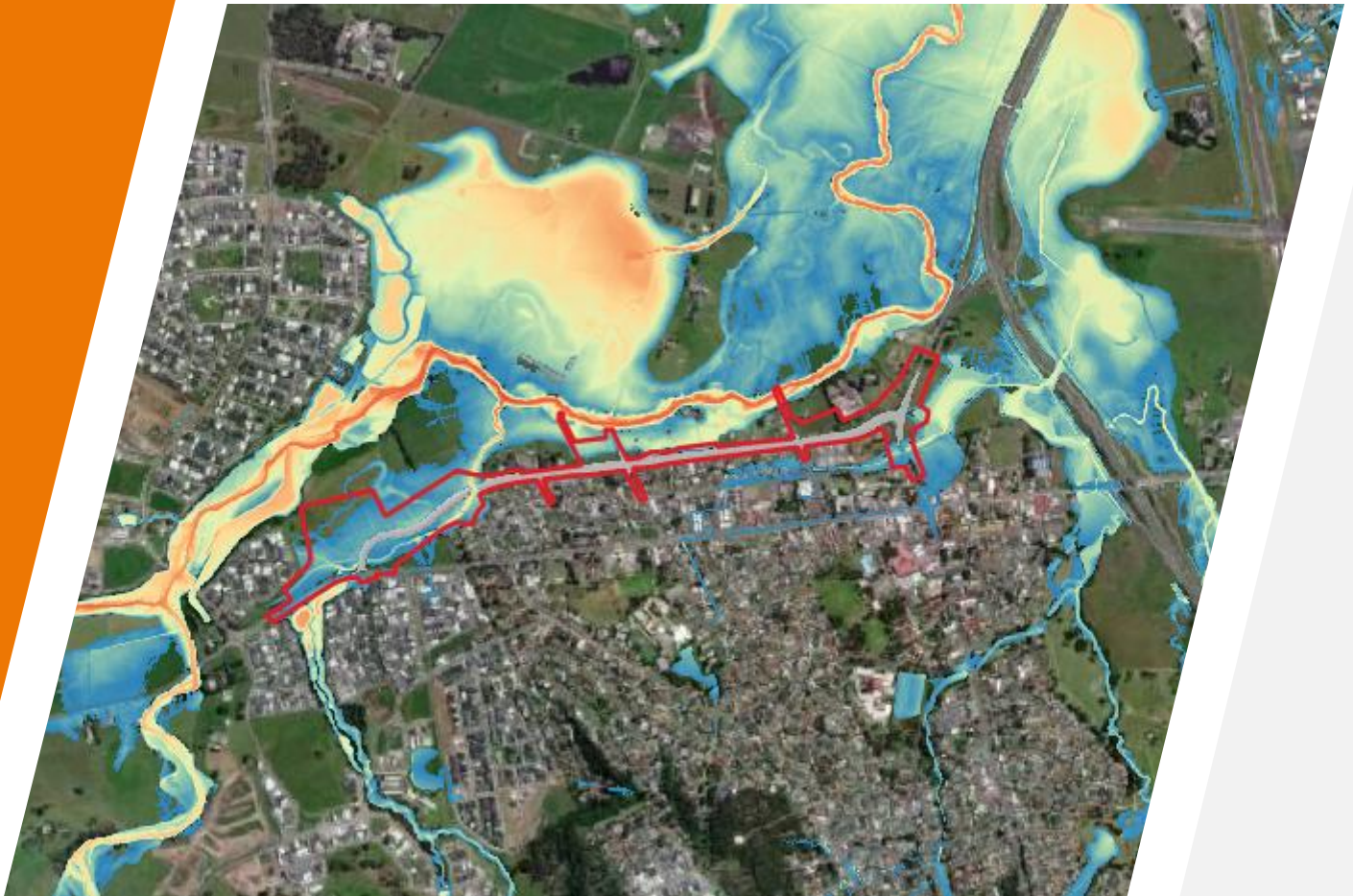




TRIPOLI WAY EXTENSION

FLOOD REPORT – 100% DESIGN UPDATE

V2.0

PREPARED FOR
SHELLHARBOUR CITY COUNCIL

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Prepared by:	Daniel Nikolich	Date:	04/11/2024
Reviewed by:	Karl Martin	Date:	06/11/2024
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List of Acronyms

Acronym	Description
AEP	Annual Exceedance Probability
DEM	Digital Elevation Model
GIS	Geographic Information System
LIDAR	Light Detection and Ranging
TWL	Top Water Level
DPE	Department of Planning and Environment
PMF	Probably Maximum Flood

1 INTRODUCTION

To support the design of the Tripoli Way Extension, and sizing of the proposed bridge and culvert system, Indesco received various iterations of the approved Macquarie Rivulet flood models. The models were verified to run correctly, and the appropriate additions and changes were to be made. Impacts of design on the surrounds are investigated within this report in terms of flood depth, flood velocity, flood hazards and flood impact mapping.

This memorandum highlights the changes from the 50% design iteration to the 100% design, and the resulting impacts as a result of the inclusions.

1.1 SUBJECT SITE

The proposed alignment encompasses the full length of the existing access roads north of Tongarra Road and extends from its intersection with Broughton Avenue in the west to Terry Street (Illawarra Highway, State Highway 25) in the east.

The area of works spans from Tullimbar through to the east of Albion Park, the site begins at the confluence of two tributaries into the Macquarie Rivulet. Yellow Rock Creek and Hazelton Creek to the west.



Figure 1-1 Locality Map

1.2 DESIGN STANDARDS

The flood investigation and design of the Tripoli Way have been undertaken in accordance with the following guides and standards:

- Shellharbour City Council DCP
- Shellharbour City Council Drainage Design Handbook
- Australian Rainfall and Runoff
- Austroads Guides to Road Design

1.3 EXISTING FLOOD STUDIES

The following flood studies have been received by Indesco and summarised in the following table.

Flood Study	Consultant
Macquarie Rivulet Flood Study: Final (2017)	WMA Water
Tripoli Way Bypass Concept Design: Flood Assessment; (2021)	Cardno
Macquarie Rivulet Flood Study: Model Update (2023)	WMA Water

1.4 EXISTING MODELS

Table 1 Received Previous Flood models.

Model Sources (Year)	Consultant
TUFLOW (2017)	WMA Water
WBNM (2017)	WMA Water
DRAINS (2021)	CARDNO
TUFLOW (2021)	WMA Water
TUFLOW (2023)	WMA Water

2 TUFLOW

2.1 HYDROLOGY

Hydrological inputs to this model have not changed from the base model and uses ARR1987 data generated from WBNM.

Inflow hydrographs included in the handover of the model include the 1% and 5% AEP (including relevant tidal events) for the critical 540-minute storm duration. The critical PMF event is the 120-minute duration as per the WMA Water report.

The data received included the TufLOW model and results from the WBNM hydrological model, but a copy of the WBNM model was not included. As such modelling undertaken within this project is limited to hydrological results of the events provided, which included the 1% AEP, 20% AEP, and PMF events for critical durations. A 2000-year event was not able to be produced without the hydrological model and where necessary structural analysis has considered the PMF in bridge design to compensate for the missing information providing a conservative approach to the design.

2.2 BASE MODEL

The latest model iteration (WMA 23) was used with the updated parameters and hydrology from the 2021 version. All existing components have been verified with provided results and files to confirm the correct operation of the received model. No parameters (excepting model grid size) have been altered and the complete model is confirmed to function. Original runtimes have been retained to keep consistent with the existing approved TUFLOW model.

The original hydrological model was not provided, only the hydrograph result outputs for use in the TufLOW model. As such no changes have been made to the project hydrology. This also means the

surface material of the proposed road is not incorporated as a change to hydrology. As the impact of the road is of a minor nature and the duration of peak flows from the road and incoming creeks are substantially different this is not considered critical to the results noting the critical durations are 540 minutes for 1% and 5% AEP, and 120 minutes for PMF.

Table 2 TUFLOW Model parameters

Parameter	
TUFLOW runtime	2020-10-AB
Coordinate System	GDA94; MGA56 ¹
Grid Size	3m
QUAD TREE	Nil ²
Critical Storm Duration ³	540 minutes
Blockage Factor	50%
Materials	Retained from original Model, see below

¹. As the flood model builds on previous iterations of the flood model that were prepared in GDA94, the CRS was not updated for the current project. The design and construction documentation however was prepared in GDA2020.

². Quad tree has been excluded from the current model iteration for consistency and compatibility with previous iterations of the TUFLOW software and model.

³. Three durations for the 1% AEP have been included in the received model, with the 540-minute duration being the critical event. All flooding at the road's design locations was determined by the tailwater level within the Macquarie Rivulet system.

2.2.1 Materials

The provided material properties have been retained from the original model, with no alterations to existing parameters. Mannings values are tabulated below.

Table 3 Model Material Parameters

Materials (Mannings Roughness – n)	Description
0.02	Roads/Pavements
0.04	Urban Residential and Commercial
0.05	Light Vegetation / Grass / Field - previously 0.035
0.03	Light Vegetation / Grass / Field Upper Catchment
0.07	Medium Vegetation / Crop / Plantation
0.1	Heavy Vegetation / Forest
0.09	Heavy Vegetation / Forest Upper Catchment
0.02	Concrete-lined Channel
0.03	Lightly Vegetated Channel
0.02	Lightly Vegetated Channel Upper Catchment
0.06	Heavily Vegetated Channel
0.025	Lightly Vegetated Channel downstream fish weir

Materials (Mannings Roughness – n)	Description
0.04	Open drains vicinity of Albion Park - prev 1D
Sensitivity test - Manning's Increase 20%	
0.024	Roads/Pavements
0.048	Urban Residential and Commercial
0.06	Light Vegetation / Grass / Field - previously 0.035
0.036	Light Vegetation / Grass / Field Upper Catchment
0.084	Medium Vegetation / Crop / Plantation
0.12	Heavy Vegetation / Forest
0.108	Heavy Vegetation / Forest Upper Catchment
0.024	Concrete-lined Channel
0.036	Lightly Vegetated Channel
0.024	Lightly Vegetated Channel Upper Catchment
0.072	Heavily Vegetated Channel
0.03	Lightly Vegetated Channel downstream fish weir
0.048	Open drains vicinity of Albion Park - prev 1D
Sensitivity test - Manning's Decrease 20%	
0.016	Roads/Pavements
0.032	Urban Residential and Commercial
0.04	Light Vegetation / Grass / Field - previously 0.035
0.024	Light Vegetation / Grass / Field Upper Catchment
0.056	Medium Vegetation / Crop / Plantation
0.08	Heavy Vegetation / Forest
0.072	Heavy Vegetation / Forest Upper Catchment
0.016	Concrete-lined Channel
0.024	Lightly Vegetated Channel
0.016	Lightly Vegetated Channel Upper Catchment
0.048	Heavily Vegetated Channel
0.02	Lightly Vegetated Channel downstream fish weir
0.032	Open drains vicinity of Albion Park - previous 1D
10	Bridge Piers - Test for non-DEM elements

2.3 MODEL ALTERATIONS

The table below summarises the changes to the base WMA 2023 model.

Table 4 Indesco 2024 Model Summary

Component	Description	Design Iteration
DEM	Tripoli Way 100% Design Tin and grading of floodplain areas adjacent outlets to Macquarie Rivulet.	100%

Component	Description	Design Iteration
2D Components	DEM modified to smooth culvert/creek outlet area as surface information was identified to reflect vegetation, not creek bed. The method used was a 2d z shape region, modifying file 2D_zshape_r. Updated material to incorporate 50% road design. Modified 2D_materials_R;	50%
1D Components	Culverts added including inlets and outlets at western section of design road. File modified 1D_Culverts_L;	50%
1D Components	Full road Drainage and Culvert outlets	100%
DEM	Additional Survey	80%
Grid Size	Grid size changed to 4m; More efficient integration of 12D models without loss of result resolution.	25%
2D Components	Layered Flow Constriction method applied for bridge modelling.	80%
Materials (manning's)	Additional parameter to model bridge piers	50%

2.3.1 DEM

The Tripoli Way Extension DEM is illustrated in the surface map presented in Figure 2-1. The DEM is a layered surface combining topographical data in order of priority final design, survey, and Lidar.



Figure 2-1 TUFLOW DEM Surface Map

Updated features from the 50% submission include barriers, a refined road design, inclusion of updated surveys, and additional grading adjacent the floodway outlet to Macquarie Rivulet near road CH1340.

2.3.1.1 Smoothing

Areas of interest were analysed for clarity and accuracy of Lidar data such as inlets and outlets of pipe and culvert systems and creek beds. Where clear inaccuracies were identified representative of vegetation being captured rather than surface data comparison was made between data sets and smoothing applied where a corrected profile could confidently be ascertained.

As identified in Table 4, a smoothing surface shape was used to correct LIDAR in the area adjacent culvert inlets and outlets. Adjacent points of elevation were used to interpolate the vertical alignment of the creek bed and reflect removal of vegetation during construction of the culvert.

The roughness of the area was also applied using a materials layer with a manning's value of 0.048 - designated in the materials file as a heavily vegetated channel to reflect the likely worst case future conditions.

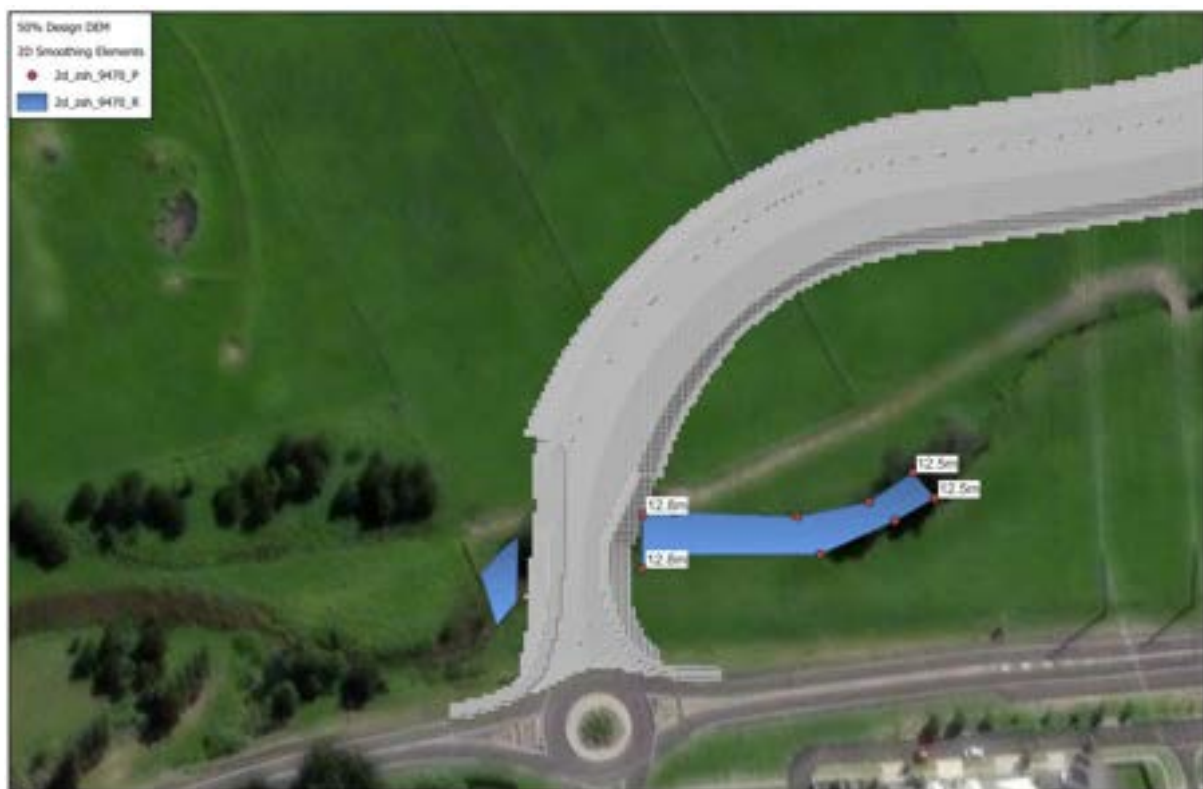


Figure 2-2 TUFLOW 2D Model.

2.3.2 1D Networks

The piped 1D network throughout the roadway in addition to the under road culverts have been included consistent with the 100% design, to show effectiveness of the drainage system, and identify any downstream flooding impacts of all design elements. All internal road draining inlets and outlets have been included within the flood model.

The bridge element is modelled as a layered flow constriction shape file to allow the ability to apply variable blockage cases to the bridge and is shown in Figure 2-3.



Figure 2-3 Hydraulic Structures Upstream Culvert

2.3.3 Bridge Modelling

The proposed bridge is modelled as a layered flow constriction element comprised of geometric representation of the pylons, abutments, superstructure span, and the railings/barriers on top of the bridge.

Flow constriction parameters within the model are as recommended by TUFLOW documentation and blockage factors are summarised as follows.

- Pylons (sub structure) - 50% blockage
- Bridge Superstructure - 100% Blockage
- Railing/Barriers - 100% Blockage.

3 BRIDGE DESIGN

Scenarios modelled in the bridge design include the following events:

- 5% AEP with 1% AEP tidal effects 540-minute duration
- 1% AEP with 5% AEP tidal effects; 540-minute duration
- PMF event with 1% AEP tidal effects 120-minute duration

The bridge has been designed to comply with the requirements of the Shellharbour Drainage Design Handbook (July, 2019). Specifically, the hydraulic design requirements stipulated under “Large Hydraulic Structures” (page 13) noting:

- All large hydraulic structures shall be designed for the 1% AEP storm event without increasing afflux and / or velocities of flow in urban areas.
- The effects of the Probable Maximum Flood (PMF) shall be investigated during the design of the major structures and where necessary, the design may require to be modified accordingly

to ensure that the failure of the major structure will not result in human injury, loss of life and property damage.

- A minimum clearance of 0.5m between the 1% AEP flood level and the underside of any major structure is required to allow for passage of debris without blockage.
- The design of large hydraulic structures shall be structurally certified. As such, a structural certification, prepared by a practicing NPER registered structural engineer, shall be submitted to Council. It should be noted that all bridges shall be structurally designed in accordance with AS (NZS) 5100:2017.
- All major structures shall be designed to facilitate the movement of fauna and comply with flora and fauna requirements imposed by the other government agencies.
- Bridges shall be designed in accordance with the Austroads publications - Guide to Bridge Technology.

The free board requirement has been calculated as the flood height for the 1% AEP event + 0.5m to the underside of the soffit of the bridge superstructure. All bridge modelling and design has been undertaken and reported inclusive of a 50% blockage factor.

The flood depth and velocity have been assessed and used to inform the structural design of the bridge. The structural design of the bridge requires assessment of the flood depth and velocity in the 1 in 2000 year event. As the 1 in 2000 year data and hydrological model were not available, or able to be replicated without the hydrology model, the PMF has been utilised as a conservative alternative. Results are presented in section 4.6.

3.1 BRIDGE DESIGN PARAMETRES

Summarized below are the considerations used for the bridge design. Maximum flood velocities, flood depths and flood levels are tabulated below.

Item	Event	Result (Maximum)
Flood Depth	1% AEP	3.30m
Flood Height	1% AEP	12.94m. A.H.D.
Flood Velocity	1% AEP	1.65m/s
Freeboard Level	1% AEP	13.44m. A.H.D.
Minimum Soffit Level	Freeboard	13.44m. A.H.D.
Flood Depth	PMF	5.32m
Flood Height	PMF	14.95m A.H.D.
Flood Velocity	PMF	1.87m/s

4 RESULTS

The following sections present the findings from the TUFLOW hydraulic modelling including flood depth, velocity, hazard and impact for the 5% AEP, 1% AEP and PMF conditions in the applicable critical durations. Further mapping in higher resolution is attached under Appendix A of this report.

Results are summarised per event for direct comparison of existing and design conditions for each scenario.

4.1 1% AEP

The design event for the project is the 1% AEP. This has been used to determine required levels and freeboard for the road and bridge works, and to assess flood impact to surrounding land.

4.1.1 Flood Depth

Flood depth maps and comparisons from existing to design conditions are presented in the following sections.

4.1.1.1 Existing Scenario

Flood conditions in the immediate vicinity of the western portion of the site adjacent the connection to Illawarra Hwy show large areas of inundation up to approximately 100mm of depth in the broader floodplain outside the extent of residential dwellings. Isolated pockets of flood inundation occur in residential areas in both existing and design conditions and depths ranging from 1m to 3m occur within Hazelton Creek.

In the central area of the design, flood depths within the floodplain range from 2m to 3m, with depths up to 8m within the primary Macquarie Rivulet creek invert.



Figure 4-1 Flood Depth Map - 540m Duration - Existing Scenario - 1% AEP



Figure 4-2 Flood Depth Map - 540m Duration - Existing Scenario - 1% AEP - West



Figure 4-3 Flood Depth Map - 540m Duration - Existing Scenario - 1% AEP - Central

Figure 4-4 presents the eastern area of the site leading to the eastern T-intersection with Illawarra Hwy. The area in the vicinity of the Illawarra Hwy intersection shows an already inundated area with flood depths in excess of 2m at the inlet into Frazer's Creek.



Figure 4-4 Flood Depth Map - 540m Duration - Existing Scenario - 1% AEP - East

4.1.1.2 Design Scenario

The most significant change to flood behaviour occurs as a result of the diversion of flood water to the west of the Tripoli Way extension embankment adjacent the roundabout connection to Illawarra Hwy.

A triple cell box culvert is proposed under the new road embankment which diverts a portion of flow through the existing creek line catering to frequent flows, while more severe storm flows are diverted around the road as overland flow within the floodplain to the west and north of the Tripoli Way extension.

Fundamentally, this does not affect the flow regime of the broader area as both flow paths reach the same confluence point as the existing scenario a short distance downstream, discharging to the same location in the Macquarie Rivulet.

There is no discernible increase in flood levels in residential areas, as shown in Section 4.2.



Figure 4-5 Flood Depth Map - 540m Duration - Design Scenario - 1% AEP

Figure 4-6 shows an increase in flood levels to the west of the Tripoli Way extension, with flood water encroaching on the access road adjacent Brushgrove Circuit. A small inlet into Hazelton Creek is inundated as a result, with no flood waters encroaching upon residential property and a minimum height different of 0.86m from top of flood water to top of the edge road. A section is shown in Figure 4-6.

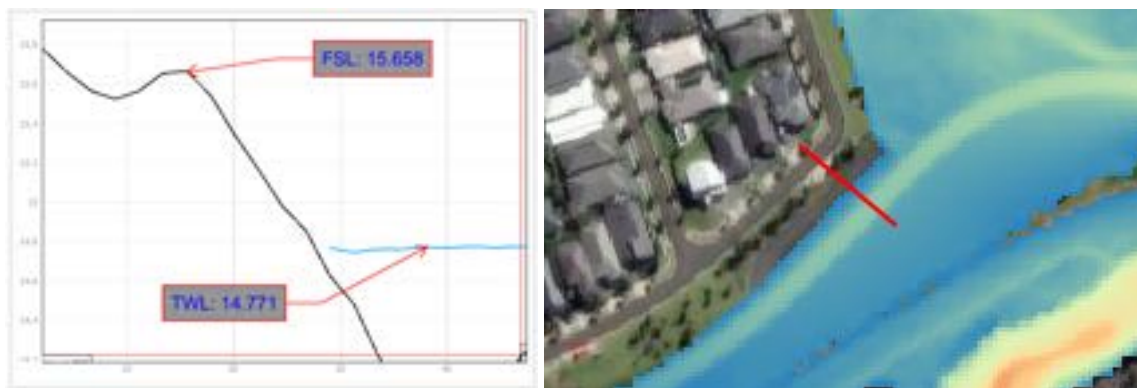


Figure 4-6 Section 1: Minimum Height Comparison



Figure 4-7 Flood Depth Map - 540m Duration - Design Scenario - 1% AEP - West



Figure 4-8 Flood Depth Map - 540m Duration - Design Scenario - 1% AEP - Central

A minor difference in flood conditions occurs around the eastern intersection with Illawarra highway. Figure 4-9 shows a slight change in flood depths occurring in the culvert crossing north of the intersection and at the flow path south of the intersection. Neither of these changes any tangible impacts other than

localised changes of less than 100mm of existing flow paths extending to small areas of impact only. No discernible changes to flood behaviour occur beyond the immediate area upstream or downstream.



Figure 4-9 Flood Depth Map - 540m Duration - Design Scenario - 1% AEP - East

4.1.2 Flood Velocity

4.1.2.1 Existing Scenario

Flood velocities through the subject site are predominantly under 2.0m/s, with some culvert and creek outlets showing the 2.0m/s or higher. Higher velocities in the vicinity of the works occur north of the site within the rivulet system, especially adjacent to the central to eastern portion of the site.

While the depth of flow is substantial in many areas of the site and surrounding region, relatively low velocity is observed due to the area being a slow-moving floodplain with high tailwater conditions rather than flash flow in waterways.

At the eastern intersection to Illawarra Hwy, the existing flood velocity is under 1.0m/s and the flow path is confined to the inlet into Frazer's Creek.

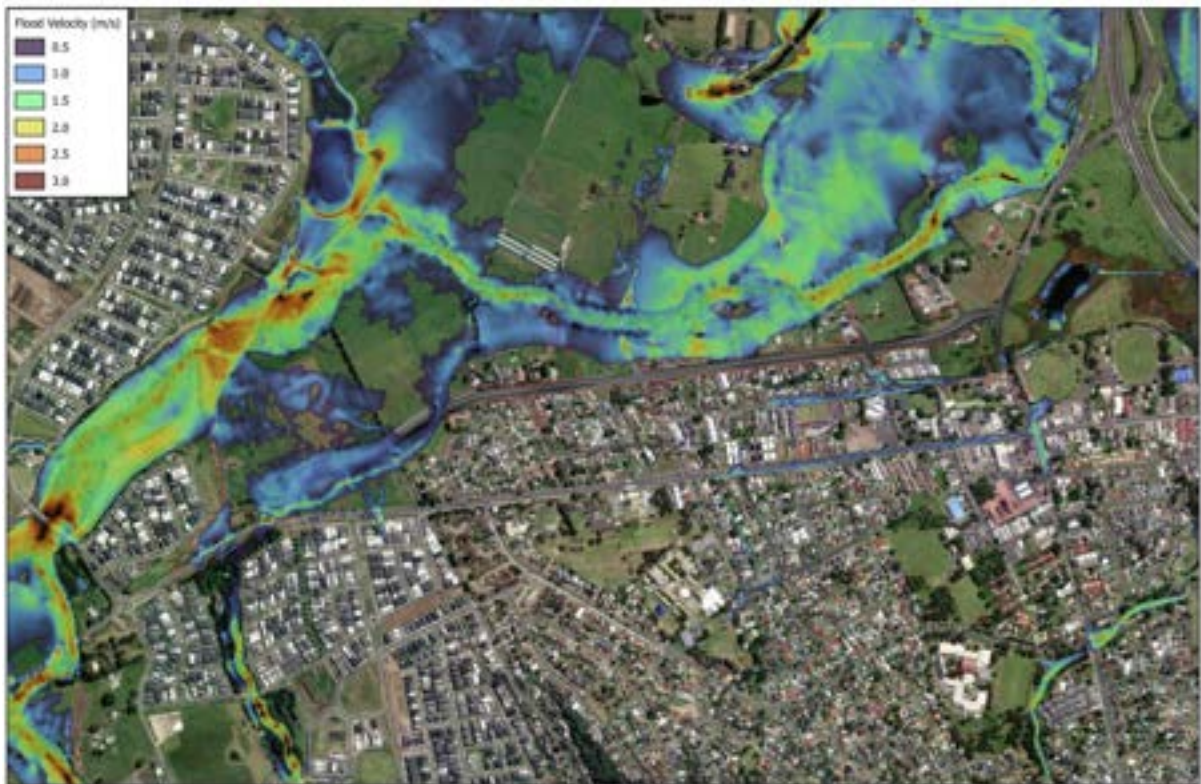


Figure 4-10 Flood Velocity Map - 540m Duration - Existing Scenario - 1% AEP

Figure 4-11 shows the western intersection to Illawarra Hwy is generally located in an area of low velocity averaging in the range of 1.0m/s. A small pocket of velocity exceeds 2.5m/s in the existing creek inlets and outlets to the west of the roundabout.

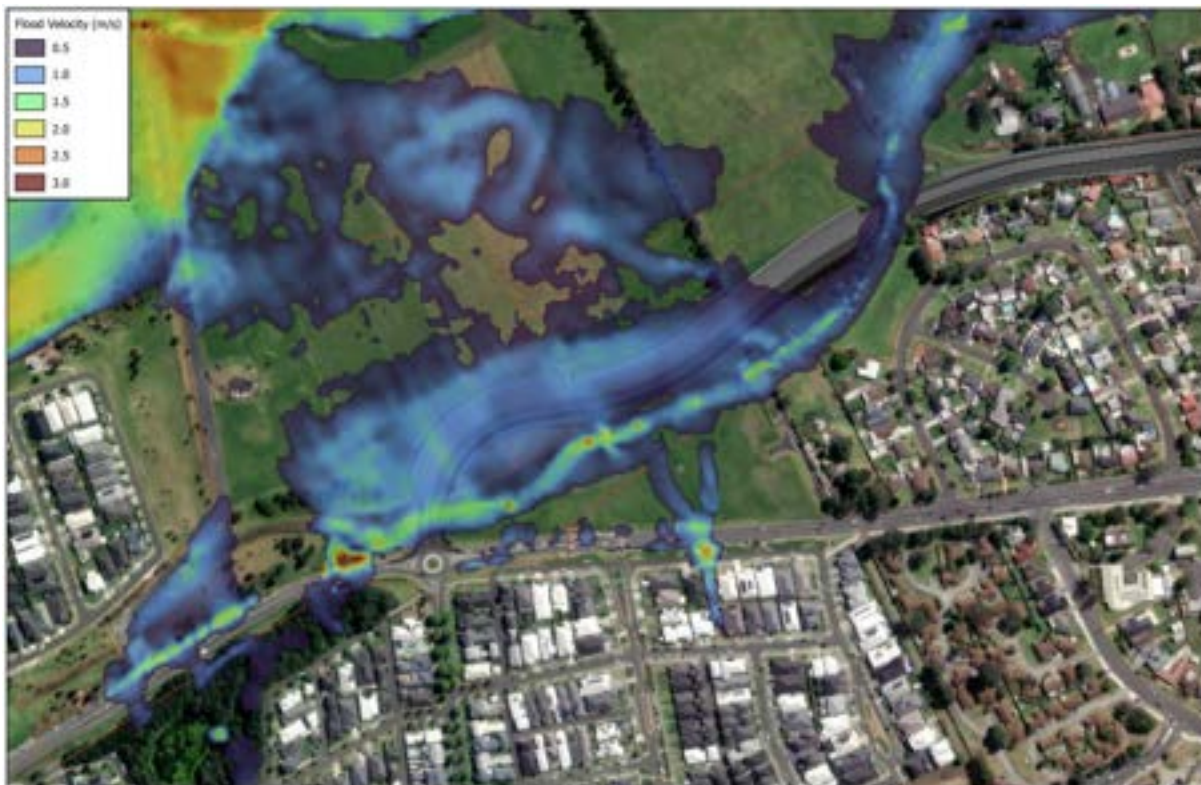


Figure 4-11 Flood Velocity Map - 540m Duration - Existing Scenario - 1% AEP - West

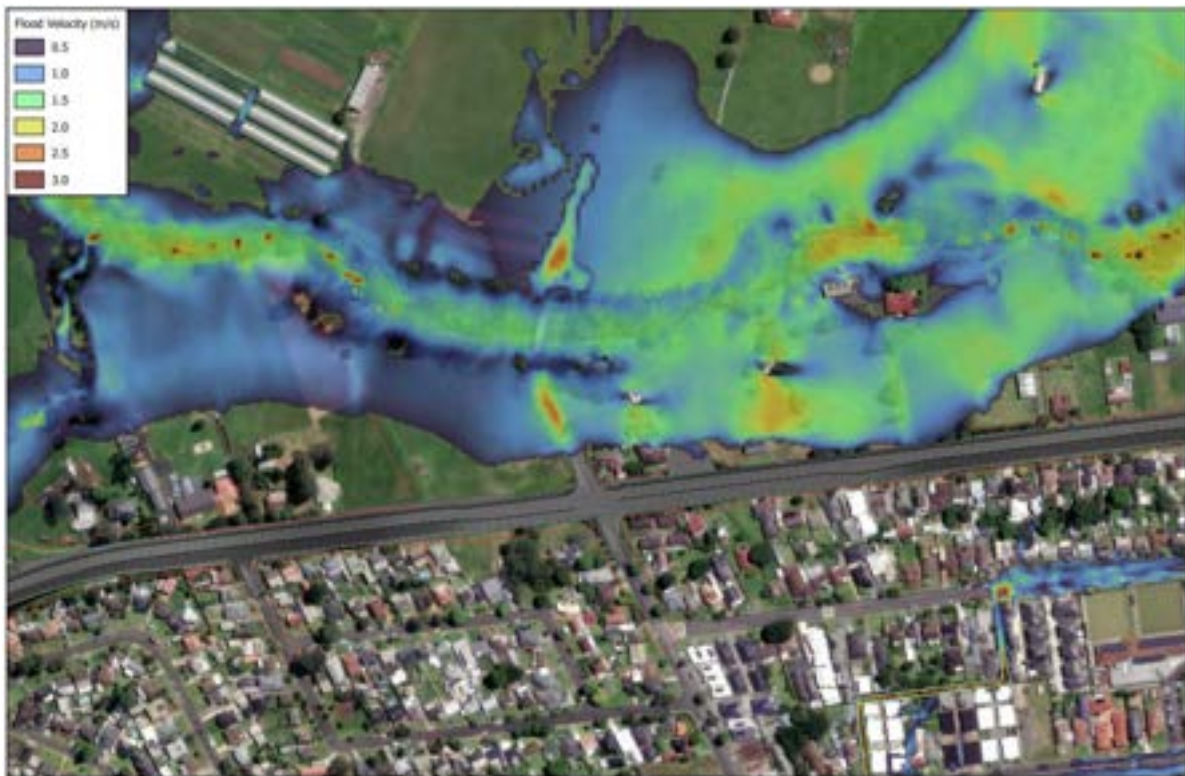


Figure 4-12 Flood Velocity Map - 540m Duration - Existing Scenario - 1% AEP - Central

Figure 4-12 shows velocities along the central stretch of design road. No velocities over 0.5m/s encroach the proposed design road however higher velocities are observed directly north within the floodplain.

The eastern connection to Illawarra Hwy is located in an area of low velocity flow with conditions only exceeding 1m/s at the road crossing south of the intersection with the Illawarra Highway Figure 4-13.

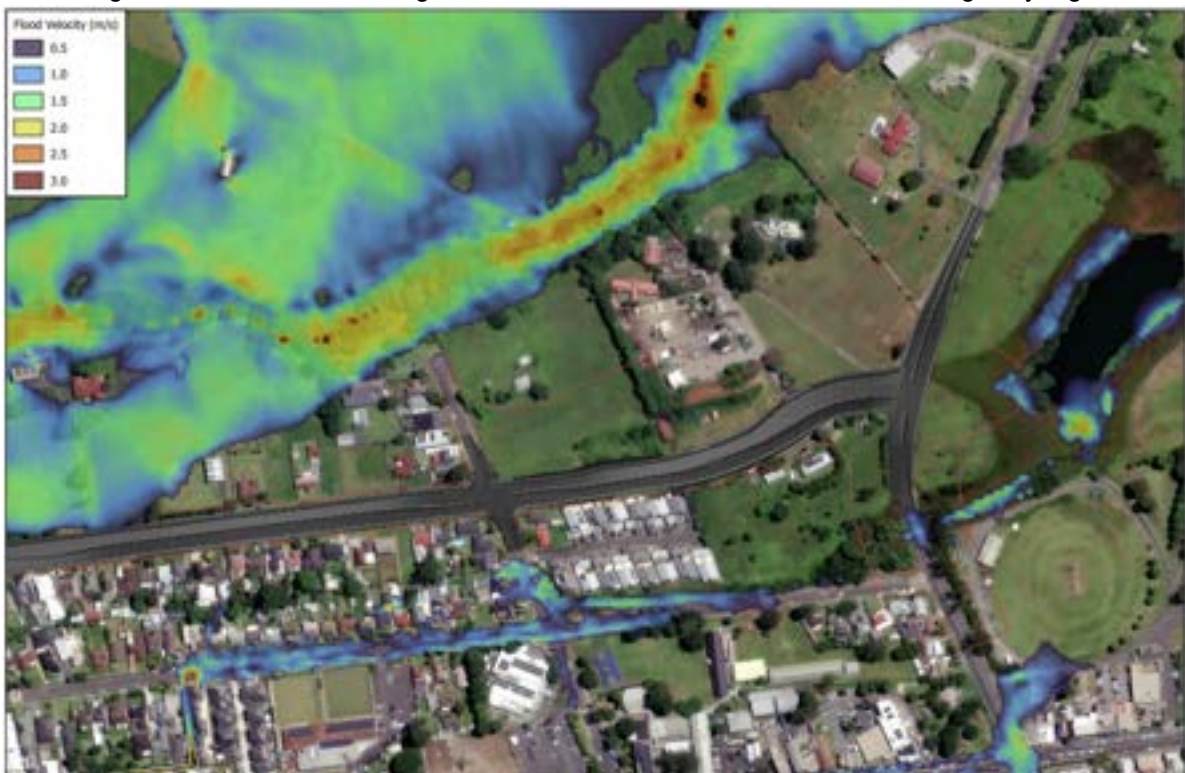


Figure 4-13 Flood Velocity Map - 540m Duration - Existing Scenario - 1% AEP - East

4.1.2.2 Design Scenario

The design shows a considerable change in the western end of the designed Tripoli Way extension and minor change near the eastern intersection. Figure 4-15 shows a change of flow conveyance path within the flood plain, and velocities maintaining a similar same range of approximately 1.0m/s with slight variations within the area. The area of road and culvert crossing Hazelton Creek remains in the same velocity range, and slightly reduced velocities are observed at the bridge crossing.

Figure 4-17 demonstrates negligible change to flow velocities in the eastern region of the design.

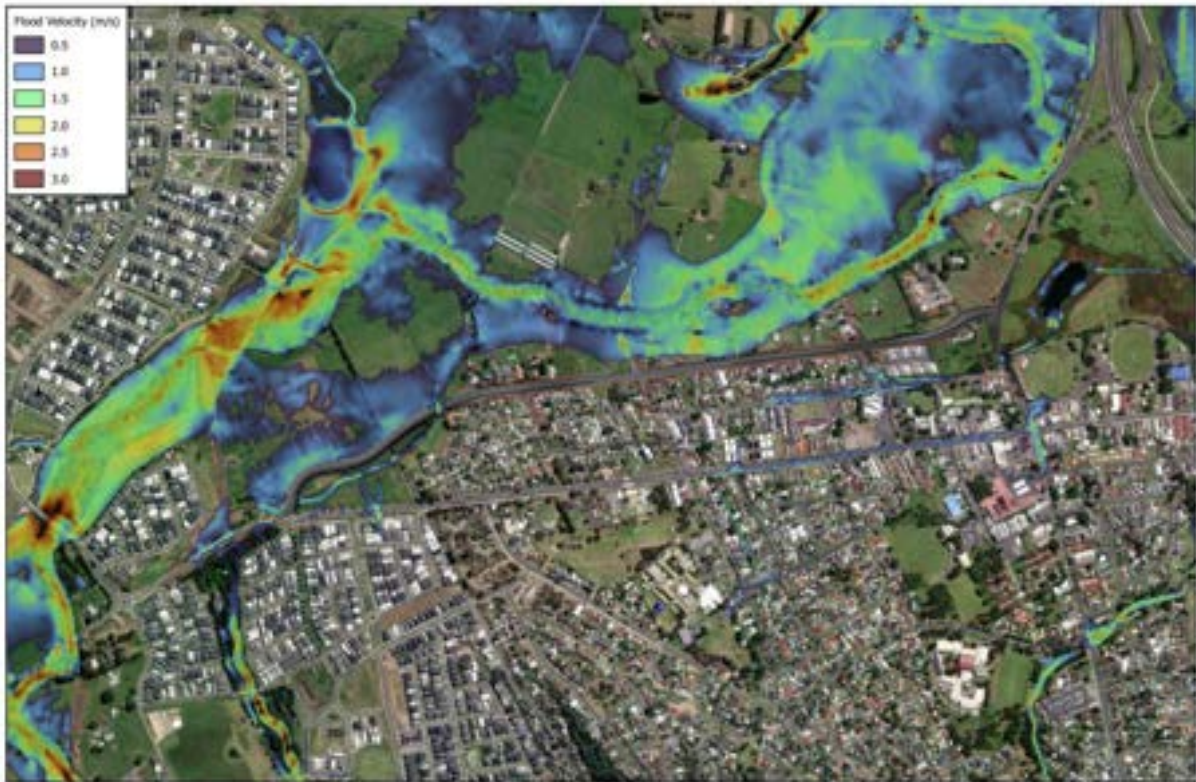


Figure 4-14 Flood Velocity Map - 540m Duration - Design Scenario - 1% AEP

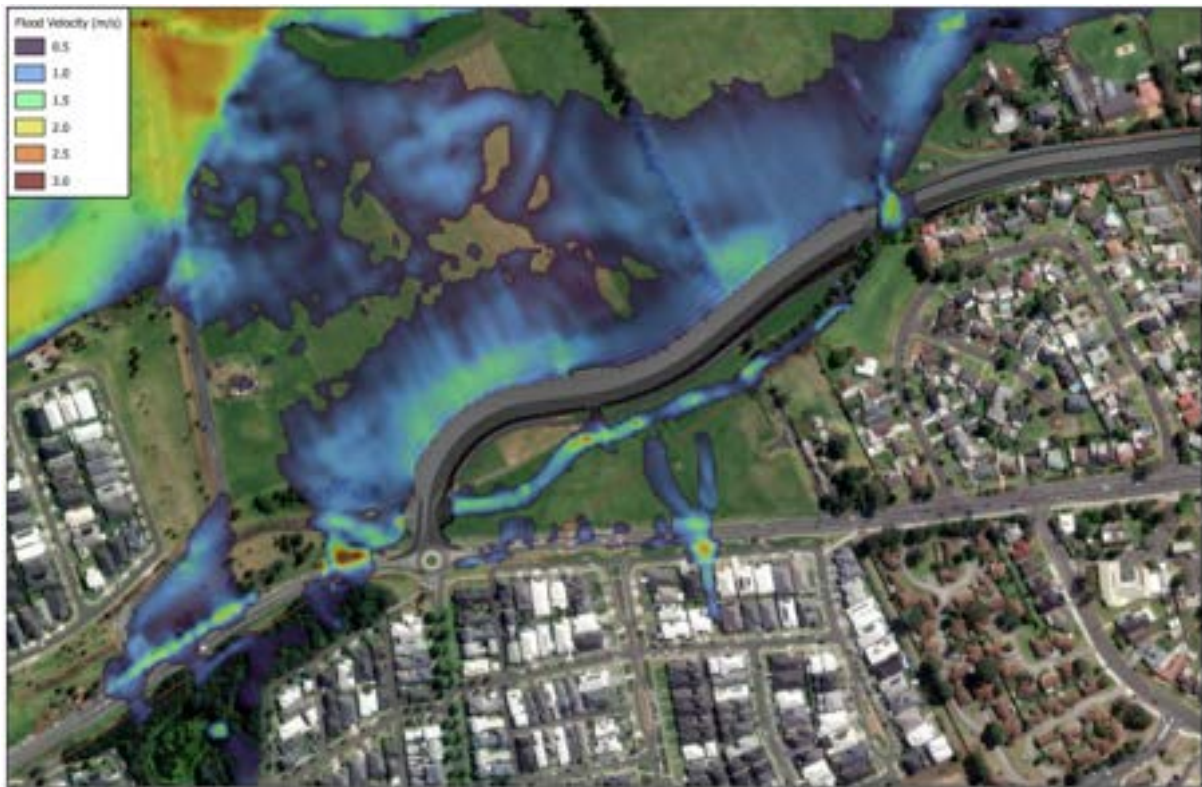


Figure 4-15 Flood Velocity Map - 540m Duration - Design Scenario - 1% AEP - West

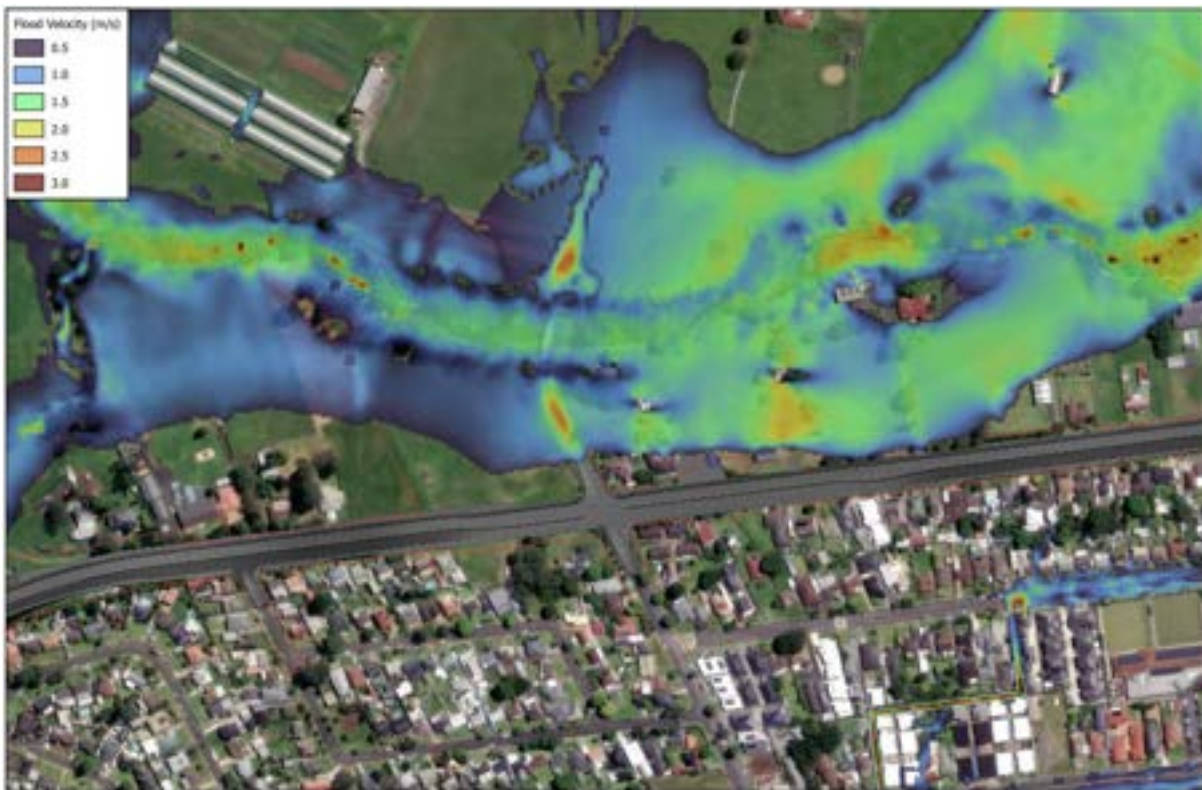


Figure 4-16 Flood Velocity Map - 540m Duration - Design Scenario - 1% AEP - Central

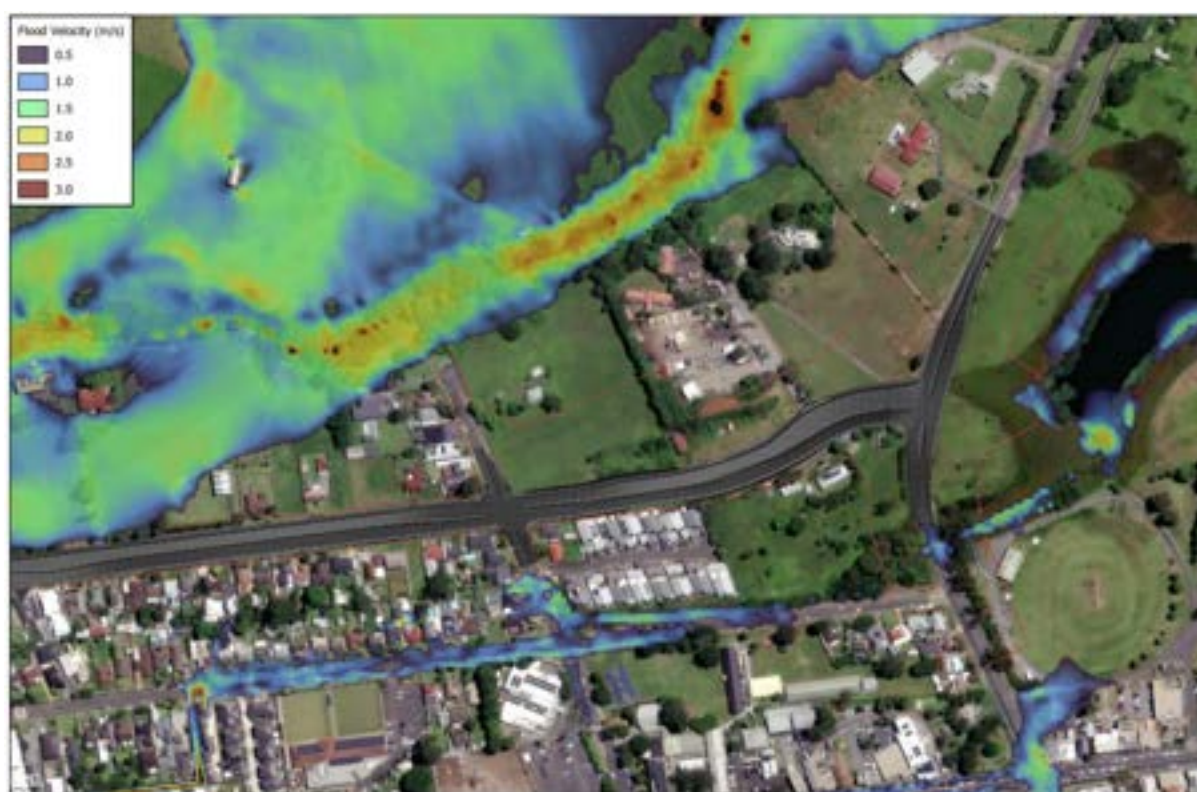


Figure 4-17 Flood Velocity Map - 540m Duration - Design Scenario - 1% AEP - East

4.1.3 Flood Hazard

The flood Hazard mapping follows the categories set out in the DPE document “FLOOD HAZARD: Flood Risk Management Guide FB03” (2022). The categories are as follows, from Figure 1 and Table 1 Respectively.

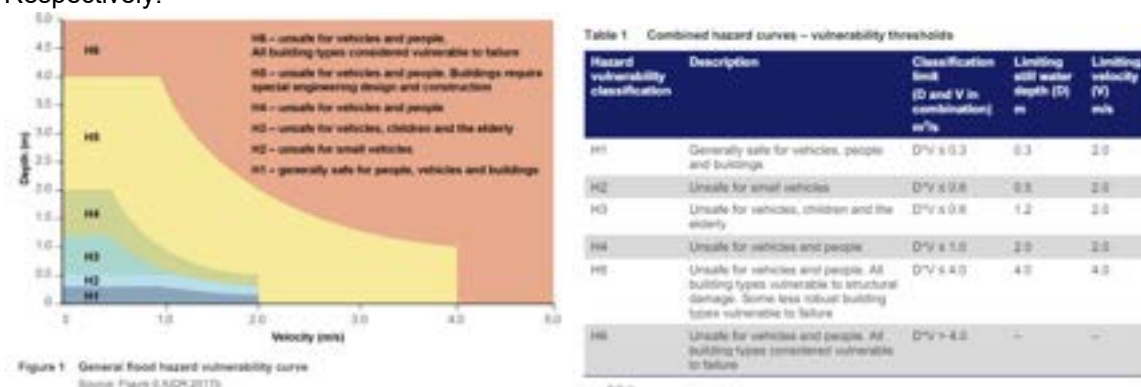


Figure 4-18 Flood Risk Manage Guide Extracts (DPE, 2023)

Figure 4-19 through to Figure 4-26 show the Flood Hazard Mapping for the 1% AEP storm event. Most areas of concern (categories H3 to H6) are confined to inlets and tributaries along the Macquarie Rivulet.

4.1.3.1 Existing Scenario

The area of the western intersection to Illawarra Hwy is subject to overland flow hazard in the existing condition. Small encroachments in the central area of design, and to the south of the eastern intersection with Illawarra Hwy are also affected by flood hazard to a lesser extent.

Higher flood hazards are present within the Macquarie Rivulet and Hazelton Creek which reach the H5 flood category.



Figure 4-19 Flood Hazard Map - 540m Duration - Existing Scenario - 1% AEP

Figure 4-20 shows large areas of hazard within the existing flood prone areas adjacent to Hazelton creek, with H4 and H5 hazard areas being present around the creek invert. Figure 4-21 demonstrates minor encroachments of H1 hazard category within the design road footprint. Figure 4-22 shows that the eastern intersection has areas of H1 hazard within the intersection and to the south.



Figure 4-20 Flood Hazard Map - 540m Duration - Existing Scenario - 1% AEP - West



Figure 4-21 Flood Hazard Map - 540m Duration - Existing Scenario - 1% AEP - Central



Figure 4-22 Flood Hazard Map - 540m Duration - Existing Scenario - 1% AEP - East

4.1.4 Design Scenario

The design provides improvement to the residences close to the western connection and reduces the flood hazard along Hazelton Creek.

The design footprint of the Tripoli Way extension is immune from flood hazard. The residences in the west benefit from a reduction in flood hazard, residences to the north of the central span and eastern connection remain in the same hazard category as the existing scenario.

Figure 4-24 shows the reduction of flood hazard within the residences, and a change in H1 to H3 hazard category within areas of the flood plain. The interface to Brushgrove Circuit remains unaffected by flood hazard, and the adjacent access road is in flood hazard category H1, making it safe for vehicles in the 1% AEP event.

No major changes are present in the remaining areas.



Figure 4-23 Flood Hazard Map - 540m Duration - Design Scenario - 1% AEP



Figure 4-24 Flood Hazard Map - 540m Duration - Design Scenario - 1% AEP - West



Figure 4-25 Flood Hazard Map - 540m Duration - Design Scenario - 1% AEP - Central



Figure 4-26 Flood Hazard Map - 540m Duration - Design Scenario - 1% AEP - East

4.2 FLOOD IMPACT MAPPING 1% AEP

Flood impact mapping demonstrates the afflux; defined as the difference of flood depth between design and existing conditions. This report compares flood afflux as a measurement between depth of existing and depth of design in terms of flood depth. Unless otherwise stated all maps relate to a comparison of flood depth (measured to respective ground surface) rather than flood height (maximum water elevation). This measurement may present a difference in flood depth occurring in regions of identical flood height due to changes in final surface levels.

The design road and all surrounding areas, including downstream into Lake Illawarra, were compared. Two areas of notable change are identified near the western intersection with Illawarra Hwy, and near Chainage 1340 of the proposed Tripoli Way Extension works. Impacts are observed elsewhere in the project, however are generally of an insignificant nature in isolated areas.

Flood impact mapping includes a wet and dry analysis, highlighting areas that have changed state when comparing existing to design i.e. areas that were completely dry becoming wet and vice versa.

4.2.1 1% AEP

Figure 4-27 shows the change of flood depth which is most significant on the western extents of the design road. Areas of the floodplain are observed with an area increase of up to 200mm in depth due to the reduced flow through Hazelton Creek. This results in a reduction in flow depth to the residences towards the east.

Although there is an increase in flood depth to the west, as this area is already floodplain this is not considered an issue.



Figure 4-27 Flood Impact Map - Design v. Existing - 1% AEP Site Wide



Figure 4-28 Flood Impact Map - Design v. Existing - 1% AEP West

At CH1340 flood impact mapping shows a reduction in the levels on the road at the new pit and pipe network, with no major increase in flood levels outside of the floodway grading. A small zone of positive afflux at the southwestern interface of the Tripoli Way Extension shows a maximum positive flood impact

of 20-30mm. The area of afflux is located within a zone with a depth of inundation exceeding 2m in the existing 1% AEP, the increase in flood depth is approximately 1% of the total depth and considered insignificant.

Three additional areas of positive afflux are observed in comparison of flood depth between existing and design scenarios. This however represents the change of depth responding to changes in ground surface level rather actual flood top water level.

The top water level is largely unchanged in these regions other than minor fluctuations. A flood impact map comparing flood height to height is presented in Figure 4-30.



Figure 4-29 Flood Impact Map - Design v. Existing - 1% AEP Central (Depth to Depth)



Figure 4-30 Flood Impact Map - Design v. Existing - 1% AEP Central (Height to Height)

The increase in road elevation adjacent the eastern intersection with Illawarra Hwy results in a reduction in water depth on the road and small increases to the west of the road embankment as per Figure 4-31.



Figure 4-31 Flood Impact Map - Design v. Existing - 1% AEP East

4.3 5% AEP

As the road has been designed for immunity to 1% AEP events and to generate no negative impacts to the surrounding area, design criteria in a 5% AEP is also achieved.

Mapping of the 5% AEP depth, velocity, hazard, and impact are summarised in the following sections for information.

Additional mapping of the 5% AEP is presented under Appendix A.

4.3.1 Flood Depth

4.3.1.1 Existing Scenario



Figure 4-32 Flood Depth Map - 540m Duration - Existing Scenario - 5% AEP



Figure 4-33 Flood Depth Map - 540m Duration - Existing Scenario - 5% AEP West

4.3.1.2 Design Scenario



Figure 4-34 Flood Depth Map - 540m Duration - Design Scenario - 5% AEP



Figure 4-35 Flood Depth Map - 540m Duration - Design Scenario - 5% AEP West

4.3.2 Flood Velocity

4.3.2.1 Existing Scenario



Figure 4-36 Flood Velocity Map - 540m Duration - Existing Scenario - 5% AEP

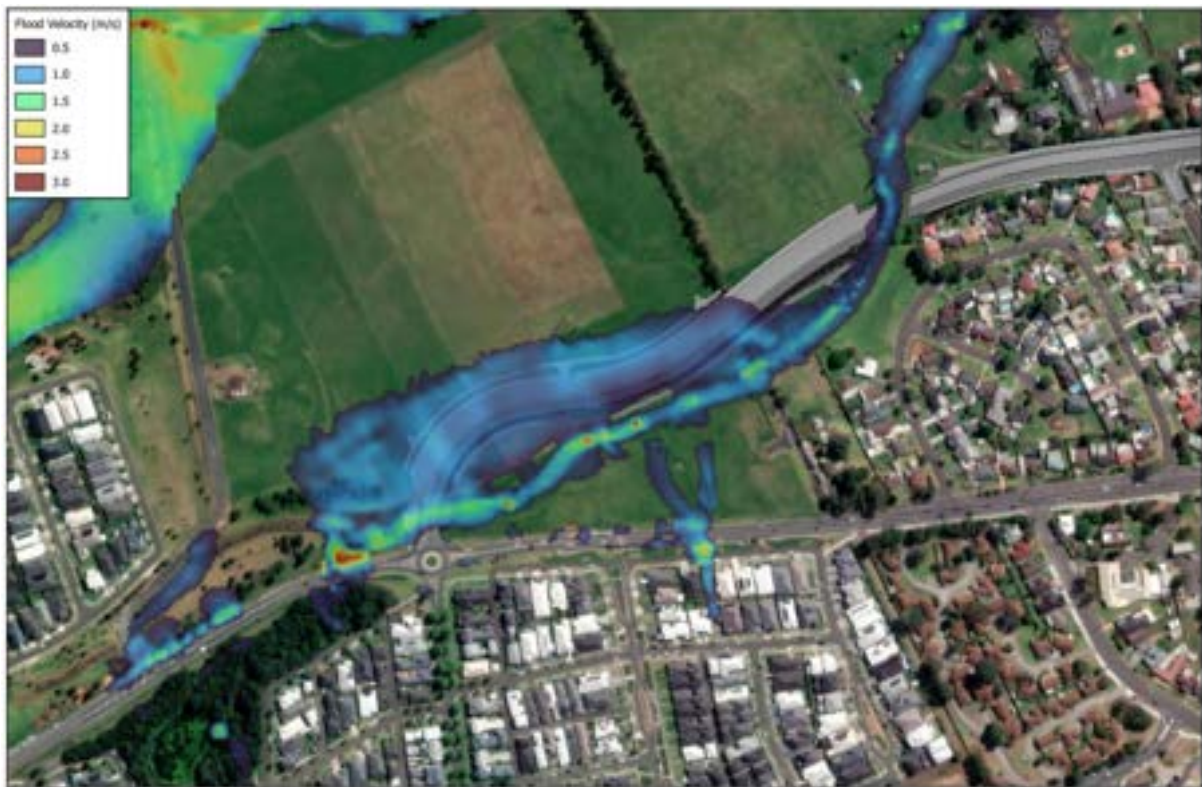


Figure 4-37 Flood Velocity Map - 540m Duration - Existing Scenario - 5% AEP West

4.3.2.2 Design Scenario



Figure 4-38 Flood Velocity Map - 540m Duration - Design Scenario - 5% AEP



Figure 4-39 Flood Velocity Map - 540m Duration - Design Scenario - 5% AEP West

4.3.3 Flood Hazard

4.3.3.1 Existing Scenario



Figure 4-40 Flood Hazard Map - 540m Duration - Existing Scenario - 5% AEP



Figure 4-41 Flood Hazard Map - 540m Duration - Existing Scenario - 5% AEP West

4.3.4 Design Scenario



Figure 4-42 Flood Hazard Map - 540m Duration - Design Scenario - 5% AEP



Figure 4-43 Flood Hazard Map - 540m Duration - Design Scenario - 5% AEP West

4.3.5 Flood Impact 5% AEP

The minor storm shows a large area of impact, with increasing flood waters in the tributaries to Hazelton and Frazer Creek when comparing to the existing event. These are not shown in the 100% event as the flood level exceeds the creek obvert level in both the design and existing scenarios whereas it is not completely inundated in the minor events.

There is an increase in flood depth in the floodplain near the western intersection with Illawarra Hwy of similar magnitude as the 1% AEP, but to a reduced extent.

Afflux at the eastern end of the proposed road is insignificant in the minor event, the average increase in flood depths throughout the greater catchment is less than 1mm.



Figure 4-44 Flood Impact Map - Design v. Existing - 5% AEP



Figure 4-45 Flood Impact Map - Design v. Existing - 5% AEP West



Figure 4-46 Flood Impact Map - Design v. Existing - 5% AEP Central



Figure 4-47 Flood Impact Map - Design v. Existing - 5% AEP East

4.4 PMF EVENT

The PMF event has been used in this investigation to set the upper limits of structural design and to assess impacts that may be of risk to safety or loss of human life. This is the highest water level perceived to be possible in the local area when probable maximum precipitation occurs and is in excess of the minimum structural requirements for bridge design.

The PMF analysis is considered to be outside the agreed design criteria for the Tripoli Way Extension project as defined in the design approach report. However, an analysis has been undertaken for information only.

4.4.1 Flood Depth

Flood depths reach a peak level of approximately 14.95m AHD at the proposed bridge and inundates the floodplain area to depths generally in the range of 1.5m-2.5m. The flow through the Macquarie Rivulet controls the tailwater level associated with the road outlets and flow through the proposed bridge.

The existing PMF scenario shows the local area and residences adjacent to the design road being inundated with flood water. The extents can be seen in Figure 4-48 and Figure 4-49 comparing the existing and design scenario. The extents are close to identical in both scenarios as the flooding is primarily caused by the major flows in the rivulet rather than local changes occurring through the proposed roadworks.



Figure 4-48 Flood Depth Map - 120m Duration - Existing Scenario – PMF Event



Figure 4-49 Flood Depth Map - 120m Duration - Design Scenario – PMF Event



Figure 4-50 Flood Depth Map - 120m Duration - Existing Scenario – PMF Event West



Figure 4-51 Flood Depth Map - 120m Duration - Design Scenario – PMF Event West

4.4.2 Flood Velocity

Flow velocity in the vicinity of the proposed road and embankments is below 2.0m/s with exception of the invert of Hazelton's Creek and local accelerations at features such as culverts and bridge piers.

The overall velocity remains largely unchanged through the Macquarie Rivulet and floodplain area as a result of the works.

Figure 4-55 shows a reduction of flood velocities south of the bridge and within the adjacent residences.

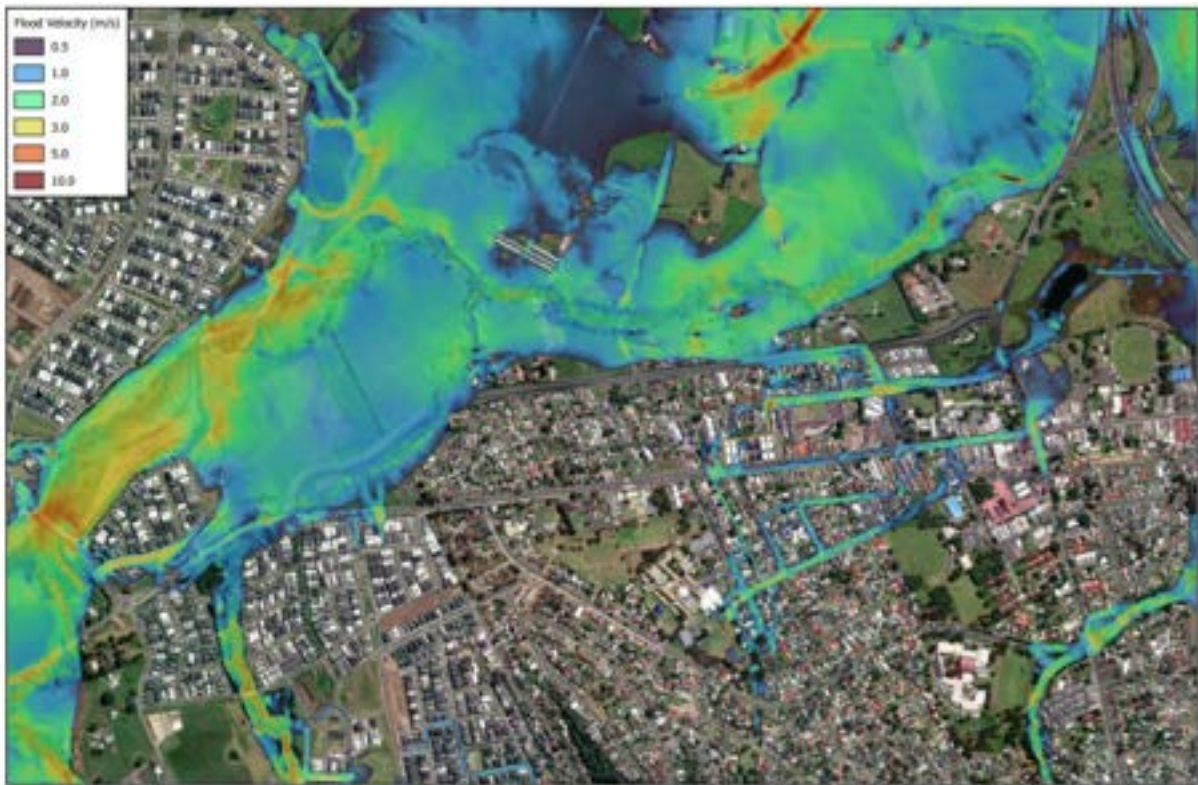


Figure 4-52 Flood Velocity Map - 120m Duration - Existing Scenario – PMF Event



Figure 4-53 Flood Velocity Map - 120m Duration - Design Scenario – PMF Event

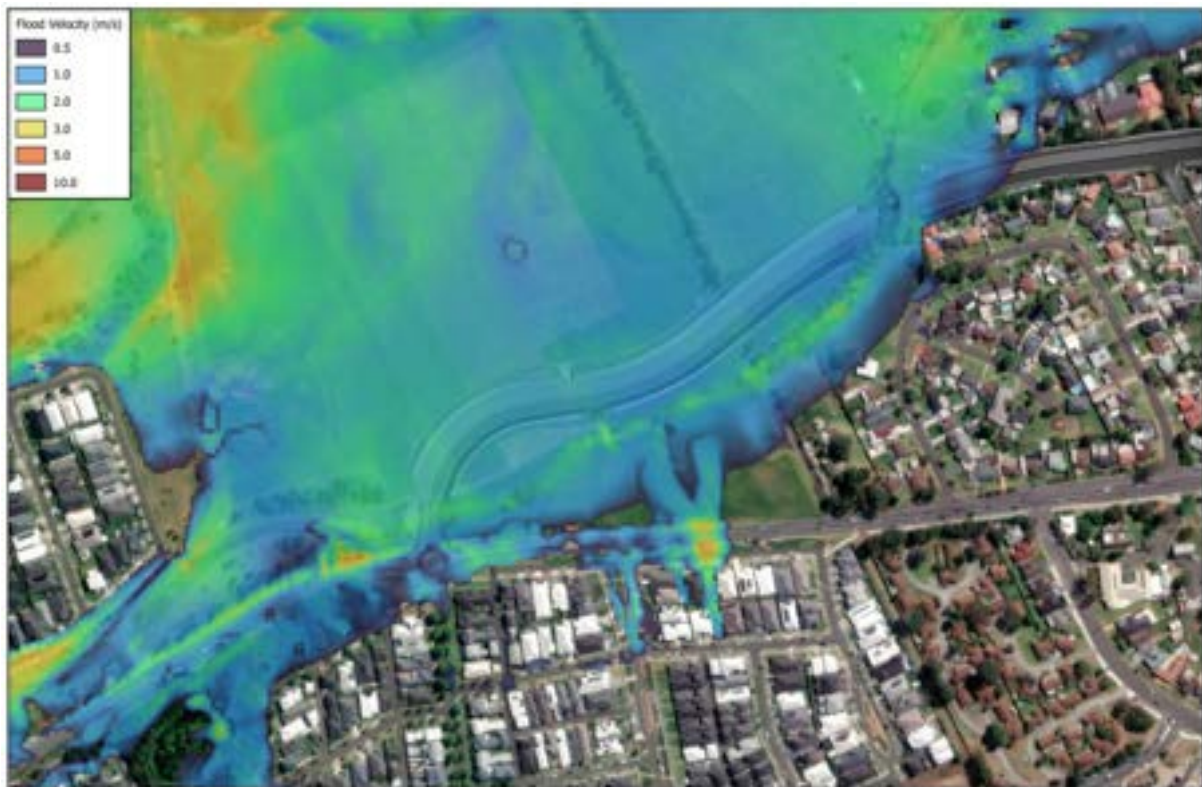


Figure 4-54 Flood Velocity Map - 120m Duration - Existing Scenario – PMF Event West

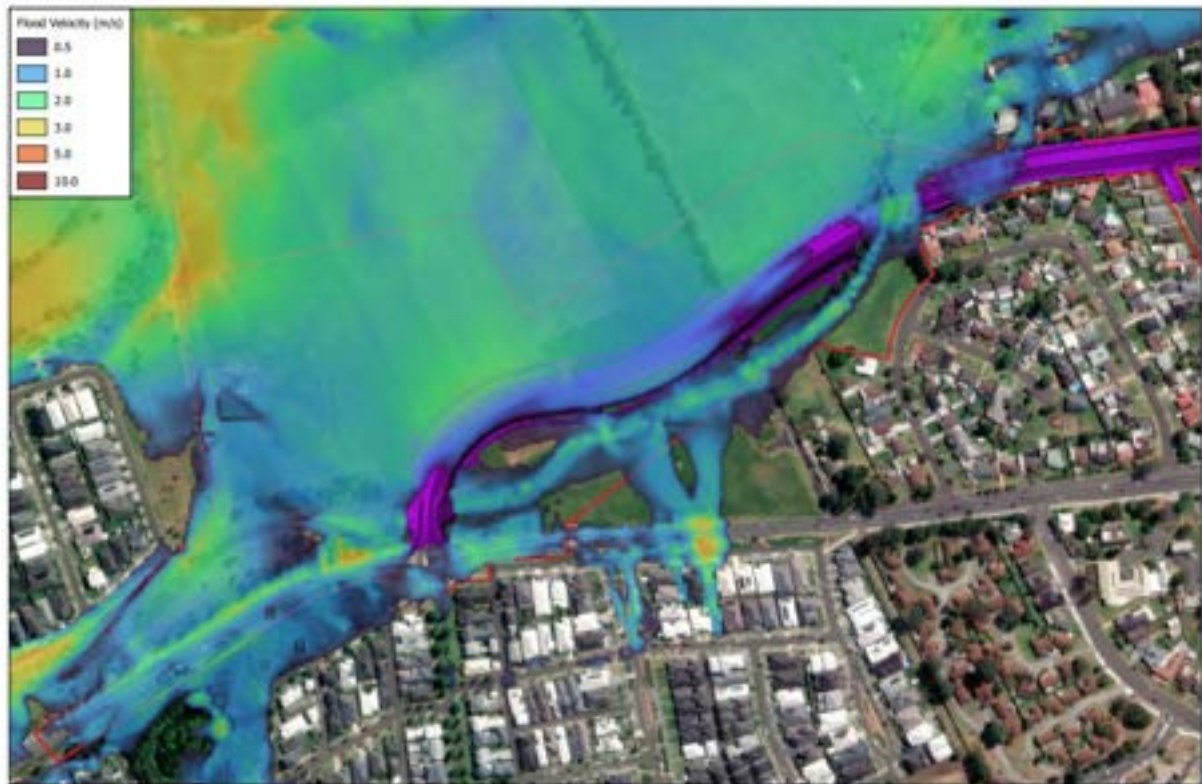


Figure 4-55 Flood Velocity Map - 120m Duration - Design Scenario – PMF Event West

4.4.3 Flood Hazard

The road is overtopped by a substantial depth of water in some areas at the western and eastern extents of the proposed road with depths exceeding 1m in short sections. As such while most areas are safe for vehicles, the hazard category does reach the H3 threshold in these areas of substantial overtopping.



Figure 4-56 Flood Hazard Map - 120m Duration - Existing Scenario – PMF Event



Figure 4-57 Flood Hazard Map - 120m Duration - Design Scenario – PMF Event



Figure 4-58 Flood Hazard Map - 120m Duration - Design Scenario – PMF Event West



Figure 4-59 Flood Hazard Map - 120m Duration - Design Scenario – PMF Event West

4.4.4 Flood Impact PMF

The PMF event demonstrates some impacts to flood height through the introduction of the raised road embankment within an area of inundated floodplain.

The largest impact is observed at the western extent of the proposed road. Level differences in the floodplain area reach a maximum of approximately 500mm near the bend in Tripoli Way adjacent the western roundabout connection.

Some impacts are observed within existing residential areas in the PMF event. These are located on Pollock Cr and Wingello Cr. These impacts are observed only observed in the PMF storm and are not reflected in the 1% AEP or 5% AEP.

Impacts within Pollock Cr area generally reach a maximum of approximately 170mm positive afflux, impacts at Wingello Cr are typically less than 50mm increase. The lots affected by positive flood afflux show flood inundation in the PMF in existing conditions as demonstrated in the dry to wet comparison.

The hazard category of the Wingello Cr area is unchanged by the proposed works and the hazard category at Pollock Cr is reduced due to a reduction in velocity in the impacted area. As such the flood impact in the affected areas is not considered to present an unacceptable safety risk and is therefore considered consistent with the Shellharbour City Council Drainage Design Handbook requirements.

Positive afflux is also observed within pockets of Tripoli Way adjacent Hamilton Road. This occurs in lots that are already affected by inundation in the PMF of at least 300mm depth.

Broader flood impacts beyond the site extent upstream or downstream within the creeks and rivulet were not observed.



Figure 4-60 Flood Impact Map - Design v. Existing - PMF



Figure 4-61 Flood Impact Map - Design v. Existing - PMF West



Figure 4-62 Flood Impact Map - Design v. Existing - PMF Central



Figure 4-63 Flood Impact Map - Design v. Existing - PMF East

4.5 CONCLUSION

The Tripoli Way Extension has been hydraulically modelled using TufLOW software and the existing Macquarie Rivulet flood model as a baseline. All changes to pits, pipes, surface topography and materials have been incorporated to assess the flood behaviour affecting the proposed road as well as any impacts of constructed assets on the surrounding areas locally and within the river system.

The Tripoli Way Extension has been modelled consistently with and complies to the applicable standards and guidelines including Australian Rainfall and Runoff, Austroads, and the Shellharbour City Council Engineering Standards and Drainage Design Handbook. The scenarios modelled were the 5% AEP, and the 1% AEP for the purposes of design. The PMF event is considered to be outside the scope of the design as per the criteria defined in the design approach report but has been modelled and included within this report for information purposes.

The proposed bridge has been designed in accordance with the Shellharbour City Council requirements for large hydraulic structures including provision of 0.5m freeboard in the 1% AEP storm.

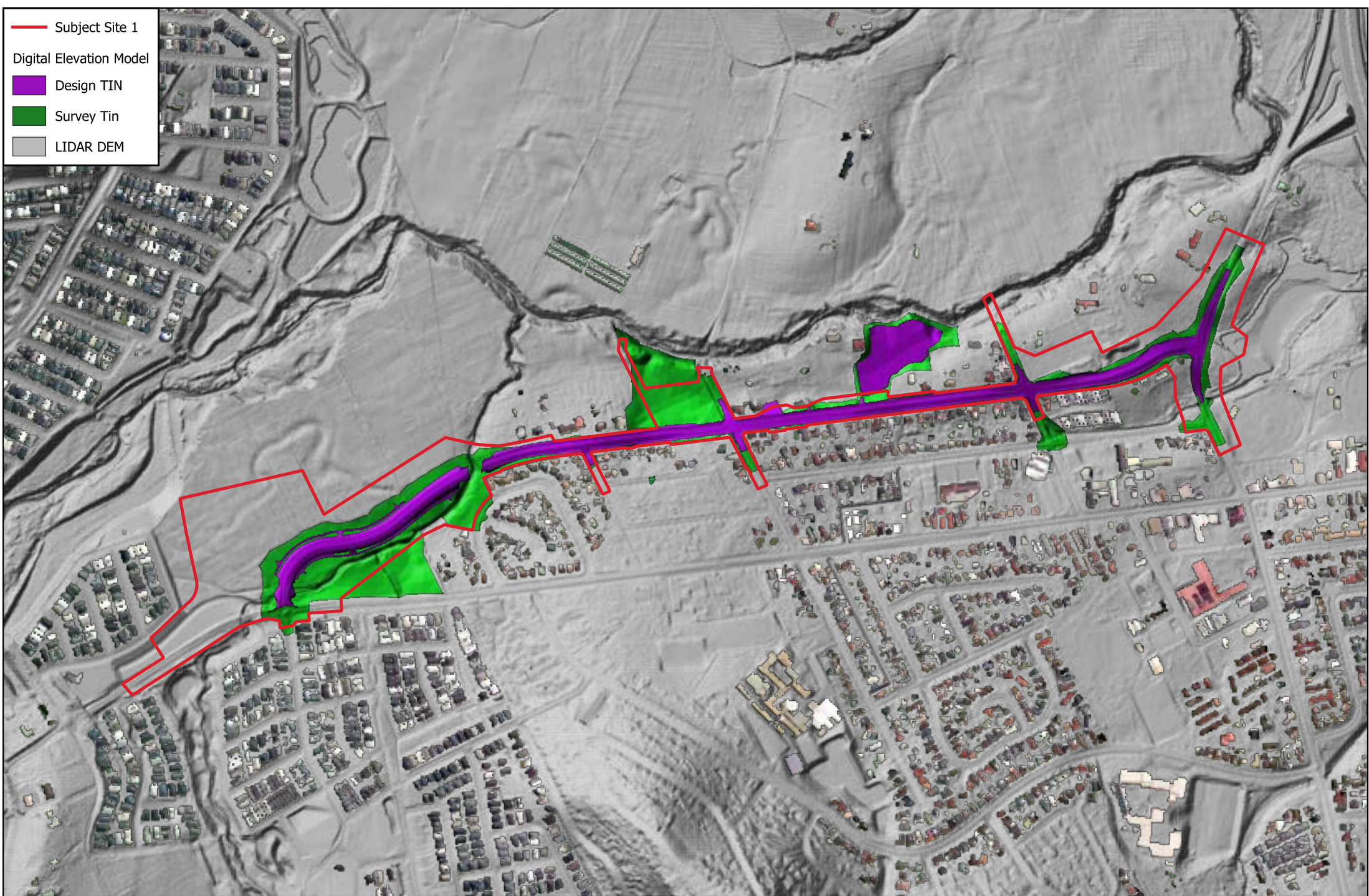
A small area of positive afflux is observed in the 1% AEP storm event adjacent road chainage 1340. This occurs due to localised filling of this area and is a maximum depth of approximately 30mm within land that is inundated by 1-2m in flood depth in existing conditions. As this change is less than 1% of the total flooding depth at the affected location this change is considered acceptable.

Existing residential lots experience nil change or negative flood afflux in the 1% AEP and 5% AEP with exception of the area adjacent road chainage 1340.

Positive afflux occurs in residential areas in the PMF event only, located in the vicinity of Wingello Cr, Pollock St and Tripoli Way near Hamilton Rd. These effects occur in areas of existing flood affection and where these occur the extent of flooding is increased spatially by approximately 5-10 metres.

The proposed Tripoli Way Extension is therefore considered to have met the necessary standards and requirements in relation to flood engineering and is in accordance with the project design criteria.

Appendix A Flood Maps



— Subject Site 1

Digital Elevation Model

■ Design TIN

■ Survey Tin

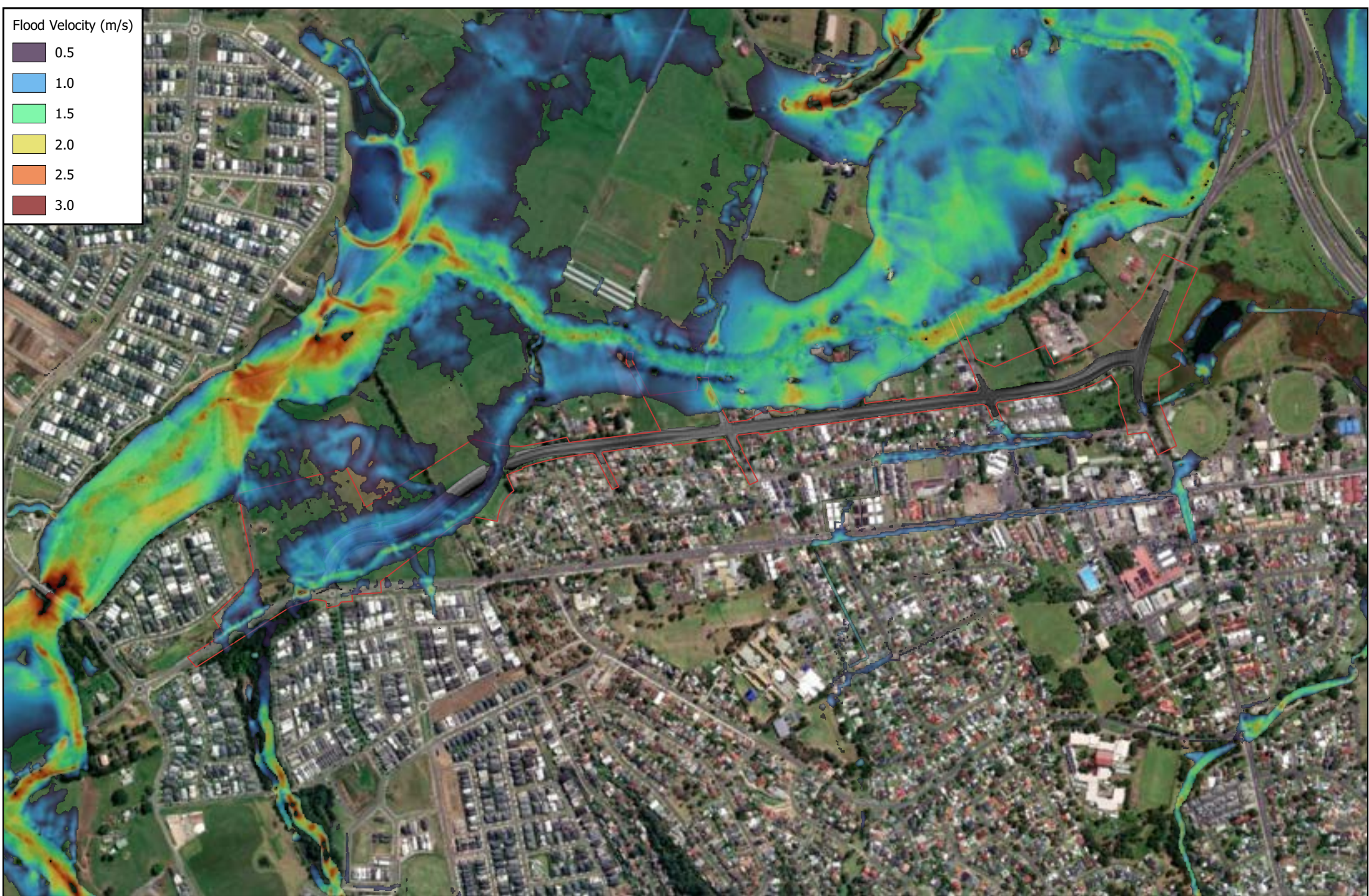
■ LIDAR DEM

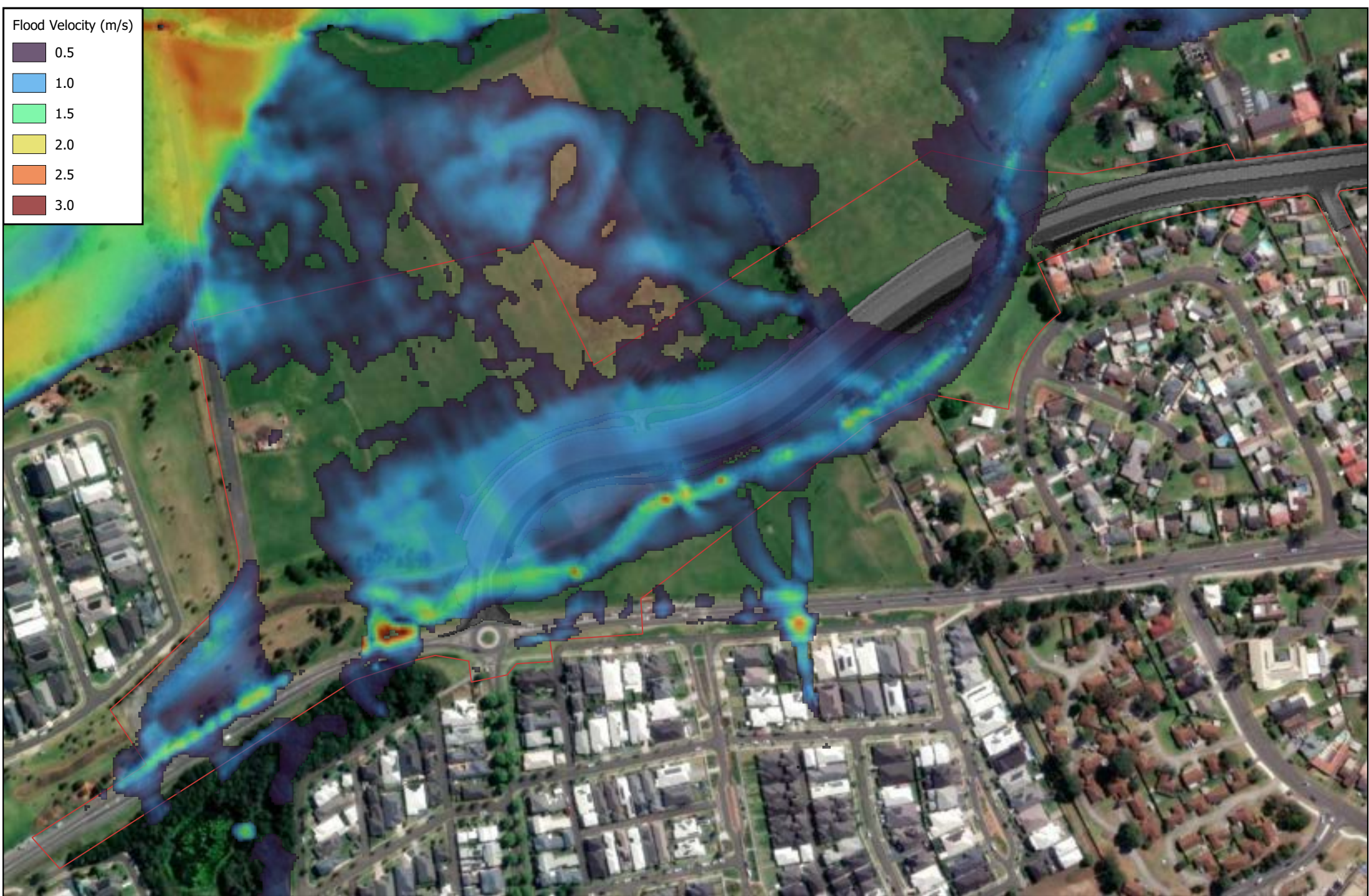


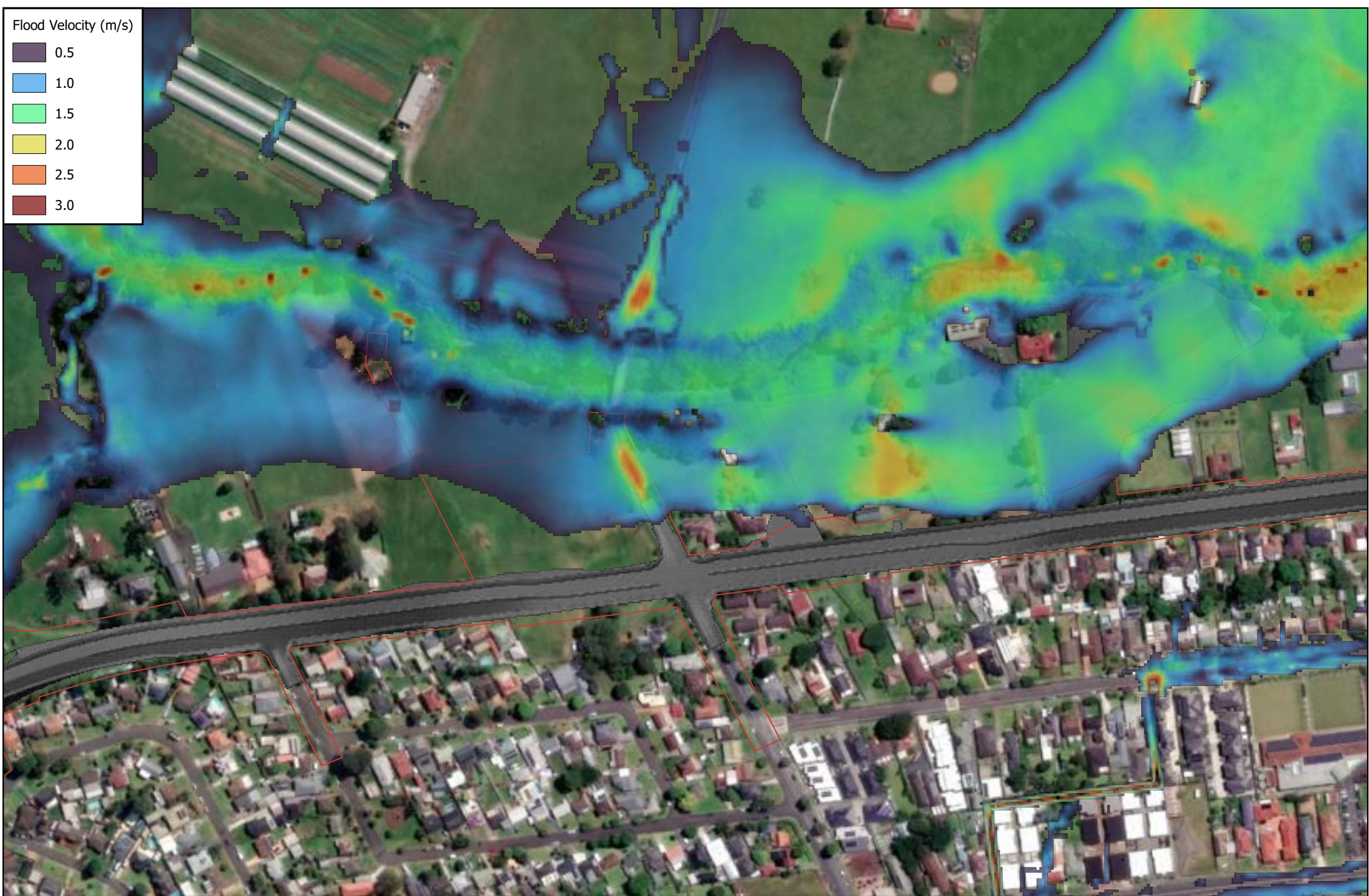


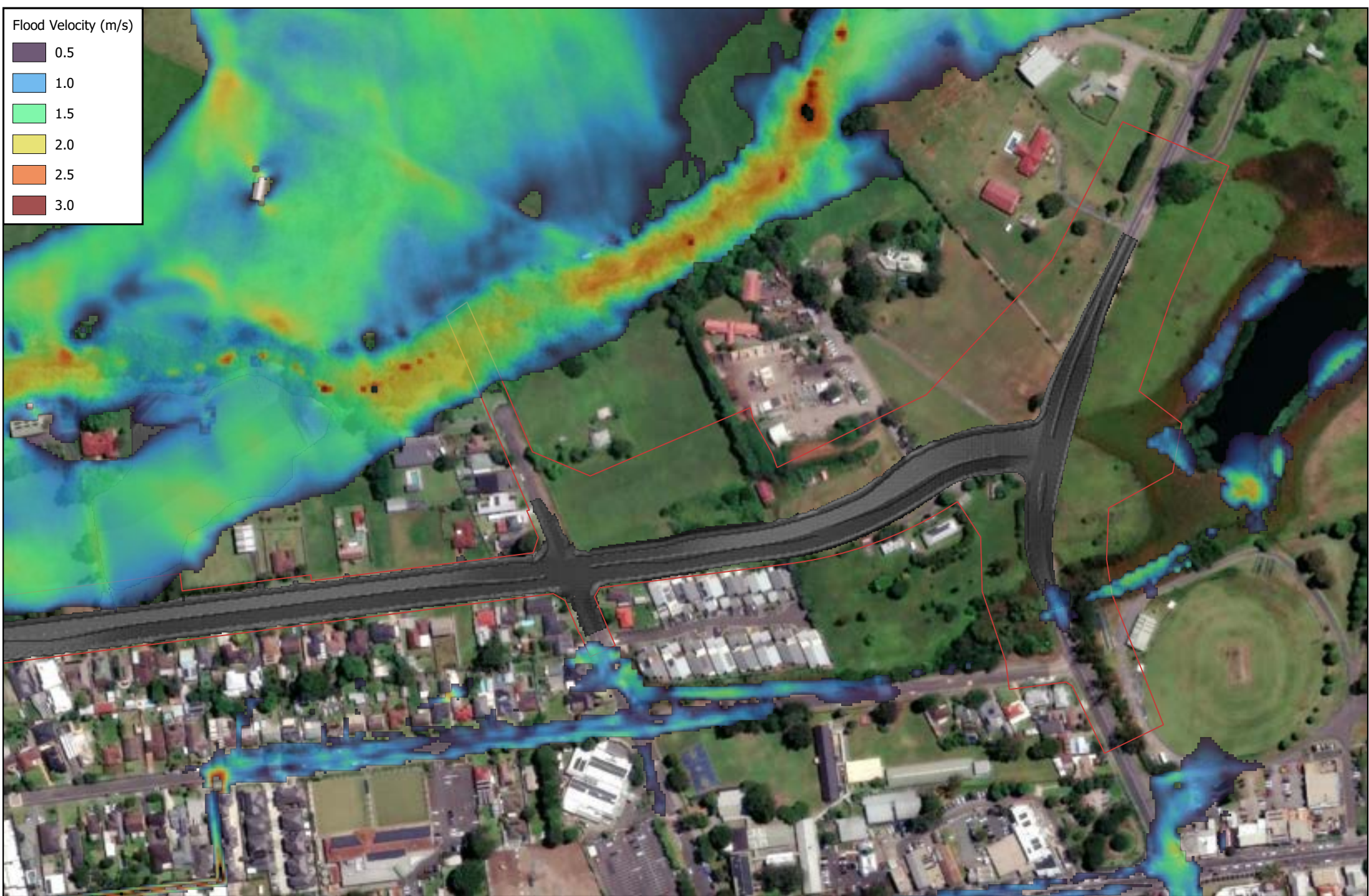












Flood Hazard Category

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles; H3 - Unsafe for Vehicles, Children and the elderly
- H4 - Unsafe for vehicles and people
- H5 - Unsafe for vehicles and people. Buildings require special engineering design and construction
- H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure









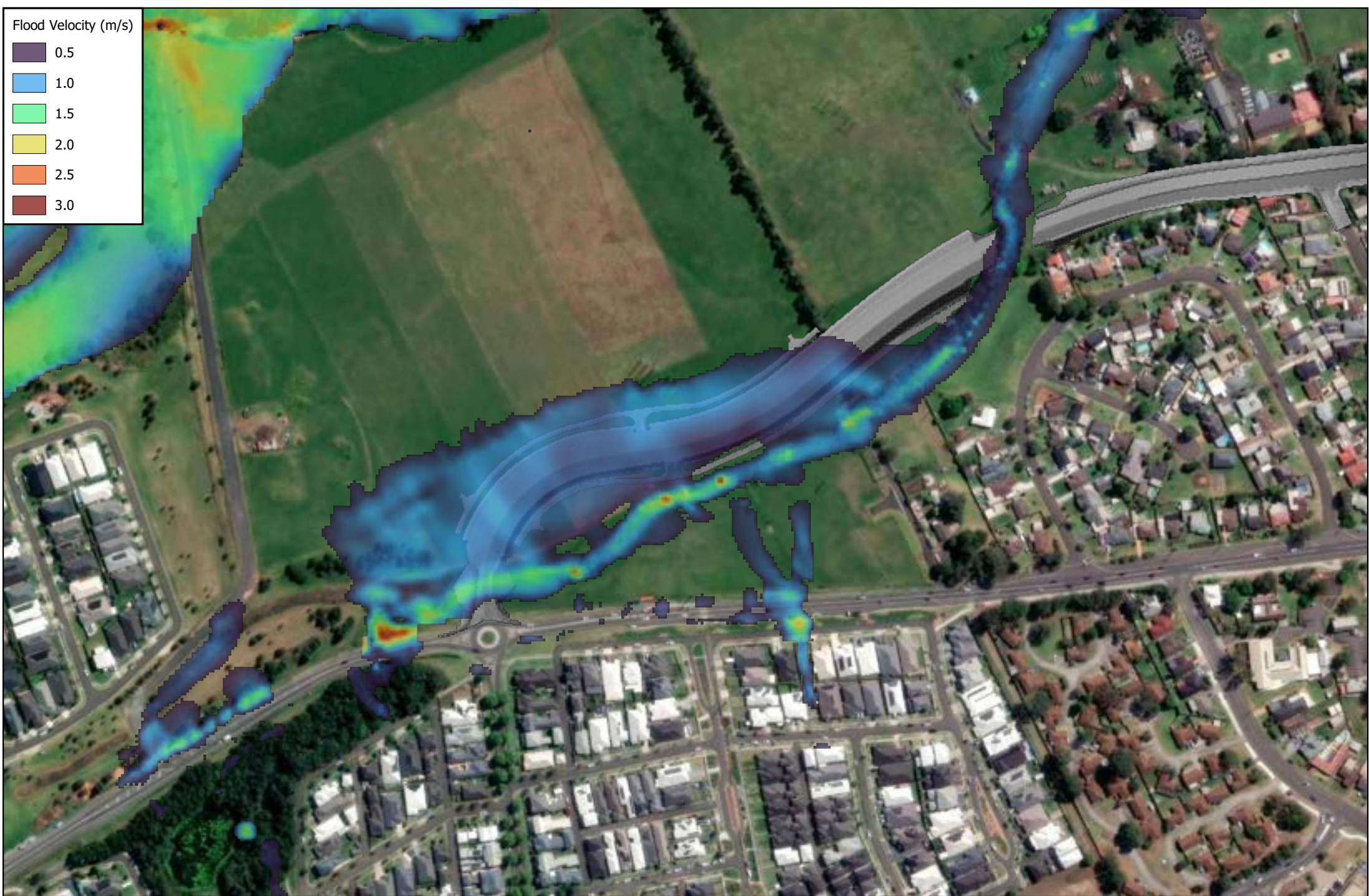


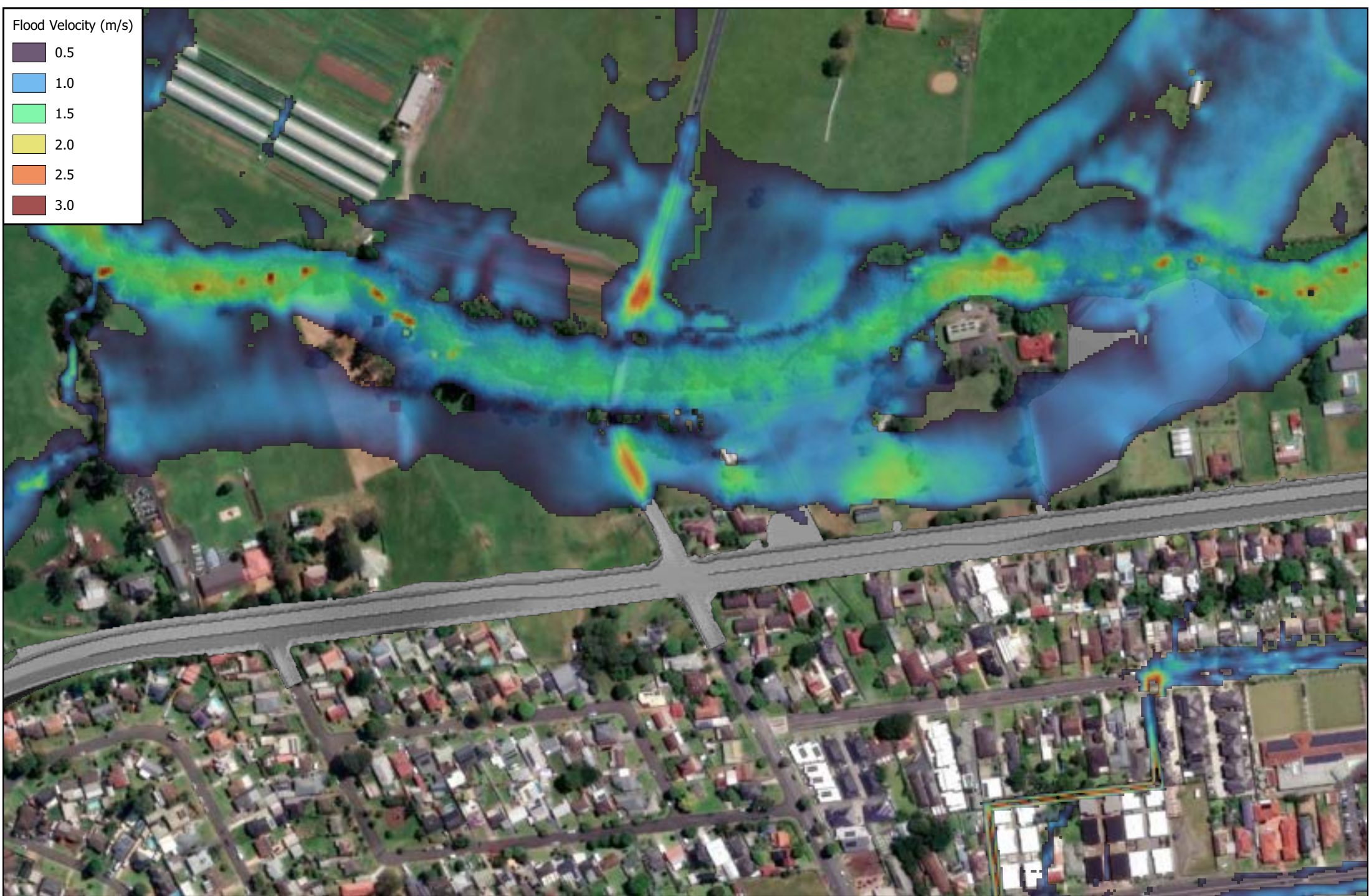


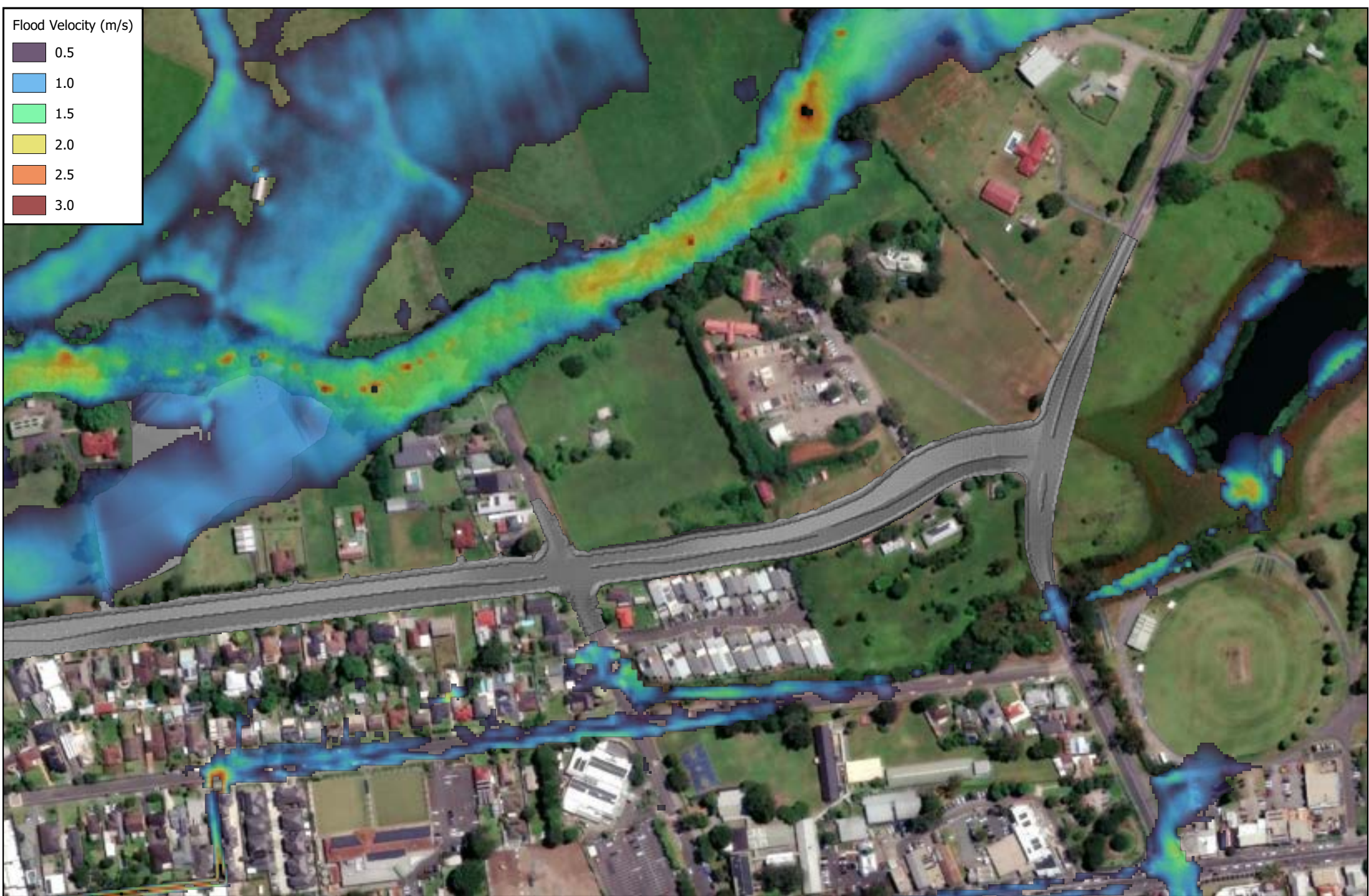










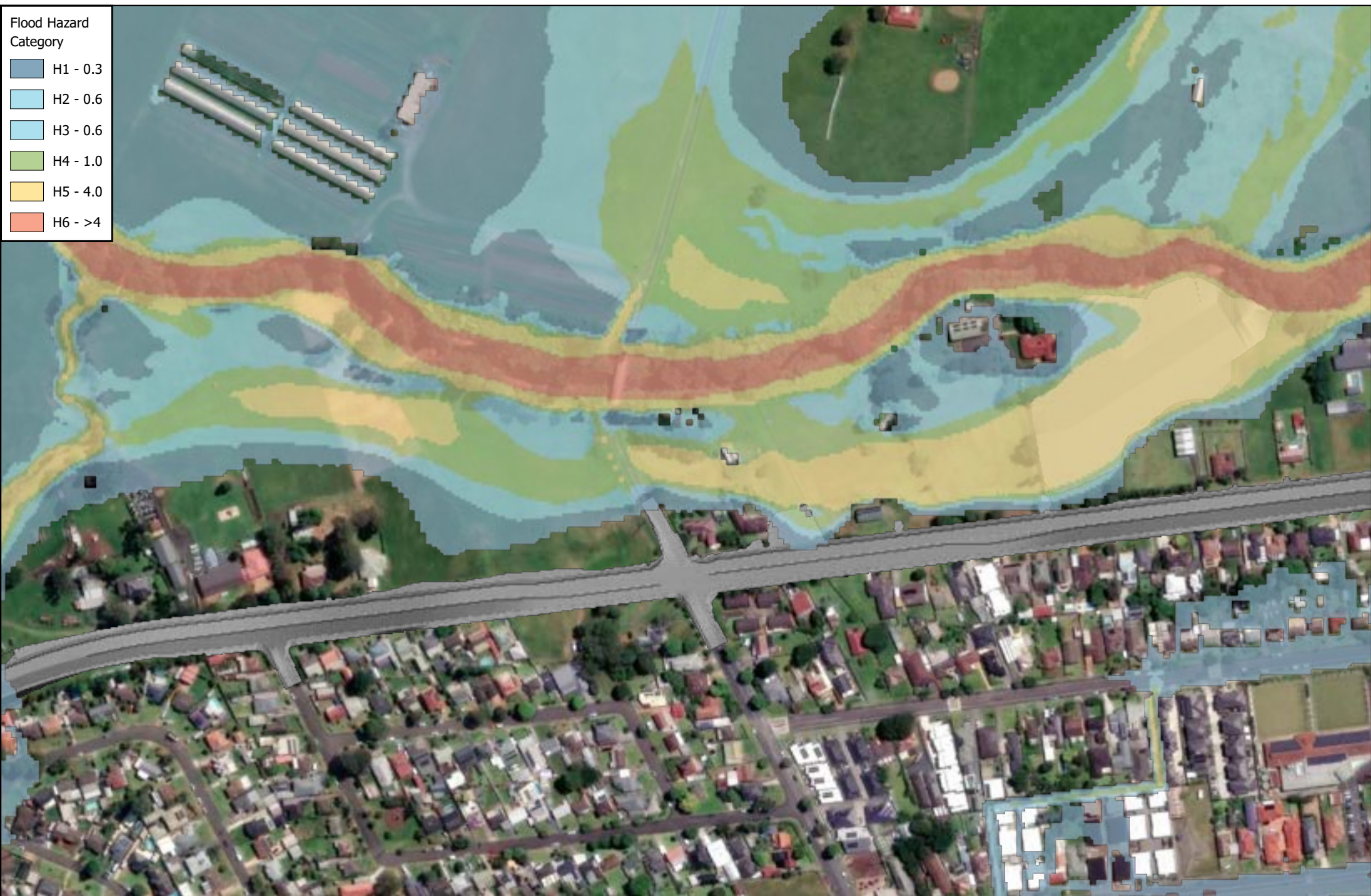


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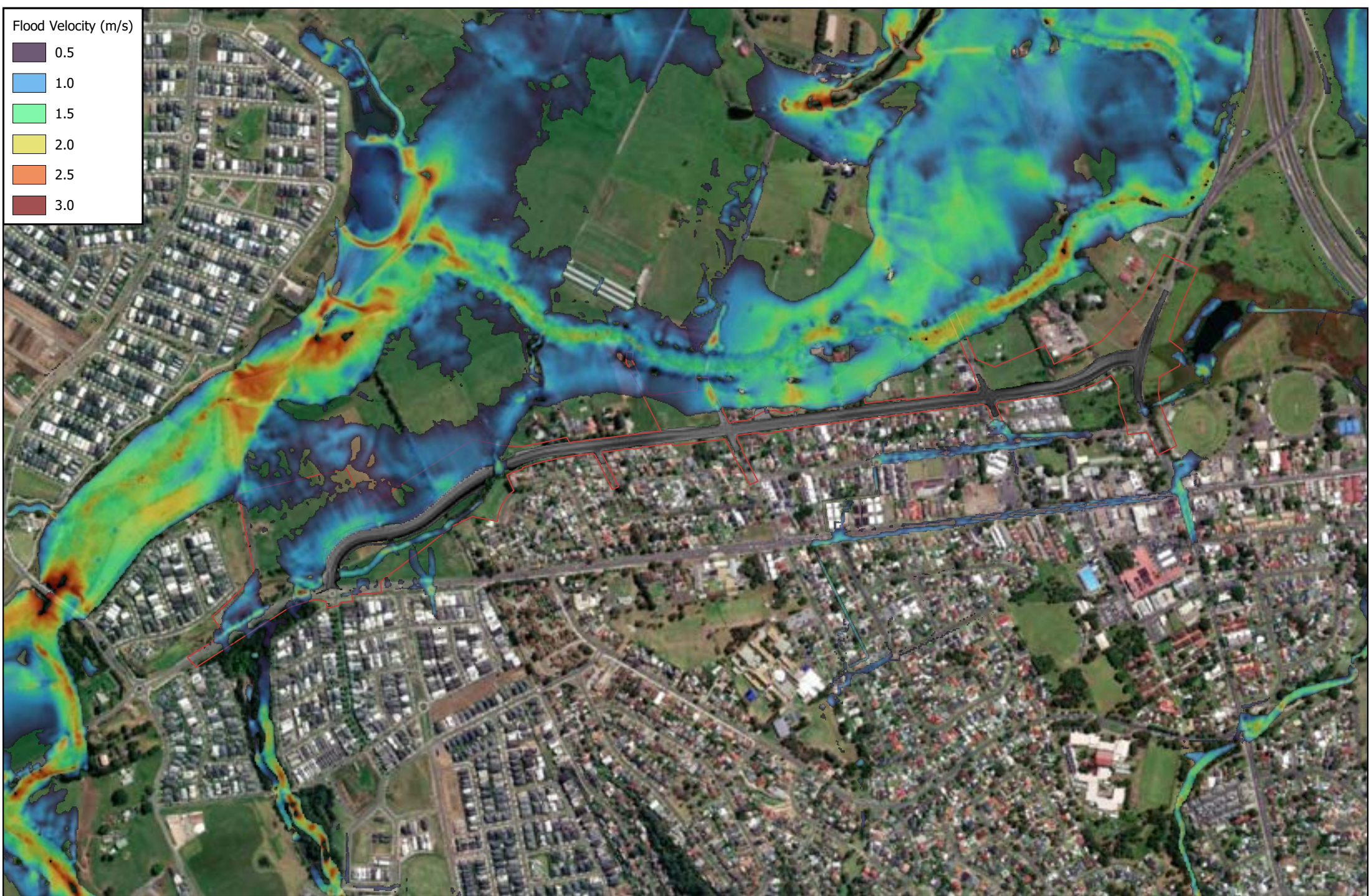


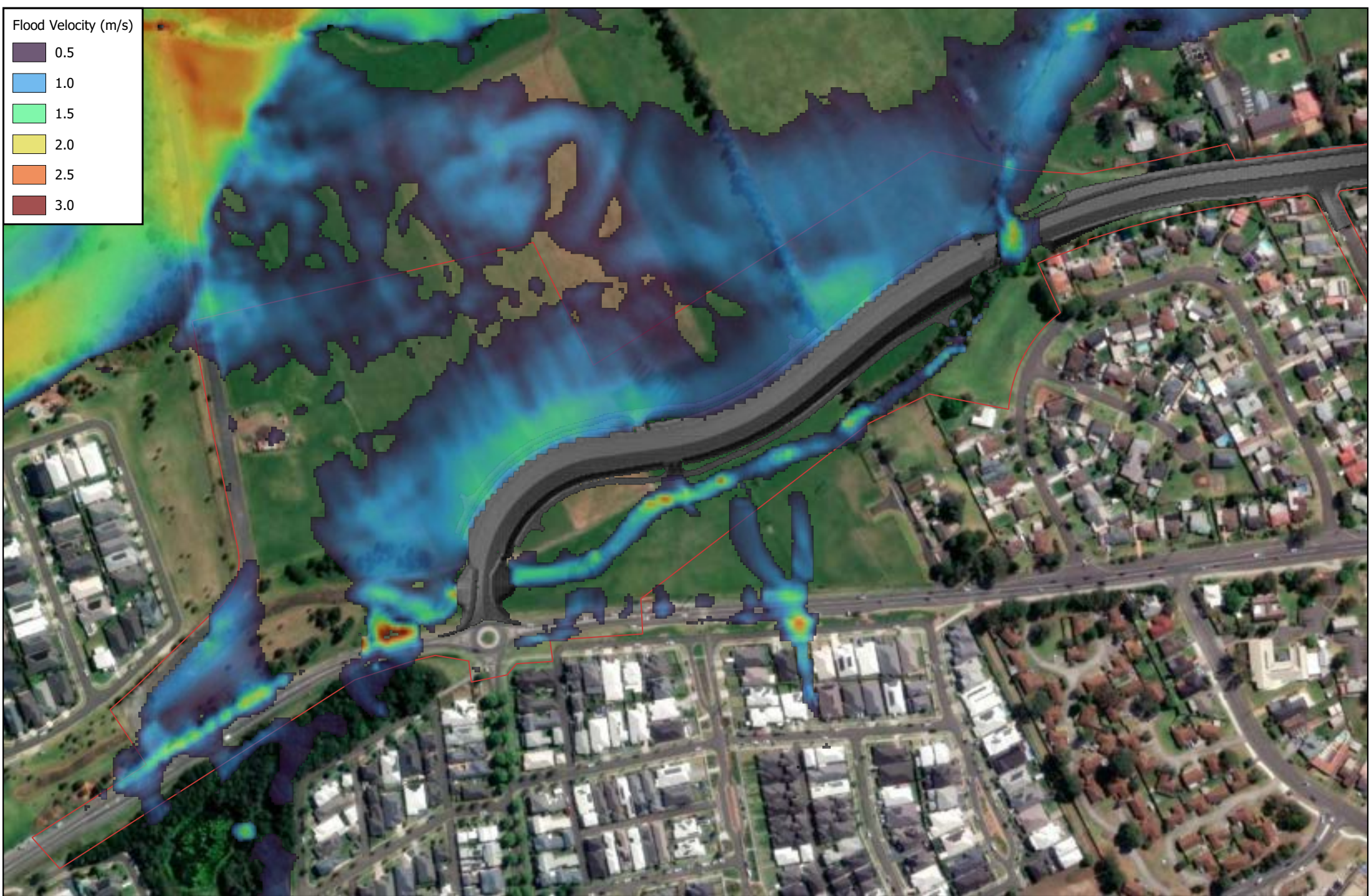


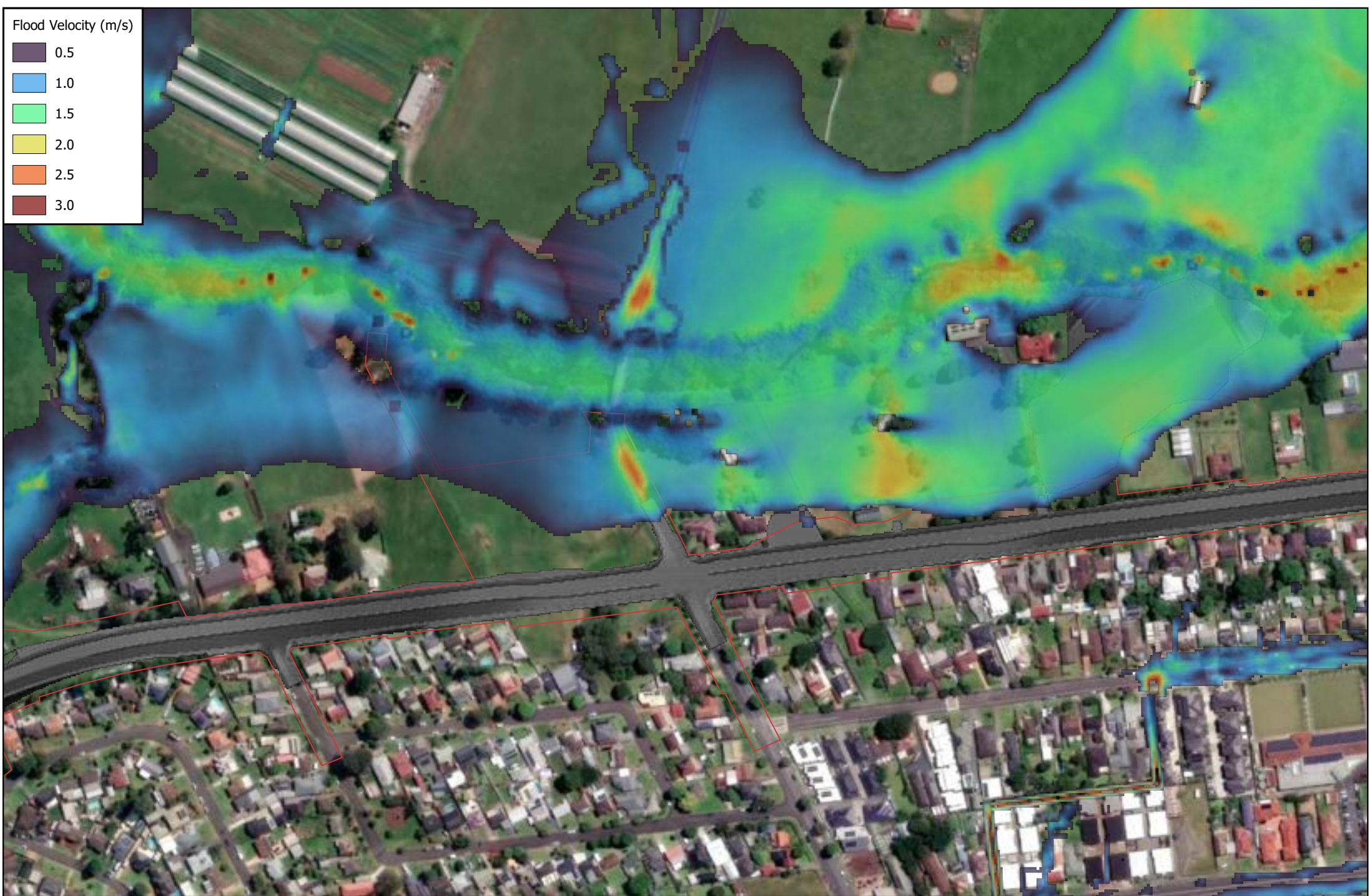


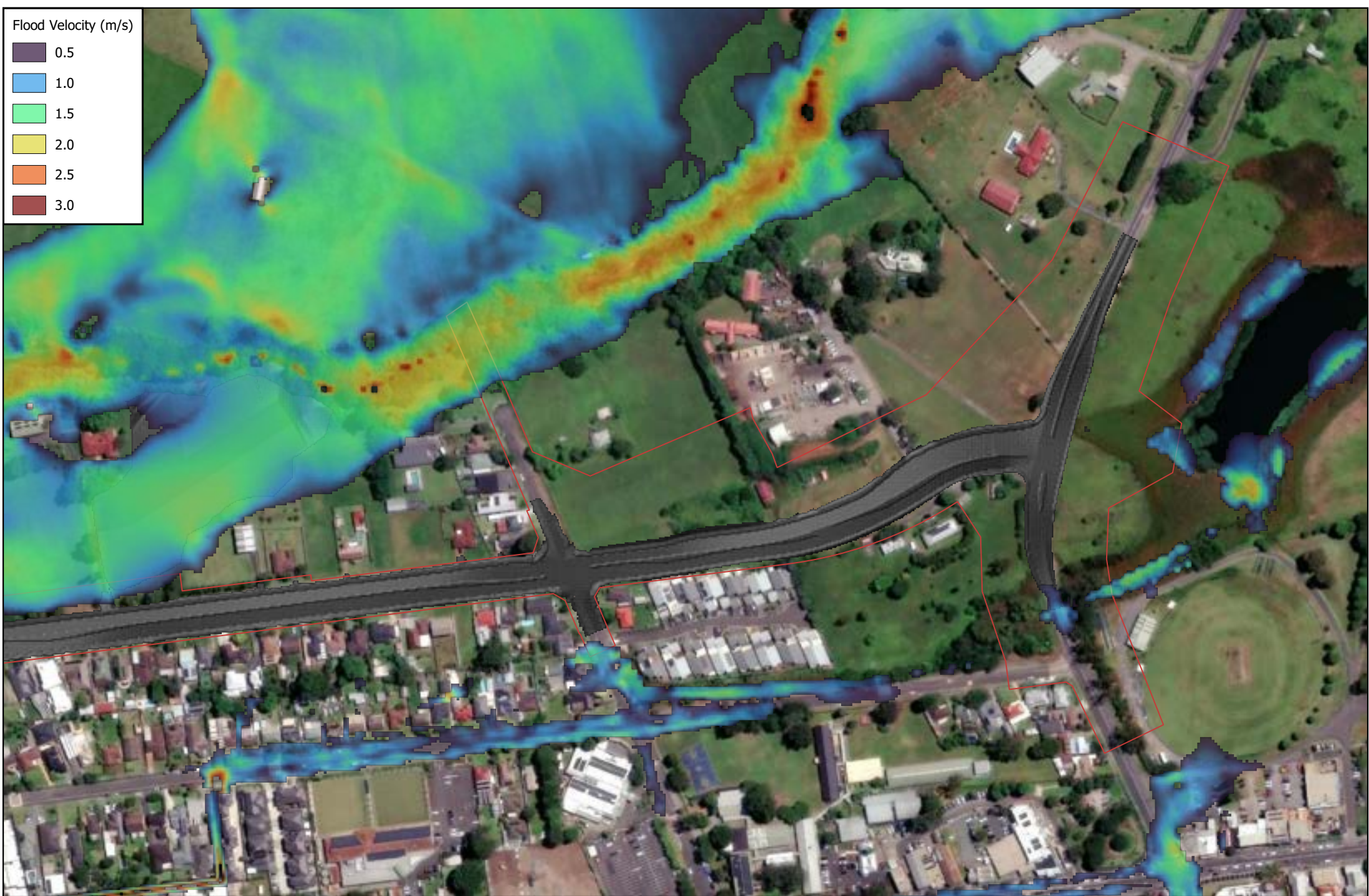












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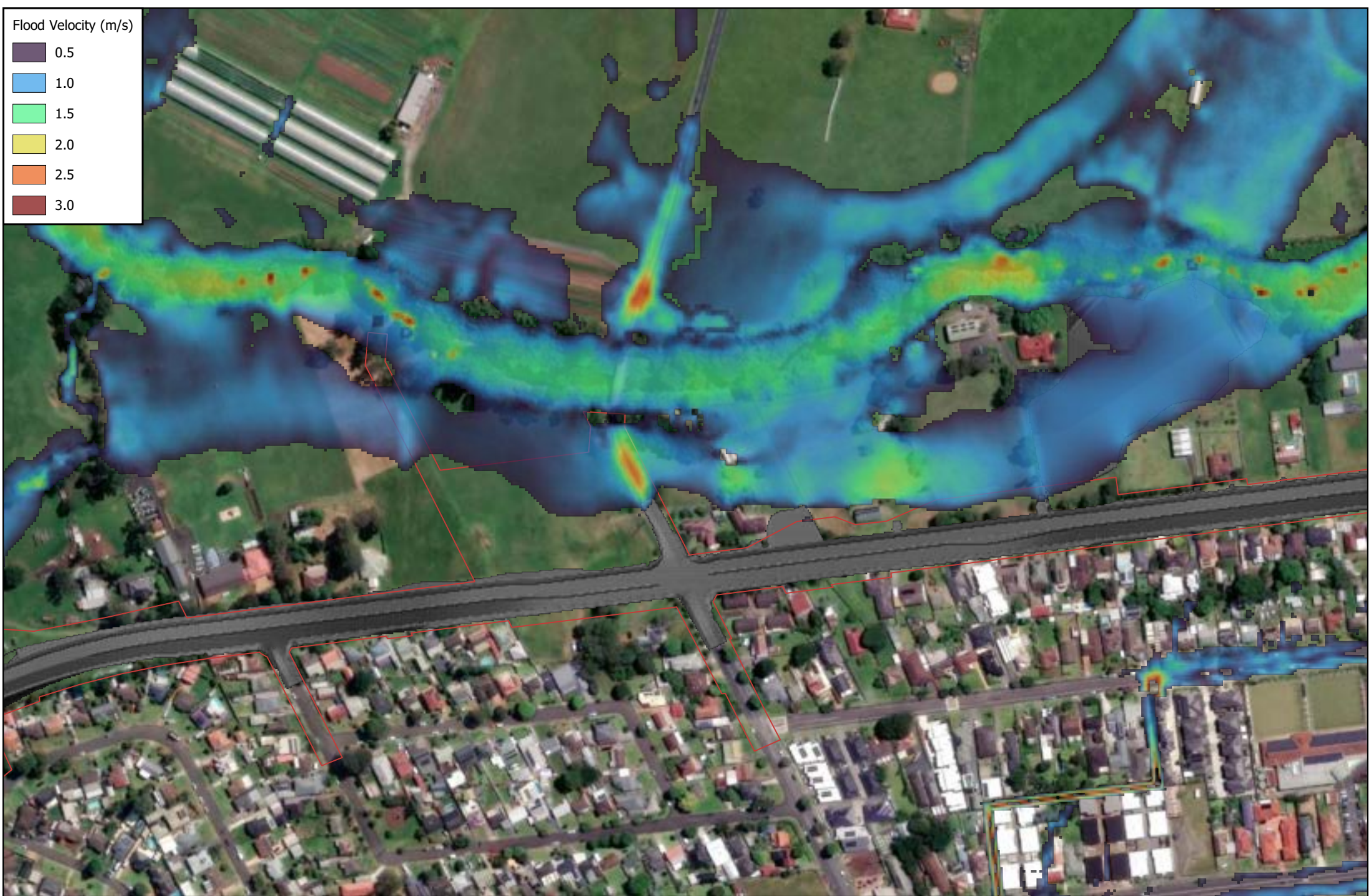


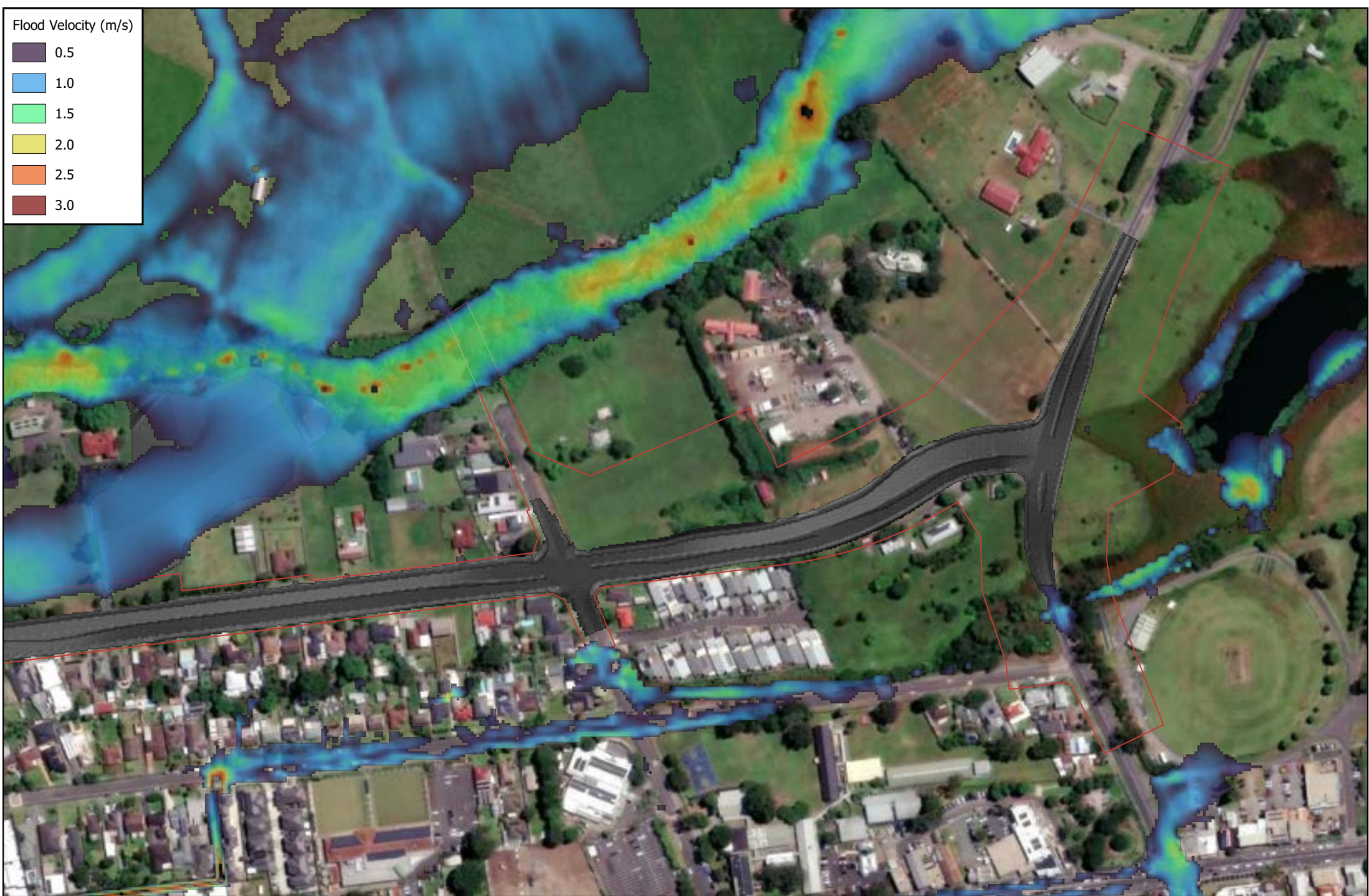










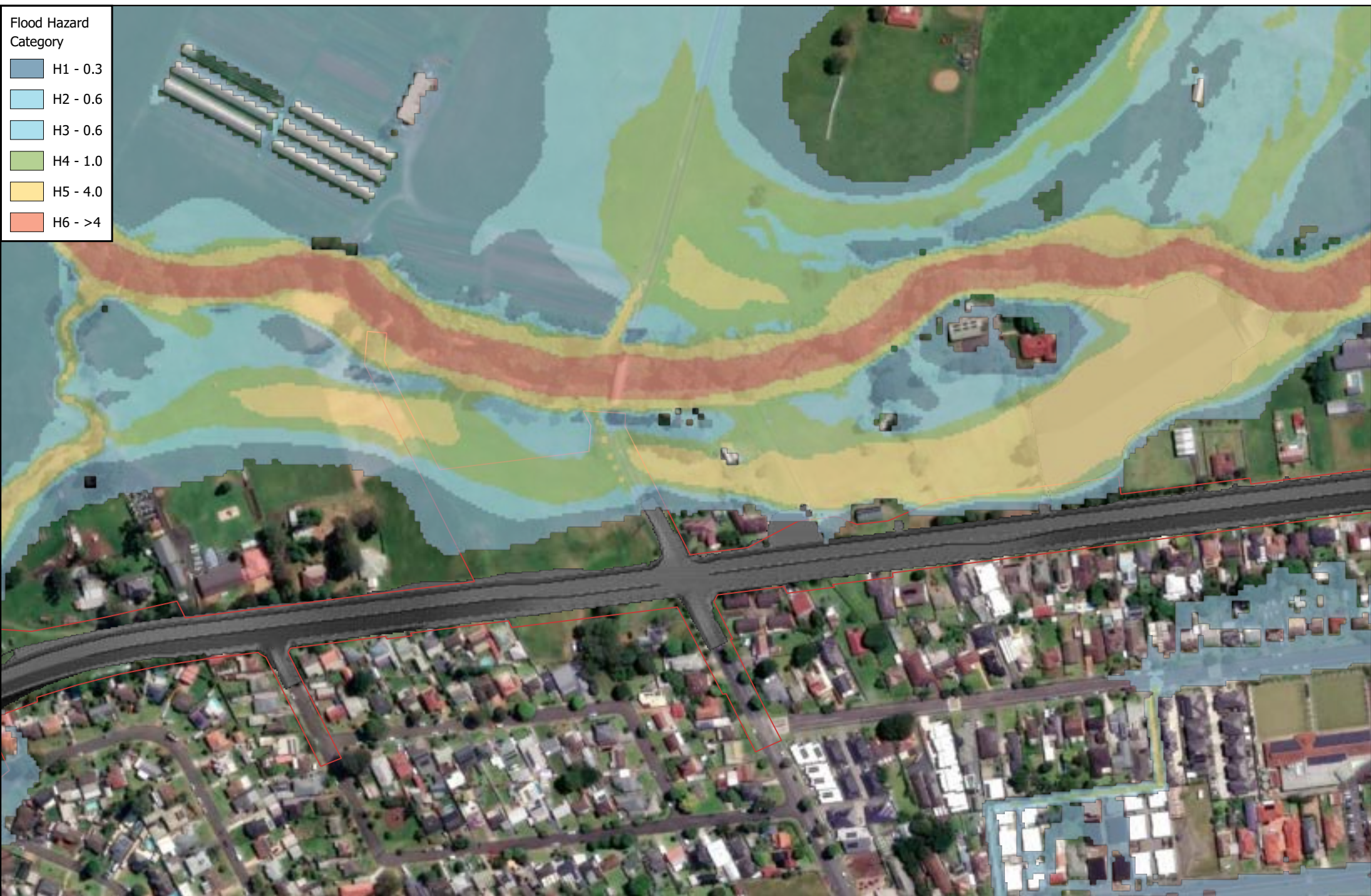


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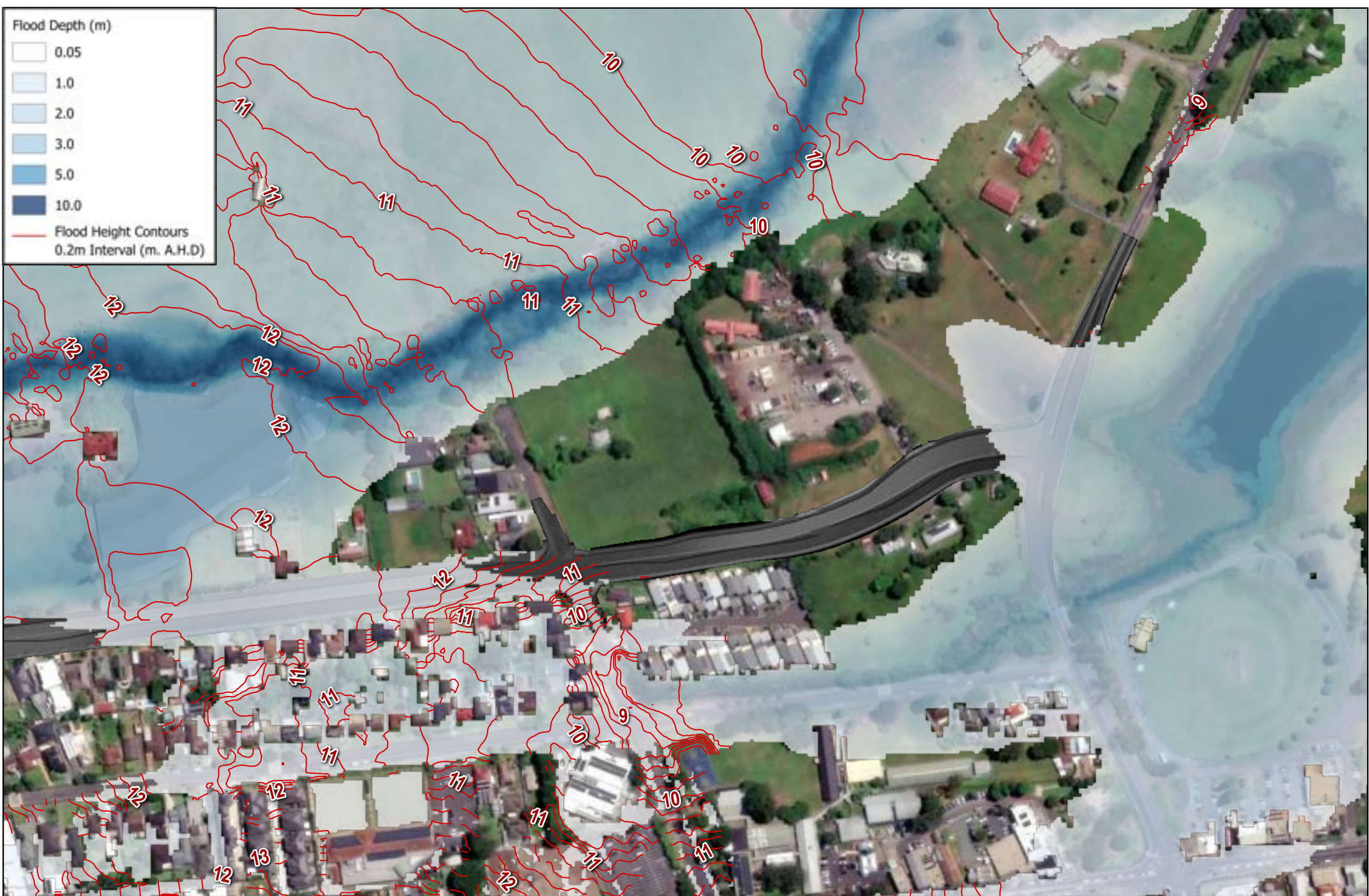


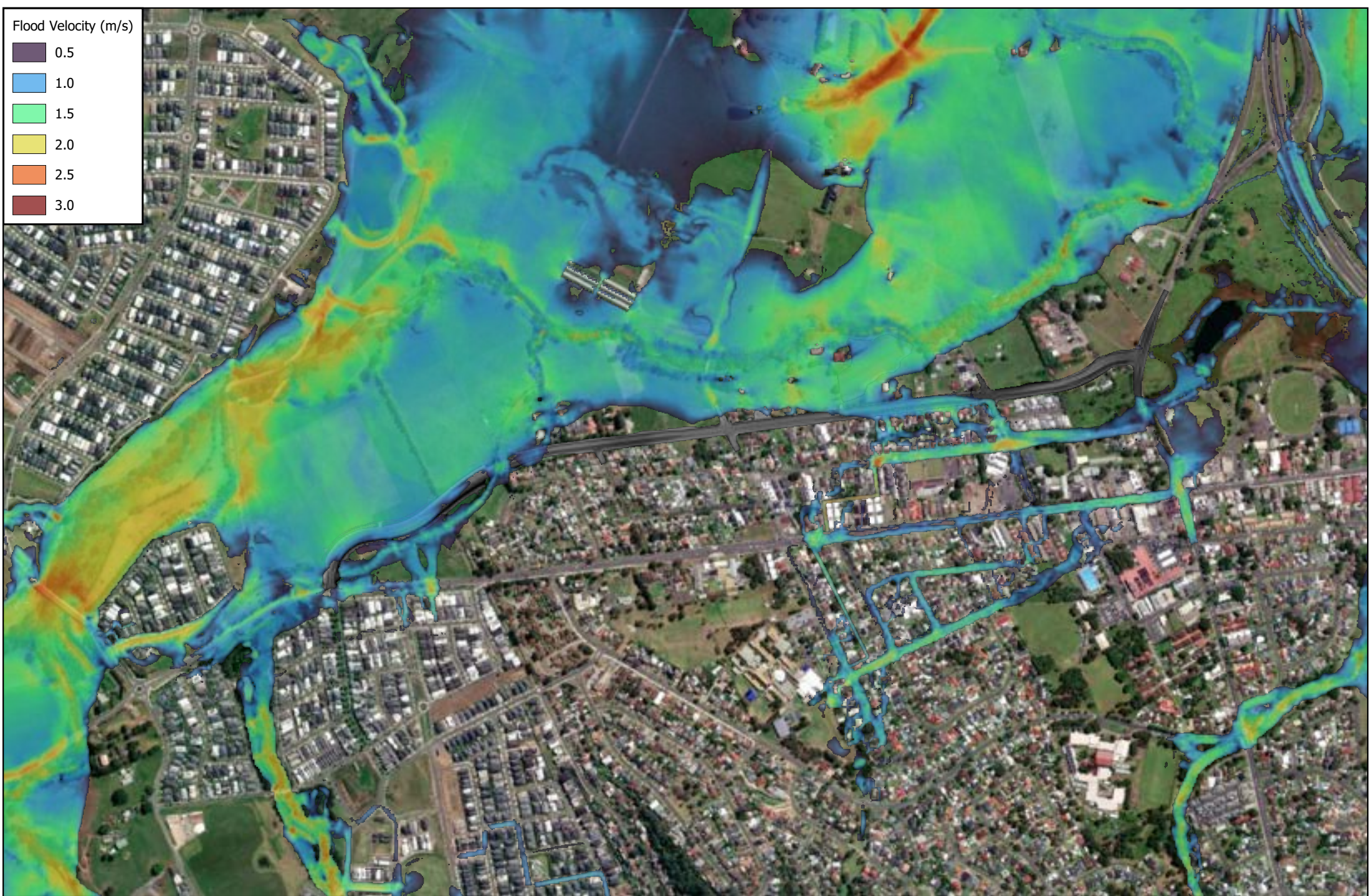


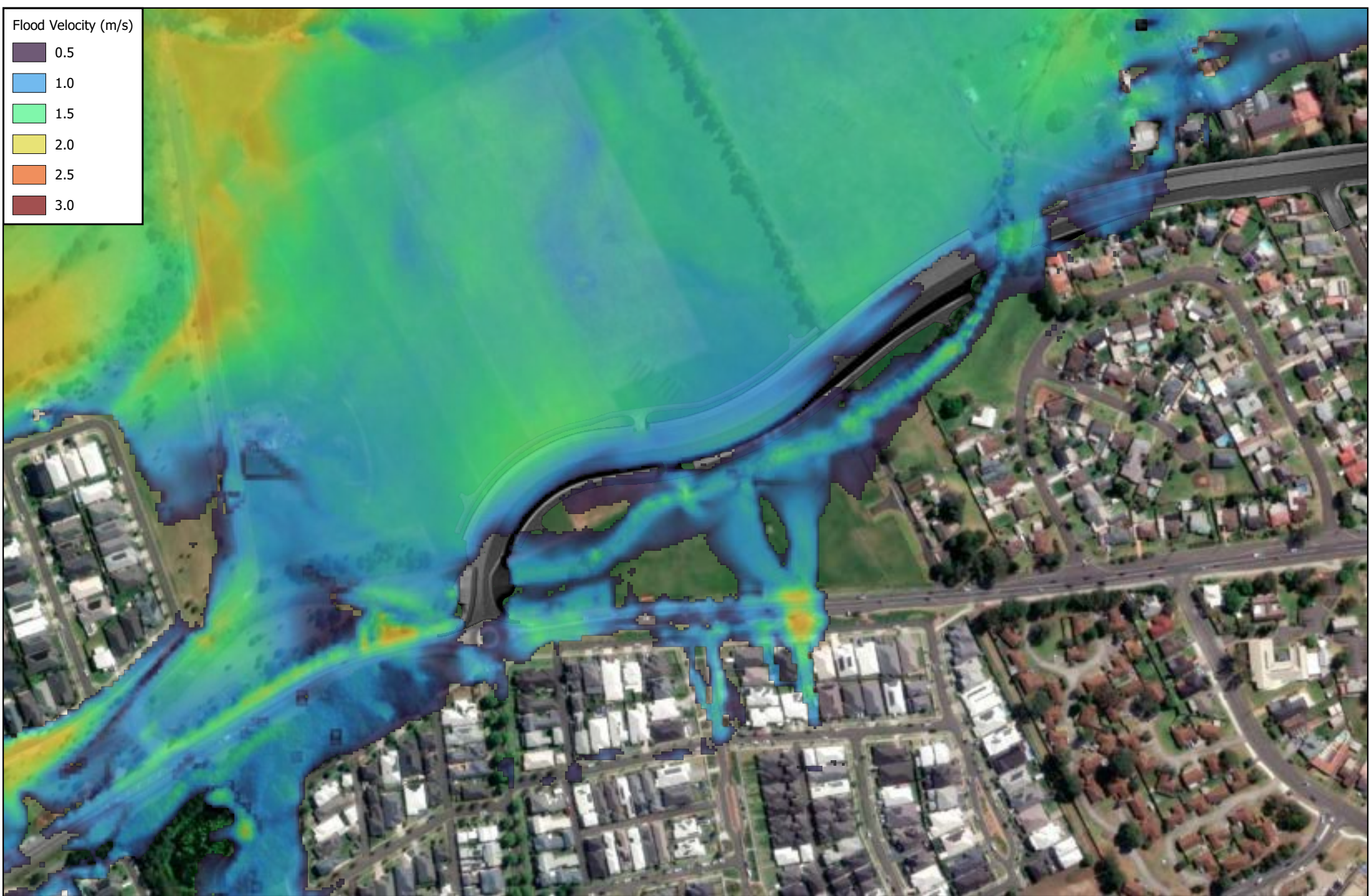


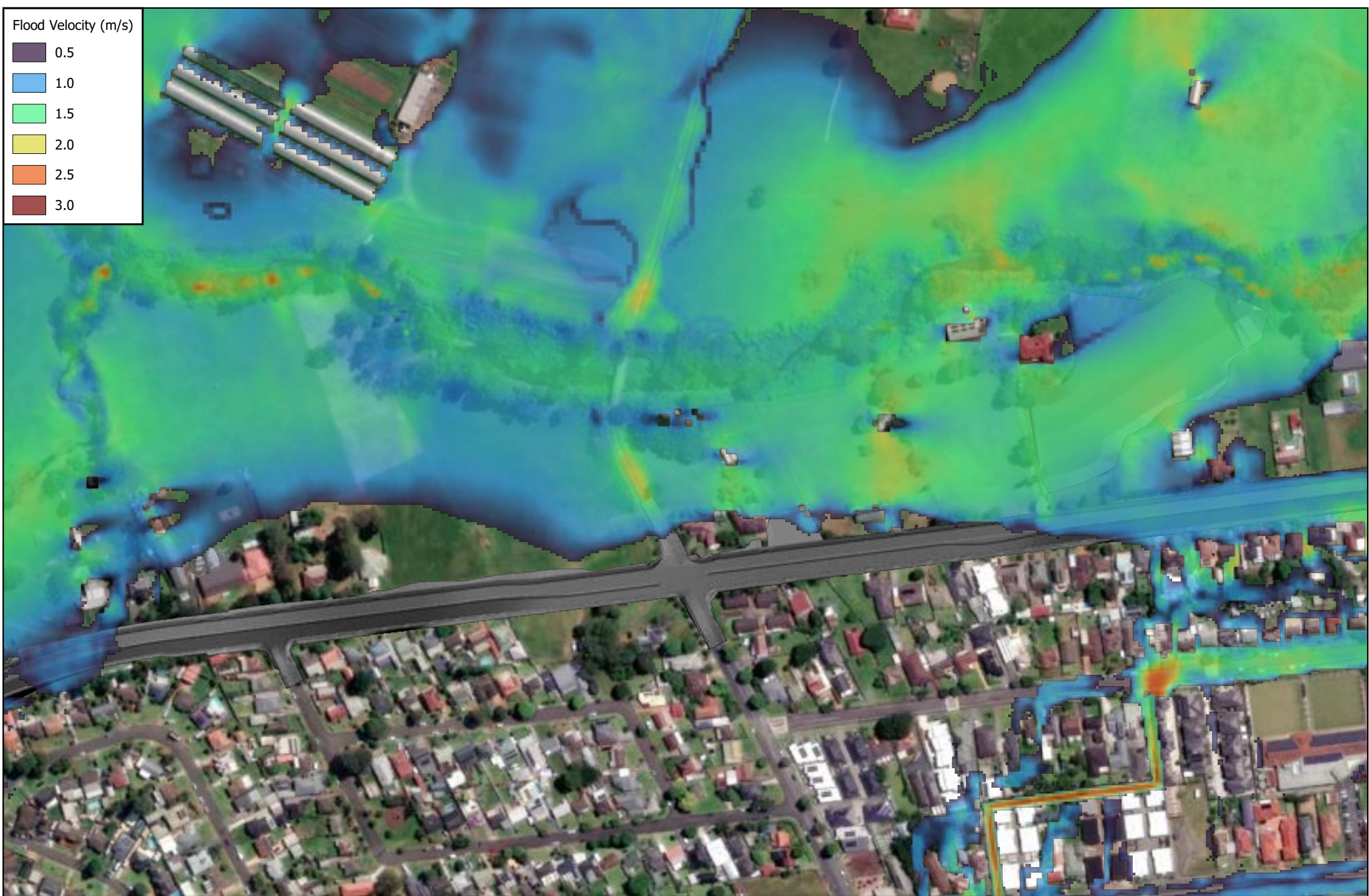


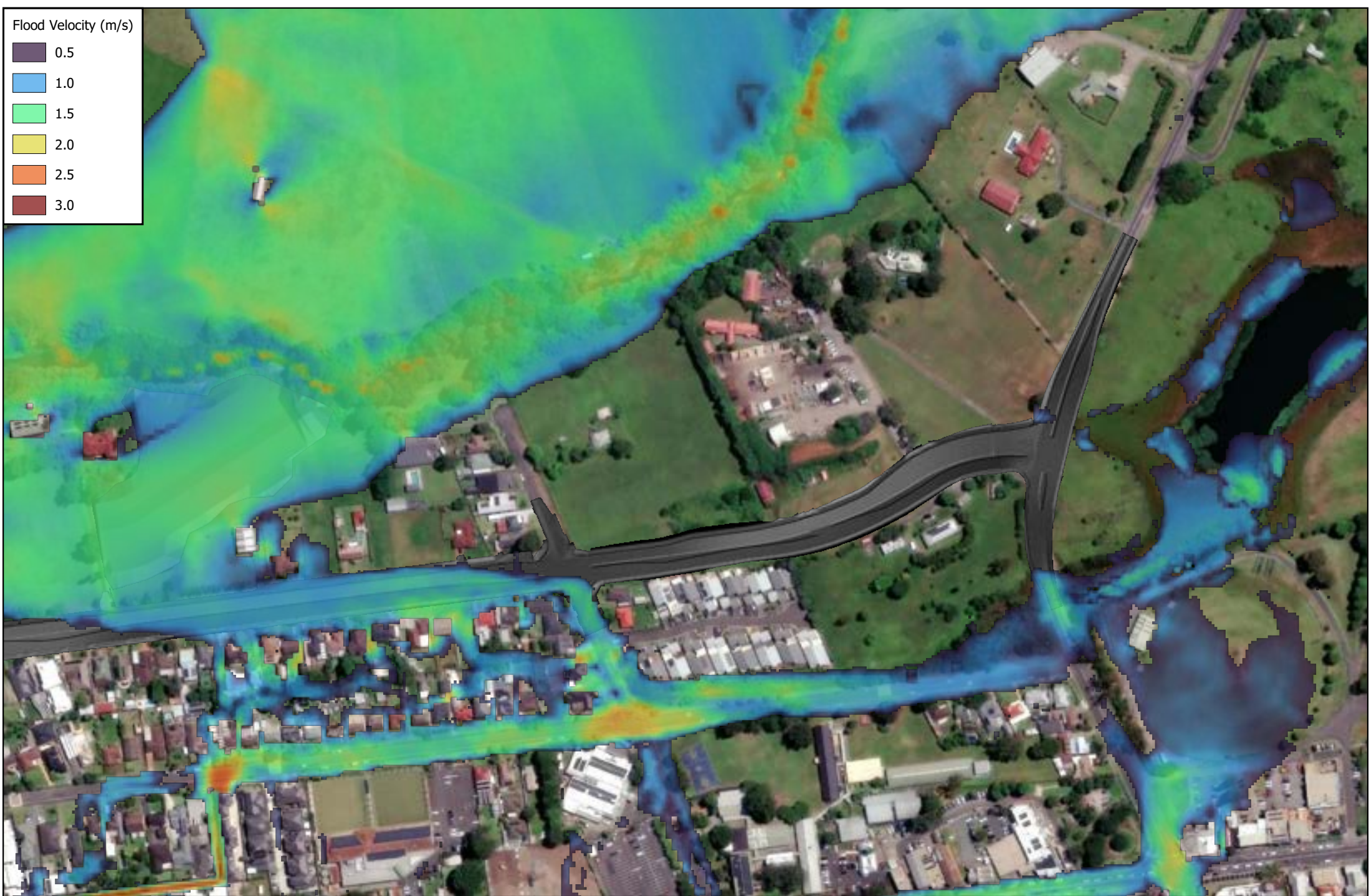










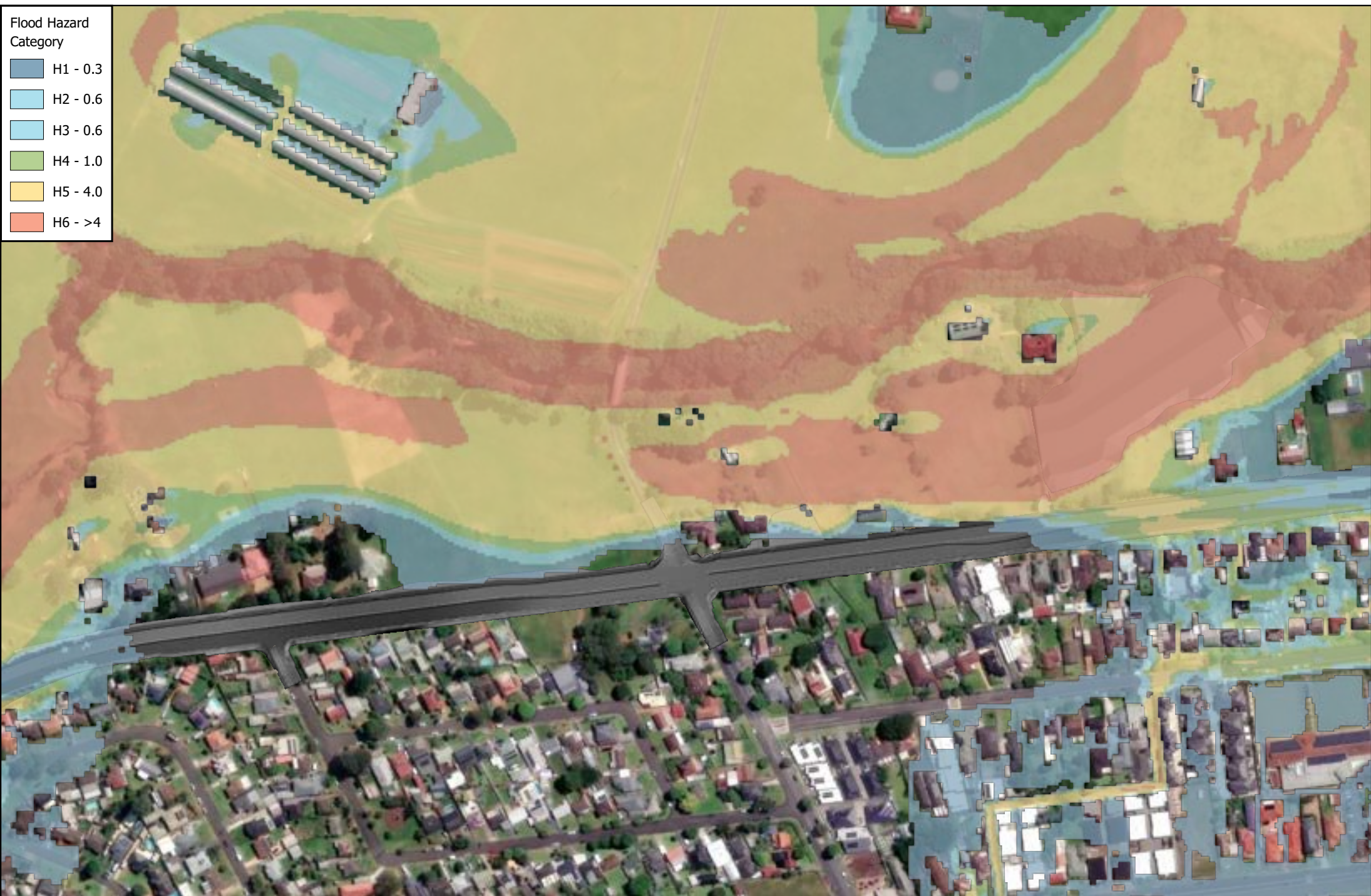


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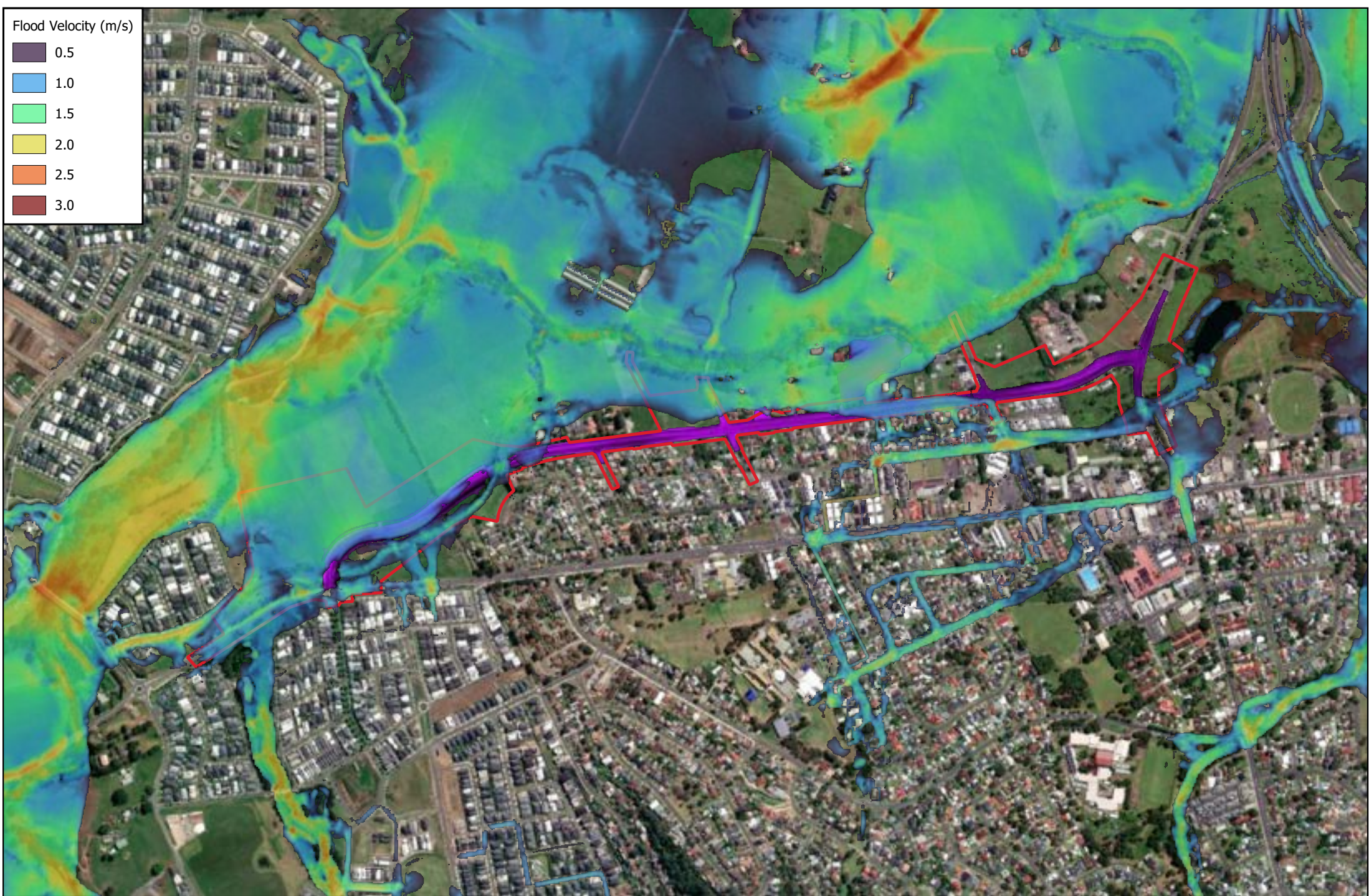


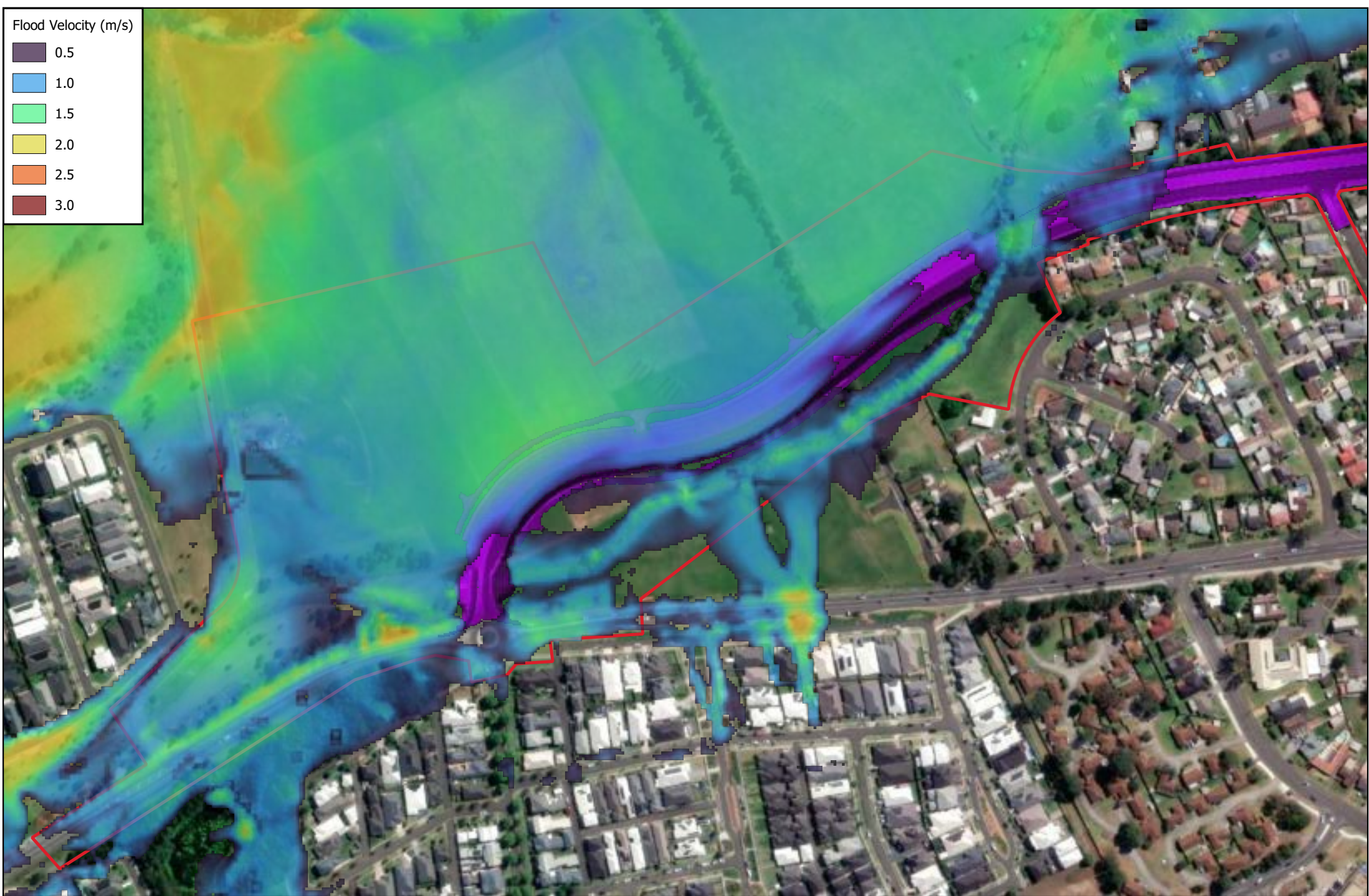


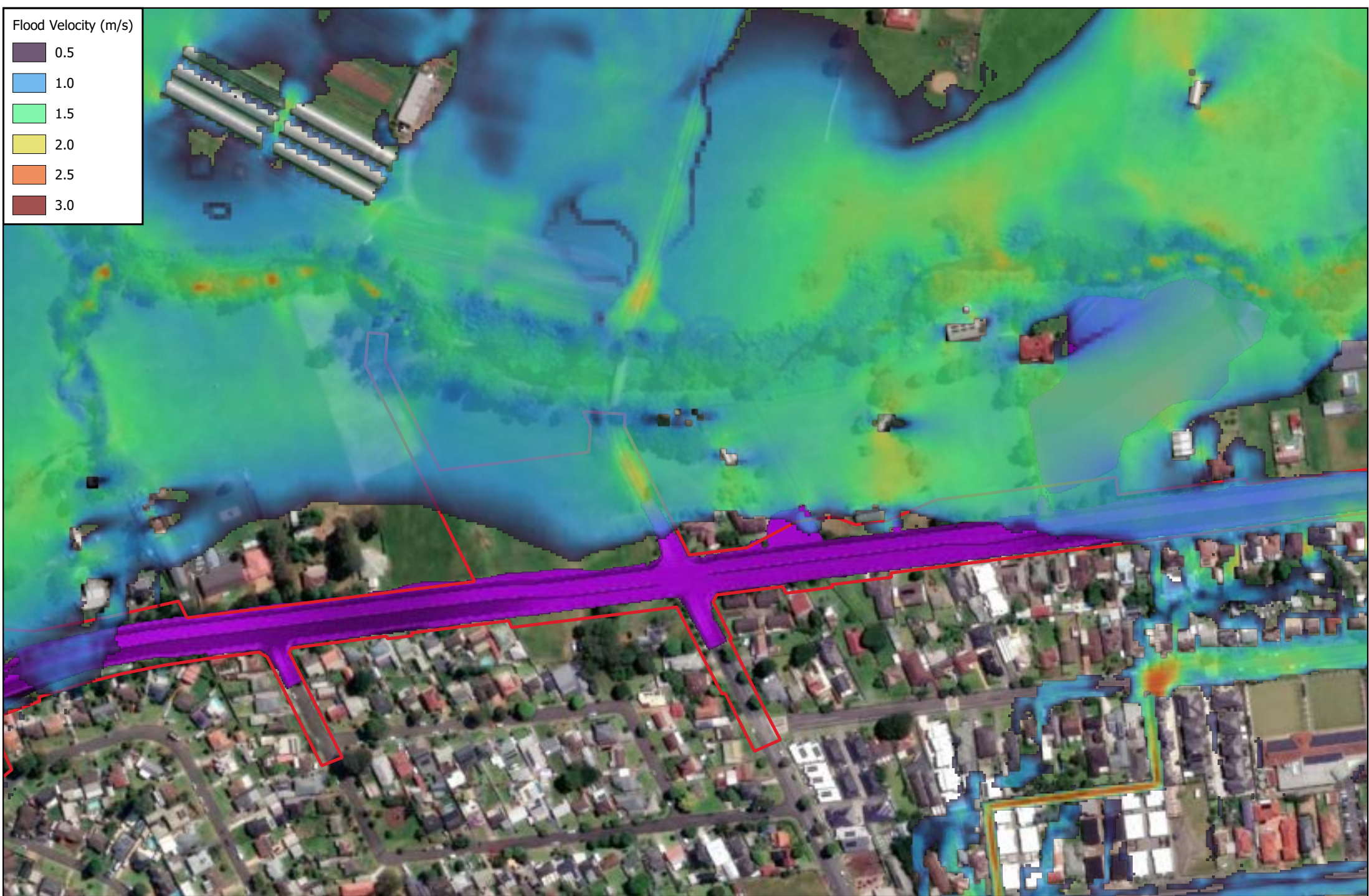


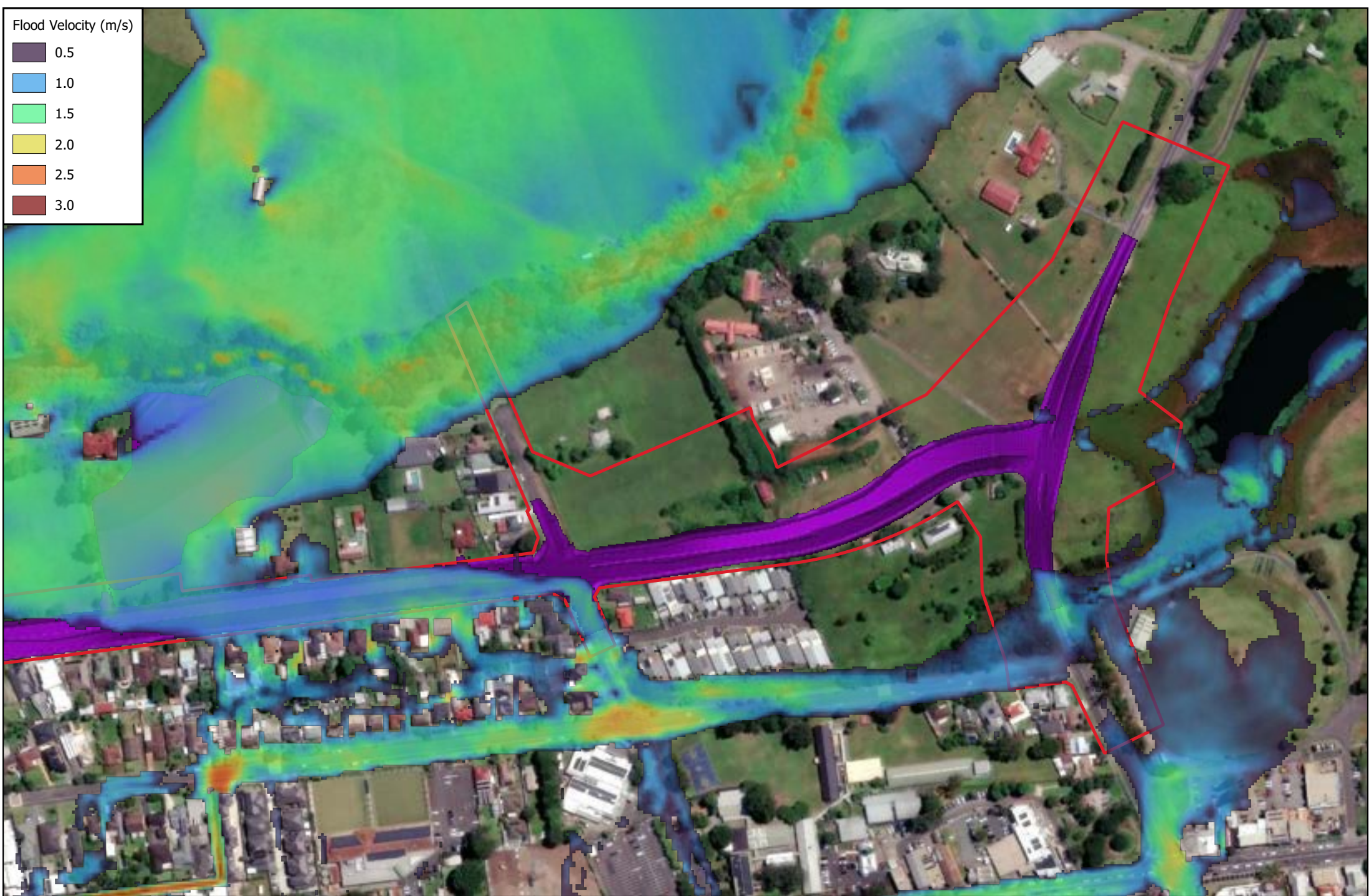












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