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Dear Liz

RE: MIDTOWN STAGE 2 DEVELOPMENT FLOOD IMPACT ASSESSMENT AND FRAMEWORK FOR FLOOD EMERGENCY RESPONSE

Introduction

This letter presents a Flood Impact Assessment (FIA) of the proposed Midtown Stage 2 development within the Ivanhoe Estate at Macquarie Park, Sydney undertaken to support the Development Application (DA) submission for this State Significant Development (SSD). This FIA addresses the flooding-related conditions outlined in the Secretary's Environmental Assessment Requirements (SEARs).

SEARs Conditions

The flooding-related SEARs conditions relevant to the proposed development are outlined below:

- *The EIS must:*
 - *Identify any flood risk on-site having regard to adopted studies for the development site, consideration of any relevant provisions of the NSW Floodplain Development Manual and the potential effects of climate change, sea level rise and an increase in rainfall intensity.*
 - *Assess the impacts of the development, including any changes to flood risk on-site or off-site, and detail design solutions to mitigate flood risk where required.*
 - *Identifies required management measures and design solutions, including water sensitive urban design and detention, to minimise the impacts of flooding on the proposed development.*
- *The EIS must also address the following flood related issues:*
 - *Finished Floor Levels (FFLs) shall be set at levels that comply with Council's freeboard requirements defined in DCP-2014-8.2 Stormwater Management Technical Manual.*
 - *Basement ramps shall raise up to PMF levels, at each location, before descending to the basements, to fully flood proof every basement.*
 - *No gaps/openings connected to any basement are allowed below the PMF level at each location.*
 - *Fences located in overland flow paths shall allow flows to pass through.*

Previous Master Plan Assessment and Findings

In 2017, BMT completed a flood impact assessment for Frasers Property Australia to support the proposed Ivanhoe Estate Master Plan (Reference: *L.S20319.03.Flood Impact Assessment for Ivanhoe Estate Masterplan.pdf*). This assessment considered the following Master Plan development components of the Ivanhoe Estate:

- buildings (residential flat buildings comprising private, social and affordable housing, seniors house comprising residential care facilities and self-contained dwellings, a new school, child care centres and minor retail development);
- public open space and roads; and
- community uses.

The above components were incorporated into a 2D hydraulic flood model (refer hereafter as the “Ivanhoe Flood Model”) and assessed against existing catchment conditions to establish the change in flood regime due to the Master Plan development.

In all modelled design events, flood conditions outside of Shrimptons Creek and within the Ivanhoe Estate were typified by shallow inundation (low depths) and low velocities (<0.2m/s). These areas are referred to as “Local Drainage” under the NSW Government’s ‘Floodplain Development Manual’ (2005).

Outside of the local drainage areas, the flood impact assessment found negligible differences in design flood conditions in the areas adjacent to Shrimptons Creek. Hence impacts on: emergency planning and evacuation, social and economic cost to the community and erosion, siltation, riparian vegetation and bank stability were not predicted to be altered due to the proposed Ivanhoe Estate Master Plan development.

Midtown Stage 2 Development Updates

The assessment herein focuses on the Midtown Stage 2 development within the Ivanhoe Estate. Subsequent to the Master Plan flood impact assessment referenced previously, the Midtown Stage 2 development seeks consent for the detailed design and construction of Blocks C2, C3 and C4. The latest architectural drawings have been provided and are listed below:

- Midtown Stage 2 – Block C2 Village Green and Community Centre by CHROFI, issued 22/6/2021.
- Midtown Stage 2 – Block C3 Residential and Retail by Fox Johnston, issued 11/6/2021.
- Midtown Stage 2 – Block C4 Residential and Social by Cox Architecture, issued 25/6/2021.

Updates to the Ivanhoe Flood Model for Stage 2

BMT have reviewed the architectural drawings for each block illustrating the proposed building footprint and public domain, as shown in Figure 1, Figure 2 and Figure 3 for Block C2, C3 and C4, respectively. Detailed building footprints (compared to those considered at the Master Plan stage) along with the surface roughness for post-development conditions were incorporated into the Ivanhoe Flood Model for this subsequent flood impact assessment.

BMT were also provided with an updated Digital Elevation Model (DEM) for the site for pre-development (ADWJohnson, issued 5/5/2021) and post-development (ADWJohnson, issued 10/6/2021) conditions. Both datasets have been used to update the Ivanhoe Flood Model, with the post-development DEM providing definition of the proposed internal roads within the Ivanhoe Estate and the earthworks along the western bank of Shrimptons Creek (introduced as part of the Ivanhoe Estate development).

This updated version of the Ivanhoe Flood Model is hereafter referred to as the “Ivanhoe Stage 2 Flood Model”.

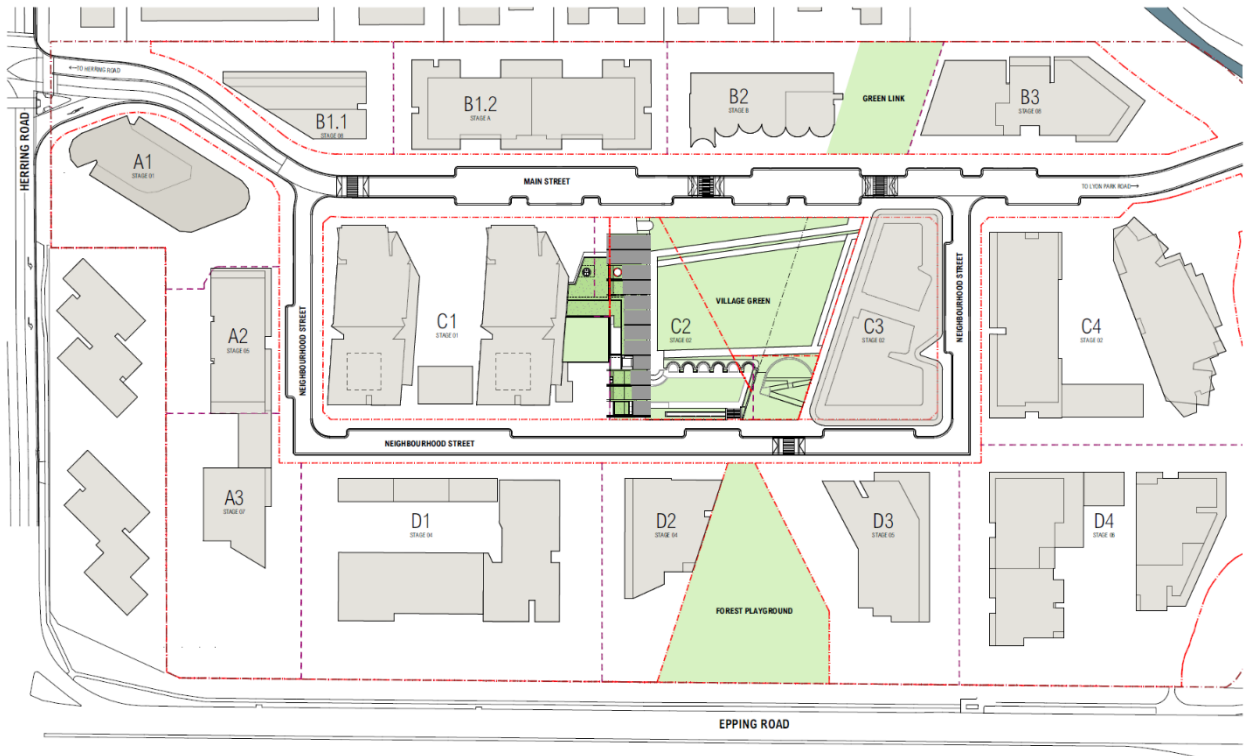


Figure 1 Midtown Stage 2 – Block C2 Village Green and Community Centre (CHROFI, Drawing Number A-A-002 Rev 02 issued 22/6/2021)

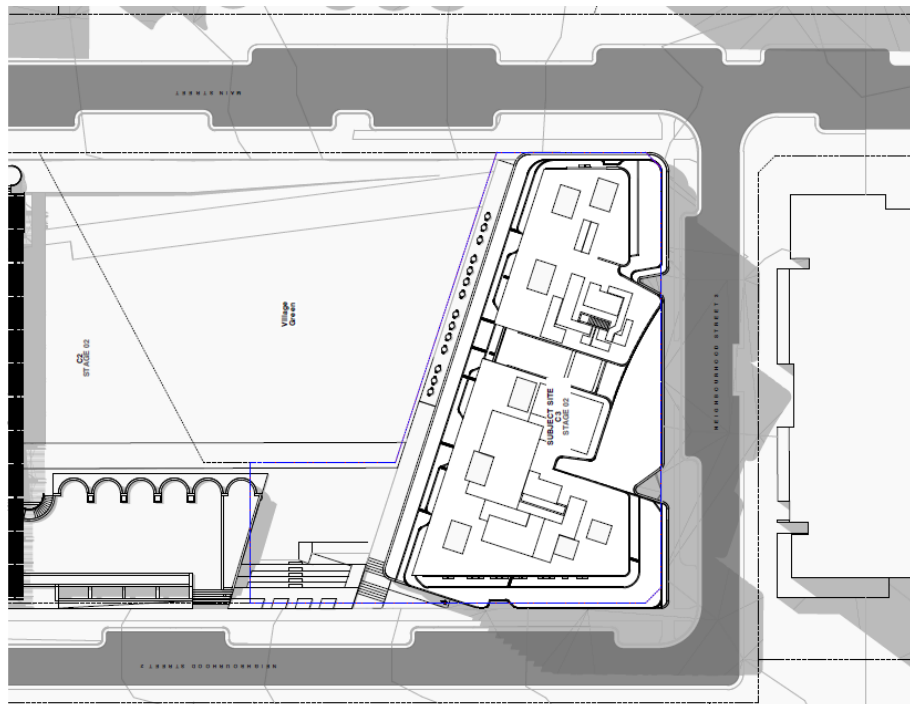


Figure 2 Midtown Stage 2 – Block C3 Residential and Retail (Fox Johnston, Drawing Number A-A-100-P3 Rev 003 issued 11/6/2021)

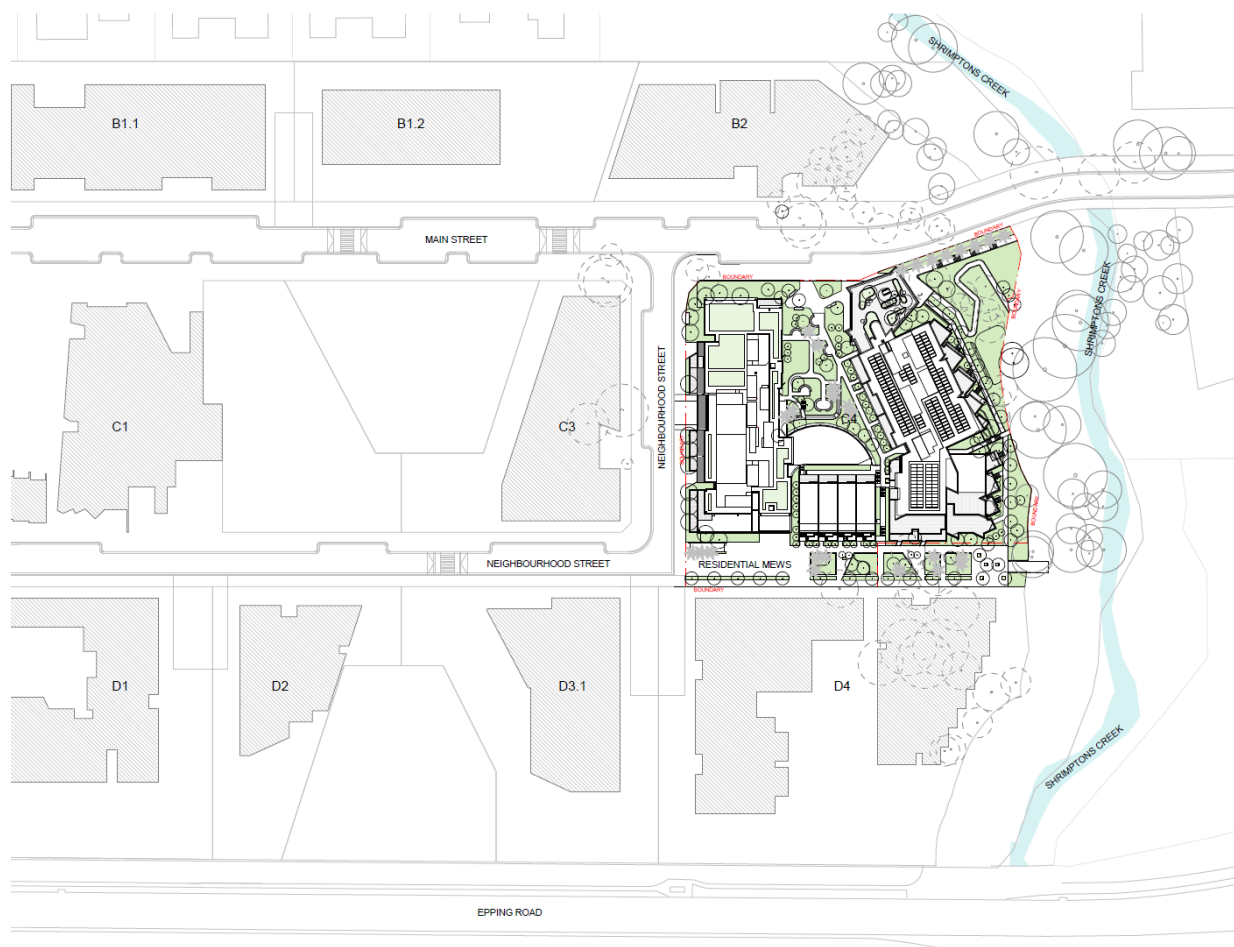


Figure 3 Midtown Stage 2 – Block C4 Residential and Social (Cox Architecture, Drawing Number A-DA-1100 Rev D issued 25/6/2021)

Flood Impact Assessment Results

The flood impact assessment was undertaken based on the Ivanhoe Stage 2 Flood Model for the following design flood events:

- 5% AEP (Annual Exceedance Probability) 2 hour critical storm for blocked¹ and unblocked scenarios;
- 1% AEP 2 hour critical storm for blocked and unblocked scenarios;
- 1% AEP plus 10% rainfall increase (climate change)² 2 hour critical storm for blocked and unblocked scenarios; and
- Probable Maximum Flood (PMF) 15 minute critical storm for unblocked scenario³.

Flood impact maps showing the peak flood level comparison between the pre-development and post-development scenarios are provided in Attachment A (note: maps were prepared based on the post-

¹ Drainage blockage methodology as per Macquarie Park Floodplain Risk Management Study and Plan Flood Study Report (Bewsher, 2010).

² Climate change assessment consistent with Macquarie Park Floodplain Risk Management Study and Plan Final Report (Bewsher, 2011). The site and adjacent creek are not subject to impacts from sea level rise.

³ Blockage scenario was not investigated for the PMF in the Macquarie Park Floodplain Risk Management Study and Plan Flood Study Report (Bewsher, 2010).

development peak flood levels minus the pre-development peak flood levels). The results show that under post-development conditions there is minimal change in the mainstream flood levels on Shrimptons Creek up to the 1% AEP design flood event including climate change, with adverse impacts highly localised and limited to within the Shrimptons Creek corridor. Therefore, there are no predicted flood impacts on adjacent properties as a result of the proposed development. The Midtown Stage 2 development extent generally does not encroach onto the 1% AEP Shrimptons Creek mainstream flood extent, even in the climate change scenario.

For the PMF extreme event, adverse flooding impacts are predicted to extend upstream of Epping Road and downstream of the Ivanhoe Estate development. However, it is important to note that this is an extremely rare event with an AEP of 1 in 10,000,000 according to *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method* (Bureau of Meteorology, 2003), and Shrimptons Creek and its adjacent floodplain are already subject to significant inundation depths.

As previously mentioned, runoff within the Ivanhoe Estate including the Midtown Stage 2 development is generally shallow overland flow outside of the Shrimptons Creek corridor and considered as “Local Drainage”. As the internal stormwater drainage and design terrain surrounding the Ivanhoe Estate have not been finalised (other than the grading of the internal roads and the earthworks along the western bank of Shrimptons Creek), the assessment herein is limited to assessing impacts primarily on Shrimptons Creek mainstream flooding and not local catchment flooding.

Finished Floor and Basement Entry Levels

Finished Floor Levels (FFLs) for the Midtown Stage 2 development have been assessed in reference to the City of Ryde’s freeboard requirements defined in *Part 8.2 Stormwater Management Technical Manual* of the City of Ryde Development Control Plan (DCP) 2014. The requirements are outlined in Table 1, with Figure 4 also referred to in categorising the site in accordance with the flood risk and overland flow precincts. Given that the site adjacent to the Shrimptons Creek corridor may experience medium to high risk flooding, the 0.5 m freeboard for habitable floor level and 0.3 m freeboard for non-habitable floor level would be applicable for the proposed development.

The buildings on Block C4, which are located at the lowest elevation of the site (compared to Blocks C2 and C3) and nearest to Shrimptons Creek, have proposed minimum FFLs of 47.0 mAHD. Compared to the peak flood levels listed in Table 2, a freeboard in excess of 0.5 m has been achieved for all events up to the PMF event.

The lowest threshold for a basement entry into the underground car park at Block C4 is proposed at 47.7 mAHD. This is above the Shrimptons Creek PMF level of 46.14 mAHD as per Table 2. Hence, the floodwaters from Shrimpton Creek will be prevented from ingressing the basement in all events up to and including the PMF.

Table 1 Freeboard Requirements based on City of Ryde DCP (2014)

Drainage System/ Overland Flow	Residential			Industrial/ Commercial	
	Land Level ^(b)	Habitable Floor Level	Non-Habitable Level ^(c)	Land Level ^(b)	Floor Level
Surface Drainage/ adjoining ground level ^(a)	-	.15m	-	-	.15m
Public drainage infrastructure, creeks and open channels	0.5m	0.5m	0.1m	0.3m	0.3m
Flooding and Overland Flow (Overland Flow Precincts and Low Risk)	N/A	0.3m	0.15m	N/A	0.3m
Flooding and Overland Flow (Medium Risk and greater)	N/A	0.5m	0.3m	N/A	-
Onsite Detention ^(d)	N/A	0.2m	0.1m	N/A	0.2m
Road Drainage Minor Systems (Gutter and pipe flow)		0.15m below top of grate			
Road Drainage		Refer to Figure 2-1.			
Detention Basins ⁽⁴⁾		The top water level shall be designed to be 0.5m below top of embankment (100yr ARI)			



Figure 4 Flood Risk and Overland Flow Precincts based on Macquarie Park Floodplain Risk Management Study and Plan Final Report (Bewsher, 2011)

Table 2 Shrimptons Creek Peak Flood Levels adjacent to Midtown Stage 2 Development⁴

Design Storm (AEP)	Peak Flood Levels (mAHD)
5%	44.42
1%	44.48
1% with climate change	44.68
PMF	46.14

⁴ Peak flood levels based on the critical of the blocked and unblocked scenarios.

Framework for Flood Emergency Response

A Flood Emergency Response Plan (FERP) is required to ensure occupants of the development site are aware of the flood risk within and adjacent to the site, and to identify measures that can be employed to safely manage the flood risk before, during and after flood events. There are a number of items that require consideration in a FERP, including:

- An appreciation for the nature of the development and on-site flood risk;
- Flood warning, evacuation and evasion procedures;
- Actions that need to be undertaken before, during and after an event;
- An event timeline indicating the time available to undertake the required actions;
- Triggers to commence actions identified;
- Roles and responsibilities and training requirements for key on-site personnel (e.g. site manager, evacuation marshals etc.);
- Flood preparedness and awareness procedures for occupants, visitors and/or end-users of the development;
- Communication requirements.

The following sections outline flood emergency response considerations and a preliminary framework for the preparation of a Flood Emergency Response Plan (FERP) for the proposed development demonstrating that a flood emergency can be safely managed on the site. However, the information documented in this report only represents a preliminary framework for flood emergency management and should be further refined and developed during the detailed design stage of the development process. Therefore, a detailed final FERP would be prepared prior to the occupation of the Midtown Stage 2 development.

Flood Response

The proposed finished levels and basement entry thresholds for the Midtown Stage 2 development place occupants and vehicles above mainstream Shrimptons Creek flood levels plus freeboard for all events up to and including the PMF. Accordingly, it is recommended that a 'shelter in place' flood emergency response be adopted, whereby occupants remain inside the buildings on-site until floodwaters recede. Nevertheless, in the event of another emergency requiring evacuation from the development during Shrimpton Creek flooding, rising road egress shall be provided from the site to Herring Road in all events up to and including the PMF.

Where occupants or visitors are located on-site but in an area below the PMF level (e.g. lower lying areas outside the buildings), they should move to the closest building and make their way indoors (i.e. to an area above the PMF) as soon as a flood alarm/sensor is activated or ideally prior to this point (for example, following observations of significant depths of water in Shrimptons Creek).

Rate of Rise and Timeline

Figure 5 plots the 1% AEP and PMF levels within Shrimptons Creek over time, showing the rate of rise and recession of floodwaters. The flood modelling results indicate that in extreme events such as the PMF, mainstream floodwaters in the creek can increase rapidly and would inundate the lower floodplain adjacent to the development site within 30 minutes of the onset of rain. Due to the limited warning time, the shelter

in place strategy proposed in the preceding section is recommended as the warning time is not considered sufficient to allow for evacuation of occupants from the site, the duration of flooding is predicted to be relatively short (i.e. about 3 hours or less for the 1% AEP and PMF events as shown in Figure 5) and safe refuge can be provided within buildings on-site.

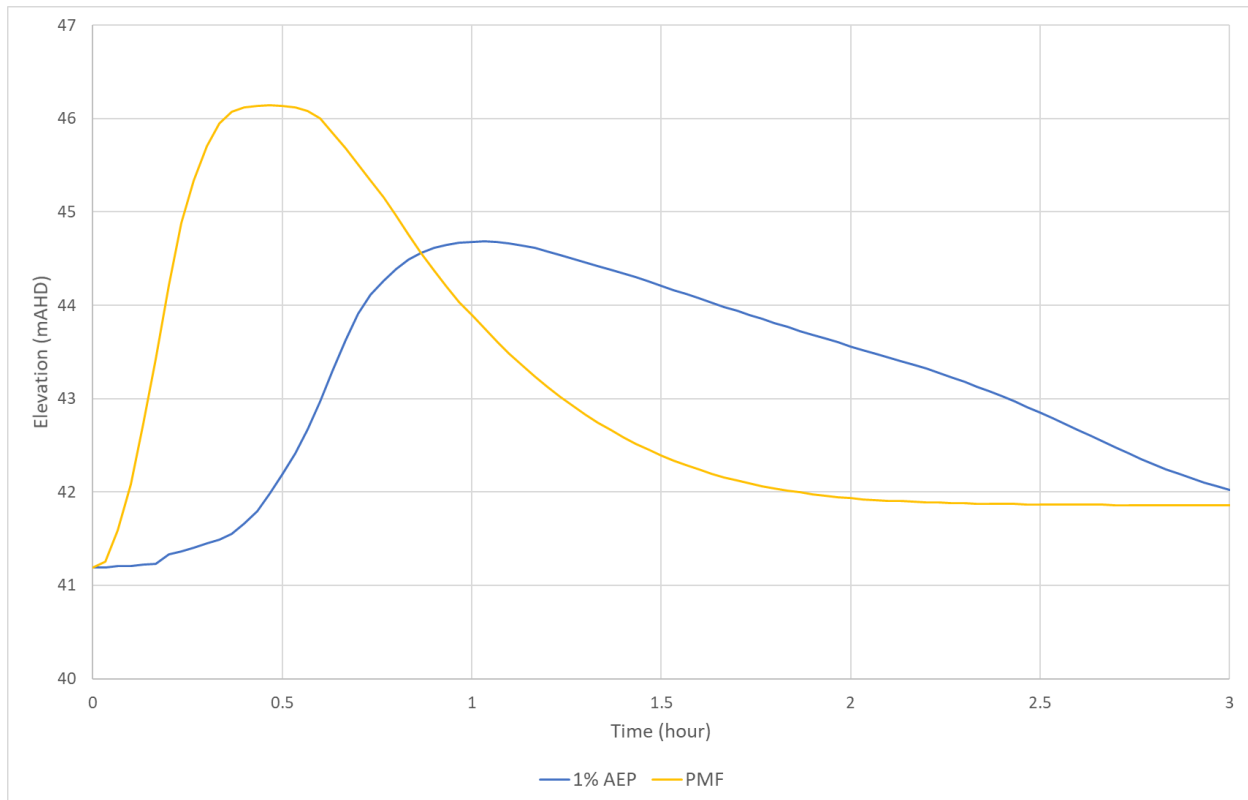


Figure 5 Shrimptons Creek Water Level Rise over Time

Flood Warning Triggers

A warning of a flood event is required to alert occupants and any other people on the site that an extreme flood may inundate the site. In order to maximise the available warning time, it is recommended that the property management monitor the Bureau of Meteorology (BoM) severe weather forecasts for warnings of flash flooding or severe weather (refer <http://www.bom.gov.au/weather-services/severe-weather-knowledge-centre/warnings.shtml>). This will allow management to be aware of the potential for an extreme event to occur and to prepare accordingly in the event of flooding eventuating. A subscription to the BoM warning service to receive updates and warnings of anticipated heavy rainfall events is recommended.

Roles and Responsibilities

Positions and responsibilities that are to be assigned to on-site personnel for managing flood response should be defined within a FERP. A chief flood warden or head warden will need to be nominated to manage the evacuation of the site during a flood. Individual building wardens will also need to be nominated for the individual building structures to manage the emergency response of local sites. There will also need to be involvement from first aid officers and other responsible staff on-site.

Communication

It is recommended that multiple communication platforms are maintained on the site (such as internet, mobile phone, or radio) so that if one communication platform fails there is redundancy. These platforms can be used to monitor for emergency warnings as well as to maintain effective communication with friends, family and emergency services during a flood event.

Within the site, the emergency siren and PA system that is installed for fire emergencies is also likely suitable for communicating with occupants during other emergencies such as a flood emergency. These emergency warning and communication systems are to be located above the PMF level.

Conclusions and Recommendations

The Flood Impact Assessment undertaken herein for the Midtown Stage 2 development found that there is minimal impacts on the Shrimptons Creek mainstream flood levels predicted to result from the proposed development for events up to and including the 1% AEP design flood with climate change (10% rainfall increase). The proposed development extent generally does not encroach onto the 1% AEP Shrimptons Creek mainstream flood extent, even in the climate change scenario.

Outside of the Shrimptons Creek corridor, runoff within the Ivanhoe Estate (including the Midtown Stage 2 development) is generally shallow overland flow and considered as “Local Drainage”. It should be noted that as the internal stormwater drainage and design terrain surrounding the Ivanhoe Estate have not been finalised (other than the grading of the internal roads and the earthworks along the western bank of Shrimptons Creek), the assessment herein is limited to assessing impacts primarily on Shrimptons Creek mainstream flooding and not local catchment flooding. It is assumed that the detailed design of the development (e.g. stormwater management plan, drainage design) will address and mitigate any local drainage impacts.

For Block C4 within the Midtown Stage 2 development, which has buildings located at the lowest elevation of the site (compared to Blocks C2 and C3) and is located nearest to Shrimptons Creek, the FFLs comply with the freeboard requirements outlined in the City of Ryde DCP (2014). The FFLs for the development should also be checked against the local drainage/overland flow freeboard requirements once the internal stormwater drainage and design terrain are finalised.

The basement ramp threshold leading into the underground car park at Block C4 is proposed above the PMF Shrimptons Creek flood levels. Hence, the floodwaters from Shrimpton Creek will be prevented from ingressing the basement in all events up to and including the PMF.

Other conditions outlined in the SEARs shall also be adhered to:

- No gaps/openings connected to any basement shall be below the PMF level at each location.
- Fences located in overland flow paths shall allow flows to pass through.

Flood emergency response considerations and a framework for the preparation of a Flood Emergency Response Plan are also provided for the proposed development to demonstrate that any residual flood risk to occupants of the site can be managed safely. However, the information documented in this report only represents a preliminary framework for emergency management to be further refined in the detailed design stage of the development process.

I trust that this letter addresses the flooding-related conditions outlined in the SEARs for the Midtown Stage 2 development. Should you have any further questions regarding this assessment, please do not hesitate to contact myself.

Yours Faithfully

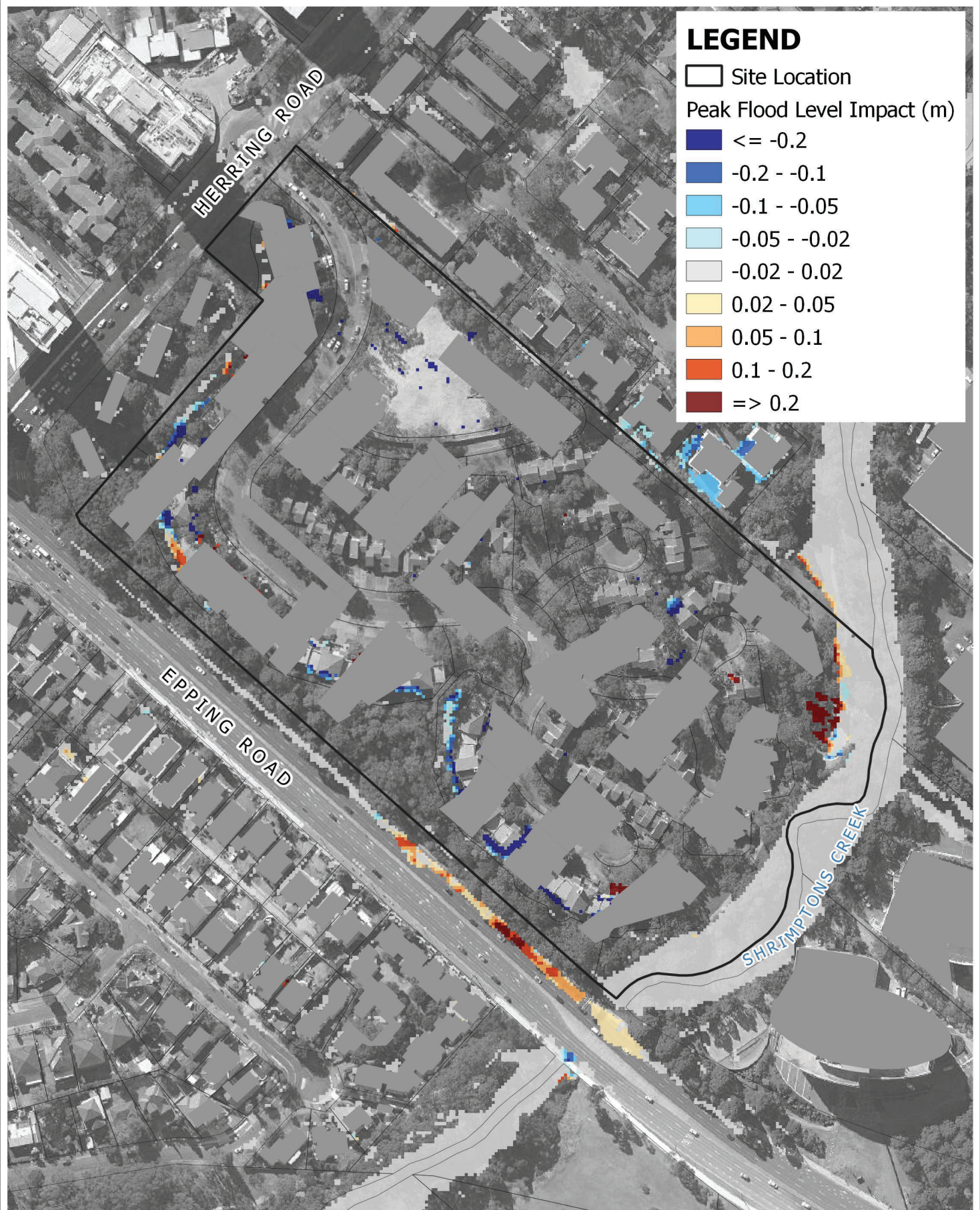


Nathan Cheah
Associate Principal Engineer
BMT

Attachments:

- *Attachment A: Flood Impact Maps*

Attachment A - Flood Impact Maps



Title:

Peak Flood Level Impact 5% AEP Event - No Blockage Scenario

Figure:
1

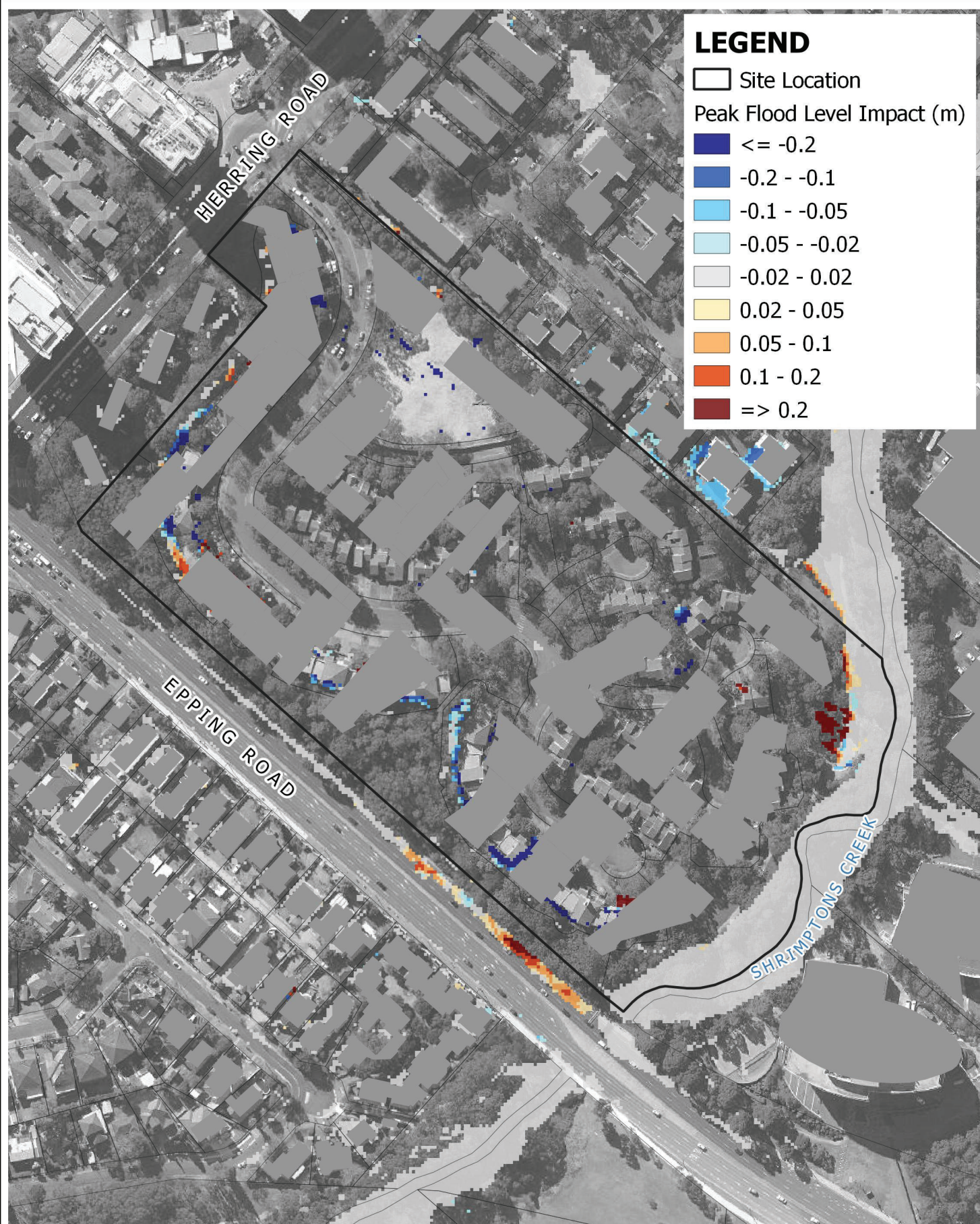
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Title:

Peak Flood Level Impact 5% AEP Event - Blockage Scenario

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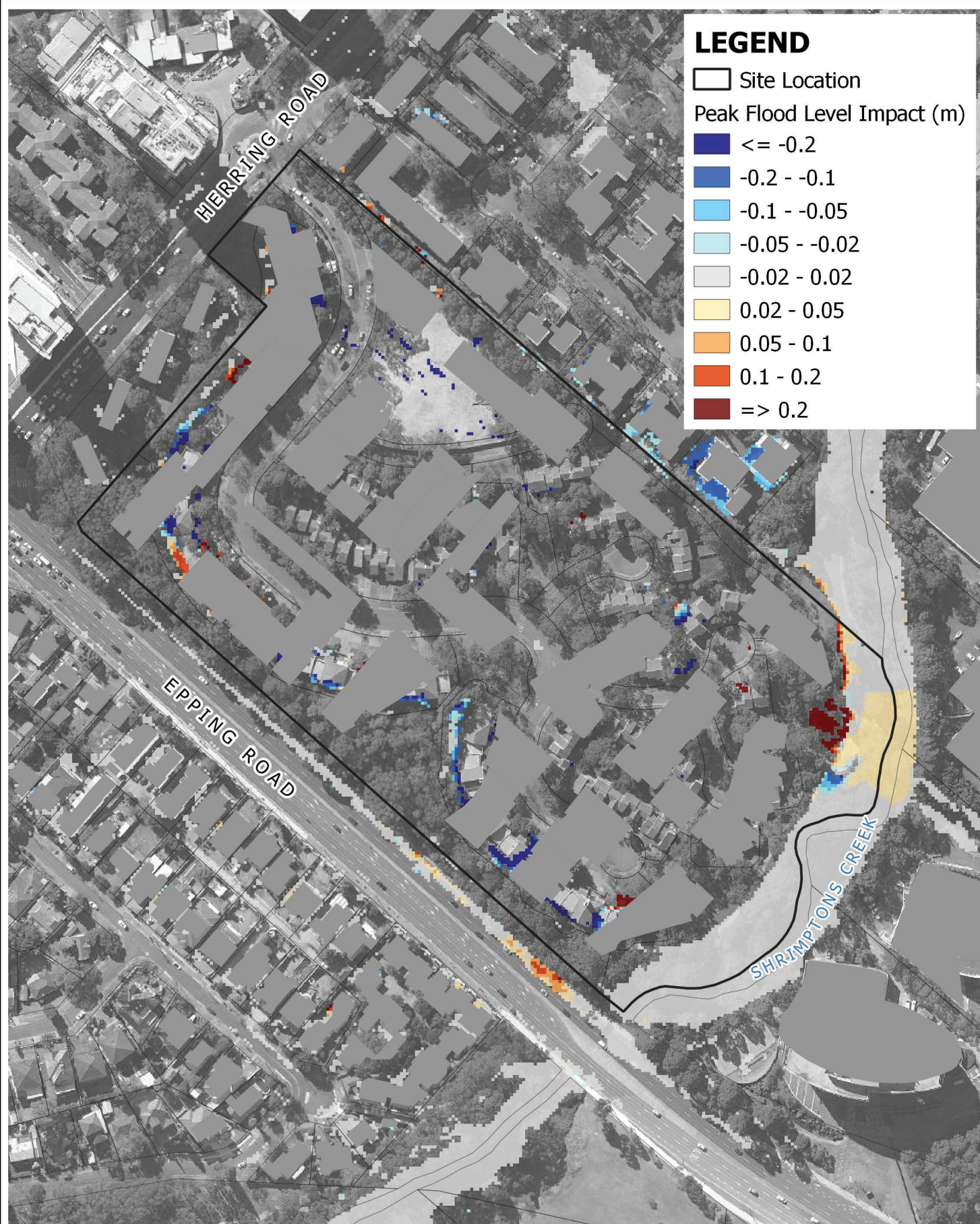
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Title:

Peak Flood Level Impact 1% AEP Event - No Blockage Scenario

Figure:
3

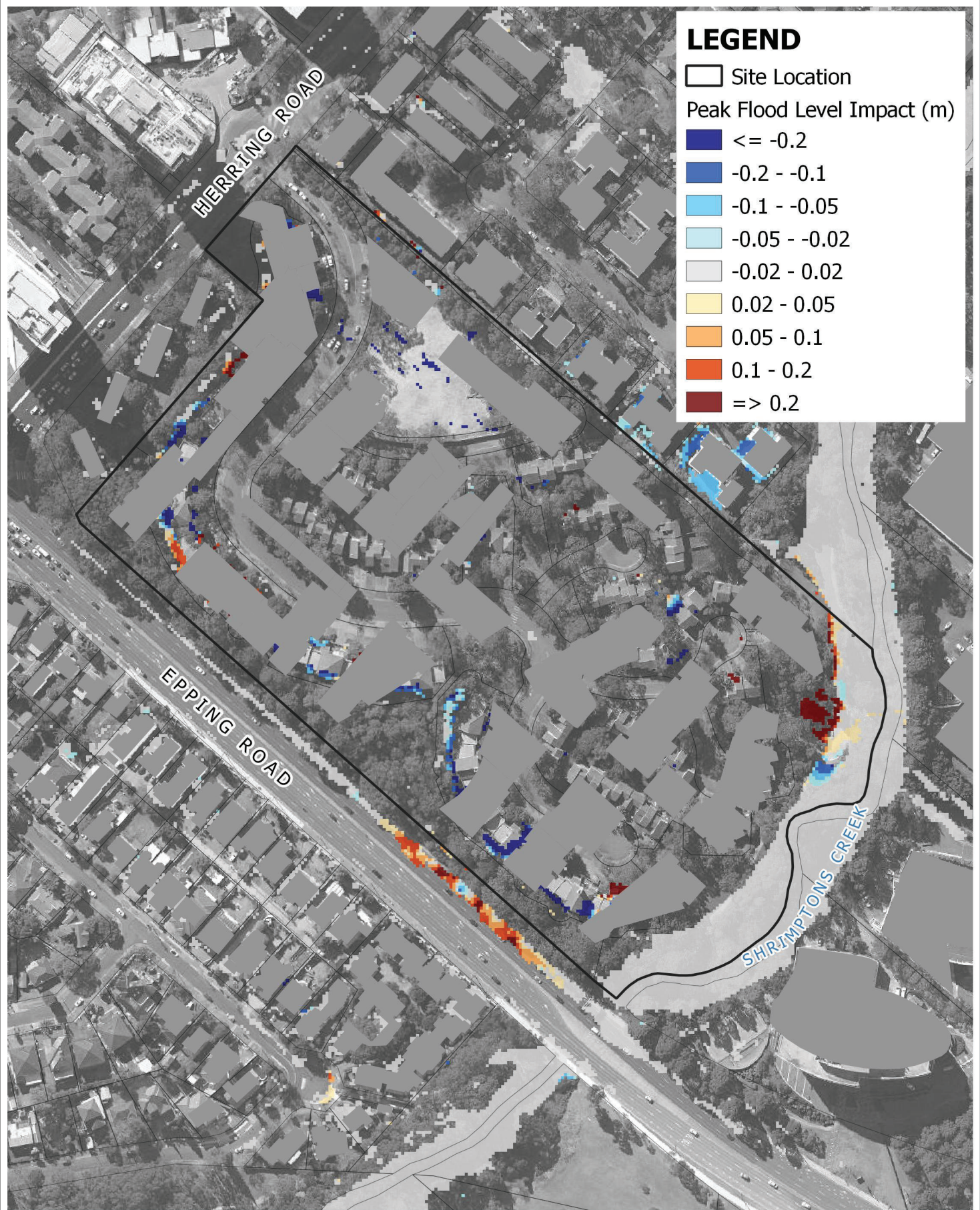
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Title:

Peak Flood Level Impact 1% AEP Event - Blockage Scenario

Figure:
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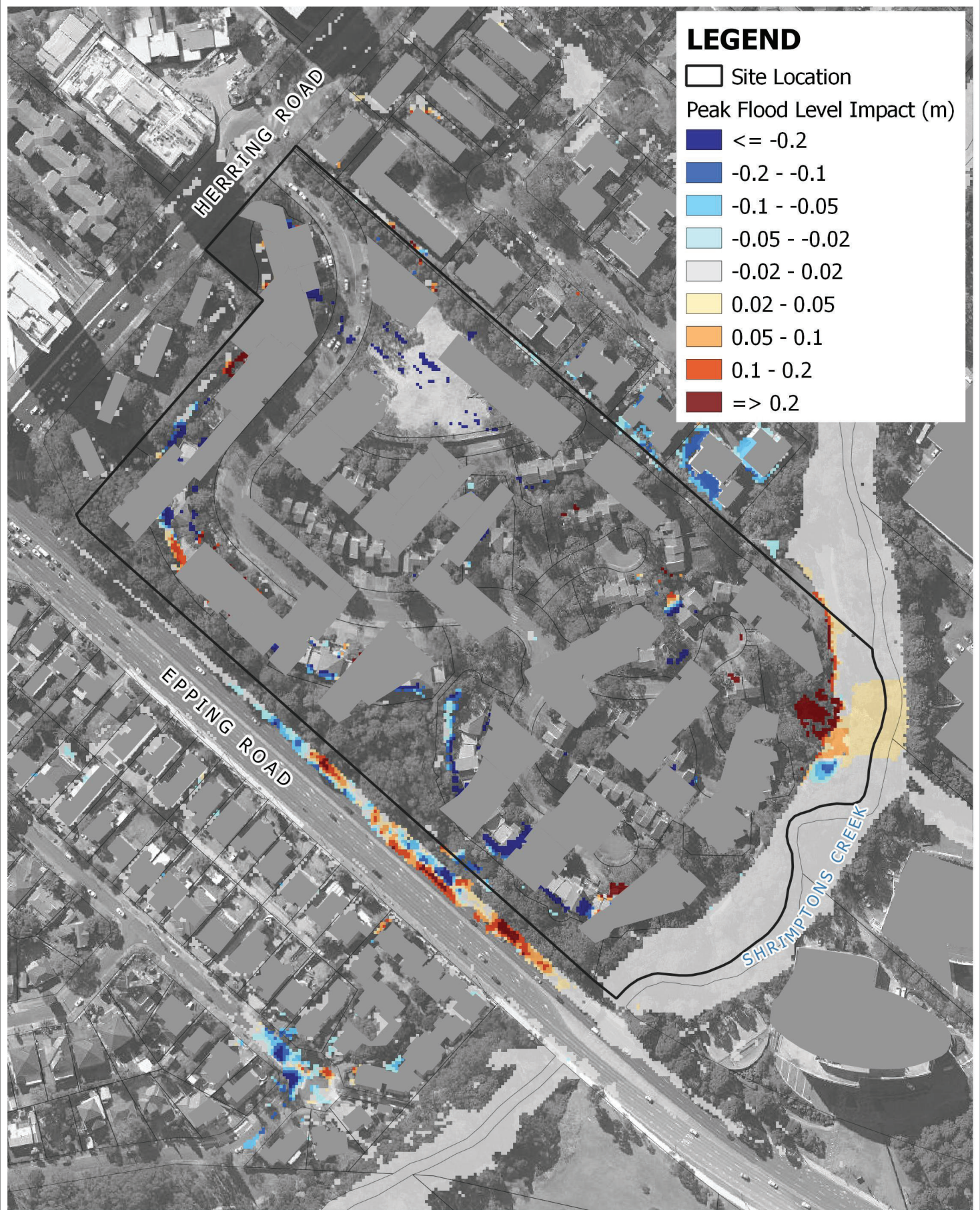
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Title:

Peak Flood Level Impact 1% AEP with Climate Change - No Blockage Scenario

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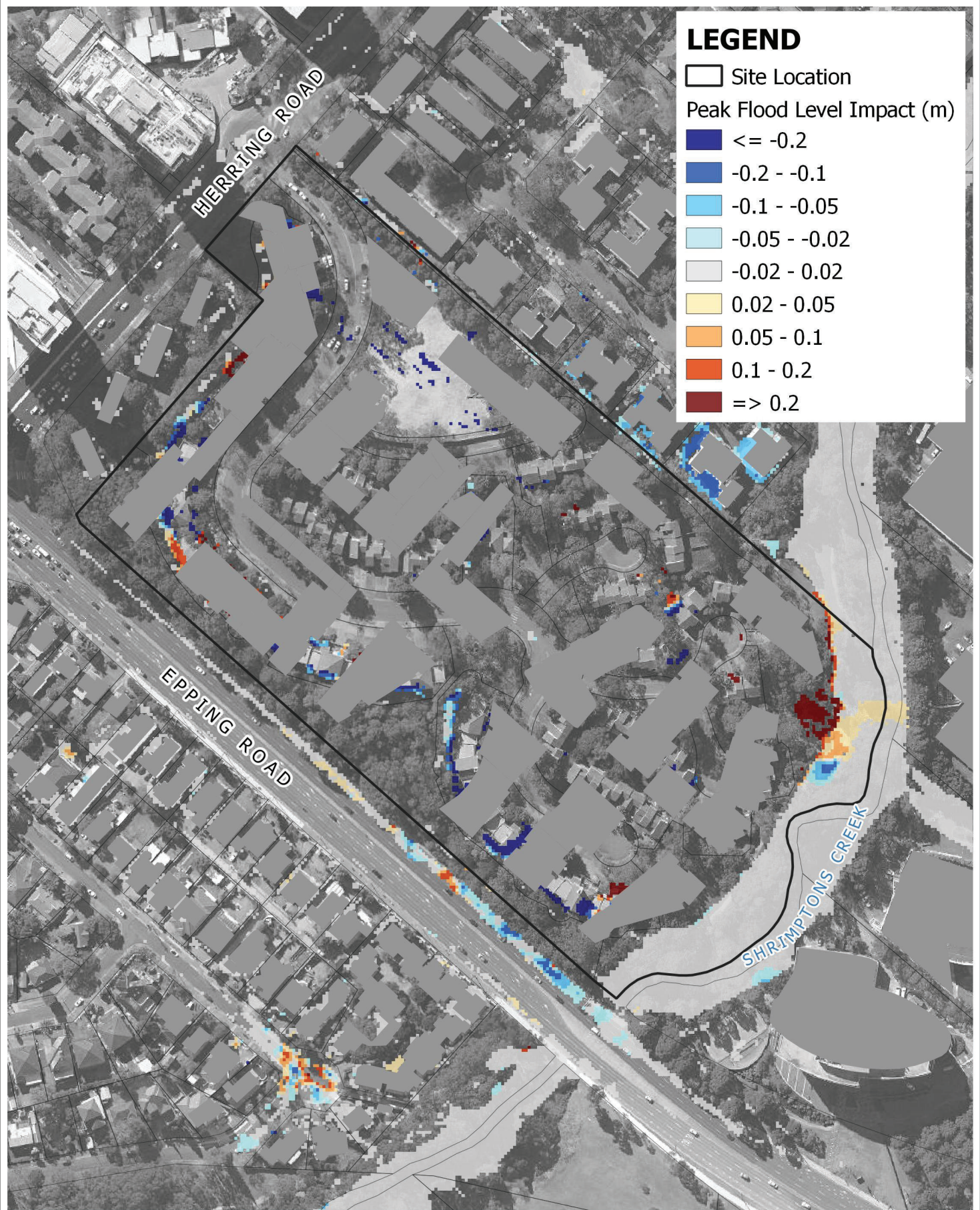
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Peak Flood Level Impact 1% AEP with Climate Change - Blockage Scenario

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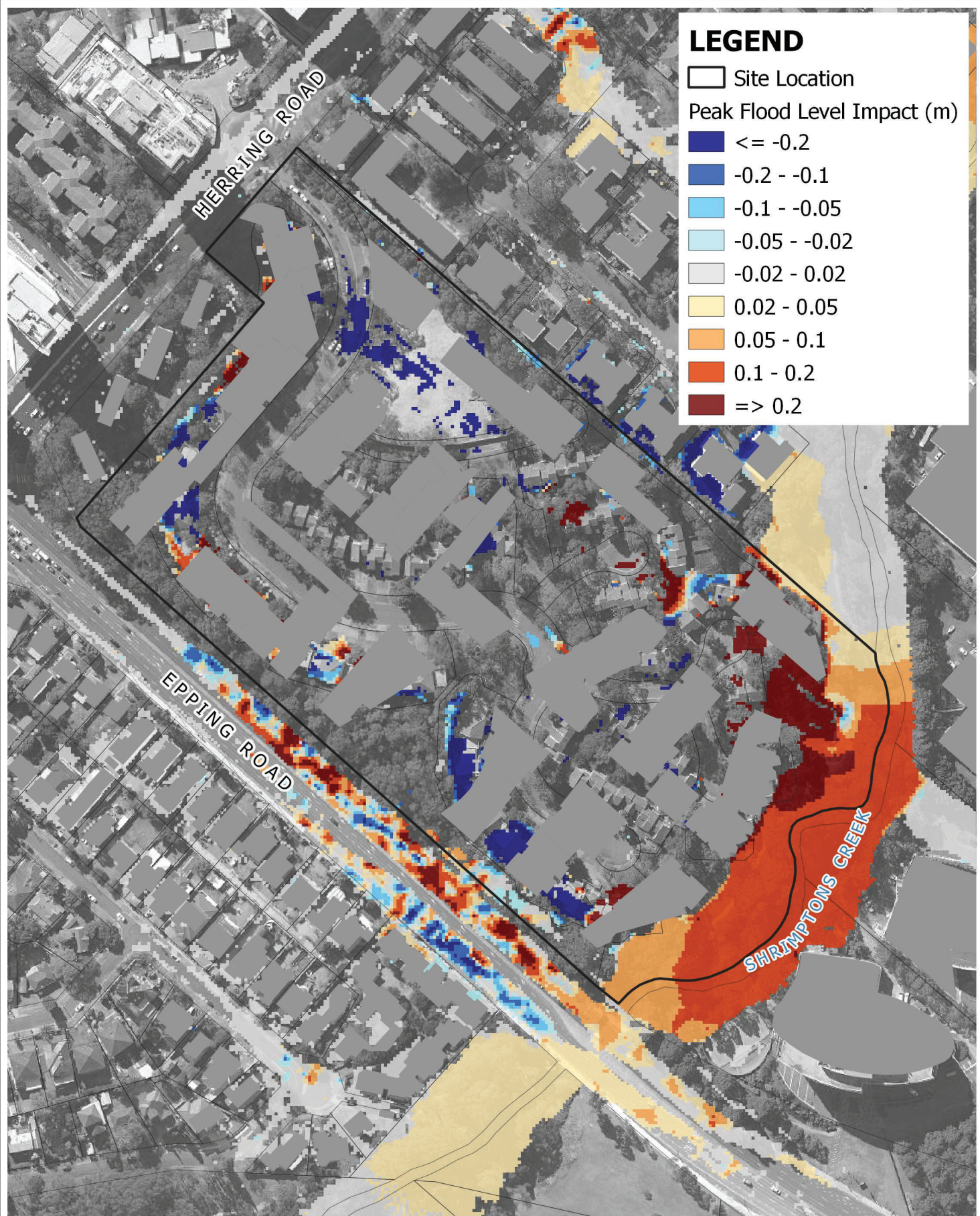
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Title:

Peak Flood Level Impact PMF Event

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