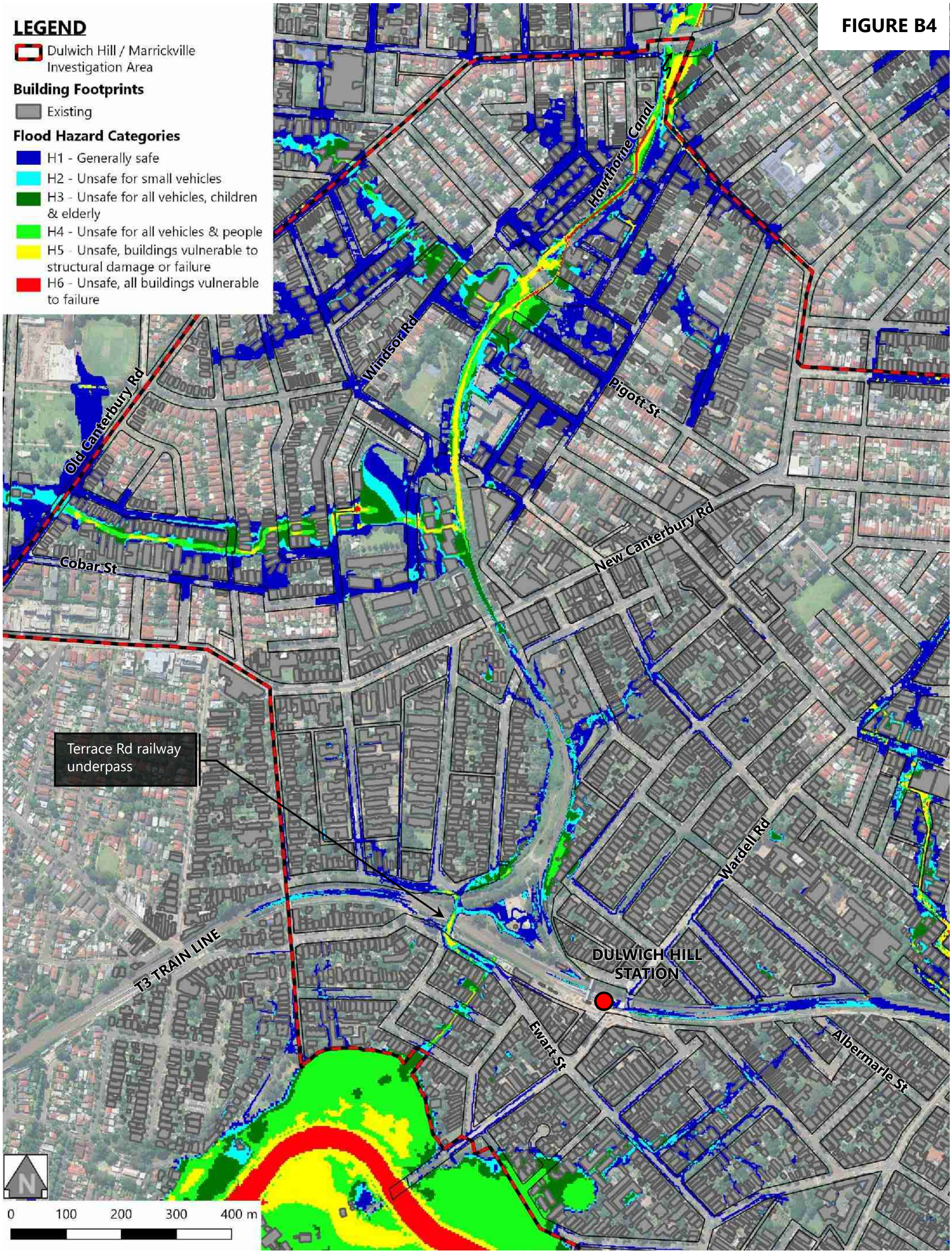
worley consulting

PEAK 1% AEP FLOW VELOCITIES FOR EXISTING CONDITIONS [DULWICH HILL / MARRICKVILLE - WEST]



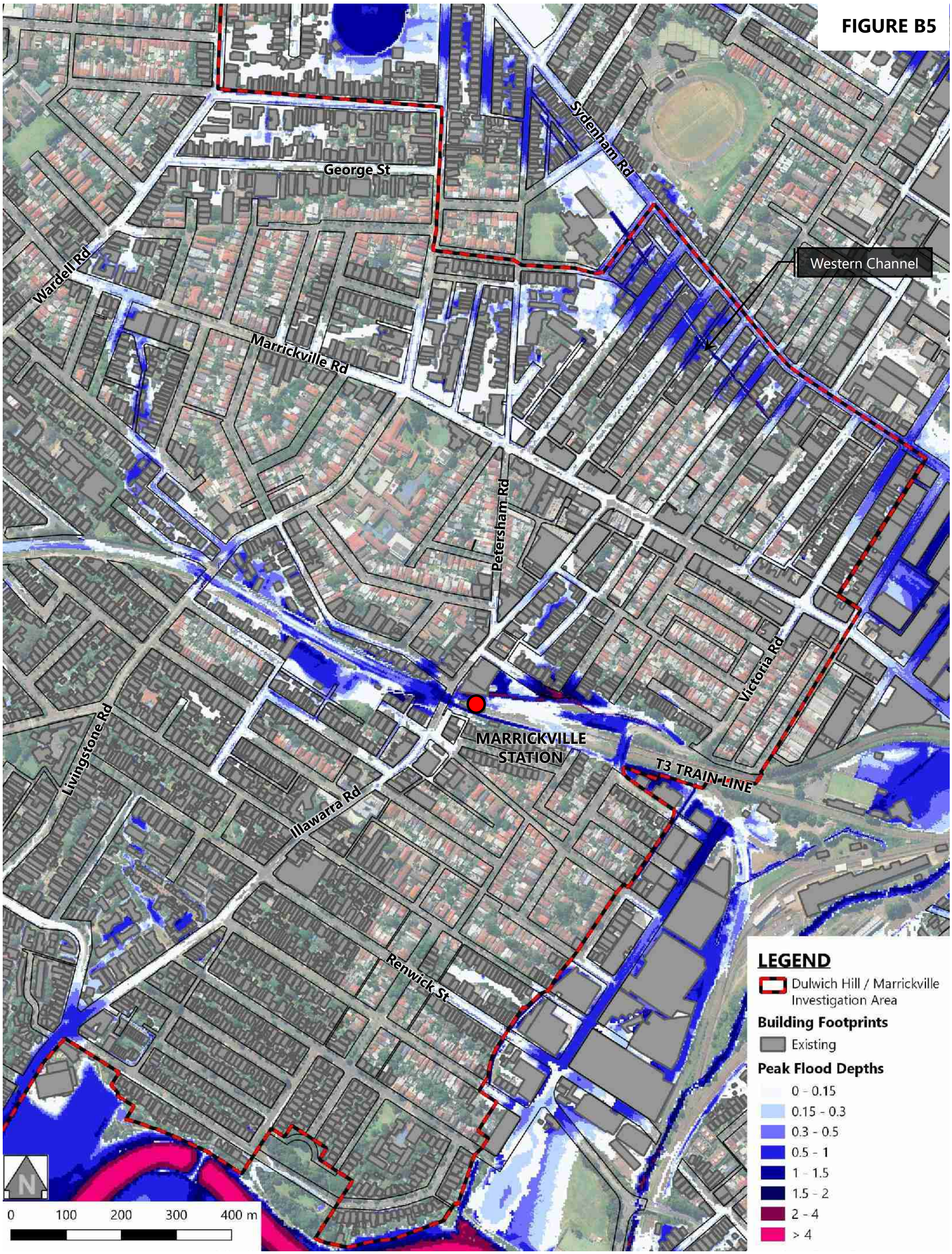
Prepared by:
worley consulting

PEAK 1% AEP FLOOD LEVELS FOR EXISTING CONDITIONS [DULWICH HILL / MARRICKVILLE - WEST]



Prepared by:
worley consulting

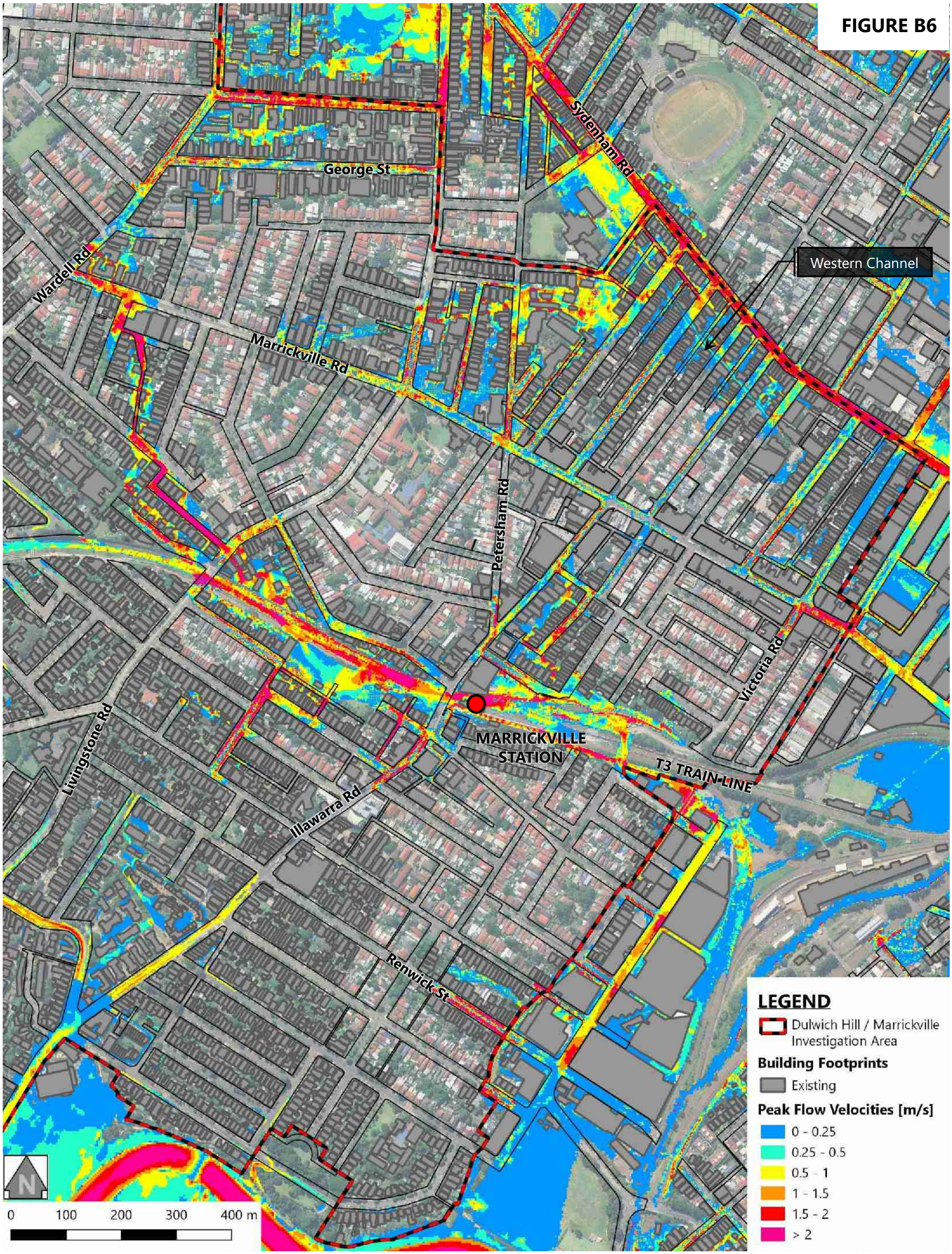
PEAK 1% AEP FLOOD HAZARD CATEGORIES FOR EXISTING CONDITIONS [DULWICH HILL / MARRICKVILLE - WEST]



Prepared by:

worley consulting

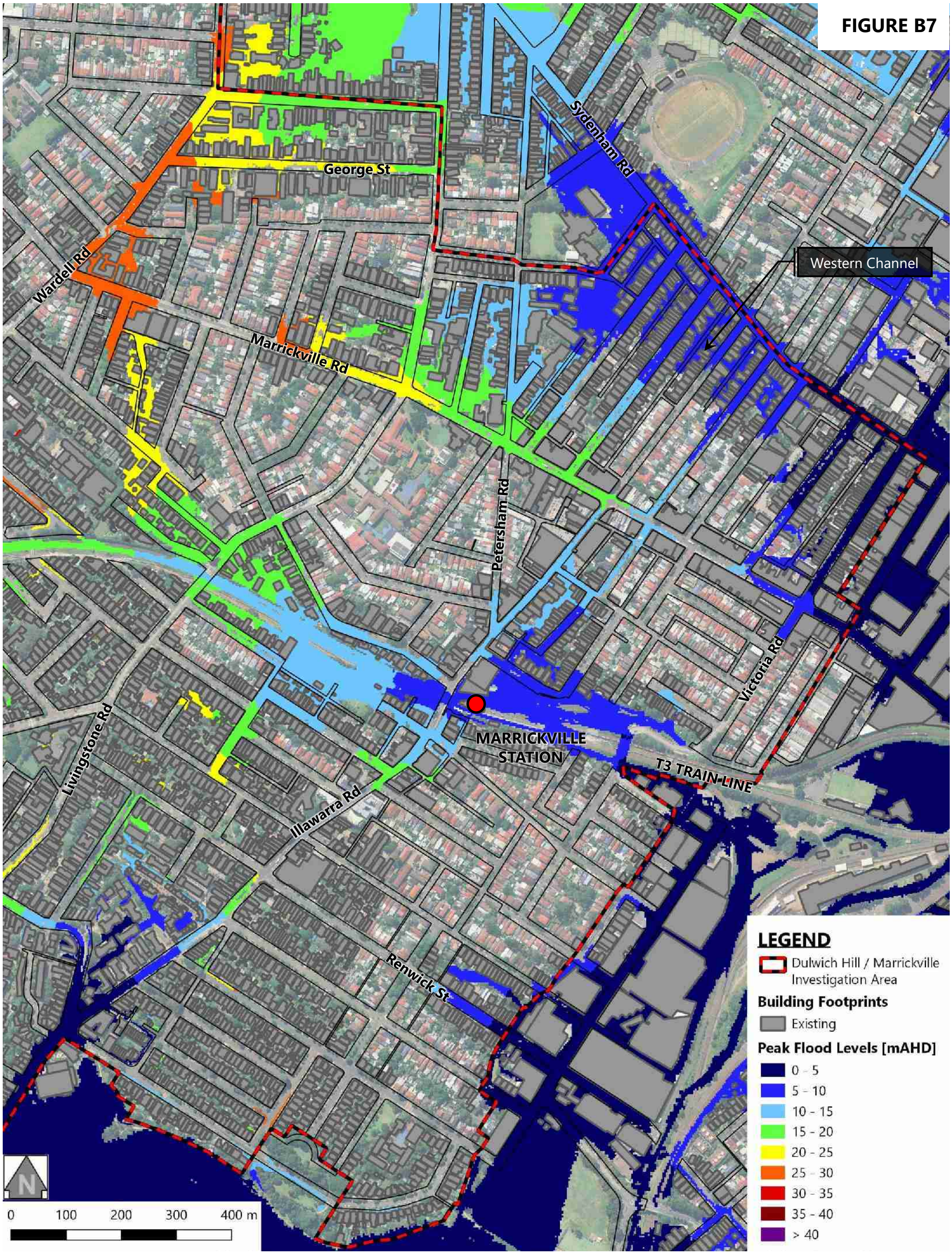
PEAK 1% AEP FLOOD DEPTHS FOR EXISTING CONDITIONS [DULWICH HILL / MARRICKVILLE - EAST]



Prepared by:

worley consulting

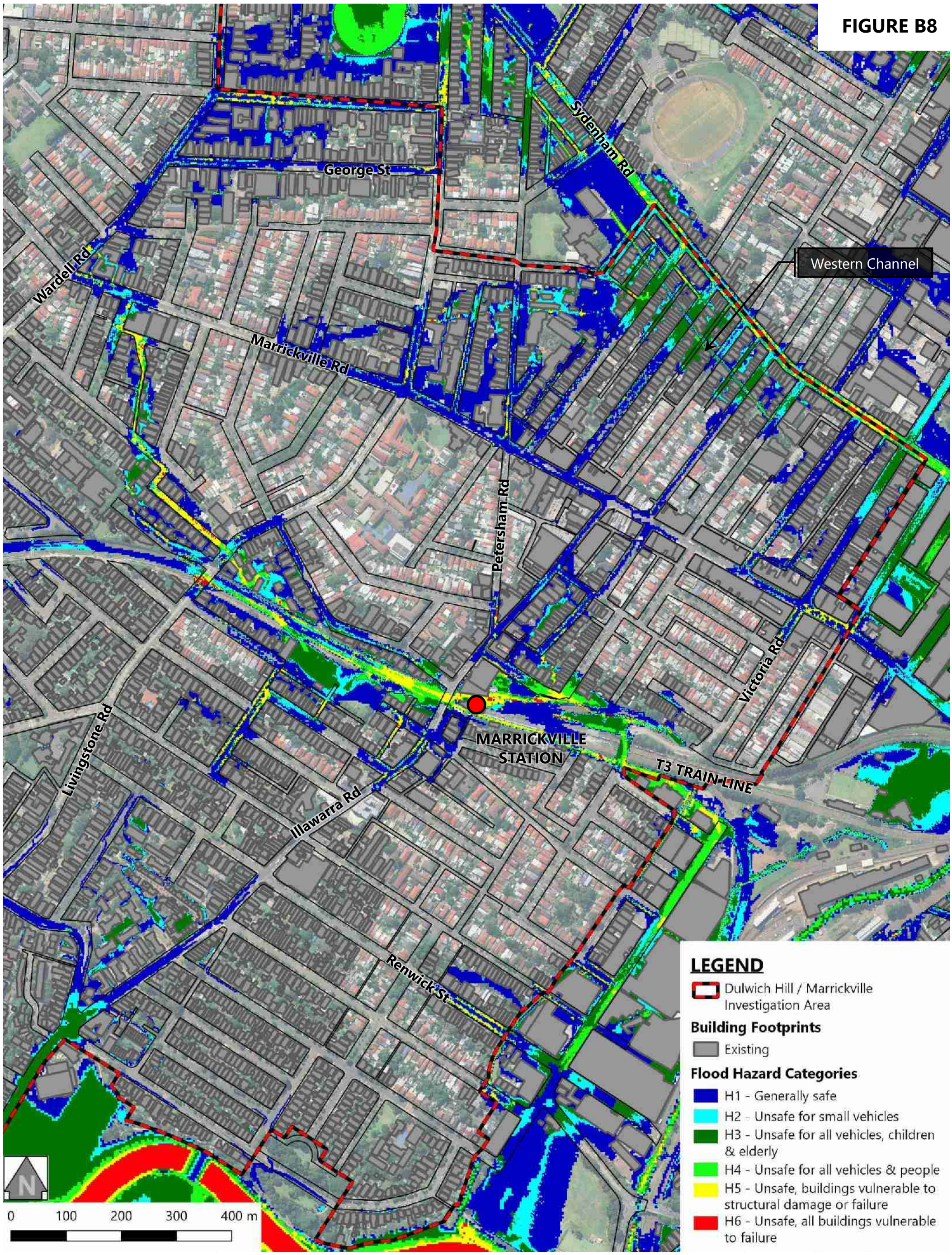
PEAK 1% AEP FLOW VELOCITIES FOR EXISTING CONDITIONS [DULWICH HILL / MARRICKVILLE - EAST]



Prepared by:

worley consulting

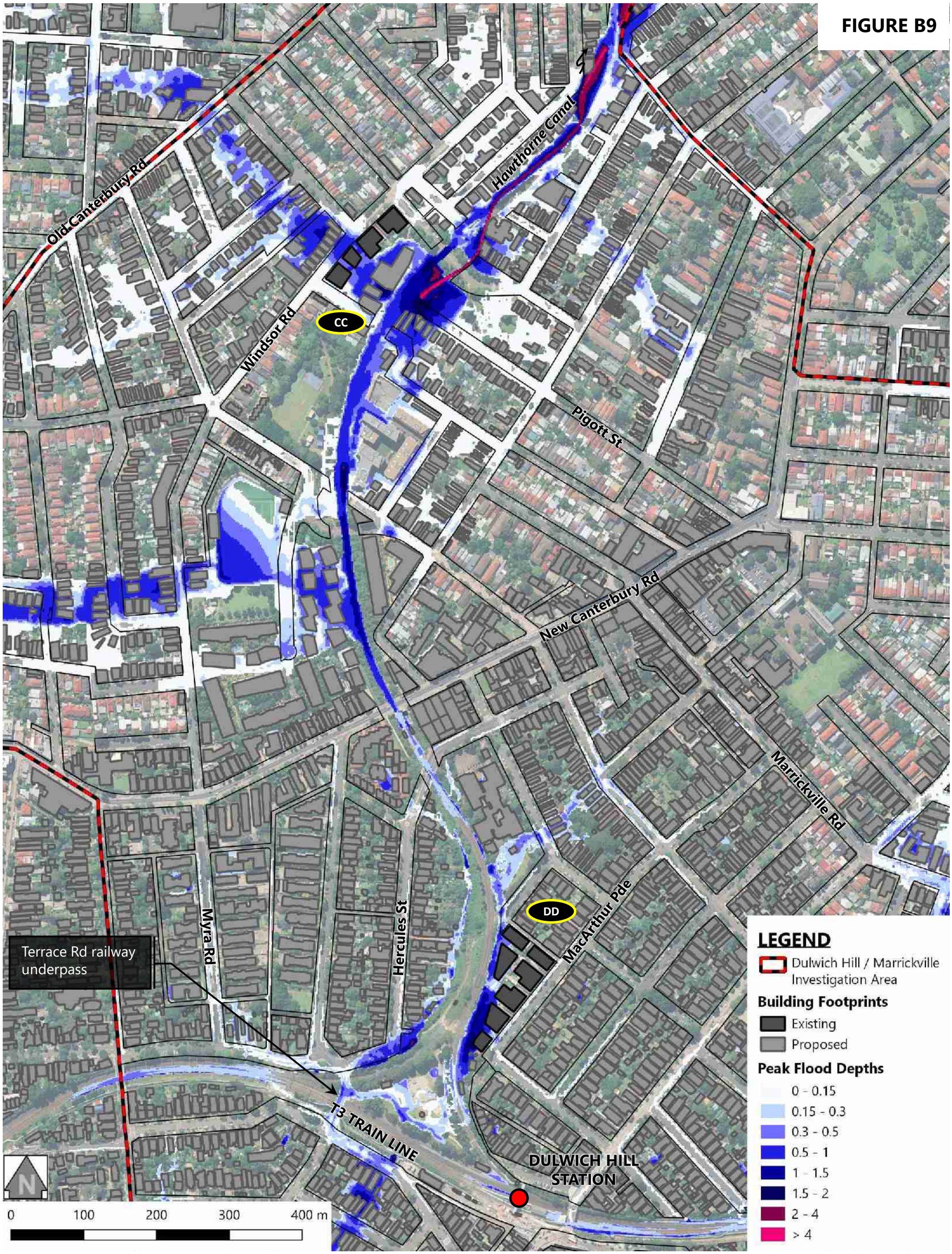
PEAK 1% AEP FLOOD LEVELS FOR EXISTING CONDITIONS [DULWICH HILL / MARRICKVILLE - EAST]



Prepared by:

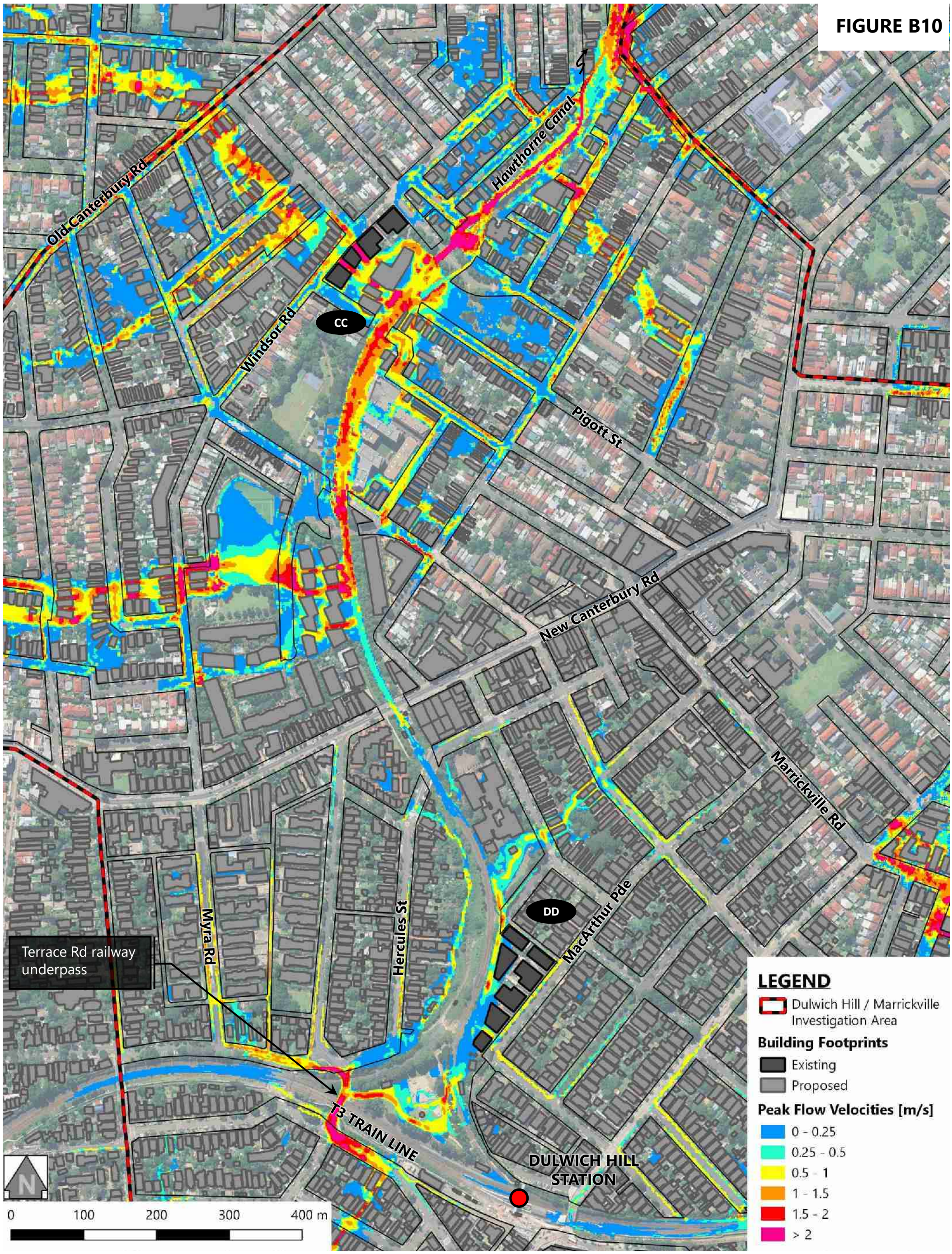
worley consulting

PEAK 1% AEP FLOOD HAZARD CATEGORIES FOR EXISTING CONDITIONS [DULWICH HILL / MARRICKVILLE - EAST]



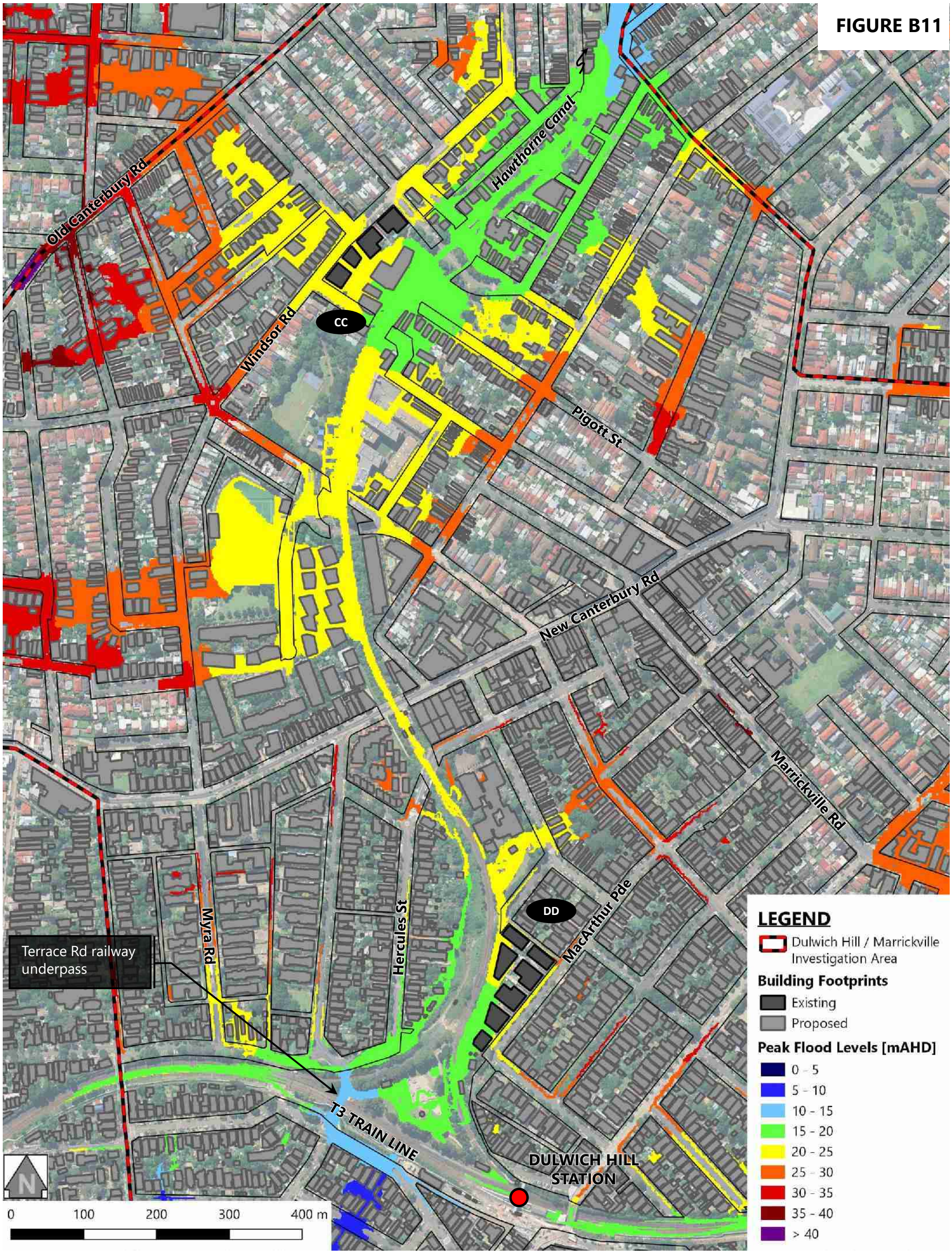
Prepared by:
worley consulting

PEAK 1% AEP FLOOD DEPTHS FOR POST-DEVELOPMENT CONDITIONS [DULWICH HILL / MARRICKVILLE - WEST]



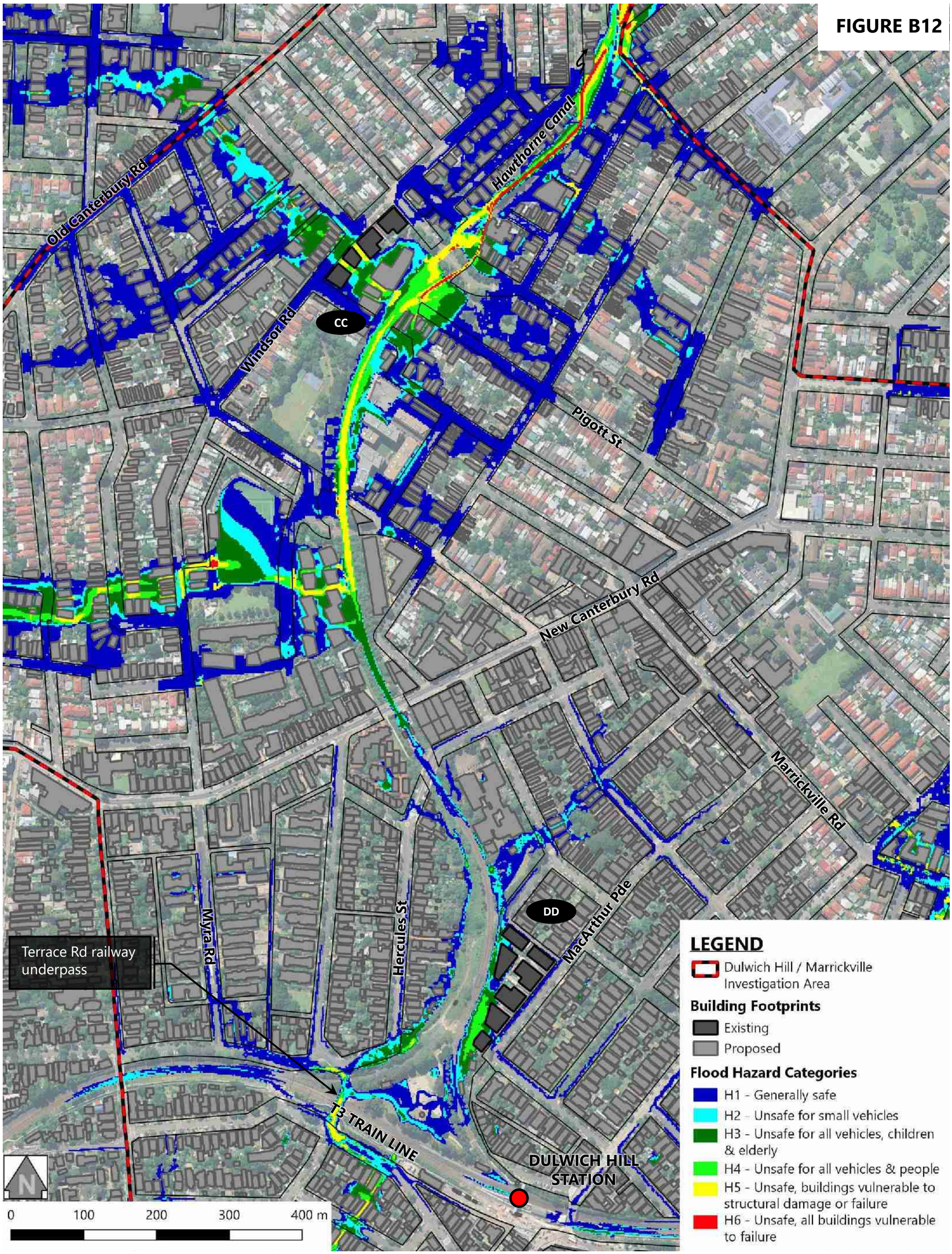
Prepared by:
worley consulting

PEAK 1% AEP FLOW VELOCITIES FOR POST-DEVELOPMENT CONDITIONS [DULWICH HILL / MARRICKVILLE - WEST]



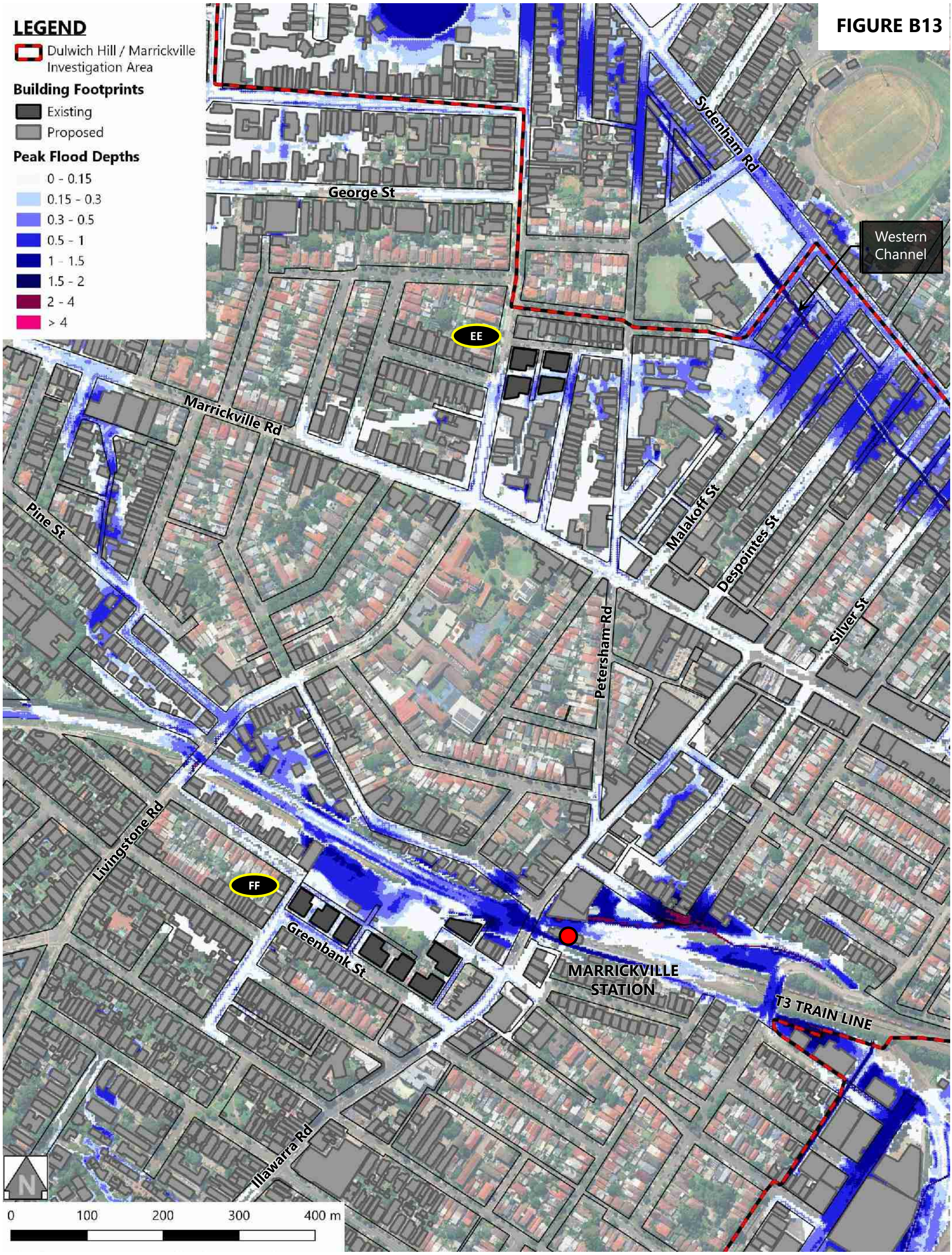
Prepared by:
worley consulting

PEAK 1% AEP FLOOD LEVELS FOR POST-DEVELOPMENT CONDITIONS [DULWICH HILL / MARRICKVILLE - WEST]



Prepared by:
worley consulting

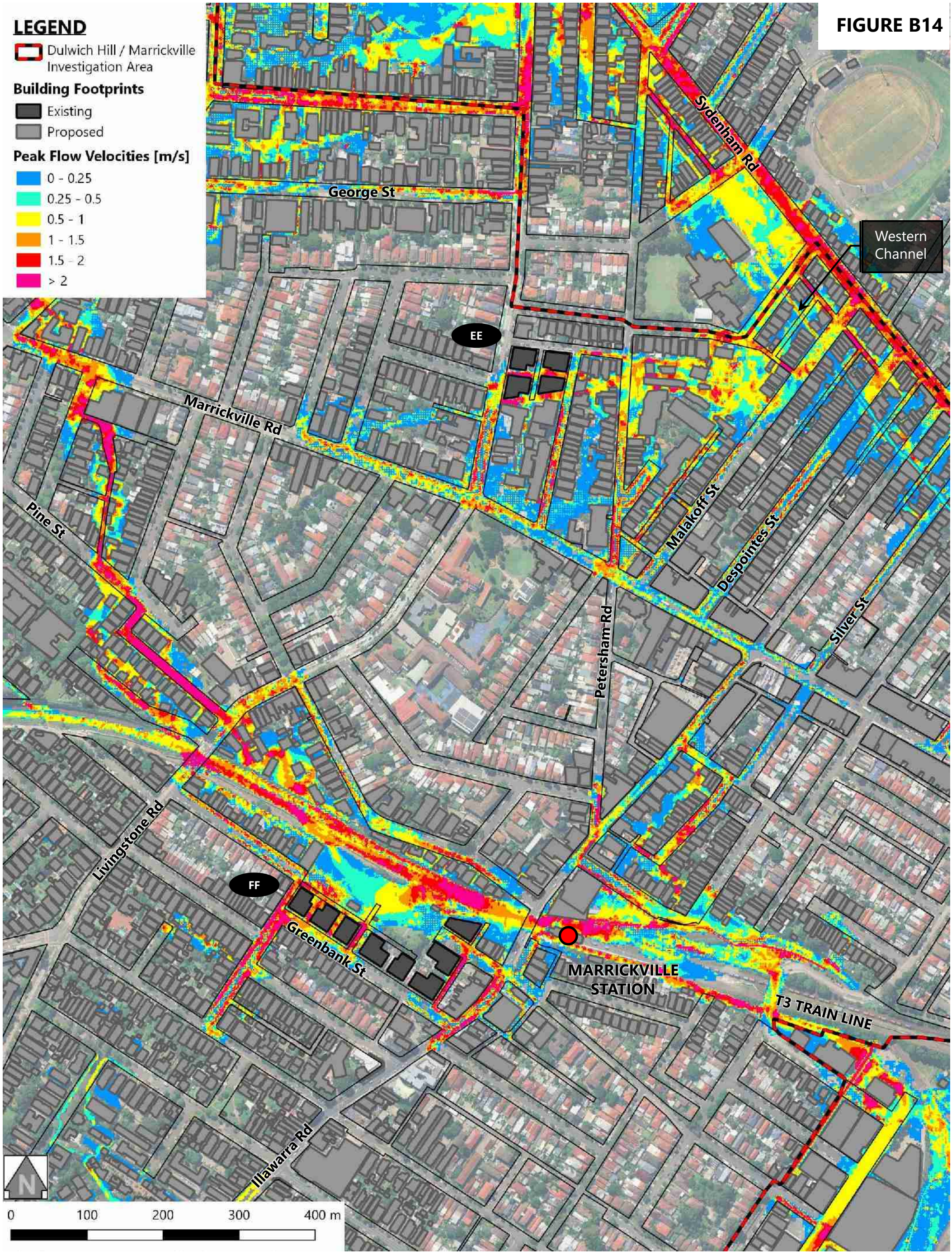
PEAK 1% AEP FLOOD HAZARD CATEGORIES FOR POST-DEVELOPMENT CONDITIONS [DULWICH HILL / MARRICKVILLE - WEST]



Prepared by:

worley consulting

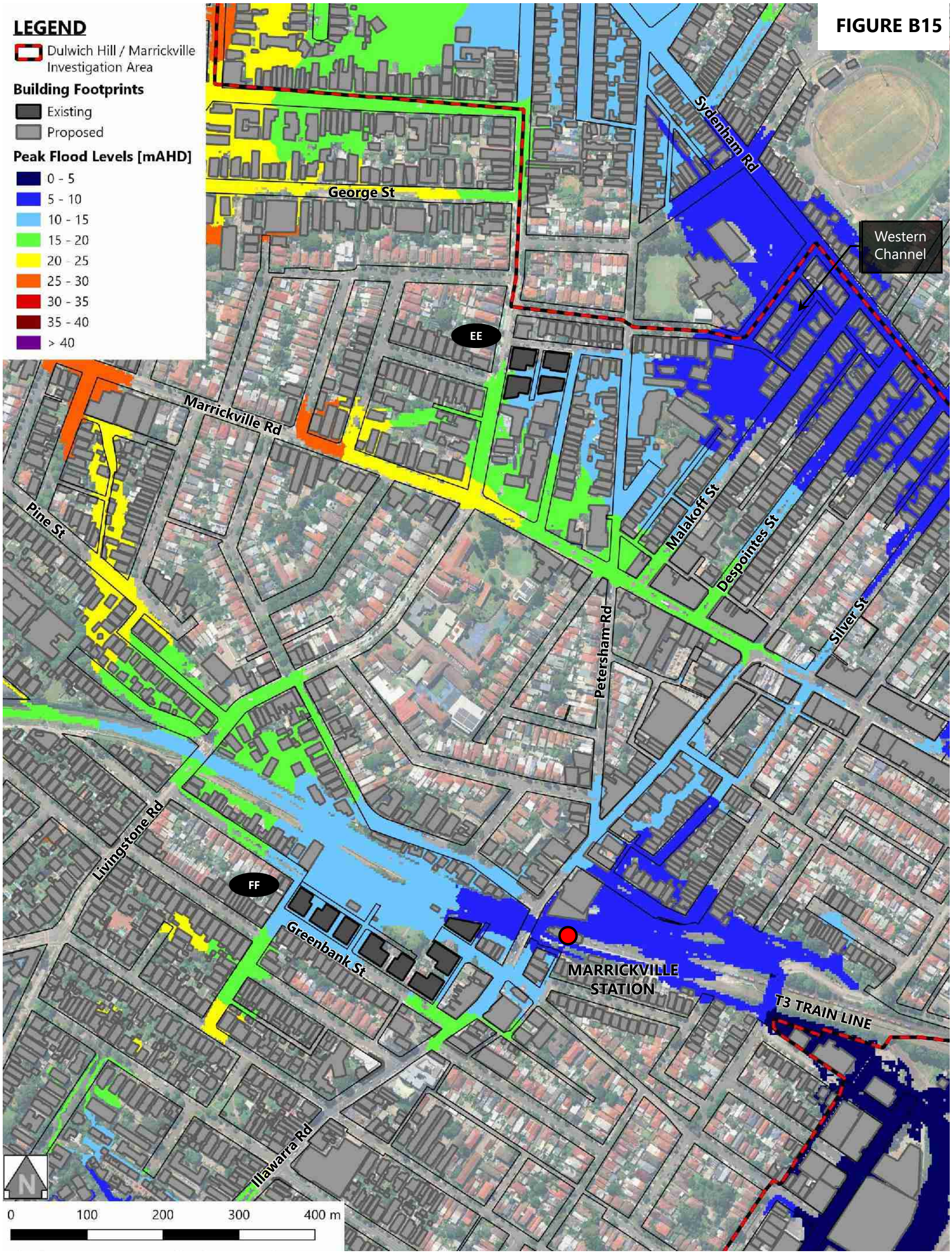
PEAK 1% AEP FLOOD DEPTHS FOR POST-DEVELOPMENT CONDITIONS [DULWICH HILL / MARRICKVILLE - EAST]



Prepared by:

worley consulting

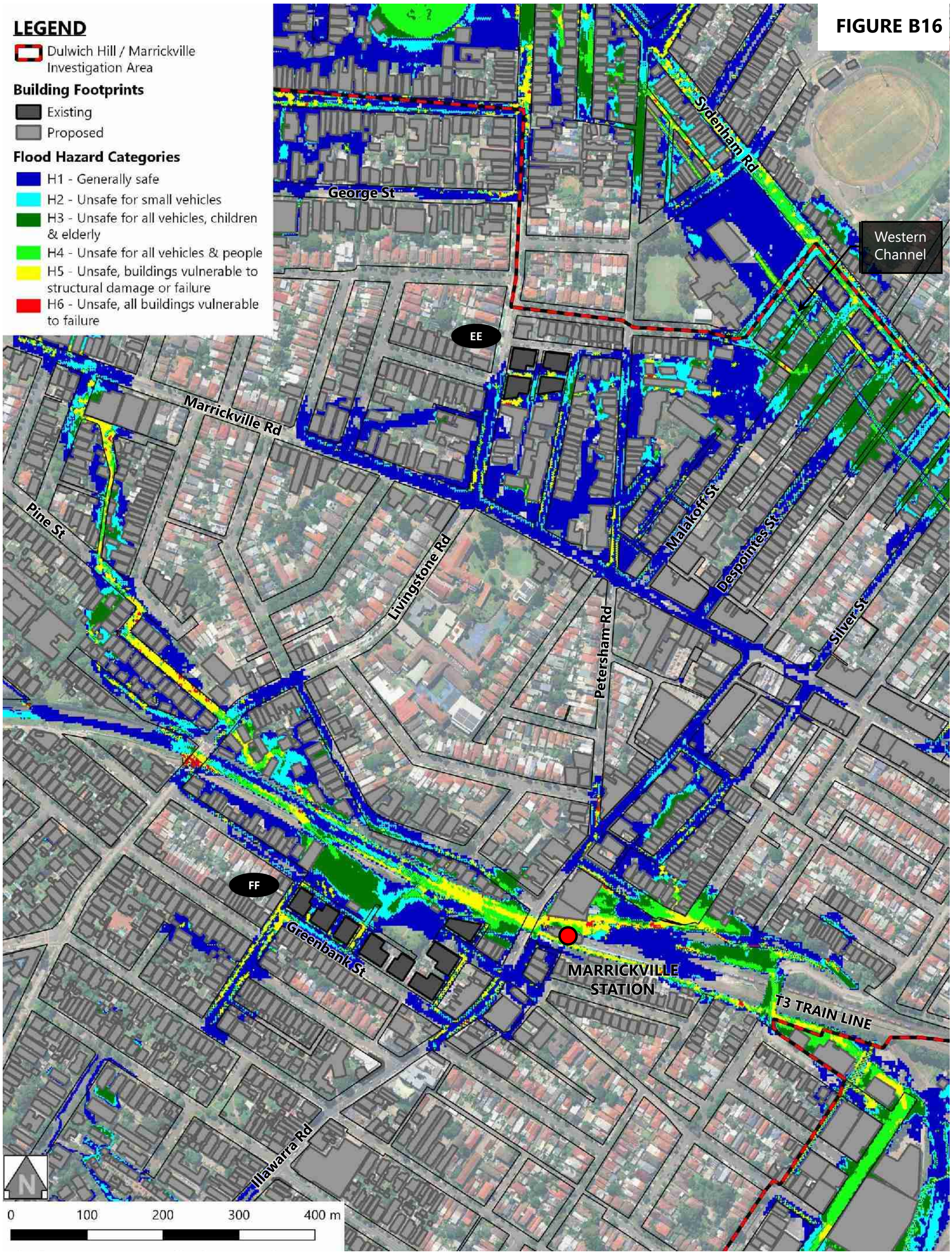
PEAK 1% AEP FLOW VELOCITIES FOR POST-DEVELOPMENT CONDITIONS [DULWICH HILL / MARRICKVILLE - EAST]



Prepared by:

worley consulting

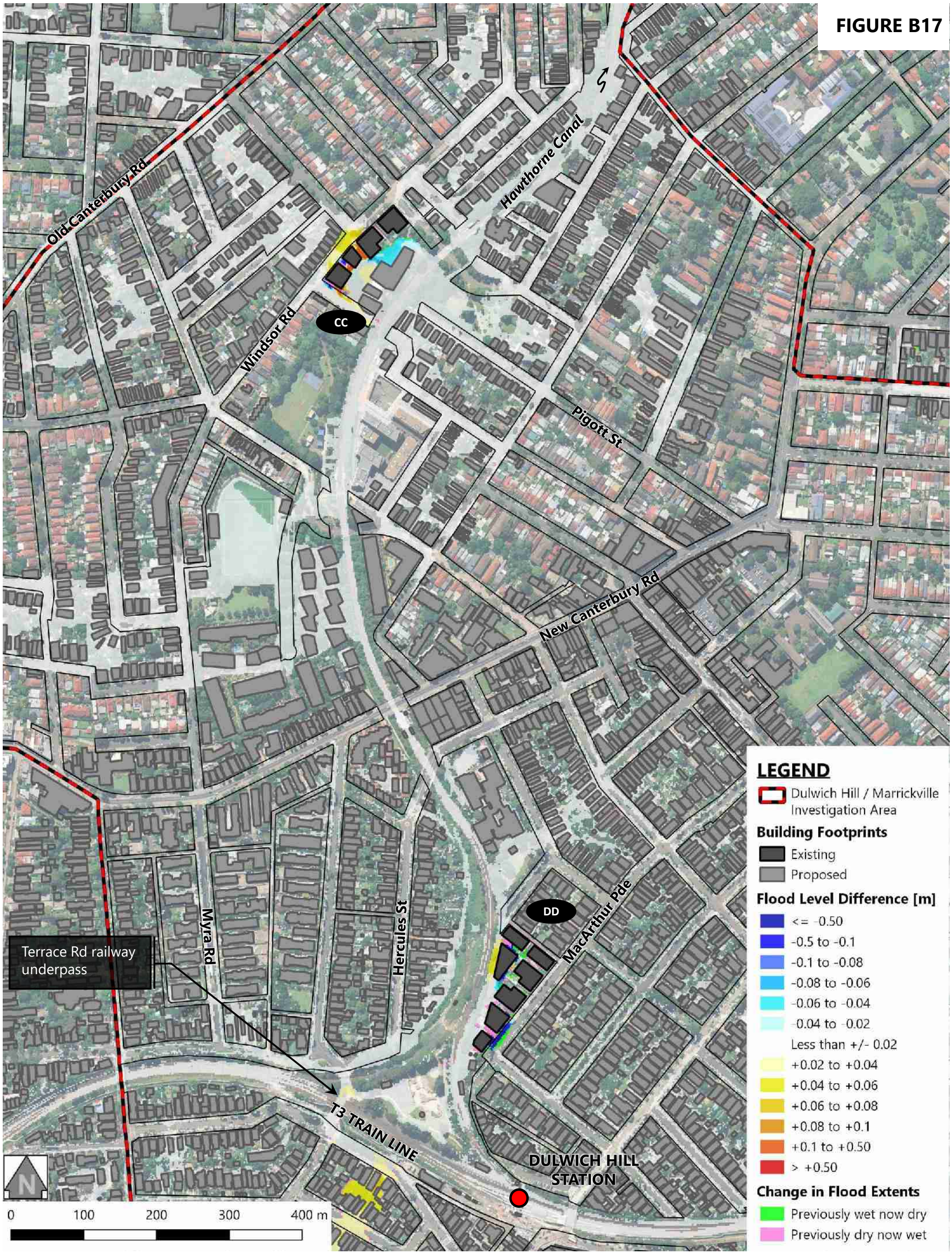
PEAK 1% AEP FLOOD LEVELS FOR POST-DEVELOPMENT CONDITIONS [DULWICH HILL / MARRICKVILLE - EAST]



Prepared by:

worley consulting

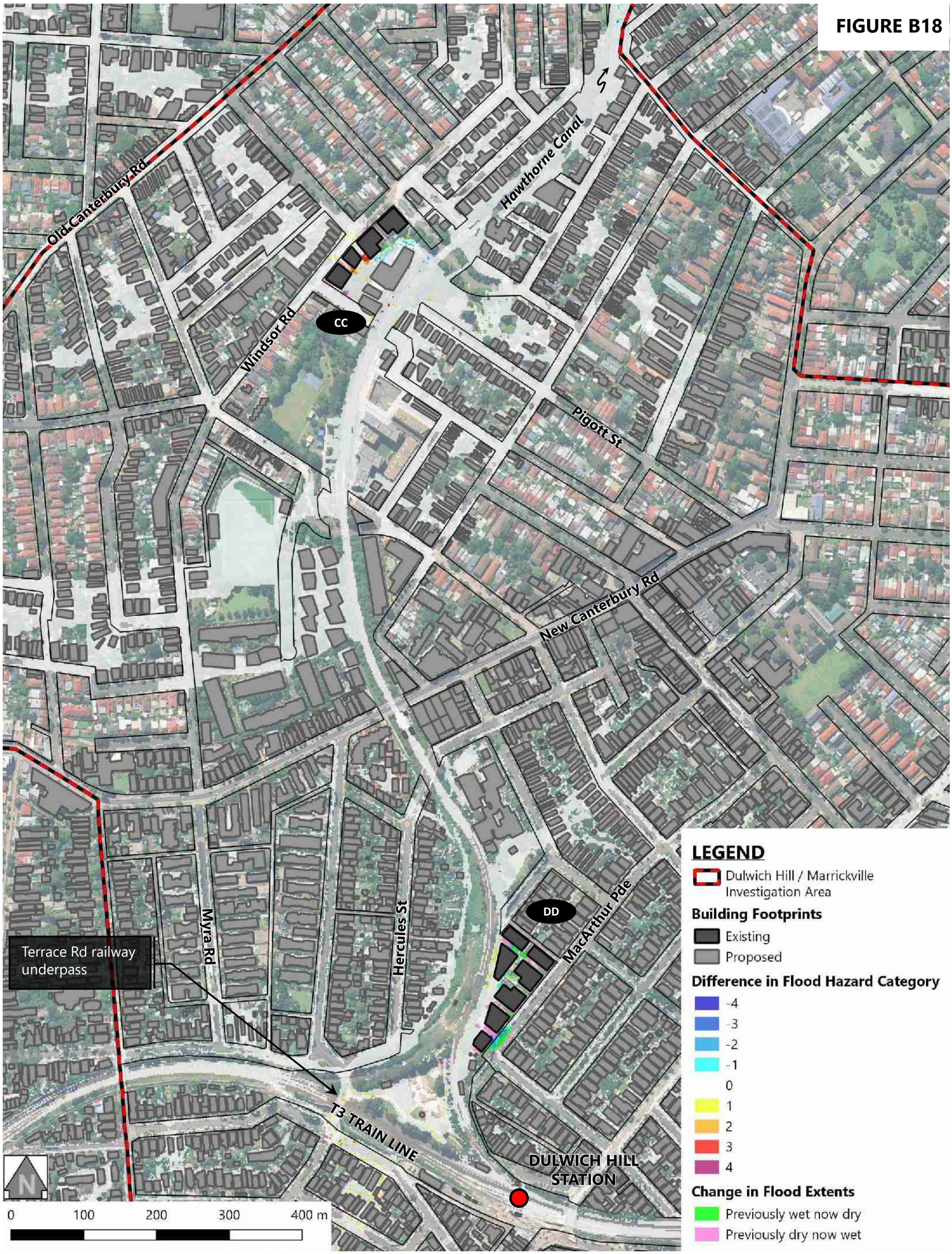
PEAK 1% AEP FLOOD HAZARD CATEGORIES FOR POST-DEVELOPMENT CONDITIONS [DULWICH HILL / MARRICKVILLE - EAST]



Prepared by:

worley consulting

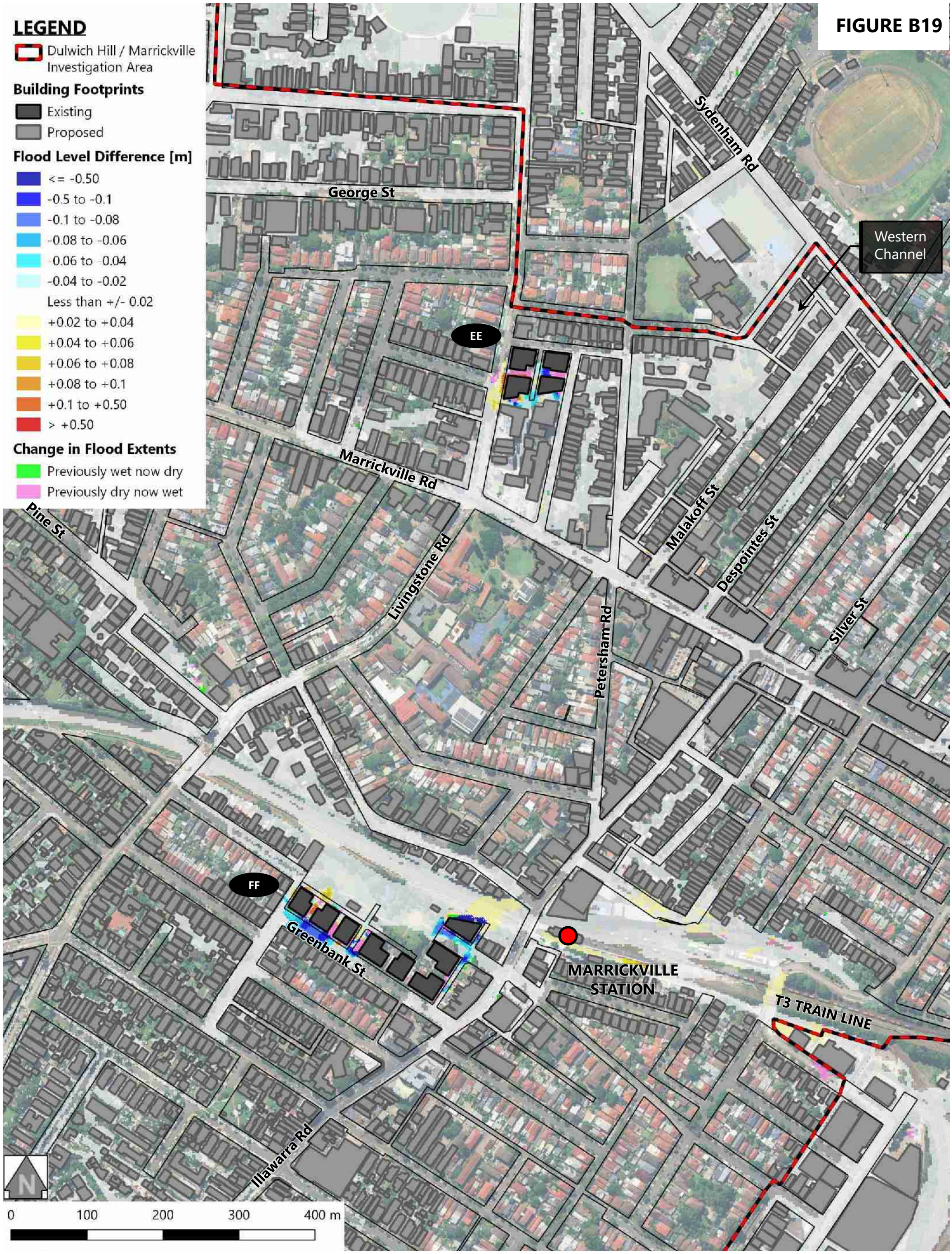
DIFFERENCE IN PEAK 1% AEP FLOOD LEVEL [DULWICH HILL / MARRICKVILLE - WEST]



Prepared by:

worley consulting

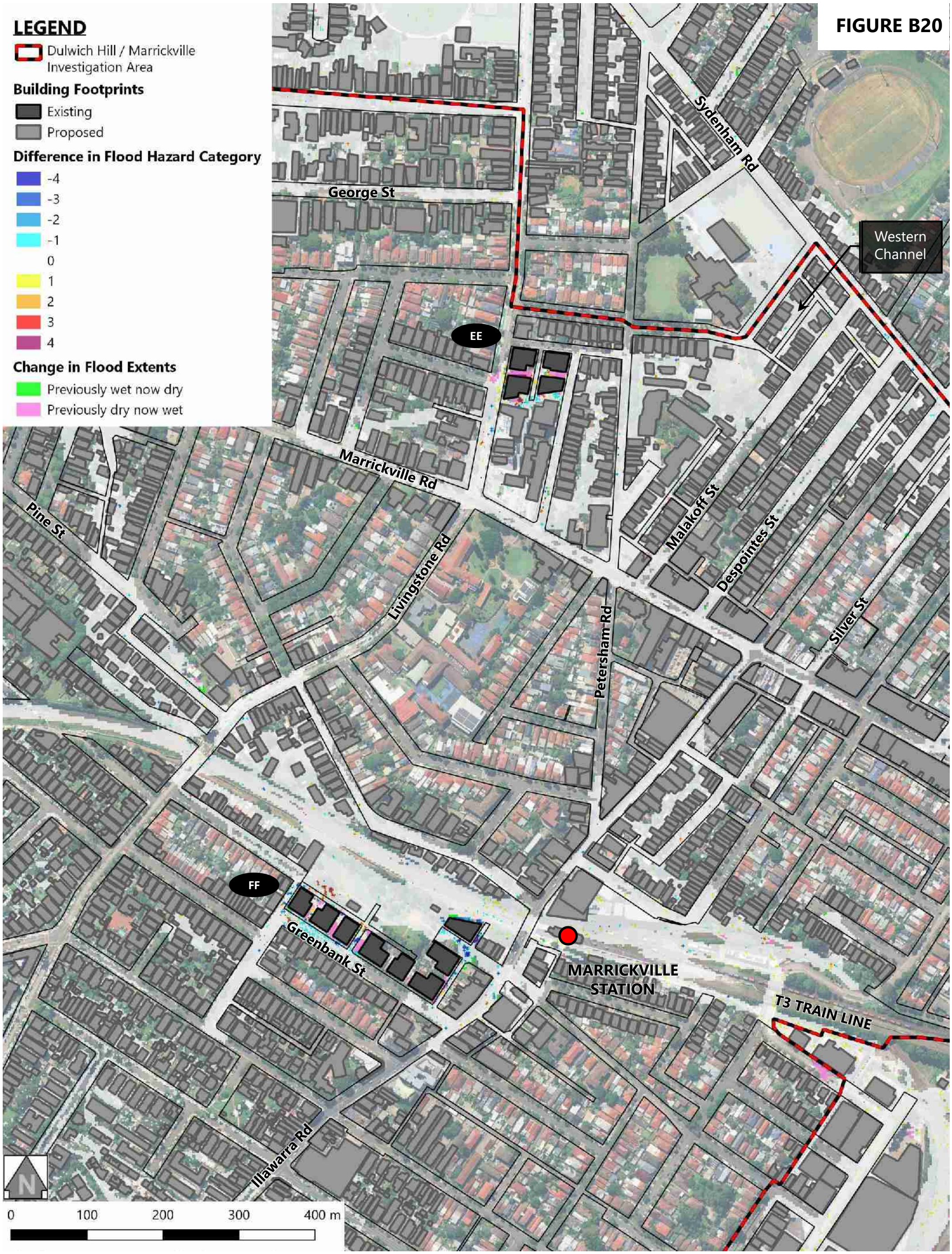
DIFFERENCE IN 1% AEP FLOOD HAZARD CATEGORIES [DULWICH HILL / MARRICKVILLE - WEST]



Prepared by:

worley consulting

DIFFERENCE IN PEAK 1% AEP FLOOD LEVEL [DULWICH HILL / MARRICKVILLE - EAST]



Prepared by:

worley consulting

DIFFERENCE IN 1% AEP FLOOD HAZARD CATEGORIES [DULWICH HILL / MARRICKVILLE - EAST]

Appendix C. PMF Mapping [Ashfield / Croydon]

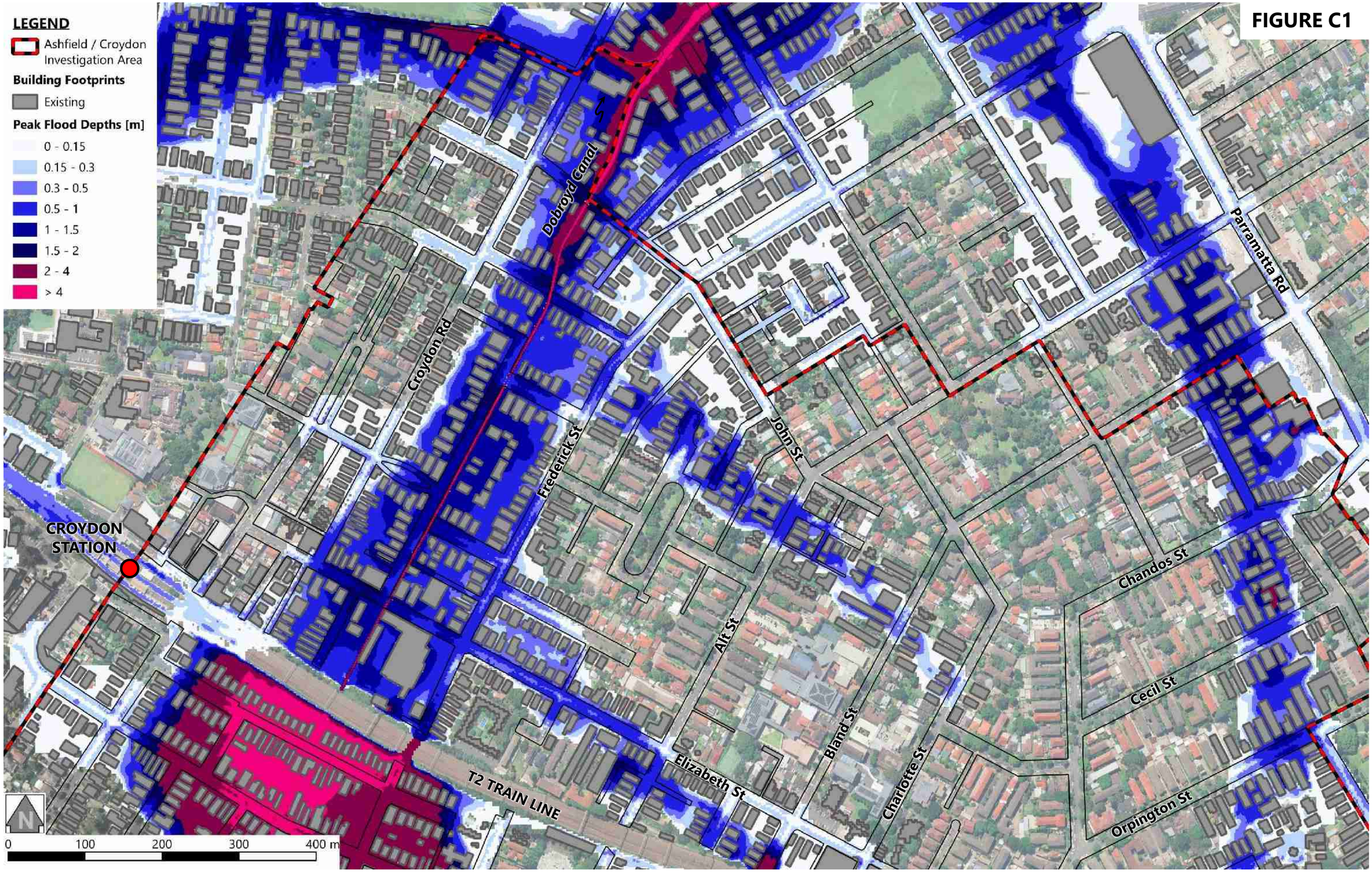


FIGURE C1

Prepared by:
worley consulting

PEAK PMF DEPTHS
FOR EXISTING CONDITIONS
[ASHFIELD / CROYDON - NORTH]

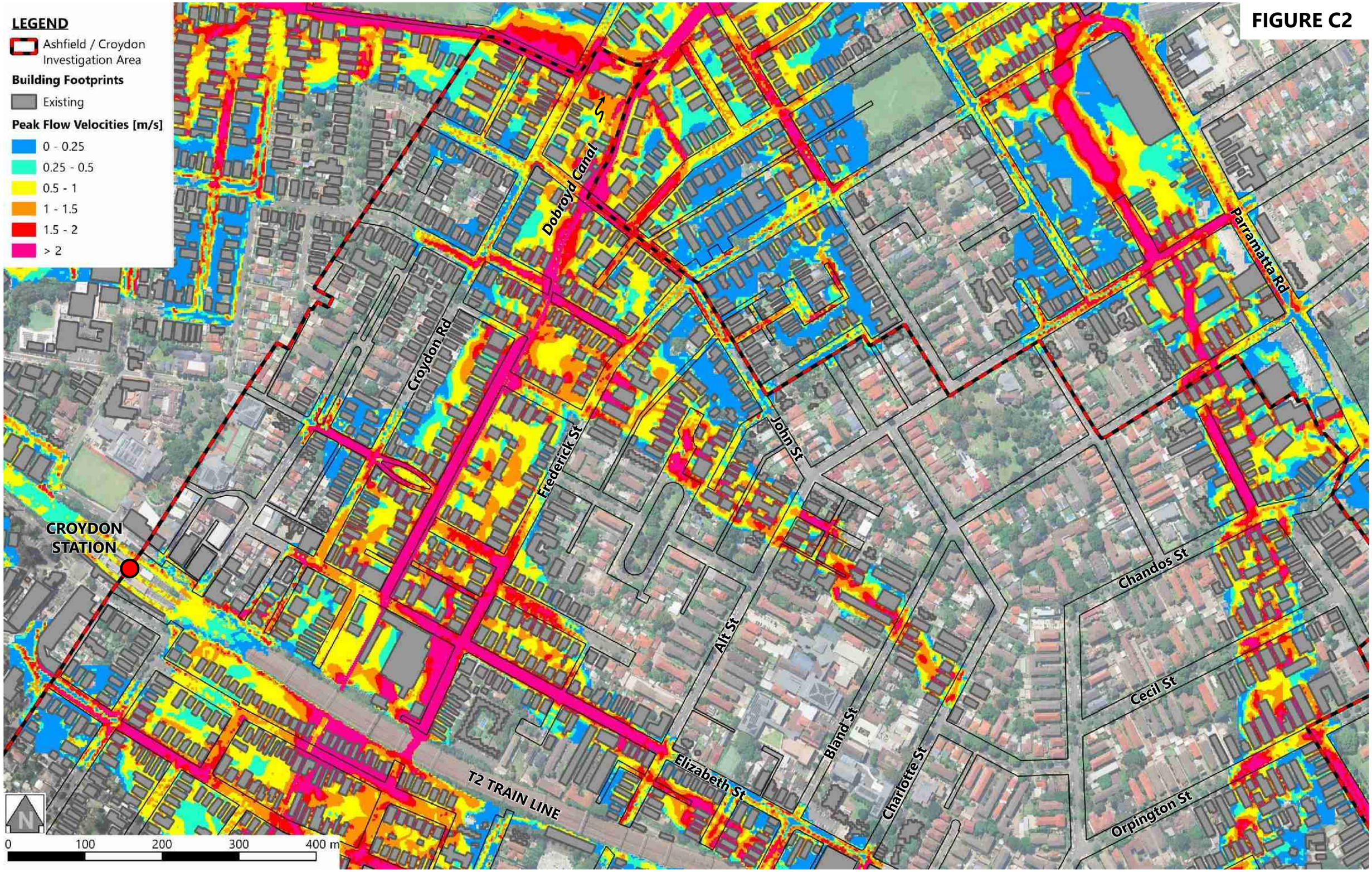
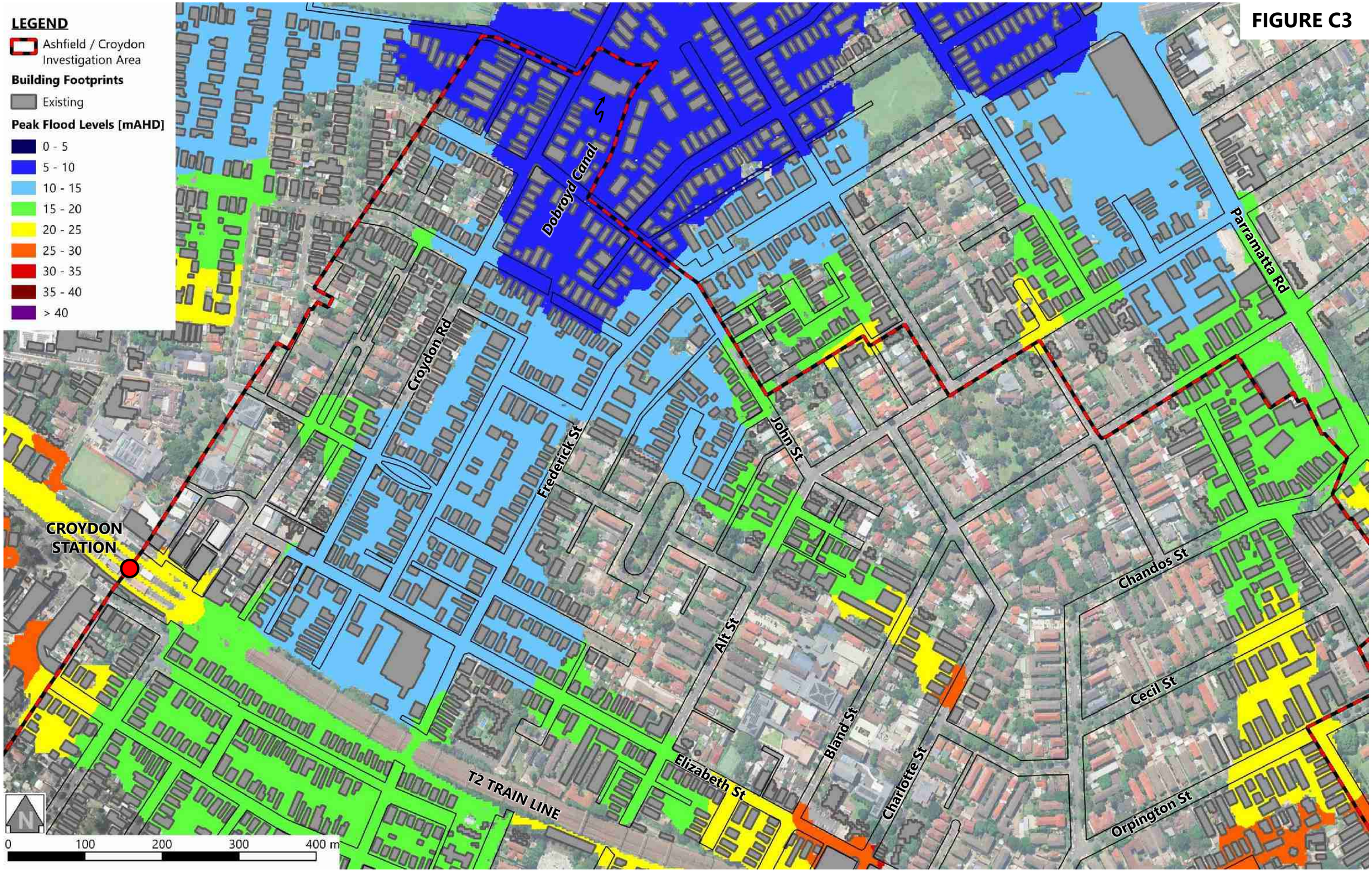


FIGURE C2

Prepared by:
worley consulting

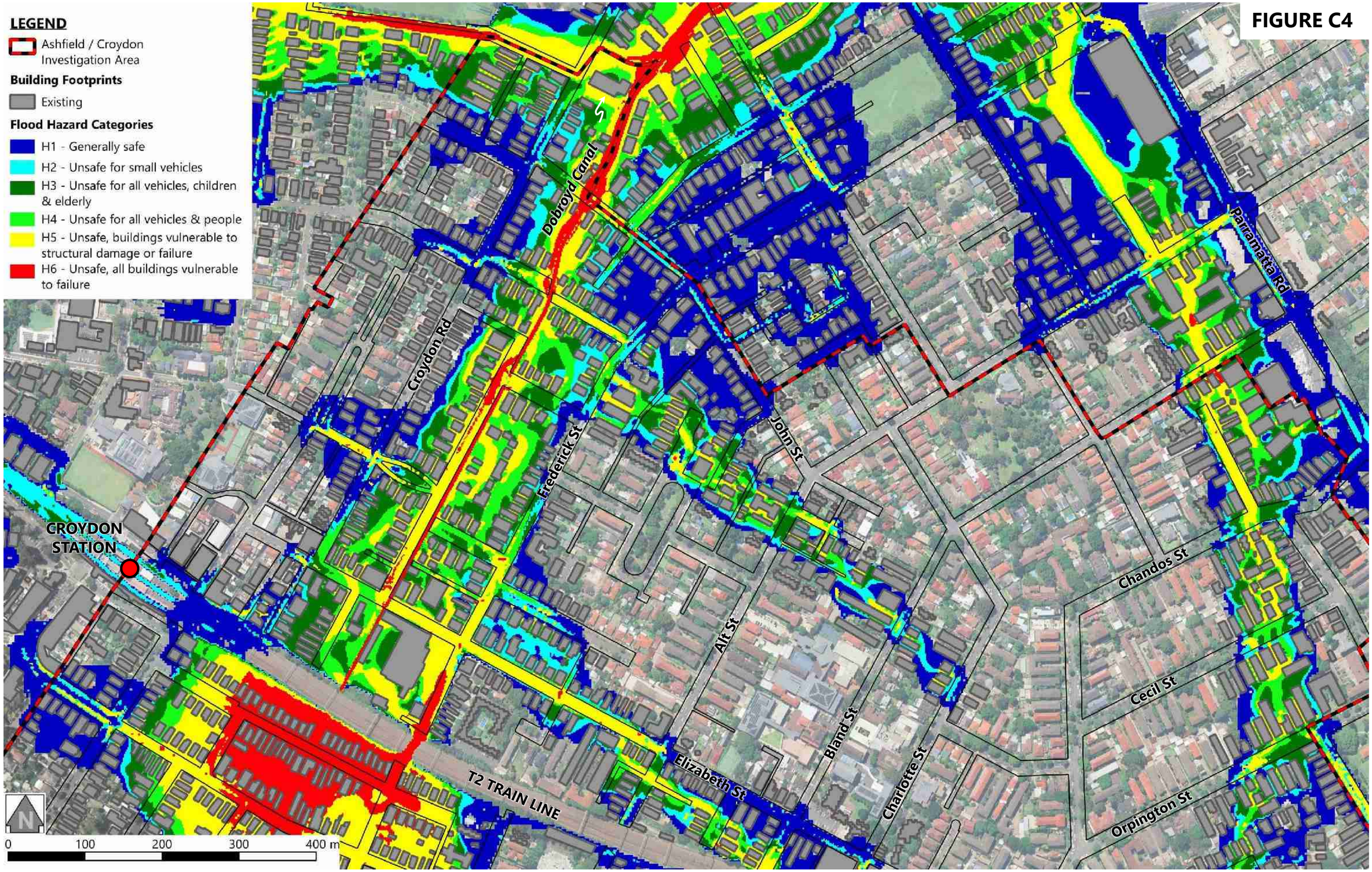
PEAK PMF FLOW VELOCITIES FOR EXISTING CONDITIONS [ASHFIELD / CROYDON - NORTH]



Prepared by:
worley consulting

PEAK PMF LEVELS
FOR EXISTING CONDITIONS
[ASHFIELD / CROYDON - NORTH]

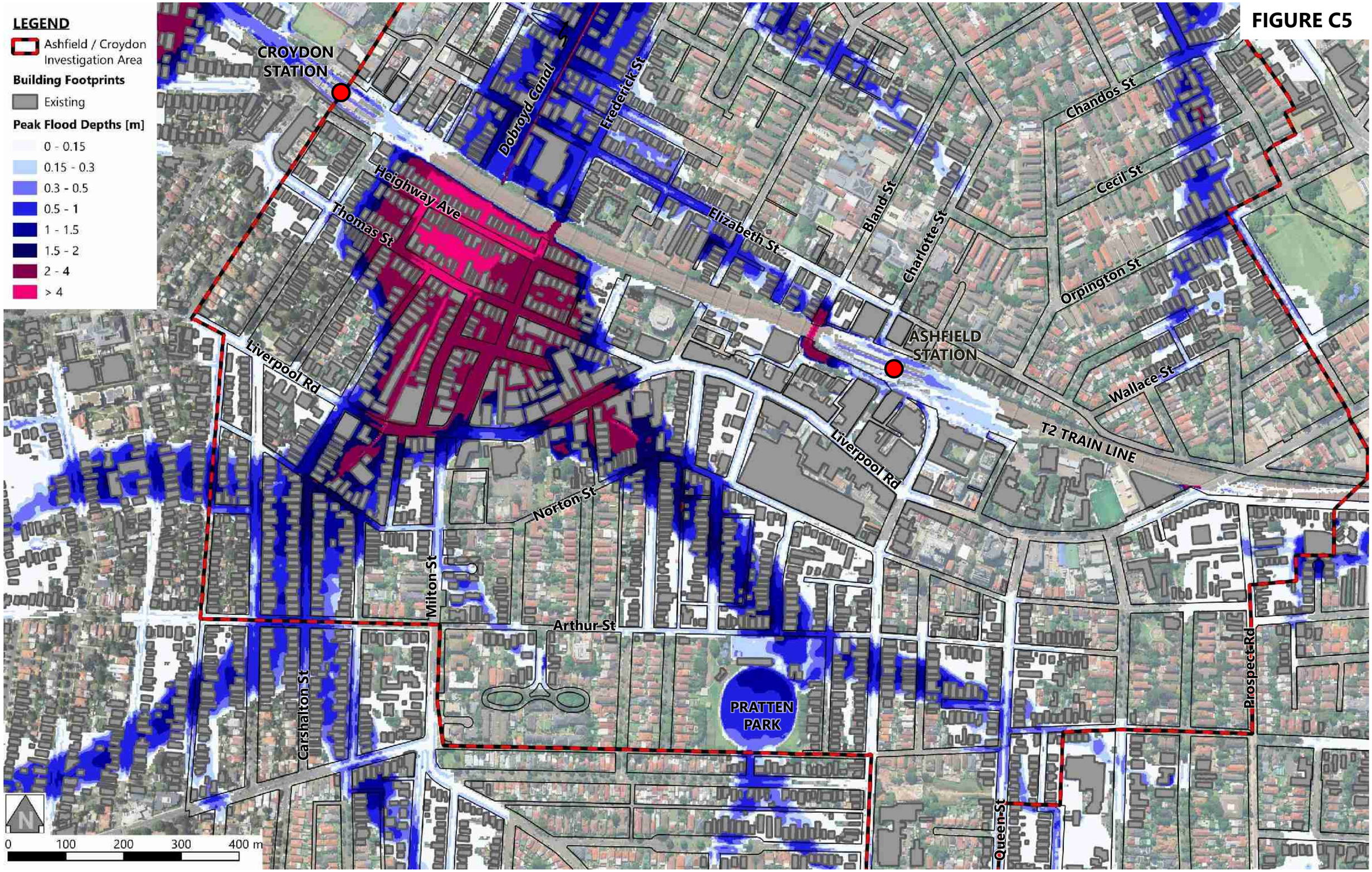
FIGURE C4



Prepared by:
worley consulting

PEAK PMF HAZARD CATEGORIES FOR EXISTING CONDITIONS [ASHFIELD / CROYDON - NORTH]

FIGURE C5



Prepared by:
worley consulting

PEAK PMF DEPTHS
FOR EXISTING CONDITIONS
[ASHFIELD / CROYDON - SOUTH]

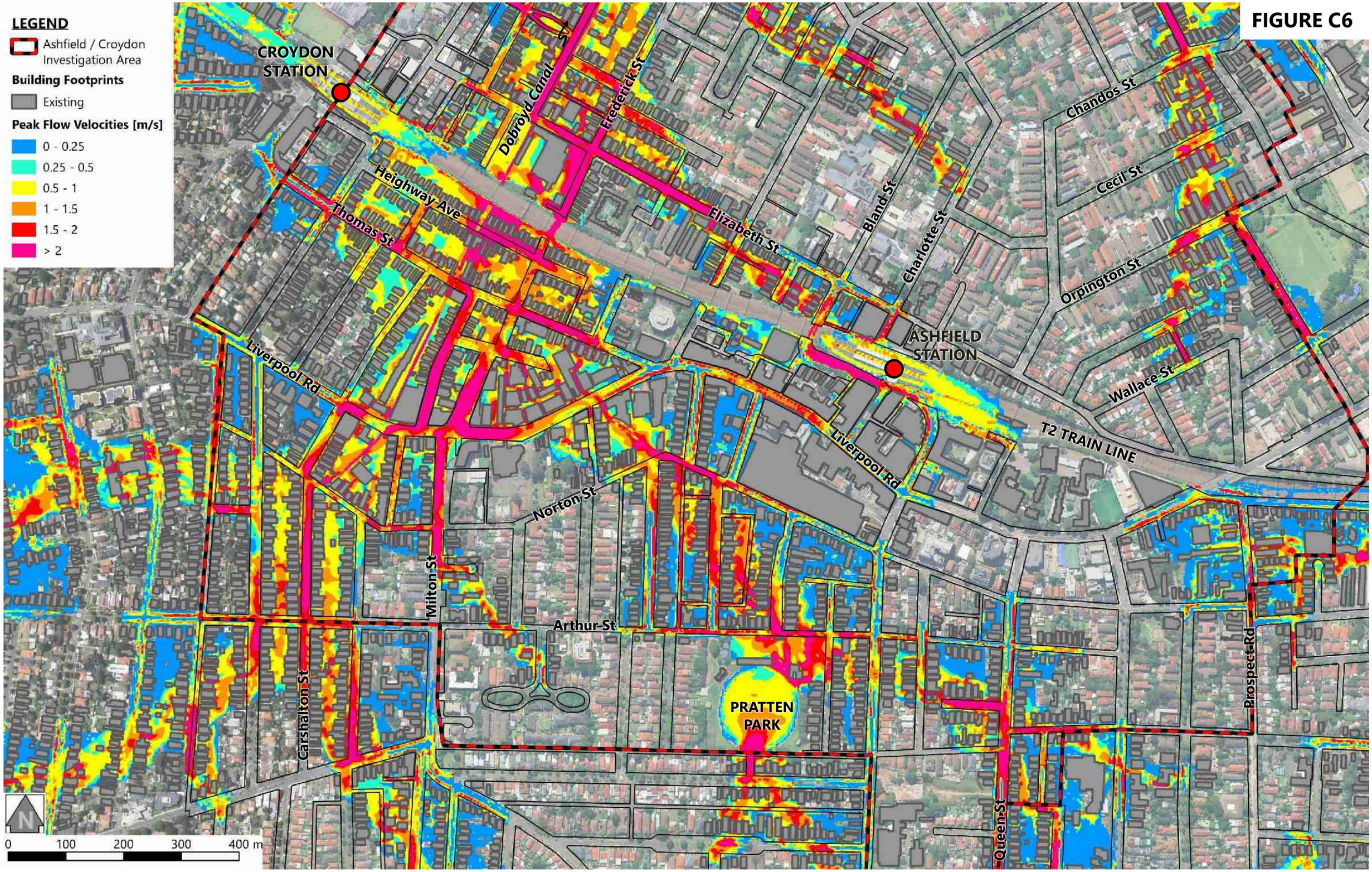


FIGURE C6

Prepared by:
worley consulting

PEAK PMF FLOW VELOCITIES FOR EXISTING CONDITIONS [ASHFIELD / CROYDON - SOUTH]

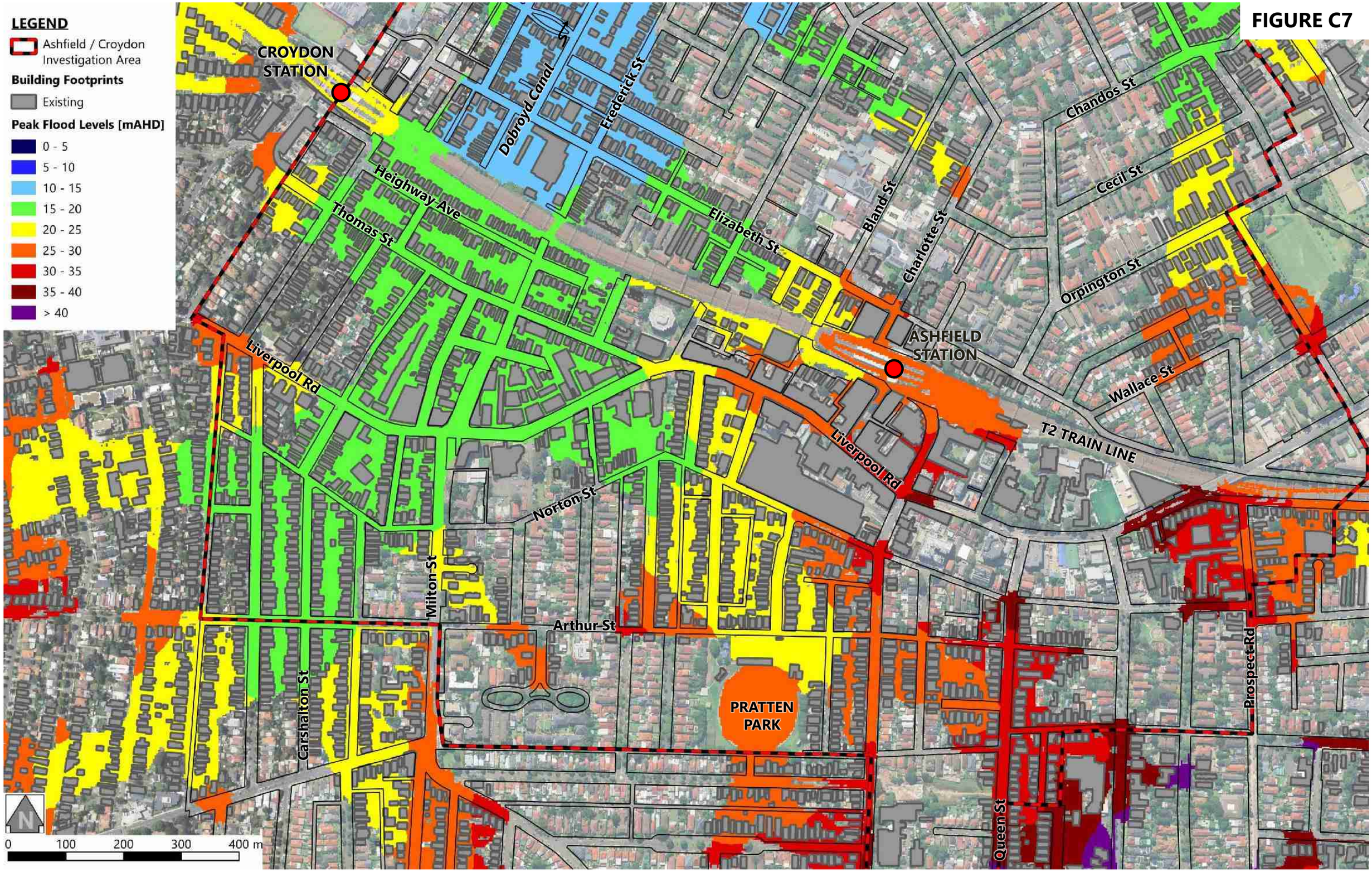
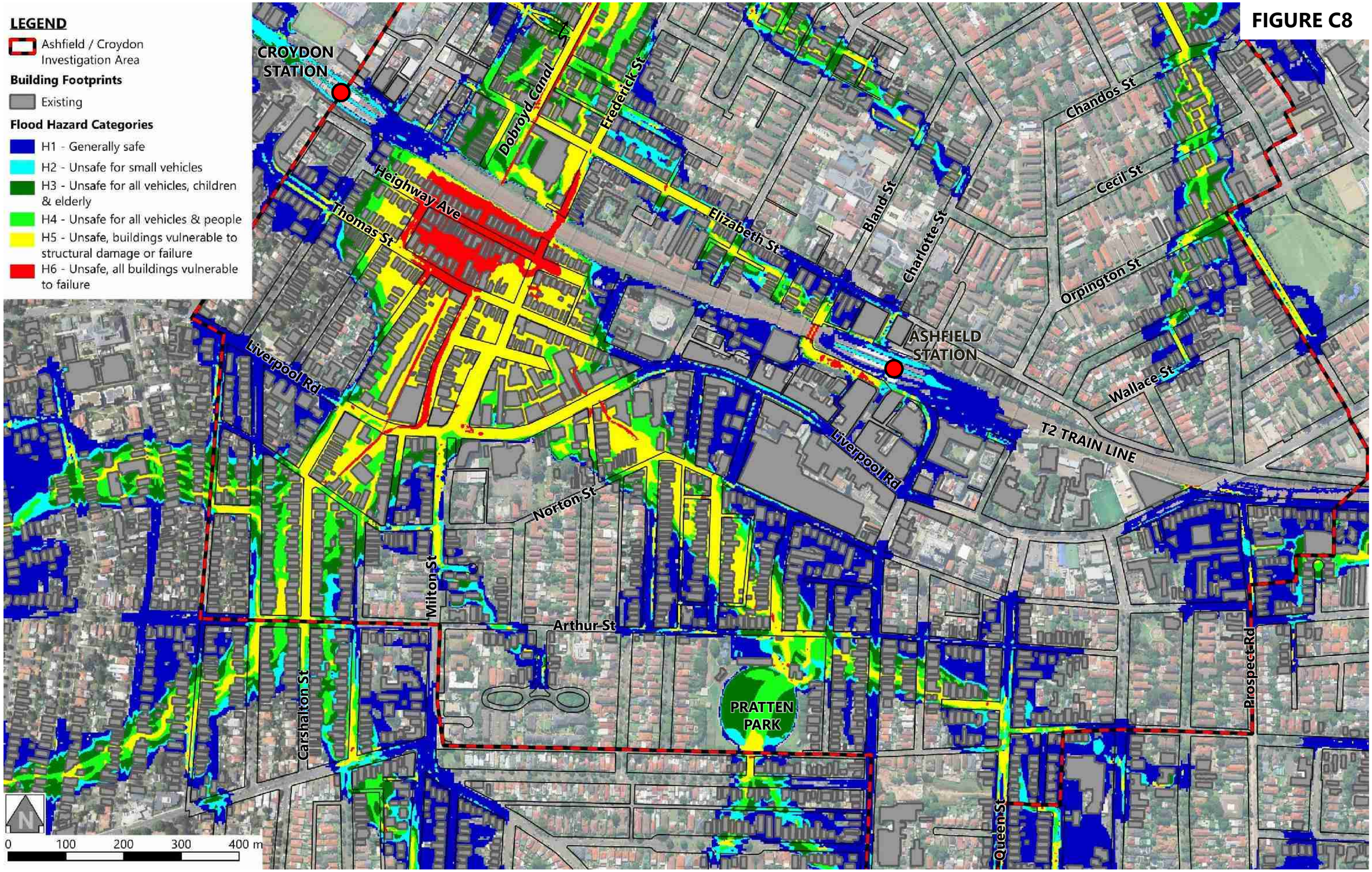


FIGURE C7

Prepared by:
worley consulting

PEAK PMF LEVELS
FOR EXISTING CONDITIONS
[ASHFIELD / CROYDON - SOUTH]

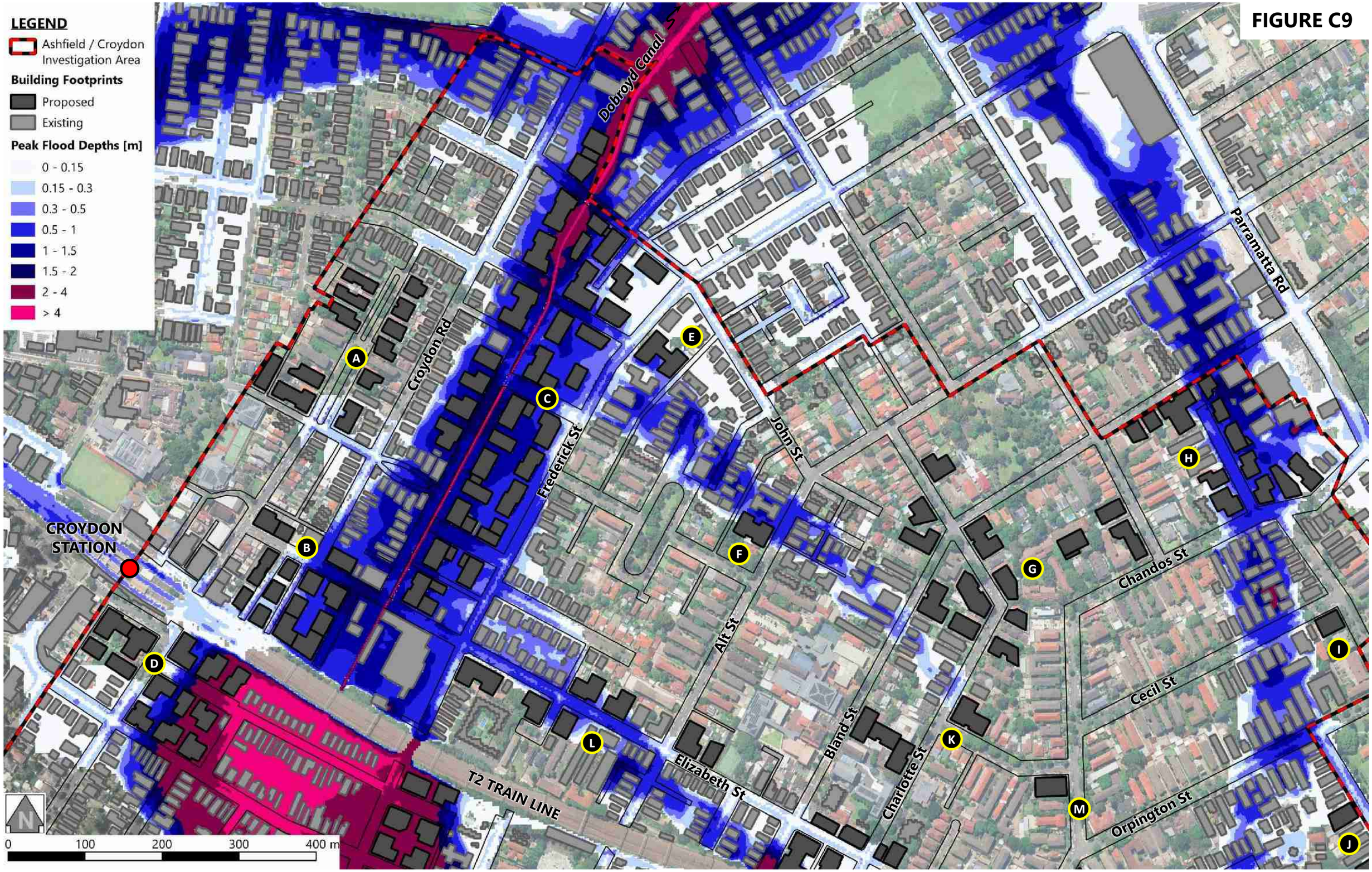
FIGURE C8



Prepared by:
worley consulting

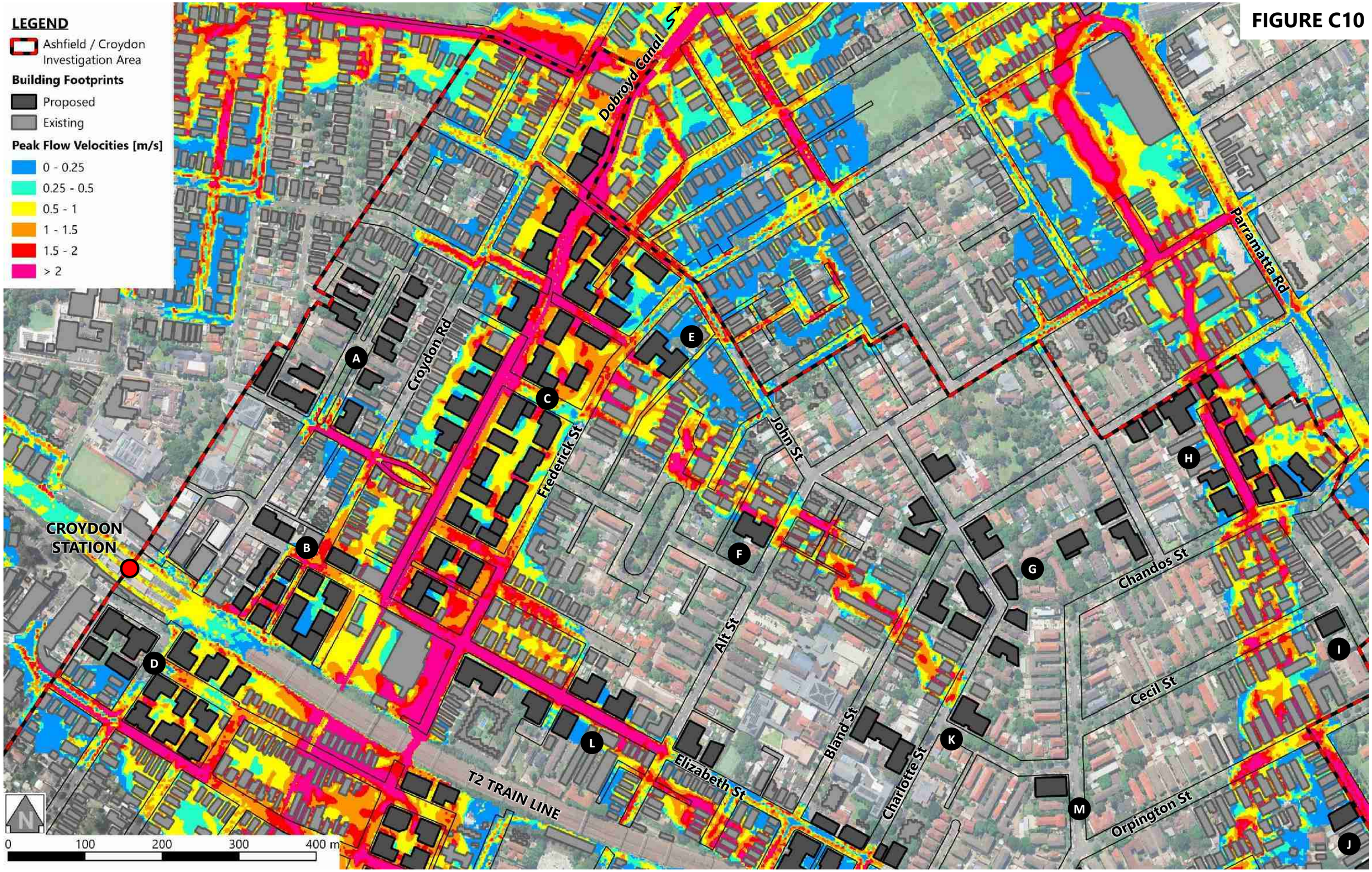
PEAK PMF HAZARD CATEGORIES FOR EXISTING CONDITIONS [ASHFIELD / CROYDON - SOUTH]

FIGURE C9



Prepared by:
worley consulting

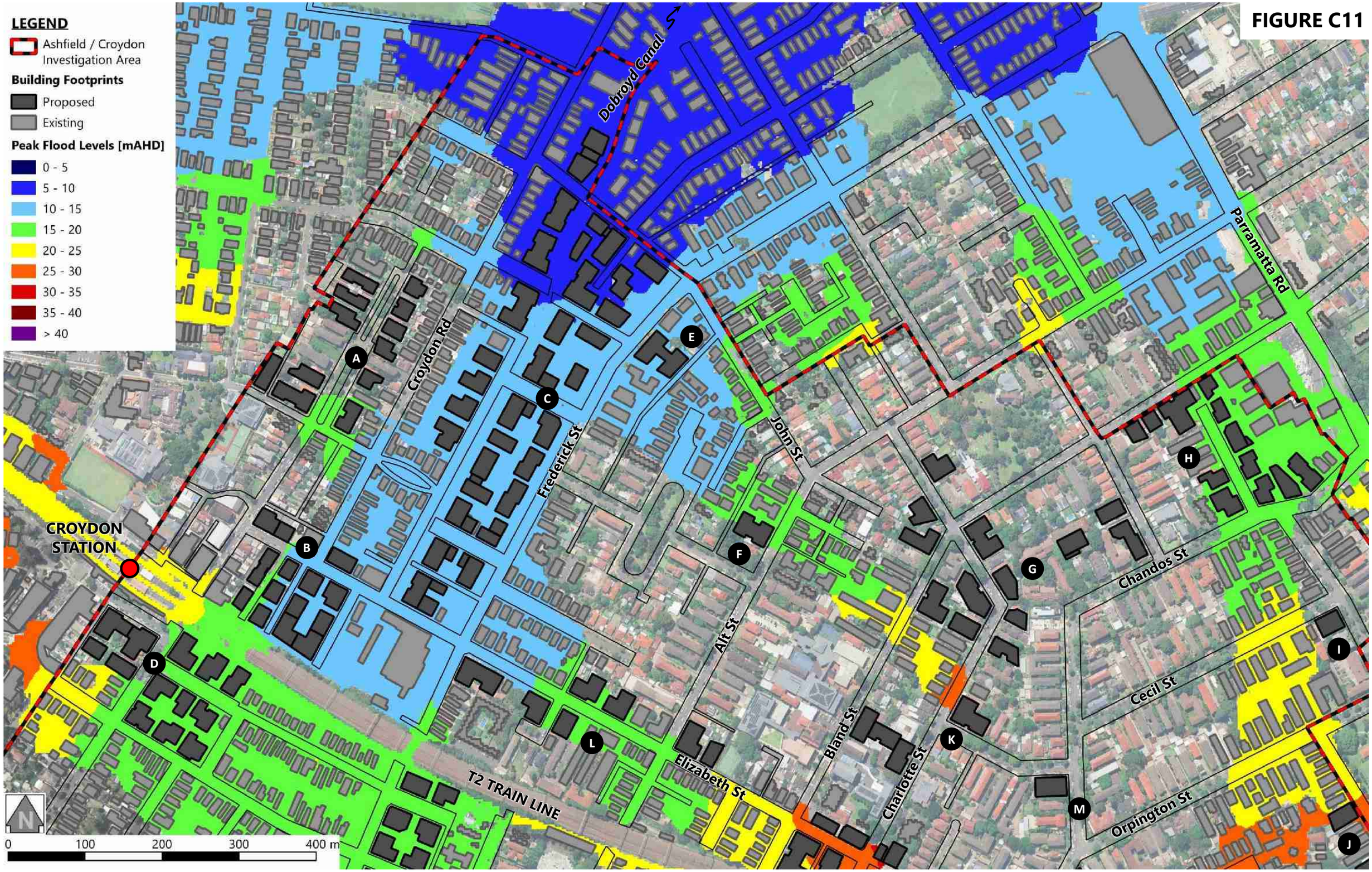
PEAK PMF DEPTHS
FOR POST-DEVELOPMENT CONDITIONS
[ASHFIELD / CROYDON - NORTH]



Prepared by:
worley consulting

PEAK PMF FLOW VELOCITIES FOR POST-DEVELOPMENT CONDITIONS [ASHFIELD / CROYDON - NORTH]

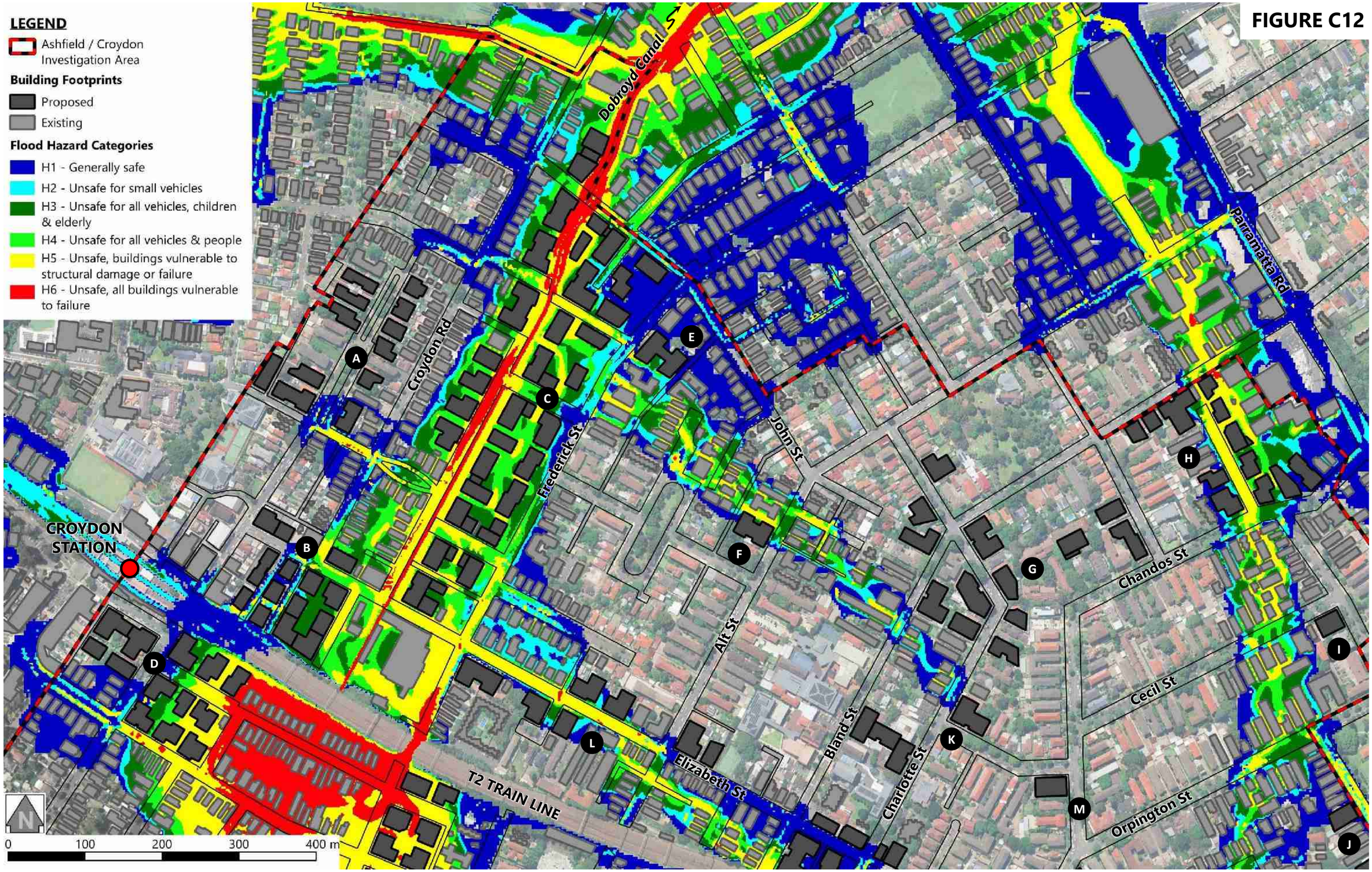
FIGURE C11



Prepared by:
worley consulting

PEAK PMF LEVELS
FOR POST-DEVELOPMENT CONDITIONS
[ASHFIELD / CROYDON - NORTH]

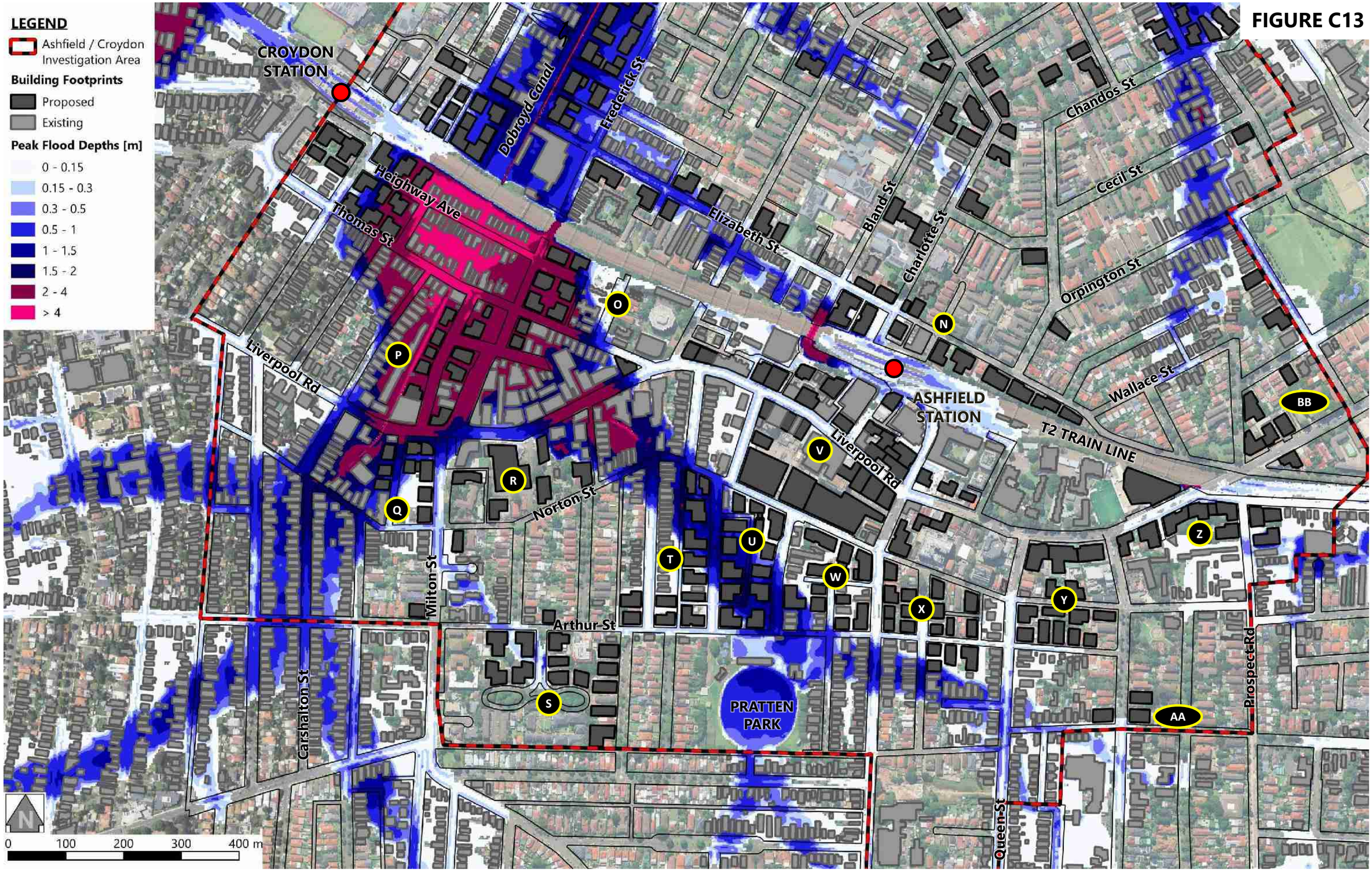
FIGURE C12



Prepared by:
worley consulting

PEAK PMF HAZARD CATEGORIES FOR POST-DEVELOPMENT CONDITIONS [ASHFIELD / CROYDON - NORTH]

FIGURE C13

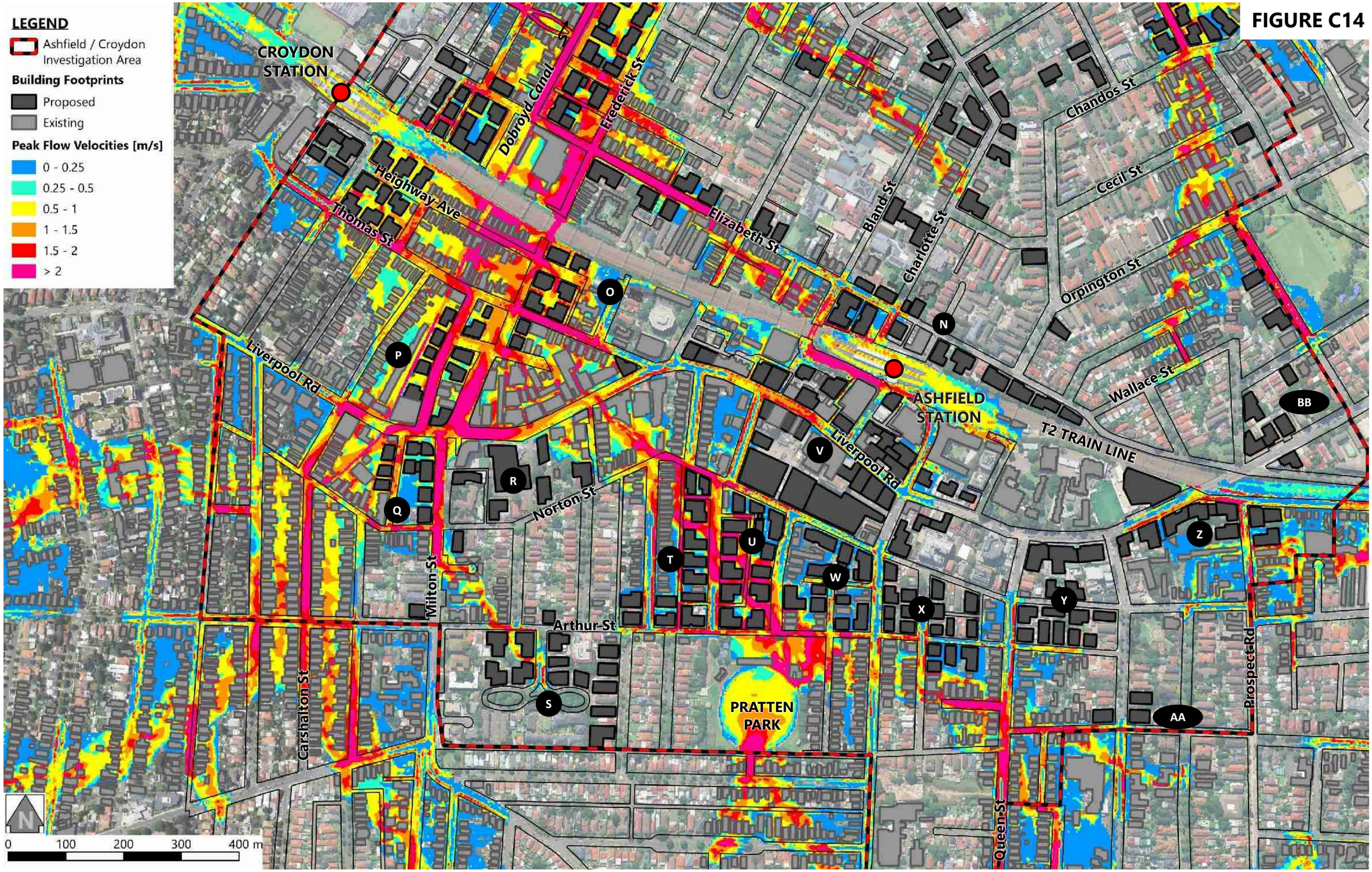


Prepared by:

worley consulting

PEAK PMF DEPTHS
FOR POST-DEVELOPMENT CONDITIONS
[ASHFIELD / CROYDON - SOUTH]

FIGURE C14



Prepared by:

worley consulting

PEAK PMF FLOW VELOCITIES FOR POST-DEVELOPMENT CONDITIONS [ASHFIELD / CROYDON - SOUTH]

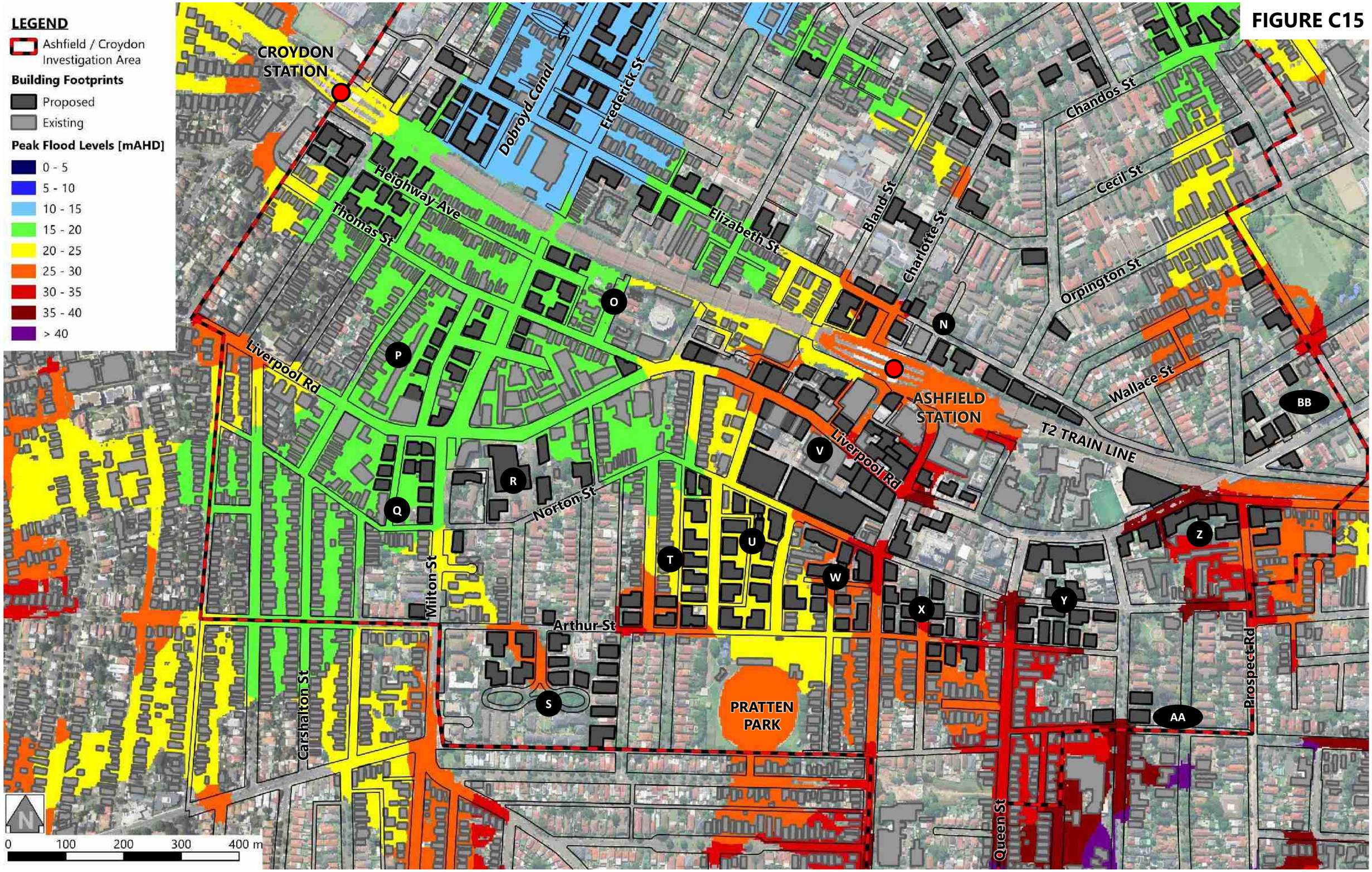
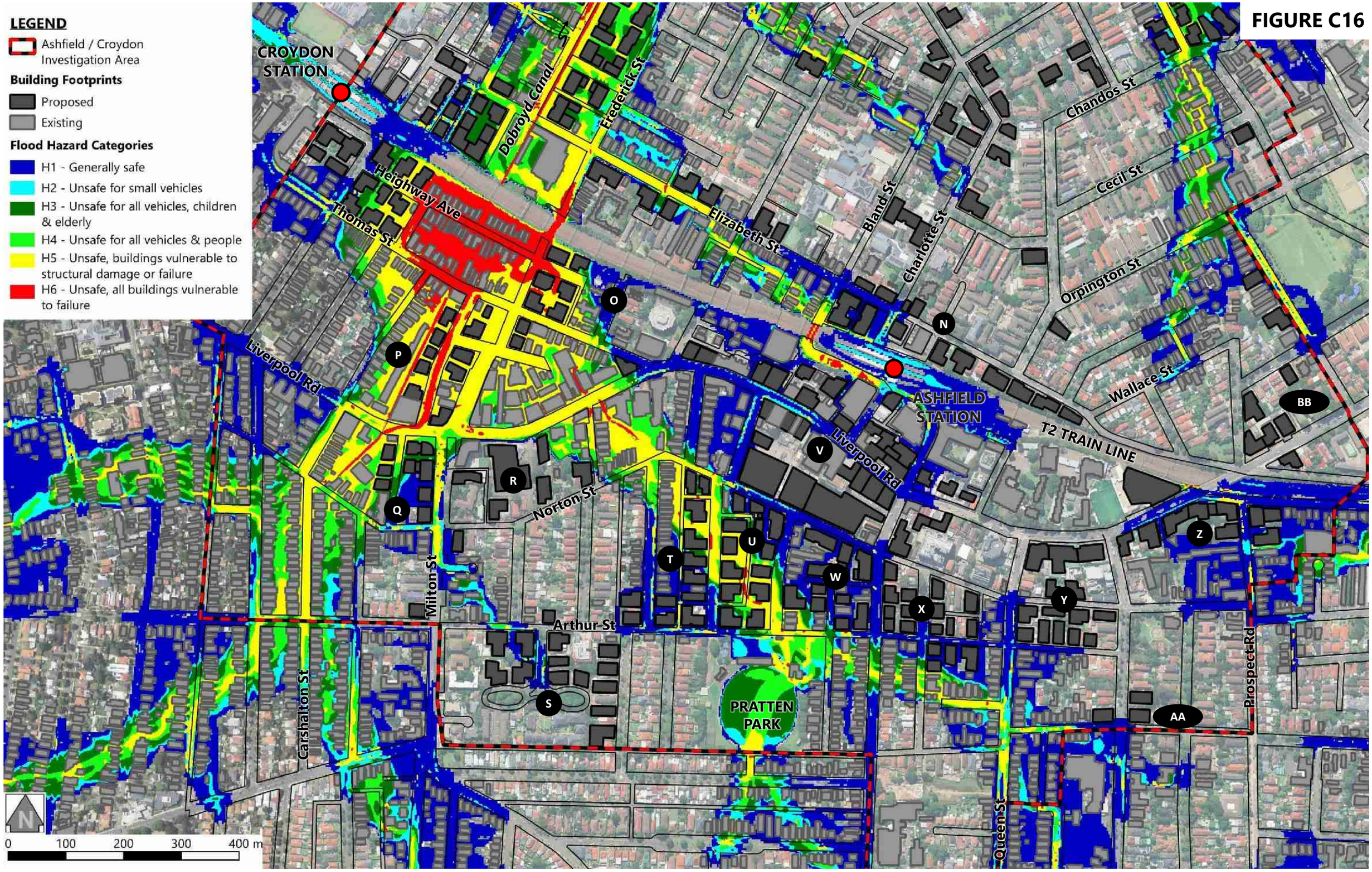


FIGURE C15

Prepared by:
worley consulting

PEAK PMF LEVELS
FOR POST-DEVELOPMENT CONDITIONS
[ASHFIELD / CROYDON - SOUTH]

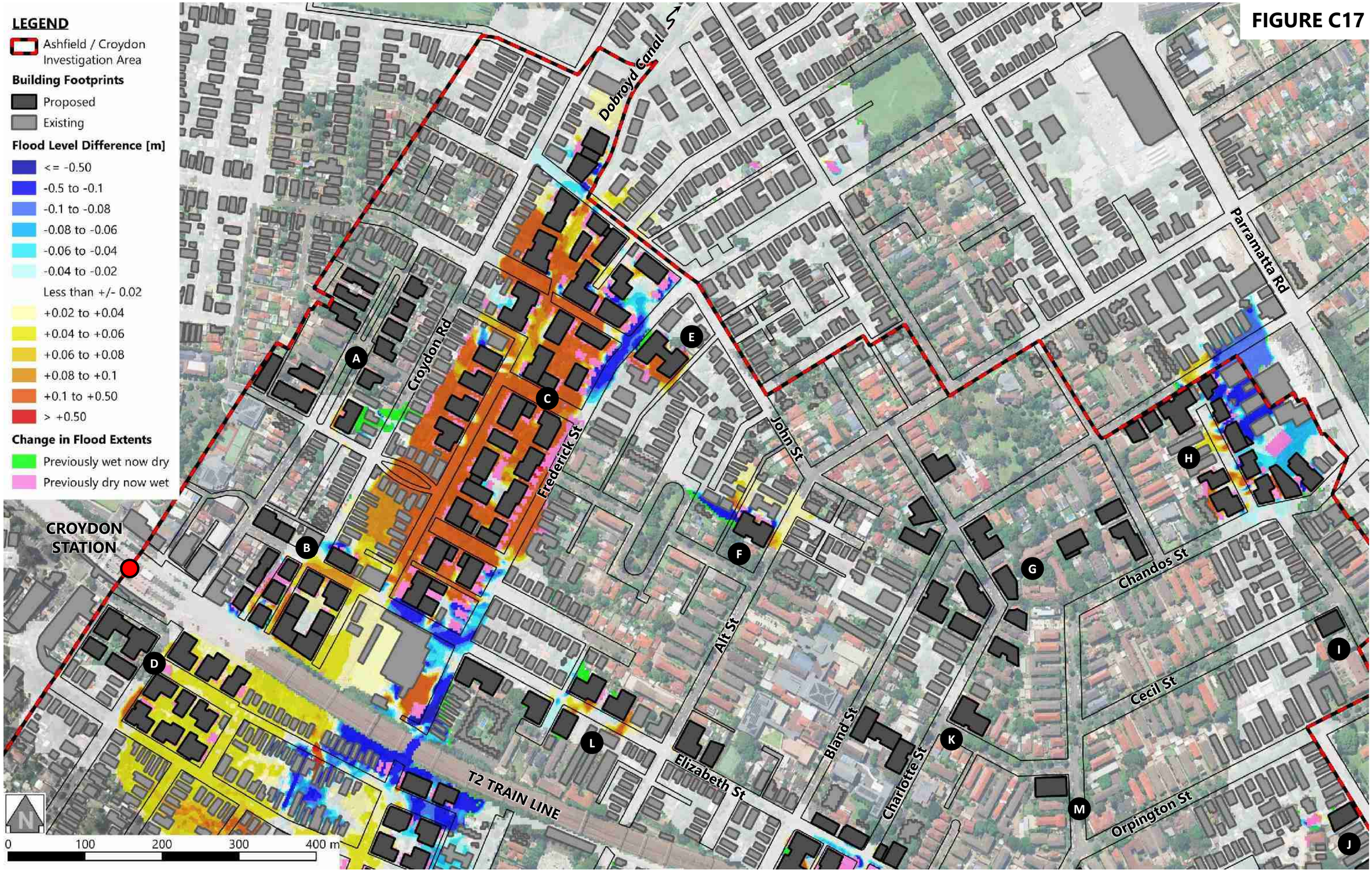
FIGURE C16



Prepared by:
worley consulting

PEAK PMF HAZARD CATEGORIES FOR POST-DEVELOPMENT CONDITIONS [ASHFIELD / CROYDON - SOUTH]

FIGURE C17

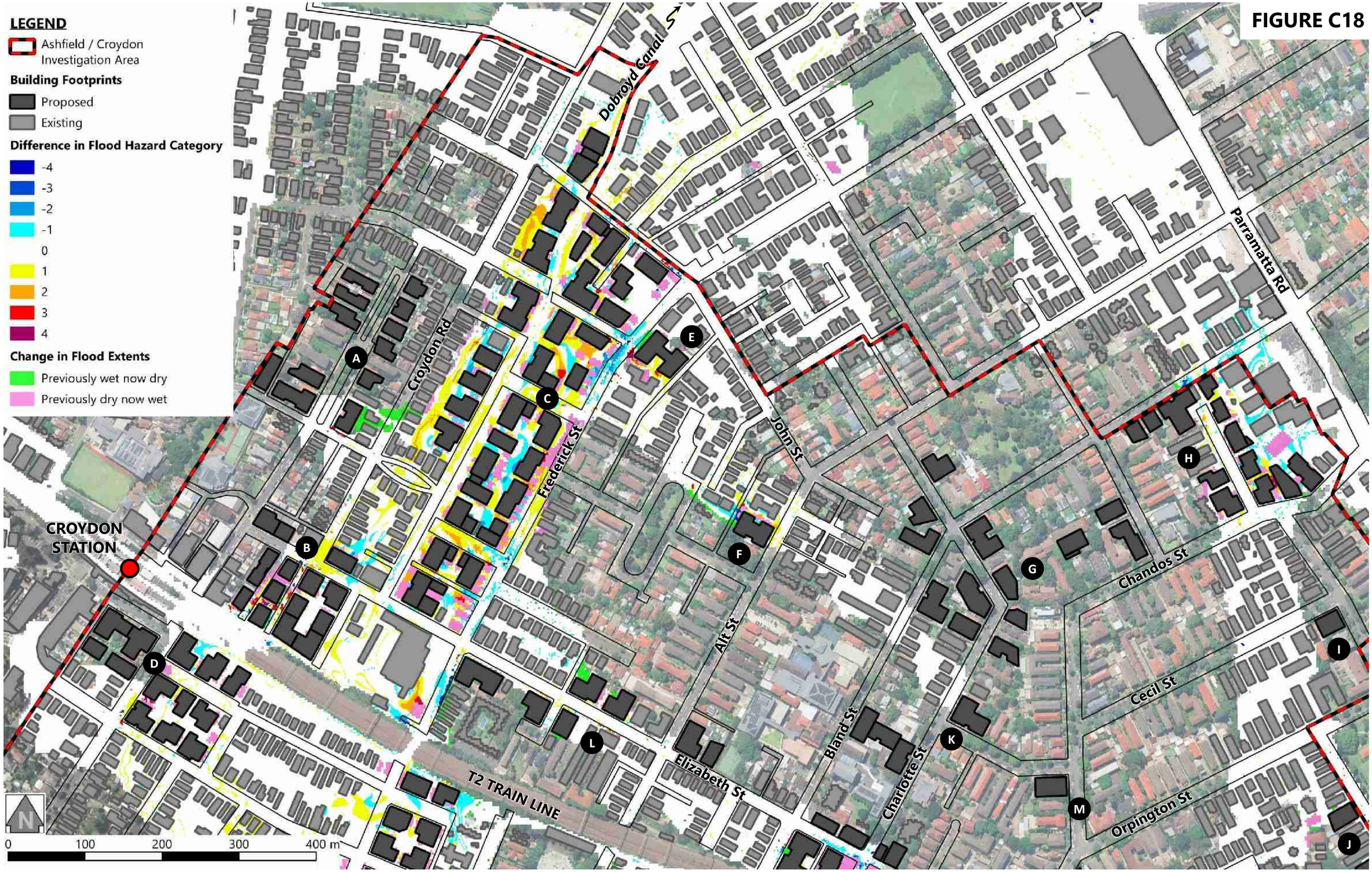


Prepared by:

worley consulting

DIFFERENCE IN PEAK PMF LEVELS [ASHFIELD / CROYDON - NORTH]

FIGURE C18

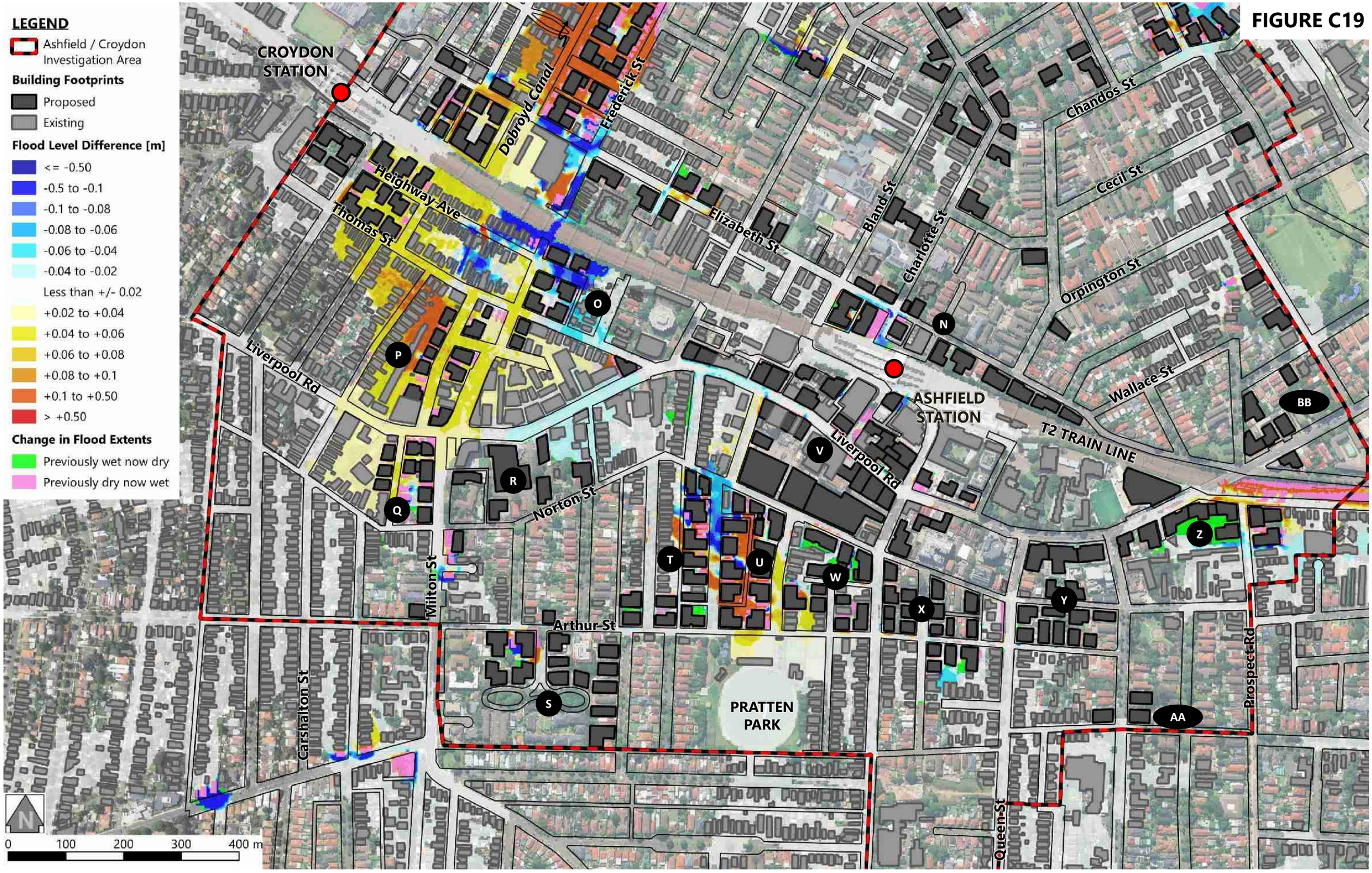


Prepared by:

worley consulting

DIFFERENCE IN PMF HAZARD CATEGORIES [ASHFIELD / CROYDON - NORTH]

FIGURE C19

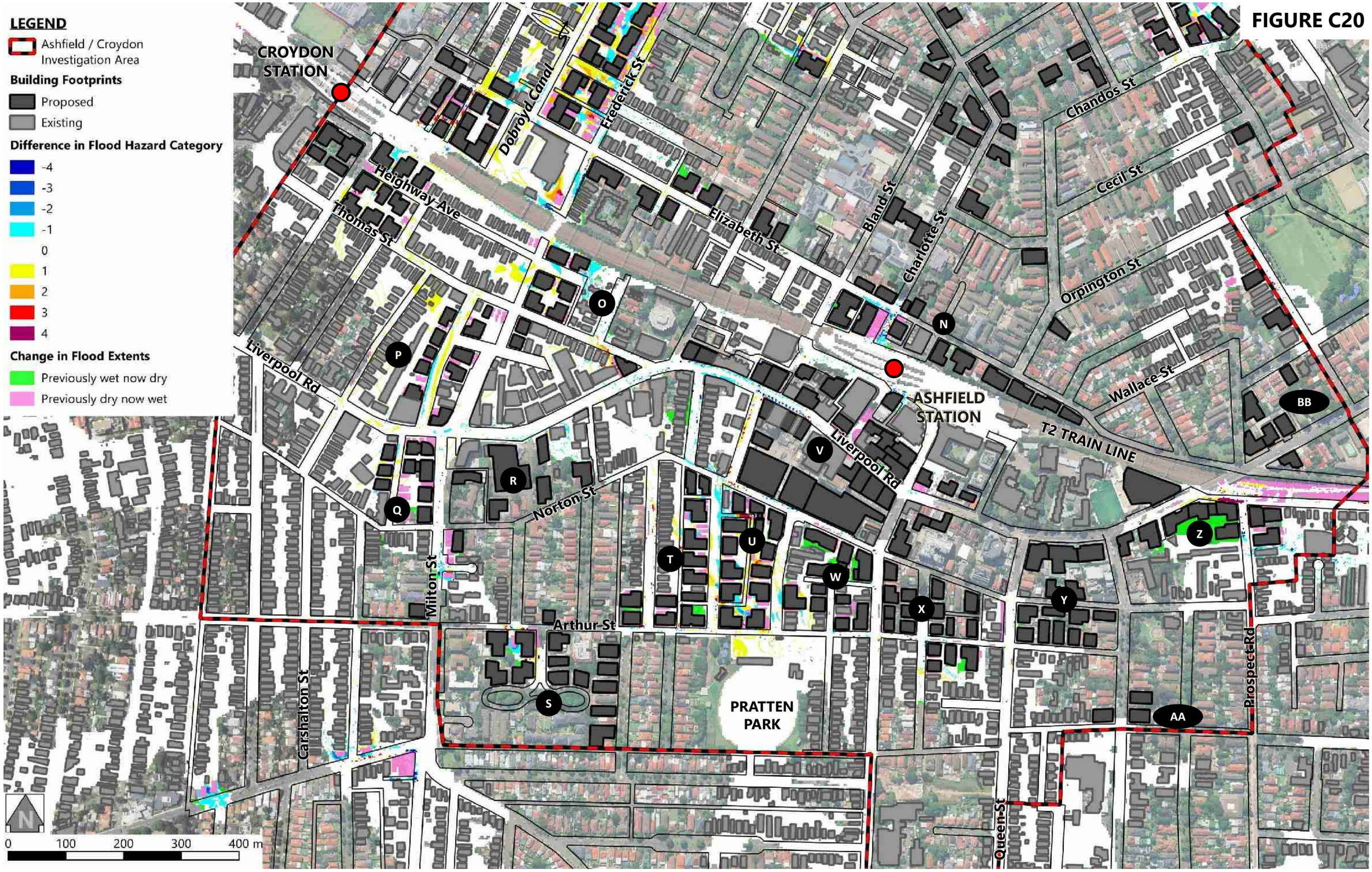


Prepared by:

worley consulting

DIFFERENCE IN PEAK PMF LEVELS [ASHFIELD / CROYDON - SOUTH]

FIGURE C20

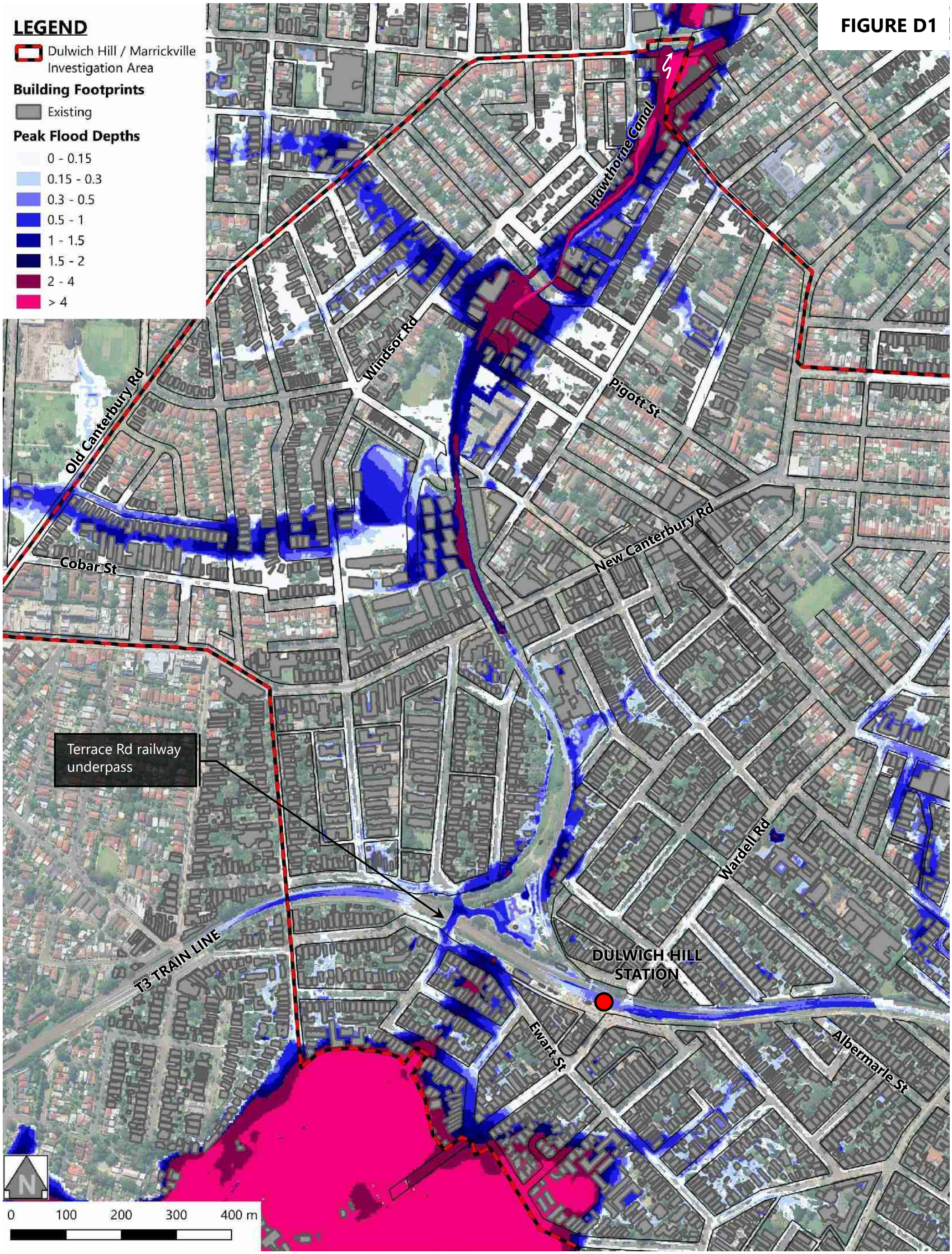


Prepared by:

worley consulting

DIFFERENCE IN PMF HAZARD CATEGORIES [ASHFIELD / CROYDON - SOUTH]

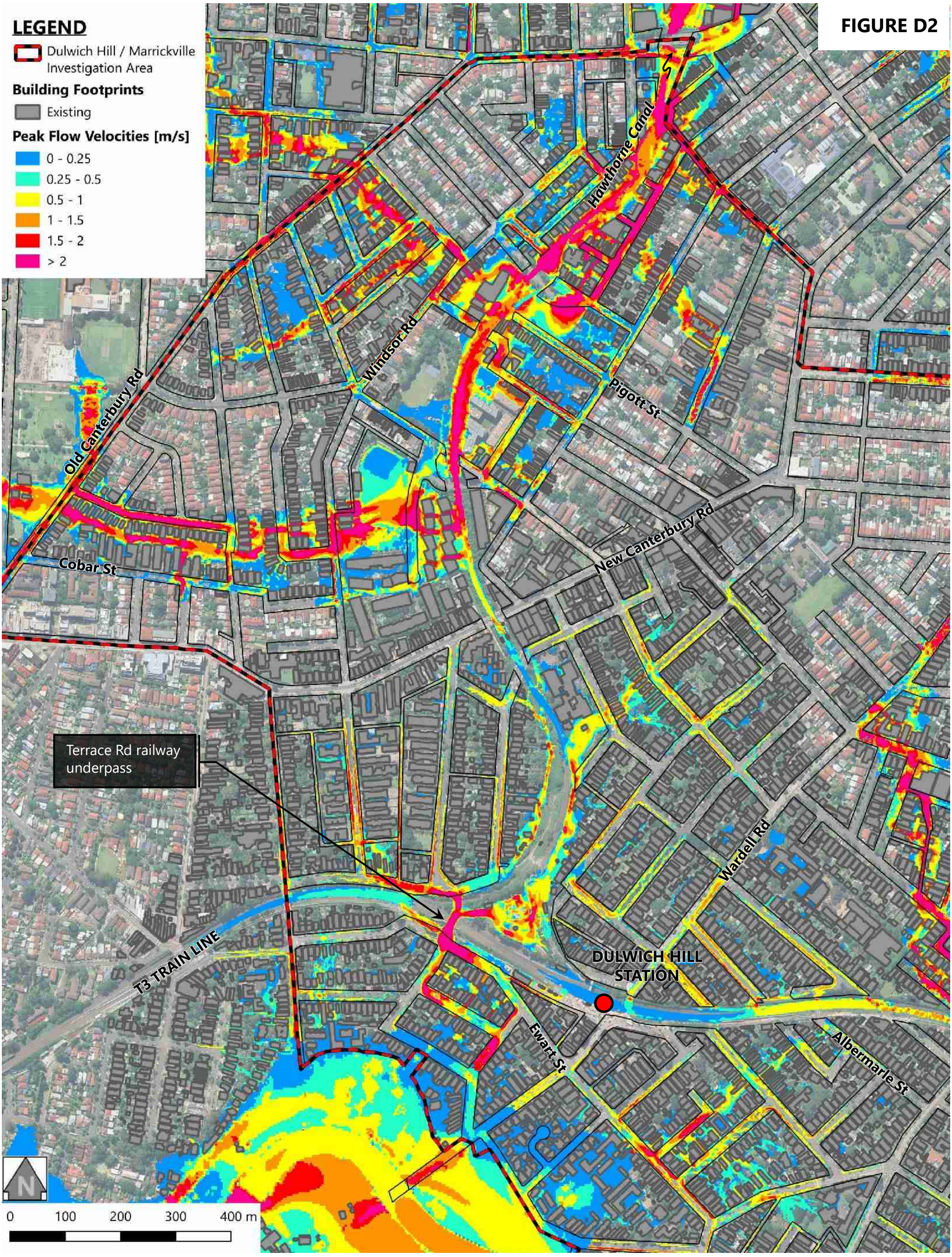
Appendix D. PMF Mapping [Dulwich Hill / Marrickville]



Prepared by:

worley consulting

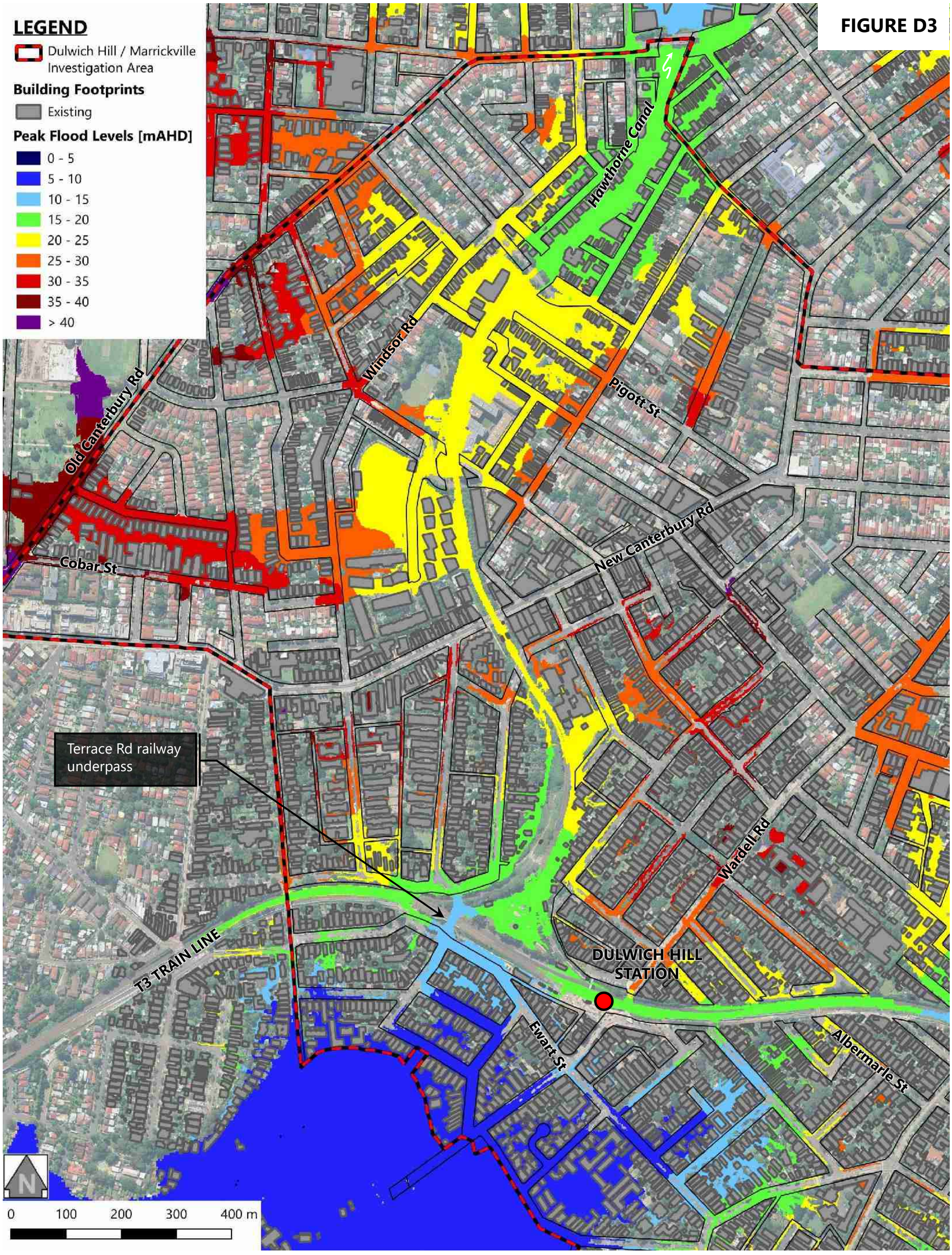
PEAK PMF DEPTHS
FOR EXISTING CONDITIONS
[DULWICH HILL / MARRICKVILLE - WEST]



Prepared by:

worley consulting

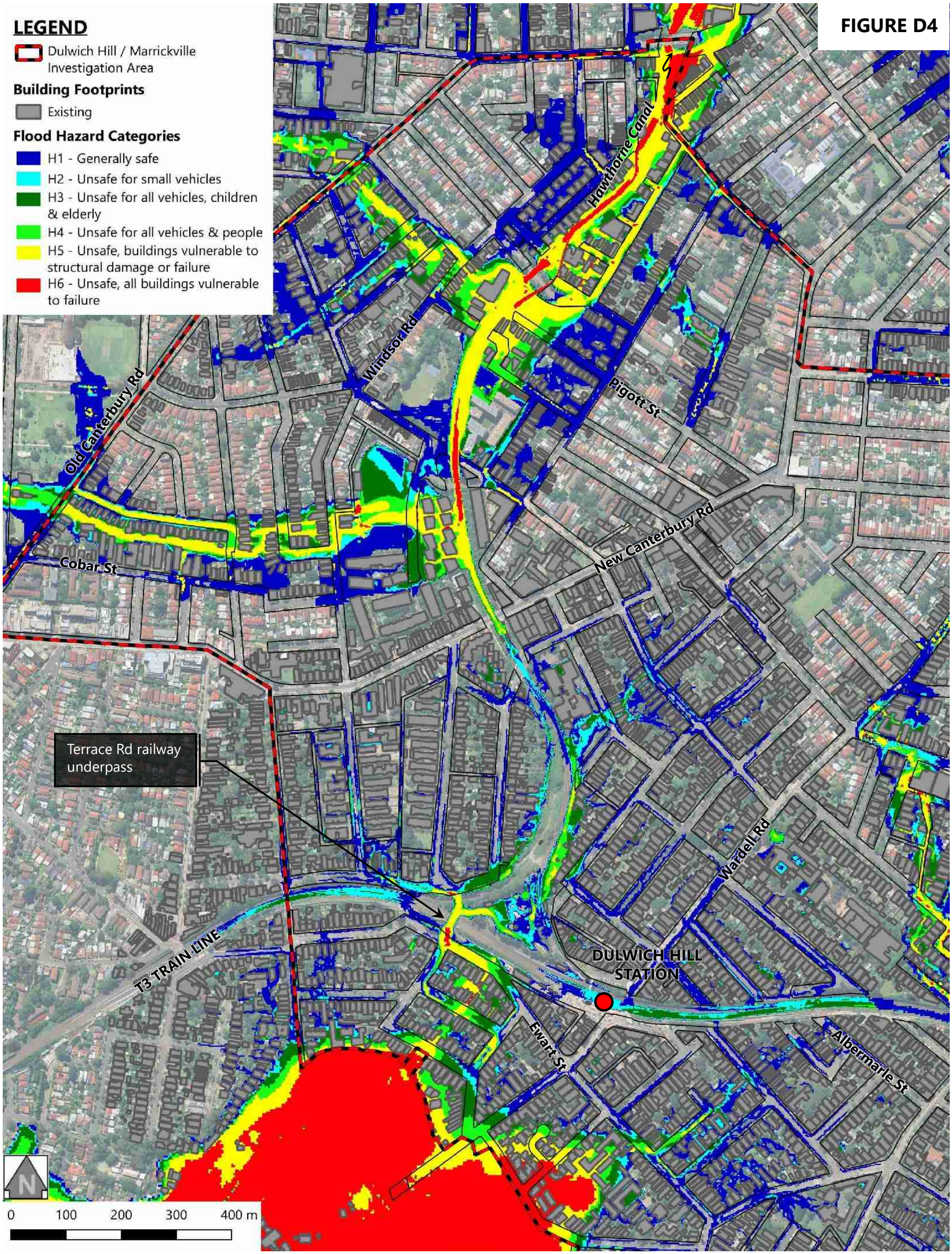
PEAK PMF FLOW VELOCITIES FOR EXISTING CONDITIONS [DULWICH HILL / MARRICKVILLE - WEST]



Prepared by:

worley consulting

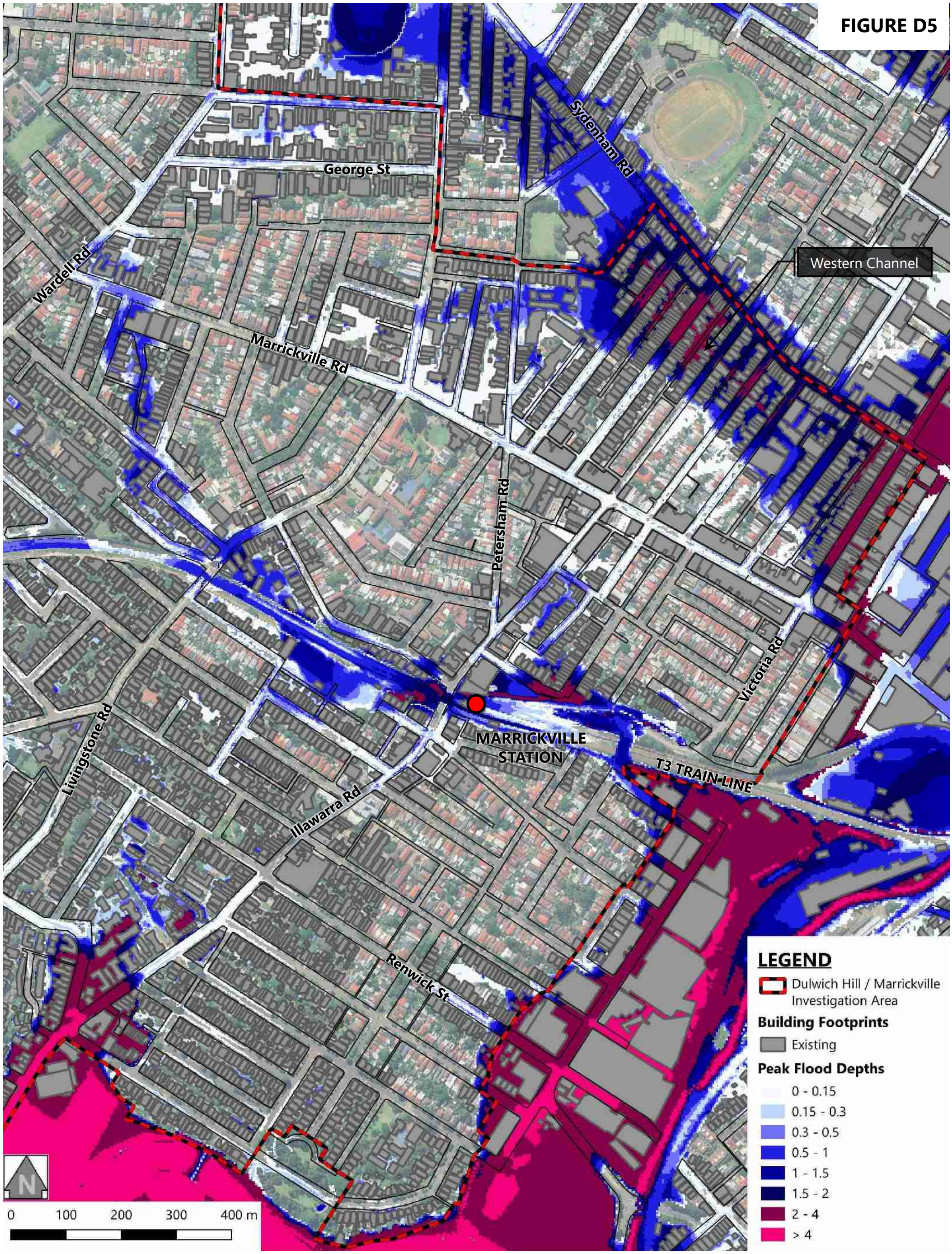
PEAK PMF LEVELS
FOR EXISTING CONDITIONS
[DULWICH HILL / MARRICKVILLE - WEST]



Prepared by:

worley consulting

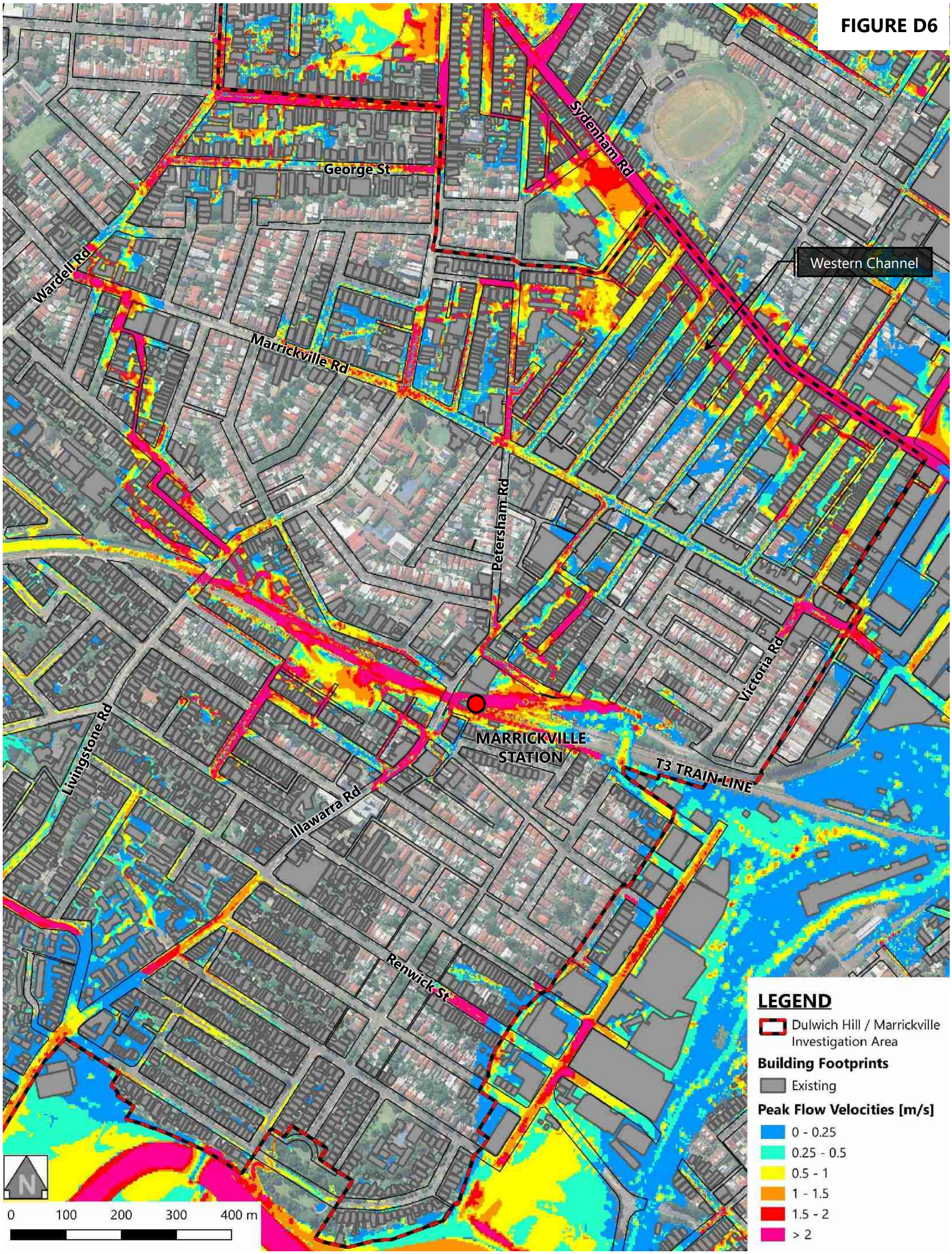
PEAK PMF HAZARD CATEGORIES FOR EXISTING CONDITIONS [DULWICH HILL / MARRICKVILLE - WEST]



Prepared by:

worley consulting

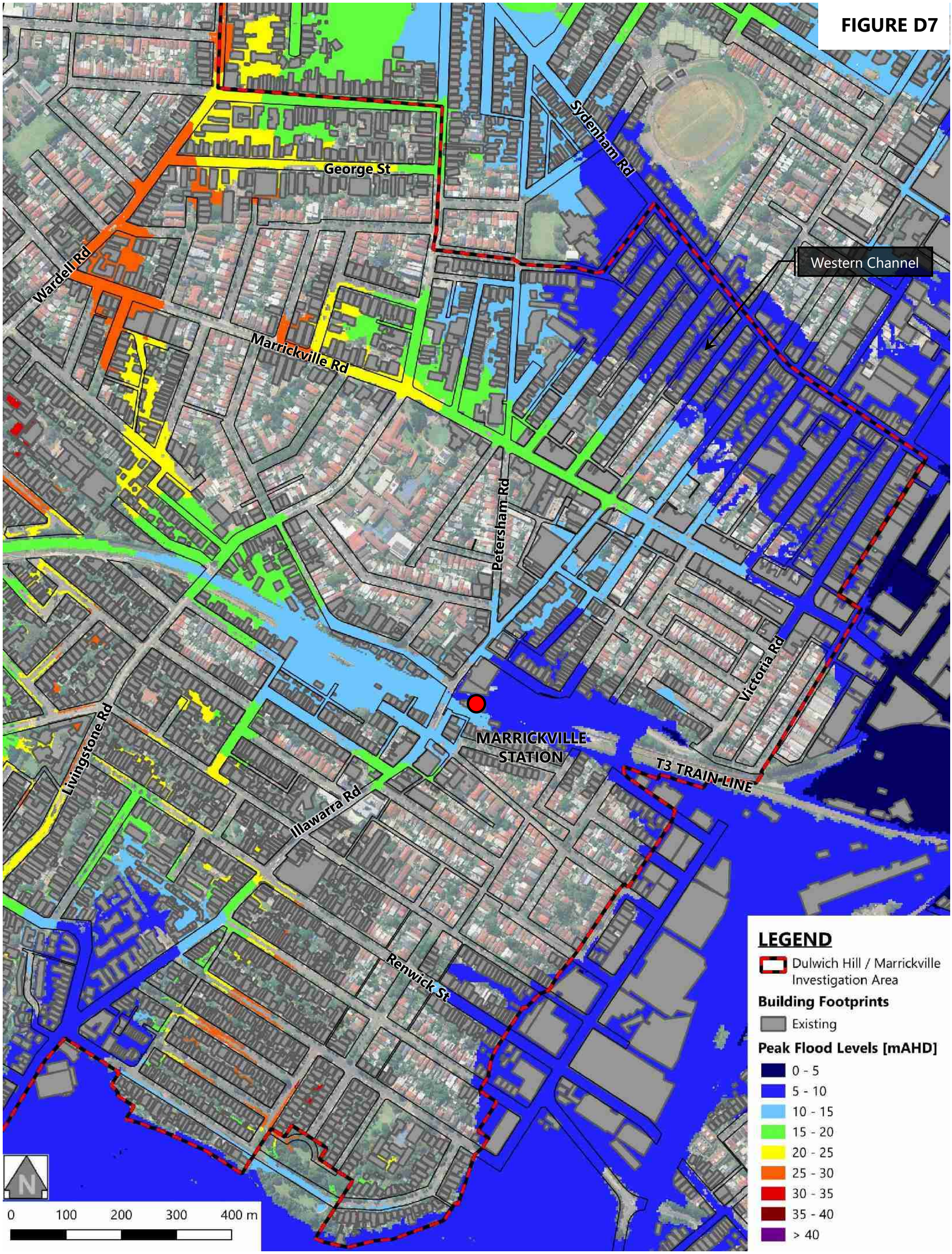
PEAK PMF DEPTHS
FOR EXISTING CONDITIONS
[DULWICH HILL / MARRICKVILLE - EAST]



Prepared by:

worley consulting

PEAK PMF FLOW VELOCITIES FOR EXISTING CONDITIONS [DULWICH HILL / MARRICKVILLE - EAST]



Prepared by:

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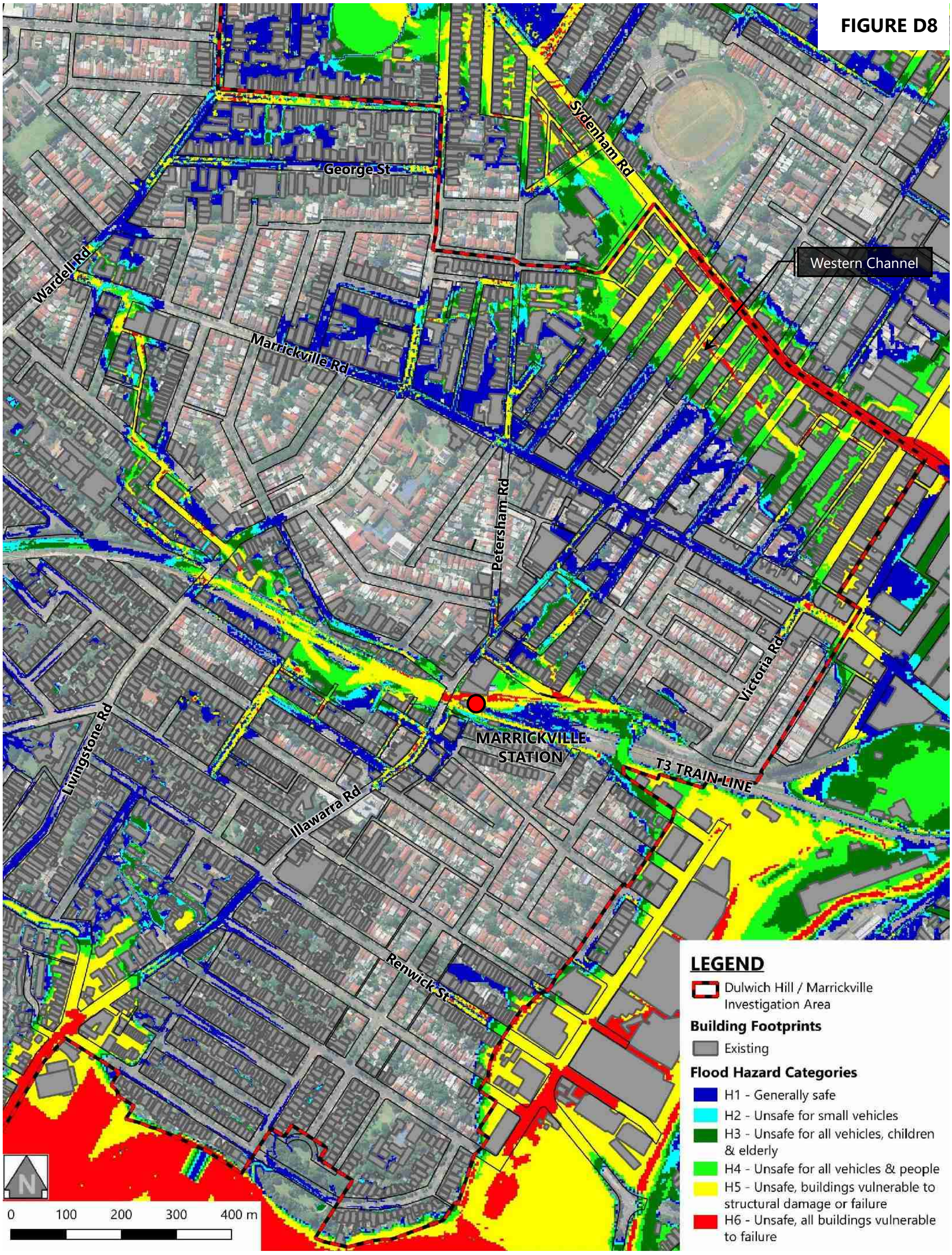
PEAK PMF LEVELS
FOR EXISTING CONDITIONS
[DULWICH HILL / MARRICKVILLE - EAST]



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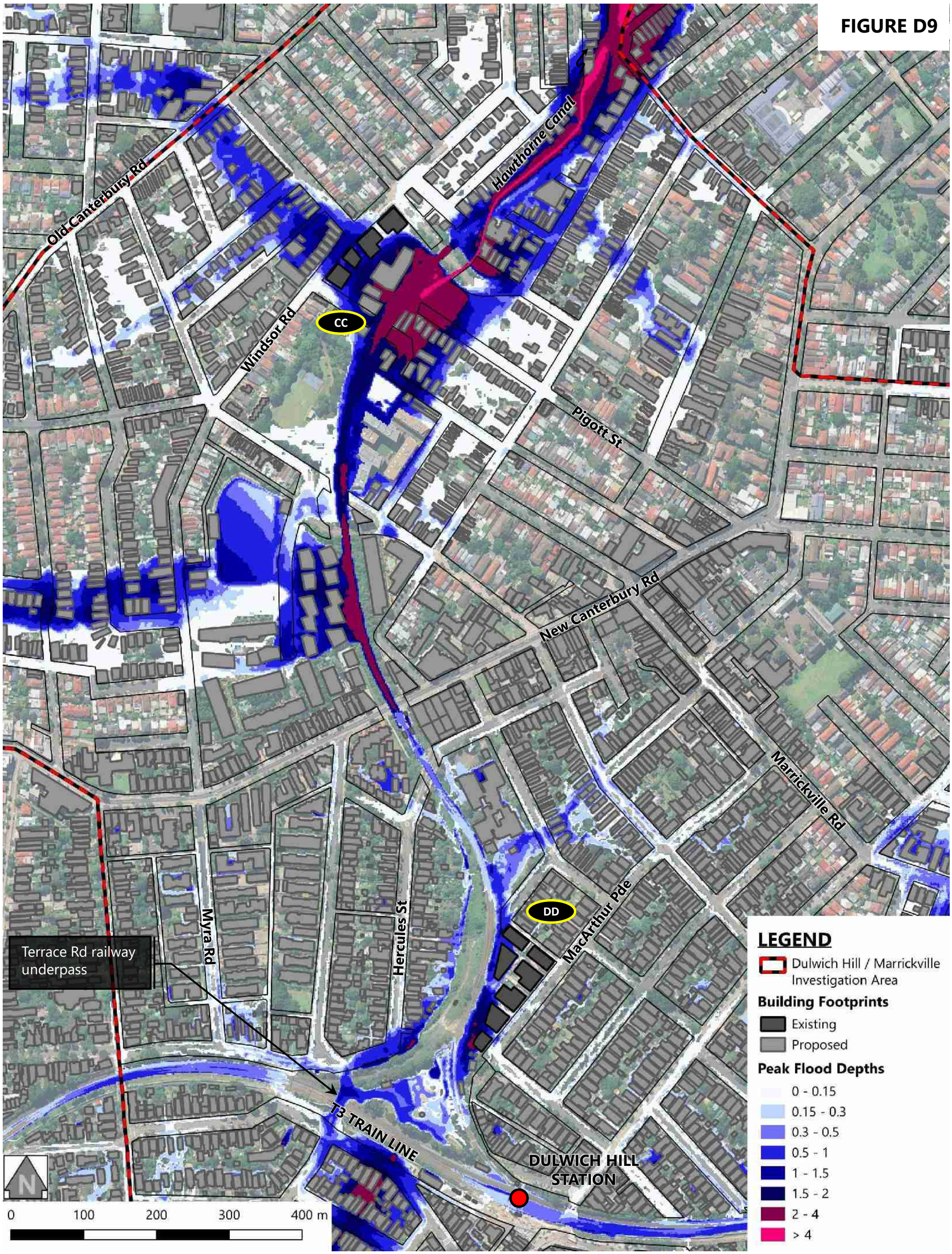
PEAK PMF HAZARD CATEGORIES FOR EXISTING CONDITIONS [DULWICH HILL / MARRICKVILLE - EAST]



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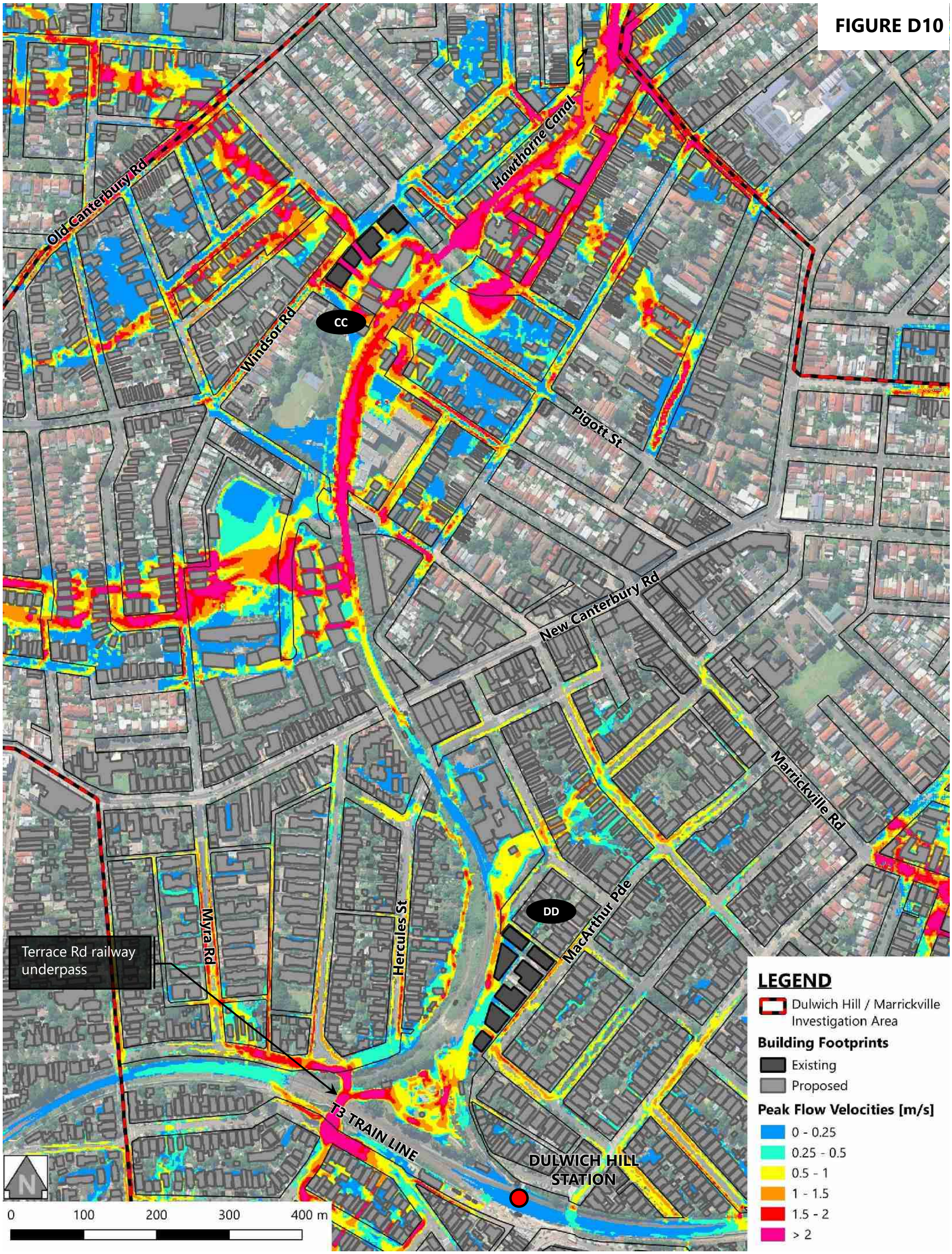
PEAK PMF DEPTHS
FOR POST-DEVELOPMENT CONDITIONS
[DULWICH HILL / MARRICKVILLE - WEST]



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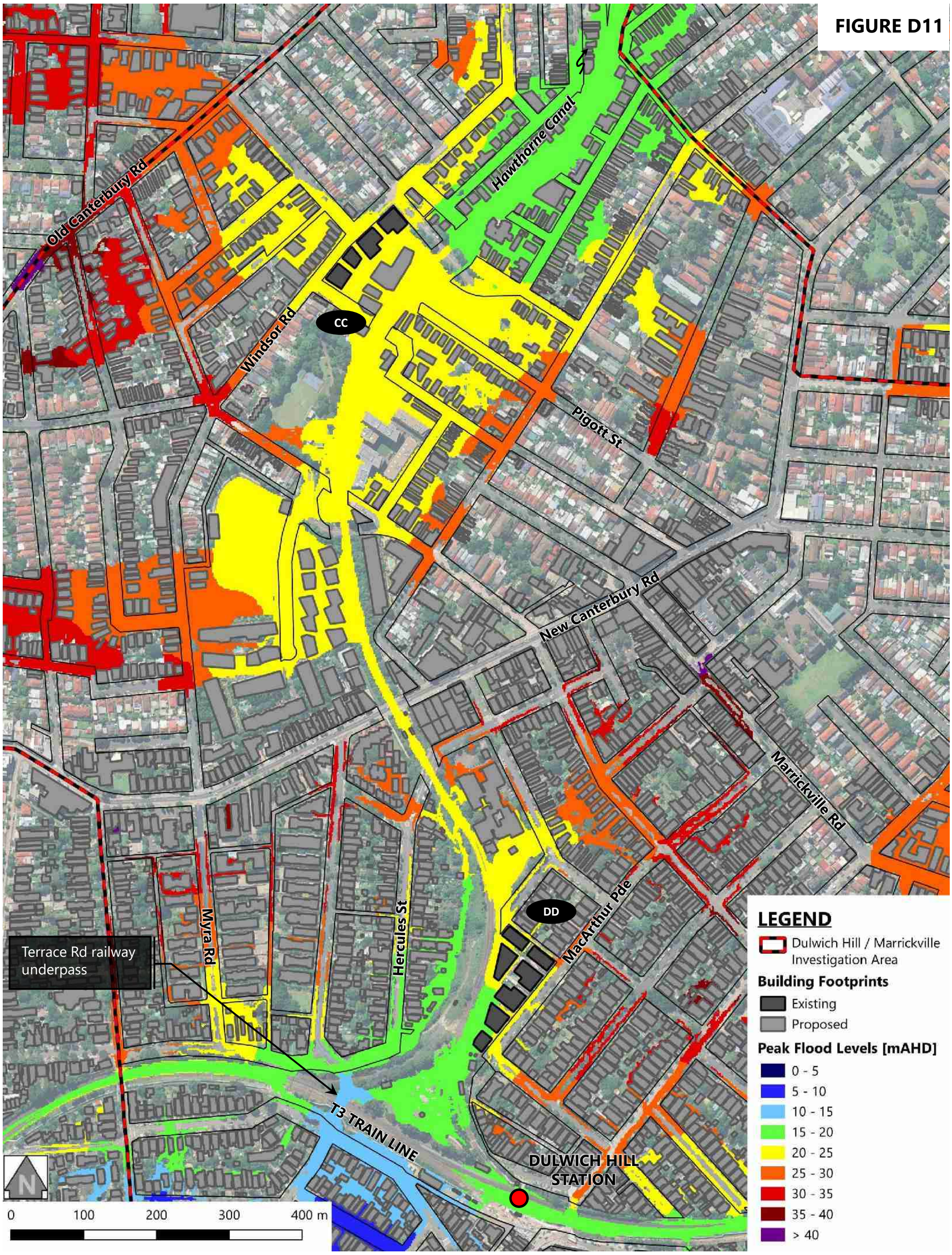
PEAK PMF FLOW VELOCITIES FOR POST-DEVELOPMENT CONDITIONS [DULWICH HILL / MARRICKVILLE - WEST]



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PEAK PMF LEVELS
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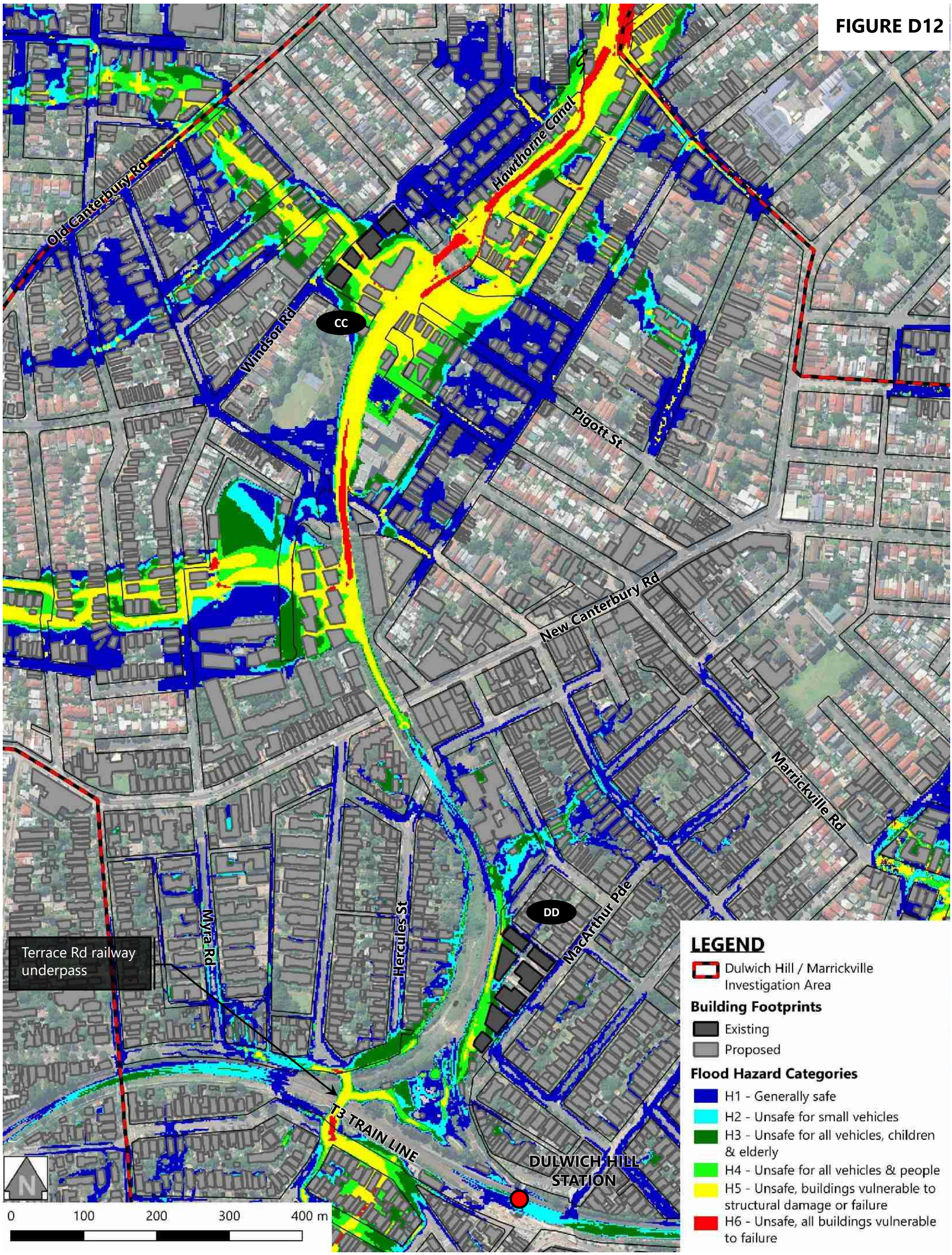

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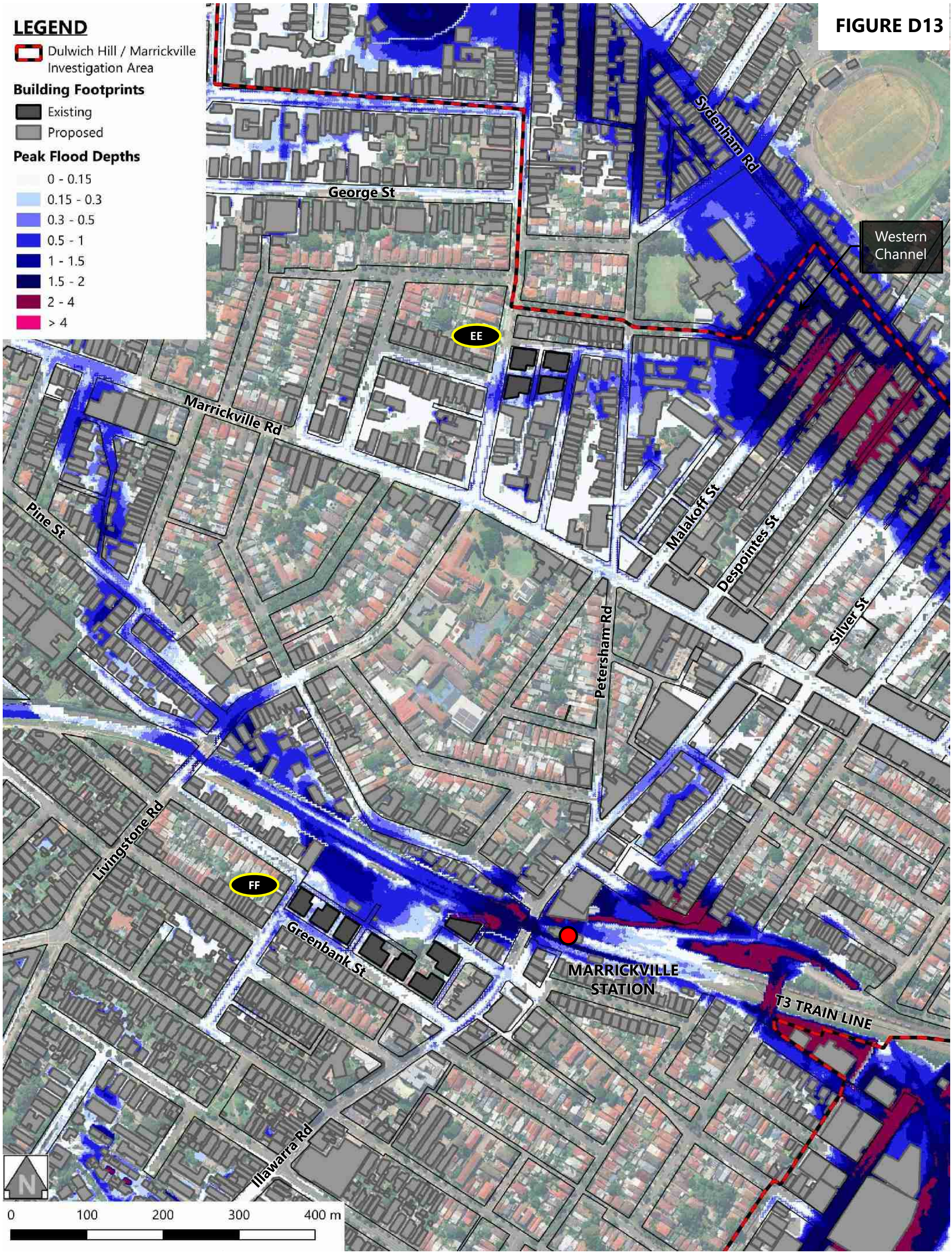
PEAK PMF HAZARD CATEGORIES FOR POST-DEVELOPMENT CONDITIONS [DULWICH HILL / MARRICKVILLE - WEST]



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PEAK PMF DEPTHS
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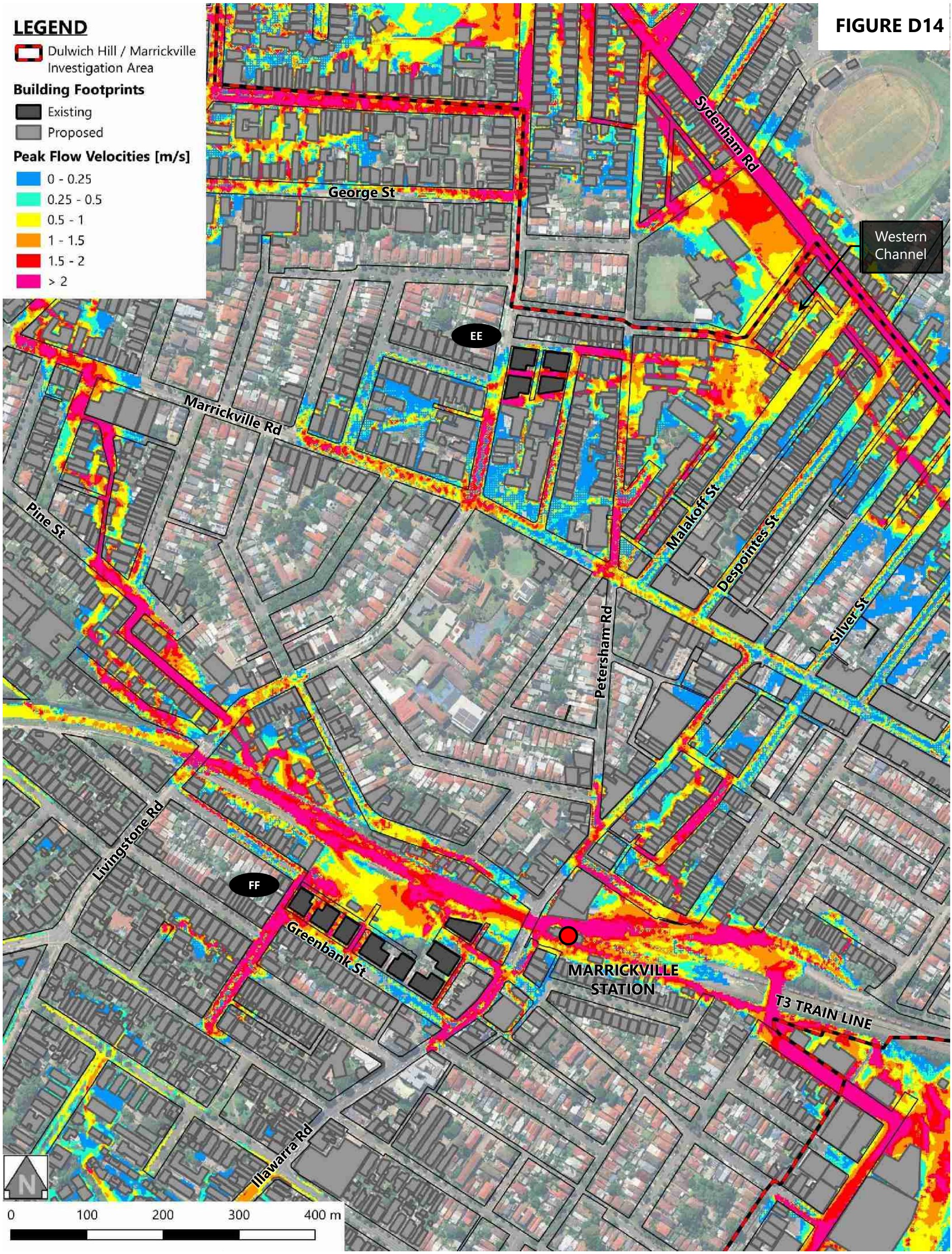

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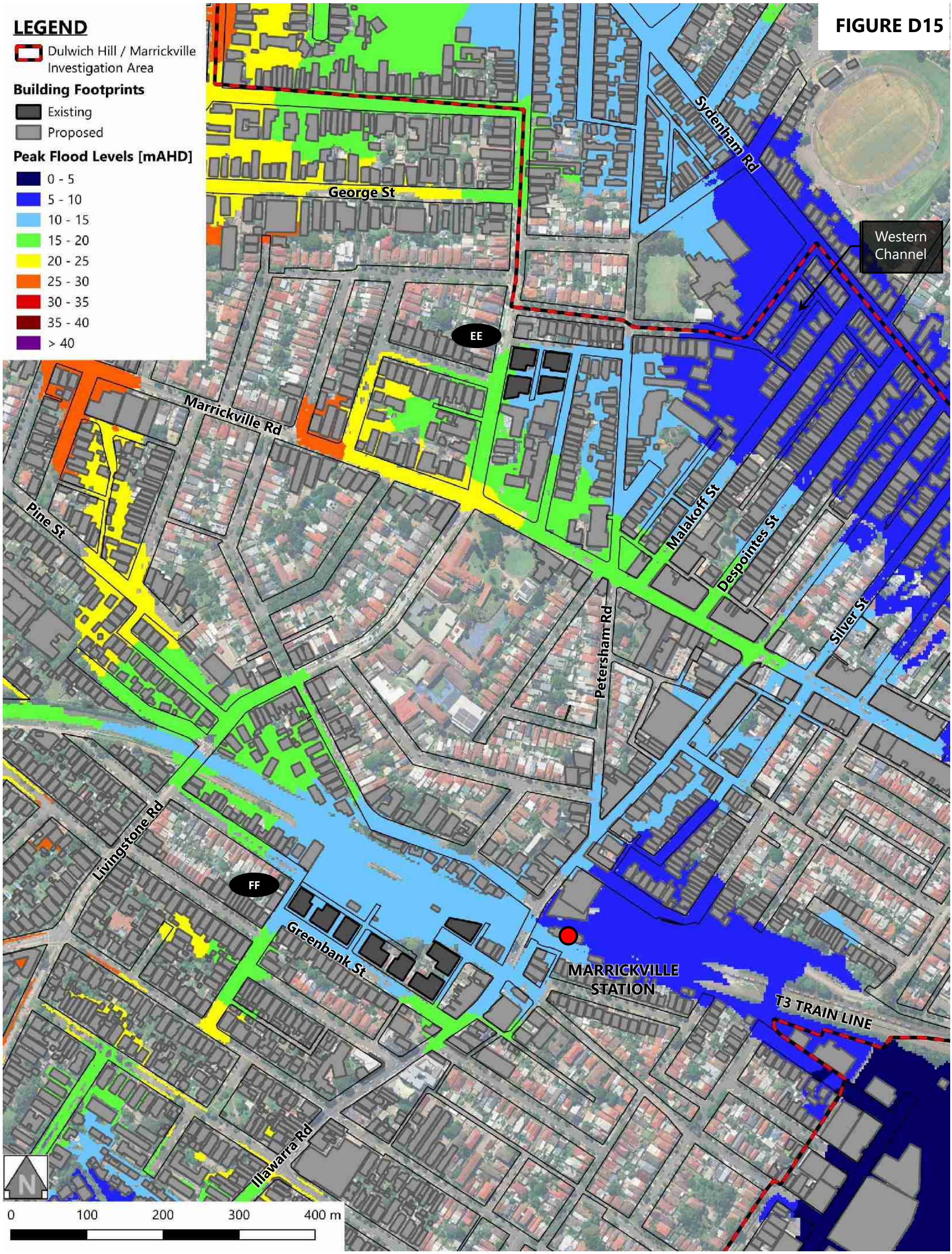
PEAK PMF FLOW VELOCITIES FOR POST-DEVELOPMENT CONDITIONS [DULWICH HILL / MARRICKVILLE - EAST]



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PEAK PMF LEVELS
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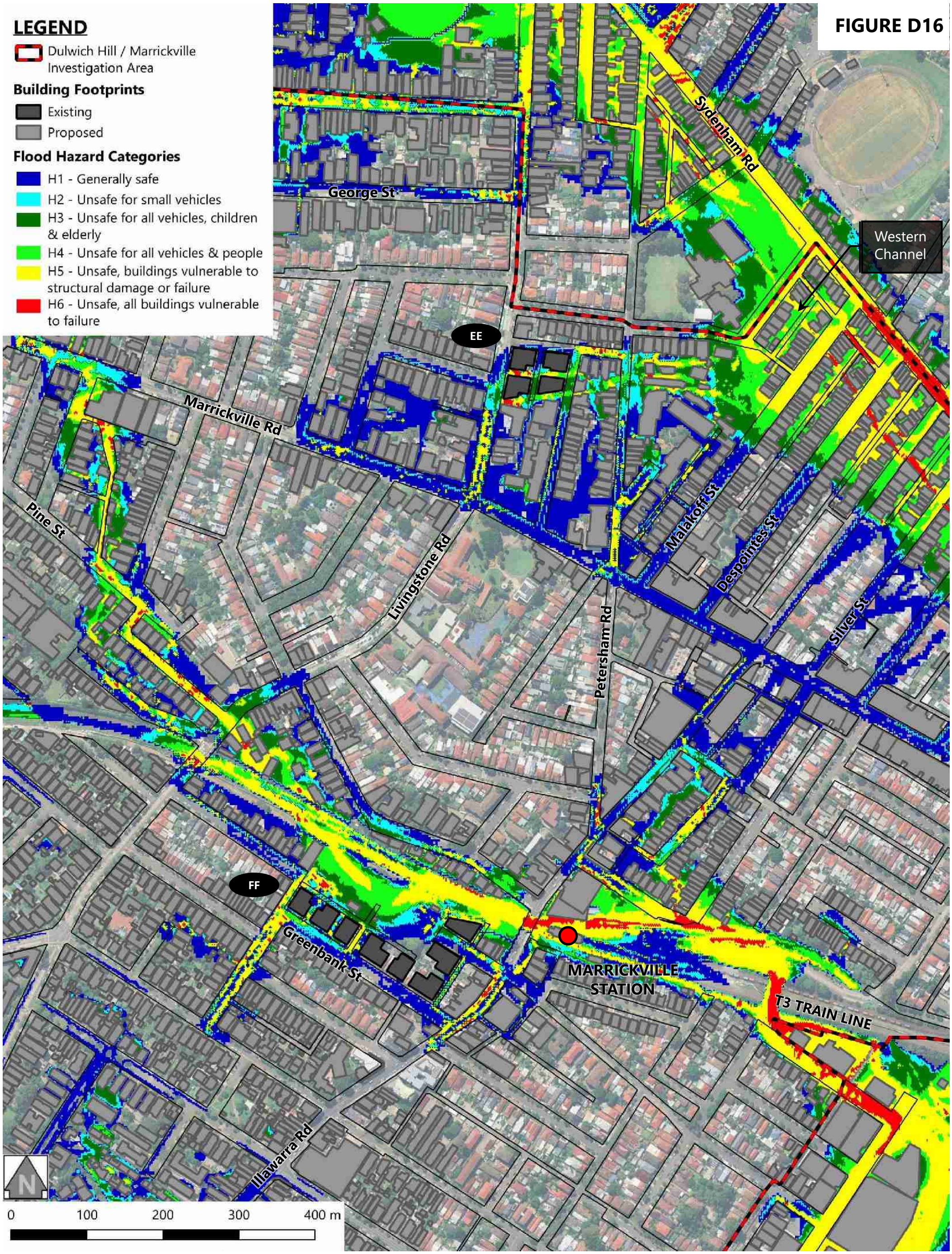

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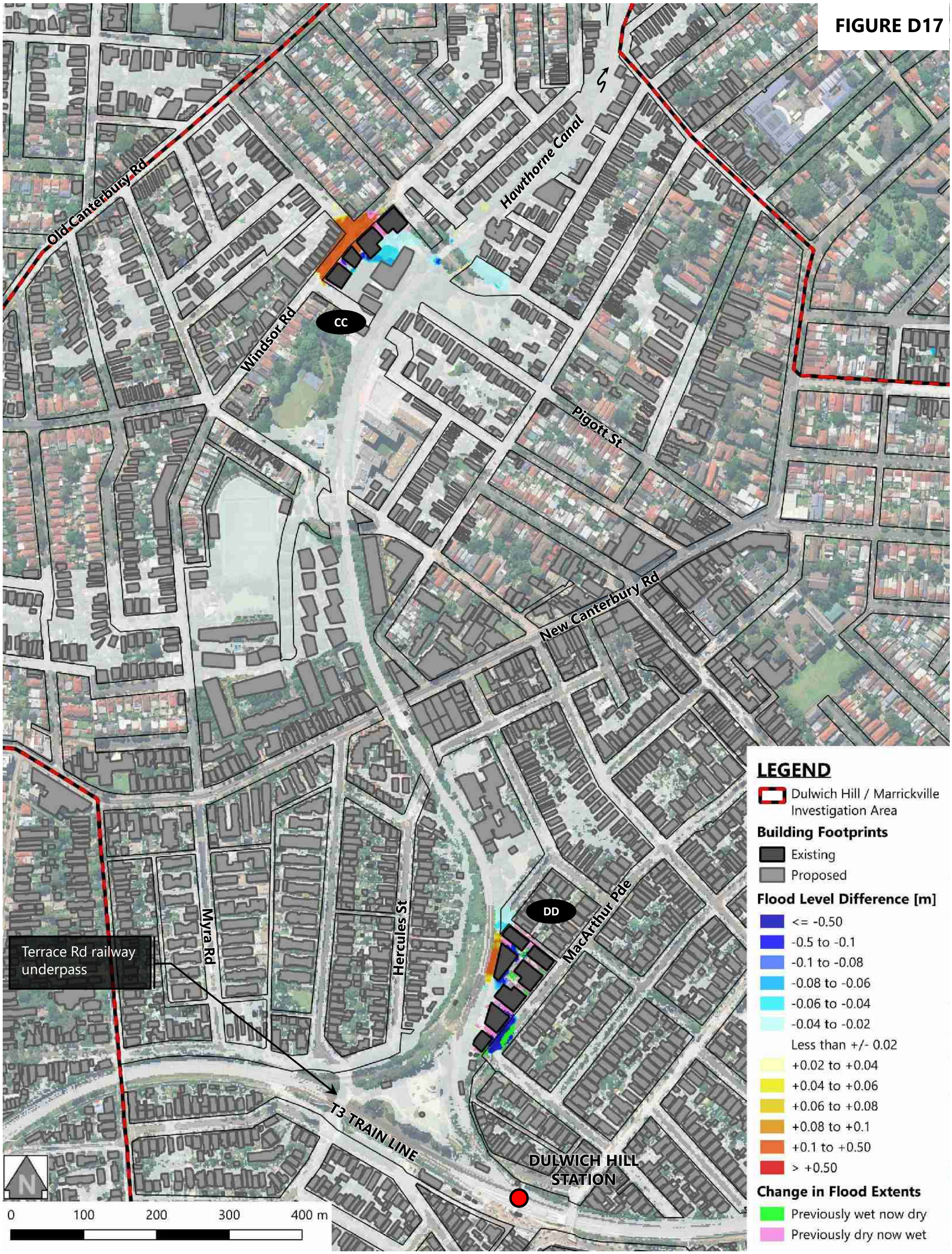
PEAK PMF HAZARD CATEGORIES FOR POST-DEVELOPMENT CONDITIONS [DULWICH HILL / MARRICKVILLE - EAST]



Prepared by:

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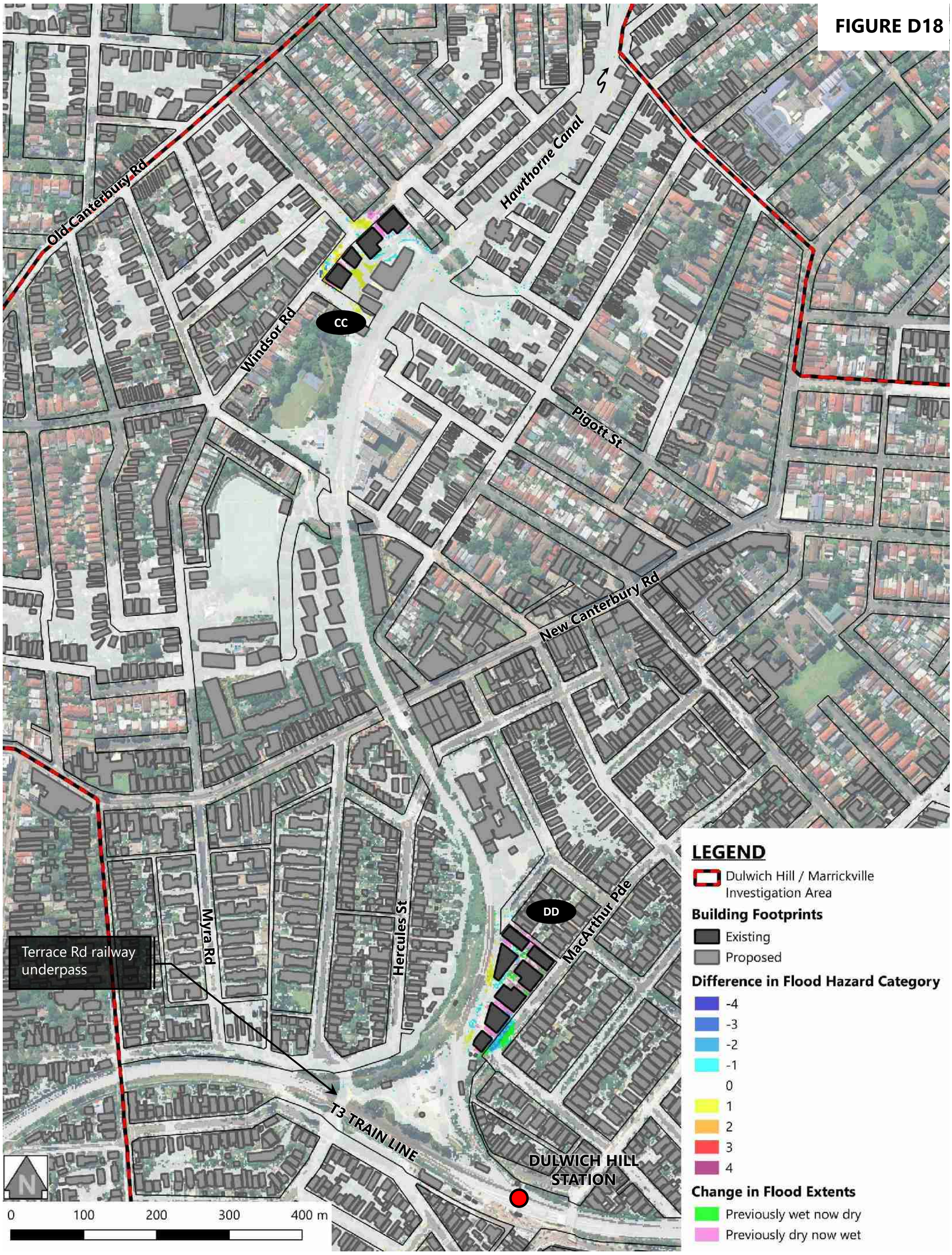
DIFFERENCE IN PEAK PMF LEVEL [DULWICH HILL / MARRICKVILLE - WEST]



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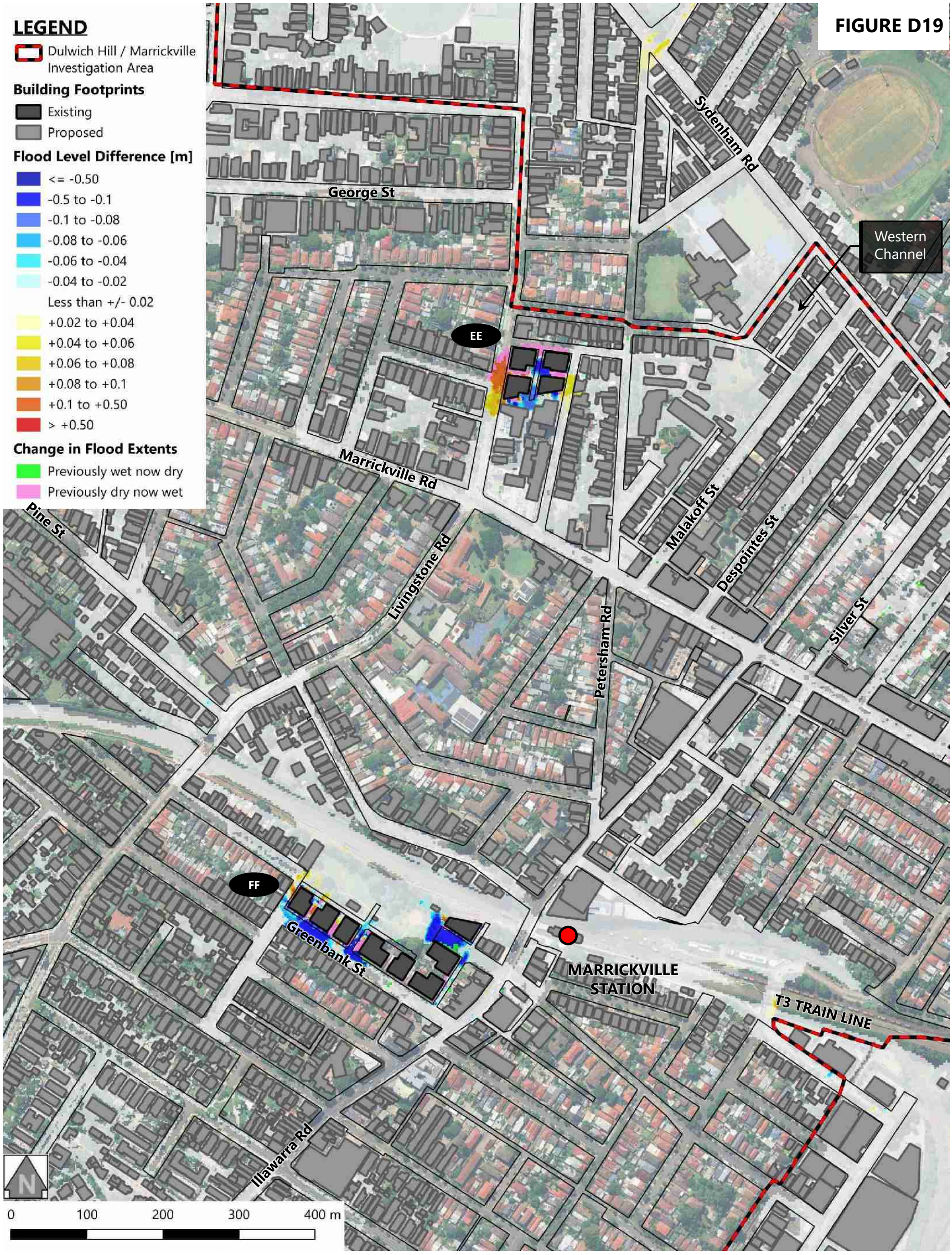
DIFFERENCE IN PMF HAZARD CATEGORIES [DULWICH HILL / MARRICKVILLE - WEST]



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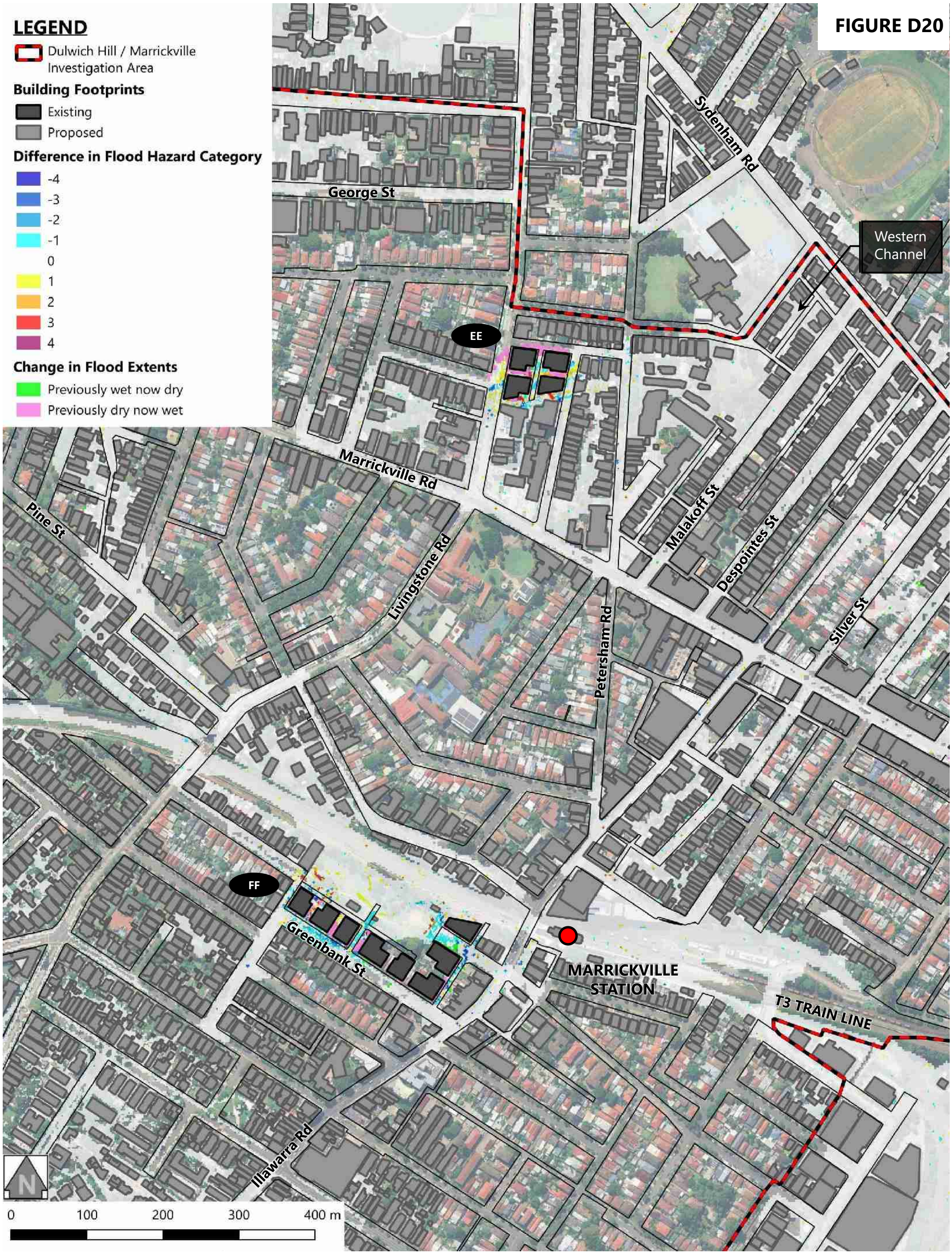

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DIFFERENCE IN PMF HAZARD CATEGORIES [DULWICH HILL / MARRICKVILLE - EAST]