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# SCAMANDER RIVER COASTAL HAZARDS RISK MITIGATION & PATHWAYS PLANNING

## Outlook Report – Coastal and River System Processes, Hazards and Climate Change Memorandum

moffatt & nichol

# MEMORANDUM

Produced For Break O'Day Council

Date **5th September 2025**

# Document Verification

| | |
|---|---|
| **Client** | Break O'Day Council |
| **Project name** | Scamander River Coastal Hazards Risk Mitigation & Pathways Planning |
| **Document title** | Coastal System and Hazards Report |
| **Document sub-title** | – |
| **Status** | Final |
| **Date** | 5th September 2025 |
| **Project number** | 251099 |
| **File reference** | 251099-MN-MO-CO-0001[A] Report |

| Revision | Description | Drafted by | Date | Checked by |
|---|---|---|---|---|
| 00 [A] | Draft issued to Break O'Day Council | NL | 12/08/2025 | PP |
| 01 [B] | Final issued to Break O'Day Council | NL | 5/09/2025 | PP |
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# Table of Contents

# List of Figures

# List of Tables

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# 1. Introduction

## 1.1. Background

SGS Planning and Economics, supported by Moffatt & Nichol (M&N), were engaged by Break O'Day Council (hereafter referred to as 'Council') to prepare the Scamander River Coastal Hazards Risk Mitigation & Pathways Plan. To inform preparation of the Plan, Moffatt & Nichol undertook a study to understand the underlying coastal and river processes and hazards associated with the township of Scamander. The study is documented herein.

The Scamander township, the second largest township in Break O'Day municipality, is located on the northeast Coast of Tasmania (see **Figure 1**), developed on either side (north and south) of the mouth of the Scamander River, as well extending north and south along the fringing coastline. The mouth of the river and township is in the middle of a 7.5 km sweep of sandy and mobile Tasman Sea coastline. The township is connected by a bridge crossing the Scamander River.


FIGURE 1: LOCATION PLAN

Like many rivers on the east coast of Australia with moderate to low annual river discharges and entering a microtidal ocean environment, there has formed a dynamic body of mobile sand at the mouth of the estuary. This deposited body of sand can accumulate at the entrance to form a barway (sand berm), similar in form to the adjacent beach, leading to an effective closing of the river mouth. This body of deposited sand at the river / ocean interface, as well as its ability to close from time to time, forms what is termed an intermittently closed and open lake and lagoon (ICOLL) (described by Maher et al., 2011, NSW DPIE, 2021).

The Scamander community, natural environment, cultural assets and infrastructure is susceptible to the potential impacts from several geo-hazards, some of which have impacted the area historically. These hazards, which are the result of natural processes, are expected to be magnified by climate change, including sea level rise, presenting significant risk to communities and the economy if they are not appropriately managed. Geo-hazards impacting Scamander and therefore forming the focus of this study are:

- river flooding;
- coastal inundation;

- open coast erosion; and
- inner-estuary and river foreshore erosion.

These hazards can act episodically, for example during event-based high river flows or coastal storms, as well as more gradually, such as salt-water intrusion, inundation by high tides and continual loss of land through sea level rise or erosion. Some of the hazards can combine within their processes and exacerbate the potential impacts. For example, high river flows can interact with a closed barway, high tide or high ocean levels during a storm to causing higher water levels than would be otherwise, for example in the scenario of an open river channel and/or no coastal storm. This combination, or compounding of hazards is particularly relevant to Scamander.

## 1.2. Study Objectives

The objectives of the study were to:

- establish an understanding of the coastal and river processes,
- develop an understanding of relevant historical modification and hazard management,
- assess the hazards, including how these could alter with climate change,
- identify limitations and data/knowledge gaps in existing hazard information, and where possible, provide direction for use within the plan in the absence of further assessment.

The study was predominantly based on a review of currently available information, including previous related studies. No primary analysis was undertaken with the exception of:

- targeted analysis of available data where appropriate; and
- a site walkover and visual inspection undertaken between 23rd to 25th inclusive.

## 1.3. Study Area and Locational Terminology

The study area of the Coastal Hazards Risk Mitigation & Pathways Plan and therefore the study reported herein comprises the township and immediately surrounding environment. For the convenience of this study, the key areas covered by the study area and referenced throughout this report have been denoted on **Figure 2**. Specific geomorphological features and physical processes are further described in later sections.


FIGURE 2: SCAMANDER RIVERMOUTH WITH KEY LOCATIONAL TERMINOLOGY DENOTED

The township of Scamander has developed around the river mouth and coast, including estuary foreshores. In places infrastructure and property have been located in low lying areas, and/or adjacent to the coastal, estuarine and river foreshores. An example is at Bridge Esplanade, where a number of properties are located on the low lying river bank, as well as at Dune Street, which north of Hodgman Street, has been develop within previous dunes and sand flats/beaches (**Figure 3**).

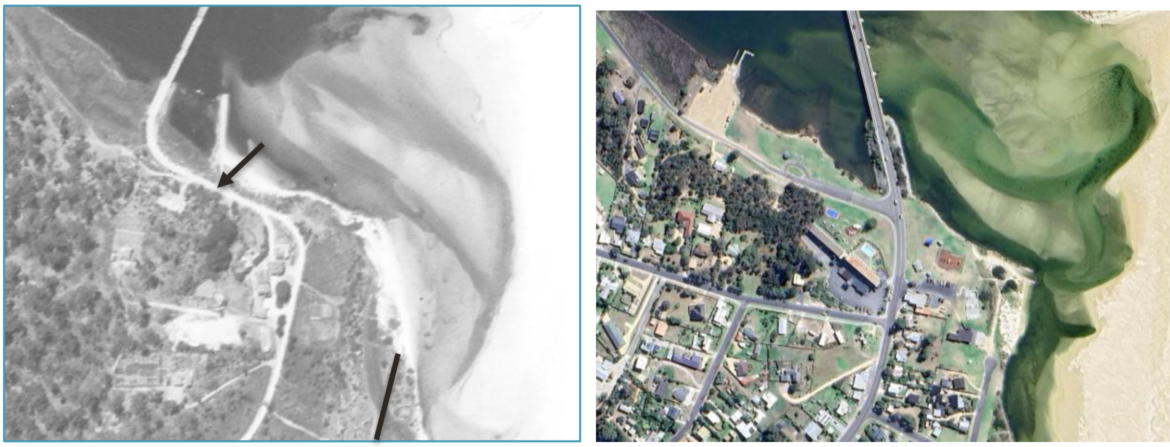


FIGURE 3: AERIAL IMAGES FROM 1950 (LEFT) AND 2024 (RIGHT) SHOWING DEVELOPMENT OF THE TOWNSHIP IN THE SOUTHERN SIDE OF THE RIVER MOUTH. FOR ORIENTATION AND REFERENCE, THE CURRENT POSITION OF DUNE STREET (ROAD) IS MARKED ON THE 1950 AERIAL IMAGE WITH A BLACK LINE. BRIDGE ESPLANADE IS MARKED BY ARROW.

The catchment and river channel has been modified over time. Fearman (2021) provides an excellent account of catchment modification and infrastructure development, particularly the history of bridge infrastructure. A summary is provided here for convenience.

Since 1865, bridging of the Scamander River has been attempted several times. Between 1865 and 1935, a series of seven bridges were constructed over the Scamander to provide safe passage along the coast to northeast Tasmania's mine fields (Fearman, 2017). Six of these bridges were destroyed by natural forces, which included the transport of increasing quantities of very large wood by floods (Fearman, 2021). The current bridge, 'Bridge 8' (along a new alignment than previous bridges) has been in place since 1991 when it replaced the previous Bridge ('Bridge 7'). Bridge 7 was removed in 2021 after a period remaining in place redundant. A timeline of the bridges is as follows:

- Bridge 1: 1865 to about 1876;
- Bridge 2: 1879 to 1889;
- Bridge 3: 1892 to 1911;
- Bridge 4: 1911 to 1913;
- Bridge 5: 1914 to 1923;
- Bridge 6: 1925 to 1929;
- Bridge 7: 1935 to 2021; and
- Bridge 8: 1991 to present.

# 2. Data Reviewed

The study was informed by a data and literature review, a limited site inspection, and consultation with stakeholders, including collation of anecdotal information from Council operational personnel and local residents.

Data reviewed included:

- Aerial imagery and elevation data obtained from Tasmanian Government's Land and Information System Tasmania (LIST)[1] was downloaded for use. Aerial imagery was available from the 1950s to present.
- Aerial imagery obtained from Google Earth. Aerial imagery was available from the 2007 to present.
- Elevation data obtained from Elvis Elevation and Depth - Foundation Spatial Data (ELVIS)[2].
- Historical shoreline position has been mapped by Geosciences Australia[3]
- Hazard reports relevant to Scamander, including both state-wide datasets and local studies were reviewed and are reference within this report.
- Anecdotal information, predominantly photos documenting physical works, flood debris lines, hazard events; and
- Metocean and coastal processes data from various sources, including wind, tide, waves and sea level.

The currently available hazard analysis, whilst forming the best available information, have noteworthy limitations. Hazard assessments do not comprise compounding from hazards as they have not completely assessed the interplay of processes. To undertake a hazard assessment in the absence of additional assessment and numerical modelling, a conceptual understanding was development to better understand the complex processes and inform hazard assessment and the plan.

[1] https://www.thelist.tas.gov.au/app/content/home

[2] Elvis Elevation and Depth is a cloud-based system allowing users to easily discover and obtain Australian elevation and bathymetry data available within their area of interest. It is developed as a partnership between participating agencies under the Intergovernmental Committee on Surveying and Mapping (ICSM) (https://elevation.fsdf.org.au/)

[3] https://maps.dea.ga.gov.au/story/DEACoastlines

# 3. Key Geomorphological Features and Coastal Forms

The physical processes and sediment transport along the Scamander River, ICOLL and open coast are complex and dynamic. They have manifest into a variety of ever-changing geomorphological forms. The key geomorphological features are briefly described here, with the forming processes described in the following section.

As previously mentioned, the system as a whole, forms an ICOLL, which can be described as follow:

> *Intermittently Closed and Open Lakes or Lagoons (ICOLLs). This refers to lakes that naturally alternate between being open and closed to the ocean. A dynamic sand beach barrier, also known as a berm, which is continuously influenced by the movement and redistribution of sand and sediments, separates ICOLLs from the ocean. These berm changes are also affected by waves, tides, flood flows and winds* (NSW DPIE, 2021).

At Scamander, the ICOLL generally reflects a typical formation, with some variation (**Figure 4**). Due to the geological controls of the lower Scamander River (Fearman, 2021), there is an unusual gorge feature. The key features are described below and are annotated for convenience in **Figure 5**. Representative photos of key features are presented in **Figure 6** to assist description.

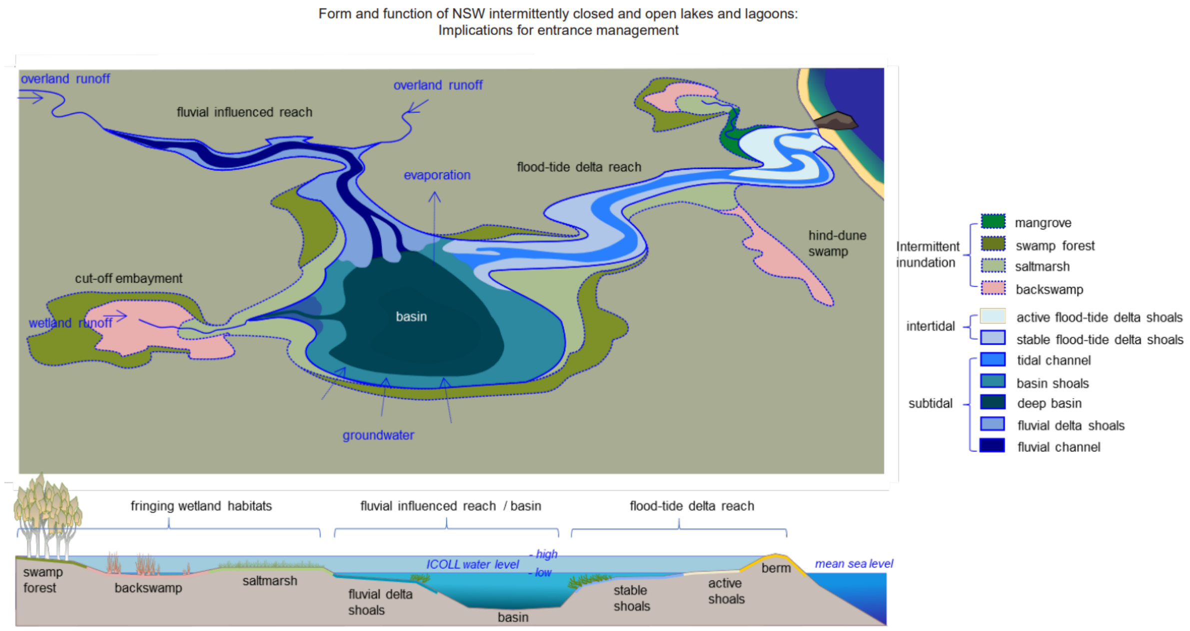



**FIGURE 4: TERMINOLOGY IDEALISED ICOLL SHOWING THE DISTRIBUTION OF KEY FUNCTIONAL ZONES AND SUBENVIRONMENTS (FROM NSW DPIE, 2021)**


FIGURE 5: IDENTIFICATION AND INDICATIVE LOCATION OF KEY GEOMORPHOLOGICAL FEATURES

The Scamander River rises at Billy of Tin Tier in the west of the catchment and flows into the Tasman Sea at Scamander. The Scamander River has two sub-catchments (Upper Scamander and Avenue Rivers), which are similar in size but differ in lithology (Fearman and Ellison, 2023). The Upper Scamander River and the Avenue River converge at about 20 m elevation, 9 km from the river mouth (WMA Water, 2023a). The Avenue River is the major tributary of the Scamander River. The majority of the Scamander River catchment is covered by native dry sclerophyll eucalypt forest, with an area of plantation forest in the lower catchment (Hydro Tasmania Consulting, 2008).

In the lower reaches of the Scamander River, the river channel is sinuous and meanders through alluvial plains, before passing through a gorge and into the ocean. Inland of the gorge is a wide basin and mudflats where saltmarsh has established. At the mouth of the river there has formed a body of sediment (mainly sand), forming a complex and highly dynamic network of channels and bars.

The sediment in the littoral zone can build into a berm, forming a similar profile as the adjacent beach, and close off across the river mouth, forming a barway. This barway can form and build during periods of low river flows and moderate wave conditions. There is only one source of elevation data know of for the berm, which is 10m resolution digital terrain model available on Tasmania LIST and 2014 1m resolution digital terrain model available on Elvis, which shows the berm elevation to be approximately 1.3m AHD. Obviously, these are taken in one point of time and the berm height could build higher than this, or the entrance be open.

Barriers are formed across the estuarine opening where there are ample sediments to be moved into river openings by wave energy and alongshore currents (Kench, 1999). Such estuaries are known as wave-dominated or barrier estuaries, as categorised by Roy et al., (2001) in their synthesis of geological properties of south-east Australian estuaries. More commonly, the feature is known as an ICOLL (Kench, 1999), as previously mentioned.

The barway can open, typically during high river flows, or when opened mechanically. When the barway is open, tidal flows can penetrate into the estuary. Tidal flows can move sediment from the bar inward, forming a flood tide delta, a process that can be added to by overwash of waves (during both entrance open and entrance closed conditions).

Spits, also called barriers, are elongate accumulations of sand formed by waves, tides and winds (Woodroffe, 2004). They are dependent upon a supply of sediment and wave energy to transport the sediment. These landforms can be reworked by rising sea levels. These features are formed and grow in the predominant direction of longshore sediment flow caused by waves (see **Section 4.2** for discussion on longshore sand transport). Generally, spits are backed by estuarine systems with salt marshes and lagoons (DTAE, 2007), such as at Scamander.

Much of the region's coastline is comprised of embayments with parallel dunes on the East Coast North, as is the case for Scamander beach, where a sandy beach is backed by dune and / or soft sediment plains. Beaches are exposed at low tide and submerged at high tide and can extend to the backshore which can be inundated by exceptionally high tides or by large waves during storms.

In the lee of the dunes, hind dune lagoons have formed north and south. Foredunes (also called frontal dunes), typically fronted by an incipient dune run parallel to the beach, they can be symmetric or asymmetric dune ridges located at the landward edge of the beach. They are formed by windblown sand deposited within vegetation. Generally, they occur as two main types, incipient and established foredune(s) (DTAE, 2007). Incipient dunes are located in front of an established foredune at the upper margin of the beach.

(a)  (b) 


**FIGURE 6: PHOTOS OF KEY GEOMORPHOLOGICAL FEATURES: (A) SCAMANDER RIVER; (B) HIND DUNE MARSH; (C) ENTRANCE (IN OPEN STATE) (D) BEACH AND BARWAY (E) INCIPIENT DUNES AND FOREDUNES (PHOTOS BY N. LEWIS).**

# 4. Physical Processes

There is a myriad of processes with complex interactions forming the geomorphological features at Scamander. Some of the key coastal and river processes are described below.

## 4.1. Wind

Wind data was extracted from the Bureau of Meteorology's online dataset[4], which includes wind speed and direction roses. The observation point for the obtained data was the St Helens Post Office, site number 092033, recorded between 1957 to 2001. Data was extracted for 9am and 3pm readings, for annual, winter and summer datasets summaries, presented below in **Figure 7**, **Figure 8** and **Figure 9** respectively. At Scamander, the prevailing wind direction is from the northwest, particularly in winter, with more SE, E and NE contributions in summer.

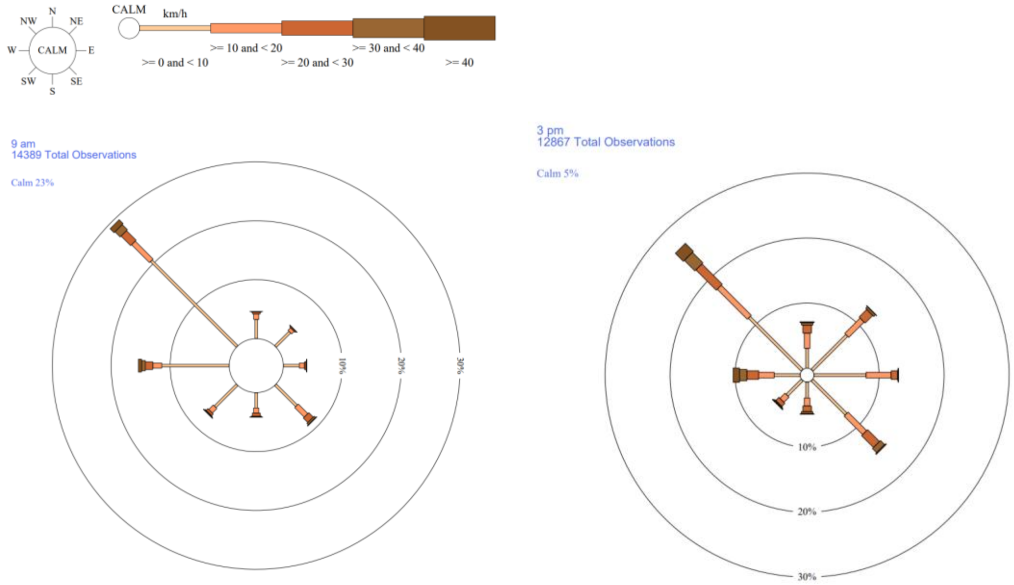
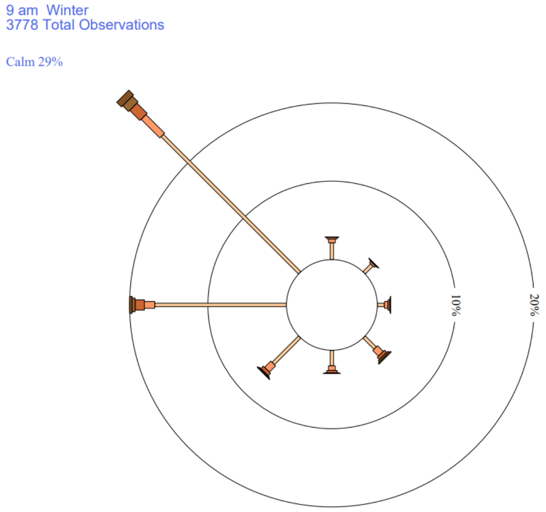



FIGURE 7: WIND ROSES FOR ANNUAL DATA - COLLECTED AT 9AM (LEFT) AND 3PM (RIGHT)


[4] http://www.bom.gov.au/climate/averages/wind/selection_map.shtml

FIGURE 8: WIND ROSES FOR SUMMER DATA - COLLECTED AT 9AM (LEFT) AND 3PM (RIGHT)



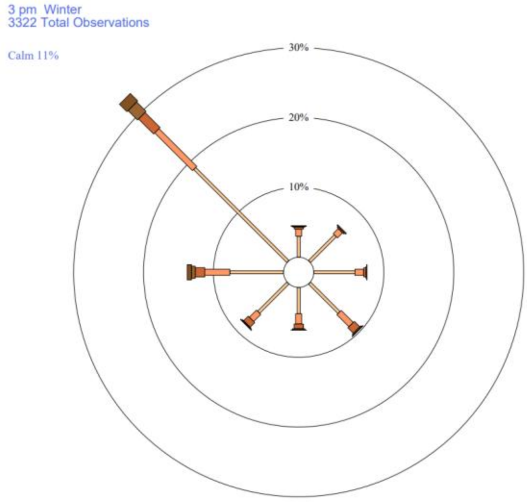




FIGURE 9: WIND ROSES FOR WINTER DATA - COLLECTED AT 9AM (LEFT) AND 3PM (RIGHT)

## 4.2. Tides

The tidal planes around Tasmania differ significantly. Scamander is a semi-diurnal[5] microtidal environment, with a tidal range between LAT and HAT of approximately 1.5m. The Australian Height datum (AHD) of HAT, MSL and LAT at Scamander is 0.84, 0.08 and -0.52 respectively[6].

## 4.3. Waves

The Australian continent extends from southern mid-latitudes to tropics in the north and, as a result, the wave climatology affecting Australia's coastal margins varies both spatially and temporally with distinct climatic processes dominating different regions Mariani et al. (2012). The southern part of Australia receives persistent moderate to high wave energy from mid-latitude low pressure systems centred within the Southern Ocean at between 50 and 60° S latitude (Short and Woodroffe, 2009) with large wave events occurring intermittently as these low-pressure systems intensify and/or extend further north towards the coastline. The uniform nature of the climatic system responsible for both the mean and extreme wave climate results in a near unidirectional wave climate along the southern continental margin. The northeast of Tasmania is sheltered from this persistent high energy by land mass sheltering.

While a portion of this south-west directed wave energy reaches the Australian East Coast, the majority of the east coast's wave energy is generated within the Coral Sea and Tasman Sea window (Short and Trenaman, 1992).

In the south of NSW, extreme waves are caused by a combination of easterly trough lows, inland and continental lows and southern secondary lows. Easterly trough lows are concentrated between April and August. On the east coast, wave direction was found to be highly variable depending on season and particular storm type (Shand et al. 2010).

[5] Characterised by two high and two low tides per day.
[6] https://nre.tas.gov.au/land-tasmania/geospatial-infrastructure-surveying/geodetic-survey/coordinate-height-and-tide-datums-tasmania

Mean significant wave height for Australian coasts is presented in **Figure 10**.

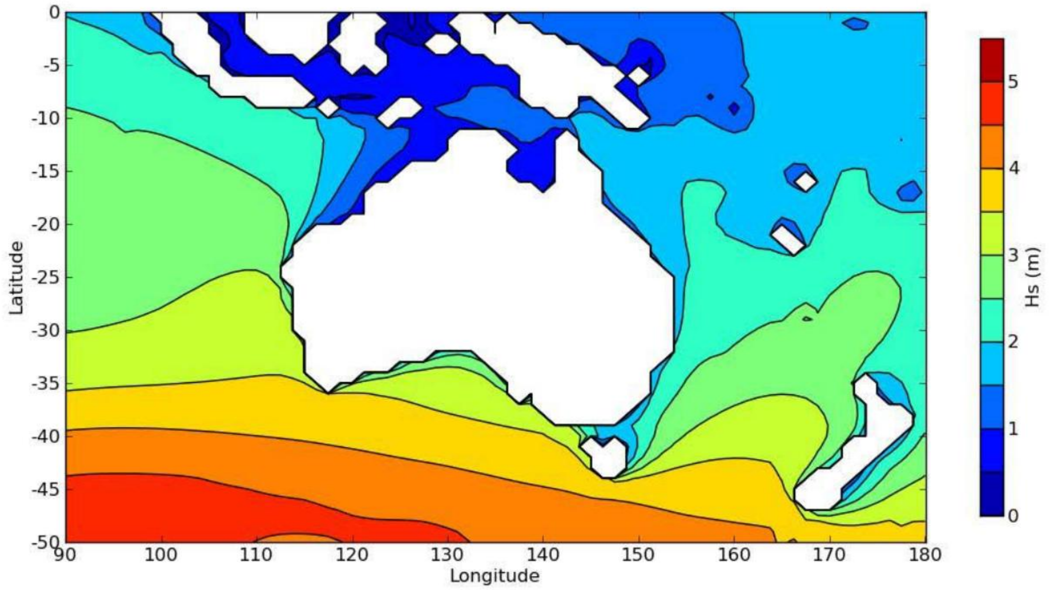



**Figure 5:** Coarse-resolution modelling of long-term mean significant wave height (Hs) for Australian coasts, from Hemer *et al.* (2007). Significant wave height is the average of the highest one third of waves in a wave train or wave record, and is related to wave energy. Despite the coarse resolution of this model several distinctive wave climates are clearly definable around the Tasmanian coast, ranging from a high energy west-southwest coast regime to lower energy east coast and Bass Strait coast wave climates.

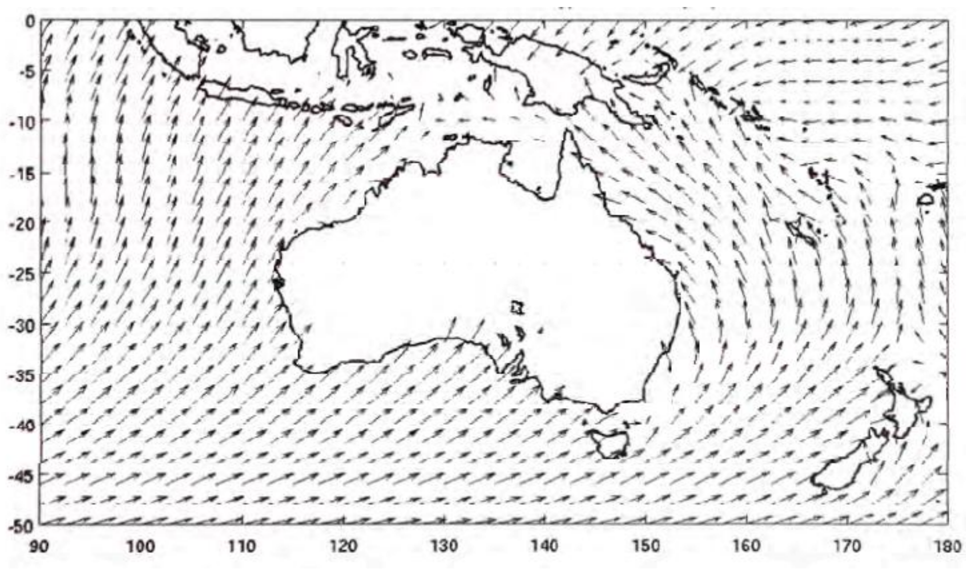



**FIGURE 10: LONG-TERM MEAN SIGNIFICANT WAVE HEIGHT (TOP) AND MEAN WAVE DIRECTION (BOTTOM) AROUND AUSTRALIA BASED ON NWW3 MODEL (1997 - 2007) (FROM HEMER ET AL., 2007)**

The identification and analysis of large events observed within a historical record allows quantification of extreme event and, using appropriate extreme value analysis, characterisation of large, low probability wave events. Maps showing adopted peak (1 hour) significant wave height around Australia for a 100 year ARI events are shown below (**Figure 11**) adopted by after collation of various studies. For the east coast of Tasmania, the 100 year ARI (1 hour) significant wave height (Hs) was estimated as 9m (indicated by orange line).

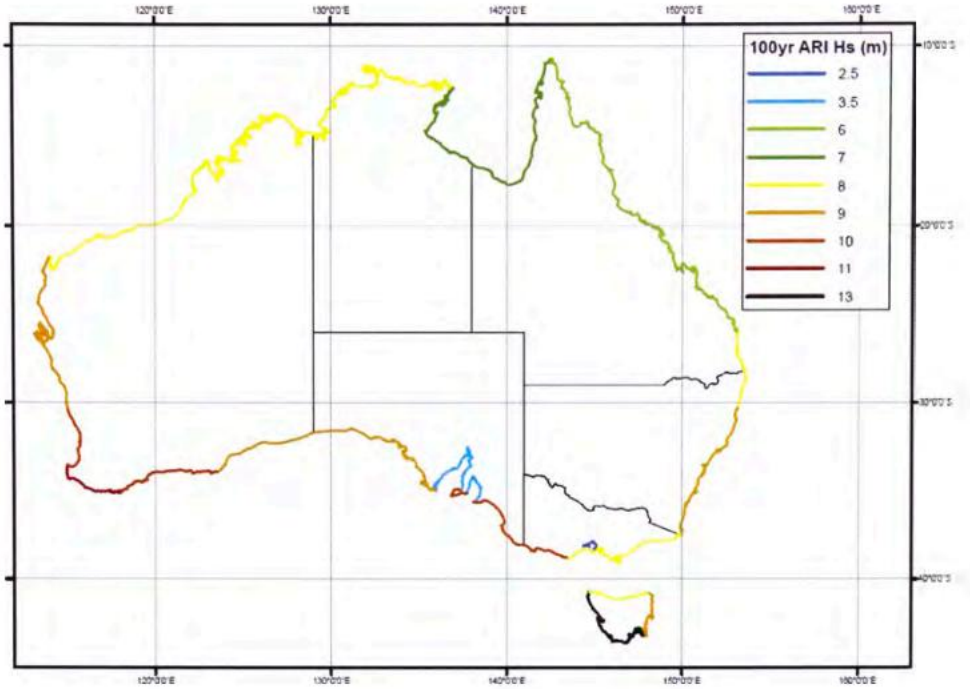



FIGURE 11: 100 YEAR ARI SIGNIFICANT WAVE HEIGHT (FROM MARIANI ET AL. 2012).

Hemer et al. (2007) derived extreme wave height values around Australia using the C-ERA-40 numerical hindcast (1957 - 2002) and NOAA WavewatchIII (NWW3, 1997 - 2009) numerical forecasts, for a range of return periods (**Figure 12**). The results presented by Hemer et al. (2007) indicated that for the north-east coast of Tasmania, the Hs is 8-9m, 5m and 4m for the 100 year ARI, 5 year ARI and 1 year ARI respectively.

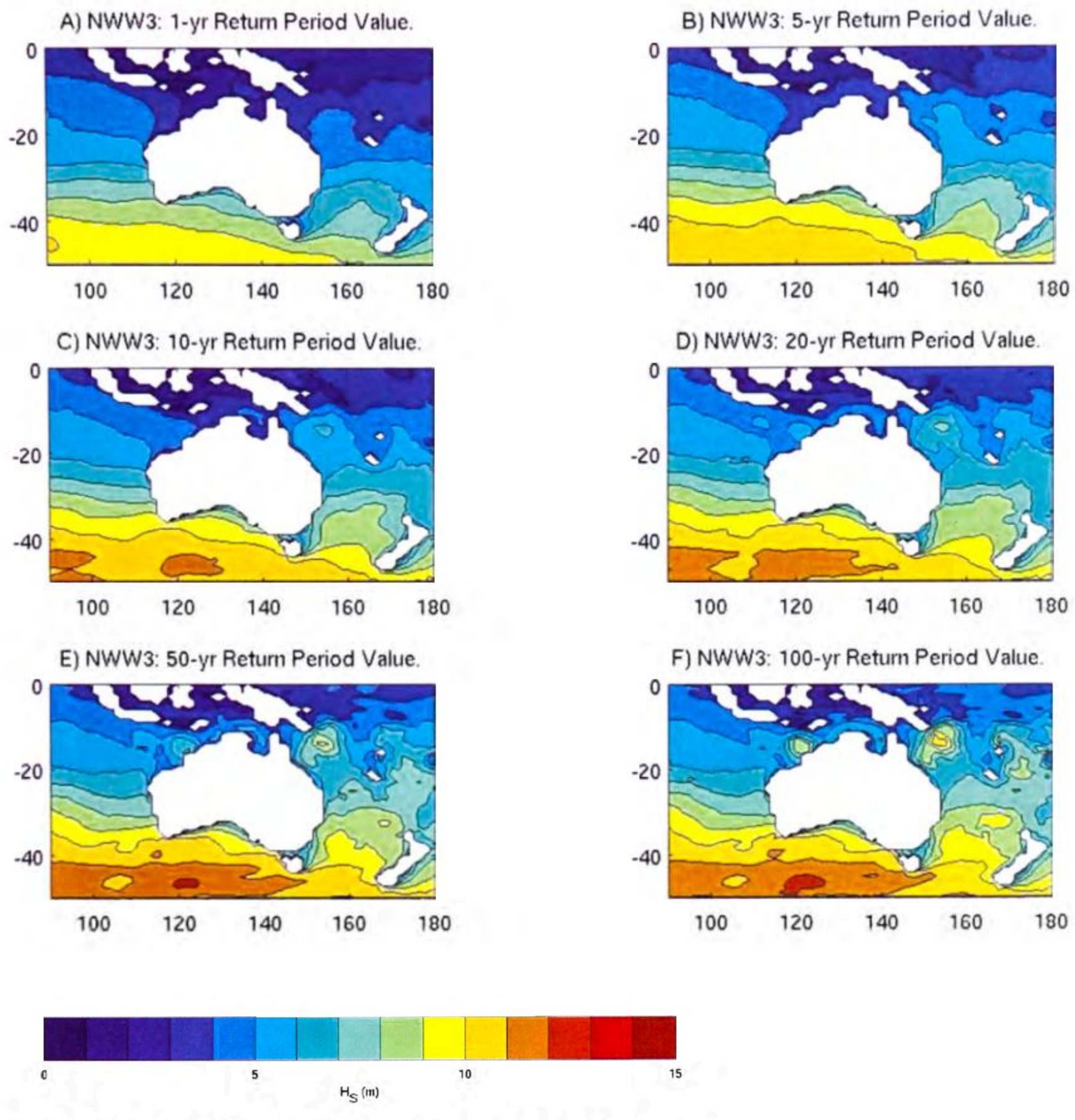



**FIGURE 12: N-YEAR RETURN AVERAGE RECURRENCE INTERVALS DETERMINED FROM NWW3 NUMERICAL DATASETS (SOURCE: HEMER ET AL., 2007)**

## 4.1. River Flows

The Scamander is a 395 km$^2$ catchment, with rugged terrain, a temperate maritime climate (mean annual rainfall 790 mm (Bureau of Meteorology, 2022), with periodic heavy rainfall events. River flow data beginning in 1968, with several interruptions, is available online[7]. River flow data was downloaded for station number 2206.1 (Scamander River U/S Scamander Water Supply) and presented graphically for level and discharge respectively in **Figure 13**.

River water levels can rise rapidly on the Scamander River. Fearman (2021) noted that flood hydrographs are steep and their form changes over the period of measurement. Fearman (2021) also highlights its unusual catchment history and reputation as a 'treacherous' river, not least reflected in its

[7] http://www.bom.gov.au/waterdata/

influence on bridge longevity. Based on the March 2021 flood event, the rate of rise of flood waters was approximately 4 hours (**Figure 14**).

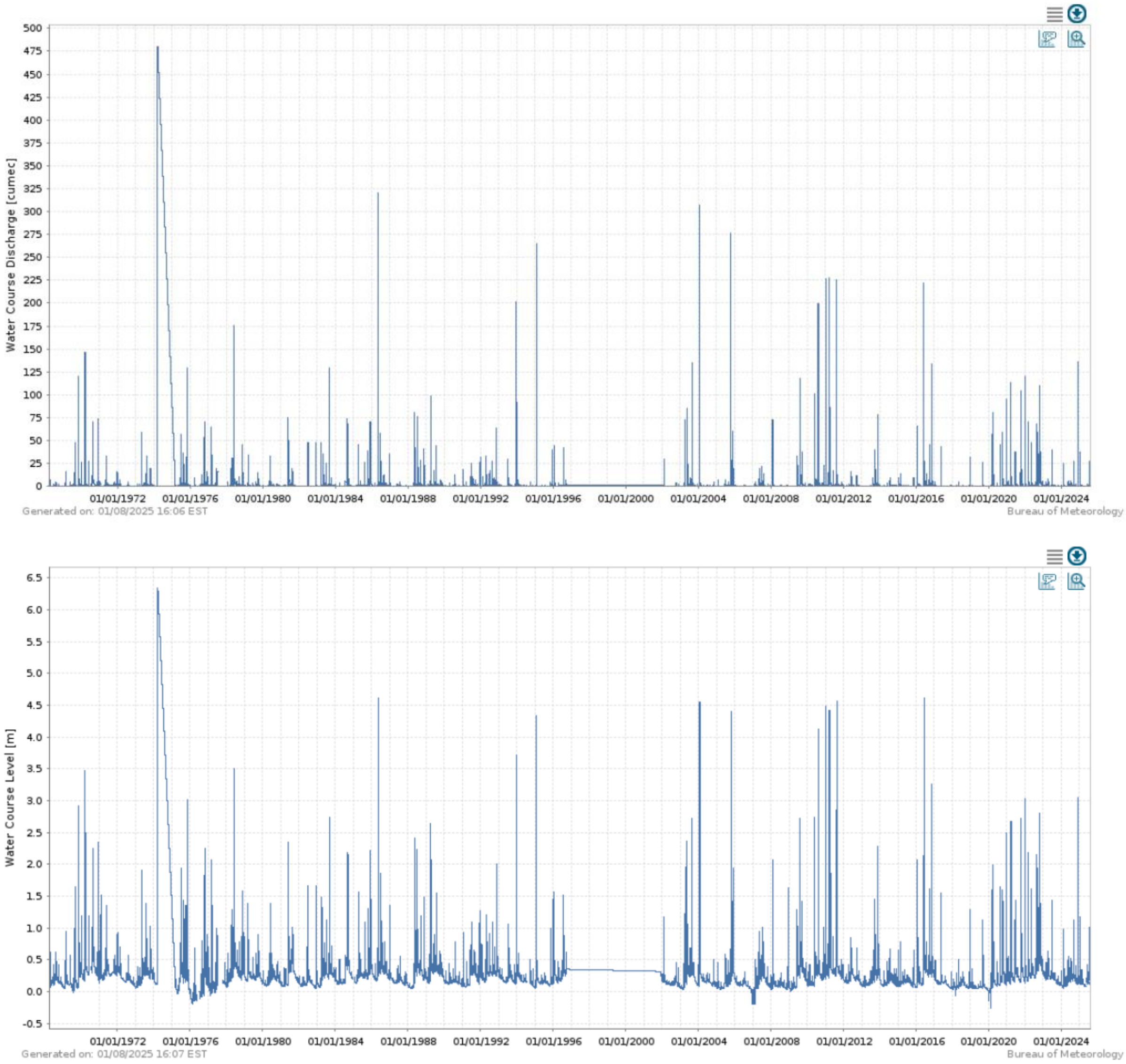



**FIGURE 13: SCAMANDER RIVER U/S SCAMANDER WATER SUPPLY (STATION NUMBER 2206.1) WATERCOURSE DISCHARGE (TOP) AND WATERCORUSE LEVEL (BOTTOM) FOR THE RECORD PERIOD OF 1972 TO 2024.**

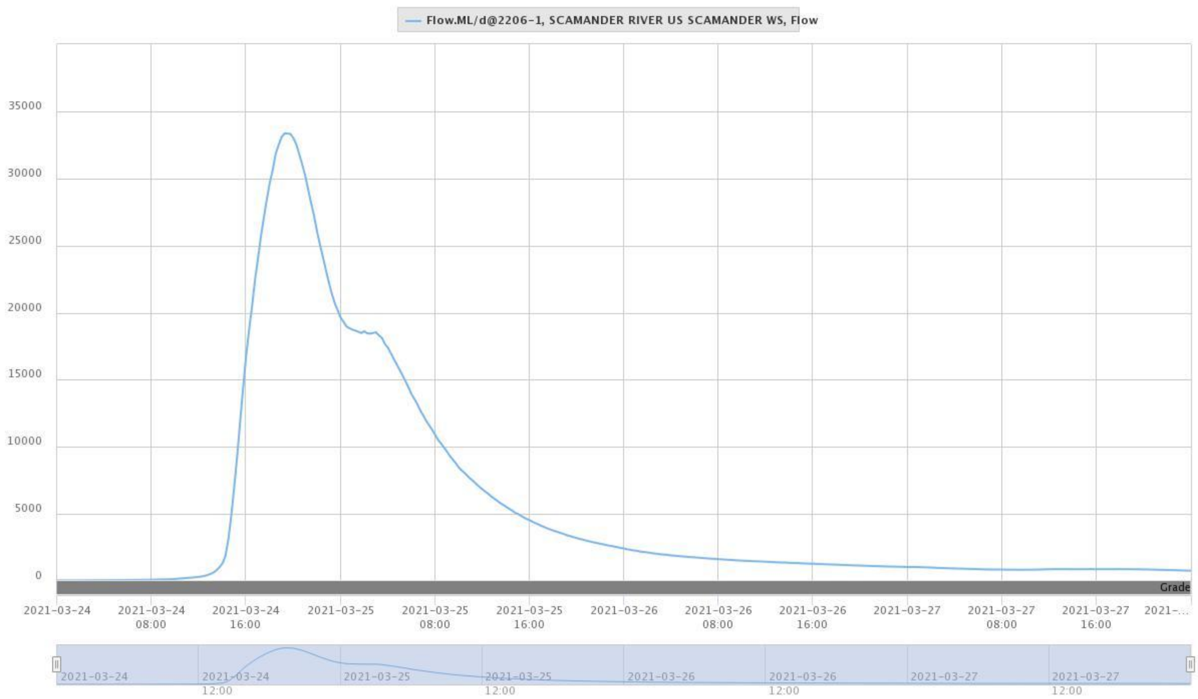



FIGURE 14: HYDROGRAPH OF THE MARCH 2021 HIGH RIVER FLOW EVENT.

## 4.2. Sediment Transport

Short (2010) suggested a timeline for formation of barriers along Australia's east coast. He found east coast sands to be high in quartz, the southern east coast averaging only 20% carbonate materials, decreasing southwards to as low as 3% off Victoria (Tasmania was not tested, but is likely to be similar). Quartz sediments are terrigenous (from the land) in origin, being supplied as bedload in rivers to the continental shelf during periods of low sea level. The east coast of Australia underwent a Postglacial Marine Transgression, 6000 to 6500 years ago, followed by stillstand at or near present sea levels. Most rivers in the region have been infilling their estuaries since that time, meaning little sediment of terrestrial origin would have reached the coast during the Holocene.

Short (2010) estimated that during the Holocene, terrigenous materials were delivered to the coast of Tasmania at a rate of 0.7 m3m-1yr-1, the lowest rate for Australia's east coast, which averages 3.1 m3m-1yr-1. Tasmanian east coast estuarine barriers have therefore gained little sediment from the landward side during this period.

The sandy texture of east coast beaches allows sediments to be reworked on shore during sea level transgression to supply beach-barrier systems and contribute to long-shore transport. These conditions mean barriers are likely to have reached a stable form shortly after the marine transgression ended, and to have remained stable through the Holocene (Short, 2010). This gives the barrier that existed at Scamander a potential age of some 5,000 years.

Most beaches on the northeast Tasmanian coast are accumulations of loose wave-deposited sand size sediment comprised of quartz with a low proportion of shell content (calcium carbonate) (DTAE, 2007). All along this coast it seems that rivers are a negligible source of sand at present (Davies 1987). The survey suggests that this section of coast could be that on which most littoral drift occurs but even here it may not be as great as might have been expected.

The amount of net littoral drift along the coast is relatively contentious. Bi-directional drift and little net drift have been previously reported (Davies, 1983). However, Byrne (2000) suggest that based on the trapping of sand coming from the south in Georges Bay (north of Scamander) for at least the last 6000 years, that volumes trapped there would indicate the net longshore drift of sand moving northward up the coast towards St Helens is estimated at somewhere between 7,000 and 10,000 cubic metres per year (Byrne, 2000). Regardless, it is likely that littoral drift operated in both a southerly and northerly direction from time to time. The low net drift may owe to the migratory ability of the entrance channel through time. Noting that the entrance location is recently dictated by the mechanical openings.

The entrance to the Scamander River at Scamander is highly mobile as the mouth of the river moves north or south in response to offshore wave conditions and to the natural movements of the meanders of the river. The maximum historical extent of the movement is probably up to 1500 metres, judging by the length of coastal escarpment north of the township. However, the normal movement appears to be less than 500 metres (Byrne, 2000).

There is no doubt that the coastal sand bars that are trapped in the river mouth have moved further westward into the estuary in the last ten years than at any time in the previous forty years. However, it is not clear whether this is due to the bridges. It is just as possible that there were fewer severe storms in the mountain ranges in the upper part of the catchment over the last ten years than there are as a long term average, and so there might have been less capacity to clear sand from the estuary (Byrne, 2000).

## 4.3. Climate Change

Climate change is expected to have implications for the coastal and river processes at Scamander. Of particular note are the predicted:

- increased intensity of rainfall;
- sea level rise; and
- increased intensity of coastal storms.

The Intergovernmental Panel on Climate Change use scenarios of atmospheric greenhouse gas concentrations (Representative Concentration Pathways, RCPs) that range from high concentrations representing continued growth of emissions in a business-as-usual fashion (RCP8.5), to lower concentrations representing very strong mitigation and removal of carbon dioxide from the atmosphere in the second half of the 20th century (RCP2.6) and two intermediate scenarios (RCP4.5 and RCP6.0).

***Sea level rise***

In March 2016, the Tasmanian Government engaged the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to develop sea level rise planning allowances for Tasmania's coastal councils based on the International Panel on Climate Change (IPCC)'s Fifth Assessment Report (AR5). This provided sea level rise predictions for a number of Tasmanian council areas (including Break O'Day) (**Figure 15**). In addition, the work provided regional appropriate sea level rise projections and allowances (SLRPAs) for all of Tasmania to 0.92 m by 2100 in the northeast of Tasmania (McInnes et al, 2016). These projections are based on the IPCC AR5's high emissions, 'business-as-usual' scenario, known as Representative Concentration Pathway 8.5, or RCP 8.5.

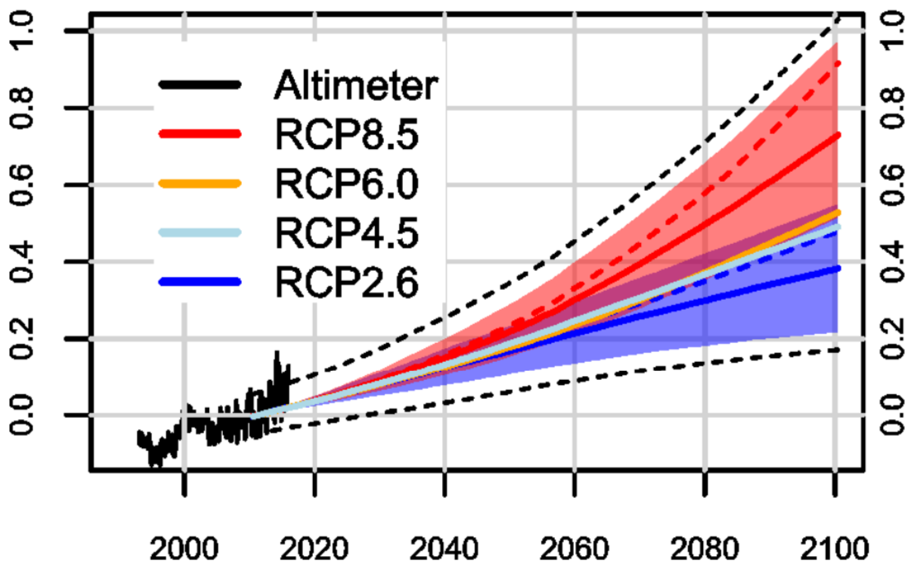



FIGURE 15: PROJECTED SEA-LEVEL RISE FOR BREAK O'DAY COUNCIL. THE BLACK LINE SHOWS THE SATELLITE-DERIVED SEA-LEVEL VARIABILITY SINCE 1993. MULTI-MODEL MEAN PROJECTIONS (THICK RED AND BLUE LINES) FOR RCP8.5 AND RCP2.6 WITH THE 5-95 PERCENTILE RANGE SHOWN BY THE RED AND BLUE SHADED REGIONS FROM 2010 TO 2100. THE BLACK DASHED LINES REPRESENT ESTIMATES OF INTERANNUAL VARIABILITY DETERMINED FROM THE SATELLITE ALTIMETER DATA COMBINED WITH THE RANGE OF THE PROJECTIONS. THICK LIGHT BLUE AND ORANGE LINES REPRESENT MULTI-MODEL MEAN PROJECTIONS FOR THE RCP 4.5 AND 6.0 SCENARIOS, RESPECTIVELY (FROM MCINNES ET AL., 2016).

***Rainfall and river flows***

Climate change factors were applied within recent river flooding studies for the Tasmanian Strategic Flood Mapping Project (WMA Water 2023), which included a rainfall scaling factor of 16.3% based on RCP8.5 for the year 2090.

# 5. Historical Trend Analysis

Given the complexity of processes associated with the geomorphological system, particularly the channels and sand bars of the ICOLL, a historical trend analysis was undertaken to inform the formulation of process understanding. The historical trend analysis focussed on the foreshore and body of sand deposited at the entrance, including channel alignment, entrance condition (open/closed) and entrance location (when open).

The historical trend analysis was undertaken using available aerial images obtained from either Tasmania's 'LIST' database, or Google Earth. Additionally, the analysis included one map from 1833 (extracted from Dawson, W. c1833. Map – East Coast No. 2 – Cornwall. 74/87264) and provided by Liese Fearman (and documented in Fearman 2012) (**Figure 16**). It is noteworthy that the location of the river entrance in 1833 was significantly further north than the current outlet.

The trend analysis allowed for identification of key changes over time in the morphology of the entrance and shoreline position. Of interest to the project was the condition of the entrance (open/closed) and when open, the location. The location of the entrance and it's state (open/closed) through time is presented in **Figure 17** and **Figure 18** below. It should be noted that on Dawson's map, the river opening is described as 'open only in the winter months' and sediments across the river mouth were sufficiently compacted to allow fording with wagons' (Dawson, Circa 1844) (reported in Fearman, 2021).

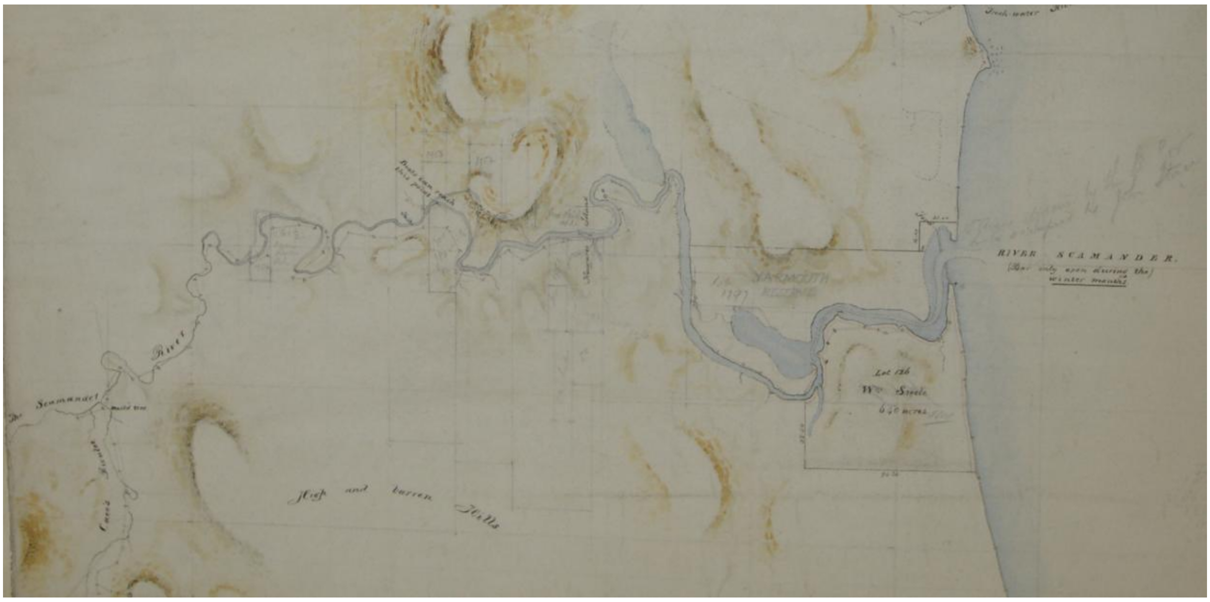
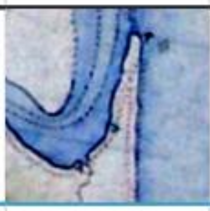



FIGURE 16: EARLY MAP OF THE ESTUARY AND OPENING OF THE SCAMANDER RIVER: (DAWSON, CIRCA 1844). NOTE: BRIDGE SITE, SPIT TYPICAL OF WAVE DOMINATED ESTUARIES EXTENDING NORTHWARD SOME 400 METRES ACROSS THE OPENING FROM THE SOUTHERN BANK, AND SOME 50 METRES SOUTH FROM NORTHERN BANK. DOTTED LINES REPRESENT A DEEPER CHANNEL WITHIN THE MAIN CHANNEL, RUNNING CLOSE TO A ROCKY POINT AT THE NORTHERN END OF THE BRIDGE. A FORD IS INDICATED FROM THE TIP OF THE SOUTHERN SPIT TO THE CONCAVE NORTHERN BANK, INSIDE THE RIVER MOUTH. (TASMANIAN HISTORICAL ARCHIVES) (FROM FEARMAN, 2021)

| | Date | Data | Condition | Location |
|---|---|---|---|---|
| | 2024-03 |  | Closed | - |
| | 2023-02 |  | Open | South |
| | 2022-08 |  | Open | South |
| | 2022-03 |  | Open | Centre/ South |
| | 2021-03 |  | Closed | - |
| 2020 | 2020-05 |  | Open | South |
| | 2018-09 |  | Open | Centre |
| | 2017-03 |  | Closed | - |
| | 2015-11 |  | Open | South |
| | 2013-08 |  | Open | South |
| | 2012-04 |  | Closed | - |
| 2010 | 2010-03 |  | Open | South |
| | 2008-03_02 |  | Open | Centre/ North |
| | 2007-03_02 |  | Open | Centre/ North |
| | 2006-03-03 |  | Open | South |
| | 2005-12-11 |  | Open | South |
| | 2003-01-05 |  | Open | South |
| | 2002-02-23. |  | Open | North |
| 2000 | 2000-11-27 |  | Open | South |
| | 1999-03-19-02 |  | Open | South |

FIGURE 17: SCAMANDER RIVER ENTRANCE STATE (OPEN/CLOSED) AND LOCATION (IF OPEN) BASED ON AVAILABLE AERIAL IMAGES AND HISTORIC MAP (CONTINUES ON NEXT PAGE)

| | | | | |
|---|---|---|---|---|
| | 1998-03-10 |  | Closed | - |
| | 1996-02-17 |  | Open | Centre |
| | 1995-04-11 |  | Open | Centre |
| | 1994-03-26 |  | Open | South |
| 2nd bridge construction ends | 1992-02-19 |  | Open | Centre |
| Rock training wall | 1991-03-02 |  | Open | South |
| 1990 | 1990-01-23 |  | Open | South |
| 2nd bridge construction starts | 1989-03-15 |  | Open | South |
| | 1986-11-03_01 |  | Open | Centre/ South |
| | 1983-01-30 |  | Open | North |

| | | | | |
|---|---|---|---|---|
| | 1982-11-01 |  | Closed | - |
| 1980 | 1981-04-23 |  | Closed | - |
| | 1979-04-29 |  | Open | North |
| 1970 | 1975-02-10 |  | Open | South |
| 1950 | 1950-03-16 |  | Closed | - |
| 1sr bridge construction | 1935 | | | |
| 1880 | 1883 |  | Open | Far North |
| | | | | |

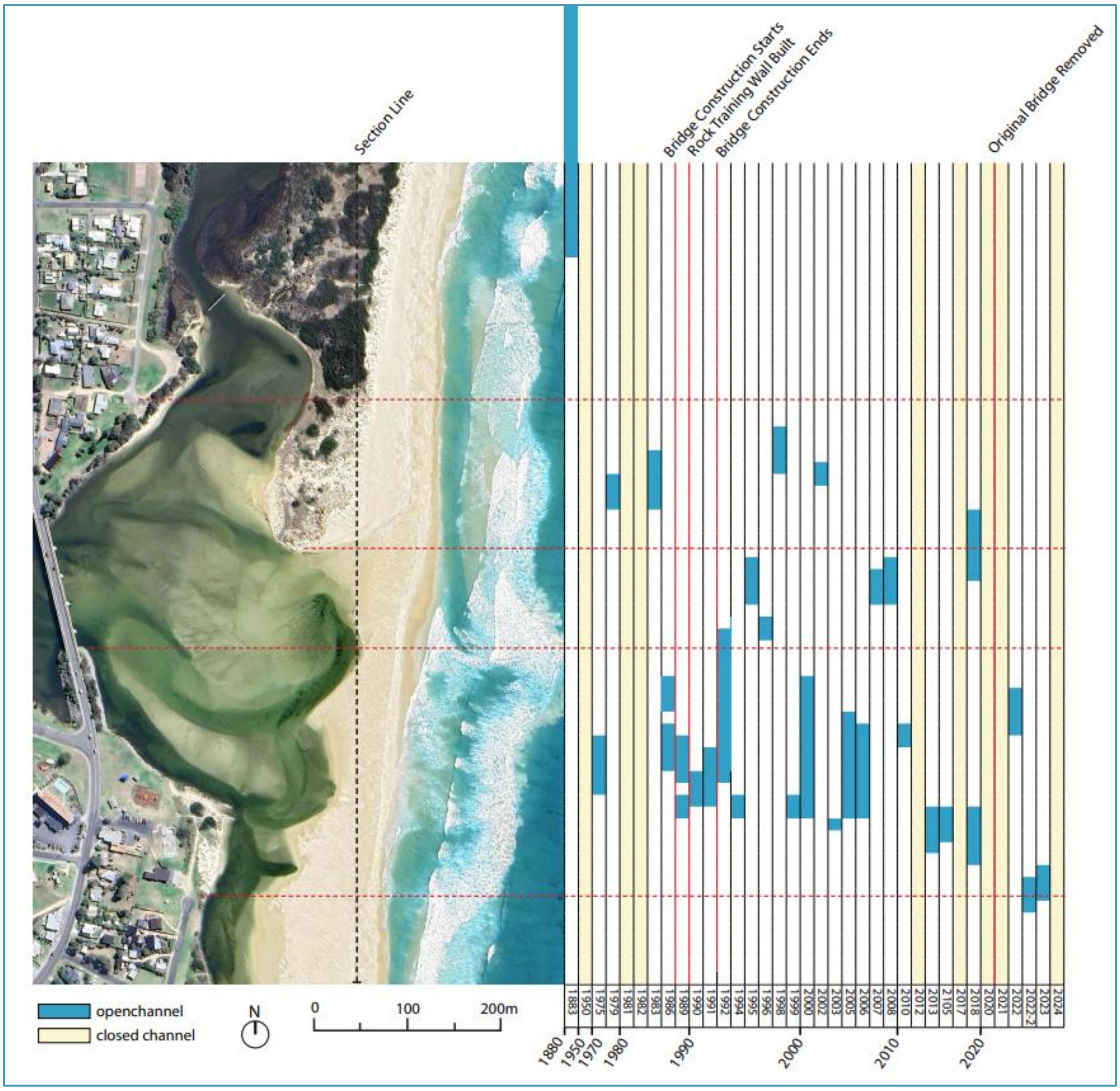



**FIGURE 18: SCAMANDER RIVER ENTRANCE STATE (OPEN/CLOSED) AND LOCATION (IF OPEN) - GRAPHED AGAINST CURRENT (2025) AERIAL IMAGE. INFORMED BY AVAILABLE AERIAL IMAGES AND HISTORIC MAP.**

The entrance was closed in seven of the 36 aerial images. The location of the entrance ocellated north and south, when open.

It should be noted however, that the available ariel imagery missed a number of key points, including:

- The mouth was well south on 2022-12-28, opposite Hodgman Street. This was confirmed by on-site photos provided by Break'O Day Council.
- Whilst not open at the time in the 1950 image, the channel and remnants of an open entrance appears to be just south Hodgman Street (going off the image shown).

From an extent point of view, the analysis is broadly consistent with the analysis of Byrne (2000) who determined that the maximum historical extent of the movement is probably up to 1500 metres, judging by the length of coastal escarpment north of the township. Byrne (2000) suggested that the normal movement appears to be less than 500 metres (**Figure 19**). However, the above analysis, supplemented by on-site photographs shows that the channel has migrated further south in recent years.


**FIGURE 19: HISTORICAL AND NORMAL MOVEMENT OF THE SCAMANDER RIVER CHANNEL ENTRANCE (FROM BYRNE 2000)**

The migration of the channel (and entrance when open) over time has been influenced by human modification. Of significance was the construction of the training wall. From construction in 1989, the training wall appears to have controlled the channel alignment and entrance location (when open) and limited migration southward.

A recent significant change has been the shoreline recession and channel alignment in front of Dune Street. Since 2015 there has been significant change. Approximately 120m of recession of dune line adjacent to Dune Street has occurred (**Figure 20**) since 2015. This change appears to coincide (maybe correlate) with damage to the landward portion of the training wall, which is still visible in the 2015 image. The result is a reformation of a hind dune marsh (**Figure 21**). The change appears to have occurred in three episodes (from interpretation of the available aerial imagery):

1. between 2015 and 2017;
2. again in 2021; and
3. another change between 2023 and 2024.

FIGURE 20: AERIAL IMAGERY FROM 2015 (LEFT) AND 2024 (RIGHT) SHOWING MEAUSRED DISTANCE OF FORESHORE CHANGE

FIGURE 21: HIND DUNE MARSH FORMED IN FRONT OF DUNE STREET. THE FORESHORE IS SHOWING EVIDENCE OF ACTIVE EROSION (PHOTO BY N. LEWIS)

Historical shoreline position has been mapped by Geosciences Australia[8] who have mapped the average shoreline position each year between 1988 and 2024. Whilst the mapping includes the inner estuary including the channel(s) and sand shoals, mapping of the complex inner estuary features is complex and not conducive to analysis by straight line shoreline mapping. It does however, corroborate the trend analysis above in showing the dynamic movement of the channels, mouth & entrance condition. Refer above for a more useful spatial trend analysis of the entrance channel. The data presented is useful for indicating the long-term trend of open coast shoreline position. The mapping demonstrates the following trends, presented for locations approximately 400m north and 400m south of the entrance respectively (**Figure 22**):

- **North of the entrance** - This coastline has retreated by -0.5 metres (±0.3) per year on average since 1988. The shoreline at this location was most seaward in 1999, and most landward in 2018. Since 1988, the median annual position of the shoreline has moved over a total distance of approximately 51 metres.
- **South of the entrance** - This coastline has been net stable since 1988 (no significant trend of retreat or growth). 'Net stable', as defined in the mapping are coastlines or regions that have remained relatively unchanged since 1988, or where shorelines have fluctuated between growth and retreat over time. The shoreline at this location was most seaward in 2023, and most landward in 2019. Since 1988, the median annual position of the shoreline has moved over a total distance of approximately 29 metres.


[8] https://maps.dea.ga.gov.au/story/DEACoastlines

**FIGURE 22: SHORELINE POSITION MAPPING (GEOSCIENCES AUSTRALIA) NORTH (LEFT) AND SOUTH (RIGHT) OF THE ENTRANCE**

# 6. Hazards

## 6.1. Hazards

Coastal hazards occur as the result of the negative impacts of natural processes. Influenced by weather patterns, seasonal variations and climate change, these processes can have a temporary or permanent influence on the coastline (Tasmanian Government, 2016). Scamander is susceptible to and currently experiences some impacts from a number of geo-hazards, including:

- coastal inundation,
- coastal erosion,
- river flooding, and
- estuarine and river foreshore erosion.

Hazards are expected to increase in magnitude with climate change, in particular through changes associated with a rising sea level, increased intensity of coastal storms and increasing rainfall intensity.

As is the case with many estuary mouths/ICOLLS, where the river processes (including flood waters) interact with ocean conditions and/or barway condition, hazards can combine. For example, the entrance condition (if closed) can impede drainage (ocean outfall) of river flood waters and therefore play an important factor in the peak water levels achieved, increasing it above a level that would otherwise be achieved under a scenario should no coastal storm be present or the barway open. Refer **Section 8.4** for information on the entrance opening. Similarly, the presence and nature of elevated ocean levels during coastal storms (storm surge/waves) can be impacted by river flooding and therefore peak water levels.

Hazards vary in their current risks and potential. Some hazards are episodic, such as river flooding and coastal inundation, whilst others, whilst episodic in nature, can cause permanent damage or loss of land (erosion). Hazards can range in magnitude, with a range of AEPs.

As mentioned previously, some of the hazards relevant to Scamander can combine within their processes and exacerbate the potential impacts. The joint probability of these combined events is usually more extreme than the separate events. For example, the joint probability of a 1% AEP Flood combined with a 1% AEP Storm Tide will be more extreme e.g. 0.1% AEP. However, undertaking statistical analysis of the joint probability of these events is often hampered by the lack of a dataset over a sufficient time period.

***Coastal Erosion***

The coastal foreshore at Scamander is susceptible to both short term episodic erosion and long-term recession of the foreshore (albeit accretion is also a possibility). Coastal erosion is the removal of coastal land by water (waves, river currents and tidal inundation), wind and general weather conditions. It is important to note that in some occurrences, coastal erosion can be temporary, with sediment returning. Long term erosion leads to coastal recession, which is the long-term movement of land due to sea level rise and typically occurs on both soft sandy and tertiary sediment coasts. Coastal erosion has many causes including tides, currents, sediment budgets, storm intensity and frequency, wave energy, fetch, sea level rise, land erodibility, and human intervention.

Rising sea levels can also trigger non-linear changes to the sediment budget of beaches, in excess of the loss of sand that naturally occurs on shores due to erosion (Tasmanian Government, 2016).

***Estuary and river foreshore erosion***

As is the case for the coastal foreshore, the estuarine foreshore and riverbanks at Scamander are susceptible to both short term episodic erosion and long-term recession, albeit by varying processes compared. Riverbank erosion is being experienced (and mitigated in placed) along Upper Scamander

Road. In the lower reaches of the river, downstream of the gorge, saltmarsh have formed. From aerial imagery, river erosion cannot be identified.

***Coastal Inundation***

Coastal inundation is the natural process of flooding of land by the sea and can be either temporary or permanent. Temporary inundation is flooding due to storm surge, extreme storm events, floods or tides. Permanent inundation is the permanent loss of land to the sea.

A storm surge is the temporary piling-up of water at the coast due to onshore wind setup and/or low barometric pressure. A storm surge combined with high tide can be particularly hazardous, and even more so in the presence of wind-generated waves and associated wave setup.

At Scamander coastal storms (surge and waves) combining with high tides can overtop the barway and adjacent beach, with waves running up over low lying areas such as Dune Street, the foreshore reserve on the south side of the river and the Pelican Sands foreshore.

***River Flooding***

River flooding is caused by the runoff of heavy rainfall in the upper catchment and resulting increases in river discharge, sufficient to exceed the river channel capacity and inundate floodplain areas. River flooding can also have dramatic impact on channel scour and the movement of the entrance position on the beach.

At Scamander, peak water levels achieved by river flooding have the potential to be significantly influenced (lower reaches of Scamander River) by the barway condition (open/closed) and / or ocean condition. River flooding has impacted roads and property, with elevated river water levels overtopping the Scamander River Road and low lying areas, for example Bridge Esplanade.

## 6.2. Previous Hazard Events

Previous hazard events have been collated from existing available information. There is a paucity of information available, limited to the river flooding history documented in WMA Water (2023a) and anecdotal information (incl. dated photos) provided by the public and Council. The information provided below is intended to inform the study and should not be considered comprehensive. There is no specific hazard magnitude cut off for the events reported. Recent hazard events are presented in **Table 1**.

Large floods in the study area include the January and March 2011, and January and June 2016 flood events (WMA Water, 2023a). The March 2011 and June 2016 events have AEPs of between 10% and 20% at the Scamander River u/s WS gauge. The highest recorded river flow and stage was in1986, when a peak flow of 555m$^3$/s achieved a stage of 6.9m AHD local.

TABLE 1: ADOPTED GENERIC SETBACKS USED TO DEFINE EROSION SUSCEPTIBILITY ZONES FOR TASMANIAN SWELL-EXPOSED

| Date | Mechanisms / Hazards | Action / outcomes |
|---|---|---|
| January 2011 | River flooding 312m3/s | |
| March 2011 | River flooding (10% AEP) 490m3/s | |
| April 2013 | | Barway opened mechanically |
| June 2013 | | Barway opened mechanically |
| January 2016 | River flooding.  45m3/s | |

| | | |
|---|---|---|
| June 2016 | River flooding (20% AEP). 373m3/s | Foreshore erosion at Pelican Sands, damage to training wall. |
| **March 2021** | River flooding 34,000 Ml/day peak flow. 393m3/s. | |
| May 2022 | | |
| June 2022 | Storm and king tide | Wave runup onto dune street |
| July 2022 | Storm and king tide | Wave runup onto dune street |
| December 2022 | | Channel migrated far south, threatening Dune Street. |

The March 2021 event was the largest recent event and comprised both river flooding and a coastal storm. A peak river flow of 34,000 Ml/day peak flow (393$m^3$/s) (somewhere in between the 10% and 20% event) was achieved. The barway was initially closed, and then opened mechanically. Storm surge and wave runup caused overtopping of the barway and foreshore areas. The channel migrated south and caused the foreshore in front of Dune Street to erode landward. The extent of wave runup was evident from debris lines (**Figure 23**), visible along Dune Street, the Pelican Sand foreshore and across the reserve on the south of the river, including Scamander SLSC. Refer **Appendix B** for more photos.


FIGURE 23: DEBRIS LINE AT THE SCAMANDER SLSC FOLLOWING THE MARCH 2021 EVENT

## 6.3. Implications of Climate Change

A recent Climate Change Risk Assessment for Tasmania (Deloitte, 2024) suggested that by 2090, many impact profiles have an extreme consequence rating. Risk profiles with a projected extreme consequence rating for 2090 include risks to marine ecosystems and species, alpine ecosystems and species, social cohesion, insurability, ocean-based aquaculture and fisheries, health care and emergency services, and buildings and structures and transportation networks. The impacts per value domain vary widely. For example, in the natural domain, environmental biomes may become significantly compromised and experience irreversible damages. In the social domain, connectedness may be broken, welfare, physical and mental health may be compromised, and key community services could be disrupted. In the economic domain this indicates the potential failure of a significant industry or sector. Finally, in the built domain buildings and structures may become uninhabitable (Deloitte, 2024).

As mentioned previously, the hazards outlined above are expected to exacerbate with climate change. Climate change projections indicate that sea level rise (SLR) is likely to increase the frequency of tidal inundation of low lying coastal land in Tasmania (Tasmanian Government, 2016). When combined with other geo-hazards, such as river flooding and storm tide events, the severity of the inundation is also likely to increase.

Climate change factors were applied within recent river flooding studies (WMA Water 2023), which included a rainfall scaling factor of 16.3% based on RCP8.5 for the year 2090. The climate change scaling factor increased the modelled 1% AEP peak river discharge from $680m^3/s$ for current climate to $875m^3/s$ for the projected 2090 climate scenario. This resulted in a 300mm increase in peak water level at the bridge.

The entrance berm height is related to wave runup processes which are controlled by ocean water level, wave height, direction and period, and beach slope. Any increase in average ocean water level through SLR will also increase the average berm height (NSW DPIE, 2021). SLR will cause general beach recession along the coast accompanied by landward and upward translation of the berm (Haines & Thom 2007; Hanslow et al. 2000). This will result in higher ICOLL water levels, and increased inundation of low-lying fringing environments. The impact on foreshore wetlands will be either drowning, aggradation in place at the same pace as sea level rise, or migration of these habitats laterally and upslope (Hanslow et al. 2018).

Bird (1993:61) predicts that the response of coastal lagoons in the lee of spits to sea level rise will be of an increase in area and an increase in depth as sea inflows during storm surges and drought periods. He indicates that "erosion of the enclosing barriers may lead to breaching of new lagoon entrances, and continuing erosion and submergence may eventually remove the enclosing barriers and reopen the lagoons as marine inlets and embayments" Alternatively, new lagoons may form in response to sea water incursion into low-lying areas on coastal plains.

Sea level rise is a key component in the expected increase in erosion. In addition to the ongoing recession pattern, additional erosion during SLR is expected to be approximately 10m horizontally for a 0.2m vertical sea level rise at Scamander (Sharples, et al., 2013).

# 7. Review of Hazard Studies

## 7.1. Coastal Erosion

Information has been reviewed and summarised in this section relating to historical observed predictive studies of erosion potential for the open coast, including under present day conditions and as a result of climate change (future sea level rise). Historical shoreline position mapping (showing recession trends) between 1988 and 2024 has been described previously.

State-wide coastal erosion susceptibility zone mapping for hazard band definition was undertaken by Sharples, et al. (2013). The work ranked the coast into four coastal erosion hazard bands (acceptable, low, medium and high) according to their susceptibility to coastal erosion and shoreline recession, both under present conditions and under projected future sea-level rise conditions.

Coastal erosion and recession susceptibility zones were defined as shoreline buffers or 'setbacks' of differing widths for each shoreline category. In Scamander the shoreline fell into three different categories (as assessed by the author), being:

- unconsolidated soft sediment shores - Swell-exposed open coast sandy shores; at Scamander, this category includes the whole ocean facing beach and dunes;
- unconsolidated soft sediment shores swell-sheltered sandy and other soft sediment shores; at Scamander, this category includes the foreshore surrounding the northern hind dune marsh; and
- 'soft rock' shores, dominantly cohesive clayey soft rock shore types. at Scamander, this category includes the foreshore fronting the Pelican Sands and southern foreshore reserve.

For each category, setbacks of four different types were generally defined, namely:

1. Storm bite erosion hazard (the amount of erosion and consequent scarp instability that could potentially occur at any time in response to "1 in 100 years" storms).
2. Shoreline recession to 2050 (the amount of shoreline recession that could potentially occur in response to projected sea-level rise to 2050, in addition to the storm bite erosion hazard).
3. Shoreline recession to 2100 (the amount of shoreline recession that could potentially occur in response to projected sea-level rise to 2100, in addition to the storm bite erosion hazard).
4. Shorelines beyond the limit of potential erosion or recession by 2100.

A pairwise assessment was finally used to rank and combine the various erosion susceptibility zones defined for each shoreline category into four final overall erosion hazard bands ranked from High through Medium, Low and Acceptable hazards (**Table 2**).

TABLE 2: GENERAL CHARACTERISTICS OF HAZARD BANDS FOR NATURAL HAZARDS INCLUDING COASTAL EROSION (REPRODUCED FROM SHARPLES ET AL, 2013, PARAPHRASED FROM DPAC 2012).

| Hazard Band | Boundaries of Hazard Bands (Likelihood of coastal erosion) | Control level (Consequences |
|---|---|---|
| Acceptable | Natural hazard does not occur, or may occur at such low frequency or magnitude as to be a negligible risk | No damage is likely to occur, or will be manageable in the normal course of events if it does; No special planning or development controls required. |
| Low | Hazard may affect an area, but frequency or magnitude is low enough | Relatively minor and infrequent damage may occur, but can be kept to acceptable levels by simple means; Simple site assessments of hazard levels should occur, resulting in |

| | | |
|---|---|---|
| | that minimal damage or loss is likely to be experienced. | implementation of any basic measures needed to limit impact of the hazard to tolerable levels. |
| Medium | Hazard may affect an area, and level of impact if it does is likely to be significant. | Structures are likely to sustain significant impacts (damage) due to the hazard over their service life unless mitigating measures are applied; Developments likely to be exposed to the hazard should be discouraged; careful assessment of the hazards and appropriate planning responses should be required for developments that do occur |
| High | Hazard is likely to affect an area, with an impact likely to be considered intolerable. | Without extraordinary measures being applied, structures are likely to sustain repeated significant damage over their design life; Development should generally be prohibited unless exceptional circumstances apply. |

The Sharples, et al. (2013) project adopted the erosion and recession susceptibility zones provided by Mariani et al. (2012), incorporating a recalculation (by the method of Mariani et al. 2012) of recession susceptibility setbacks to the 0.2m and 0.8m sea-level rise by 2050 and 2100 relative to 2010 allowances that are the adopted basis for Tasmanian coastal hazard policy (TCCO, 2012).

***Soft sediment - Swell-exposed open coast sandy shores***

Sharples, et al. (2013) used SBEACH and XBEACH modelling software was used to calculate generic short-term storm bite magnitudes (S1) for a 'design storm' comprising two back-to-back 100 year ARI storms; an allowance for a zone of reduced foundation capacity (or dune instability) backing the consequent erosion scarp was calculated as an additional setback (S5) using the method of Nielsen et al. (1992); and long term shoreline recession resulting from two sea-level rise scenarios of 0.4 m and 0.9 m rise by 2050 and 2100 relative to 1990 was estimated using a simplified application of the Bruun Rule. See Mariani et al. (2012) for further details of the conceptual basis and methodology used. The erosion susceptibility zones are shown diagrammatically in (**Figure 24**). Distances calculated for the Tasmanian east coast for S1, S3 and S5 are provided in (**Table 3**).

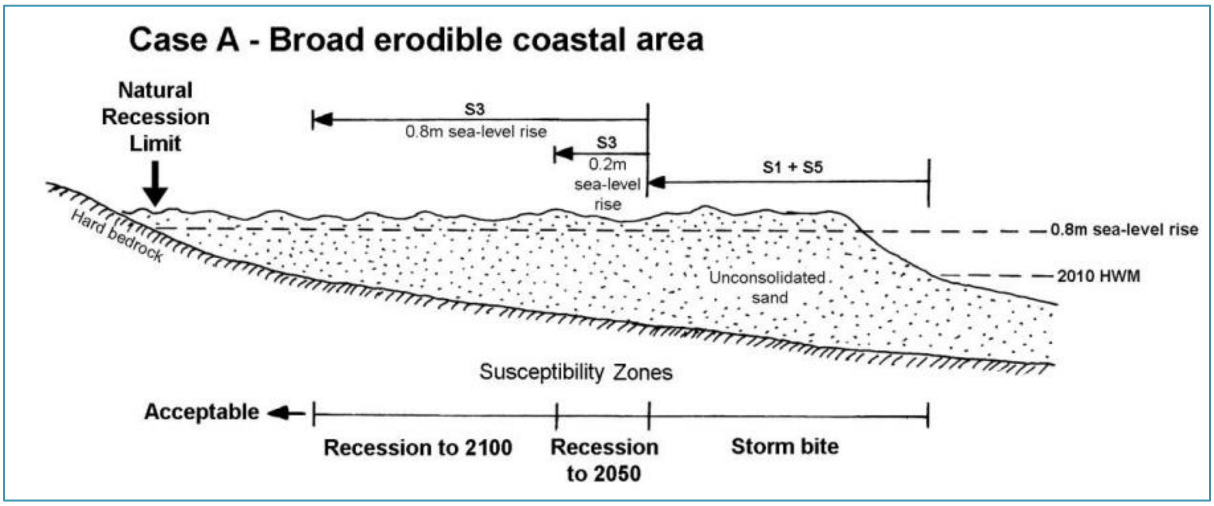



FIGURE 24: DIAGRAM ILLUSTRATING HOW COASTAL EROSION SUSCEPTIBILITY ZONES FOR TASMANIAN SWELL-EXPOSED (OPEN COAST) SANDY BEACHES ARE DEFINED IN SHARPLES ET AL (2013). COASTAL EROSION HAZARDS ARE 'ACCEPTABLE" (I.E., UNLIKELY) TO LANDWARDS OF THE NATURAL RECESSION LIMIT OR THE FULL EXTENT OF (S1 + S3 (0.8M SLR) + S5), WHICHEVER COMES FIRST. 'HWM' IS THE MEAN HIGH WATER MARK.

### TABLE 3: ADOPTED GENERIC SETBACKS USED TO DEFINE EROSION SUSCEPTIBILITY ZONES FOR TASMANIAN SWELL-EXPOSED SANDY SHORES. THESE ARE THE GENERIC MODELLED SETBACKS CALCULATED FOR TASMANIAN COASTS BY MARIANI ET AL. (2012), WITH MODIFICATIONS MADE BY SHARPLES, ET AL, 2013).

| **Coastal Region** | **S1 (m)**<br>Storm Bite:<br>2 x 100 ARI storms | **S3 (m)**<br>Recession due to sea-level rise<br>(Bruun Factor = 50) | | **S5 (m)**<br>Width of zone of reduced dune stability |
|---|---|---|---|---|
| | 4.0 m GL AHD | 0.2 m SLR by 2050 relative to 2010 | 0.8 m SLR by 2100 relative to 2010 | 4.0 m GL AHD |
| East Tas coast (Region 15):<br><br>Cape Portland to Cape Pillar | 38 | 10 | 40 | 10 |

**Table 3:** Definition of coastal erosion susceptibility zones for Tasmanian swell-exposed sandy shores, using modelled generic coastal erosion setbacks calculated by Mariani *et al.* (2012), and natural recession limits mapping prepared by Chris Sharples, Paul Donaldson and Hannah Walford (this project). The susceptibility zones are shore-parallel buffer zones whose widths are specified in this table, and are measured landwards from the present day (nominally 2010) cartographically-defined High Water Mark (HWM) line. A near- term erosion susceptibility zone is defined using storm bite (S1) erosion allowances and consequent dune instability zones (S5), since large storm erosion events could occur at any time. Medium and longer term recession susceptibility zones are defined as those additional areas to landwards of the storm bite susceptibility zone that may be subject to shoreline recession due to sea-level rise (S3) by 2050 and 2100 respectively, relative to 2010.

| **Coastal Region** / **Erosion susceptibility** | **Susceptibility zone widths (landwards from High Water Mark) in metres** | | | |
|---|---|---|---|---|
| | North Tas coast (Region 14):<br><br>Cape Woolnorth to Cape Portland | East Tas coast (Region 15):<br><br>Cape Portland to Cape Pillar | Storm Bay, SE Tas coast (Region 15a):<br><br>Cape Pillar to Southeast Cape | West – South Tas coast (Region 16):<br><br>Southeast Cape to Cape Woolnorth |
| Storm bite and consequent reduced foundation stability zone<br>(**S1 + S5**) | 35 m landwards from HWM, or to natural recession limit | 48 m landwards from HWM, or to natural recession limit | 35 m landwards from HWM, or to natural recession limit | 73 m landwards from HWM, or to natural recession limit |
| Potential shoreline recession to 2050<br><br>(**S3** to 2050) | 10 m landwards of storm bite hazard zone or to natural recession limit | 10 m landwards of storm bite hazard zone or to natural recession limit | 10 m landwards of storm bite hazard zone or to natural recession limit | 10 m landwards of storm bite hazard zone or to natural recession limit |
| Potential shoreline recession to 2100<br><br>(**S3** to 2100) | 40 m landwards of storm bite hazard zone, or to natural recession limit | 40 m landwards of storm bite hazard zone, or to natural recession limit | 40 m landwards of storm bite hazard zone, or to natural recession limit | 40 m landwards of storm bite hazard zone, or to natural recession limit |
| Unlikely to be susceptible | Landwards of recession to 2100 hazard zone or landwards of natural recession limit | Landwards of recession to 2100 hazard zone or landwards of natural recession limit | Landwards of recession to 2100 hazard zone or landwards of natural recession limit | Landwards of recession to 2100 hazard zone or landwards of natural recession limit |

#### *Soft sediment - Swell-sheltered sandy and other soft sediment shores*

For the swell-sheltered sandy and other soft sediment shores, coastal erosion susceptibility zones were defined as in **Table 4**.

TABLE 4: DEFINITION OF COASTAL EROSION SUSCEPABILITY ZONES FOR SWELL-SHELTERED (ESTUARINE, TIDAL LAGOON, OR CHANNEL) SANDY OR OTHER SOFT SEDIMENT SHORES IN TASMANIA (SHARPLES ET AL., 2013)

| **Erosion susceptibility** | **Susceptibility zone width** (metres) | **Rationale** |
|---|---|---|
| Storm bite and consequent reduced foundation stability zone | 22 m landwards from HWM, or to natural recession limit | Potential short term erosion hazard = 12 m (max. recorded sheltered sandy shore storm bite for Tasmania, at Five Mile Beach – see Table 13) + 10 m reduced stability zone (Mariani *et al*. 2012). |
| Potential shoreline recession to 2050 | 27 m landwards of storm bite hazard zone or to natural recession limit<br><br>(i.e., to 49 m landwards of HWM or to natural recession limit) | Potential additional hazard to 2050 relative to 2010 = 0.34 m/yr. (maximum recorded long term sheltered soft sediment shore annual recession rate for Tasmania - Table 14) x 2 (allowance for acceleration of recession with ongoing sea-level rise) x 40 years (2010-2050). |
| Potential shoreline recession to 2100 | 61 m landwards of storm bite hazard zone or to natural recession limit<br><br>(i.e., to 83 m landwards of HWM or to natural recession limit) | Potential additional recession hazard to 2100 relative to 2010 = 0.34 m/yr. (maximum recorded long term sheltered soft sediment shore annual recession rate for Tasmania - Table 14) x 2 (allowance for acceleration of recession with ongoing sea-level rise) x 90 years (2010-2100). |
| Unlikely to be susceptible | Landwards of recession to 2100 hazard zone or landwards of natural recession limit | Areas deemed to have negligible hazard of coastal erosion or recession before 2100. |

***Soft rock coastal erosion susceptibility zoning***

For the swell-sheltered sandy and other soft sediment shores, coastal erosion susceptibility zones were defined as in **Table 5**.

### TABLE 5: DEFINITION OF COASTAL EROSION SUSCEPABILITY ZONES FOR SOFT ROCK SHORES IN TASMANIA (SHARPLES ET AL., 2013)

| **Erosion susceptibility** | **Dominantly cohesive clayey soft rock shore types** [susceptibility zone widths & rationales] | **Very coarse boulder clays ('self-armouring' shores)** [susceptibility zone widths & rationales] |
|---|---|---|
| Potential near-term recession (to 2030) | To 14 metres landwards of HWM or to full landwards extent of soft rock, whichever is less.<br><br>[Maximum recorded historic recession rate of 0.35 metres per year for Tasmanian soft rock shores x 2 allowance (Trenhaile 2011) for acceleration with sea-level rise to 2030 compared to 2010] | n/a<br><br>[Not considered to have significant near-term erosion susceptibility.] |
| Potential recession to 2050 | To 28 metres landwards of HWM or to full landwards extent of soft rock, whichever is less.<br><br>[Maximum recorded historic recession rate of 0.35 metres per year for Tasmanian soft rock shores x 2 allowance (Trenhaile 2011) for acceleration with sea-level rise to 2050 compared to 2010.] | n/a<br><br>[Not considered to have significant erosion susceptibility to 2050.] |
| Potential recession to 2100 | To 63 metres landwards of HWM or to full landwards extent of soft rock, whichever is less.<br><br>[Maximum recorded historic recession rate of 0.35 metres per year for Tasmanian soft rock shores x 2 allowance (Trenhaile 2011) for acceleration with sea-level rise to 2100 compared to 2010] | To 20 metres landwards of HWM or to full landwards extent of very coarse boulder clays, whichever is less.<br><br>[conservative low hazard zone for 'self-armouring' boulder clays (allowance for some settling and minor slumping during 'self-armouring' process in response to longer – term sea-level rise to 2100).] |
| Unlikely to be susceptible | Soft rock areas over 63 metres landwards of HWM, or areas beyond mapped landwards extent of soft rock.<br><br>[Areas beyond maximum mapped soft rock extent OR soft rock areas landwards of areas potentially susceptible to recession to 2100 band.] | Beyond 20 metres landwards of HWM or beyond full landwards extent of very coarse boulder clays, whichever is less.<br><br>[Based on assumption that self-armouring-process under credible sea-level rise scenarios will limit zone of settling related to wave-winnowing of clay matrix to less that arbitrarily-defined 20m landwards of HWM to 2100.] |

**Results**

An extract of the mapped shorelines from Sharples et al., (2013) at Scamander is presented below (**Figure 25**). Open coast ocean-facing foreshores are mapped showing the 101m wide buffer, as shown in **Table 3**. For the majority of the zones mapped, the lack of development currently within the buffer zone means that the impacted zones are generally the natural environment (dunes/hind marsh foreshores).

The mapping shows erosion susceptibility of foreshore on the north and south seaward of the bridge. This represents the 'Pelican Sands' foreshore and foreshore and reserve in front of the play area. This zone does implicate private and public property, as well as a number of assets.

The mapping shows a number of properties to be impacted by the Medium and Low bands location Scamander Avenue/Tasman Highway and the norther hind dune lagoon.

Dune Street is not assessed as being susceptible to erosion. This is most likely due to the shoreline position during the assessment (which has now changed) and also the fact that the assessment does not account for erosion associated with river channel movements (see below section on limitations / recommendations).

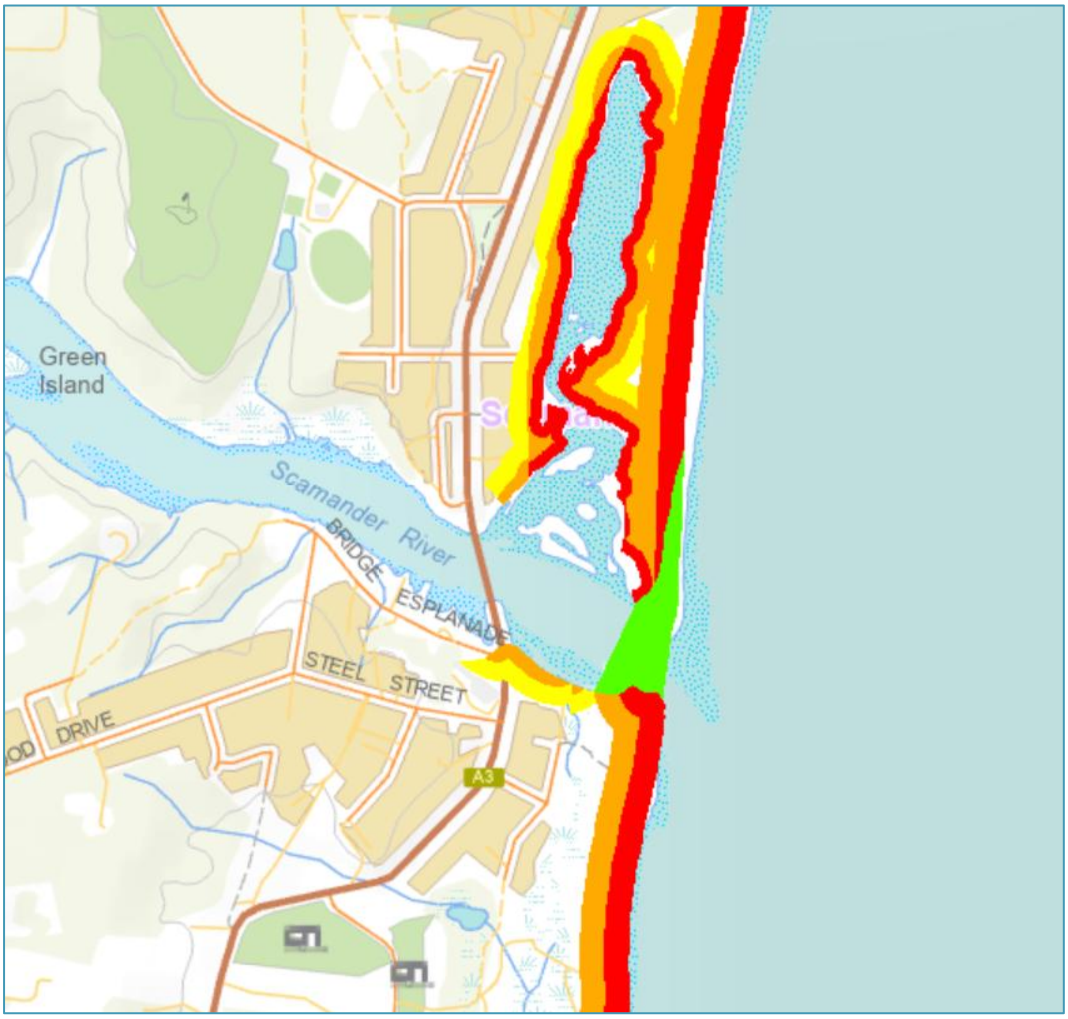



FIGURE 25: EROSION HAZARD BANDS; HIGH (RED); MEDIUM (ORANGE); LOW (YELLOW) (SHARPLES ET AL., 2013).

**Limitations and recommendations**

Coastal landform behaviour including storm erosion and longer-term shoreline recession is driven by a complex range of processes and factors that vary considerably from one coastal location to another. These may include the inherent resilience of the physical shoreline substrate type, local wave climate exposure, storm frequencies and magnitudes, local sediment sources and sinks, tidal and river discharge currents and the effects of artificial changes to the coast (Sharples, et al., 2013).

The report acknowledges the complexity of processes and the limitation of the assessment, suggesting that the assessment provides a first-order delineation of coastal hazard zones for the purposes of defining hazard management and planning policies appropriate to each zone. These hazard bands are applied by the Tasmanian Planning Provisions and Policies and regulate land use development and works across Tasmania, however. Further, it is stated that inherent in the broadly-defined nature of each hazard zone and the complex nature of coastal processes, that there may be scope to justify modifying the planning constraints defined for each zone on a case-by-case basis depending on the specific mix of conditions found at specific locations within each zone. However, at present, and in the absence of further site-specific assessment, this Sharples, et al. (2013) assessment is the best-known source of coastal erosion estimates.

Since the study of Mariani et al. (2012), which the current erosion hazard bands are based, some parts of the methodology for open coast erosion assessment have developed, particularly when undertaking site specific assessments. This includes the approach of probabilistic analysis and further understanding of local storm bite. However, no widely applied methods exist for estuarine foreshores. Sharples, et al., (2013) states 'only limited measured storm bite and recession rate data has yet been compiled for Tasmanian sandy beaches, and none for other soft sediment shores such as muddy estuarine shores'.

With that said, the methods used are reasonable and appropriate for use in long term spatial adaptation planning with some important exceptions at Scamander:

1. The foreshore in front of Dune Street has receded in the recent years (particularly between 2015 and present) and has now re-formed a hind dune marsh and foreshore adjacent to the road. The Sharples, et al. (2013) assessment did not include this as a foreshore and erosion risk is not mapped here. Since the 2013 assessment, the foreshore in this location has changed significantly. It would therefore be reasonable to apply the inner estuary buffers to the foreshore at Dune Street, where currently fronted by the hind dune marsh.
2. The assessment categorises the foreshore reserve to be 'soft rock', however, it is currently protected by a rock revetment, albeit the revetment showing signs of damage.
3. Pelican Sands foreshore is categorised as 'soft rock'. Whilst this shoreline has previously been protected, that protection is now mostly lost. The foreshore appears to be of a soft sediment (sandy) rather than soft rock. This is therefore considered an overestimate.
4. The foreshore of the northern hind dune marsh is categorised correctly based on the assessment methodology, However, it is well sheltered. Regardless, the setbacks are generous and potentially an overestimate, but in the absence of further studies is applicable for use.

## 7.2. Coastal Inundation

Coastal inundation extent and hazard mapping has been undertaken by Lacey, et al. (2015) and Lacey (2016), prepared for the project "Coastal Inundation Stage 4" for the Tasmanian Department of Premier and Cabinet (DPAC). The project was concerned with mapping of a set of sea level rise scenarios around the Tasmanian coast and a representation of a set of those scenarios as inundation hazard bands. Stage 4 revised maps of the extent of storm tide inundation associated with 1% AEPs for each of the years 2010, 2050 and 2100. The project map projected inundation associated with updated annual exceedance probability (AEP) and revised local government area (LGA)-specific height allowances data for the IPCC. RCP8.5 climate change scenario was utilised.

Modelled storm tide AEP predictions for the whole Tasmanian coast from CSIRO (McInnes et al. 2009, McInnes et al. 2012) were used as the source dataset in the AEP calculations. The focus of the McInnes et al (2012) study, hence the Lacey et al (2015) hazard mapping was the contribution of storm surges and astronomical tides to extreme sea levels which are referred to as storm tides. Although wave breaking can further elevate sea levels through wave setup and wave runup, these processes are not considered in the study or mapping (see below section regarding limitations).

Coastal Inundation Hazard Maps showing High, Medium, Low and Investigation bands of coastal inundation likelihood were prepared. The High, Medium and Low bands were based on the extent the following permanent and storm tide inundation scenarios, being:

- High band is the area vulnerable to sea-level rise by 2050 from the mean high tide, rounded up to the nearest 100 mm.
- Medium band is the area vulnerable to a 1% AEP storm event in 2050 rounded up to the nearest 100mm plus 300 mm added for freeboard.
- Low band is the area vulnerable to a 1% AEP storm event in 2100 rounded up to the nearest 100mm plus 300 mm added for freeboard.
- Coastal Inundation investigation band is the area below the 10 metre contour and within 1000 metres from the coast in the non-LiDAR mapped areas.

**Results**

Coastal inundation hazard mapping extracts from Lacey (2026) are provided below in **Figure 26** and a more geographically focussed in version of the same output in **Figure 27**. In Scamander, the majority of the high hazard band mapping is located on the immediate foreshore and / or low lying intertidal areas, such as saltmarsh and hind dune marshes. The low and medium band mapping includes the following locations:

- Dune Street – a number of properties in the low hazard band and one in the medium band.
- Scamander SLSC and adjacent foreshore in Medium and Low bands.
- Bridge Esplanade (road), as well as adjacent foreshore (north) and properties (south) in the Low and Medium bands.
- Foreshores of the hind dune marshes almost exclusively in the Low and Medium bands,
- Pelican sands foreshore, including pump station – in the Low and Medium bands.

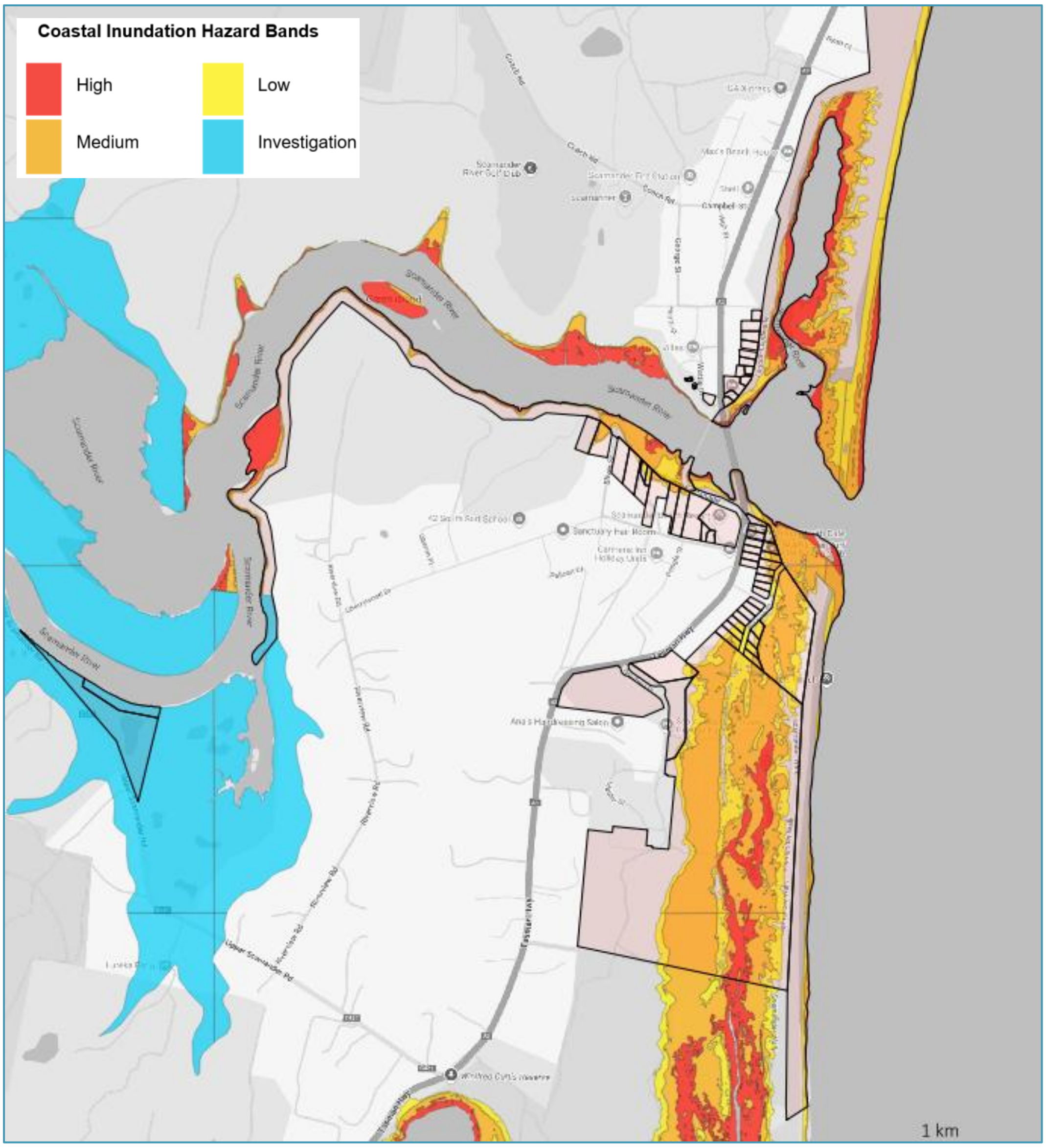



FIGURE 26: COASTAL INUNDATION HAZARD BANDS AT SCAMANDER (LACEY ET AL, 2016, ACCESSED THROUGH TASMANIA LIST)

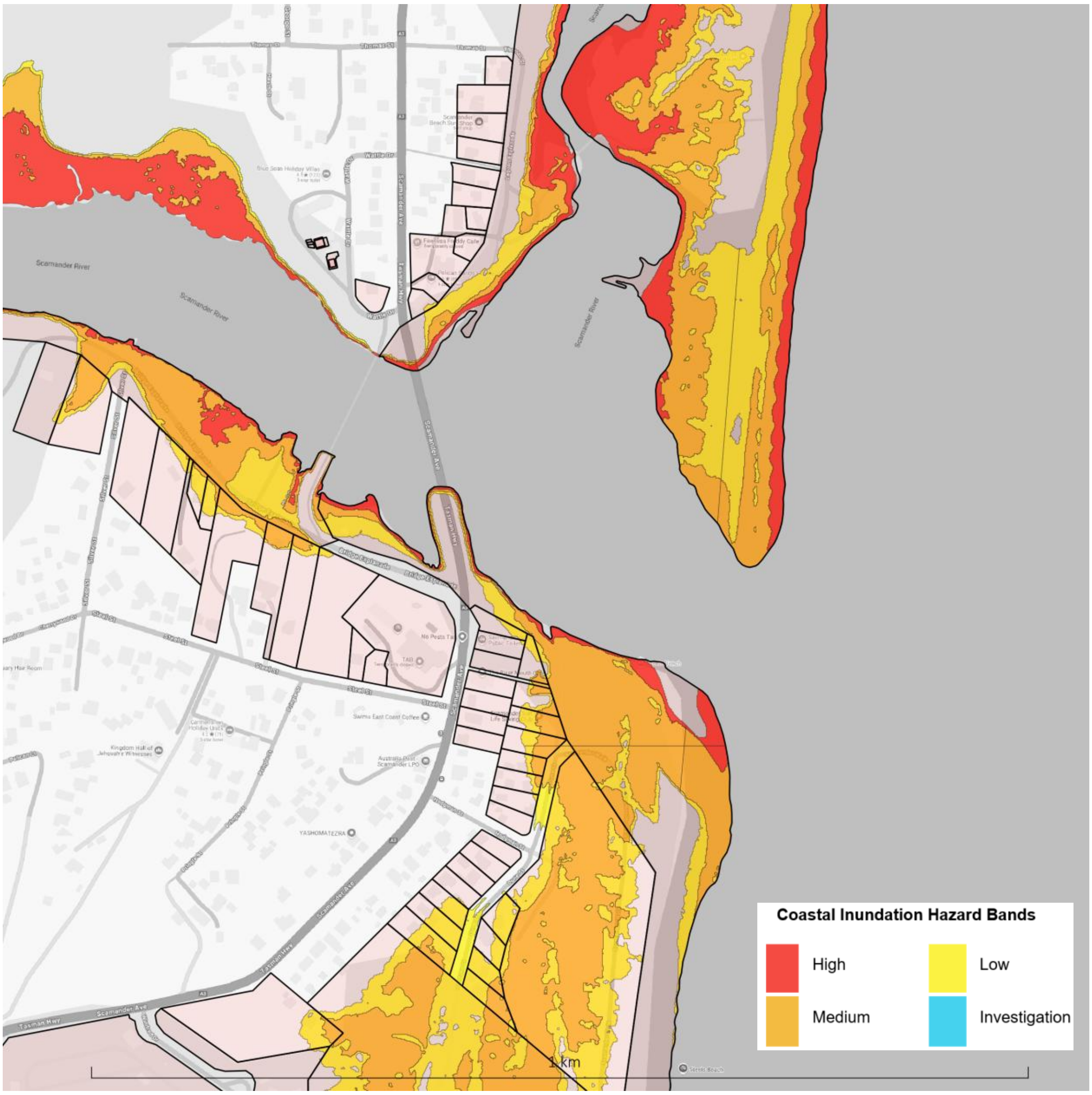



**FIGURE 27: COASTAL INUNDATION HAZARD BANDS AT SCAMANDER (LACEY ET AL, 2016). ZOOM IN TO TOWNSHIP.**

### Limitations

The methods used are reasonable and appropriate for use in long term spatial adaptation planning with some important exceptions at Scamander:

1. The focus of the McInnes et al (2012) study, hence the Lacey et al (2015) hazard mapping comprised the contribution of storm surges and astronomical tides to extreme sea levels, which are referred to as storm tides. Although wave breaking can further elevate sea levels through wave setup and wave runup, albeit mitigated in the presence of a beach berm. These processes are not considered in the study or mapping. These omitted processes are very important for Scamander. For example, wave set up and runup were understood to have impacted much of the foreshore in the March 2021 event (refer **Figure 23** and **Appendix B**).
2. The storm surge inundation mapping did not include any interaction with river flooding. Whilst less of a concern than the omission of wave processes, the interaction of storm surge with river flooding can increase total water levels.
3. For wave-exposed foreshores, the coastal inundation estimates could be considered an underestimate.

## 7.3. Catchment Flood Modelling

River flood mapping was undertaken for the Scamander River by WMA Water (2023a, 2023b) for the states Tasmanian Strategic Flood Mapping Project[9]. The mapping was based on hydrologic and 2D hydrodynamic modelling of the catchment and river system. Calibration was undertaken against 3 historic events (January 2011, March 2011, June 2016). 'Design' event modelling was undertaken for the 2%, 1%, 1% climate change, and 0.5% AEP events. Parameters provided within the results are peak flood level, depth, velocity, and hydraulic hazard.

Downstream boundaries were applied at the base of the model to provide interaction with the ocean. Synthetic tide data was provided by the Bureau of Meteorology (BOM) and was used to set a varying tide level for the calibration events. This data was extracted off the coast of St Helens at 10 min time increments and was imported as a time varying boundary condition. The below **Figure 28** shows an example of the synthetic tide data that was extracted off the coast of St Helens for the June 2016 event. Note there is no calibration information to verify the function of the tailwater condition thus the study did not make any allowance for local storm effects.

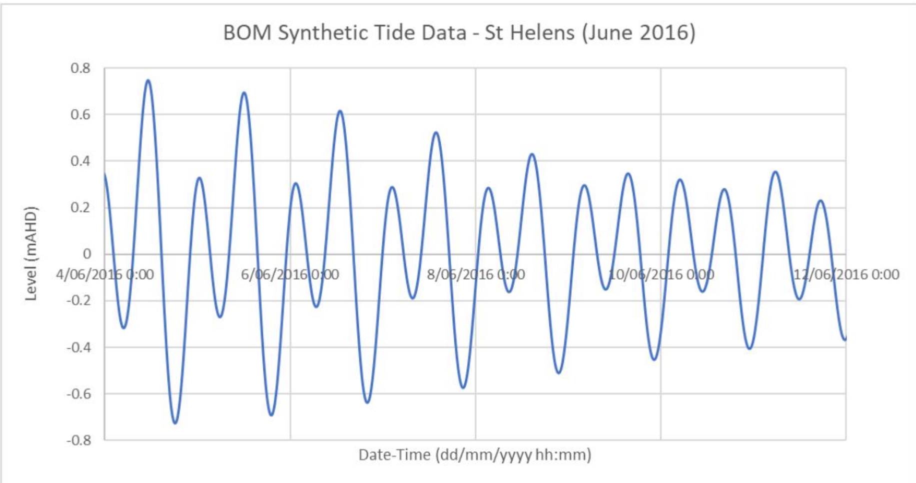



**FIGURE 28: SYNTHETIC TIDE DATA OFF THE COAST OF ST HELENS (JUNE 2016) USED AS DOWNSTREAM BOUNDARY IN THE FLOOD MODELLING (WMA WATER, 2023)**

Climate change factors were applied within the study, downloaded from the Australian Rainfall-Runoff (ARR) data Hub[10]. ARR recommends the use of the RCP4.5 and RCP8.5 values, however the Tasmanian Interim Planning Scheme recommends the use of RCP8.5 and this was adopted within the study. Using RCP8.5 results for the year 2090 give a rainfall scaling factor of 16.3% to the IFDs used within the modelling.

In addition to increased rainfall intensity, sea level rise was included in the modelled climate change scenario and was applied at the downstream boundary of the hydrodynamic model (added to the tidal level). The rise in water level was taken from the Tasmanian Local Council Sea Level Rise Planning Allowances, which uses sea level rise projections based on RCP 8.5 for 2100. This gave a rise in sea level of 0.92m for the Break O'Day Council area.

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[9] https://www.ses.tas.gov.au/floodmaps/
[10] https://data.arr-software.org/

**Results**

Results for the WMA Water (2023a, 2023b) estimate a peak flow at Scamander River u/s of Scamander WS for a number of return periods, including:

- 2% - 576 $m^3$/s;
- 1% - 680 $m^3$/s;
- 1% CC – 875 $m^3$/s; and
- 0.5% AEP - and 847 $m^3$/s.

Resulting peak flood depth, velocity and hazard category were mapped and are presented in the WMA Water (2023a) report as well as being available on Tasmanian LIST. Extracts of the mapping are presented below for the 1% AEP (**Figure 29**) and 1% AEP CC (rainfall increase factor of 16.3% and SLR of 0.92m) (**Figure 30**).

River flooding for the modelled scenario 1% AEP results in a peak water level at the bridge of 2.93m AHD and impacts:

- Foreshores of the hind dune marshes,
- Pelican Sands foreshore,
- Bridge Esplanade

Flood waters at more extreme events are in part constrained by the gorge. River flooding spreads across the wide floodplain upstream of the gorge. Downstream of the bridge, flood waters spread into the north and south hind dune marshes. Whilst depth increases with the climate change scenario, the horizontal extent does not change significantly between the 1% AEP and 1% AEP climate change scenarios. Notably, the flood water in the southern hind dune marshes links in with Henderson Lagoon in the 1% AEP event.

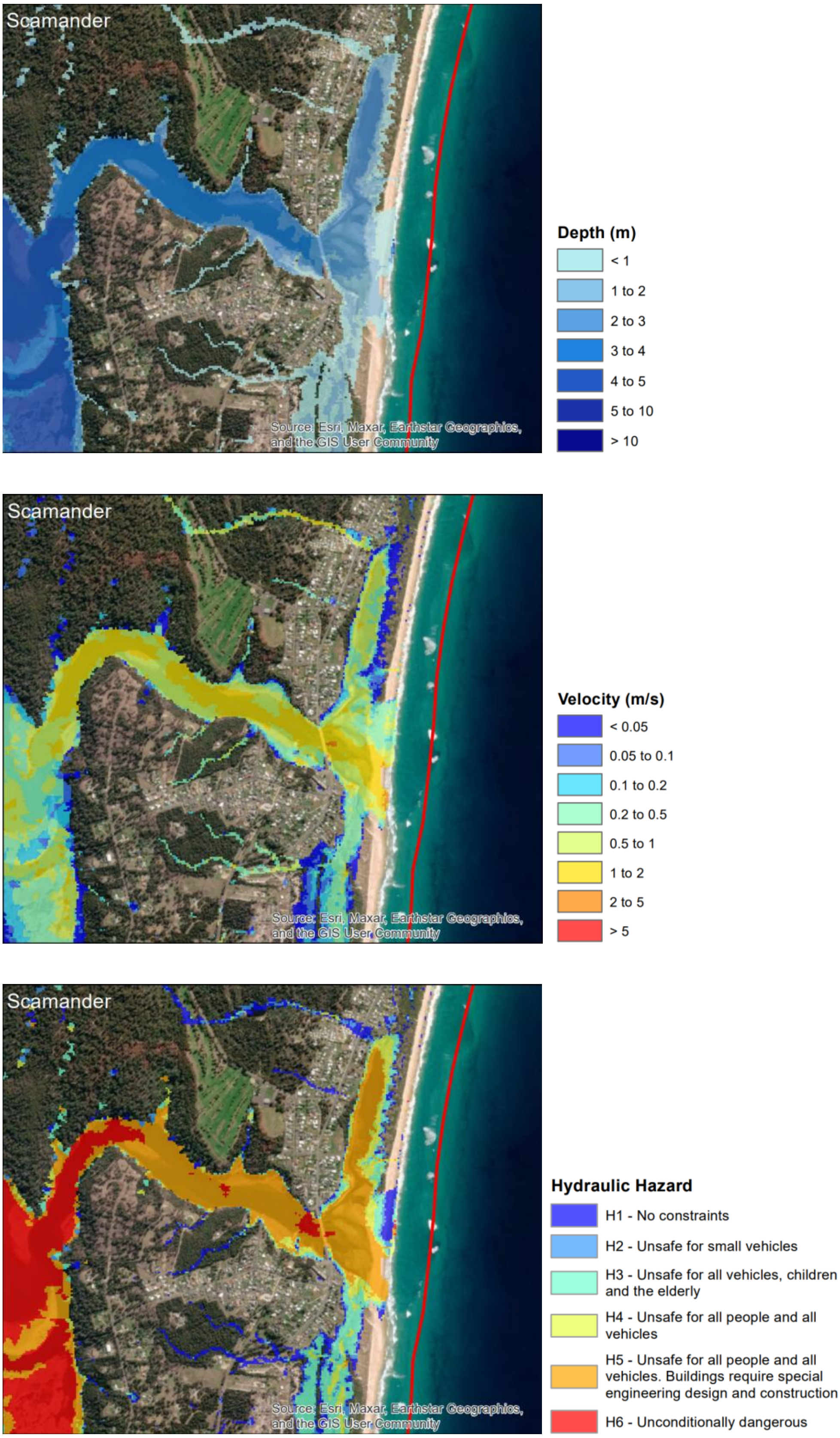


**FIGURE 29: MODELLED 1% AEP PEAK FLOOD DEPTH (TOP), PEAK VELOCITY (MIDDLE), PEAK HYDRAULIC HAZARD (BOTTOM) (FROM WMA WATER, 2023)**

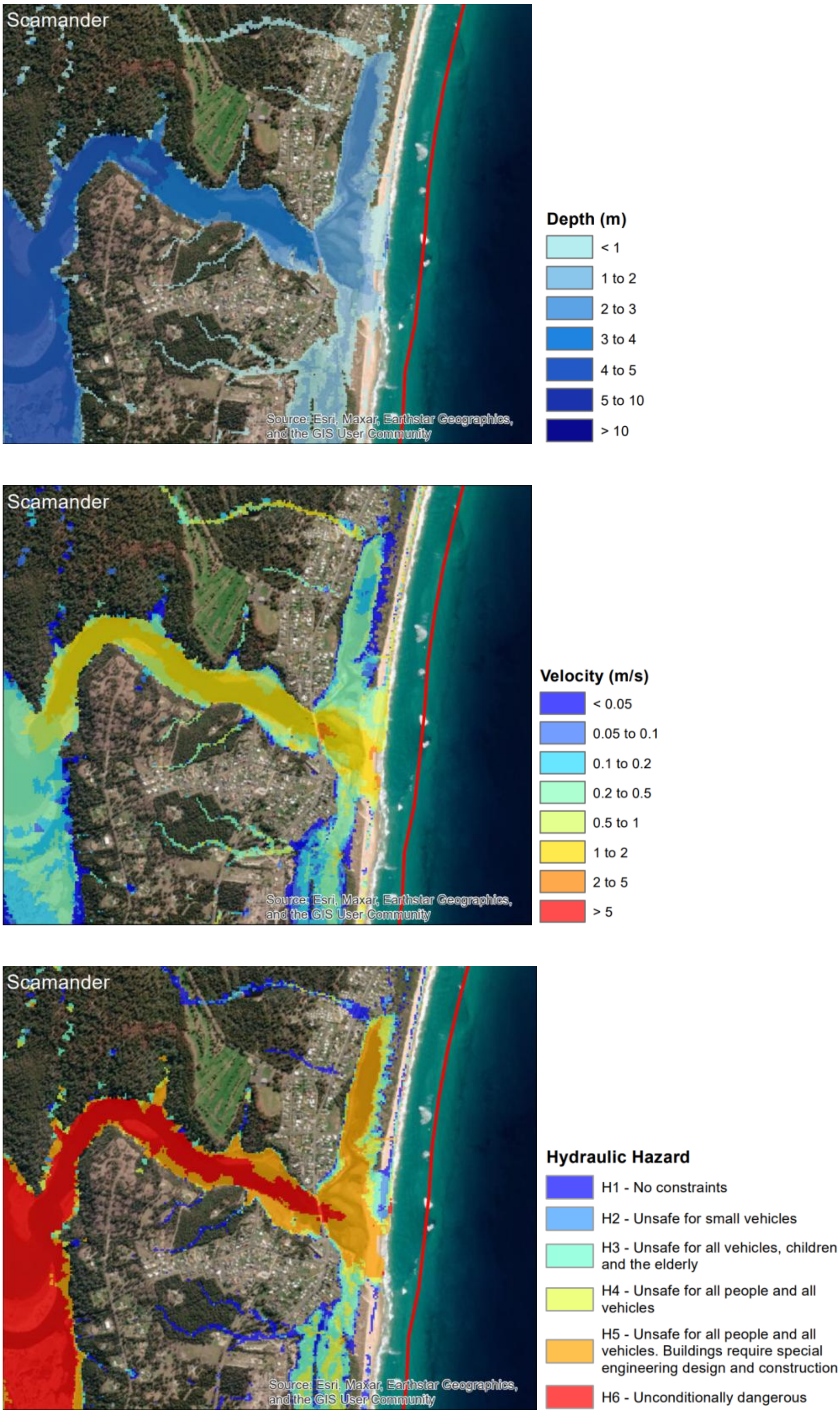


**FIGURE 30: MODELLED 1% AEP PLUS CLIMATE CHANGE PEAK FLOOD DEPTH (TOP), AEP PEAK VELOCITY (MIDDLE), PEAK HYDRAULIC HAZARD (BOTTOM) (FROM WMA WATER 2023)**

**Limitations and recommendations**

The WMA Water (2023a) study documents a number of limitations, including:

- several of the gauges have poor or no quality information. Future works may consider improving gauges in the area to ensure higher quality data is present for future rainfall events.
- some discrepancies in levels in the DEM were identified in Scamander River downstream of the gauge. Future analysis should review the ground levels to ensure appropriateness.
- uncertainty in the spatial pattern of the rainfall. An issue for the March 2011 event in particular, where there was 170 mm of rain recorded on the coast and 465 mm of rain recorded at Gray, only 7 km inland. The rainfall gauges in this area are largely on the coast or inland of the main ranges, and therefore there is a high level of uncertainty in the spatial pattern of the rainfall and the rainfall volume over the study area for this event.

Regardless, the results of the assessment are the best available information. The detail of the analysis is appropriate for use in long term spatial adaptation planning. However, importantly for the study area the assessment lacks critical detail regarding:

- the interaction of ocean processes (during storms); and / or
- the barway condition.

The application of sea level rise (0.92m) is useful to use as a proxy for increase ocean levels during a storm (or a barway closure) but is incorporated in the study with increased rainfall (not decoupled).

## 7.4. Estuarine Foreshore Erosion

There have been no studies know of that have categorised estuarine or river erosion risk upstream of the Tasman Highway bridge, noting some parts of the estuary foreshore downstream of the bridge are captured by the Shaples et al., (2013) work.

There is an ongoing erosion and risk of further erosion along the river and estuary foreshore. Notably, there is active erosion at Dune Street (described earlier in **Figure 21**). A cursory inspection of the riverbanks along Upper Scamander Road identified riverbank sections protected from rock and gabions (refer **Figure 31** below). In places the riverbank is close to the road and low lying.

FIGURE 31: RIVERBANK ROCK PROTECTION ALONG UPPER SCAMANDER ROAD (PHOTO BY N. LEWIS)

## 7.5. Summary of Available Hazard Information

A summary of available hazard information described in the above sections is provided below in **Table 6**, for convenience.

TABLE 6: SUMMARY OF AVAILABLE QUANTITATIVE HAZARD INFORMATION AND RECOMMENDATIONS FOR USE

| Hazard | Principle assessment | Primary limitation |
|---|---|---|
| Coastal erosion | Sharples et al., (2013) | The assessment is the best available information for the risk of coastal erosion hazard.<br><br>However, as a result of recent shoreline change (between 2015 and 2025), there is an underestimation of erosion risk at Dune Street foreshore. Further, the Pelican Sands foreshore is categorised and assessed as being 'soft' rock', which potentially provides and underestimation.<br><br>**Propose to utilise the information, with the application of the setbacks be applied to the current Dune Street Foreshore.** |
| Estuary foreshore erosion | None | **An assessment of river and estuarine (upstream of the bridge) foreshore erosion hazard risk should be undertaken.** |
| Coastal inundation | Lacey, et al. (2015), Lacey (2016) | The assessment is the best available information for the risk of coastal inundation hazard.<br><br>However, storm surges and astronomical tides only are assessed. Wave setup and wave runup processes are not considered. As a result, there is an underestimation of total inundation levels, particularly those exposed to ocean waves.<br><br>**Propose to utilise the information, with the context and understanding of a likely of underestimation.** Wave set up and runup should be added to a coastal inundation assessment in time, however will require wave data and modelling. |
| River flooding | Tasmanian Strategic Flood Mapping Project (WMA Water, 2023) | The assessment is the best available information for the risk of river flooding hazard.<br><br>However, the interaction of river flows with potential ocean storm conditions and/or barway closed condition are not adequately assessed for Scamander. Without the assessment of a barway closed condition nor coastal storm condition, the results are considered an underestimation of peak water levels and not considering all conditions.<br><br>**Propose to utilise the information, with the context and understanding of a likely of underestimation. Appropriate assessment of the downstream boundary should be added to the assessment in time.** |

# 8. Previous and Ongoing Management of Coastal Hazards

Scamander has had a long history of human modification, interaction with and management of hazards. Most notable is the multiple bridges constructed, a number of which to damaged and even removed by river hazards (Fearman, 2021). The management of hazards has taken form in a number of different forms, including both passive infrastructure and active operations. A summary previous and ongoing management of coastal hazards is provided below.

## 8.1. Training Wall

A training wall was constructed in 1989 which was built out to the edge of the water from the dune line (**Figure 32**). The training wall was not designed with constructed form our to modern engineering practices, but rather rocks and concrete dumped on the sand (Byrne, 2000) (**Figure 33**). The training wall was slightly extended in 1991 during the construction of the bridge. The poor condition of the training wall was reported in 2000 by Byrne (2000), who noted that the wall was beginning to collapse.

Until 2015, the training wall remained in place and appears to have been effective in controlling the channel from migrating south. It is noteworthy that during this period the channel did migrate north on occasion and did close on occasion. After 2015, the training wall is less visible, presumably getting damaged in the 2016 storm event. Following this, the channel was once again able to migrate south. Whilst remnants of the training wall are visible today, it is now severely damaged and has failed, collapsed, rocks displaced and in places buried with sand.

FIGURE 32: AERIAL IMAGE FROM 2ND MARCH 1991 SHOWING THE PRESENCE AND LOCATION OF THE TRAINING WALL

FIGURE 33: CONSTRUCTION OF THE TRAINING WALL IN 1989

## 8.2. Bridge Abutment

In 1991, at the time of bridge construction. The abutment, which was built for the bridge and protrudes significantly into the Scamander River channel, was armoured with large rock to protect from scour and erosion (**Figure 34**). A cursory visual inspection indicates that the rock remains largely as placed.

FIGURE 34: BRIDGE ABUTMENT SCOUR PROTECTION (PHOTO BY N. LEWIS)

## 8.3. Foreshore Erosion Protection

Foreshore protection has been implemented seaward of the bridge on the south and north side of the river. The existing revetment on the south side, constructed between 1992 and 1994, is successful in preventing movement of the entrance further south and protects the foreshore from erosion. In 2000, Byrne (2000) determined that this revetment is in need of repair in some places. This situation has not changed since that report was published. Observations during a site inspection revealed that foreshore erosion is happening in the lee of the revetment (**Figure 35**). No rock underlayer or geofabric were visible, which are key components to rock revetment design. Damage to the revetment may indicate that the rock armour layer is undersized.

FIGURE 35: FORESHORE EROSION PROTECTION ROCK WALL (PHOTO BY N. LEWIS)

On the north side of the river, seaward of the bridge, at the location known as 'Pelican Sands', there were foreshore protection work undertaken in 1996 and again between 2002 and 2005 (Council pers. comms.). Prior to this, it appears from aerial images that the foreshore was experiencing erosion and was certainly more landward of its current position. Since being implemented, the protection works have collapsed and / or been washed away. In parts this foreshore is now experiencing erosion. Some informal protection works have been placed, such as large logs and building material.

## 8.4. Entrance Opening

It is understood that entrance opening is undertaken by Council 2-3 times a year typically. Entrance opening is undertaken pro-actively when heavy rain is forecast. The entrance opening is conducted by local contractors under the direction and inspection of Council. The opening is undertaken by mechanical means, using an excavator, with excavated material (sand) side-cast to form a pilot channel (**Figure 36**). The pilot channel then typically increases in size as high river levels flow out and / or tides penetrate the estuary.

Entrance opening is often problematic and inconsistent in success, impacted significantly by the risks posed by storm waves and high surge. **Appendix A** provides a photo record of barway opening in May and June 2025.

FIGURE 36: BARWAY OPENING PROCEDURE (AT COMPLETION)

## 8.5. Localised Mitigation

Some localised informal mitigation has been implemented. Notably, at the Scamander SLSC, which has experienced inundation during coastal storms have installed post and panel flood board (see **Figure 37**). It is understood that a property along Bridge Esplanade is planning on undertaking property raising (Council pers. comms.).


FIGURE 37: POST AND PANEL BOARDS AT SCAMANDER SLSC

# 9. Synthesis

The Scamander township has been developed around the Scamander River mouth. The river mouth forms an ICOLL, comprising highly dynamic channels and sand shoals. At the mouth of the river a barway closes under low river flow and gentle swell conditions. Natural channel migration and breakout (and location) is somewhat now controlled by the mechanical opening pre or during flooding. The barway, when it forms is indicatively around 1.3m AHD, albeit expected to vary through time.

Infrastructure and property have been built in hazard zones. Hazards have therefore been managed by various means, including infrastructure such as a training wall and foreshore erosion protection. The training wall was damaged and is no longer performing a significant function and other previously implemented management interventions are in various states of condition.

The channel alignment and resulting entrance has migrated significantly over time. The earliest record (circa. 1833) shows it north of its current location. Migration south has also occurred. The training wall, constructed in 1989 and slightly extended in 1991, was effective in limiting the southern extent of the channel migration until 2016. It appears that the training wall was significantly damaged in the 2016 storm. Since then, the channel has migrated south again. Most notably, this has caused significant foreshore alignment change in front of Dune Street. Prior to the construction of the training wall, the channel had previously migrated south also.

The oscillating location (north/south) of the entrance channel, despite the various human interventions, including training wall, suggests that the wave directions and net wave climate conditions are variable and as much a driver of entrance location than the river flows and channel breakout. Formation of spit and bars, as well as the northward channel migration when the training wall was in place suggests there is northerly sediment transport at times. It was also noted that the entrance filled in when the training wall was in place.

Scamander is susceptible to and currently experiences some impacts from a number of geo-hazards, including coastal inundation, coastal erosion, river flooding, and estuarine and river foreshore erosion. As is the case with many estuary mouths/ICOLLS, where the river processes (including flood waters) interact with ocean conditions and/or barway condition, hazards can combine. For example, the entrance condition (if closed) can impede drainage (ocean outfall) of river flood waters and therefore play an important factor in the peak water levels achieved, increasing it above a level that would otherwise be achieved under a scenario should no coastal storm be present or the barway open. The magnitude and impact of river flooding is therefore highly reliant on the barway opening, particularly lower return period events.

Hazard assessments that have been undertaken are useful in providing current and future risks but have limitations. The assessments typically include underestimates. For example, river flooding does not include for scenarios where the barway world be closed, nor does it include a scenario where there is a storm surge and wave. Coastal inundation assessment does not include waves. In the case of coastal erosion, there have been changes to the foreshore location since the assessment, most notably at the foreshore fronting Dune Street.

All the hazards assessed here are expected to exacerbate in magnitude with climate change, in particular through changes associated with a rising sea level, increased intensity of coastal storms and increasing rainfall intensity. The evolution of the ICOLL morphology under climate change is highly unpredictable, but there is a general consensus that ICOLLs would migrate landward. Without intervention, the channel is expected to continue to migrate.

# 10. References


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# 11. Appendix A: Barway Opening May/June 2025

# 12. Appendix B: March 2021 Flood Event – post event photos

River Road

Pelican Sands Foreshore

Pelican Sands foreshore


Scamander Surf Lifesaving Club

Pump station off Dune Street