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This document was created in response to a Freedom of Information request made to CSIRO.

FOI Number: FOI2020/41

Date: 3 August 2020

Request: A list of studies undertaken since 2015 that quantify the exposure of Australian residential and/or businesses exposed to sea level rise and copies of any studies

Document(s): 1
4 publicly available

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Attachment B

FOI2020/41 - Document Schedule

Doc No	Date	Description	Section of Act	Decision
1.	2019	Western Port Bay Infrastructure Risk Mapping	s22	Part exempt
	2014-15	City of Port Phillip Flood Adaptation Modelling A journal paper was produced to summarise the outcomes of this work and can be accessed here: Journal Paper: https://onlinelibrary.wiley.com/doi/10.1111/jfr3.12556		Publicly Available
	2015	Natural Disaster Resilience Project (WA-NDRP) Bunbury Flood Modelling, Western Australian • Maps: https://doi.org/10.25919/5de00b45746d2 • Report: https://doi.org/10.25919/5de00b403a0b2		Publicly Available
	2015-16	City of Greater Geelong, Geelong Flood Modelling • Website with report and videos: http://www.ourcoast.org.au/ Report: http://www.ourcoast.org.au/resources/report_CoGGFloodAdaptationEffectivenessStudy_CSIRO2016.pdf		Publicly Available
	2020	Port Phillip Bay Coastal Hazard Assessment The project is in progress. The website for the project is here: https://www.marineandcoasts.vic.gov.au/coastal-programs/port-phillip-bay-coastal-hazard-assessment		Publicly Available

Infrastructure Risks Mapping

For the Western Port Region

Mahesh Prakash, Fareed Mirza, Raymond Cohen and Julian O'Grady

EP197851

13th November 2019

Prepared for Lalitha Ramachandran, Technical Project Manager, South East Water

Commercial-in-confidence

Citation

Prakash M., Mirza F., Cohen R. and O'Grady J. (2019) Pre-feasibility study into constructed coastal wetlands for the Western Port region – a report prepared for South East Water, EP197851

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Important disclaimer

Acknowledgments

This project was funded by South East Water through an open request for proposal and is being delivered by CSIRO Data61.

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Executive summary

This report provides the outcomes from an Infrastructure Risks Mapping exercise of South East Water assets for the Western Port Region. The infrastructure risks mapping was carried out as an add-on to the Constructed Coastal Wetland project for the Clyde Cardinia Augmentation project. It was carried out specifically for sea level rise related inundation and related storm surge and tidal effects and therefore relates to only sea level rise related climate change components. The coastal inundation modelling was carried out by using CSIRO Data61's SWIFT flood modelling capability (https://research.csiro.au/swift).

The infrastructure risks mapping was done for both above ground (such as Water Treatment Plant) as well as below ground (such as sewer pipes) infrastructure. The risks mapping was done by classifying the risk into five categories namely "Untouched", "Negligible", "Low", "Medium" and "High". Although these are qualitative in nature it provides an initial basis to understand the level of risk and use it as the basis for future planning including for climate-related financial disclosure considerations.

The flood inundation hazard calculation for coming up with the above category definition essentially used a standard engineering definition of "hazard" which is a product of the "water depth" and "water speed".

Based on the risks mapping water pipes and sewer pipes are most affected around Tooradin and Warneet regions and begin to get impacted even at a sea level rise of 0.2 m. Maintenance holes are also impacted in these locations and also show minor impact around Hastings on the western arm especially for sea level rise of 0.8 m and above. Most of the treatment plants are not impacted by the inundation except for the one at Blind Bight which starts getting impacted beyond a sea level rise of 0.6 m. Also although the treatment plant at Somers is not directly impacted the approach to it does have an impact at higher sea level rise scenarios beyond 0.6 m. This means some infrastructure consideration might need to be given for the approach roads towards this plant in future years. For below ground infrastructure it has to be noted that the risk is also related to salinity egress that could impact performance.

A subsequent introduction to South East Water's infrastructure risks assessment and how to improve assets resilience through adaptation planning, using these maps, was provided as a workshop by Lalitha Ramachandran (Technical Project Manager) with support from Rianda Mills (IWM Enabler). The workshop materials are available from Chris Tancheff, IWM Enabler, Liveable & Sustainable Futures.

1. Inundation Modelling

The following section covers inundation hazard modelling of the storm tide and sea level rise scenarios. The outputs from the inundation modelling are then used as input into the infrastructure risks mapping.

1.1 Modelling Inputs & Assumptions

The *Western Port Coastal Hazard Assessment Study* carried out by Water Technology, Arrowsmith et al. (2014), was used as the basis to provide inputs into the modelling for this study. The need to simulate scenarios rather than use data from that study was because South East Water required depth, speed and water retention time information for the relevant sea level rise scenarios. These parameters were not accessible through the outputs from that study. Also, all the sea level rise scenarios requested by South East Water were not simulated in Arrowsmith et al. (2014). It should also be noted that for the current study we have focussed on coastal inundation and have not included catchment effects.

Inundation was computed for the following sea-level rises in consultation with South East Water: 0.2 m, 0.6 m, 0.8 m and 1.1 m. These values are consistent with the recommendations made for such studies by the State of Victoria and cover a range that includes the highest plausible sea level rise for the region for an extreme 2100 climate change event. It has to be noted that current sea level rise as per Church et al. (2013) is already around 8 cm higher than 2000 levels in the region of interest.

The inundation modelling was performed using SWIFT, CSIRO Data61's hydrodynamic flood modelling capability (https://research.csiro.au/swift/). It has the ability to concurrently carry out coastal and catchment flooding. Built on top of SWIFT is the **Cities Flood Adaptation Solutions Tool (CFAST)** which can be used to evaluate the effectiveness of hard and soft adaptation measures. This project focussed on just using SWIFT for the flood modelling component.

1.2 Input data

The Digital Elevation Model (DEM) was sourced from 2017 Victorian Coastal DEM (VCDEM). The coverage is a mix of 5m and 10m resolution data.

The project domain is bounded by the coordinates (-38.445, 145.155) to (-38.1, 145.6).

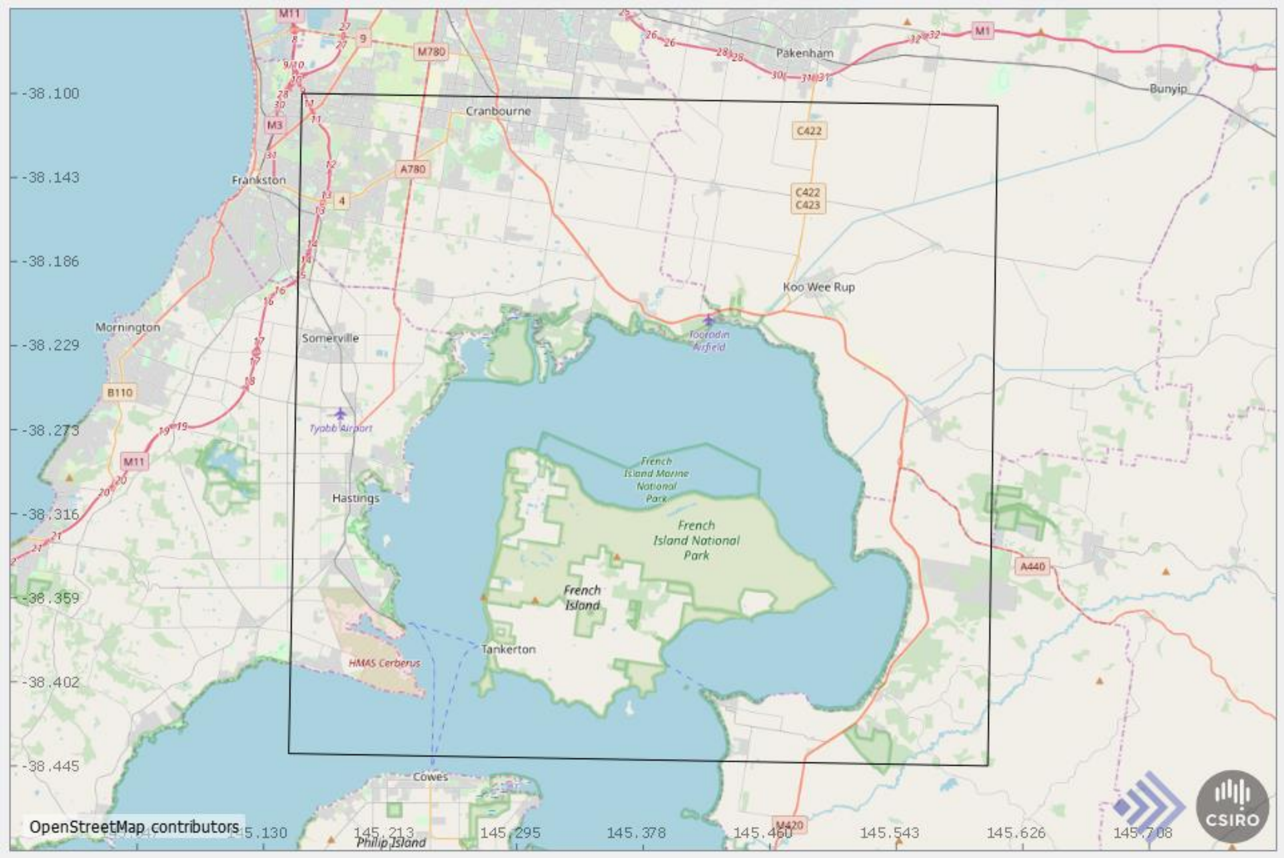

Figure 1: Boundary of the simulation domain for the hydrodynamic modelling using CSIRO Data61's SWIFT tool.

OpenStreetMap (https://www.openstreetmap.org/#map=4/-28.15/133.28) is used to provide the background to the maps for visualising the simulated outputs.

Storm surge conditions were modelled using value >0.4m at Stony Point between 1993 and 2012, sourced from the report by Water Technology, Arrowsmith et al. (2014). The data points were digitised and used as input to the SWIFT model. The graph represents the combined height of astronomical tide and 1% AEP storm surge, giving the 1% storm tide values.

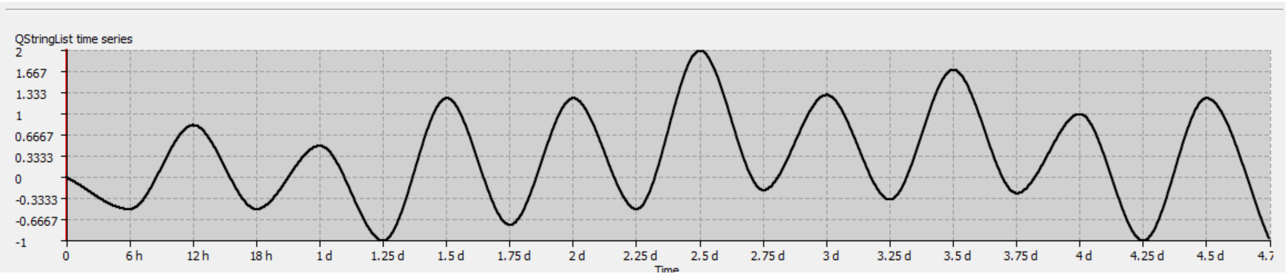

Figure 2: Storm surge and tidal input into the SWIFT model.

1.3 Validation

The flood extent reported by Water Technology for the *0.8 SLR + Storm Tide* was used to compare/benchmark the extents computed with the SWIFT model. Although both outputs are modelled outputs such comparison does provide a level of confidence in the results obtained from the modelling exercise. The agreement in extents was verified visually by overlapping the maps and examining at clear landmarks. After allowing for variation stemming from uncertainty caused by differences in initial conditions, input data and modelling algorithms, it was concluded that the flood extent computed in the two models are sufficiently in agreement to proceed with extracting further outputs from SWIFT such as water speed and time of inundation.

Figure 3: Comparison of inundation extent for 0.8 m SLR between the Water Technology study, Arrowsmith et al. (2014), left panel and the current study using SWIFT, right panel.

1.4 Outputs

The SWIFT simulation runs produced sets of flood extents showing maximum water height, maximum speed and time of inundation of flood water. The time of inundation of flood water was calculated for water that is 0.3 m and higher so that any “thin” amounts of long lived water can be ignored from the analysis. Outputs for the four different sea level rise scenarios (0.2 m, 0.6 m, 0.8 m and 1.1 m) have been presented in the figures below (Figures 4 to 24).

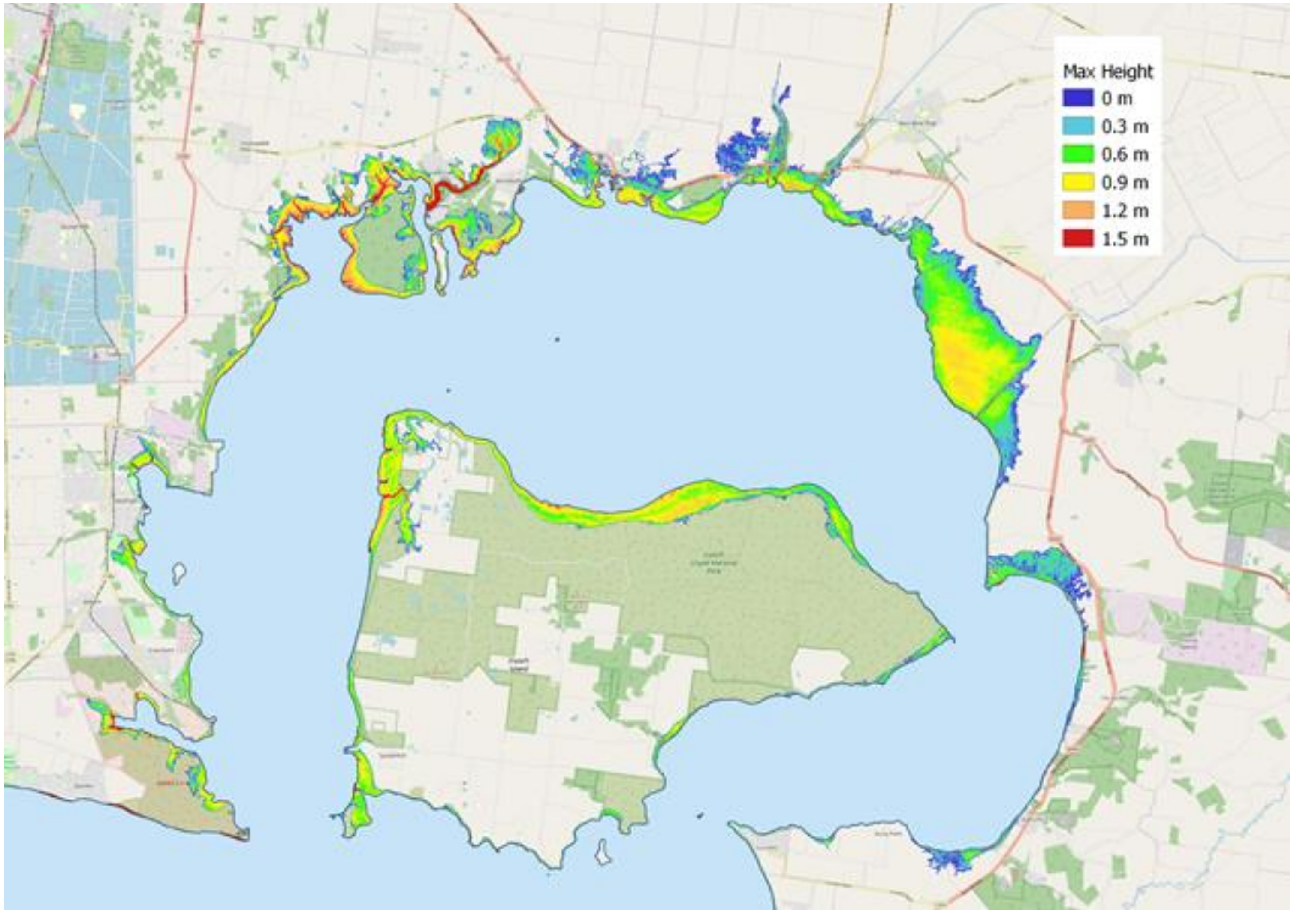

Figure 4: Flood extent coloured by maximum water height for sea level rise scenario of 0.2 m. Includes a 1% AEP storm surge.

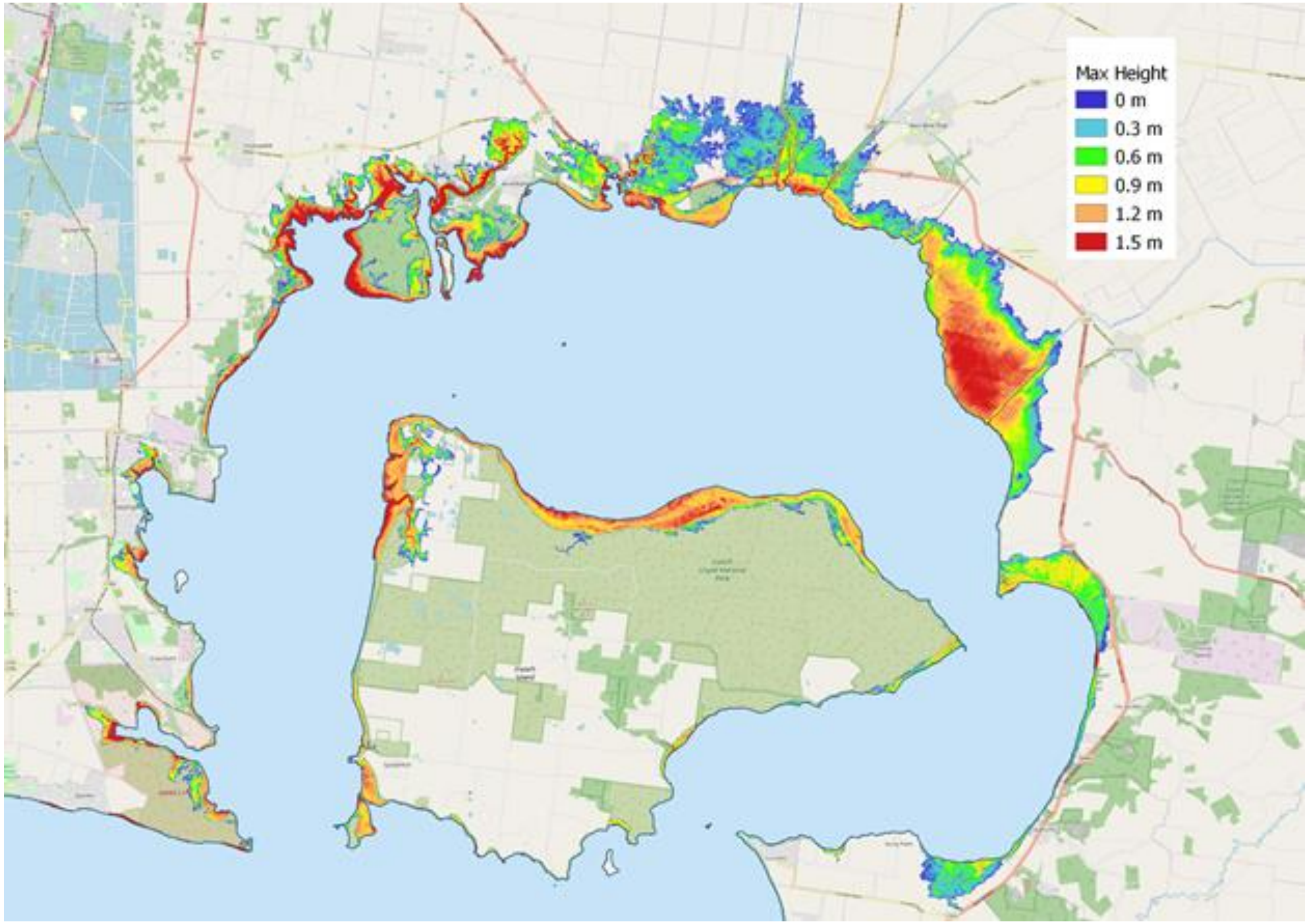

Figure 5: Flood extent coloured by maximum water height for sea level rise scenario of 0.6 m. Includes a 1% AEP storm surge.

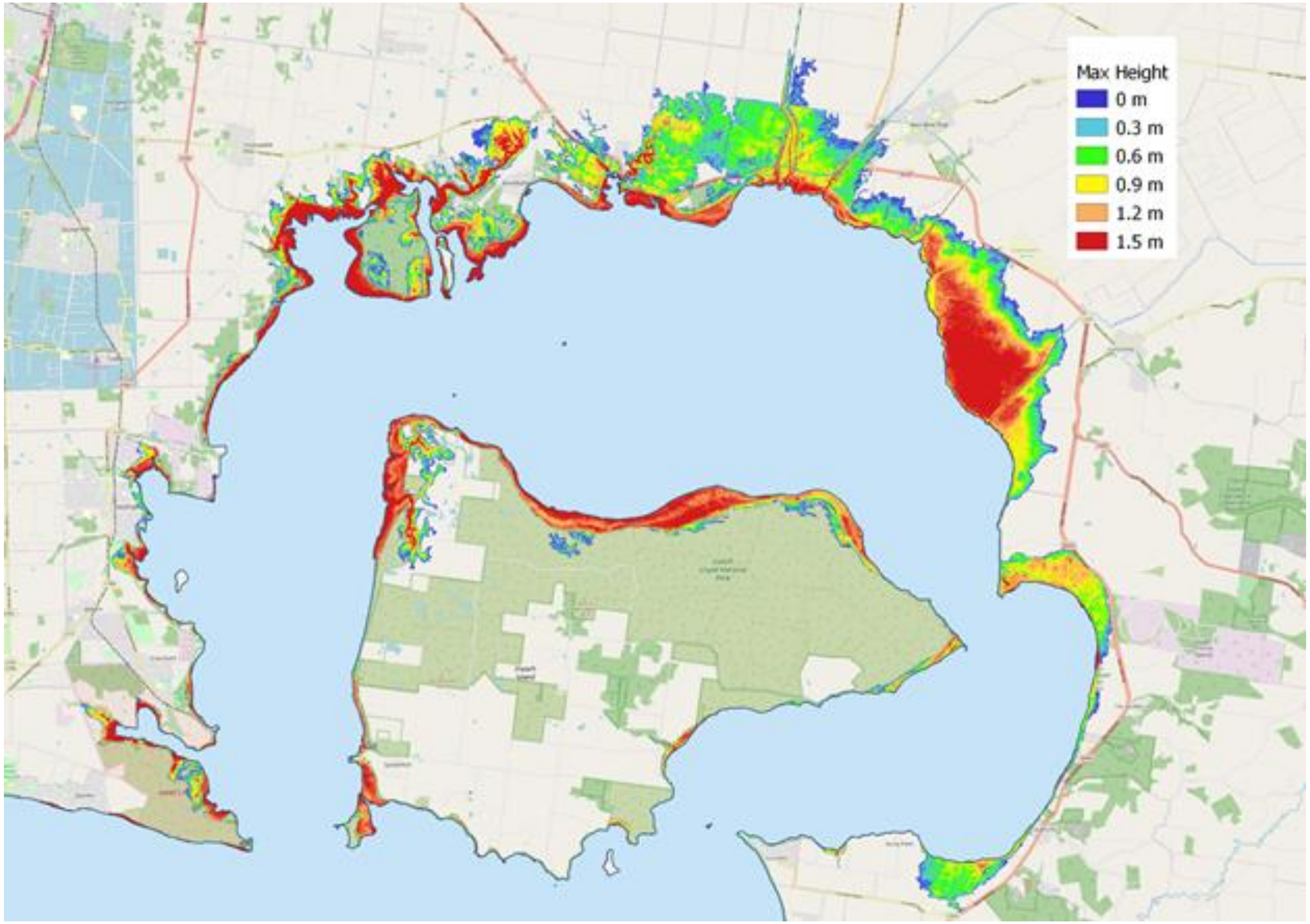

Figure 6: Flood extent coloured by maximum water height for sea level rise scenario of 0.8 m. Includes a 1% AEP storm surge.

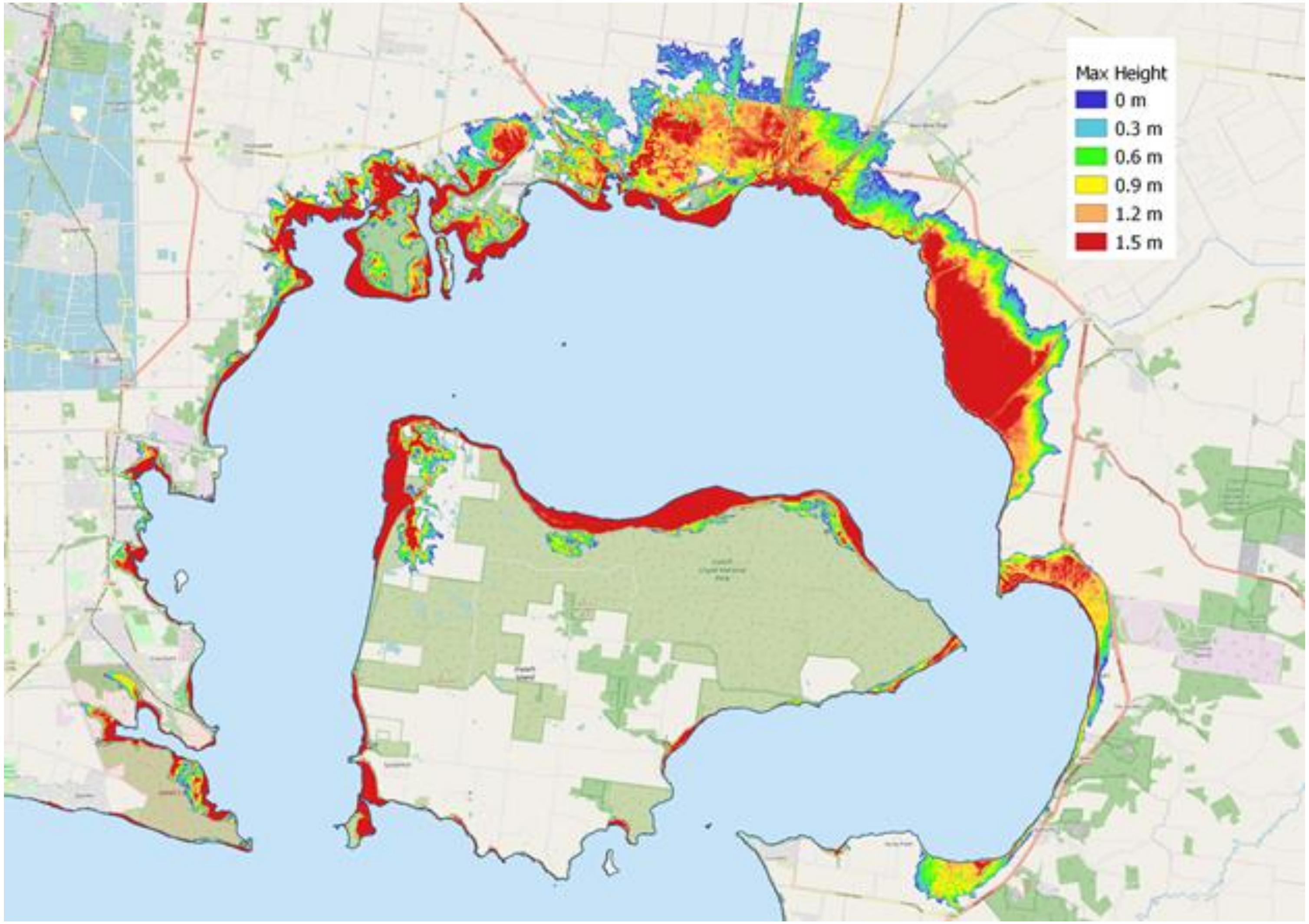

Figure 7: Flood extent coloured by maximum water height for sea level rise scenario of 1.1 m. Includes a 1% AEP storm surge.

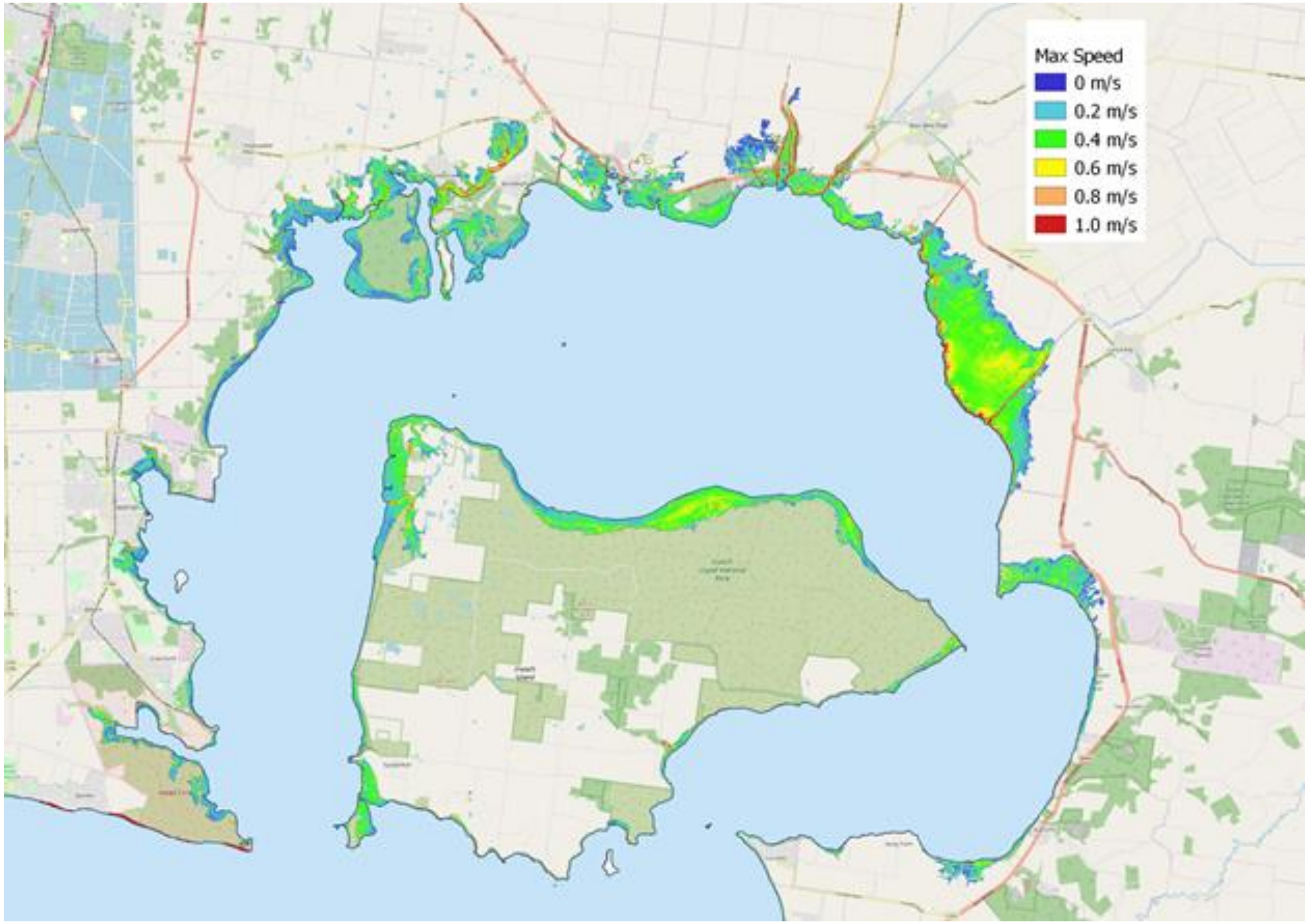

Figure 8: Flood extent coloured by maximum water speed for sea level rise scenario 0.2 m. This includes a 1% AEP storm surge event.

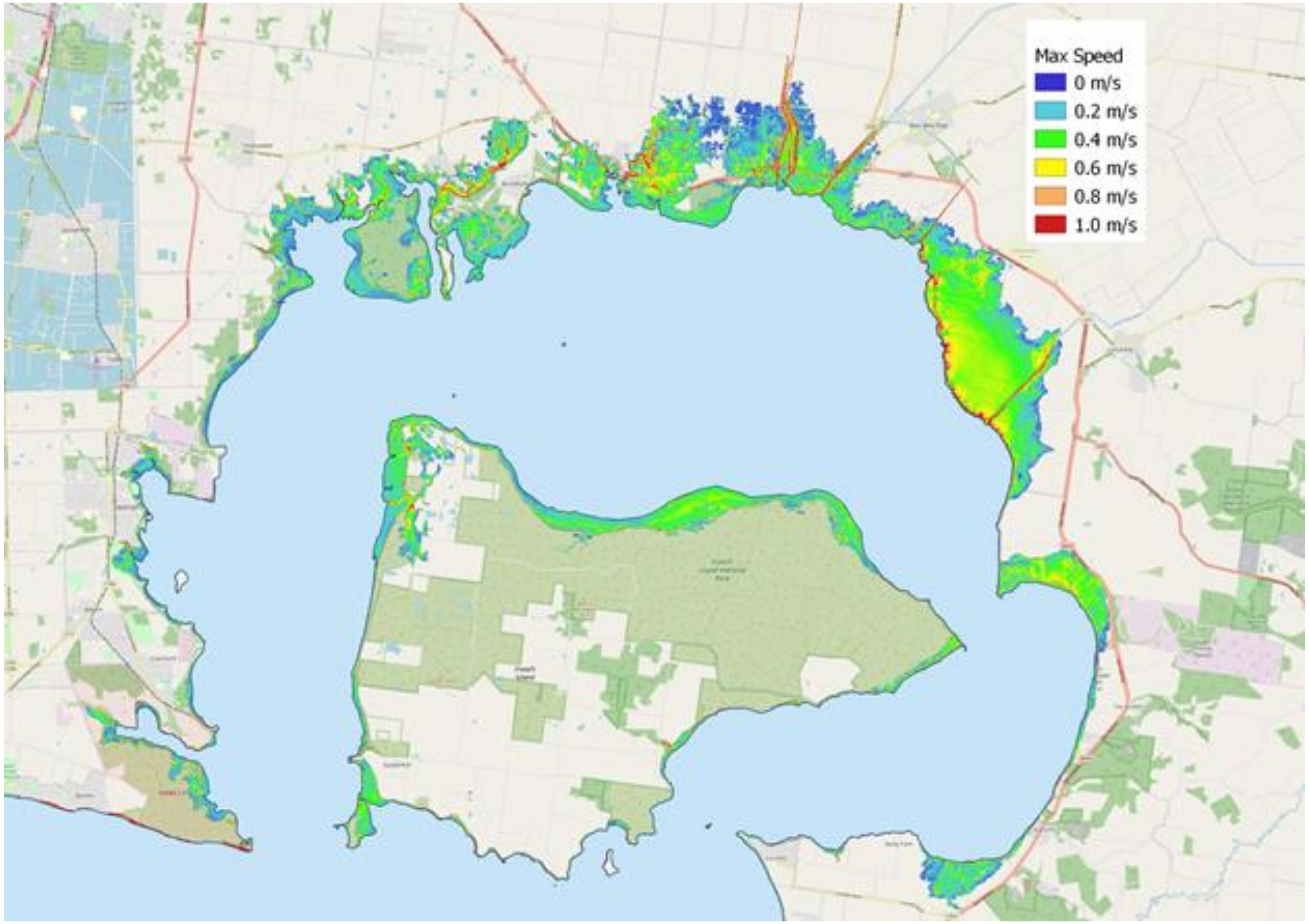

Figure 9: Flood extent coloured by maximum water speed for sea level rise scenario 0.6 m. This includes a 1% AEP storm surge event.

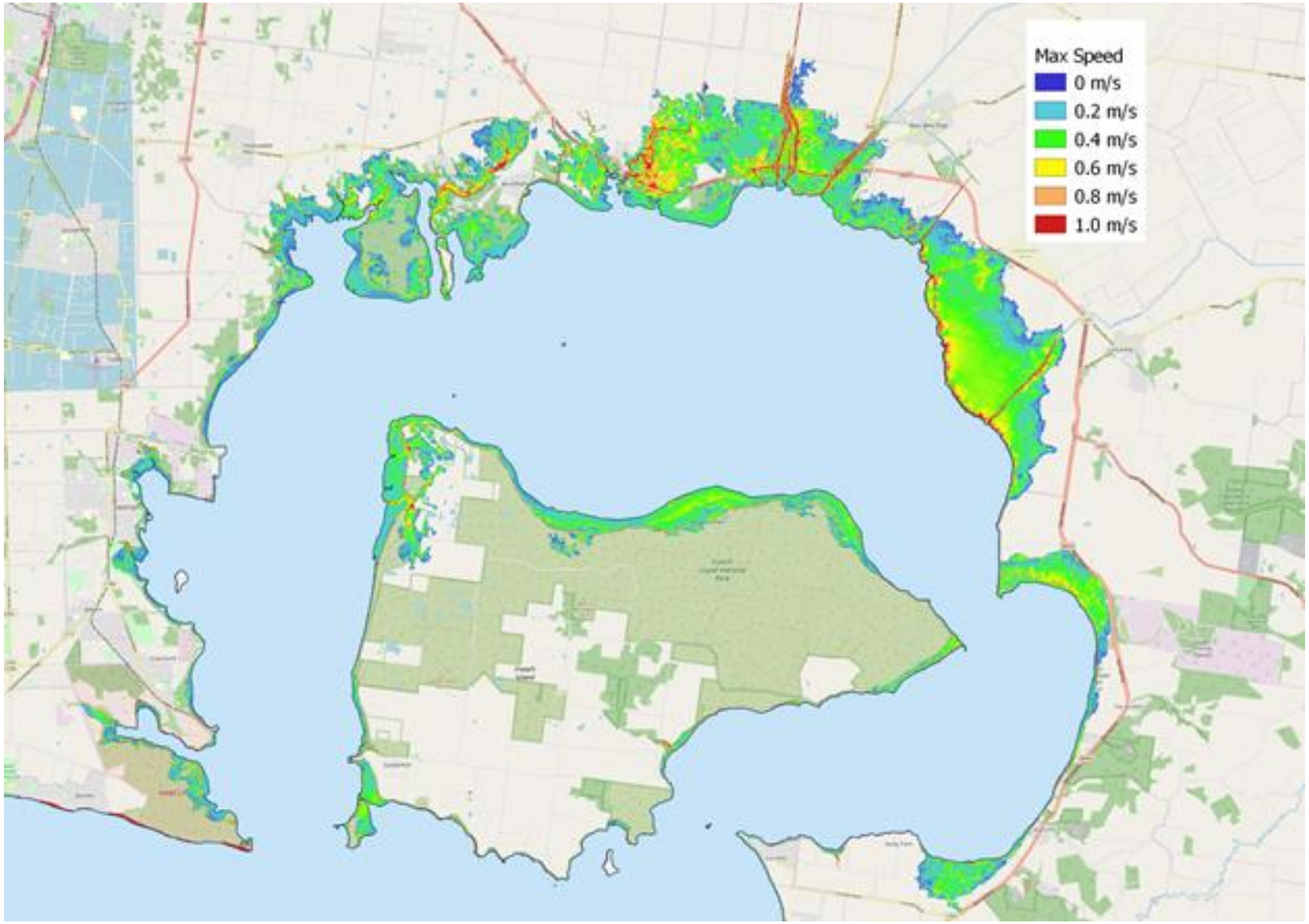

Figure 10: Flood extent coloured by maximum water speed for sea level rise scenario 0.8 m. This includes a 1% AEP storm surge event.

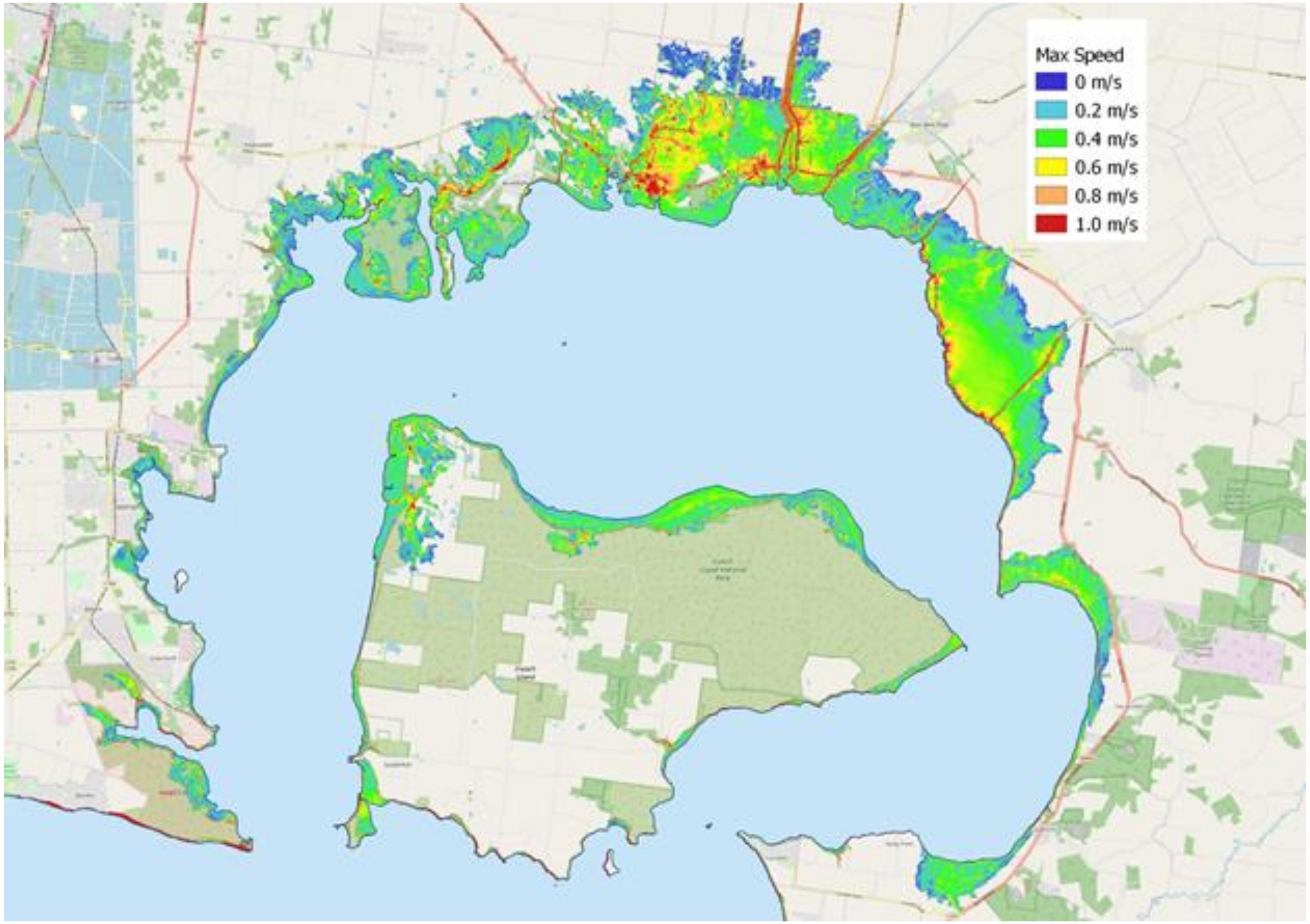

Figure 11: Flood extent coloured by maximum water speed for sea level rise scenario 1.1 m. This includes a 1% AEP storm surge event.

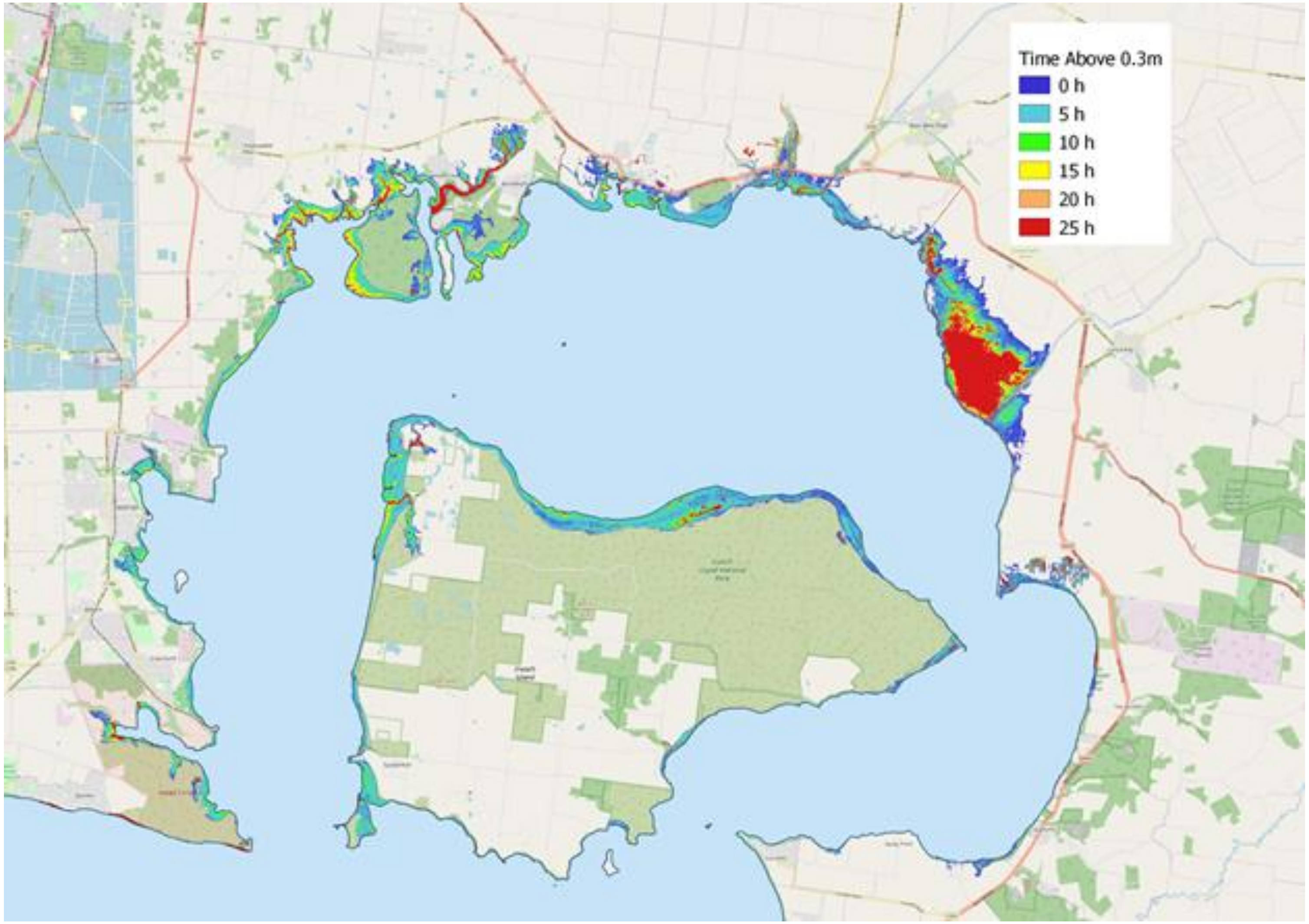

Figure 12: Flood extent coloured by time of inundation for sea level rise scenario 0.2 m. This includes a 1% AEP storm surge.

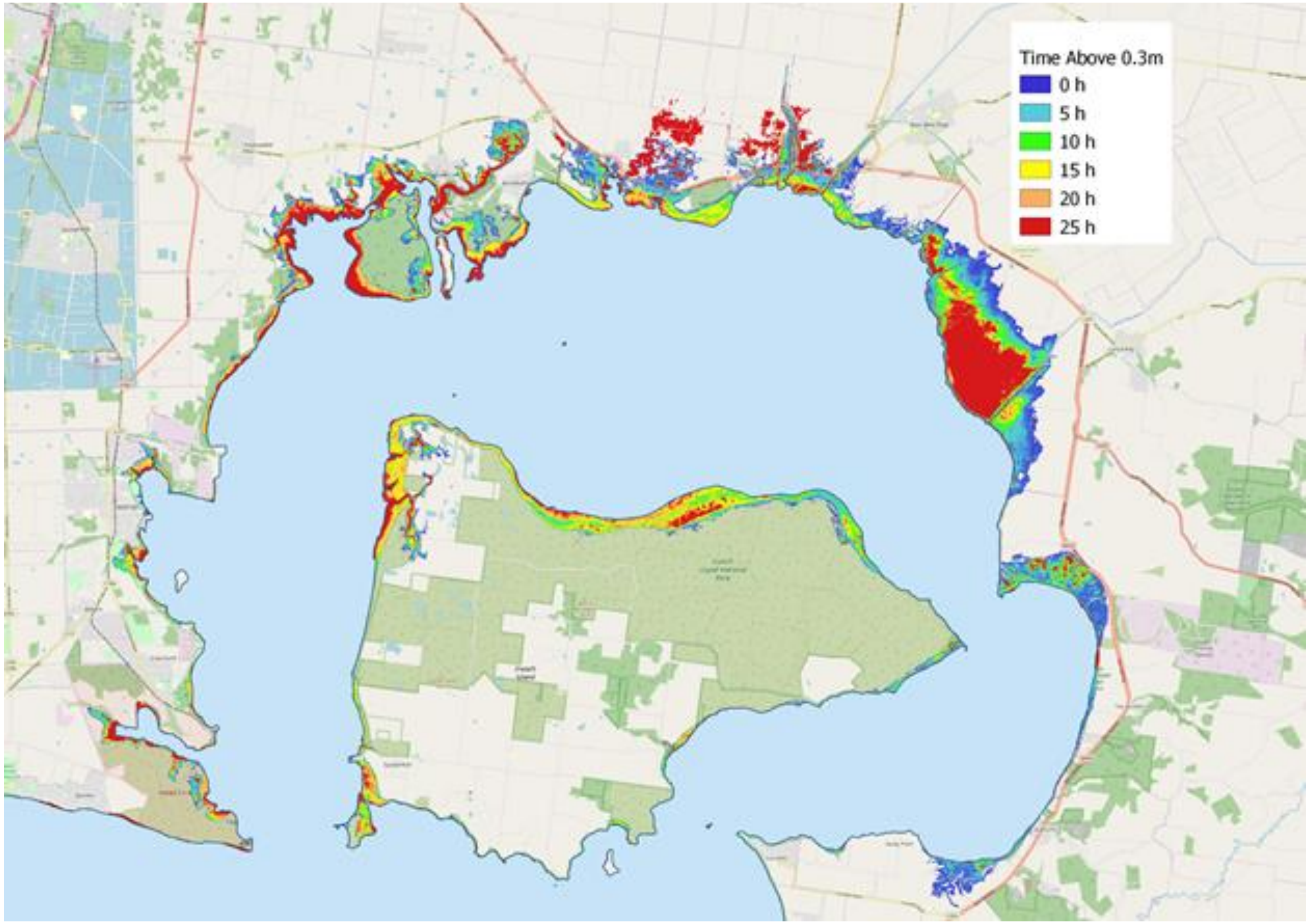

Figure 13: Flood extent coloured by time of inundation for sea level rise scenario 0.6 m. This includes a 1% AEP storm surge.

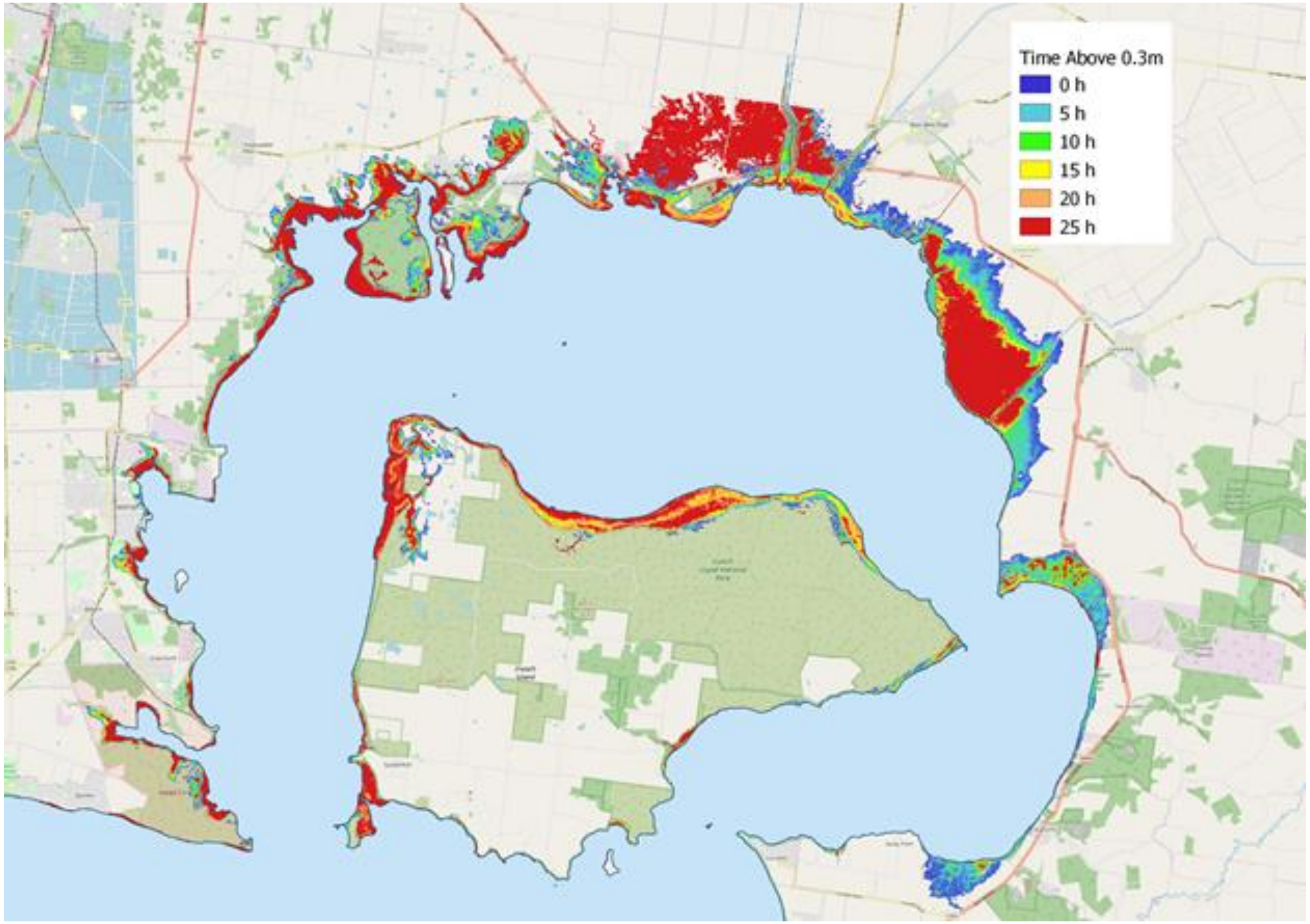

Figure 14: Flood extent coloured by time of inundation for sea level rise scenario 0.8 m. This includes a 1% AEP storm surge.

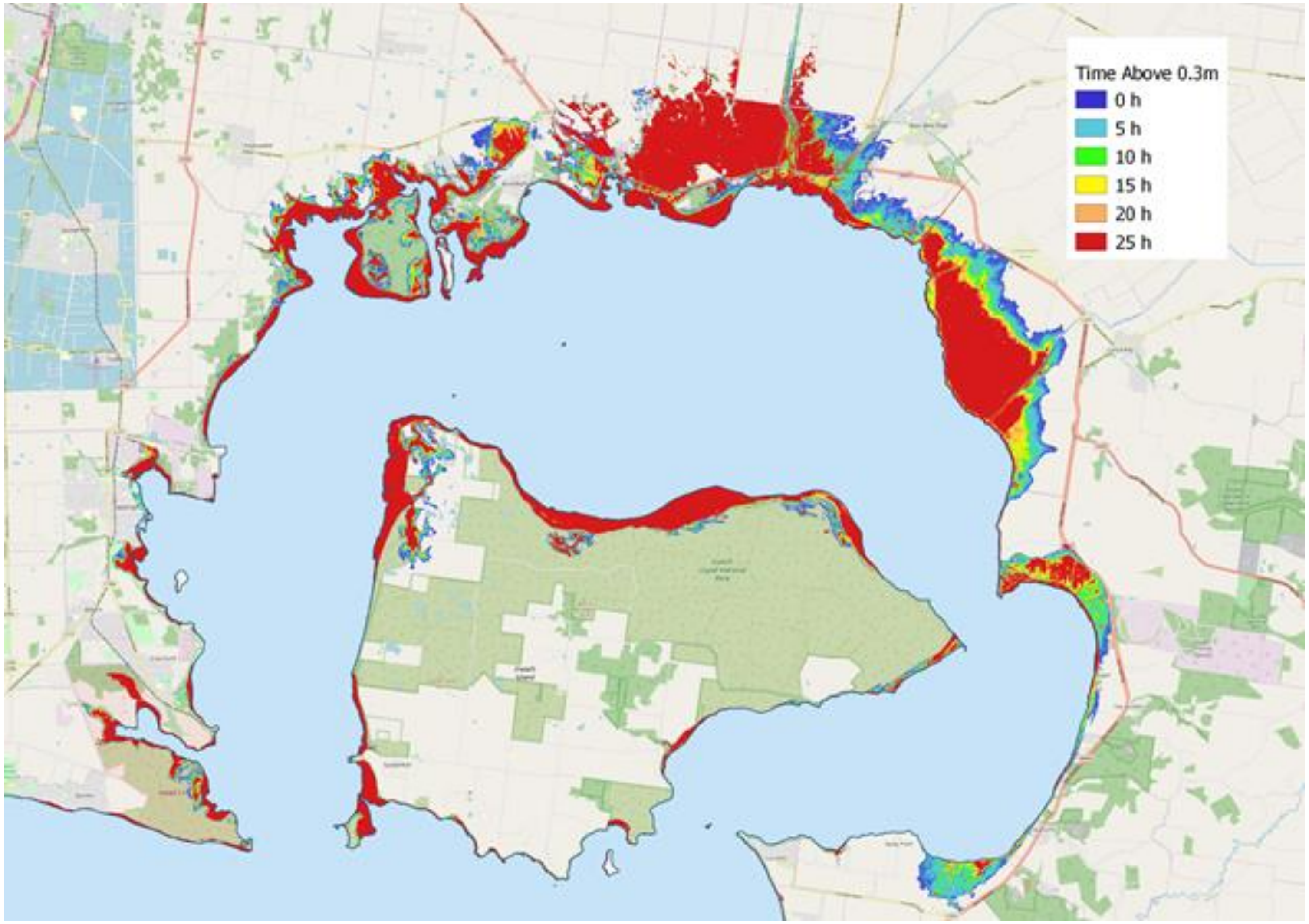

Figure 15: Flood extent coloured by time of inundation for sea level rise scenario 1.1 m. This includes a 1% AEP storm surge.

2.Infrastructure Risks Mapping

To calculate and assign an indicative hazard class for assets in the flood impacted areas, a new overlay was calculated, being the product of Maximum Height by Maximum Speed, normalised into five categories:

Untouched (0), Negligible (0 to 25%), Low (25% to 50%), Medium (50% to 75%) and High (75% to 100%), where Untouched means the asset is not impacted by the flood at all whereas High means the asset is very significantly impacted by the flood. There were several asset classes for which data was supplied by South East Water and included Water Pipes, Sewer Pipes, Maintenance Holes, Treatment Plant Properties, Sewer Emergency Relief Structures (ERS), Water Storages and Water Pump Stations. In order to clearly represent the risk associated with each type of infrastructure maps are presented below with water pipes, sewer pipes and maintenance holes represented independently and the rest including the treatment plants combined into a single map.

Water pipes and sewer pipes are most affected around Tooradin and Warneet regions and begin to get impacted even at a sea level rise of 0.2 m. Maintenance holes are also impacted in these locations and also show minor impact around Hastings on the western arm especially for sea level rise of 0.8 m and above. Most of the treatment plants are not impacted by the inundation except for the one at Blind Bight which starts getting impacted beyond a sea level rise of 0.6 m. Also although the treatment plant at Somers is not directly impacted the approach to it does have an impact at higher sea level rise scenarios beyond 0.6 m. This means some infrastructure consideration might need to be given for the approach roads towards this plant in future years.

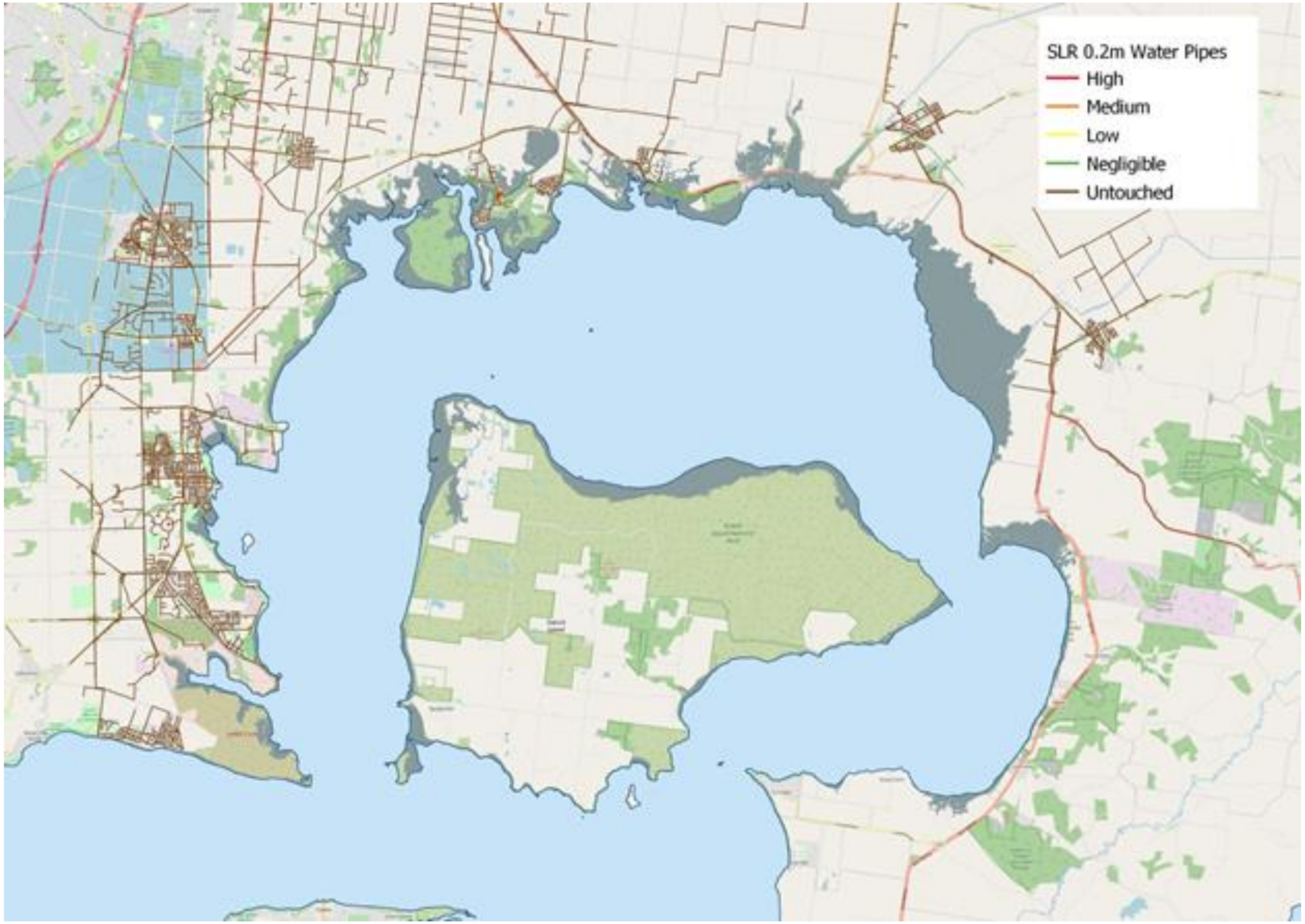

Figure 16: Infrastructure Hazard for Water pipes for sea level rise scenario 0.2 m. This includes a 1% AEP storm surge.

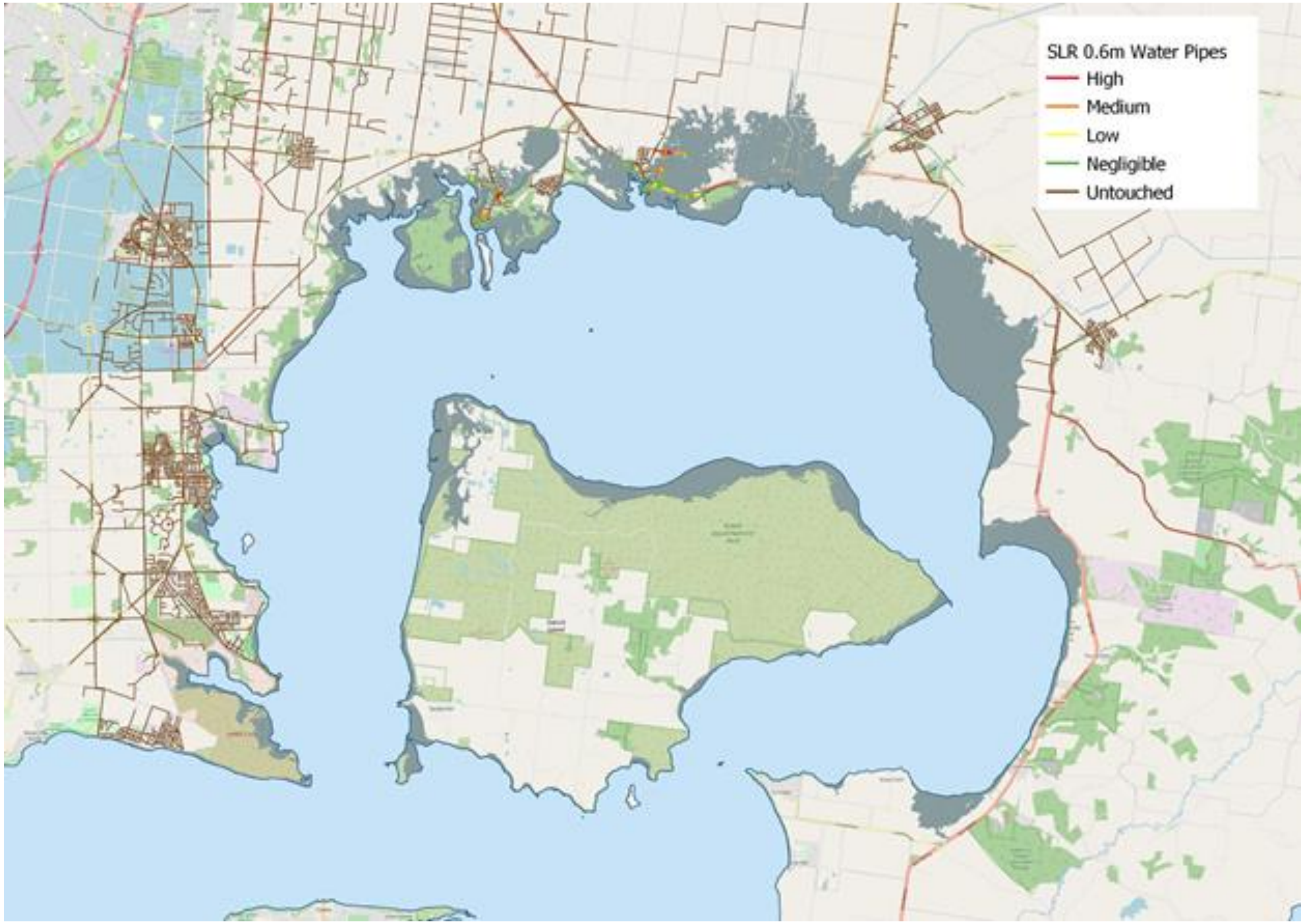

Figure 17: Infrastructure Hazard for Water pipes for sea level rise scenario 0.6 m. This includes a 1% AEP storm surge.

Figure 18: Infrastructure Hazard for Water pipes for sea level rise scenario 0.8 m and (d) 1.1 m. This includes a 1% AEP storm surge

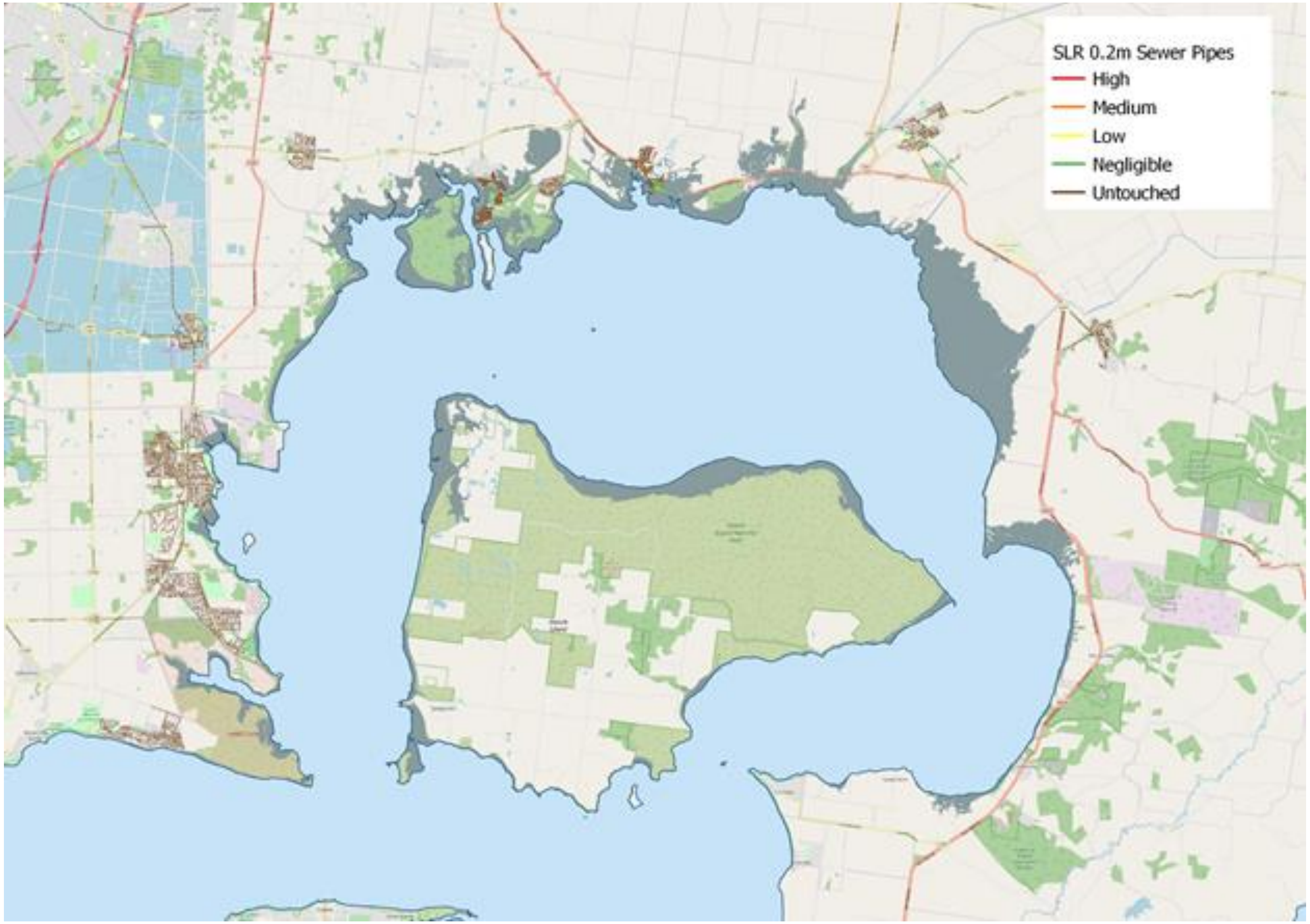

Figure 19: Infrastructure Hazard for Sewer pipes for sea level rise scenario 0.2 m. This includes a 1% AEP storm surge.

Figure 20: Infrastructure Hazard for Sewer pipes for sea level rise scenario 0.6 m. This includes a 1% AEP storm surge.

Figure 21: Infrastructure Hazard for Sewer pipes for sea level rise scenario 0.8 m. This includes a 1% AEP storm surge.

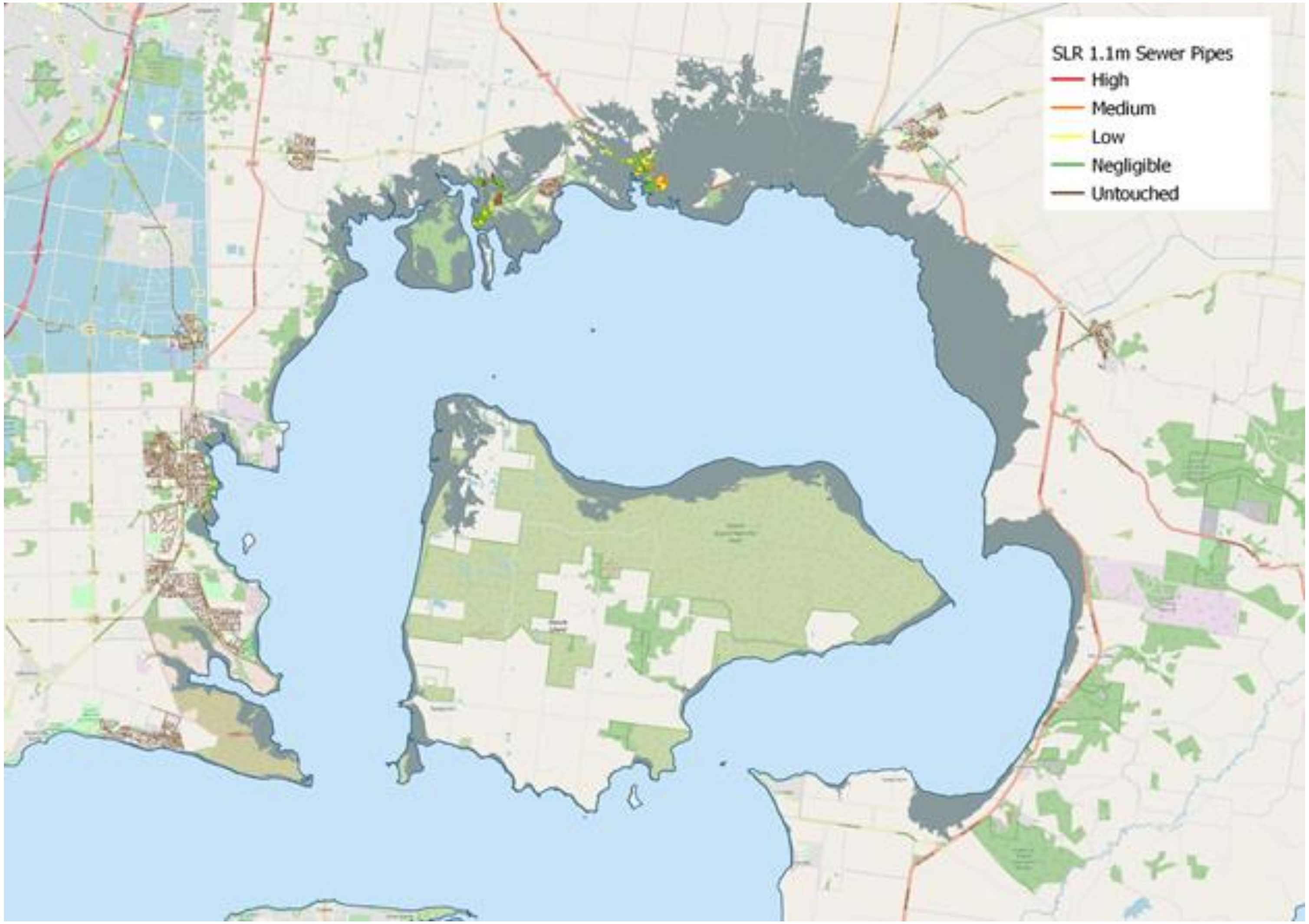

Figure 22: Infrastructure Hazard for Sewer pipes for sea level rise scenario 1.1 m. This includes a 1% AEP storm surge.

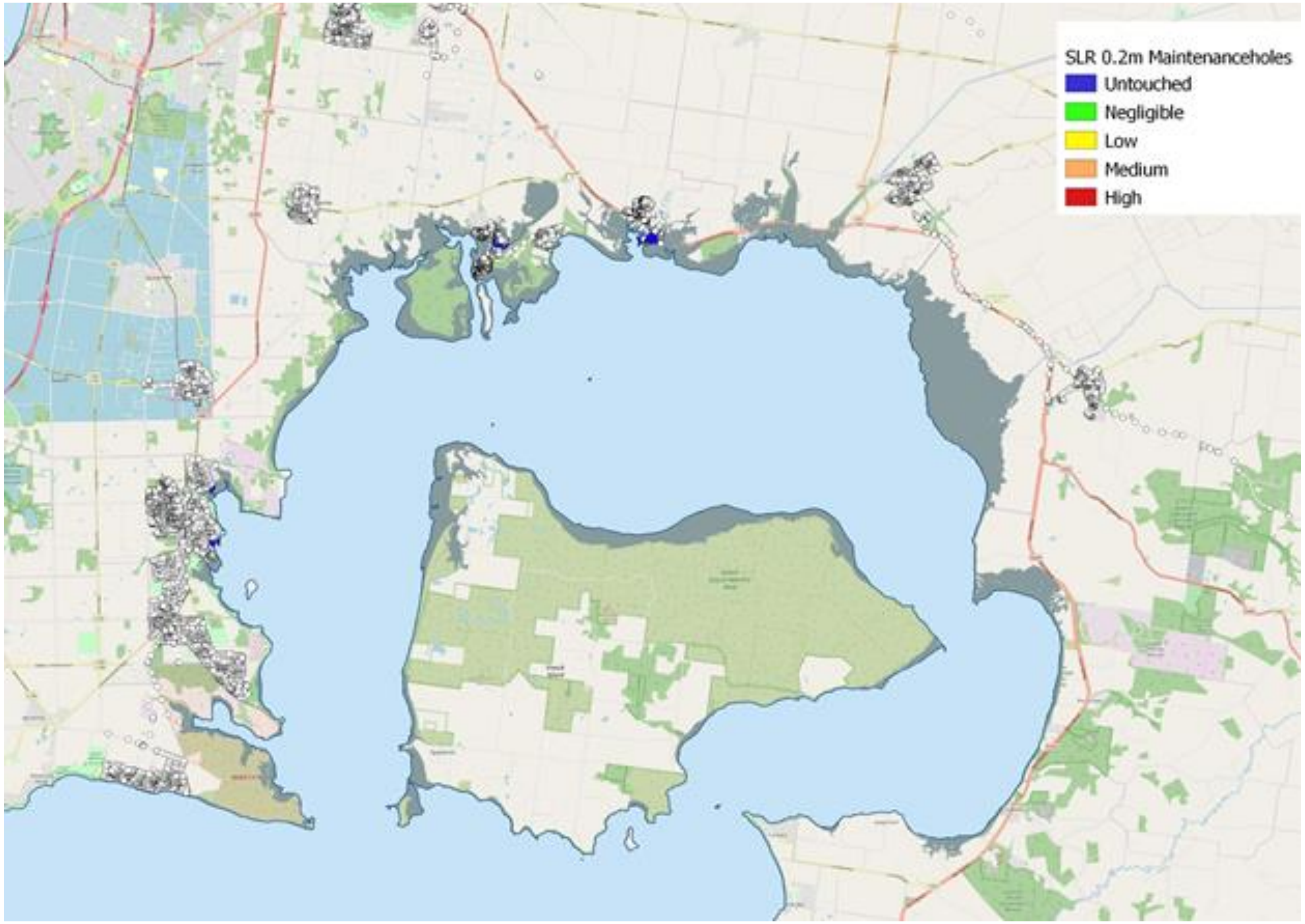

Figure 23: Infrastructure Hazard for Maintenance Holes for sea level rise scenario 0.2 m. This includes a 1% AEP storm surge.

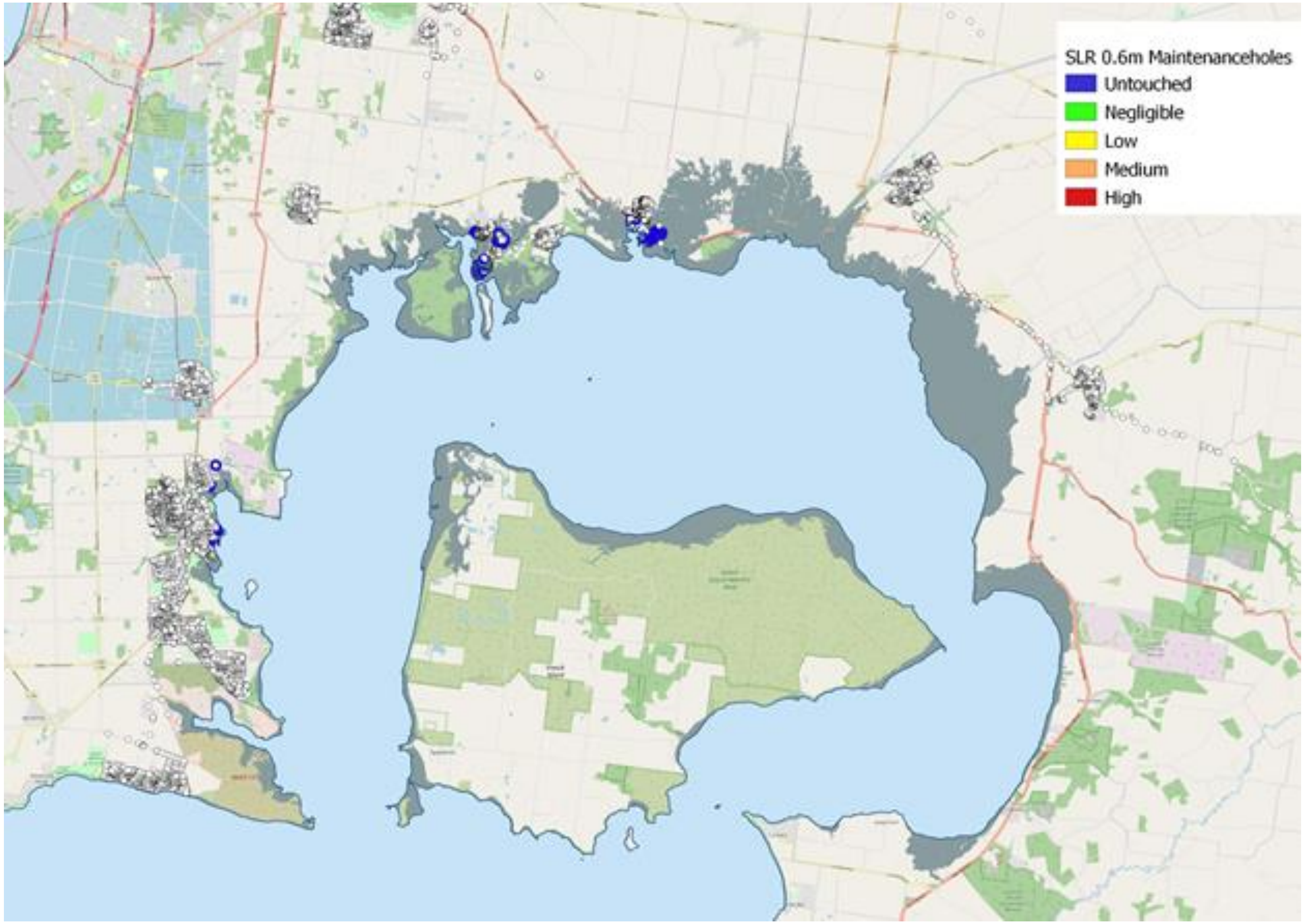

Figure 24: Infrastructure Hazard for Maintenance Holes for sea level rise scenario 0.6 m. This includes a 1% AEP storm surge.

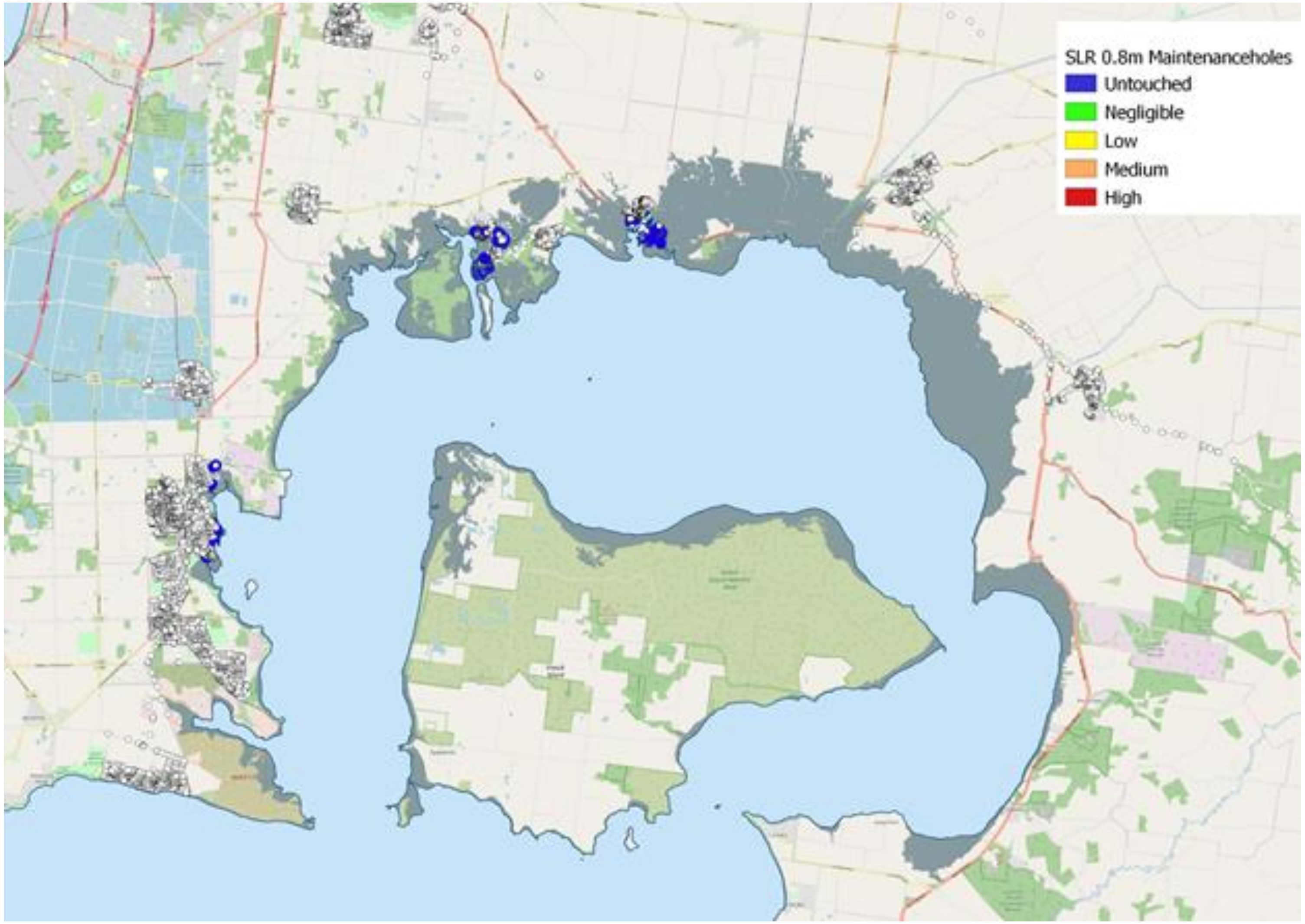

Figure 25: Infrastructure Hazard for Maintenance Holes for sea level rise scenario 0.8 m. This includes a 1% AEP storm surge.

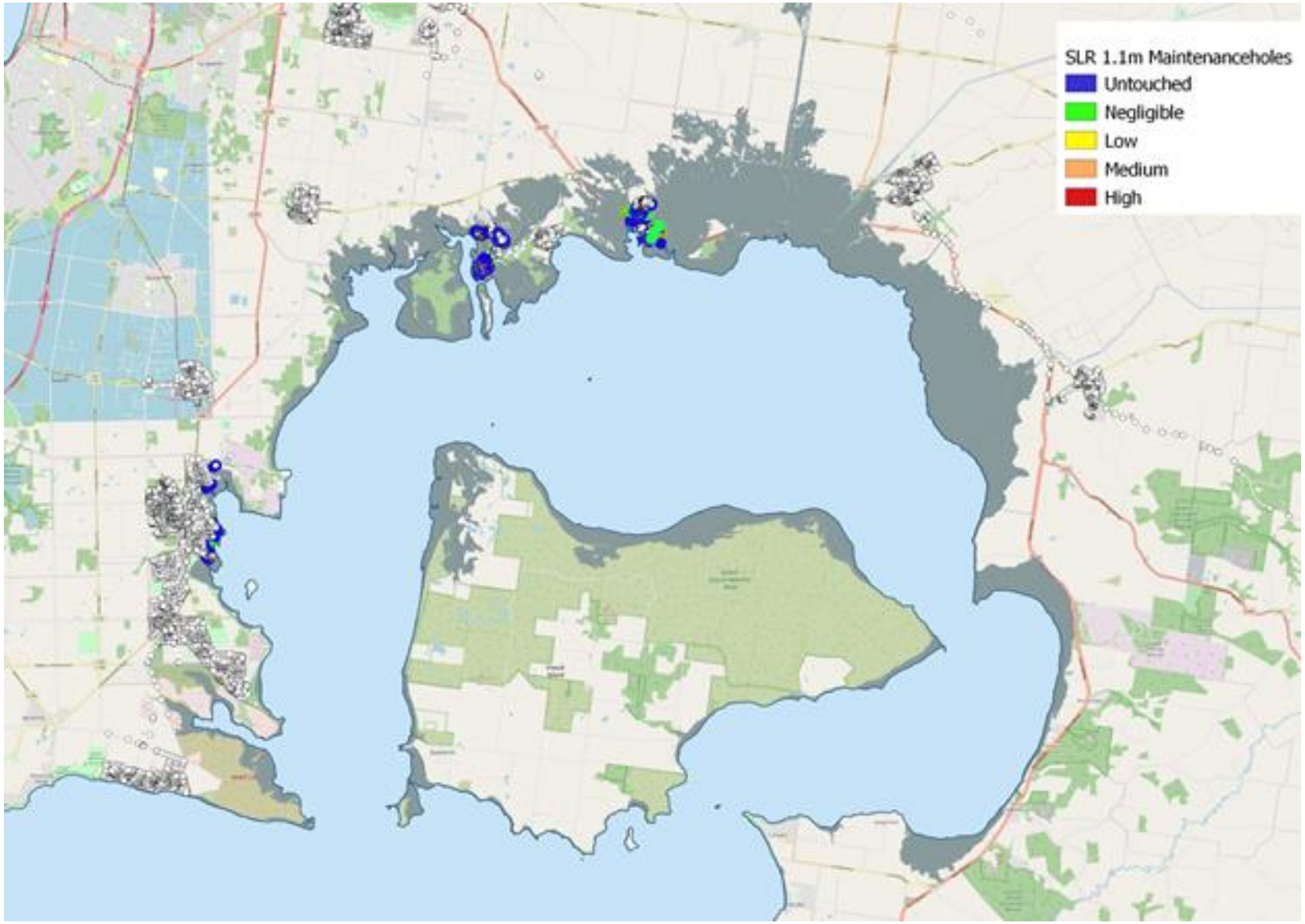

Figure 26: Infrastructure Hazard for Maintenance Holes for sea level rise scenario 1.1 m. This includes a 1% AEP storm surge.

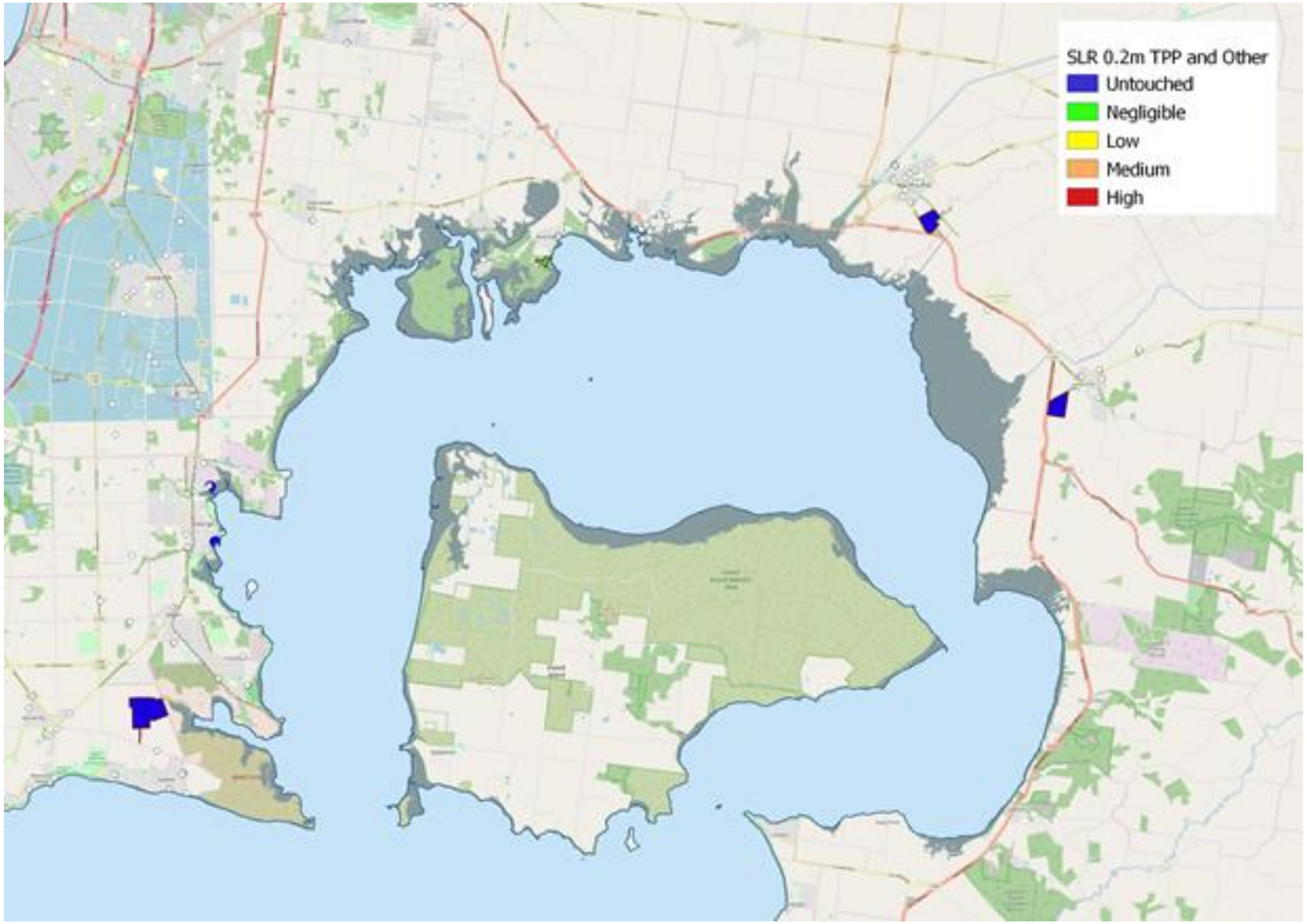

Figure 27: Infrastructure Hazard for Treatment Plant Properties, Sewer ERS, Water Storages and Water Pump Stations for sea level rise scenarios 0.2 m. This includes a 1% AEP storm surge.

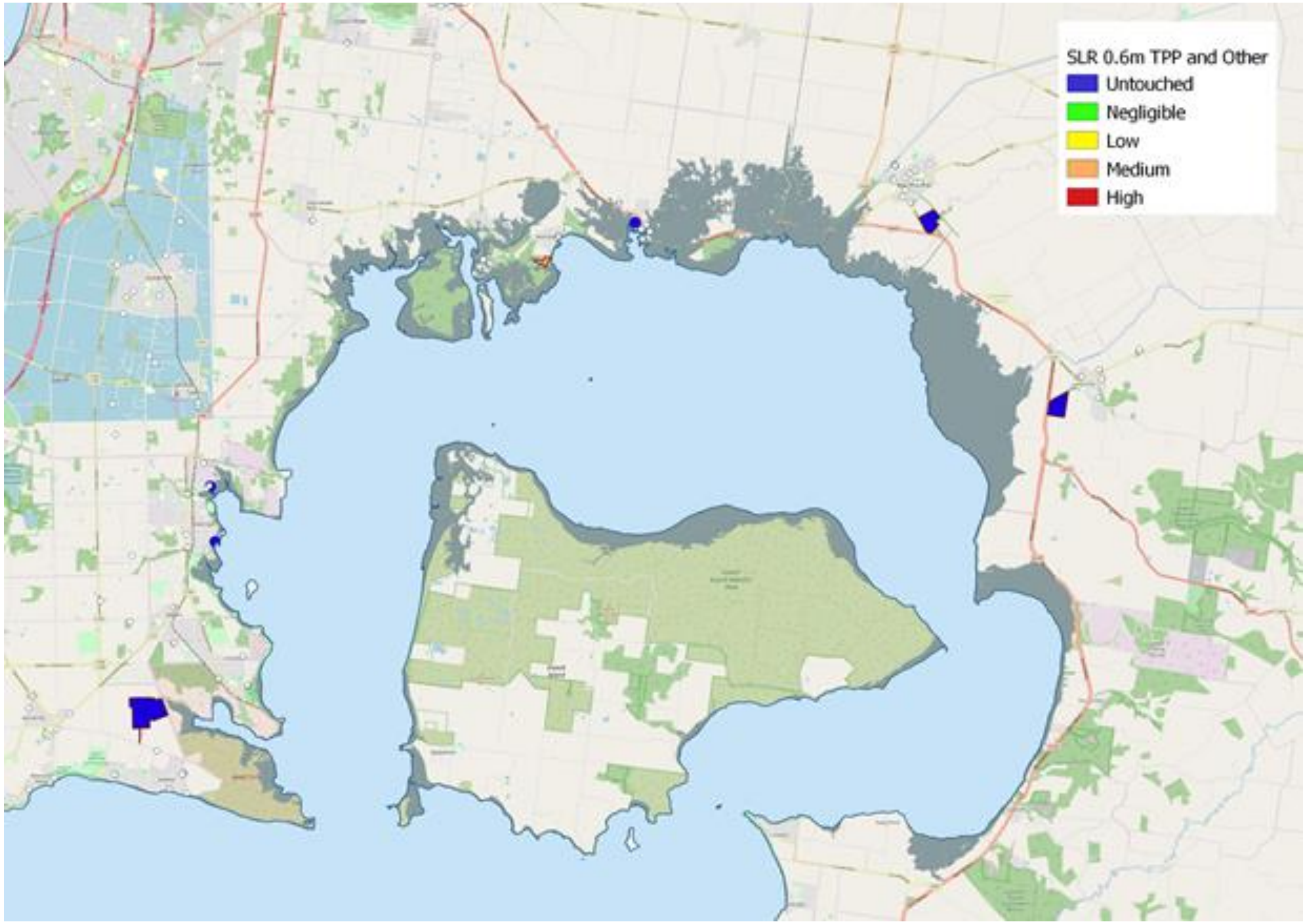

Figure 28: Infrastructure Hazard for Treatment Plant Properties, Sewer ERS, Water Storages and Water Pump Stations for sea level rise scenarios 0.6 m. This includes a 1% AEP storm surge.

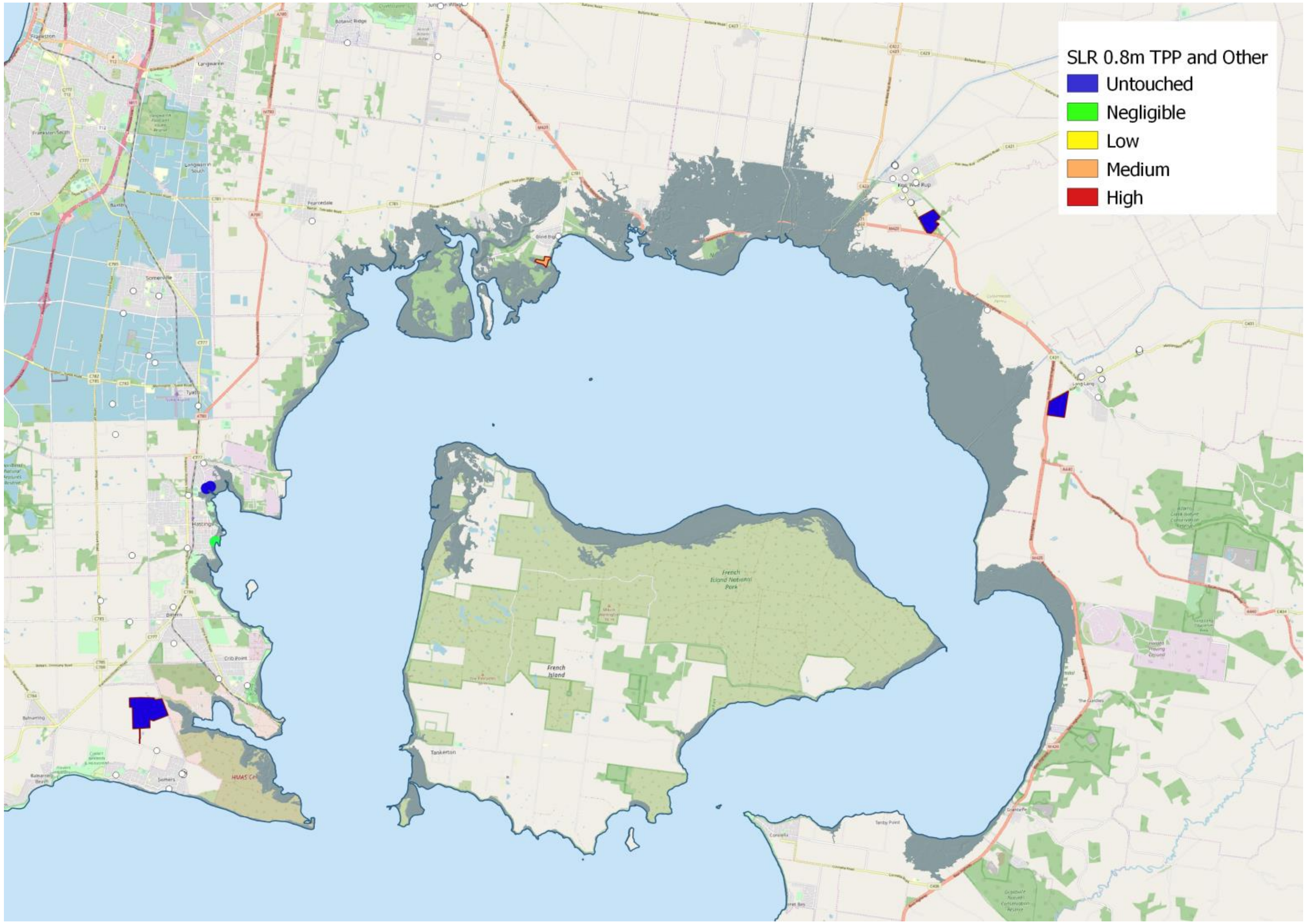

Figure 29: Infrastructure Hazard for Treatment Plant Properties, Sewer ERS, Water Storages and Water Pump Stations for sea level rise scenarios 0.8 m. This includes a 1% AEP storm surge.

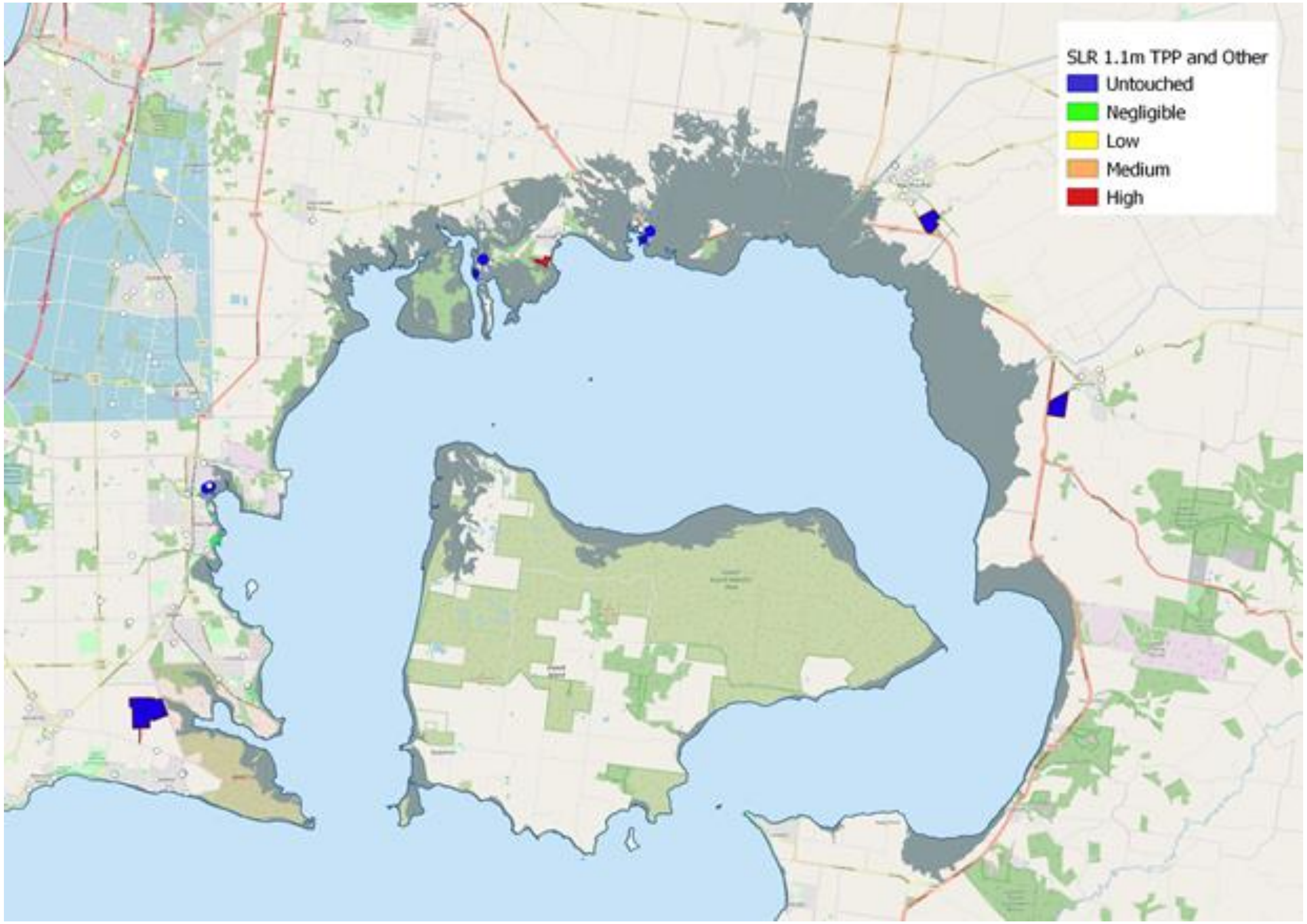

Figure 30: Infrastructure Hazard for Treatment Plant Properties, Sewer ERS, Water Storages and Water Pump Stations for sea level rise scenarios 1.1 m. This includes a 1% AEP storm surge.

3.Conclusions

This report is a summary of potential infrastructure risks identified for South East Water assets in the Western Port region, in relation to sea level rise and storm surge inundation. The risk was calculated for each infrastructure type using a standard engineering definition of "hazard" namely a product of "water depth" and "water speed". This hazard was then normalised to arrive at five hazard categories for each infrastructure type: Untouched (0), Negligible (0 to 25%), Low (25% to 50%), Medium (50% to 75%) and High (75% to 100%).

Based on the assessment it was found that water pipes and sewer pipes are most affected around Tooradin and Warneet regions and begin to get impacted even at a sea level rise of 0.2 m. Maintenance holes are also impacted in these locations and also show minor impact around Hastings on the western arm especially for a sea level rise of 0.8 m and above. Most of the treatment plants are not impacted by the inundation except for the one at Blind Bight which starts getting impacted beyond a sea level rise of 0.6 m. Although the treatment plant at Somers is not directly impacted the approach to it does have an impact at higher sea level rise scenarios beyond 0.6 m. This means some infrastructure consideration might need to be given for the approach roads towards this plant in future years.

It has to be noted that the following were not included in our risk calculations:

- Catchment flood modelling,
- Existing or future adaptation strategies.

This means that some of the risks identified might be on the upper end. Local adaptation conditions will need to be taken into consideration while assessing the overall risk to these infrastructure assets.

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CONTACT US
t 1300 363 400
+61 3 9545 2176
e csiroenquiries@csiro.au
w www.data61.csiro.au

FOR FURTHER INFORMATION
Dr Mahesh Prakash
Group Leader
t [redacted]
e
w www.data61.csiro.au

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