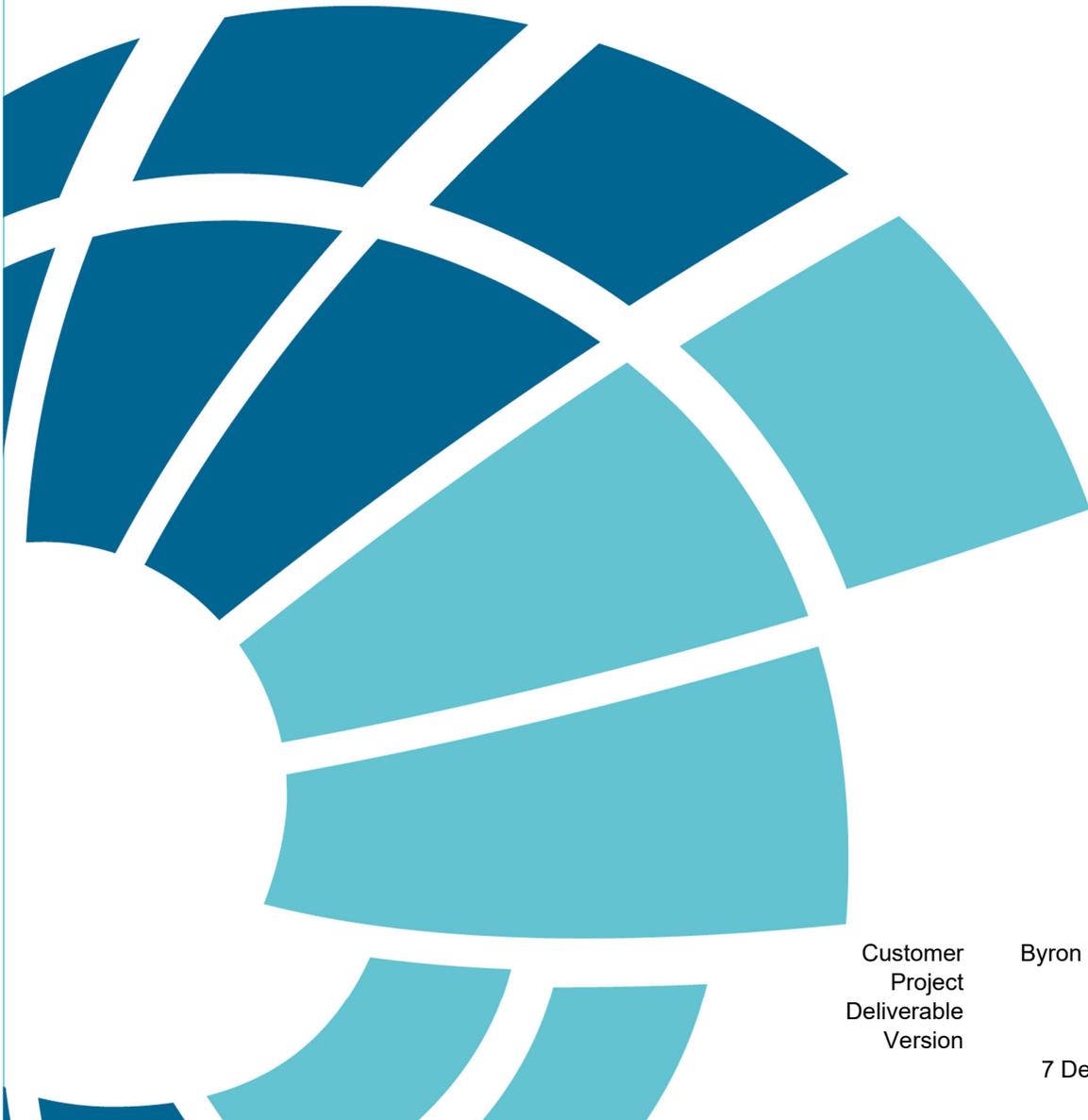


# Sandhills Stormwater Management System Byron Bay - Flood Impact Assessment



Customer  
Project  
Deliverable  
Version

Byron Shire Council  
A12258  
001  
02  
7 December 2023

## Document Control

### Document Identification

Title	Sandhills Stormwater Management System Byron Bay - Flood Impact Assessment
Project No	A12258
Deliverable No	001
Version No	02
Version Date	7 December 2023
Customer	Byron Shire Council
Customer Contact	Rob Van Iersel
Classification	BMT (OFFICIAL)
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Project Manager	Damion Cavanagh

### Amendment Record

The Amendment Record below records the history and issue status of this document.

Version	Version Date	Distribution	Record
01	18 November 2022	Byron Bay Council	Flood Impact Assessment
02	07 December 2023	Byron Bay Council	Flood Impact Assessment

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## 1 Introduction

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The Sandhills Crown Reserve is centrally located within the town of Byron Bay, generally bound by Lawson Street to the north, Massinger Street to the east, Middleton Street to the west and the Byron recreation ground to the south.

The Reserve was subject to intensive sand mining activities in the early 1960s, though since restoration of the Site it has been left largely untouched, allowing regrowth of native vegetation communities.

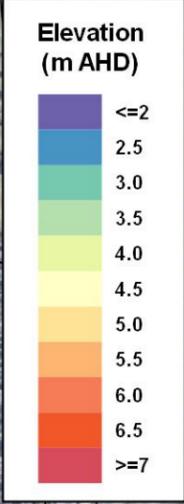
The proposed development is located on the eastern portion of the Sandhills Crown Reserve, the land located to the east of the Cowper Street road reserve. The existing Site has an open drain that runs through the Site and connects into a piped network at Cowper Street, as shown in Figure 1.1.

Byron Shire Council ('Council') is currently investigating reinstating the wetland system within the Site, with the intent of improving the Site's environment and cultural values, flood mitigation, stormwater treatment and storage, integration with catchment water cycle management, providing education and recreation opportunities and creating connections between key sites in and around the town centre.

The scope of works, as shown in Figure 1.2 includes:

- A series of three artificial wetlands, including two permanent open water zones, for stormwater management and water quality improvements.
- A series of circulation paths/boardwalks and seating nodes around the wetlands.
- Revegetation/rehabilitation.

This report is part of the EIS under Part 5 of the EP&A Act and will assess the flood impact of the proposed development. The report has been developed to address the requirements of the SEARs (No.# 1808) issued for the project in respect of flooding.



- Legend**
-  Piped Network
  -  Site Boundary
  -  Cadastral Boundaries

Title: **Existing Site Layout**

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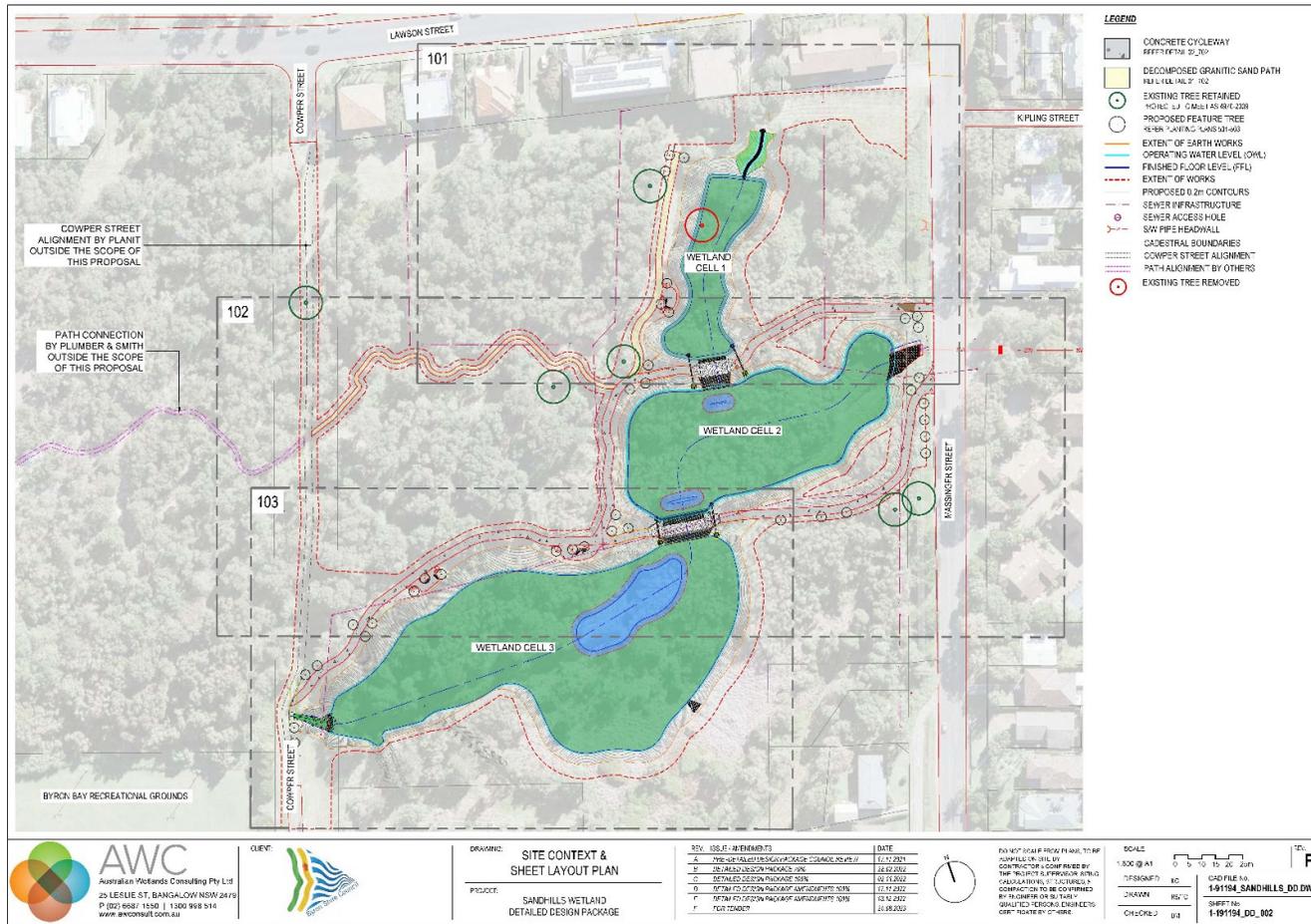


Figure 1.2 Proposed Site Layout (Source : AWC)

## 2 Regulatory Considerations

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The selected assessment approach has considered a number of key documents, including:

- Byron Development Control Plan (DCP) 2014; and
- Byron Local Environment Plan (LEP) 2014.

Supporting these documents are a variety of technical flood studies and floodplain risk management plans.

### 2.1 Development Control Plan

Council maintains Chapter C2 of the DCP 'Areas Affected by Flood' to support development decisions in flood affected areas. One of the aims of the DCP is to define detailed standards and requirements for land development to minimise the adverse effects of flooding on that development and the broader community.

Part of the Site experiences flooding during the 1% Annual Exceedance Probability (AEP) design flood event. The Site contains a range of flood development zones from no development to low hazard flood affected land, as per the Belongil Creek Floodplain Risk Management Plan (BMT WBM, 2015).

The development proposal does not include the construction of habitable dwellings, or other types of buildings or structures as the project provides for the construction of environmental features (i.e., wetlands) and as such there is no applicable requirements in relation to flood planning levels. However, the landform changes associated with this project have the potential to alter flood flows and levels and are necessarily addressed as part of this study.

The DCP does not include details of acceptable flood impacts, i.e., afflux, that may be generated by a development. In this regard, flood impacts are considered on a case-by-case scenario by Council based on a variety of factors that combine to identify 'acceptable' impact limits.

### 2.2 Local Environment Plan

The DCP also gives effect to the requirements of the Byron LEP 2014, Provision 5.21 related to Flood Planning, as repeated below for completeness.

1. *"The objectives of this clause are as follows:*
  - 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,*
  - d. *To enable the safe occupation and efficient evacuation of people in the event of a flood.*
2. *Development consent must not be granted to development on land that 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. Incorporated 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 or riparian vegetation or a reduction in the stability of river banks 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 the development if the surrounding area is impacted by flooding or coastal erosion.”*

Council has recently adopted clause 5.22 Special Flood Provisions, which primarily applies to sensitive and hazardous development types. The proposed development does not fall within the development types specific to the clause.

### **2.3 Assessment Approach**

In considering the mandated requirements of the LEP and the current stage of the development proposal along with the advisory requirements of the DCP, the following assessment outcomes are included in the report:

- Assessment of the flood impact of the development (i.e., offsite) impacts. In this regard, the flood model has been used to simulate the 18%, 10%, 5%, 2% and 1% Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF) design flood events under current climate conditions (i.e., non-climate change).
- The potential flood impacts of the proposed development have been considered in isolation, i.e., no consideration has been given to cumulative impacts.
- Assessment of flood hazard impacts for the 1% AEP event.

## 3 Flood Model

---

Council's adopted Belongil Creek Flood Study TUFLOW model (BMT WBM, 2015) has been used for the Flood Impact Assessment (FIA).

### 3.1 Existing Case

#### Topography

The existing case scenario has been updated to include the topographic survey of the Site, as provided by Planit Consulting on 29 September 2022.

The existing base case did not include the Byron Bay Bypass, however, the bypass has been updated for this model, as it is a large structure that will have an impact on the flood behaviour of the area.

#### TUFLOW Version

The version of TUFLOW used to run the flood models has been updated to the most recent TUFLOW version (2020). A sensitivity test of the unmodified existing case was undertaken between the 2011 TUFLOW version used in the adopted Flood Study to the 2020 version of TUFLOW. This update was required to obtain the required hazard output.

Figure 3.1 shows the comparison between the 1% AEP peak flood level results for these TUFLOW versions. In general, the 2020 TUFLOW version provides lower results than the 2011 TUFLOW version in the vicinity of the Site, although, there is also a local increase in flood levels to the south-west of the Site. The differences shown in Figure 3.1 are considered adequate, particularly as the flood impact assessment will be comparing the existing and developed case using the 2020 version of TUFLOW.

### 3.2 Developed Case

#### Topography

The developed case scenario has also been updated to include the design topography, as provided by Planit Consulting on 29 September 2022 (1-191194 Sandhills\_Wetland\_2D\_REV\_B NO planting.dwg). The design drawings were updated in August 2023 as a detailed design version. No revision of the previous flood modelling was undertaken as the changes between design version were not deemed to have an influence on previous modelling results.

#### Structures

The proposed development includes a series of weirs and culverts between the wetland areas. These have been simulated as 1d elements linked to the 2d model domain.

#### Manning's Roughness

The representation of the materials roughness (i.e., Manning's 'n' values) of the wetland area has been updated to reflect the proposed conditions.

#### Initial Water Level

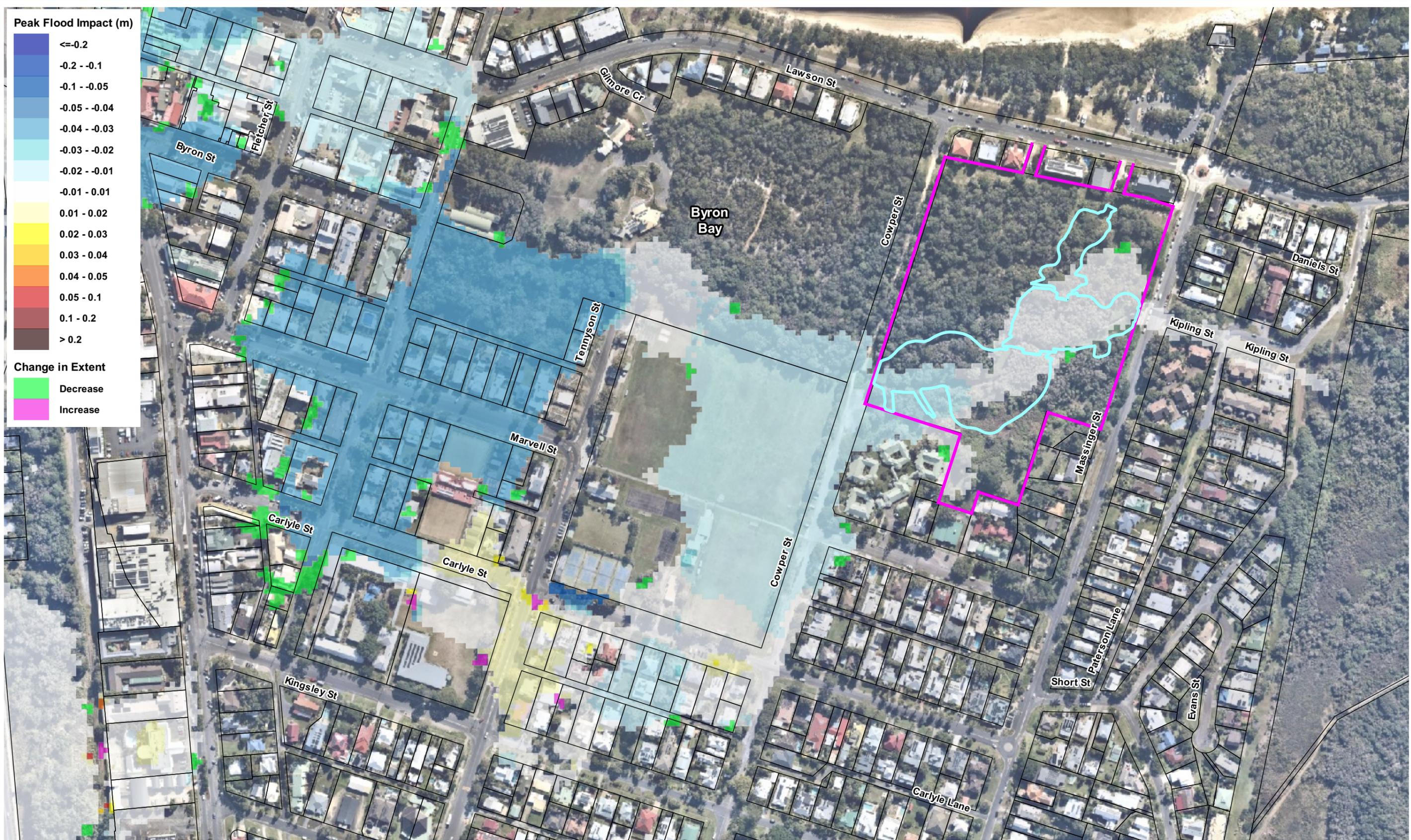
In order to simulate the worst-case scenario for flooding, an initial water level was applied to the open water bodies. The level of each was set to a level to simulate the storages as being full at the start of the simulation.

### 3.3 Design Flood Events

The existing and design scenarios have been simulated for six design flood events, namely the 18%, 10%, 5%, 2% and 1% Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF) events. Further to this, a further five design scenarios were simulated to cover climate change scenarios as part of the 2014 Local Environment Plan, as shown in Table 3.1.

**Table 3.1 Climate Change Scenarios**

Scenario	Predicted Sea Level Rise	Catchment Inflow (Rainfall Event)	Ocean Boundary Peak Tailwater Condition m AHD	Increase in Rainfall Intensity
100 year event in 2050	0.4	5% AEP 1% AEP	2.6 (ocean dominated) 2.4 (rain dominated)	0
100 year event in 2100 (FPL event)	0.8	5% AEP 1% AEP	3.1 (ocean dominated) 2.9 (rain dominated)	0
Sensitivity Test 1	0.4	5% AEP 1% AEP	2.6 (ocean dominated) 2.4 (rain dominated)	10%
Sensitivity Test 2	0.9	5% AEP 1% AEP	3.1 (ocean dominated) 2.9 (rain dominated)	30%
Sensitivity Test 3	0.9	1% AEP	3.1 (ocean and rain dominated)	30%



**LEGEND**

- Wetland Area
- Site Boundary
- Cadastral Boundaries

<p>Title:</p> <p><b>Comparison of TUFLOW versions on the 1% AEP Design Flood Event</b></p> <p>BMT endeavours to ensure that the information provided in this map is correct at the time of publication. BMT does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.</p>	<p>Drawing:</p> <p style="font-size: 1.2em;"><b>3.1</b></p>	<p>Rev:</p> <p style="font-size: 1.2em;"><b>A</b></p>
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## 4 Existing Flood Behaviour

There is an existing open channel that runs through the Site, from east to west. The open channel drains into a piped drainage network on Cowper Street, which drains to an ocean outlet at Clarkes Beach. The limited capacity of this outfall causes significant flooding at the existing playing fields at Cowper Street and the surrounding properties.

Flooding across the Site is as a result of local runoff flowing along the open drain. Most of the flooding on Site occurs to the south of the open drain.

Peak flood levels throughout the Site are fairly consistent, with limited flood gradient across the Site, as shown in Figure 4.1. Similar flood levels are experienced to the west of the Site, between Cowper Street and Tennyson Street. The water levels to the west of Tennyson Street are typically lower for all events except the PMF, as Tennyson Street acts as a weir. Table 4.1 shows the typical flood levels across the Site for each event.

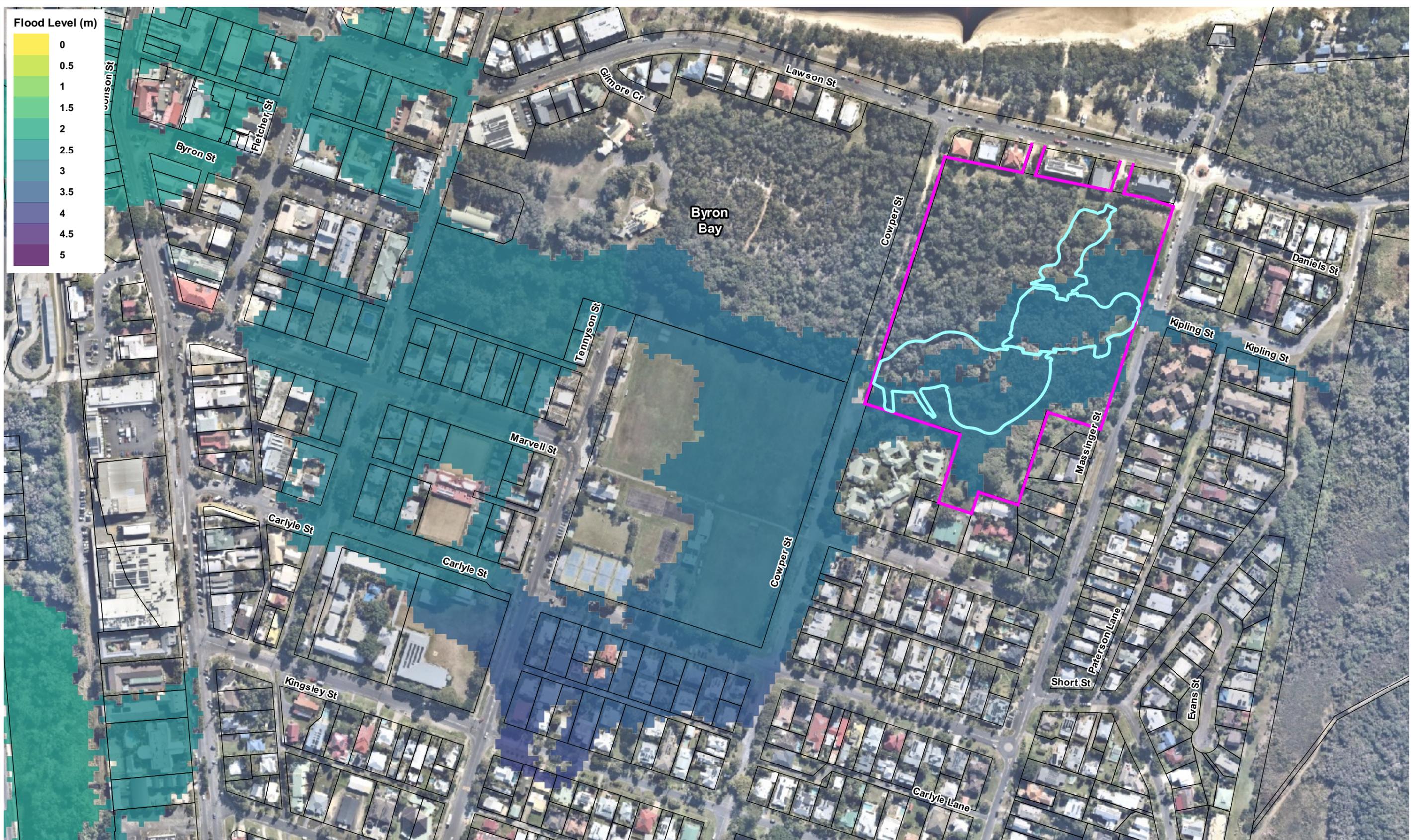
The sensitivity testing shows that the Site is sensitive to a change in rainfall intensity and is insensitive to an increase in sea level, as reflected by the peak flood levels across the Site.

Figure 4.1 to Figure 4.3 shows the peak flood level, depth and velocity for the 1% AEP design flood event.

**Table 4.1 Typical Flood Level across Site**

Event	Peak Flood Level (m AHD)
18% AEP	2.82
10% AEP	2.90
5% AEP	3.09
2% AEP	3.14
1% AEP	3.17
PMF	5.5
2050 Climate	3.17
2100 Climate	3.17
Sensitivity Test 1	3.21
Sensitivity Test 2	3.26
Sensitivity Test 3	3.26

The deepest water on the Site is experienced in the open channel, as shown in Figure 4.2. There is significant ponding to the west of the Site, across Cowper Street, as well as between Tennyson Street and Middleton Street.



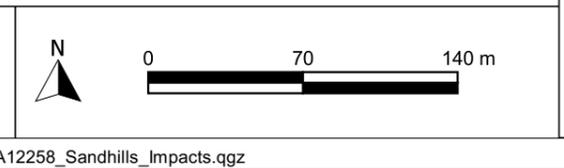
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-  Wetland Area
-  Site Boundary
-  Cadastral Boundaries

Title: **Existing Case 1% AEP Peak Flood Levels**

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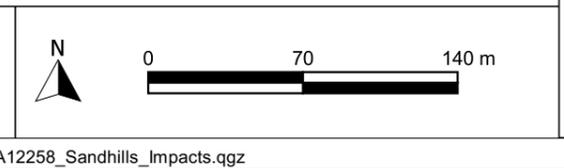
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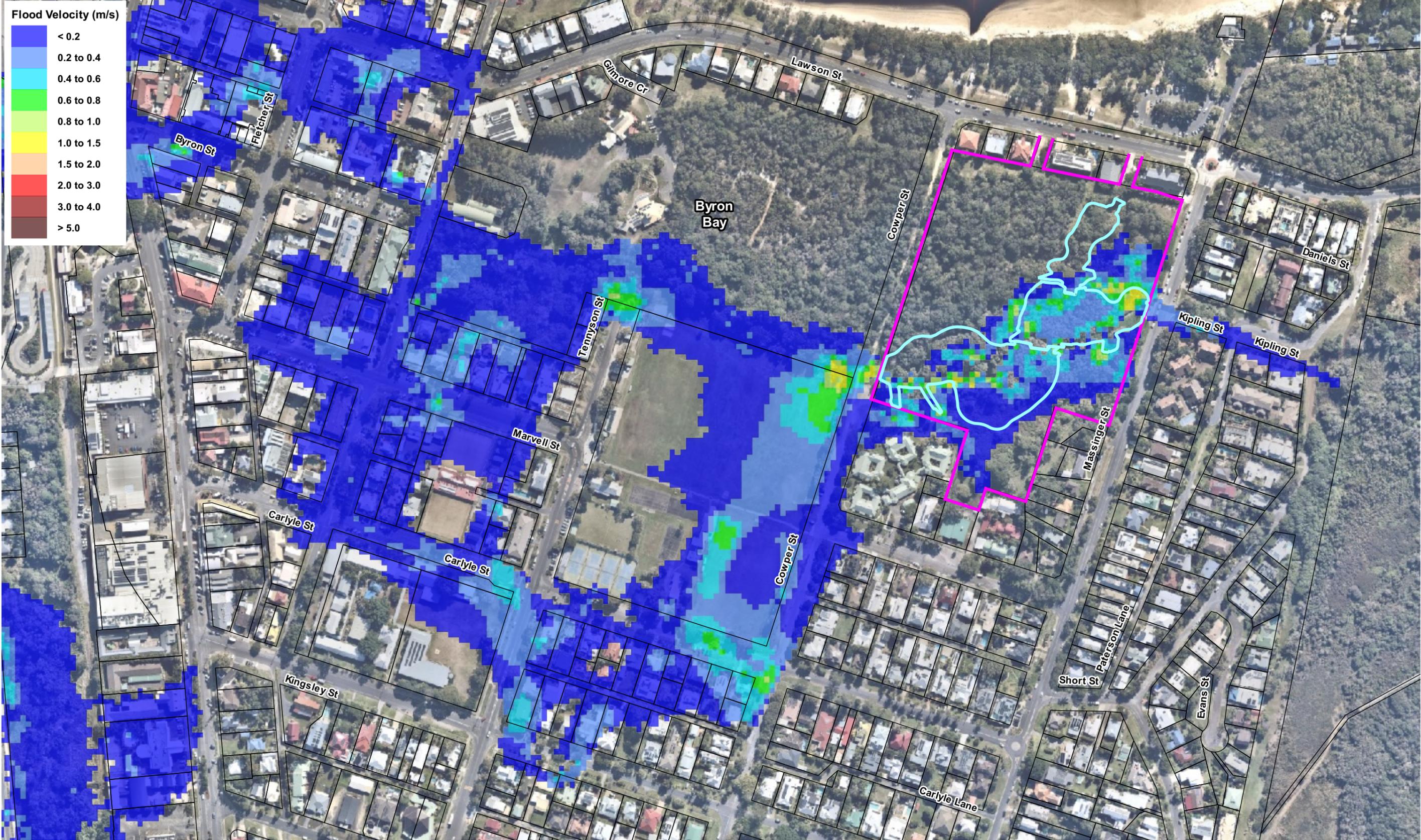
- Wetland Area
- Site Boundary
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Title: **Existing Case 1% AEP Peak Flood Depths**

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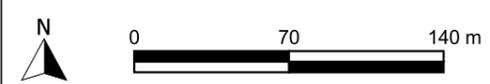
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- Wetland Area
- Site Boundary
- Cadastral Boundaries

Title: **Existing Case 1% AEP Peak Flood Velocity**

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## 5 Developed Flood Behaviour

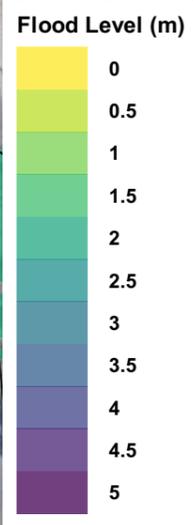
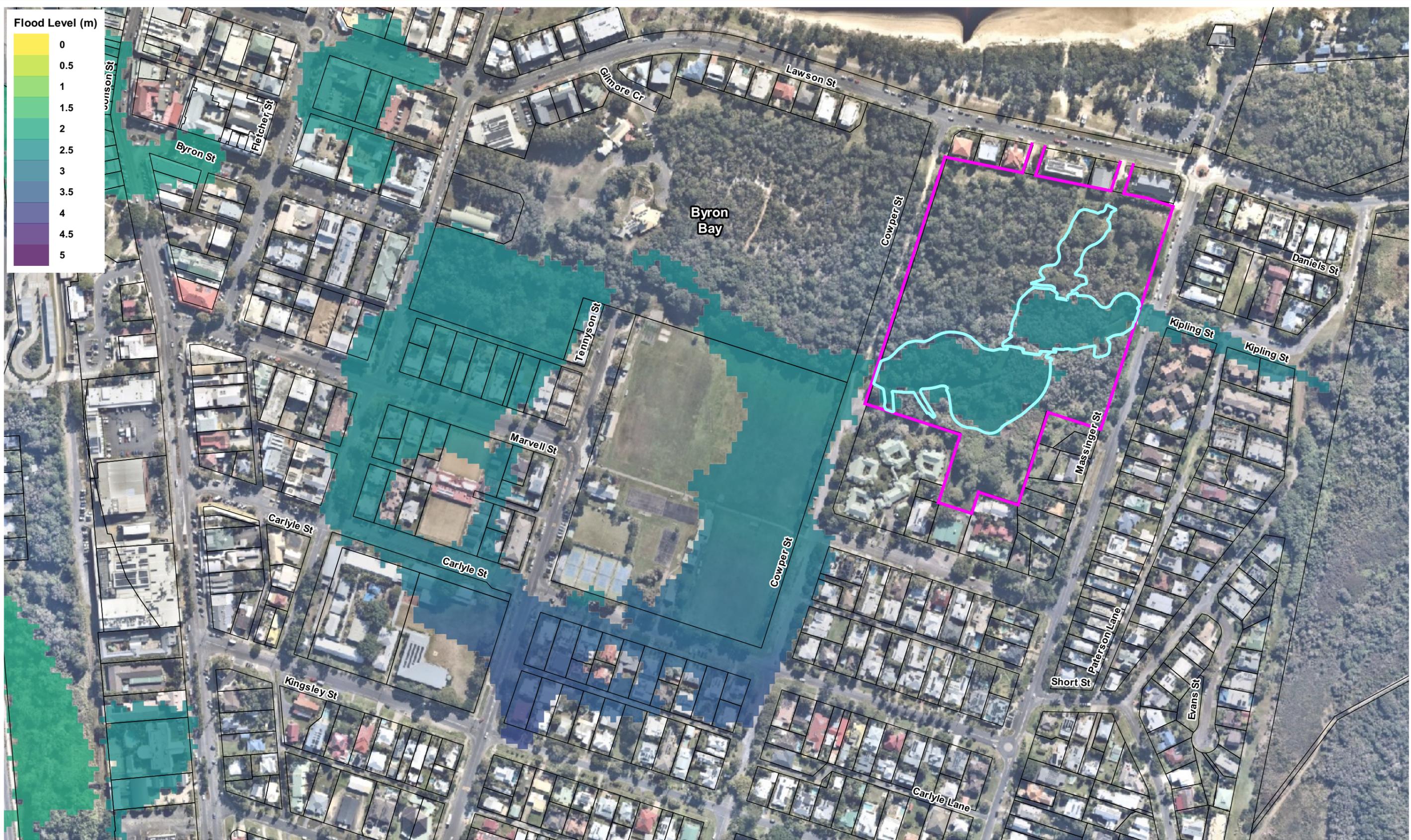
As per the existing case, the Site is dominated by local rainfall. During the 18% AEP design flood event the flood waters are contained within the wetland area. From the 10% AEP design flood event, there is flow breaking out of Wetland 3. From the 5% AEP design flood event there is also break out flow from the west of Wetland 2 and between Wetland 1 and 2.

Similarly to the existing case, peak flood levels throughout the Site are fairly consistent, with limited flood gradient across the Site, as shown in Table 5.1. Figure 5.1 to Figure 5.3 show the peak flood levels for the 18%, 1% AEP and PMF design flood events. Figure 5.4 to Figure 5.5 show the peak flood level depth and velocity for the 1% AEP design flood event.

The wetland areas act as storage basins, typically slowing the flood water down as it travels through the Site. The wetlands influence the time of the flood level peak between Cowper and Tennyson Streets in the 1% AEP design flood event.

Table 5.1 Typical Flood Level across Site

Event	Peak Flood Level (m AHD)
18% AEP	2.67
10% AEP	2.78
5% AEP	2.99
2% AEP	3.07
1% AEP	3.11
PMF	3.55
2050 Climate	3.11
2100 Climate	3.11
Sensitivity Test 1	3.18
Sensitivity Test 2	3.26
Sensitivity Test 3	3.25

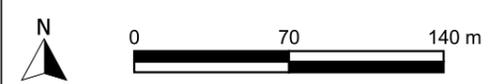


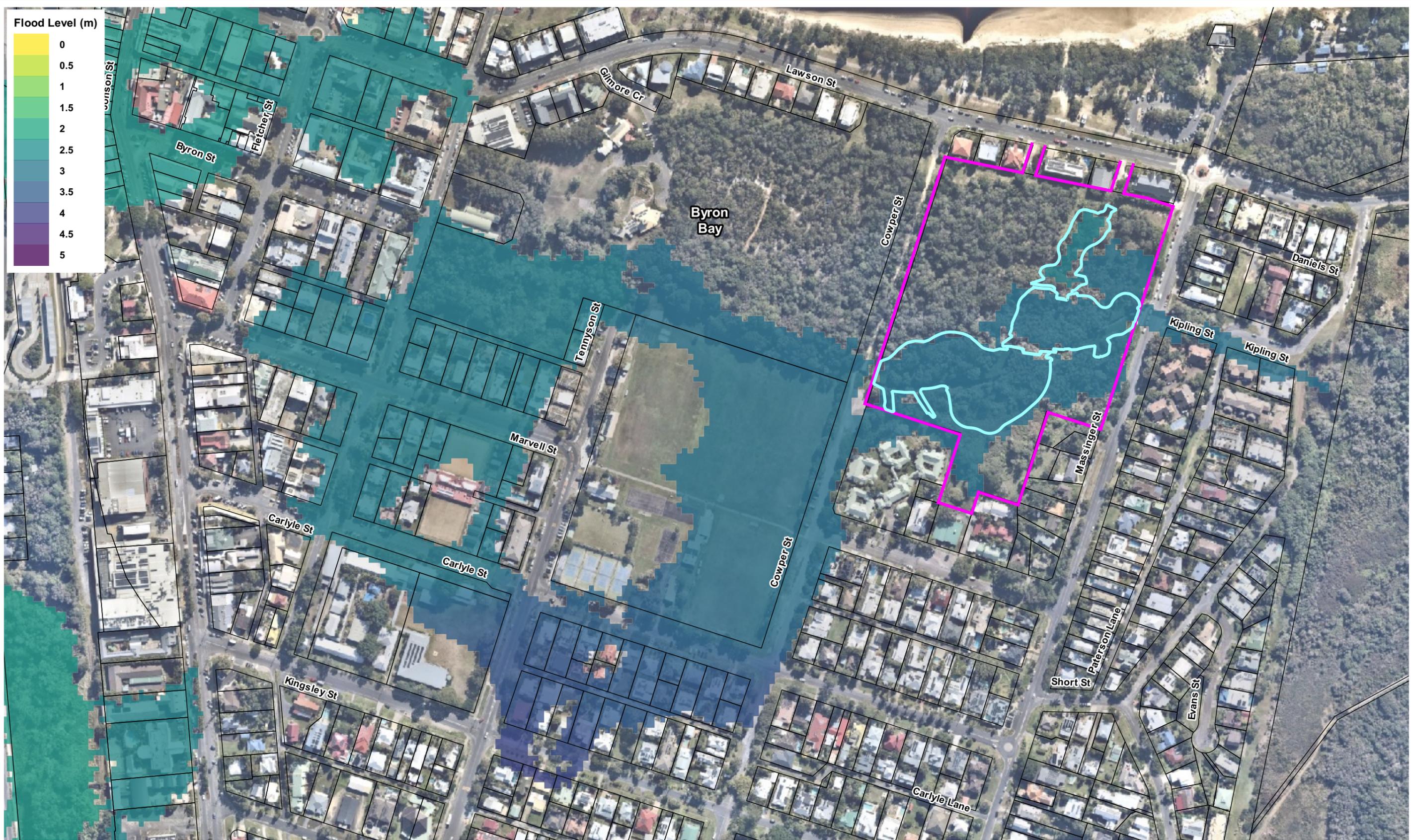
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Title: **Developed Case 18% AEP Peak Flood Levels**

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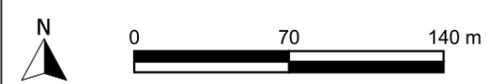
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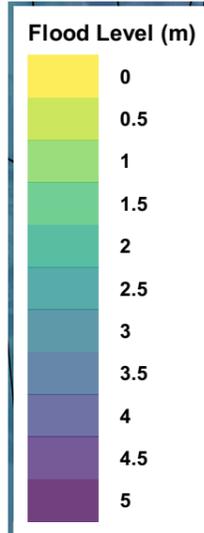
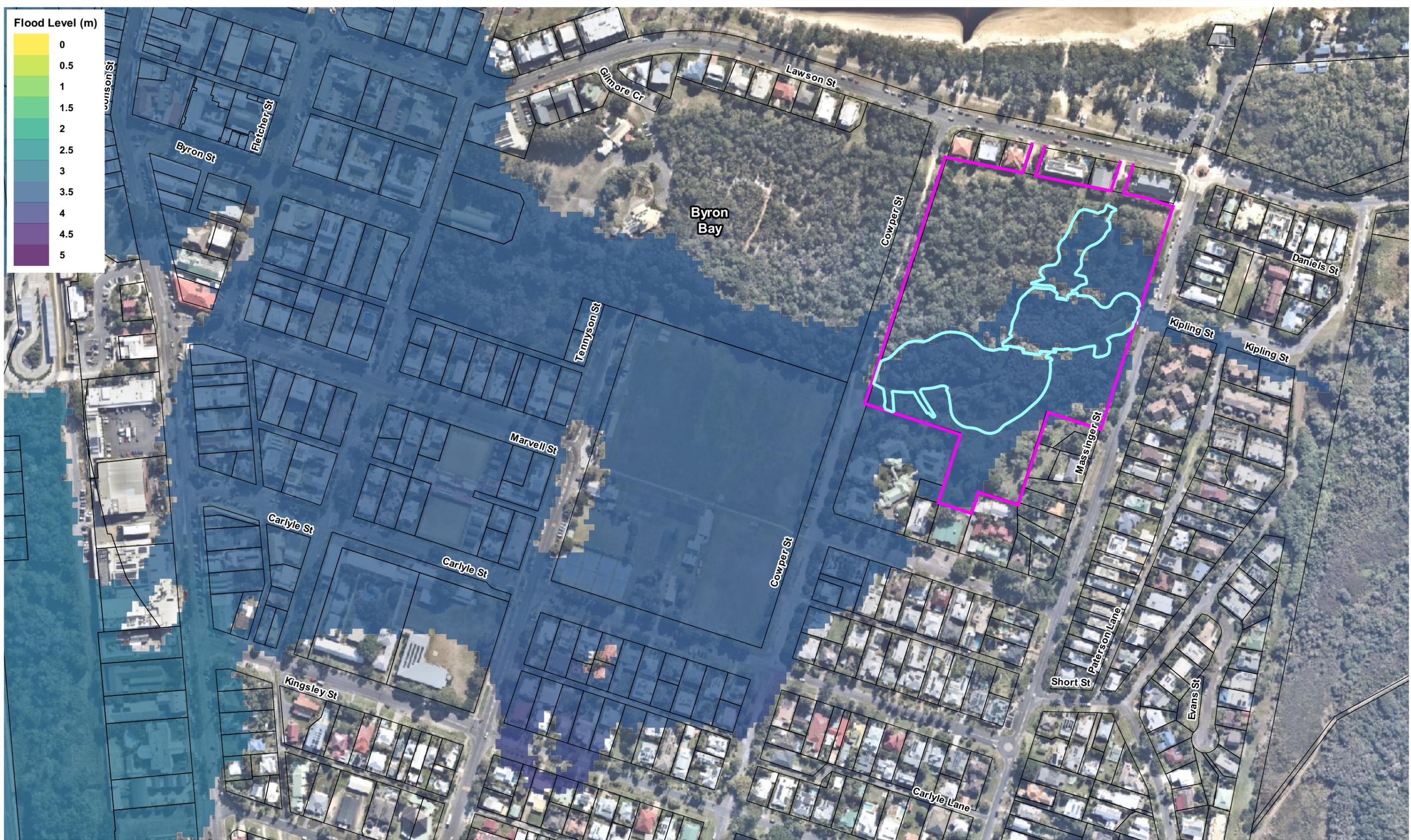
- Wetland Area
- Site Boundary
- Cadastral Boundaries

Title:  
**Developed Case 1% AEP Peak Flood Levels**

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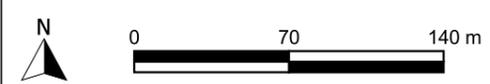
**LEGEND**

- Wetland Area
- Site Boundary
- Cadastral Boundaries

Title:  
**Developed Case PMF Peak Flood Levels**

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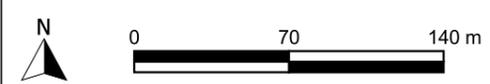
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- Wetland Area
- Site Boundary
- Cadastral Boundaries

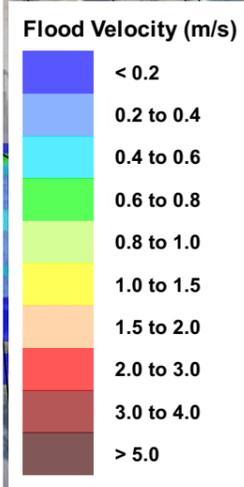
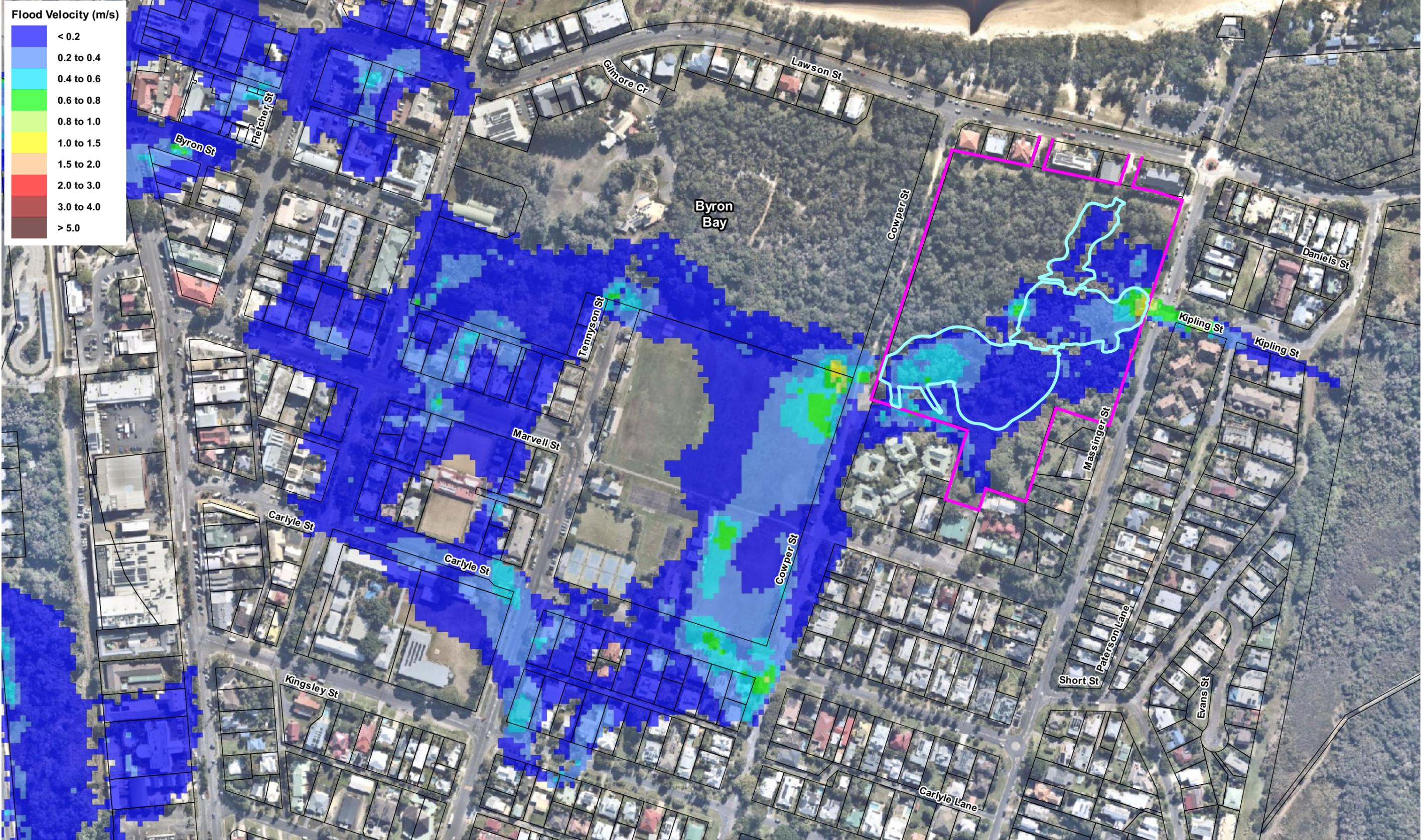
Title:  
**Developed Case 1% AEP Peak Flood Depths**

Drawing: **5.4**      Rev: **A**

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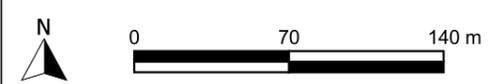


- LEGEND**
- Wetland Area
  - Site Boundary
  - Cadastral Boundaries

Title: **Developed Case 1% AEP Peak Flood Velocity**

Drawing: **5.5** Rev: **A**

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## 6 Flood Hazard

### 6.1 Flood Hazard Classifications

The flood hazard classifications have been defined by the Australian Emergency Management Institute (AEMI) in 2014. Table 6.1 provides a definition of these hazard categories and Figure 6.1 shows the criteria to determine the hazard classification. The 2020 version of TUFLOW has this hazard classification as an optional output.

Table 6.1 Flood Hazard Definitions

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

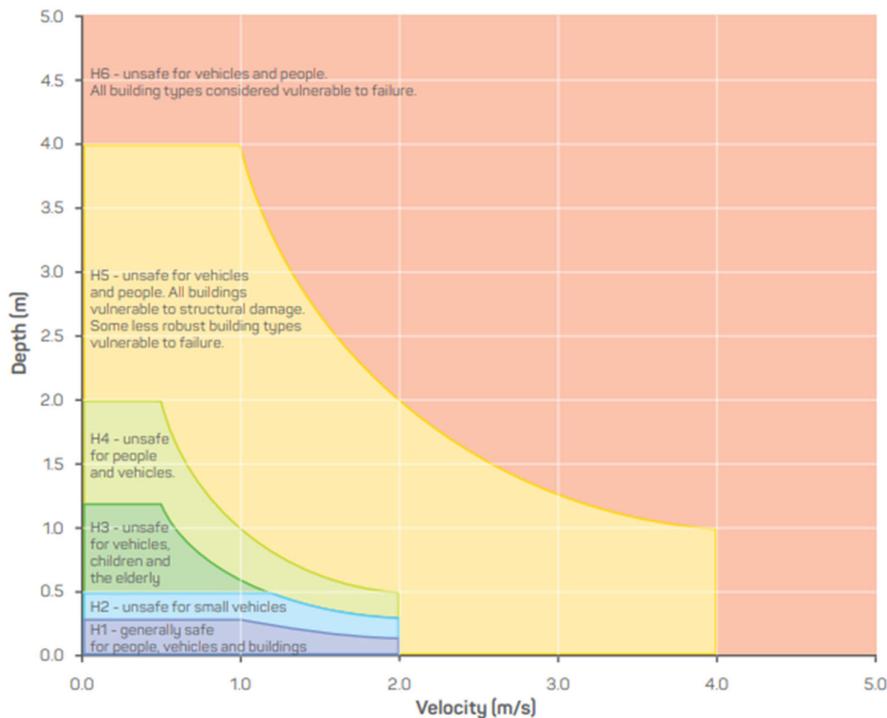


Figure 6.1 General flood hazard vulnerability curves (AEMI, 2014)

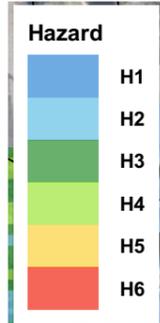
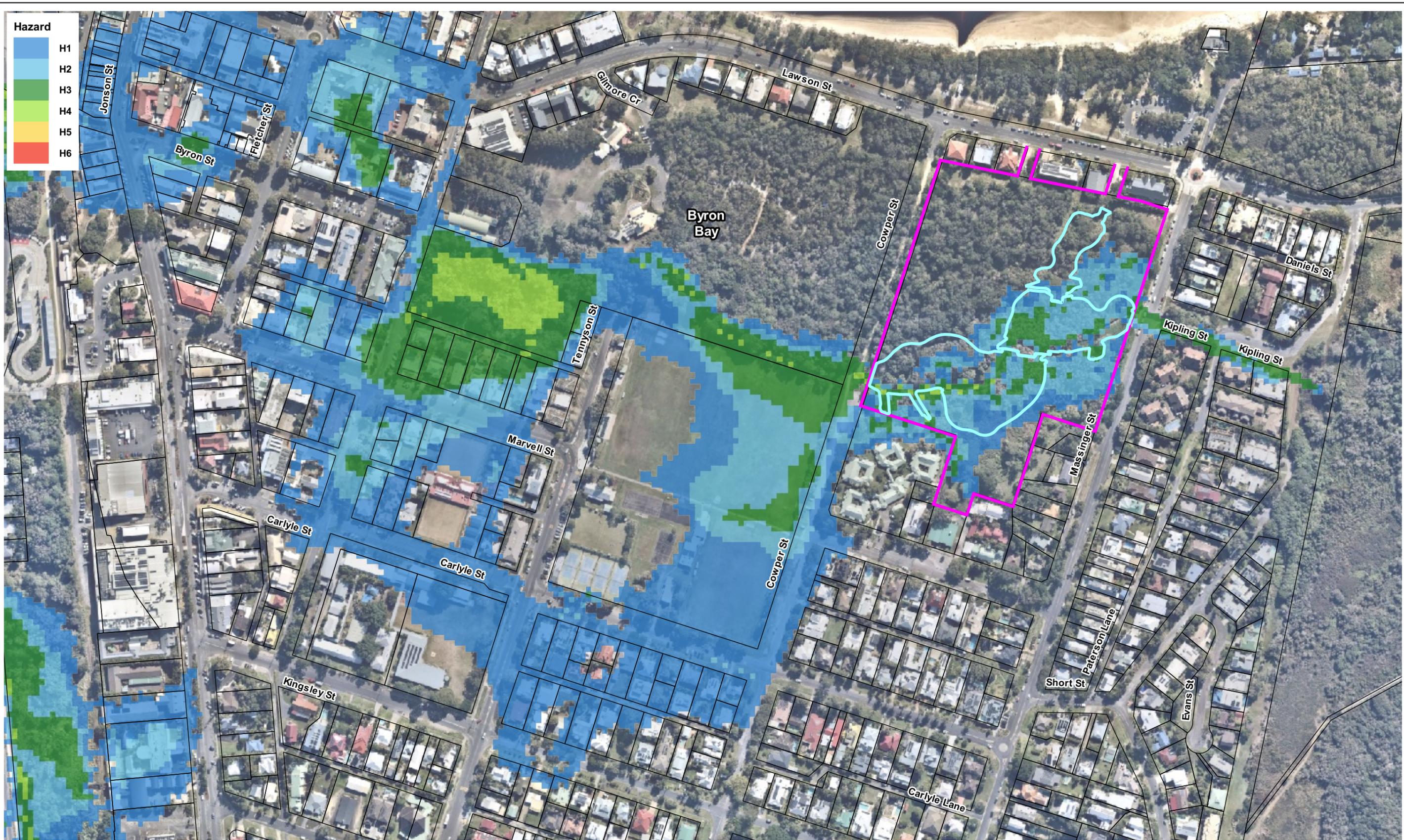
## 6.2 Existing Flood Hazard

The existing flood hazard across the Site is predominantly H2, with areas of higher flood hazard along the open channel, as shown in Figure 6.2. Upstream of the Site, the flood hazard is predominantly H3. Downstream of the Site, the flood hazard is predominantly H1. There are pockets of higher hazard to the west of Cowper Street and between Middleton Street and Tennyson Street.

## 6.3 Developed Flood Hazard

Figure 6.3 shows the flood hazard for the developed scenario. Within the Site boundary, the flood hazard has increased, with a large area of H4. This is as a result of the increased depth associated with the new open water areas. The increase in flood hazard is contained within the wetland areas.

Downstream of the Site, there is a decrease in the extent of the areas of higher hazard. This decrease is observed in both pockets of the higher hazard, i.e., to the west of Cowper Street and between Middleton and Tennyson Streets.



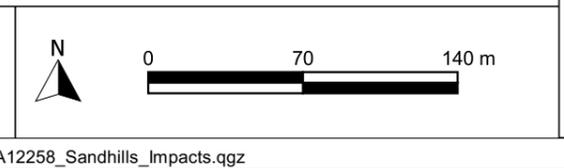
**LEGEND**

-  Wetland Area
-  Site Boundary
-  Cadastral Boundaries

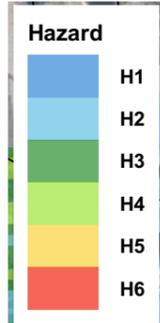
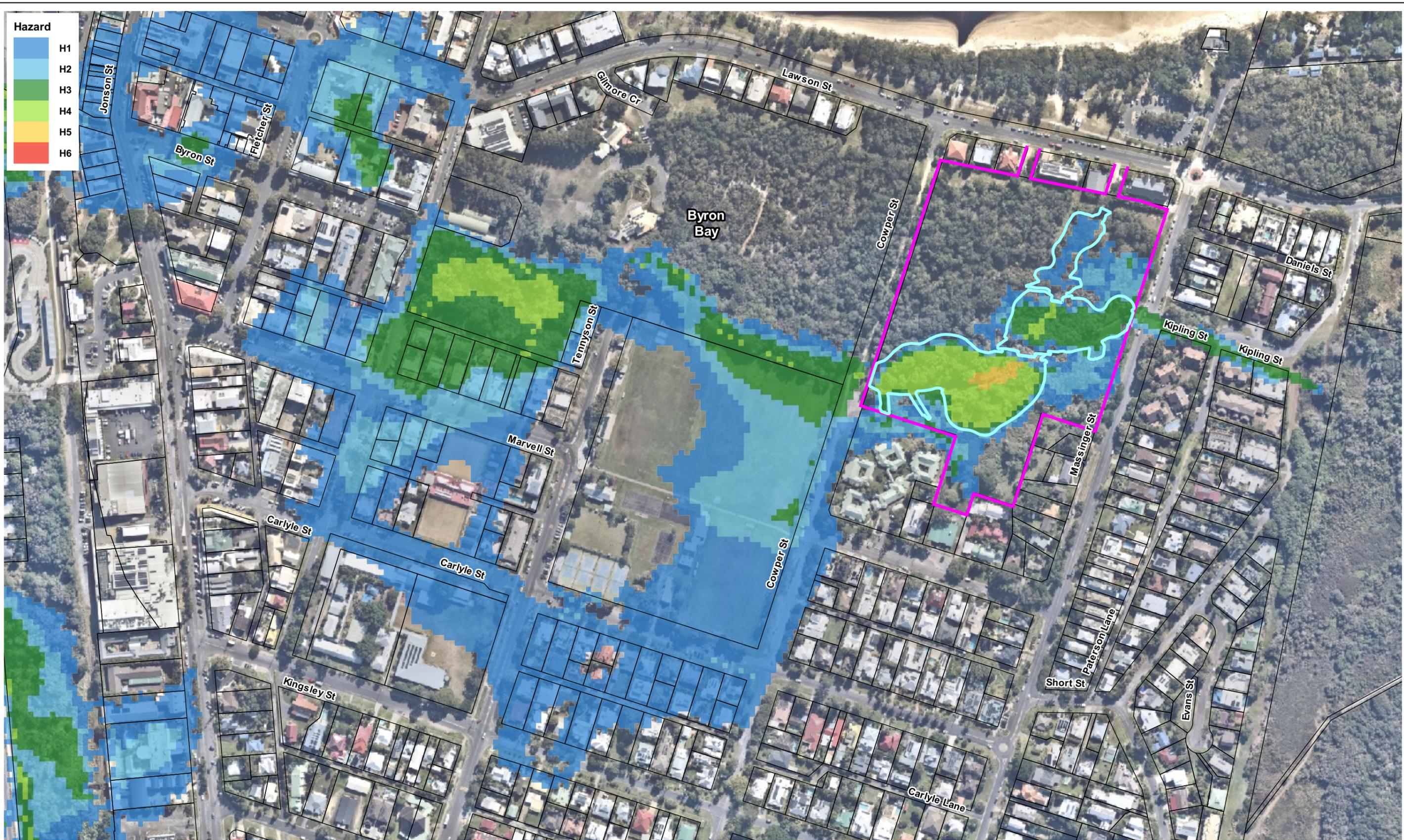
Title: **1% AEP Existing Case Hazard**

Drawing: **6.2** Rev: **A**

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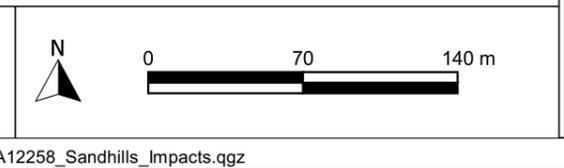
**LEGEND**

-  Wetland Area
-  Site Boundary
-  Cadastral Boundaries

Title: **1% AEP Developed Case Hazard**

Drawing: **6.3**      Rev: **A**

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## 7 Flood Level Impact

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The relative impact of the proposed wetland restoration has been considered in terms of potential changes to existing flood behaviour. Flood level impact mapping was prepared for the full range of existing climate events, as shown in Figure 7.1 to Figure 7.6.

Overall, the proposed wetland restoration results in a decrease in flood levels and extent outside of the Site boundary for events up to and including the 1% AEP design flood event. For events up to and including the 10% AEP design flood event, the decrease in peak flood levels is seen to occur between Cowper and Tennyson Streets and in the overland flow path to the east of the Site. In events between the 5% and 1% AEP design flood events, the decrease in flood level also extends between Tennyson and Fletcher Streets. The PMF event overall shows no change in peak flood levels off Site.

While current climate impacts have been assessed in this report, consistent with the other events assessed impacts would not be expected for future climate change flood impacts scenarios based on the development style, which has effectively resulted in removal of material from the floodplain.



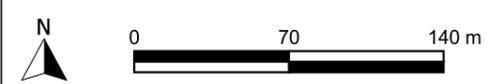
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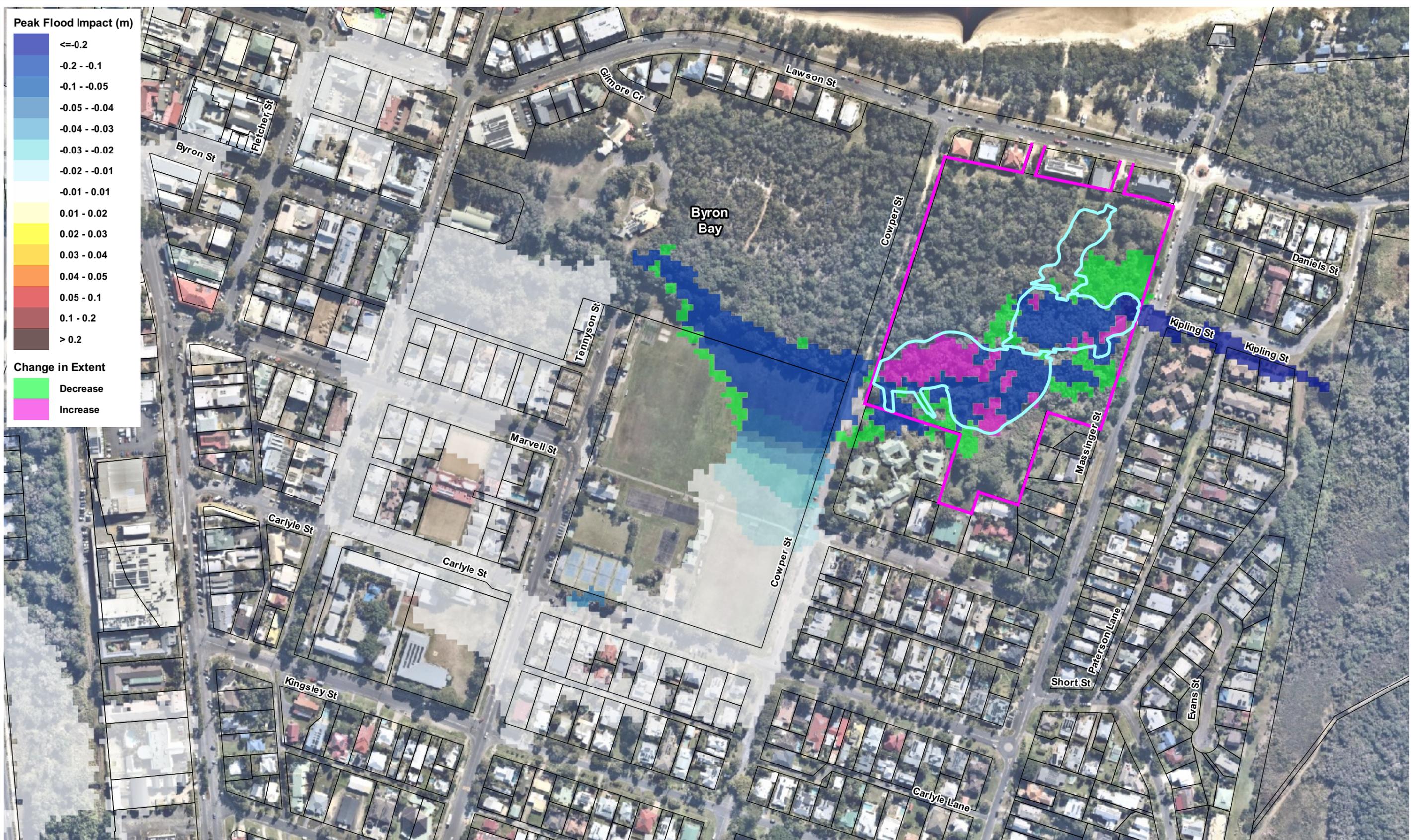
- Wetland Area
- Site Boundary
- Cadastral Boundaries

Title:  
**18% AEP Peak Flood Level Impact**

Drawing: **7.1**      Rev: **A**

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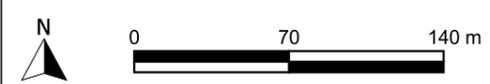
**LEGEND**

- Wetland Area
- Site Boundary
- Cadastral Boundaries

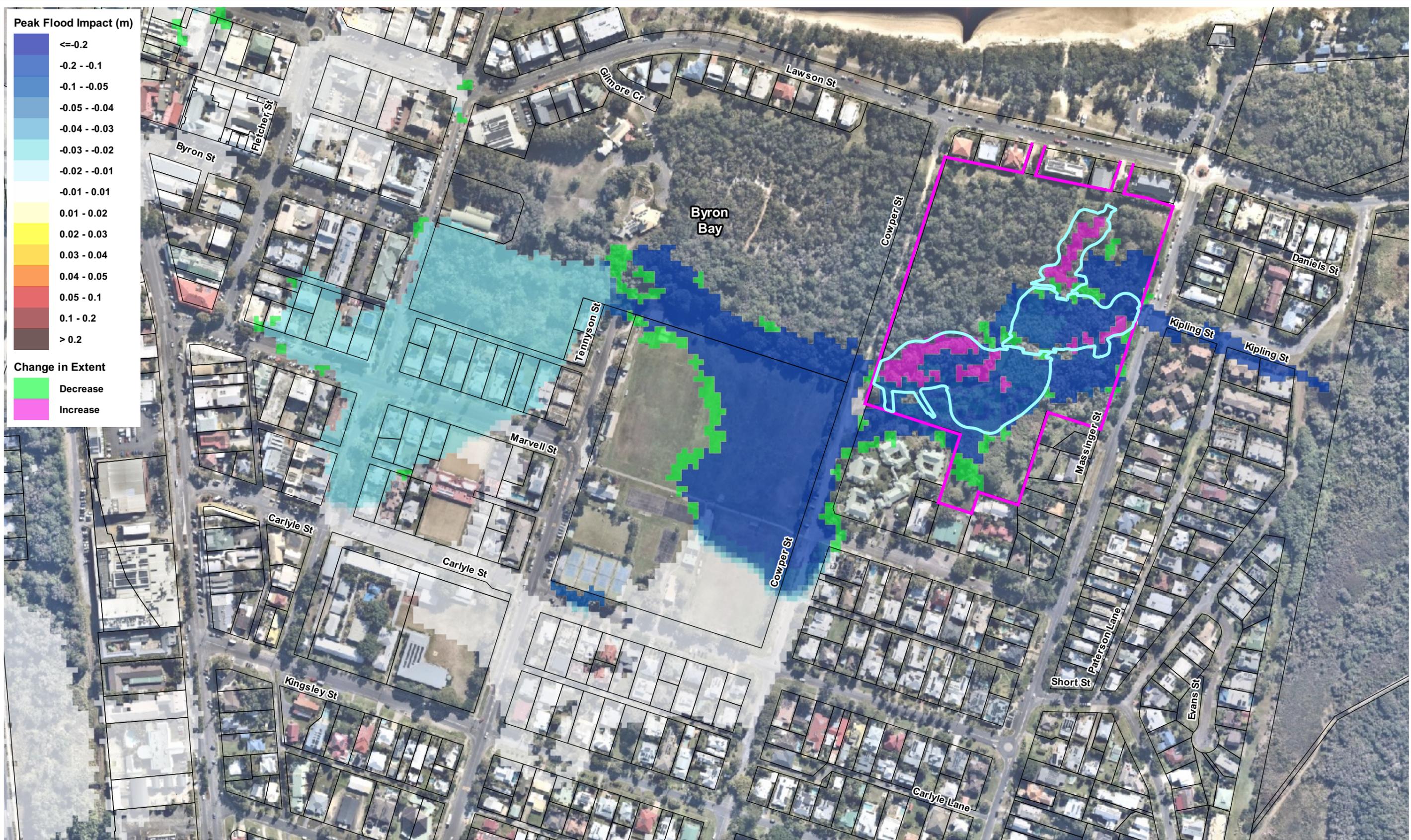
Title: **10% AEP Peak Flood Level Impact**

Drawing: **7.2**      Rev: **A**

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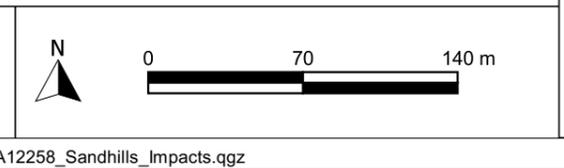
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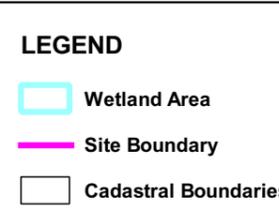
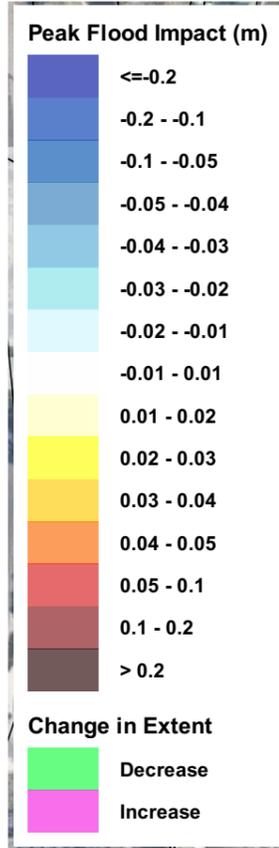
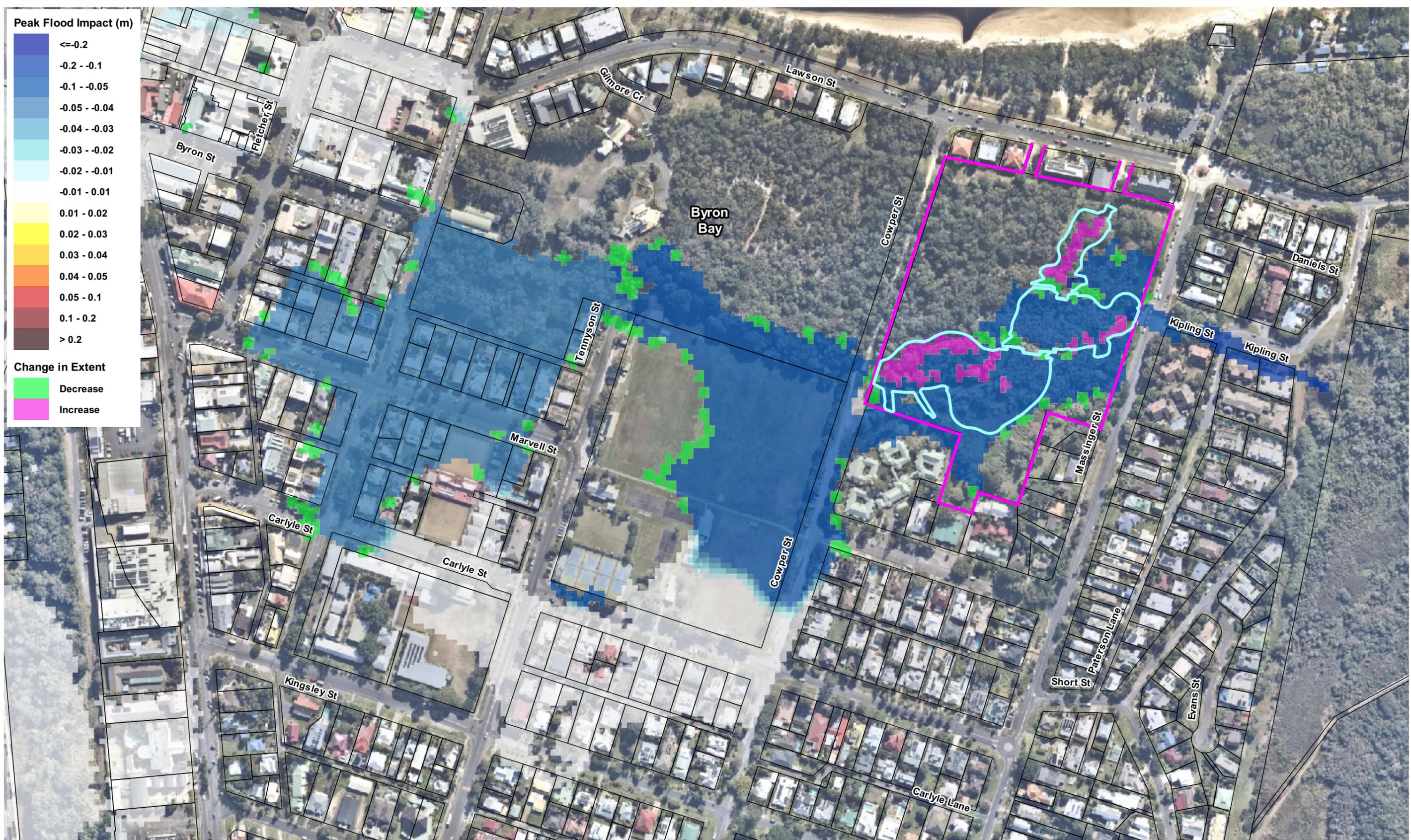
- Wetland Area
- Site Boundary
- Cadastral Boundaries

Title: **5% AEP Peak Flood Level Impact**

Drawing: **7.3**      Rev: **A**

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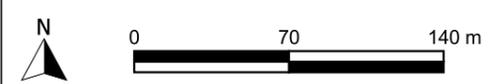




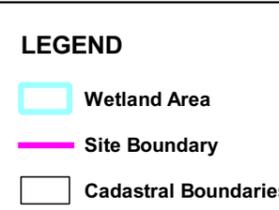
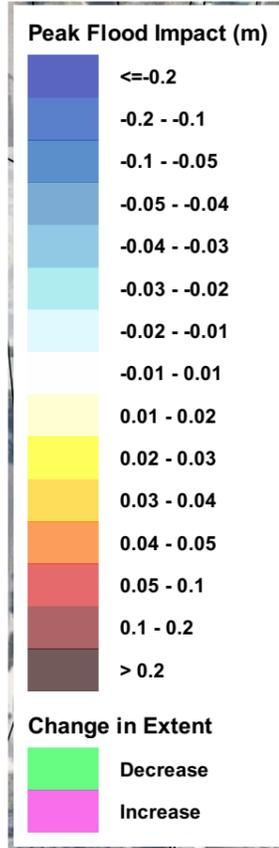
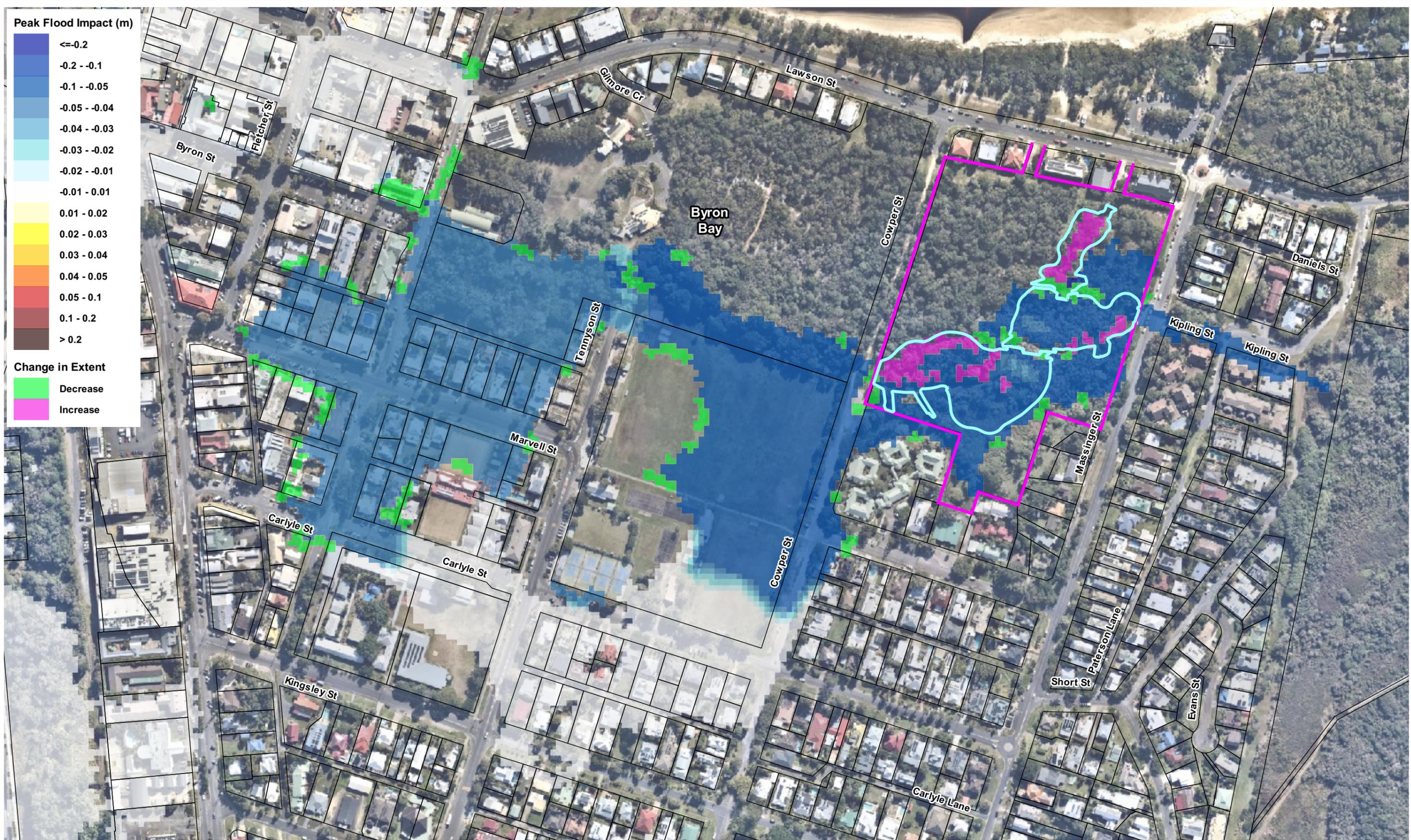
Title: **2% AEP Peak Flood Level Impact**

Drawing: **7.4**      Rev: **A**

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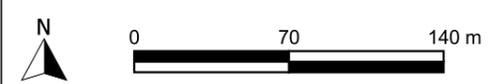
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Title: **1% AEP Peak Flood Level Impact**

Drawing: **7.5**      Rev: **A**

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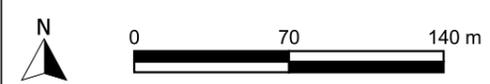


- LEGEND**
- Wetland Area
  - Site Boundary
  - Cadastral Boundaries

Title:  
**PMF Peak Flood Level Impact**

Drawing: **7.6**      Rev: **A**

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## 8 Conclusion

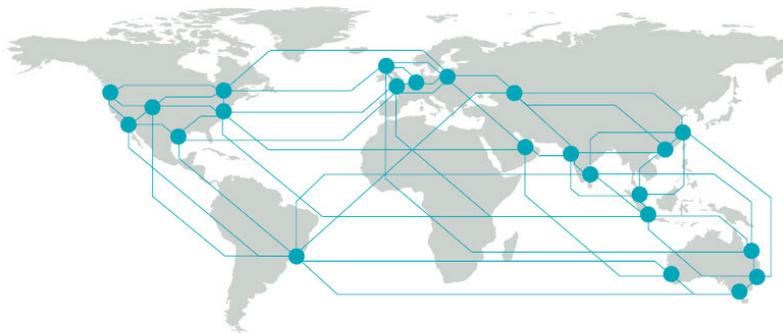
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This report has summarised the outcomes of a flood impact assessment that was completed for the wetland restoration at Sandhills Crown Reserve in Byron Bay.

The assessment was completed using an updated version of the TUFLOW model originally developed for the Belongil Creek Flood Study (BMT WBM, 2015). An assessment was completed for the 18%, 10%, 5%, 2%, 1% AEP and PMF design flood events.

Overall, the proposed wetland restoration decreases the peak flood levels in the surrounding area. Off-site, there was also a decrease in the flood hazard. Within the Site, there is an increase in flood hazard, which is contained to the wetland areas.

The results indicate compliance with Council's DCP, LEP and the project SEAR requirements.



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