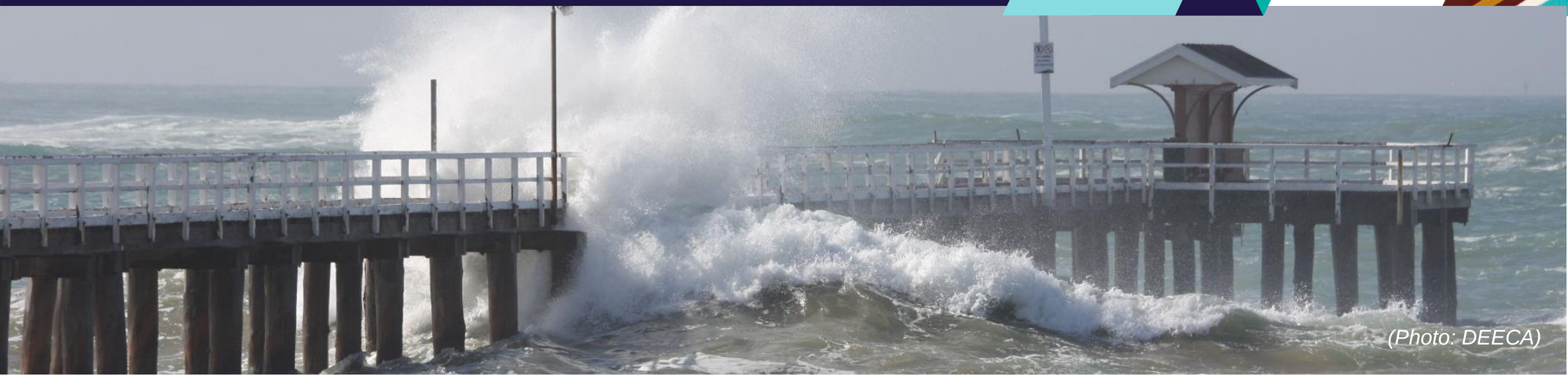
Port Phillip Bay Coastal Hazard Assessment

Summary #4: Inundation hazard assessment



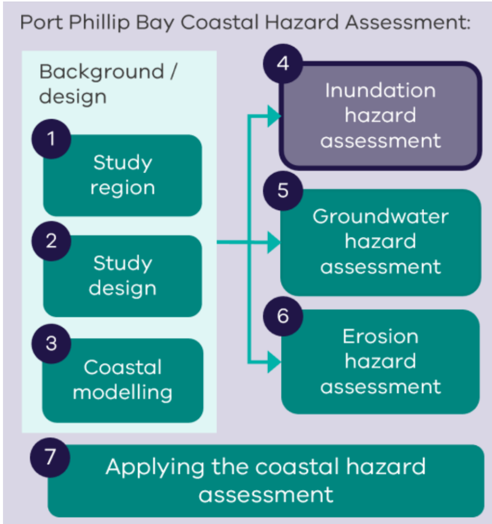
(Photo: DEECA)

Overview

The Port Phillip Bay Coastal Hazard Assessment (PPBCHA) looks at likely coastal hazard impacts around Port Phillip Bay. This includes data analysis and modelling for a range of future climate change scenarios. Results will help land managers and the community to consider climate change in their future planning.

This summary provides an overview of the inundation (flooding) hazard assessment. This is the fourth in a series of summaries providing an overview of the PPBCHA technical work.

In this summary:



Some lower lying land around Port Phillip Bay is prone to coastal flooding. With sea level rise, areas flooded by the sea during storms may become bigger.

We have modelled storm tides and mapped coastal inundation. This will help us understand more about increasing tidal areas and where we may experience flooding when we have storms.

What is inundation?

Inundation is the flooding of low-lying land and can be:

- Permanent inundation by regular tidal cycles
- Temporary inundation associated with storms (event-based inundation)

Inundation of some environments is an important natural process. These might include salt marshes, mangroves, mud flats and other low-lying ecosystems. Overtopping or breaches in dunes, coastal barriers, beach access points or protection works can flood land behind. Coastal flooding can also combine with catchment flooding of creeks, waterways and drains due to rainfall.

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Key terms

Inundation	Also known as flooding, where water covers land that is normally dry. In the context of this project, the flooding is via water from sea (rather than rivers and rain)
Permanent inundation	Regular flooding as part of the local tidal cycle, rather than storms and weather conditions. With sea level rise, previously dry land is becoming impacted by the tides.
Storm tide (temporary) inundation	Temporary flooding by sea water of low-lying coastal land from a locally elevated sea level (storm tide).
Tides	The daily rising and falling of the sea level. Linked to the gravitation forces of the moon and sun.
Tidal range	The difference between the water level at high tide and the previous or following low tide water level.
Storm tide	The total elevated sea height at the coast during a storm, combining storm surge and the predicted tide height.
Storm surge	Elevated sea level at the coast caused by the combination of low pressure and high winds associated with a severe storm.
Overtopping	When water from the sea or ocean washes over the top of natural or manmade features (e.g., beaches, sand dunes, cliffs, seawalls)
Planning horizon	An indicative timeframe by which we expect a projected sea level rise scenario to occur. The Marine and Coastal Policy requires us to plan for sea level rise of not less than 0.8 metres by 2100.

Point Lonsdale (Photo: Alluvium)

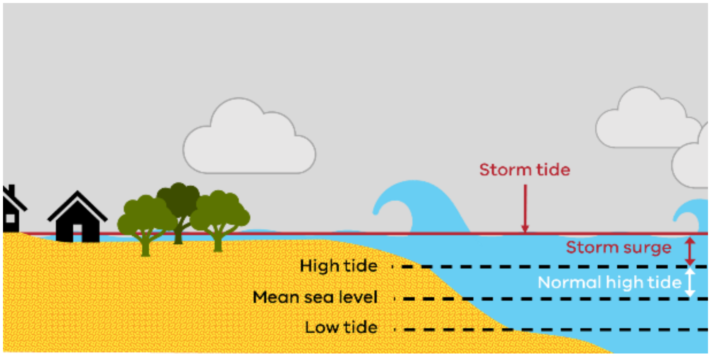
Storm tide inundation

Storm tide inundation is the temporary inundation (flooding) of low-lying coastal land from a locally elevated sea level (storm tide). Combined influences cause storm tides, including:

- the predicted tide
- low pressure air systems causing increases in sea level (storm surge)
- high wind-generated waves associated with severe storms.

Storm tides inundate low-lying land for periods of hours to days, including coastal wetlands, marshes, inlets and estuaries.

Storm tide inundation can also combine with catchment flooding from severe rainfall events, increasing the extent, depth or duration of inundation in some areas.



Permanent inundation

Permanent inundation occurs when low-lying areas become regularly flooded as part of the local tides.

Increases in mean sea level over time will increase the size of tidal areas. Land that was previously dry will become gradually more impacted by the tides.

The more frequent (permanent) nature of this type of inundation means how we use these areas will change over time.

Modelling storm tide inundation

To assess inundation hazards, we need to understand how waves, tides and water levels interact with the shoreline and low-lying coastal areas.

Like many parts of the PPBCHA, the inundation hazard assessment brings together a range of inputs, including:

- Waves and water levels (modelled)
- Local geomorphology and landform analysis
- Land and seabed surveys
- Catchment rainfall and flows
- Knowledge of natural features
- Man-made features and structures (including coastal protection and drainage networks)

Summary #3: Coastal modelling describes the hydrodynamic and wave model in more detail. The model provides simulated wave and water levels for the entire bay. It is a key input to inundation modelling.

We use all these inputs to examine how elevated water levels and waves behave during storm events.

These advanced modelling and analytical methods:

- Model the dynamic movement and timing of water as it advances and recedes with a storm/tide
- Consider wave energy and how waves run up the beach
- Include current coastal protection structures, and how water may 'overtop' these structures
- Account for rainfall and river flows for major rivers that may occur together with a storm event

Middle of the Bay (Photo: Alluvium)

Designs storms and conditions

To estimate inundation, we first establish 'design' events to use for baseline and future sea level rise scenarios. These are storm conditions, based on analysis of past events. They can include both storm tide and rainfall events.

The shape of Port Phillip Bay means different weather conditions affect areas of the Bay in different ways. The direction the weather system comes from often drives this. Inundation modelling included varying design storms (waves and water levels). This reflects the varied storm conditions across the Bay.

Summary #2: Study design provides more information on storm events, including Annual Exceedance Probabilities (AEPs).

The design events for our storm tide inundation modelling included:

- multiple planning horizons (sea level rise scenarios): present-day (0.0 m), 0.2 m, 0.5 m, 0.8 m, 1.1 m, and 1.4 m
- different storm tide events: 1%, 2% and 5% AEP
- storm tide events with and without 10% AEP catchment (rainfall) events.

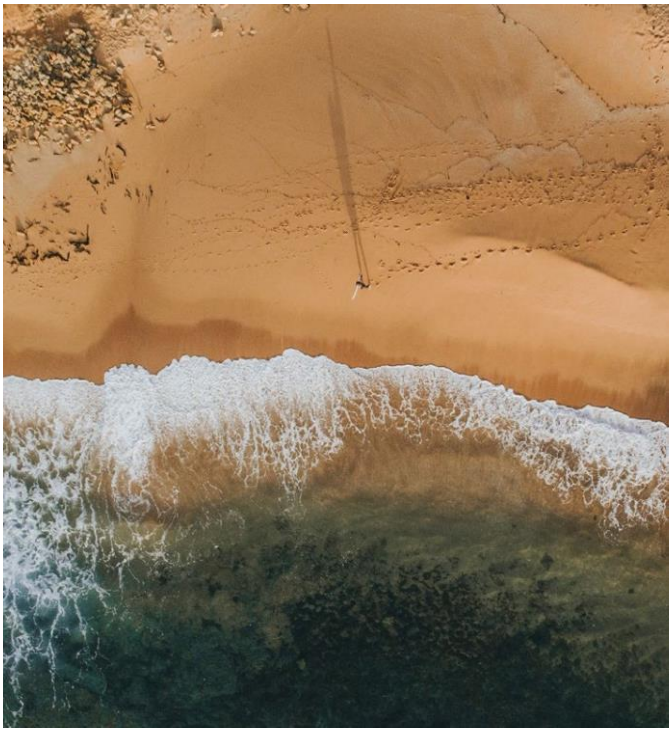
Our inundation modelling used these design storms to estimate storm tide inundation hazard areas.

Most previous modelling use simple 'bathtub' or 'bucket-fill' concepts. This is quite simplistic, based on water levels and ground surface elevations. This method looks at the Bay like a bathtub. It fills up in the same way a bath does when you add water. Lower parts fill up first, then higher parts, until water levels reach the design level. This method can sometimes overestimate flooding.

The PPBCHA project advanced our understanding. We used more complex technical thinking and methods. We considered the timing and dynamics of sea water flowing over land in more detail, and the paths the water can take. This means we accounted for the rising and falling tides. This includes the time it takes for flooding to reach inland areas.

Modelling approach

Inundation hazard modelling and analysis integrates various processes. These include coastal inundation, rainfall, drainage, inland catchment flooding and waves. This provided combined inundation hazard results for the entire bay.



(Photo: Alexander Jason via Unsplash)

We modelled two levels of detail for the inundation hazard assessment, for different parts of the Bay: 5 metre (more detail) and 25 metre (less detail).

Our modelling considered how different processes interact together. In some areas, the coastal processes are more complex. We used more model detail and studied extra processes in some locations.

	More detail	**Less detail**
Grid resolution	5 m	25 m
Used for:	Low-lying, urban areas	Less urban areas
Dynamic overland inundation due to combined sea level rise and storm tide	✓	✓
Catchment flows from rainfall over the model grid (10% AEP rainfall event)	✓	✓
Local wave overtopping where seawalls and barriers were present	✓	
Stormwater drainage	✓	

Model resolution

Our models rely on grids to organise data so that it represents a geographical area (i.e. the Bay). Model grids have a ‘resolution’. High resolution (finer) grids enable more detailed models and results. These models take much longer to process. Low resolution (coarser) grids process quickly but have less detail.

Summary #3: Coastal modelling provides more information about model grids and how models work.

Outputs of the model

The storm tide inundation modelling estimated a range of parameters linked to waves and water levels. It considered processes both out in the bay (offshore) and onshore. This includes where flooding goes and how deep the water gets for different storm events.

We arranged the results for each design event into grids. Mapping these result grids helps us understand more about storm tide inundation. The level of detail available in the results reflects the model resolution we defined (outlined above).

Modelling permanent inundation

(Regular inundation from tides)

Tides in Port Phillip Bay are complex. Tidal processes, including the tidal range, vary in different parts of the Bay. We use simple bathtub models to examine how increases in mean sea level will change water levels around the Bay.

Tidal range – the difference between the water level at high tide and the previous or following low tide water level.

Highest astronomical tide (HAT) – highest water level predicted to occur under average meteorological conditions.

Australian Height Datum (AHD) - A datum (reference elevation) that sets zero elevation as mean sea level.

There are three main reference locations used to observe tides around the Bay – at Geelong, Williamstown and Port Phillip Heads. We use records of water levels to understand more about local tide conditions and make future predictions.

We can use local highest astronomical tide (HAT) water levels, incorporating up to 0.8 m sea level rise by 2100, to represent regularly occurring water levels due to tides.

Future estimated tide level = HAT + sea level rise

	Geelong	Williamstown	Port Phillip Heads
Local HAT (m AHD)	**0.66**	**0.52**	**0.88**

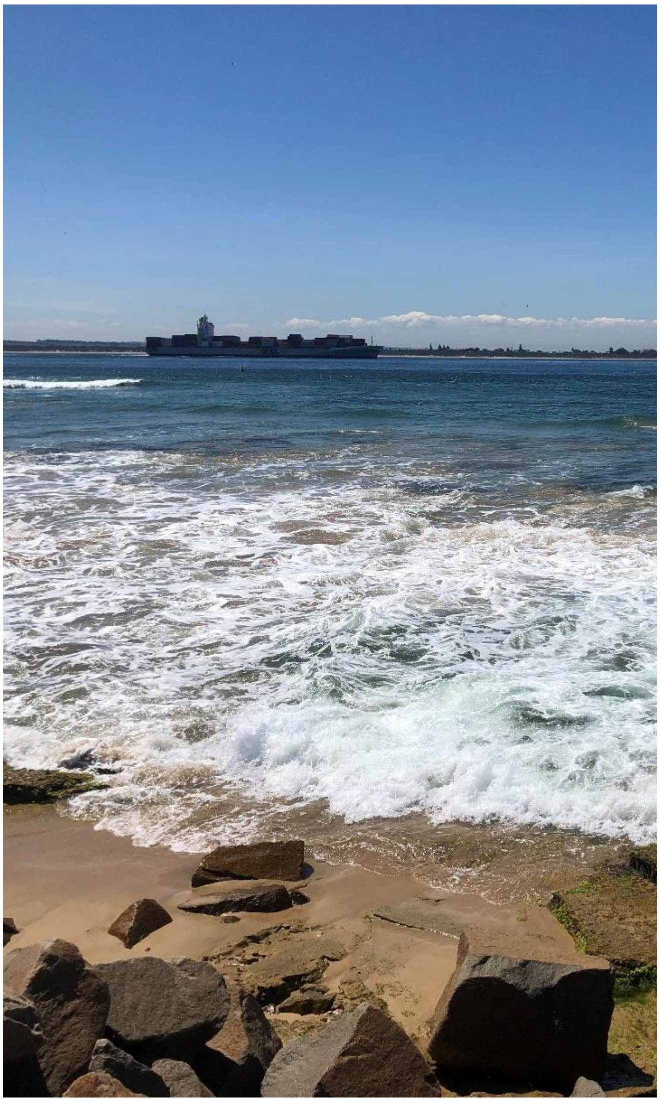
We choose the nearest reference station to represent specific locations in the Bay.

We must consider local tide conditions to understand how mean sea level increases will change water levels for different parts of the Bay.

The permanent inundation modelling uses simple bathtub models to examine increasing water levels (described further above). These are less sophisticated methods compared to the storm tide modelling.

We know some limitations in how we have modelled permanent inundation. However, this work provides results that use the latest ground surface elevations (land and sea), matching those used for the latest storm tide and erosion modelling.

This allows for some comparison between hazard types.



Looking across the Heads, from Point Nepean (Photo: Alluvium)

Mapping inundation

We map results from the inundation modelling to visualise where storm tide may go. Mapping helps highlight areas exposed to inundation hazards for a certain storm event condition. We refer to these as “inundation hazard extents”.

We estimate and map storm tide levels and extents around the entire Port Phillip Bay region. This mapping covers all coastal communities within ten local government areas adjacent to the Bay.

Using mapped extents

Mapped model results help us understand coastal inundation areas along the Port Phillip Bay coastline. This allows us to examine how the coastline might respond if these conditions were to occur.

By mapping results, we can compare extents of different storm events and sea level rise scenarios. We can also explore how hazard extents vary for different hazard types (inundation compared to erosion). We use mapping to assist us in identifying focus areas for adaptation.

The **Hazard mapping supplement** provides more information on the coastal hazard maps and how to interpret them.

What do the results tell us?

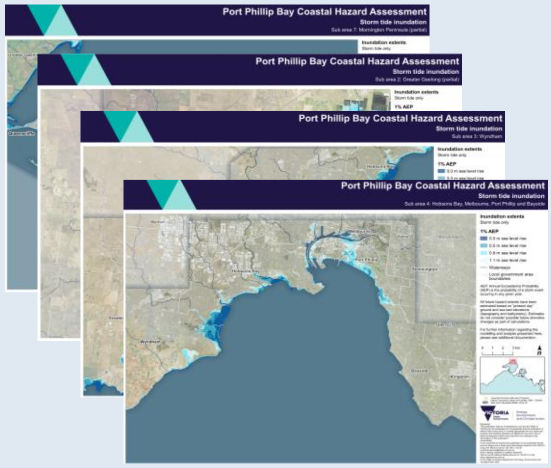
Understanding flood prone areas provides a starting point for planning our hazard adaptation. We know that some areas around Port Phillip Bay already experience flooding during storm tide events. Inundation hazard areas increase with sea level rise.

Knowing the locations where flooding might happen allows us to prioritise these areas for further analyses. Understanding timing is also important. Linked to sea level rise, we can estimate how long we have until we may experience flood impacts, and when further management is likely needed.

Summary #7: Applying the coastal hazard assessment provides more information on the next steps for applying assessment results.

Williamstown Beach (Photo: Alluvium)

Several map sets accompany this summary, with both Bay-wide and more detailed maps. These represent a selection of storm tide flooding and permanent inundation modelling scenarios.



- **Storm tide inundation extents**
  - By storm event probability
  - By planning horizon (sea level rise scenario)
- **Storm tide inundation depths**
  - By planning horizon (sea level rise scenario)
- **Permanent inundation**
  - By water level

Maps are presented for the entire Bay and seven sub-areas:

Sub areas	Local government areas (LGAs)
1	Greater Geelong (partial), Queenscliff
2	Greater Geelong (partial)
3	Wyndham
4	Hobsons Bay, Melbourne, Port Phillip and Bayside
5	Kingston, Frankston
6	Mornington Peninsula (partial)
7	Mornington Peninsula (partial)

Mapping also helps us explore **vulnerability** and **risk.** We do this by considering the values, uses and infrastructure located in (exposed to) hazard areas. This includes the possible impacts (consequence) if they experienced coastal flooding.

Storm tide inundation extents

The following map of the whole bay shows inundation extents for various sea level rise scenarios from 0.0 m to 1.1 m of sea level rise. It uses coloured bands to show flooded areas.

These bands:

- show areas potentially affected by short-term (temporary) inundation
- are in absence of any management measures
- highlight inundation areas arising due to certain local weather (storm) conditions.
- use present day ground and seabed elevations

The bands do not represent:

- a ‘loss’ of coastal land
- areas flooded by storm tides all at the same time

Sub-area maps are available for more detail of the storm tide hazards**.**

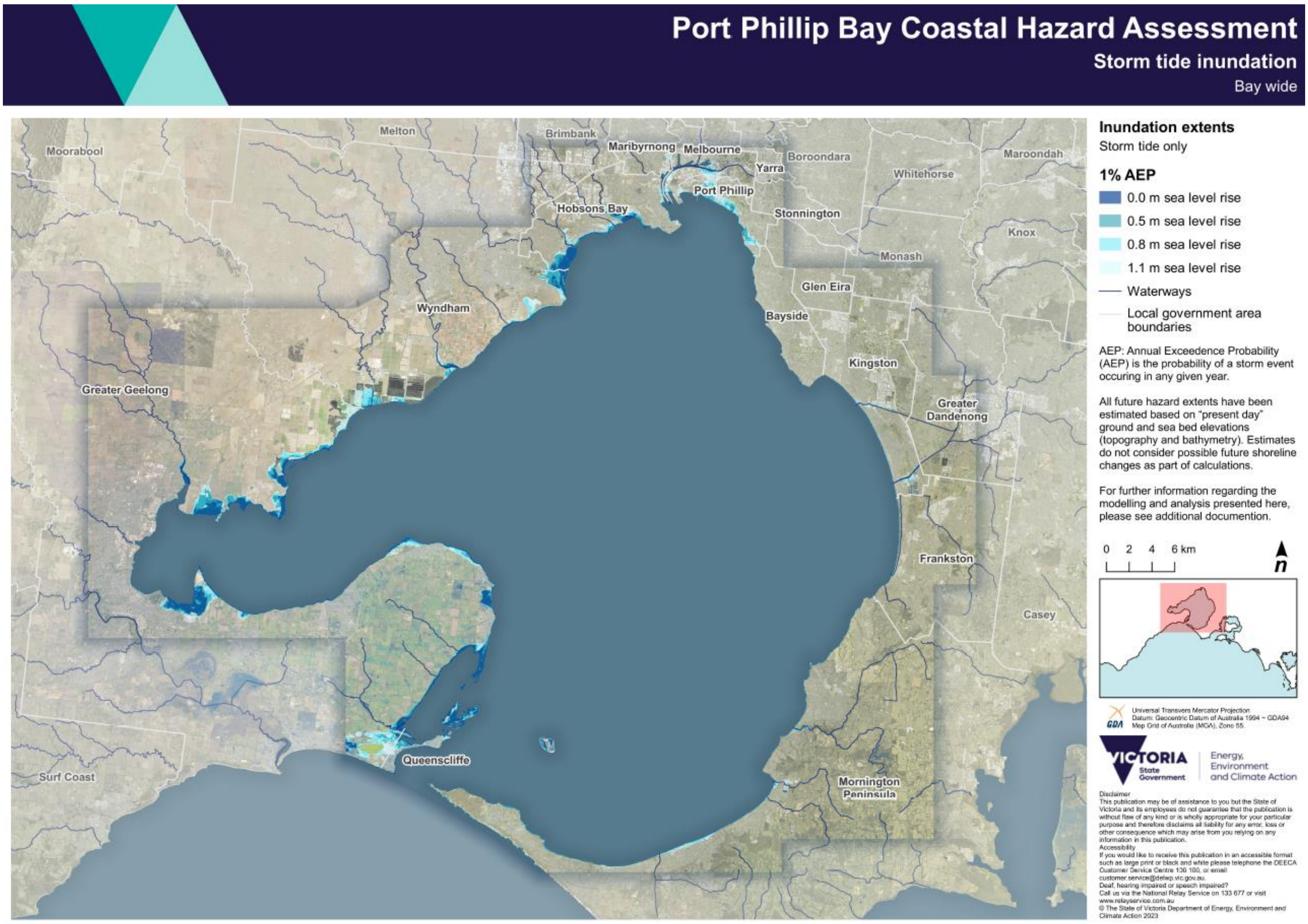
We examined the size of increasing inundation areas for each local government area (LGA). This can show possible hazard impacts.

Flood prone areas around Port Phillip Bay:

- **west and south west** - Point Lonsdale, Queenscliff, Swan Bay, Portarlington, Point Henry, Avalon, Point Wilson
- **north west** - Werribee and Altona
- **north** - Southbank, Port Melbourne to Elwood
- **east and south east** – Mordialloc and Patterson Lakes, Martha Cove

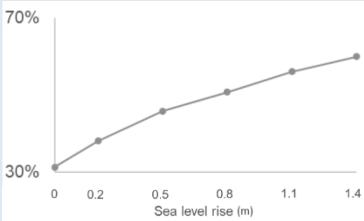
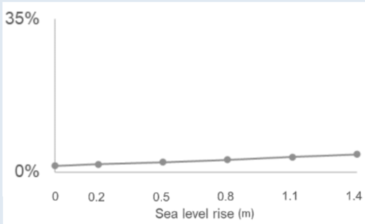
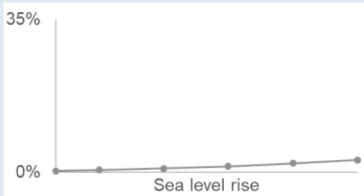
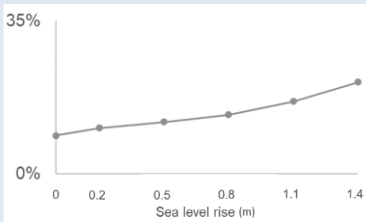
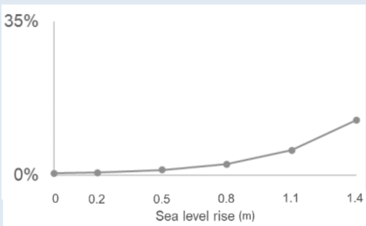
What do inundation areas tell us?

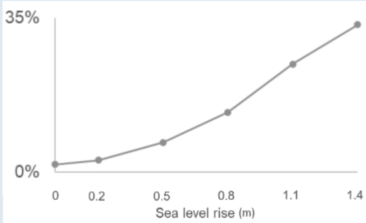
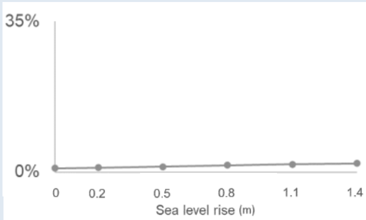
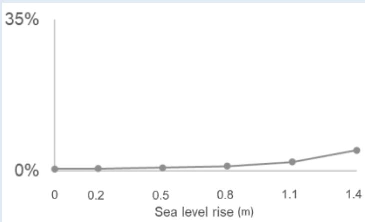
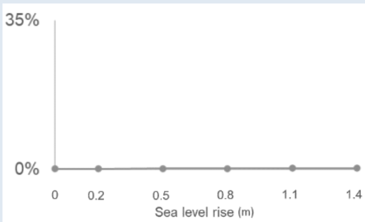
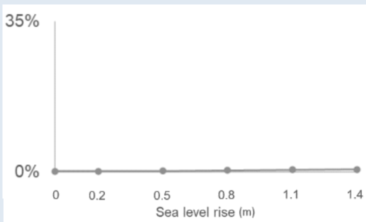
Area/s being prone to inundation hazards, doesn’t necessarily mean they need management /action. Land and asset managers need to look at the values, uses and infrastructure within these areas and implications of any flooding. This can inform decisions on our response.



Storm tide inundation with extents by sea level rise scenario - Bay wide (Source: DEECA)

Summary: Storm tide inundation extents (by area)

LGA (size)	Current inundation hazards for 1% AEP event	Longer term / over time	Percentage of total LGA area
Queenscliff (9.4 km²)	• Almost 3 km² within present day inundation hazard extent. • As a small LGA, this is over 30% of total land in the LGA.	• Areas within the inundation hazard extent increase substantially under 0.2 m and 0.5 m sea level rise. • More than half this local government area is within the inundation hazard extent beyond 0.8 m sea level rise.	
Greater Geelong (1,162 km²)	• Almost 17 km² within present day inundation hazard extent. • As a large LGA, this is around 1.5% of total land in the LGA	• Areas within the inundation hazard extent increase linearly with sea level rise • An area 2-3 times larger than present day (~47 km²) is within the inundation hazard extent under 1.4 m sea level rise. This is around 4% of total land in the LGA	
Wyndham (542 km²)	• Over 2 km² within present day inundation hazard extents. • As a large LGA, this is around 0.4% of total land in the LGA	• Areas within the inundation hazard extent increase linearly with sea level rise • The rate of increase accelerates somewhat beyond 0.5 m sea level rise, reaching nearly 3% of the total LGA at 1.4 m sea level rise	
Hobsons Bay (64.7 km²)	• Over 5.6 km² within present day inundation hazard extent. • This is nearly 9% of total land in the LGA.	• Areas within the inundation hazard extent increase, with accelerated increase past 0.8 m sea level rise • An area 2-3 times larger than present day (~13.5 km²) is within the inundation hazard extent under 1.4 m sea level rise. This is over a fifth of total land in the LGA	
Melbourne (37.7 km²)	• Almost 0.2 km² within present day inundation hazard extent. • This is only around 0.5% of total land in the LGA	• Areas within the inundation hazard extent increase significantly beyond 0.8 m sea level rise • Around 2.5% of land in the LGA is within the inundation hazard extent under 0.8 m sea level rise, increasing to 12.5% under 1.1 m sea level rise	

LGA (size)	Current inundation hazards for 1% AEP event	Longer term / over time	Percentage of total LGA area
Port Phillip (20.5 km^2)	• Almost 0.4 km^2 within present day inundation hazard extent. • This is almost 2% of total land in the LGA.	• Areas within the inundation hazard extent increase significantly beyond 0.5 m sea level rise • The rate of increase accelerates substantially • A quarter of land in the LGA is within the inundation hazard extent under 1.1 m sea level rise.	
Bayside (37.2 km^2)	• Over 0.3 km^2 within present day inundation hazard extent. • This is just under 1% of total land in the LGA	• Areas within the inundation hazard extent increase linearly with sea level rise • The overall proportion of land in the LGA within the inundation hazard extent remains low (<2%)	
Kingston (91.5 km^2)	• Almost 0.5 km^2 within present day inundation hazard extent. • This is less than 0.5% of total land in the LGA	• Areas within the inundation hazard extent remain low (<1% of total LGA) until 0.8 m sea level rise • Nearly 5% of land in the LGA is within the inundation hazard extent under 1.4 m sea level rise	
Frankston (130 km^2)	• Approximately 0.1 km^2 within present day inundation hazard extent. • This is a very small proportion of total land within the LGA (<0.1%)	• Areas within the inundation hazard extent increases to three times that of present day under 1.4 m sea level rise • The overall proportion of land in the LGA within the inundation hazard extent remains low (<0.3%)	
Mornington Peninsula (Port Phillip Bay side only) (729 km^2)	• Almost 1 km^2 within present day inundation hazard extent. • This is very small proportion of total land within the LGA (~0.1%)	• Areas within the inundation hazard extent increases to three times that of present day under 1.4 m sea level rise • The overall proportion of land in the LGA within the inundation hazard extent remains low (<0.6%)	

Storm tide inundation depths

Water depth is a useful thing consider for coastal inundation. The depth of water can influence the degree of impact of a flooding event. This might be via water damage to assets and values. Temporary disruptions to services, roads and pedestrian access can also occur.

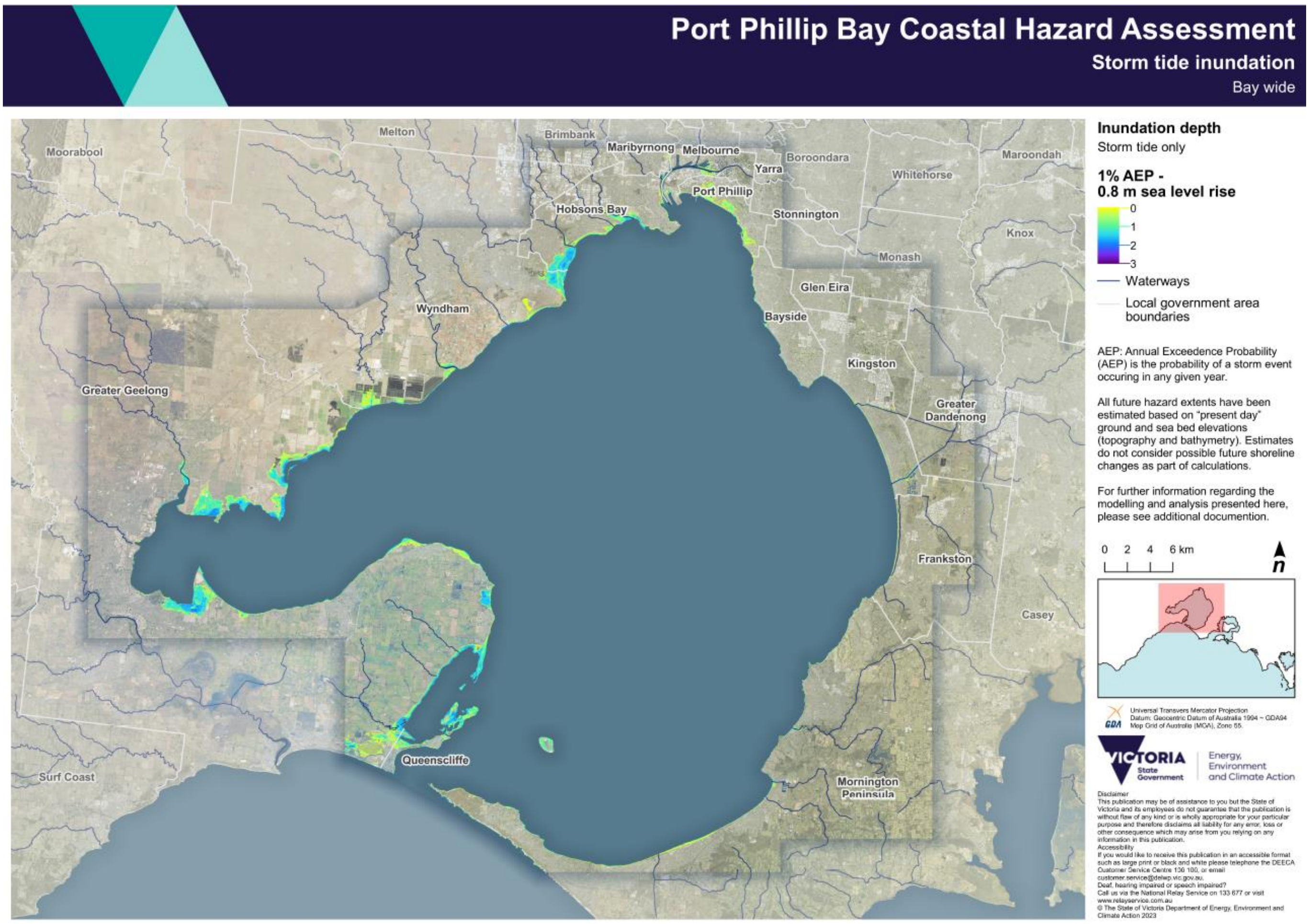
Deeper water can also present additional public safety risks. Unpredictable flows and currents pose a risk. Many dangers hide under the water surface.

We mapped inundation hazard extents by depth. The areas covered by flooding match those presented in inundation extents further above. The colour shows the depth of water. Shallower water (<1 metre) is yellow and green colours and deeper water is darker blue (up to 3 metres).

The following map of the whole bay shows inundation water depths for a 1% AEP storm event, for 0.8 m of sea level rise (nominally by 2100)

Modelling showed deeper water (>1 m) for:

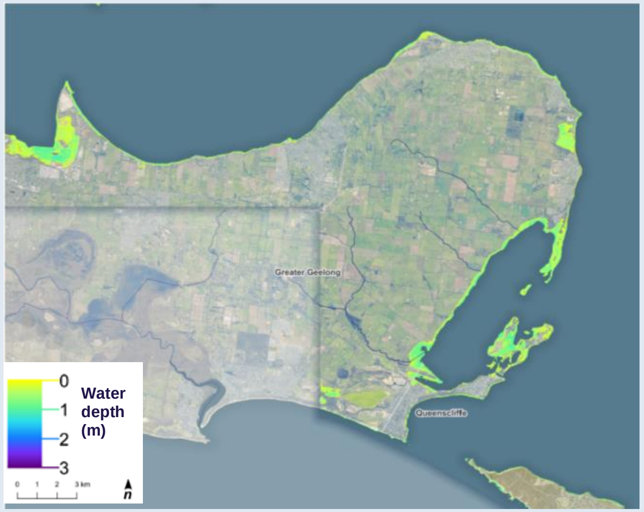
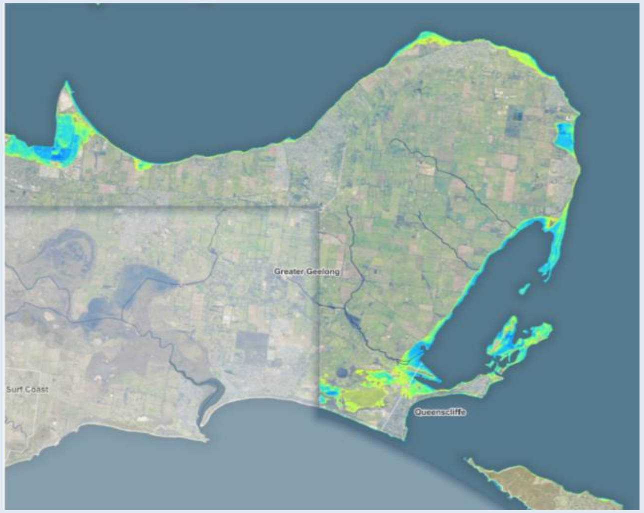
- some of the more natural, low lying areas, such as adjacent coastal wetland areas and waterways
- beaches and coastal reserves
- low lying urbanised areas, including coastal roads and drainage outlets and networks



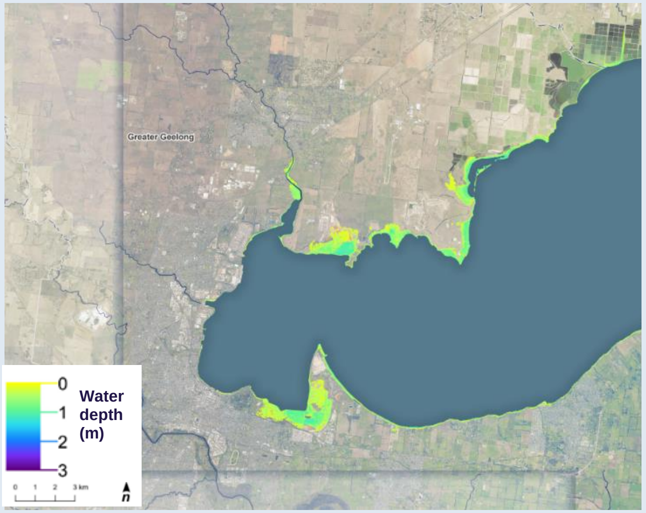
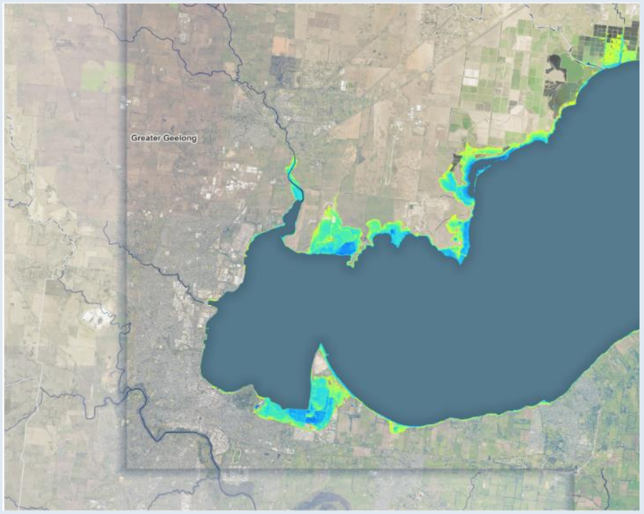
Storm tide inundation depths for 0.8 m sea level rise - Bay wide (Source: DEECA)

Summary: Storm tide inundation depths – comparing present day and 0.8 m of sea level rise for a 1% AEP storm tide with no rainfall.

<table>
<tr><th>Relevant LGAs</th><th>1% AEP storm at 0.0m SLR</th><th>1% AEP storm at 0.8m SLR</th><th>Key findings</th></tr>
<tr><td>Queenscliff

Greater Geelong</td><td>
</td><td>
</td><td>Modelling shows deeper water projected for some of the more natural, low lying areas, such as adjacent coastal wetland areas.

Water depths above 1 metre at:
Lake Victoria (Point Lonsdale)
Salt Lake (Bellarine Peninsula)
Moolap Saltworks</td></tr>
<tr><td>Greater Geelong

Wyndham</td><td>
</td><td>
</td><td>Modelling shows deeper water projected for some of the more natual, low lying areas, such as adjacent coastal wetland areas.

Water depths above 1 metre at:
Spit Nature Conservation Reserve and Point Wilson
The Western treatment plant
Moolap Saltworks</td></tr>
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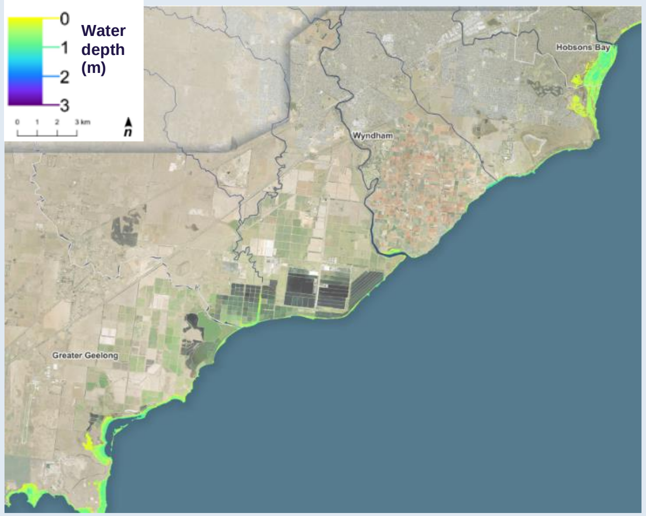
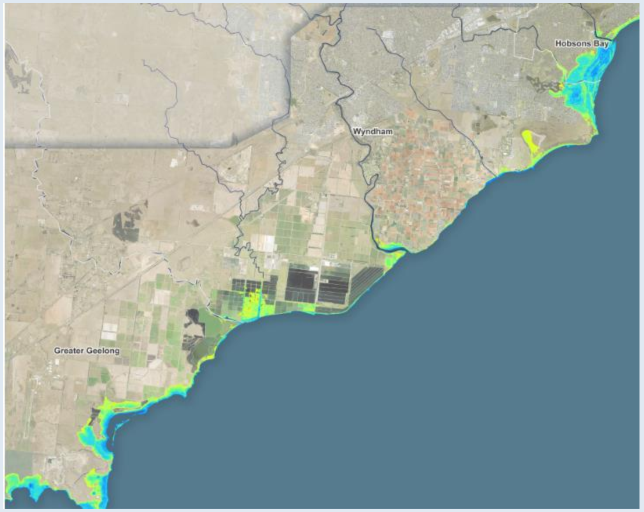
Wyndham

Hobsons Bay</td><td>
</td><td>
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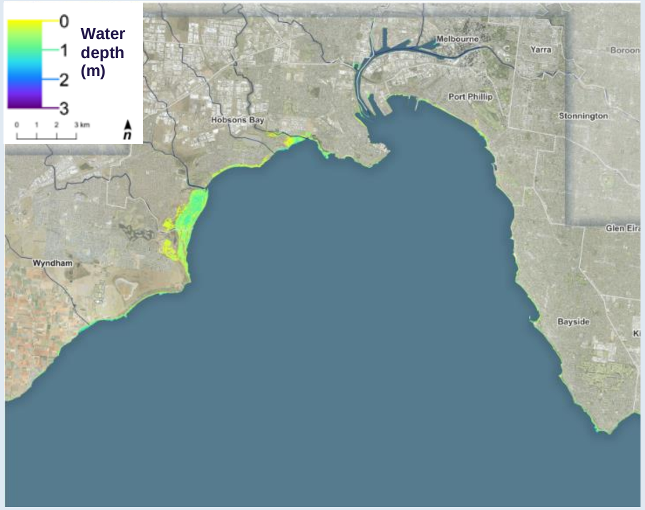
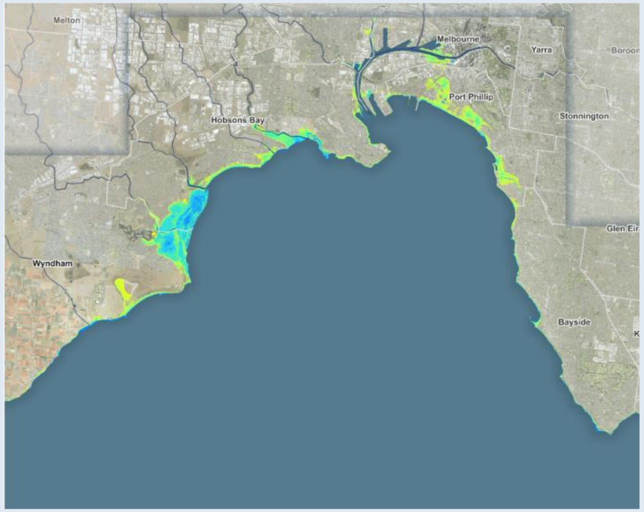
Water depths above 1 metre at:
Spit Nature Conservation Reserve and Point Wilson
The Western treatment plant
Cheetham Wetlands</td></tr>
<tr><td>Wyndham

Hobsons Bay

Melbourne

Port Phillip

Bayside

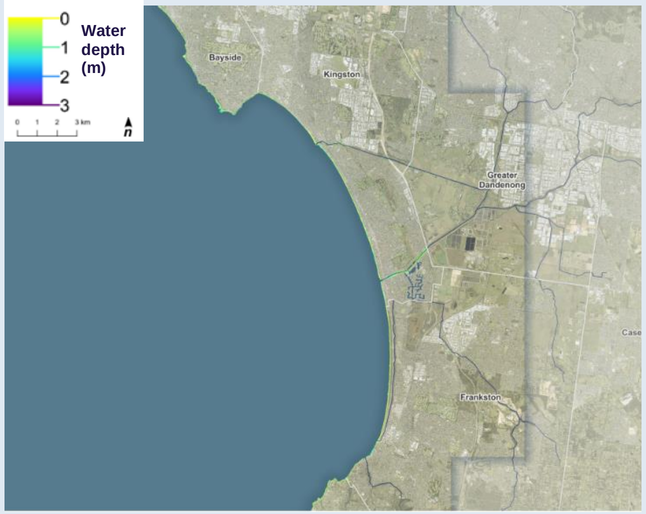
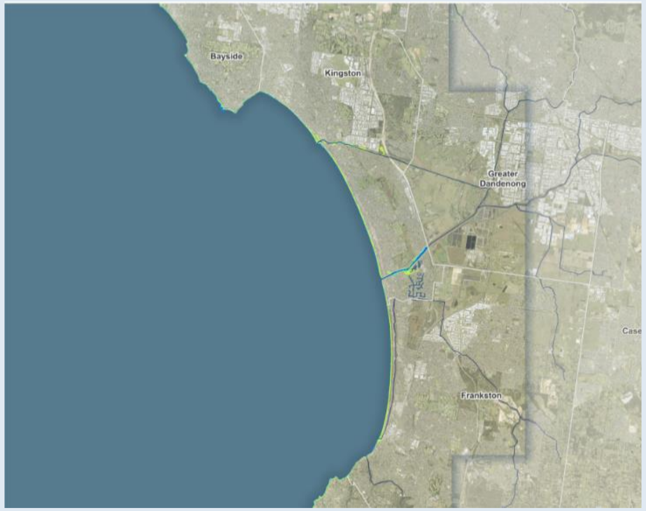
Kingston</td><td>
</td><td>
</td><td>Modelling shows deeper water projected for some urbanised low lying areas.

Water depths above 1 metre at:
Altona, Seaholm and Williamstown Foreshores (Hobsons Bay)
Southbank and Lower Yarra River
Some low lying urbanised areas in Albert Park, Middle Park, Port Melbourne
Coastal reserves/beach between the bay and coastal road route (Beach Road)
Elwood Canal</td></tr>
</table>

<table>
<tr><th>Relevant LGAs</th><th>1% AEP storm at 0.0m SLR</th><th>1% AEP storm at 0.8m SLR</th><th>Key findings</th></tr>
<tr><td>Bayside

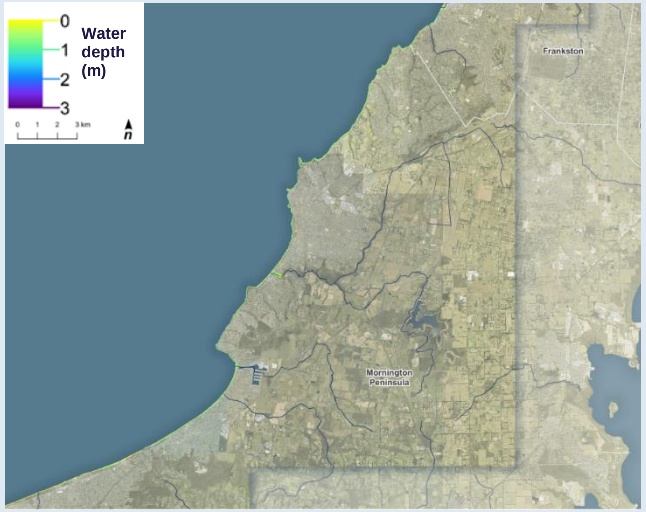
Kingston

Frankston

Mornington Peninsula</td><td>
</td><td>
</td><td>The natural elevation is higher for many areas in this part of the bay.

This means deeper flooding impacts are

• near to the coast and within some waterways – Mordialloc Creek, Patterson River.</td></tr>
<tr><td>Frankston

Mornington Peninsula</td><td>
</td><td>
</td><td>The natural elevation is higher for many areas in this part of the bay.

This means deeper flooding impacts are:

• nearer to the coast and within some waterways – Balcombe Creek, Martha Cove.
• at beaches and coastal reserves between the bay and the coastal road route (Point Nepean Rd, Marine Parade)</td></tr>
</table>

Relevant LGAs	1% AEP storm at 0.0m SLR	1% AEP storm at 0.8m SLR	Key findings
Mornington Peninsula **(Queenscliff)** **(Greater Geelong)**			Deeper flooding impacts are: • near to the coast and within some waterways. • at beaches and coastal reserves between the bay and the coast road route (Point Nepean Rd, Marine Parade).

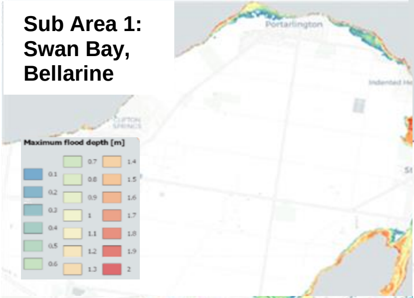
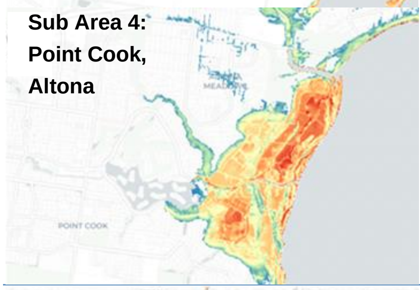
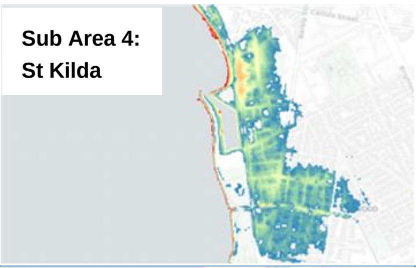
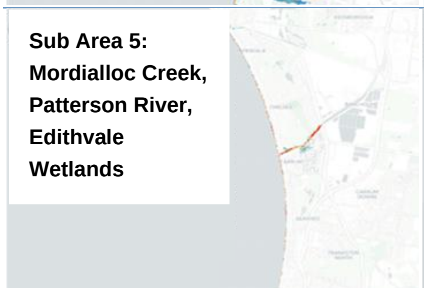
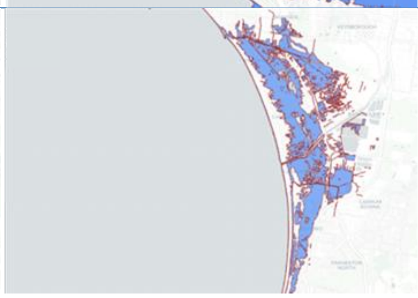
How do recent results compare to previous storm tide inundation mapping?

Before this project, we have relied upon storm tide maps for Port Phillip Bay, developed as part of the Future Coasts project (in 2009).

Comparing maps for the two storm tide models, we can see notable differences in some locations.

The main drivers of these differences are:

- Revised (improved) methods for estimating design storm conditions (including wind forcing)
- Previous model was a bathtub (static) model which can overestimate inundation extents. It doesn't consider time taken to flood and how it relates to rising/falling tides. Current modelling more accurately accounts for these dynamics.

Latest modelling (flood depths)	Previous modelling (Future Coasts)	Comparison
Sub Area 1: Swan Bay, Bellarine 		Flood extents for the two models are similar in these areas on the Bellarine Peninsula and Cheetham Wetlands. In less urban settings, coastal flooding is mainly driven by overland flows rather than through built (piped) drainage networks or flows via river systems or creeks. This means the flood dynamics (timing of flooding) has less influence. Simple bathtub models can offer reasonable estimates.
Sub Area 4: Point Cook, Altona 		
Sub Area 4: Port Melbourne, Lower Yarra 		Previous extents were much larger in some built up areas (i.e. Southbank, Port Melbourne). These more urban settings have extensive pipe drainage networks and coastal structures. Timing of floods and tides, and space within pipes in the network is important in these more built up areas. These impacts were not well allowed for in the previous bathtub modelling. This meant overestimates of the flood extent. It is also unclear how previous modelling accounted for coastal protective structures.
Sub Area 4: St Kilda 		
Sub Area 5: Mordialloc Creek, Patterson River, Edithvale Wetlands 		Previous extents were much larger with flooding via Mordialloc Creek and Patterson River. Bathtub modelling assumes when creek banks overtop, all nearby areas lower in elevation become wet. New modelling more accurately allows for time taken for water to flow over land and how long water levels remain high enough to overtop the bank.

Permanent inundation extents

Regular inundation from tides

Mapped areas of permanent inundation represent areas that are likely to be prone to regular inundation by tidal patterns. These areas increase with sea level rise.

We mapped water level inundation (tidal) extents from the static bathtub model. The mapped bands are at 0.1 metre water level increments for the whole bay. We can consider what tides may look like under each sea level scenarios for different locations.

Regular tidal inundation	= Highest Astronomical Tide (HAT)	+ Sea Level Rise (SLR)

We choose the nearest or most suitable reference station to represent specific locations in the Bay.

	Geelong	Williamstown	Port Phillip Heads
Local HAT (m AHD)	0.66	0.52	0.88

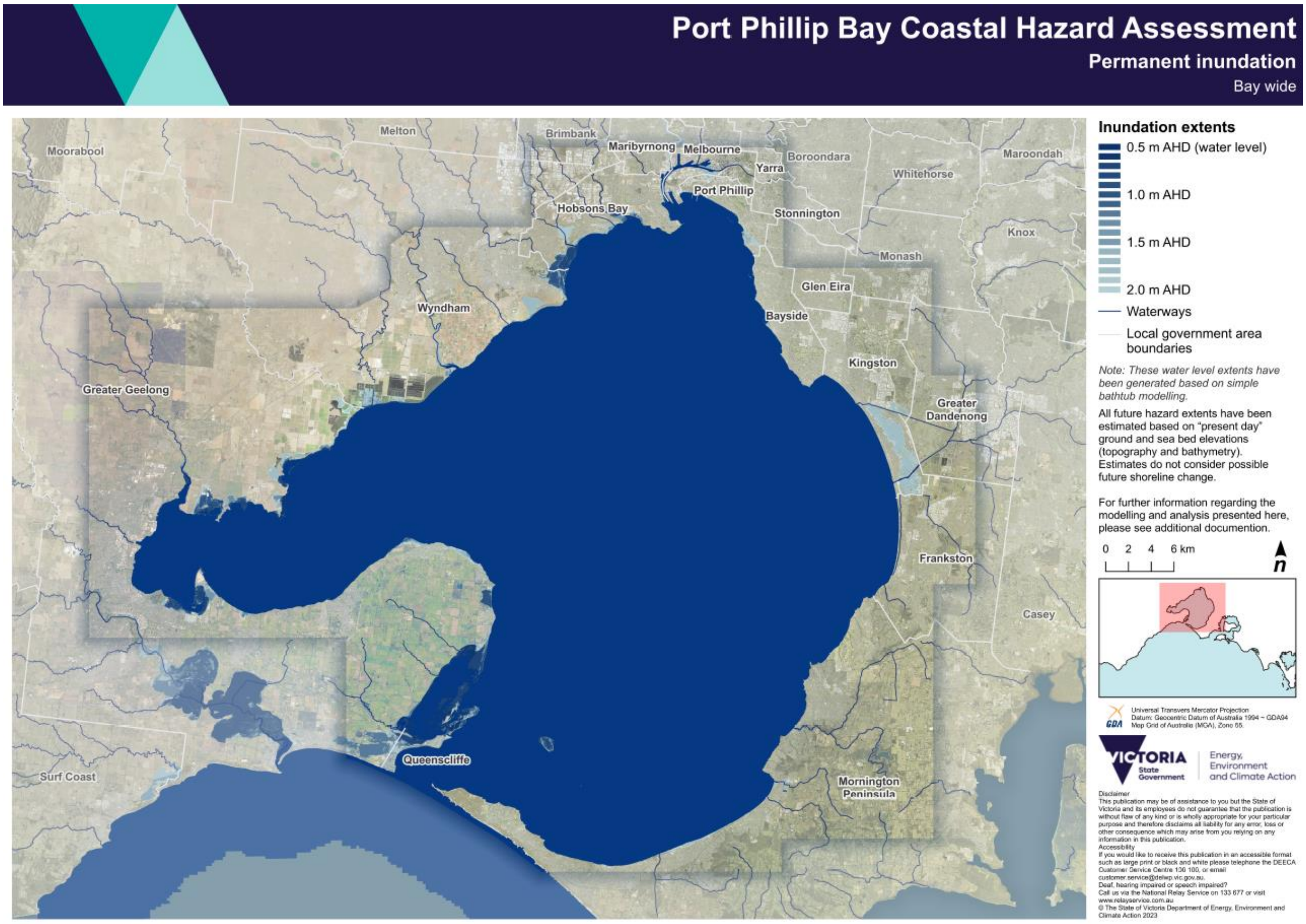
These water level bands:

- show areas potentially affected by long-term (permanent) inundation
- are in absence of any management measures
- use present day ground and sea bed elevations

The bands do not necessarily represent:

- a 'loss' of coastal land, but may show where land-use is likely to change over time

> ⚠ We must consider local tide conditions to understand how mean sea level increases will change water levels for different parts of the Bay.



Permanent inundation extents (based on static bathtub modelling) - Bay wide (Source: DEECA).

As with storm driven flooding, some of the lower-lying areas increasingly inundated by tides are across the western half of the Bay:

- **west and south west** - Point Lonsdale, Queenscliff, Swan Bay, Portarlington, Point Henry, Avalon, Point Wilson
- **north west** - Werribee and Altona
- **north** - Southbank, Port Melbourne to Elwood

Increasing tidal areas have longer lasting impacts, potential getting wet each tide. These areas are likely to face more permanent change, compared to the temporary flooding that happens during a storm.

Sub-area maps are available for more detail of the permanent inundation hazards

Ranelagh Beach, Mount Eliza (Photo: Alluvium)

What next?

Inundation modelling gives us a regional perspective of inundation areas around the Bay. This is for a range of storm events and sea level rise scenarios.

Hazard maps highlight areas potentially impacted by different coastal hazard types. This is if we make no changes to how we manage these areas.

We have some time to allow us to carefully and proactively plan our response to future hazards.

Mapping allows us to think about:

- what and where the hazards are
- when hazards may occur
- how they change over time

This means we can better plan for the future and develop an appropriate response.

Using maps as the foundation, we can determine where to focus our efforts next. This might be analyses and obtaining extra information to aid decision making. Some areas may need local-scale studies, to better determine risk or adaptation planning.

We can build upon this knowledge with:

- **Exposure assessments** - what things (values, uses, infrastructure) are within inundation prone areas (exposed)
- **Vulnerability and risk assessments** - what is the impact (consequence) of inundation on these things
- **Economics assessments** – what are the costs/ economic implications of coastal hazard damages and/or losses
- **Adaptation planning** – what are the range of actions available to manage current and future inundation risks

Quantifying exposure, vulnerability and risk informs management decisions of these areas.

Summary #7: Applying the coastal hazard assessment details how we can use hazard modelling findings, to make regional and local (site-based) adaptation decisions.

We acknowledge Victorian Traditional Owners and their Elders past and present as the original custodians of Victoria’s land and waters and commit to genuinely partnering with them and Victoria’s Aboriginal community to progress their aspirations.

Accessibility

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