Coastal Hazard Vulnerability and Risk Assessment Guidelines

Report for Mornington Peninsula Shire Council

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Definitions & Glossary

The following definitions and descriptions are provided to ensure clarity and consistency in understanding of key terms used throughout these guidelines. For the assessment of landslide hazards refer to the specific definitions provided in Australian Geomechanics Society (2007a).

Term	Definition
Annual Exceedance Probability (AEP)	Refers to the probability or risk of a flood of a given size occurring or being exceeded in any given year. A 90% AEP flood has a high probability of occurring or being exceeded; it would occur quite often and would be relatively small.
ABSLMP	Refers to the Australian Baseline Sea Level Monitoring Program which has been collecting high quality measured water levels at Portland, Lorne, and Stony Point in Victoria since 1991
Astronomical tide	Water level variations due to the combined effects of the Earth's rotation, the Moon's orbit around the Earth and the Earth's orbit around the Sun.
Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level. Introduced in 1971 to eventually supersede all earlier datums.
Average Recurrence Interval (ARI)	Refers to the average time interval between a given flood magnitude occurring or being exceeded. A 10-year ARI flood is expected to be exceeded on average once every 10 years. A 100-year ARI flood is expected to be exceeded on average once every 100 years. The AEP is the ARI expressed as a percentage.
Backshore	The backshore extent landward from the swash limit.
Berm	A coastal berm is a nearly horizontal shore parallel ridge formed on the beach due to the onshore movement of sand by wave action. Berms form at the entrance to estuaries when the catchment flows are insufficient to prevent or limit the onshore movement and disposition of sand by wave action.
Catchment	The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main waterway.
Coastline	Means the line of the low water mark off the coast which includes any bay, inlet, estuary and any waters within the ebb and flow of the tide.
Coastal Zone	Refers to a wider area seaward and landward where geological materials and landforms are dominantly shaped by interaction of recent and ongoing marine and terrestrial processes.
Coastal Hazard	A term to collectively describe physical changes and impacts to the natural environment which are significantly driven by coastal or oceanographic processes. VC171 defines Coastal Hazard to mean "an occurrence of an event within coastal Victoria which includes the individual or combined effects of inundation by the sea, the effects of storm tides, river flooding, coastal erosion, landslip and sand drift which adversely affects or may adversely affect human life, property or aspects of the environment."

Coastal Erosion	Coastal erosion is the process of winds, waves and coastal currents shifting sediment away from a localised area of the shoreline.
Estuary	The seaward limit of a drowned valley which receives sediment from both river and marine sources and contains geomorphic and sedimentary conditions influenced by tide, wave and river processes
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from elevated sea levels and/or waves overtopping coastline defences.
Flood hazard	Potential risk to life and limb caused by flooding. Flood hazard combines the flood depth and velocity.
Floodplain	Area of land which is subject to inundation by floods, i.e., flood prone land.
Geomorphology	The study of the origin, characteristics, and development of landforms
Intertidal	Pertaining to those areas of land covered by water at high tide, but exposed at low tide, e.g., intertidal habitat. Also called "shore zone"
Inundation	Flooding because of oceanic conditions is often referred to as inundation rather than flooding although the terms are interchangeable. In this guide the term flooding is used in preference to inundation.
Landslide	The movement of a mass of rock, debris, or earth (soil) down a slope.
LiDAR	Spot land surface heights collected via aerial light detection and ranging (LiDAR) survey. The spot heights are converted to a gridded digital elevation model dataset for use in modelling and mapping
MHWS	Mean High Water Springs, i.e., the mean of spring tide water levels over a long period of time.
MSL	Mean Sea Level.
Nearshore	The region of land extending from the backshore to the beginning of the offshore zone.
Nominal flood protection level (NFPL)	Is the minimum level (elevation) requirement for building floors and services (e.g., sewer openings & electrical fittings) and is measured in metres AHD. The NFPL affects the height of floors and building services above the ground surface
Offshore	The zone seaward of where waves interact with the seabed
Precautionary Principle	Where there are threats of serious or irreversible environmental and other damage, lack of full certainty should not be used as a reason for postponing measures to prevent environmental or other degradation.
Risk	Risk is expressed as the combination of the consequences of an event and the associated likelihood of occurrence.
Risk Assessment	Risk Assessment is the overall process of risk identification, risk analysis and risk evaluation.

Risk Management Process	The systematic application of management policies, procedures and practices to the activities of communicating, consulting establishing the context, and identifying, analysing, evaluating, treating, monitoring and reviewing risk (ISO 31000: 2018) establishing the context, and identifying, analysing, evaluating, treating, monitoring and reviewing risk (ISO 31000: 2018)
Sea Level Rise (SLR)	A permanent increase in the mean sea level above the 1990 mean sea level.
Shoreline	The physical interface of land and sea – typically taken as the 0 m AHD contour for coastal hazard assessment datum purposes. Sea level rise since 1990 should be added to 0 m AHD to give an estimate of the current shoreline datum for assessing coastal erosion.
Shoreline Class	A length of coast with a characteristic appearance in plan and profile and comprised of a limited range of geological materials (DEECA, 2023). Referred to as Shoreline Types in the Western Port Local Coastal Hazard Assessment (Water Technology, 2014).
Shore Zone	Also termed the intertidal zone. Area between the lowest low-water level and the landward limit of swash during storms. On intertidal areas of unconsolidated sediment (boulders, gravel, sand, mud), the shore zone is also referred to as the beachface where sediment moves cross-shore and along-shore in response to wave-induced currents in the swash and backwash. A sub-unit of the shore zone is the supratidal zone—an area landward of direct swash that is impacted by wave splash and occasionally washed by a storm surge. The supratidal zone is the seaward limit of the backshore and overlaps the shore zone. On rocky shores the shore zone is a shore platform.
Spring Tides	Tides with the greatest range in a monthly cycle, which occur when the sun, moon and earth are in alignment (the gravitational effects of the moon and sun act in concert on the ocean).
Storm Surge	The increase in coastal water levels caused by the barometric and wind set-up effects of storms. Barometric set-up refers to the increase in coastal water levels associated with the lower atmospheric pressures' characteristic of storms. Wind set-up refers to the increase in coastal water levels caused by an onshore wind driving water shorewards and piling it up against the coast.
Swash limit (wave runup)	This is the oscillating line marking the limit to which water from a breaking wave extending landward. It defines the wet-dry beach margin and is best recorded by video photography from aerial or fixed ground cameras. Swash is driven by wave height, wavelength, and beach slope while the runup distance is determined largely by beach grain size, wave turbulence, swash-backwash interaction, and infiltration.1
Storm tide	Coastal water level produced by the combination of astronomical and meteorological (storm surge) ocean water level forcing
Susceptibility	See Vulnerability

[1] Erikson, et al., (2007) Swash zone characteristics, California, Coastal engineering 2006: proceedings of the 30th international conference: San Diego, California, USA, 3-8 September 2006.

Tidal Planes	A series of water levels that define standard tides, e.g. 'Mean High Water Spring' (MHWS) refers to the average high water level of Spring Tides.
Tidal Prism	The volume of water moving into and out of an estuary or coastal waterway during the tidal cycle.
Tidal Range	The difference between successive high water and low water levels. Tidal range is maximum during Spring Tides and minimum during Neap Tides.
Tidal Waterways	The lower portions of coastal rivers, creeks, lakes, harbours, and ICEs affected by tidal fluctuations.
Topography	A surface which defines the ground level of a chosen area.
Vulnerability	In the coastal context, the susceptibility of people and places along the coast to adverse impacts from coastal hazards. Includes the degree of exposure, and ability to cope with, respond to and adapt to coastal hazards (DEECA, 2023)
Wave Setup	The increase in mean water level due to the presence of waves
Wave runup	See Swash limit above.
Wind Setup	The vertical rise of the water surface above the still water level caused by wind stresses on the water surface.
Wind Shear	The stress exerted on the water's surface by wind blowing over the water. Wind shear causes the water to pile up against downwind shores and generates secondary currents.

Abbreviations

ABSLMP	Australian Baseline Sea Level Monitoring Project
AGS	Australian Geomechanics Society
ARR	Australian Rainfall and Runoff
DELWP	Department of Environment Land Water and Planning
DEECA	Department of Energy Environment and Climate Action
DSE	Victorian Department of Sustainability and Environment
SLR	Sea level rise
VCMP	Victorian Coastal Monitoring Program
WPLCHA	Western Port Local Coastal Hazard Assessment

CONTENTS

1. Introduction

The aim of this guideline is to provide an overview and clarity relating to the purpose, methodology and outcomes of Coastal Hazard Vulnerability and Risk Assessments (CHVRAs).

1.1. About Coastal Hazards

Natural processes such as erosion and inundation continually shape our diverse and dynamic coastline. When these processes may have a negative impact on environmental, cultural, social, and economic values along the coast, we refer to them as coastal hazards. Definitions of coastal erosion, inundation and other coastal hazards vary nationally and for different Victorian locations and types of shorelines.

The coastal hazards being considered within this Guide are:

- Erosion hazards for:
  - Hard rock cliffs with and without a beach,
  - Soft rock cliffs with and without a beach,
  - Low earth scarp, and
  - Sandy shorelines.
- Inundation hazards for:
  - Storm tide inundation, and
  - Permanent inundation.

These coastal hazards and their definitions are consistent with the *Victoria's Resilient Coast* - Coastal Hazards Extended Guideline (DEECA, 2023) which builds upon earlier Victorian guidelines (DELWP, 2012), and align with the work undertaken as part of the Western Port Local Coastal Hazard Assessment (Water Technology, 2014). For flood risks, the approach outlined is consistent with the Guidelines for Development in Flood Affected Areas (DELWP, 2019). Additional consideration is also given to factors such as acid sulphate soils which contribute to risks associated with these hazards and must be considered under Clause 12.02-1S of the Mornington Peninsula Planning Scheme, as well as links to detailed geotechnical assessment requirements where landslide risks are identified.

1.2. What is a Coastal Hazard Vulnerability & Risk Assessment?

A Coastal Hazard Vulnerability and Risk Assessment (CHVRA) is the approach for assessing the exposure of a location or property to coastal hazards, the associated likelihood and consequences of exposure, and the risks to life and property. The level of detail within a CHVRA will depend on the scale of the assessment, shoreline class, specific place-based needs, and complexity of the potential risks. The purpose of this guide is to set out the requirements of any CHVRA prepared as part of a development application to the Mornington Peninsula Shire Council, and it is based on the specific needs of Council.

A Coastal Hazard Vulnerability & Risk Assessment (CHVRA) must be prepared by a suitably qualified coastal engineer or coastal processes specialist, with inputs from other specialists such as geotechnical and flood engineers where relevant, using a risk management framework.

The CHVRA must:

- Consider the requirements of the Marine and Coastal Act (2018), the Marine and Coastal Policy (2020), and Victoria's Resilient Coast - Adapting for 2100+ framework, guidelines and support documents.

- Consider factors including sea level rise and its associated natural hazards as set out in the Marine and Coastal Policy March 2020 and Clause 13.01-2S (Coastal inundation and erosion).
- Maintain the health and function of ecosystems and habitats as set out in the Marine and Coastal Policy March 2020 by avoiding disturbance of acid sulfate soils under Clause 12.02-1S (Protection of the marine and coastal environment).
- Consider the implications of coastal processes on the development.
- Consider the implications of the development on existing development and coastal processes and/or inundation.
- Apply the precautionary principle and use best available data in its approach.
- Be consistent with the risk management framework set out in AS 5334-2013: Climate Change Adaptation for Settlements and Infrastructure
- Assess the risk of coastal hazards to the state Sea Level Rise benchmark (+0.8m for 2100).
- Consider the requirements of the DELWP (2019) *Guidelines for Development in Flood Affected Areas.*

Guidance material may change over time, and the most recent and relevant data, information and guidance should be used when undertaking a CHVRA.

Where the CHVRA will be assessing coastal inundation, the application will be referred to Melbourne Water, and there may be additional requirements from them. Advice from Melbourne Water on their requirements including flood levels and finished floor levels should be sought prior to undertaking the work. Melbourne Water's *Interim Development Assessment Principles* provides guidance on their assessment approach for properties affected by coastal inundation.

There are two levels of CHVRA reports, a basic CHVRA and a detailed CHVRA. The requirements for each are described in detail in this document. Where the outcome of a basic CHVRA is that the proposed development is classed as medium risk or higher to life or property then a detailed CHVRA is required, which must:

- Include a peer review prepared by a suitably qualified coastal engineer or coastal processes specialist, as selected in agreement with the Mornington Peninsula Shire Council, and at the applicant's expense.
- Address the outcomes of the peer review.

The overall CHVRA process is summarised in
Figure 1.

Without adequate justification (e.g., type of structure proposed), Council is unlikely to support any argument that a CHVRA is not required due to the predicted lifespan of any proposed buildings and works. Life cycle planning approaches must be consistent with the Victorian Marine and Coastal Policy (DELWP, 2020, p.54, Section 11.3).

Consistent with the Victorian Marine and Coastal Policy (DELWP, 2020, p.39, Section 6.18) Council is also unlikely to support an application that relies on protective works and structures (e.g., seawalls) on marine and coastal Crown land as State Government and Crown land managers do not have an obligation to manage marine and coastal Crown land or coastal processes for the primary purpose of protecting private property. This includes provision of structures or works.

Where the CHVRA identifies risk due to coastal hazards, the proponent may propose mitigation measures in accordance with the hierarchy of adaption actions outlined in the Victorian Marine and Coastal Policy (DELWP, 2020) and described in the Victoria's Resilient Coast Guidelines (DEECA, 2023). Any mitigation measures must consider the ability to cope with, respond to and adapt to coastal hazards and help inform a risk-based adaptation management response.

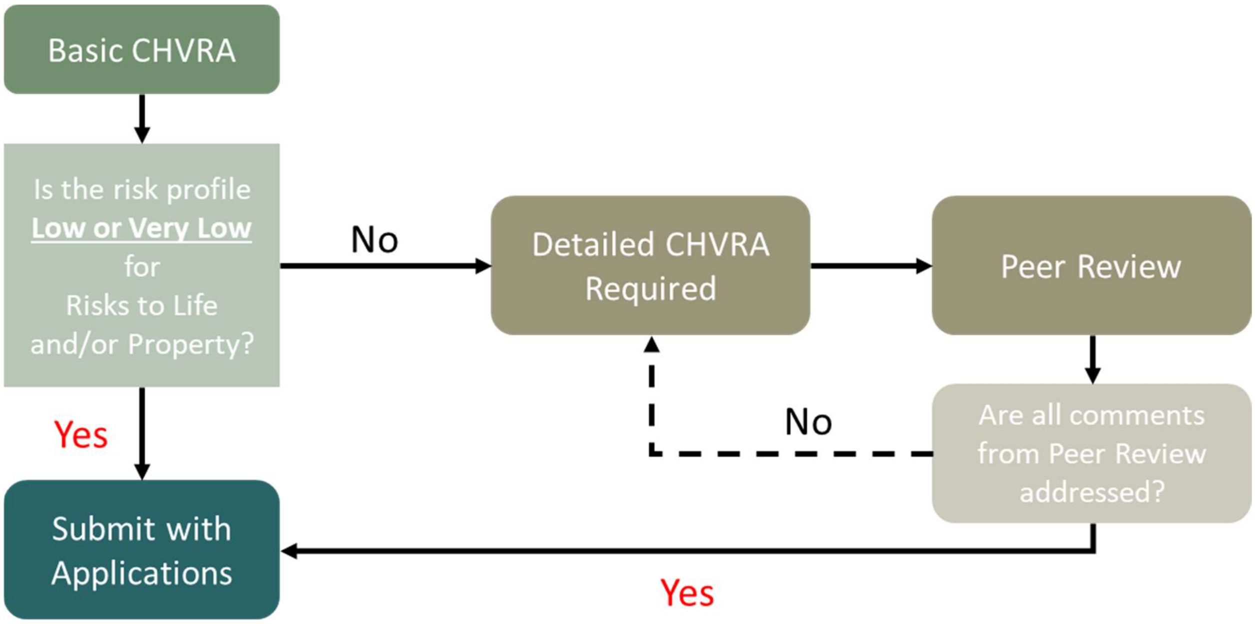

Figure 1 Outline of the CHVRA process

This guidance document focusses on the requirement of CHVRAs within Land Subject to Inundation Overlays (LSIO) and Erosion Management Overlays (EMOs) in the Western Port region. However, if required to prepare a CHVRA as part of a use and/or development planning application, where the subject site/s is not covered by an EMO or LSIO, this guidance document should still be used as a reference.

1.3. What should be covered by a CHVRA?

Mornington Peninsula Shire Council through Amendment C271morn has introduced the requirement for a CHVRA to be provided for planning permit applications for all developments where a property is within the LSIO2-4 and/or EMO6 overlays. Development and works on marine and coastal Crown land will require consent under the Marine and Coastal Act 2018 and where they also need a planning permit the CHVRA requirement will apply. A CHVRA include coastal erosion and inundation assessment. The assessment must address the objectives of the relevant overlay(s) and is prepared at the cost of the applicant.

The Erosion Management Overlay EMO6 requires consideration of potential future coastal erosion and the consequence of that for development. The objectives of EMO6 are:

- To ensure that development can be carried out in a manner which will not adversely increase the landslip risk to life or property affecting the subject land or adjoining or nearby land.
- To respond appropriately to the threats of coastal hazards including erosion and landslip and identify at risk areas and plan for sea-level rise of not less than 0.8 metres by 2100.
- To ensure future development is designed and located in response to threats from coastal hazards.

The Land Subject to Inundation Overlay LSIO2-4 requires consideration of potential future coastal inundation and the consequence of that for development. The objectives of LSIO2-4 are:

- To protect land vulnerable to coastal inundation from inappropriate development.
- To identify at risk areas and plan for sea-level rise of not less than 0.8 metres by 2100.
- To plan for projected sea level rises to ensure that the community and assets are not exposed to an unacceptable level of risk associated with the coastal impacts of climate change.
- To ensure new development is designed to respond appropriately to the identified flood hazard.

Section 5 of this Guide sets out the application requirements for a CHVRA considering all the objectives above. There are two levels of erosion focussed CHVRA; a basic assessment, and a detailed assessment which are described further in Table 1. Where the location being assessed is within an LSIO, all basic and detailed assessments should also meet any other specific flood related information and reporting requirements as defined by Melbourne Water.

Table 1 Description of the levels CHVRAs and their general requirements

Level of CHVRA	General Description (see Section 4 and 5 for details)	When is this level of assessment required?
Basic	Assemble relevant data (see Section 4). Desktop review and evaluation of coastal erosion & inundation hazards relevant to the specific shoreline class based on the WPLCHA output or more recent detailed coastal hazard investigations or mapping if available (see Section 5). For instance, Melbourne Water has revised flood levels for Western Port since the WPLCHA was completed and the revised levels are available via flood information requests. For areas outside Western Port including Port Phillip Bay, the best available coastal hazard mapping should be applied, and flood levels requested from Melbourne Water where appropriate. Risk assessment and evaluations including identification of risk treatment requirements and risk re-evaluation (Section 5). If the outcome of the assessment indicates a low level of risk to life or property, then a detailed CHVRA is not required. If the outcome of the assessment indicates a medium or above level of risk to life or property and proposed risk treatments cannot reduce this risk to an acceptable level a detailed CHVRA will be required to support any development application.	Applicable to all applications.
Detailed	Same approach as for a basic assessment, plus: Refinement of the coastal hazard exposure estimates based on detailed modelling and analysis applying best practice methods of assessment for the local geomorphology, coastal processes, and oceanographic conditions. All detailed analysis should follow the requirements of the *Victoria's Resilient Coast - Coastal Hazards Extended Guideline*. The flood levels and floor level requirements as set by of Melbourne Water should also be confirmed. Where risk due to landslides is identified as medium or above the specific hazard analysis and risk assessment approach as outlined in the *Guideline for landslide susceptibility, hazard and risk zoning for land use planning* (AGS (2007a)) is required.	Where the risk to life or property is medium or above and cannot be reduced through risk treatments.

1.3.1. Melbourne Water Referrals

Melbourne Water is the Referral Authority for flooding, as identified through LSIO2-4 and applications referred to Melbourne Water must meet Melbourne Waters assessment criteria related to floor levels and safety.

1.4. Who Should Prepare a CHVRA?

The CHVRA must be prepared by a specialist with the relevant expertise, such as:

- A suitably qualified coastal specialist, which is a person with:
  - A relevant qualification in coastal engineering, coastal sciences, geomorphology, and significant relevant professional experience (10 years or more); or
  - A relevant engineering qualification (that is civil, environmental, geotechnical engineering) and significant relevant professional experience (10 years or more).

Additional skills may be required such as flood engineering, ecology, or soil science, however their work must be overseen by the coastal specialist.

If the CHVRA identifies erosion risk to people or property because of landslides caused by coastal processes where the risk is medium or above, then a geotechnical hazard and risk assessment report by a suitably qualified geotechnical engineer or engineering geologist with experience in landslide risk assessment is required. This is discussed further in Section 5.

Where risk treatments (often termed "mitigation measures") are proposed that require the physical construction of works, then the assessment, design, and approval of the works would need to be obtained from the relevant qualified professional e.g., a qualified geotechnical engineer for the assessment and design of slope stabilisation works.

1.5. Submission and Approvals

Submission of a CHVRA does not constitute approval of the application because the findings of a CVHRA may warrant substantial changes to a use and/or development, a substantial engineering solution that cannot meet other requirements applicable to the subject site and as identified within the Mornington Peninsula Planning Scheme, or the assessment may find that the proposed use and/or development is not safe to proceed altogether.

Melbourne Water is the determining authority for the LSIO and therefore any application for a property affected by the LSIO will be referred to Melbourne Water for assessment and decision.

2. Geomorphic Setting & Coastal Processes

2.1. Geomorphic Setting

The geomorphic setting relates to the type of shoreline being assessed and includes consideration of the relevant geomorphic processes and shoreline classes. A detailed description of these aspects was completed for all Western Port Bay in the Western Port Local Coastal Hazard Assessment (WPLCHA) by Water Technology in 2014. The recent Victoria's Resilient Coast Coastal Hazards Extended Guideline (Water Technology, 2022) has built upon the 2014 study and adopted many of the same geomorphic terms, however there are slight differences in terminology between the two documents which are summarised in Table 2.

Table 2 Comparison between geomorphic terminology in the WPLCHA and the Coastal Hazard Extended Guideline

Western Ports Local Coastal Hazard Assessment	Coastal Hazards Extended Guideline
Geomorphic sub-cell	Shoreline class
Coastal wetland fringed shorelines	Estuarine environmental/coastal floodplains
Low earth cliff shorelines	Low earth scarp
Hard rock cliff and shore platform	Hard/soft rock cliffs with platform and / or beach
Platform beach and bluff	Hard / soft rock cliffs with platform and / or beach
Sandy spit shorelines	Sandy shorelines
Estuarine and tidal channels	Estuarine environments / coastal floodplains
Not assessed	Engineered shoreline

Information on the geomorphic setting needs to be included within a CHVRA to provide context for the assessment and ensure that the assessment methods applied in determining hazard exposure and risk are the most appropriate for the specific geomorphic setting and shoreline Information from the WPLCHA is suitable for use in the CHVRA, however if high resolution local (site specific) data is available this can be utilised. Where to find such information is discussed in Section 4 and a detailed description of the different shoreline classes is provided in the Coastal Hazards Extended Guideline.

For locations outside of Western Port, the appropriate shoreline class as defined by the Coastal Hazards Extended Guideline should be defined.

If risk treatments are proposed, they must be suitable for the relevant shoreline class at the site and be designed or assessed using the applicable standards or codes.

2.2. Physical Coastal Processes

Physical coastal processes are the mechanisms driving change along the coastline, and include climate variable, winds, wave, currents, and tides. It is important to understand the interactions and cyclical nature of these physical processes. A detailed description of these processes is included in the WPLCHA reporting, including discussion of:

- Climate variables (wind, rainfall)
- Ocean systems (bathymetry, wave and currents, sediment transport)
- Water levels (tide, storm tides, sea-level rise)

A description of these processes is included in the Coastal Hazards Extended Guideline (Water Technology, 2022). The information on physical coastal processes from the WPLCHA is suitable for use in the CHVRA, however if high resolution local (site specific) data is available this can be utilised, particularly where new modelling is being undertaken. Where to find such information is discussed in Section 4 and a detailed description of the different shoreline classes is provided in the Coastal Hazards Extended Guideline.

For locations outside of Western Port the relevant coastal process information should be sourced by the coastal specialist.

3. Coastal Hazard Definitions

As mentioned in Section 1.1, the coastal hazards being considered within this Guide are:

- Erosion hazards:
    - Hard rock cliffs with and without a beach,
    - Soft rock cliffs with and without a beach,
    - Low earth scarp, and
    - Sandy shorelines.
- Inundation hazards:
    - Storm tide inundation, and
    - Permanent inundation.

Each hazard is defined further in the following sections. For locations outside of Western Port checks should be undertaken as to whether other coastal hazards as defined by Victoria's Resilient Coast Adapting to 2100+ framework are applicable and need to be assessed.

3.1. Erosion Hazards

Erosion is the loss of sediment from the shoreline because of terrestrial and coastal processes. The most relevant processes to be considered will be defined by the geomorphic setting and shoreline class for a given location. The following definitions are adopted from the Coastal Hazards Extended Guideline:

- **Short-term erosion (storm bite)** is erosion that occurs on a short-term basis, often during a storm. The shoreline and beach then gradually regain sediment (rebuilds). This category of erosion is relevant to **Sandy** shorelines.

- **Long-term erosion (recession or retreat)** is a continuing movement of the shoreline position in a landward direction, occurring either gradually over many years, or when the shoreline does not recover following a short-term erosion event. This category of erosion is relevant to **Sandy, Low-earth Scarp, Soft and Hard Rock** shoreline classes.

Long-term recession at a rate over and above that which is naturally occurring for some shoreline classes (Sandy, Low-earth Scarp and Soft Rock) is the predicted outcome of sea level rise. This additional category of recession must be incorporated into the CHVRA.

The coastal erosion processes and mechanisms are described further in the Coastal Hazards Extended Guideline. Estimates of the different categories of erosion for the different shoreline classes have been provided as outputs from the WPLCHA and is suitable for use in a basic CHVRA.

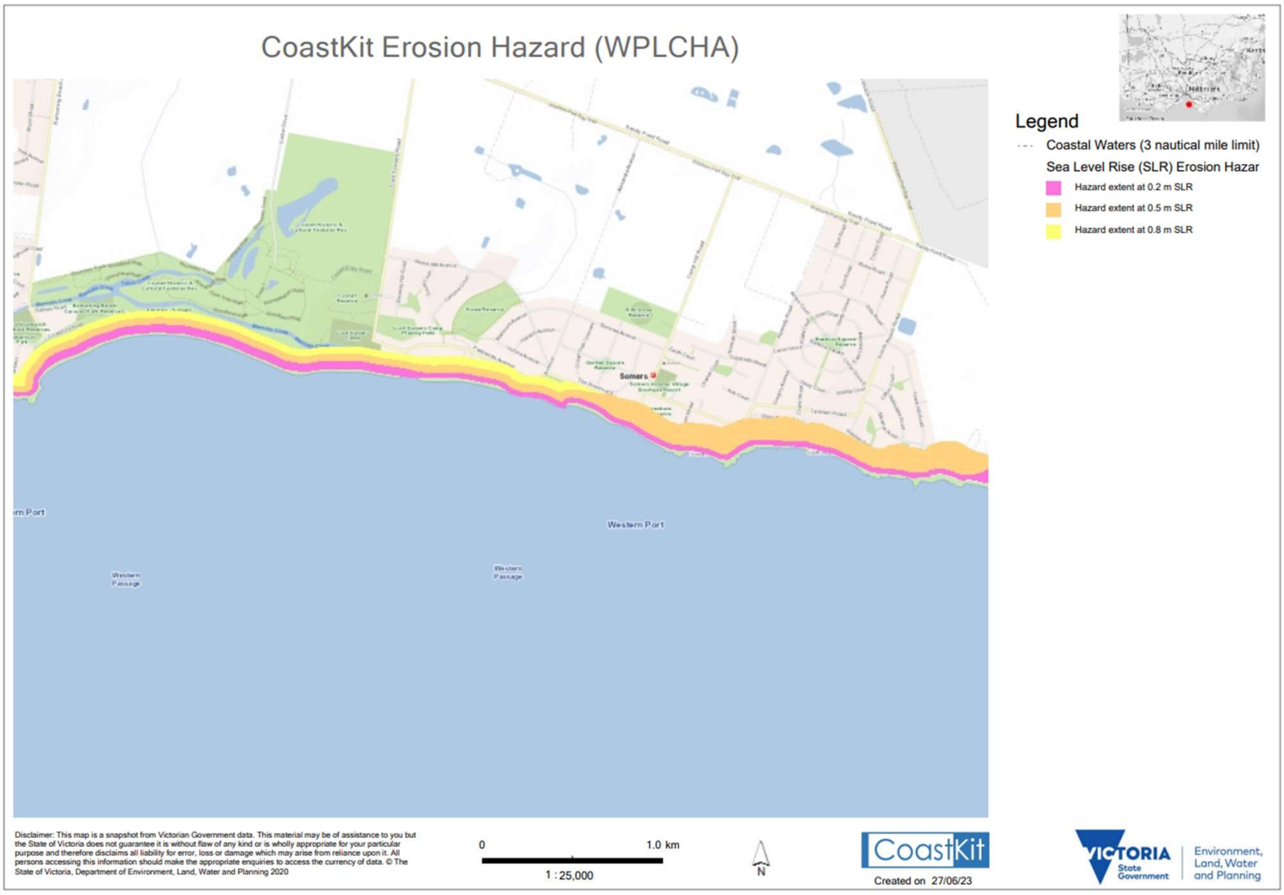

Figure 2 Shoreline erosion estimates based on shoreline classes from the WPLCHA (accessed via CoastKit https://mapshare.vic.gov.au/coastkit/)

If high resolution local (site specific) data is available this can be utilised, and the erosion hazard recalculated. Where to find such information is discussed in Section 4 and a detailed description of the different shoreline classes is provided in the Coastal Hazards Extended Guideline.

Both short-term and long-term coastal erosion processes can potentially trigger or reactivate slope failure processes (e.g., landslides). For soft or hard rock shorelines where the risk rating to people or property is medium or above, a landslide hazard and risk assessment based on AGS (2007a) is required.

3.2. Inundation Hazards

Coastal inundation hazards are typically related to the temporary direct inundation of low-lying land because of overtopping or breaching of dunes, coastal barriers, beach access points or protection works; and/or because of elevated water levels in adjacent waterways from catchment or coastal processes.

- **Storm-tide inundation** is caused by a combination of tides, storm-surges, and high wave action during severe weather events, Figure 3.

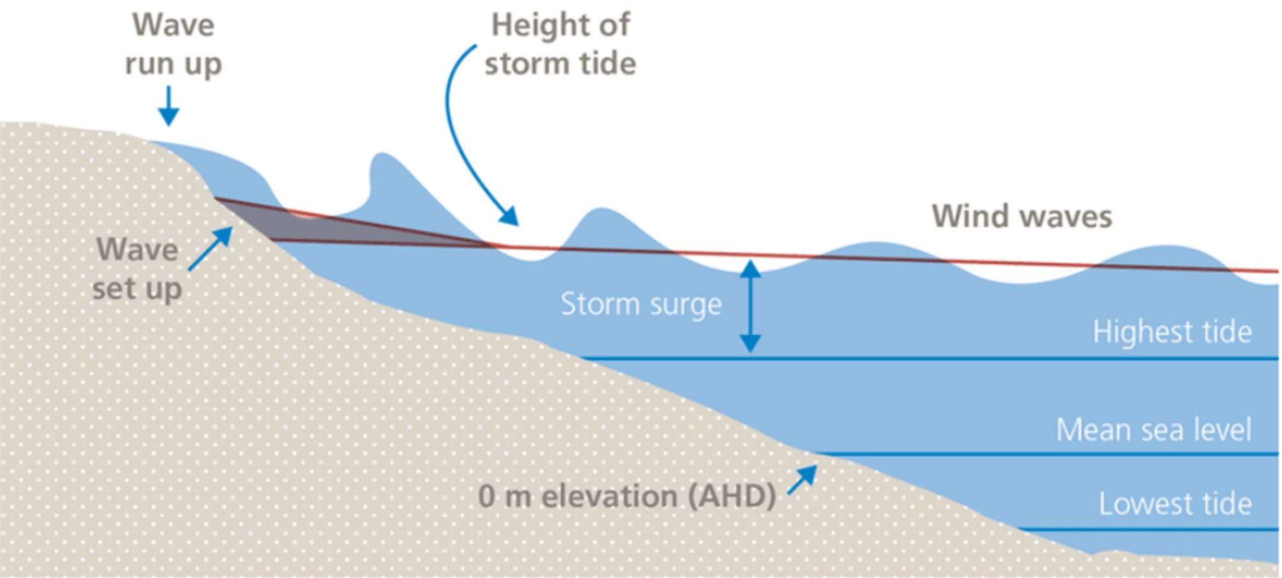

Figure 3 Components of a storm tide event (Source: DELWP)

- **Permanent inundation** occurs when low-lying areas are regularly flooded due to the tide. Although not typically a significant issue under current sea level conditions, this type of inundation is likely to having increasing level of impact with sea level rise.

The inundation processes and mechanisms are described further in the Coastal Hazards Extended Guideline. Estimates of coastal inundation have been provided as outputs from the WPLCHA and is suitable for use in a basic CHVRA.

Maps of the peak flood depths and velocities for a property and the access routes should be provided where possible. If the property is fronting the coast or could be affected by wave run-up then estimates of wave run-up should be provided and included in the mapping of flood depths.

The assessment of inundation hazards for a basic assessment must include storm tide inundation, while a detailed assessment should consider both storm tide and permanent inundation.

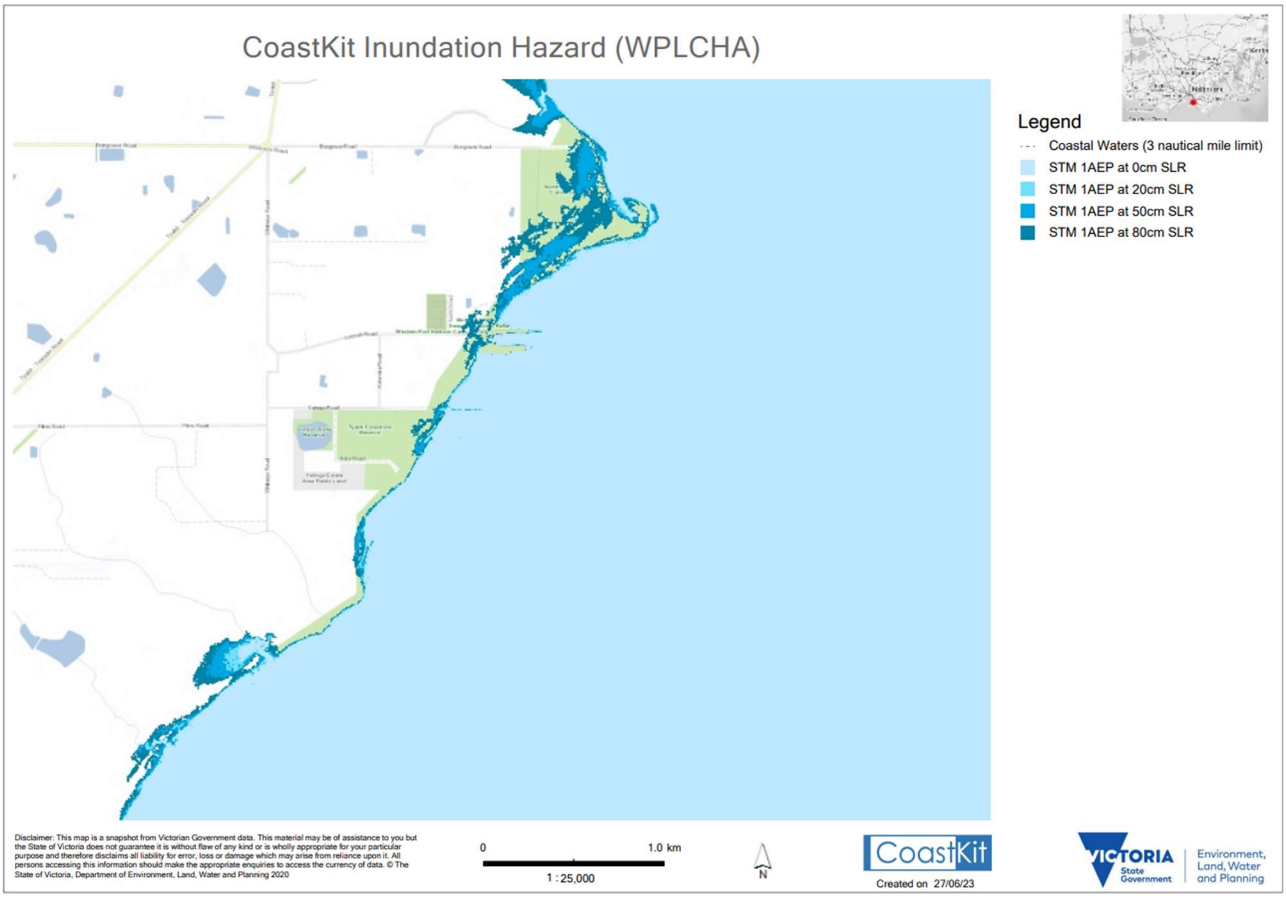

Figure 4 Inundation estimates from the WPLCHA (accessed via CoastKit https://mapshare.vic.gov.au/coastkit/)

3.3. Planning Horizons and Sea Level Rise Scenarios

In line with Victoria's Resilient Coast – Adapting for +2100 guidelines (DEECA, 2023), the best practice approach for CHVRAs is to consider the following planning horizons and sea level rise increments.

Table 3 Recommended planning horizons and sea level rise increments for CHVRAs (from DEECA, 2023)

Period	Time step	Indicative horizon	Sea level rise increment
Baseline	Baseline of historic and current data	Present day	Mean sea level (MSL)
Short term	10 to 25 years	2040	MSL +0.2 m
Medium term	25 to 50 years	2070	MSL +0.5 m
Long Term	50 to 100 years	2100	No less than MSL +0.8 m

Sea level rise increments for consideration within a CHVRA are based on the Marine and Coastal Policy 2020 and future updates to sea level rise benchmarks should be considered when undertaking the assessment.

All applications will be assessed against the state sea level rise benchmark, which is currently +0.8 m for 2100. For flooding, Melbourne Water typically requires that the minimum floor levels are set at 600 mm above the 1% AEP flood event including +0.8m sea level rise by 2100. The tolerability of flooding and any flood risk treatments will only be assessed using the long term (2100) planning horizon.

4. Coastal Hazard Information & Data

4.1. General

All CHVRA's need to consider the following documents:

- Marine and Coastal Act 2018
- Marine and Coastal Policy (DELWP, 2020)
- Marine and Coastal Strategy (DELWP, 2022)
- Victoria's Resilient Coast – Adapting for 2100+ guidelines and supporting documents
- Guidelines for Development in Flood Areas (DELWP, 2019)
- Victorian Floodplain Management Strategy (2016)
- Planning Practice Note 53 (2023) Managing Coastal Hazards and the Coastal Impacts of Climate Change
- Melbourne Water (2023) Sea level Rise Guidelines – Interim Development Assessment Principles
- Mornington Peninsula Planning Strategy and Planning Policy Framework with specific reference to Clause 13.01-1S and 13.01-2S
- Siting and Design Guidelines for Structures on the Victorian Coast (DEWLP, 2020)
- AS 5334-2013: Climate Change Adaptation for Settlements and Infrastructure
- Western Port Local Coastal Hazard Assessment (Water Technology, 2014)
- Mapping outputs from the Western Port Local Coastal Hazard Assessment and subsequent inundation modelling by Melbourne Water)

These documents and guidance material may change over time, and the most recent and relevant information should be used when undertaking a CHVRA.

DEECA has prepared guidelines to support planning and management of Victoria's marine and coastal environment which can be accessed here: Guidelines (marineandcoasts.vic.gov.au)

The updated Coastal Hazards Extended Guideline (Water Technology, 2022) contains a high-level guide specifically on coastal hazard data and information, including example sources, organisations, databases, and libraries that hold the relevant data. A brief overview of those data sources and information on how to access them is provided in the following sections.

4.2. Coastal Hazard Data

4.2.1. Western Port Local Coastal Hazard Assessment

The main resources for coastal hazard information in Western Port are the Western Port Local Coastal Hazard Assessment (Water Technology, 2014) (WPLCHA) and the subsequent Melbourne Water Planning for Sea Level Rise Guidelines.

The data layers (erosion and inundation hazard extents plus the shoreline classification) can be accessed via CoastKit. CoastKit is the central repository of Victorian marine and coastal scientific projects and datasets and can be accessed at CoastKit Victoria (mapshare.vic.gov.au). The CoastKit database includes information on shoreline geology, and the erosion and inundation hazard layers from the WPLCHA and the inundation layer from the Melbourne Water guidelines. The database also provides access to the coastal acid sulphate dataset, and other relevant information such as wave height and direction, sediment data, information on coastal protection assets and infrastructure.

The inundation datasets can be downloaded from the Victorian Datashare portal: Datashare - A search and discovery tool that enables assessment of DELWP's Spatial Data resources. (maps.vic.gov.au).

For the Western Port region, the LSIO2-4 layer was derived from the Melbourne Water Planning for Sea Level Rise Guidelines inundation layer (which was based on the WPLCHA inundation layers), while the EMO6 layer was derived from the WPLCHA erosion layers. However, when assessing coastal inundation advice must be sought from Melbourne Water on the most up to date flood levels prior to commencing the work.

4.2.2. Topography and Bathymetry

Topographic and bathymetric data are required to characterise the site and assist with interpretation of coastal processes. State-wide high resolution topographic and bathymetric data is available from DEECA, collected regularly as part of the Co-ordinated Imagery Program (CIP).

Localised and more recent topographic survey data may be available from the Victorian Coastal Monitoring Program (VCMP) Citizen Science Drone Program. The VCMP program captures drone-based photogrammetry (not LiDAR) of beaches across Victoria and the accuracy and quality should be checked for each project.

Link to the VCMP: Victorian Coastal Monitoring Program (marineandcoasts.vic.gov.au)

Localised bathymetric survey may be available from Port Authorities or research agencies and a bathymetric dataset for the Victorian coast including the areas of Bass Strait and Western Port Bay within the Mornington Peninsula Shire is available via the Datashare portal.

For the CHVRA, survey of the property to confirm critical levels and features is recommended for a detailed assessment, however the scope of any survey requirements should be discussed with the consultant undertaking the project.

For flood assessments (i.e., coastal inundation) there are specific requirements for survey and levels of the site, refer to Section 7 for details.

4.2.3. Geomorphic Setting

It is recommended that the geomorphic setting and characterisation of the shoreline from the WPLCHA be adopted for any CHVRA.

Local survey and analysis may be used to further refine the shoreline classes defined for a site if a detailed assessment is being completed.

4.2.4. Oceanographic Data

In general, Victoria's coastal region is influenced by wind and wave forces from the Southern Ocean, and the relatively shallow waters of Bass Strait which limits the degree and direction of waves and storms along the central coastline.

Requirements for oceanographic data will depend on whether any modelling is being undertaken to refine or extend the erosion and inundation extents from those presented in the WPLCHA. Source of data include:

- The Bureau of Meteorology (BOM) Australian Baseline Sea Level Monitoring Program (ABSLMP) and OceanMaps.
- CoastKit Wave Buoy and Statistics and http://www.vicwaves.com.au/
- The CSIRO CAWCR Wave Hindcast model can be accessed via the CSIRO Data Access Portal https://data.csiro.au/collection/csiro:39819

- VCMP longshore sediment transport modelling (contact: vcmp@delwp.vic.gov.au)

4.2.5. Other Data

Imagery

Imagery is used in the assessment of coastal change. Types of imagery that can be of use include:

- Satellite imagery (e.g., Digital Earth Australia Map (ga.gov.au))
- Aerial imagery (e.g., Google Earth, NearMap etc)
- Historic imagery (e.g., Aerial Photography (fsdf.org.au), Victorian State Library)

Sea Level Projections

Sea level projections are estimates of future sea levels based on modelling of a range of future climate change scenarios. Sea level projections are produced periodically by the Intergovernmental Panel on Climate Change (IPCC), which is the United Nations body for assessing the science related to climate change (https://www.ipcc.ch/). The IPCC has recently (August 2021) finalised the first part of the Sixth Assessment Report. This is called "Climate Change 2021: The Physical Science Basis, the Working Group I contribution to the Sixth Assessment Report".

The IPCC 6th Assessment Report Sea Level Projection Tool https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool provides rate of rise projections for Portland, Lorne, and Stony Point.

Any CHVRA should assess coastal erosion and/or inundation because of sea level rise, up to and including the current State Sea Level Rise Benchmark. The WPLCHA assessed erosion and inundation for the following sea level rise increments (assuming a 0 m AHD baseline): +0.2 m, +0.5 m, +0.8 m. Higher increments of sea level increments can be assessed by extrapolating the results of the previous assessment.

However, the acceptability of any approvals will be based on the +0.8 m sea level rise scenario only.

Coastal Acid Sulphate Soils

Coastal acid sulphate soils (CASS) occur naturally along many parts of Victoria's coastal zone and if disturbed can react with oxygen and produce sulfuric acid. This can adversely affect the environment with impacts such as acidification of water and soil, de-oxygenation of water, poor water quality, dissolution of soil, rock and concrete, and corrosion of metals. Further information can be found here: Coastal Acid Sulfate Soils | VRO | Agriculture Victoria

Mapping of coastal acid sulphate soils can be viewed on the Coastkit site and the State-wide Coastal Acid Sulphate Soils dataset can be downloaded from the Victorian Datashare portal: Datashare - A search and discovery tool that enables assessment of DELWP's Spatial Data resources. (maps.vic.gov.au).

4.3. Geotechnical Data

Where specialist geotechnical advice is required, additional geotechnical site investigations may be required. These requirements should be discussed with a qualified Geotechnical Engineer.

5. Risk-Based Coastal Hazard Assessment

5.1. What is a Risk-Based Assessment?

The risk management process described in AS/NZS ISO 31000:2018 Risk Management – Principles and Guidelines (previously AS/NZS 31000:2009) is one way of achieving a structured approach to the management of risk and is summarised in Figure 5. This is the approach outlined in AS/NZS 5334-2013 “Climate change adaptation for settlements and infrastructure - A risk-based approach”.

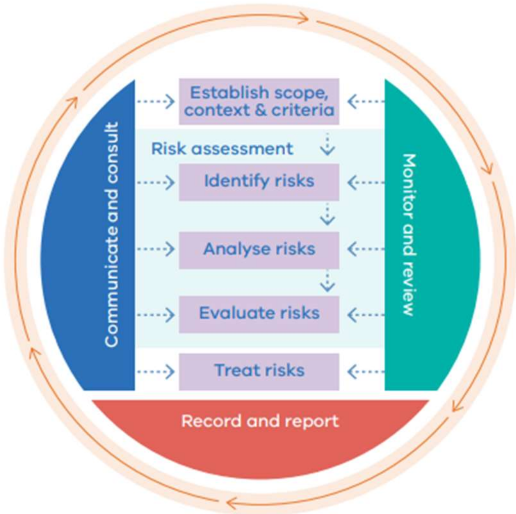

Figure 5 Risk Management Process (taken from DEECA (2023) and adapted from AS/NZS ISO 31000:2018)

In essence and in its simplest form, the risk process involves answering the following questions (adapted from AGS, 2007a):

- What might happen? (Assess exposure to coastal hazards).
- How likely is it? (Assess the probability of occurrence).
- What impact, damage or injury may result? (Assess the consequence of the hazard).
- How important is it? (Assess the significance of the impact in relation to the regulatory criteria and public opinion).
- What can be done about it? (Assess treatment options including management and mitigation options).

The following risk-based framework has been developed to undertake coastal hazard vulnerability and risk assessments.

5.2. The Coastal Risk Framework

Victoria's Resilient Coast - Adapting to 2100+ framework sets out the strategic approach to coastal hazard risk management and adaptation and builds upon the Marine and Coastal Policy (2020) and the earlier Victorian Coastal Hazard Guidelines (2012). Risk assessment was part of the previous Victorian Coastal Hazard Guidelines (DELWP, 2012). The risk framework for CHVRAs is outlined in Figure 6, and comprises the following main elements:

1. Identify the Hazard - starting with defining the geomorphic setting, the coastal drivers and processes of change and the specific requirements of the relevant Overlay (LSIO2-4 or EMO6). Then characterise the specific hazard being considered by the CHVRA - for example, what type of erosion hazard(s) are relevant to the location.
2. Evaluate Exposure to the Hazard - defining the spatial extent of the hazard. It also includes determining when such hazards might occur and/or provides an estimate of the annual probability (i.e., likelihood).
3. Consequence Analysis - determines the level impact of consequence from a hazard assuming it occurs. When undertaking a coastal hazard assessment this includes an estimation of exposure and sensitivity of an element at risk. When combined with adaptive capacity then is then termed vulnerability and is a measure of consequence in broader risk assessment terminology.
4. Risk Estimation - the combination of the likelihood of a particular hazard occurring and the consequence gives an estimate of risk for the asset or people being considered.
5. Risk Evaluation – is the process by which estimates of risk levels are compared against an organisation's criterion for risk acceptance. As such, risk may be deemed either acceptable, tolerable, or unacceptable.
6. Risk Mitigation and Control - is the process of managing the risk through treatment or mitigation actions to achieve one of the following options: avoid the risks, reduce the likelihood, reduce consequences, transfer the risk, or accept the risk. The Marine and Coastal Policy (2020) outlines the hierarchy of adaptation options to consider when looking to mitigate or control coastal risks.

As shown in Figure 6, risk is a measure of likelihood (sometimes termed "probability") and consequence (sometimes termed "severity") of an adverse effect to health, property or the environment and is estimated as the product of likelihood and consequences.

For the risk assessment process, the likelihood and consequence are combined to generate a risk classification. Likelihood examines the probability of an inundation or erosion event occurring, as well as its frequency. The consequence ranking constitutes the physical impact of the event to the asset together with its vulnerability and adaptive capacity. Vulnerability may be considered in terms of the type of person at risk from the hazard (e.g., children and the elderly are more vulnerable to flood waters than adults), or the assets (e.g., a small car or light building are more vulnerable to flood waters than a large office block, whether the building is in landslide extent or downslope). Both likelihood and consequence descriptions and how to select an appropriate rating are discussed further in the following sections.

Where an initial risk assessment for a site identifies coastal process triggered landslides as a medium or greater risk, the landslide risk must be further assessed in more detailed in accordance with the 'Practice Note Guidelines for Landslide Risk Management', Australian Geomechanics Journal, Vol. 42, No. 1 (B. Walker, W. Davies & G. Wilson, March 2007) quantitative risk assessment procedures for loss of life and either quantitative or qualitative for property loss. Note that the current guidance for landslide risk assessment does not explicitly account for changes in risk levels because of sea level rise and coastal processes. A collaborative approach between the coastal specialist and geotechnical engineer / engineering geologist is required in this instance.

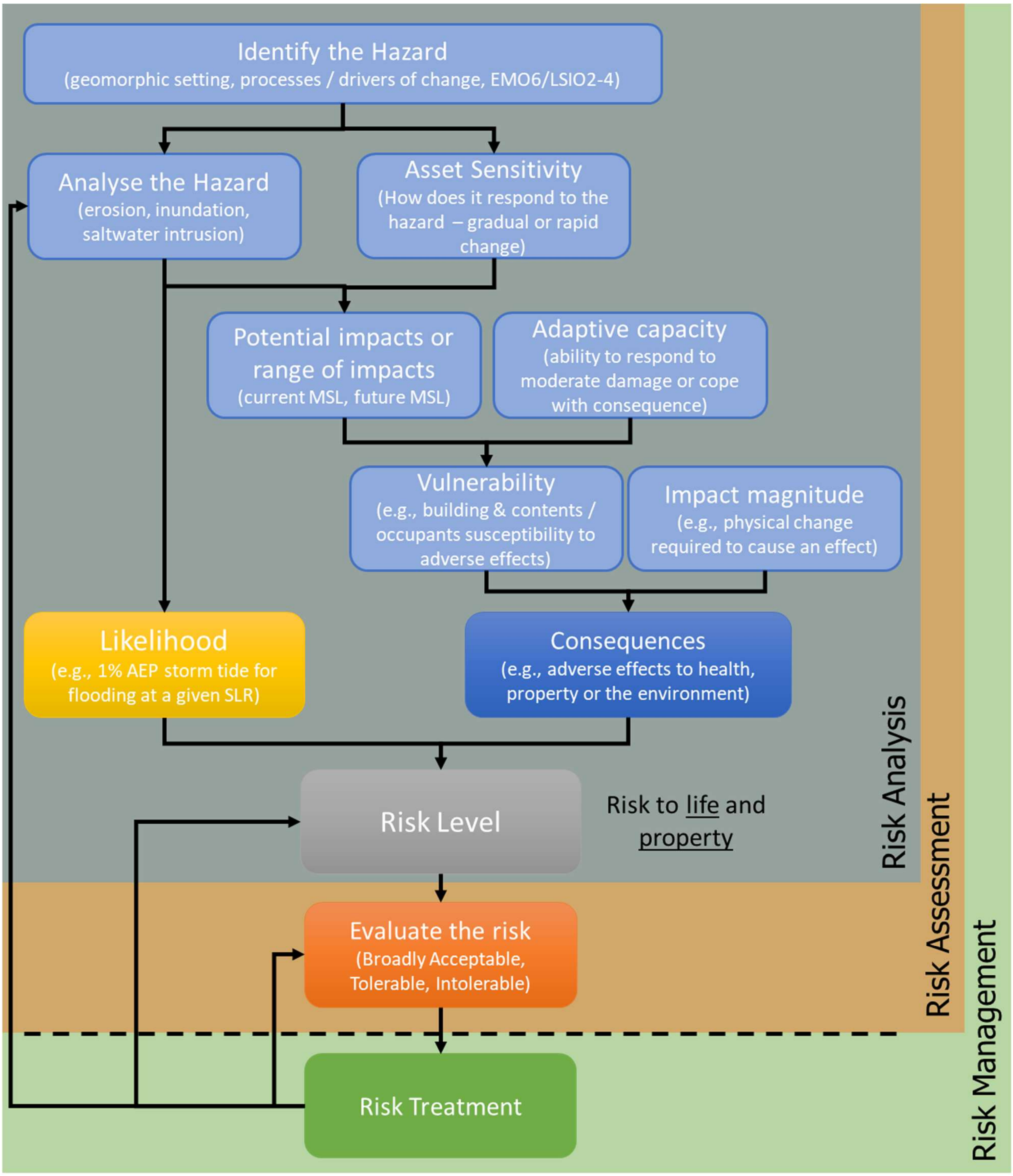

Figure 6. Overview of the risk assessment process for CHVRA

5.2.1. Likelihood Ratings

Likelihood can be defined in several ways for a coastal hazard risk assessment, with different interpretation depending on whether erosion or inundation is being considered. Here we provide recommendations for assigning a likelihood for coastal erosion and inundation hazard risk assessments to allow the CHVRA to accommodate the different drivers for these types of hazards. The likelihood rating description from AS5334-2013 is presented in Table 4 along with the recommended event likelihoods from DEECA (2023) which are broadly relevant to both hazards.

Table 4 Likelihood Rating adapted from AS5334-2013

Likelihood Rating	Descriptor	Recurrent or event risks	Long-term risks	DEECA(2023) Hazard AEP/event
Almost certain	Could occur several times per year	Has happened several times in the past year and in each of the previous 5 years *or* could occur several times a year	Has a greater than 90% chance of occurring in the identified time period of the risk is not mitigated	MHWS or HAT
Likely	May arise about once per year	Has happened at least once in the past year and in each of the previous 5 years *or* may arise about once a year	Has a 60-90% chance of occurring in the identified time period if the risk is not mitigated	10% AEP storm tide
Possible	Maybe a couple of times in a generation	Has happened during the past 5 years but not in every year *or* may arise once in 25 years	Has a 40-60% chance of occurring in the identified time period if the risk is not mitigated	1% AEP storm tide
Unlikely	Maybe once in a generation	May have occurred once in the last 5 years *or* may arise once in 25 to 50 years	Has a 10-30% chance of occurring in the future if the risk is not mitigated	0.5% AEP storm tide
Rare	Maybe once in a lifetime	Has not occurred in the past 5 years *or* unlikely to occur during the next 50 years.	May occur in exceptional circumstances, i.e., less than 10% chance of occurring in the identified time period if the risk is not mitigated	0.2% AEP storm tide

Erosion

Coastal erosion is the result of a combination of erosion hazards, some based on a storm event, while others relate to longer term trends in sediment movement. The likelihood of an erosion hazard occurring is therefore the probability that by a certain time when X m of sea level rise has occurred, that the erosion hazard may have reached a specific extent.

The current mean sea level erosion hazard is based on the 1% AEP storm tide, and so the likelihood of the erosion hazard occurring is the same as the event, which is defined as Possible (see Table 4). Erosion because of long term (existing) trends is defined as Likely under current and future sea level conditions assuming that current sediment transport regimes and coastal processes are maintained. Erosion because of sea level rise is more uncertain and our understanding of how different shoreline classes respond to this continues and will continue to improve over time.

Within the WPLCHA an evaluation of the shoreline trajectories and uncertainty in predictions of future change was included (refer to the Erosion Hazard Report, R05) and provides a qualitative basis for defining the combined likelihood of erosion for different shoreline classes, Table 5.

Table 5 Qualitative likelihood of coastal erosion within the erosion hazard zones based on shoreline classes

Western Port Local Coastal Hazard Assessment Terminology	Coastal Hazards Extended Guidelines Terminology	Likelihood of Predicted Erosion Occurring
Coastal wetland fringed shorelines	Estuarine environmental / coastal floodplains	Likely
Low earth cliff shorelines	Low earth scarp	Likely
Hard rock cliff and shore platform	Hard / soft rock cliffs with platform and / or beach	Possible
Platform beach and bluff	Hard / soft rock cliffs with platform and / or beach	Possible
Sandy spit shorelines	Sandy shorelines	Possible
Estuarine and tidal channels	Estuarine environments / coastal floodplains	Possible

The likelihood ratings in

Table 5 can be adopted for the relevant shoreline class in a CHVRA. For Western Port, erosion hazard extents have been predicted for current sea level, +0.2 m, +0.5 m, and +0.8 m of sea level rise. The erosion hazard assuming +0.8 m sea level rise must be assessed. The lower sea level rise thresholds can be assessed to understand the change in risk over time, but any planning decisions will be based on the +0.8 m sea level rise assessment.

Probabilistic assessment of erosion hazards provides a quantitative measure of the likelihood of the predicted erosion occurring over the time being considered. If this information is available, it can be used to update the likelihood ratings indicated in

Table 5.

Inundation

The likelihood of inundation occurring is conceptually simpler. Where a 1% AEP storm tide is used to define a hazard (e.g., short-term inundation), this is taken as the event likelihood under any sea level rise scenario. For example, the frequency of a 1% storm tide is the same under current MSL as it is with +0.8 sea level rise, however the magnitude of what constitutes a 1% storm tide will be different (e.g., the 1% AEP storm tide for the south of Western Port currently is 2.1 m, and with +0.8m MSL it will be 2.9 m). A 1% AEP storm tide event is considered to have a Possible likelihood rating. If a 10% AEP storm tide is being assessed, a Likely rating should be adopted. When reviewing a flood assessment, Melbourne Water will only assess the 1% AEP flood event +0.8 m sea level rise scenario.

Permanent inundation hazard is assessed based in regular tidal events, so occurring multiple times per year. In this case, the likelihood rating is Almost Certain.

5.2.2. Consequence Ratings

Consequence ratings are also dependent both on exposure to the hazard, whether erosion or inundation are being considered, and the risk being assessed.

For CHVRAs specific and quantifiable consequences for life (safety) and property (damage) as well as must be evaluated. This aligns the assessment with the Guidelines for Development in

Flood Affected Areas (DELWP, 2019) and the AGS (2007a) for landslide risk assessments. Other elements at risk which can be considered where relevant include services (such as water supply, drainage, or electricity supply), roads, and vehicles on roads.

Erosion - Safety and Damage

The following consequence levels for people (Table 6) and property (Table 7) are recommended for coastal erosion risk assessments. These criteria have been adapted from AGS (2007c).

Table 6 Provisional consequences levels for assessing safety to people (adapted from AGS, 2007c)

Consequence Level	Person in Open Space	Person in a Vehicle	Person in a Building	Descriptor
Insignificant				No impact
Minor				No or only minor injury expected
Moderate	If struck by a rockfall	If the vehicle is damaged only	If debris strikes the building only	Loss of life or serious injury not expected
Major	If struck by debris	If the vehicle is partly buried / crushed	If the building is inundated with debris	Loss of life is possible, not expected
Catastrophic	If buried by debris	If the vehicle is buried / crushed	If the building collapses	Loss of life expected

Table 7 Consequence levels for assessing property damage (from AGS, 2007c)

Consequence Level	Descriptor
Insignificant	No damage
Minor	Limited damage to part of the structure, and/or part of the site requiring some reinstatement stabilisation works
Moderate	Moderate damage to some of the structure, and/or significant part of the site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage
Major	Extensive damage to most of the structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.
Catastrophic	Structure(s) is completely destroyed and/or large-scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.

Flood/Inundation - Safety and Damage

Consequence in terms of flood safety and damage are defined within Australian Rainfall and Runoff (2019) and the DELWP (2019) Guidelines which provide flood hazard thresholds for people which can be interpreted as consequence levels, as shown in Table 8. The consequence level applies when any of the criteria is exceeded. Often the peak velocity of coastal flooding will not be known so where no modelled data is available, we conservatively assume it will be high (i.e., > 2m/s).

Melbourne Water will assess flooding against the DELWP (2019) safety criteria. Where the flood depth exceeds the H2 threshold values as detailed in DELWP (2019) Council will define the flood safety risk as **Not Acceptable**.

Flood damage related consequences are assessed by comparison of the property floor levels with the required finished floor level (FFL) as specified by Melbourne Water. The FFL is a function of the 1% AEP flood event level plus freeboard. Any floor levels set below the FFL as specified by Melbourne Water or less than +0.6m above the 1% AEP flood level at 2100, if no FFL has been specified by Melbourne Water, will be deemed **Not Acceptable.**

Table 8 Flood safety for people & vehicles hazard/vulnerability levels (adapted from Australian Rainfall and Runoff; DELWP, 2019; DPE, 2022)

Consequence Level (hazard / vulnerability classification)	Depth x Velocity (D x V)	Velocity	Depth	Description
H1	≤ 0.3	2.0	0.3	Generally safe for people
H2	≤ 0.6	2.0	0.3	Unsafe for people in small vehicles
H3	≤ 0.6	2.0	0.5	Unsafe for people in vehicles, children, and the elderly
H4	≤ 1.0	2.0	1.2	Unsafe for people in vehicles and people
>H5	≤ 4.0	4.0	4.0	Unsafe for people in vehicles and people.

The DELWP (2019) Guidelines also state that siting of the development is also an important consideration, as the development and access should be located on land with the lowest overall hazard. Importantly "*people attempting to enter or leave a property during a flood should not be endangered by deep or fast-flowing water*."

Therefore, the CHVRA must assess the consequences in relation to both flood safety and damage on the site and for access to the site.

The safety criteria apply to both current and future sea level condition, unless advised differently by Melbourne Water. The Melbourne Water Interim Development Assessment Principles (2023) require that:

- New development should be designed to minimise exposure of people to dangerous floodwaters.
- The 'Flood Safety' principles and assessment criteria in the DELWP Guidelines will be considered for the 2100 1% AEP flood event in the assessment of coastal inundation.
- Where flood depths for the 2100 1% AEP exceed the safety criteria in the DELWP Guidelines, development may not be supported.

The same approach can be adopted for property, such as vehicles and buildings. The building category selected should be relevant to the proposed development. Velocity information is often not readily available for coastal inundation hazard assessments, and therefore safety is assessed predominantly using the depth hazard criteria and thresholds.

5.2.3. Risk and Risk Tolerance

The likelihood and consequence levels are combined to provide a risk rating, based on the erosion risk matrix in Table 9, and the flood safety risk matrix in Table 10. The flood safety risk matrix differs from the erosion risk matrix to allow for consistency with Melbourne Water's decision guidelines and the DELWP (2019) Guidelines. Flood damages and risks to property are assessed based on the FFL requirements as discussed previously.

Once the risks are quantified, the acceptability level of the risk must be assessed. A description of the tolerability and implications of different risk levels are described in Table 11. Risk must be assessed for each hazard and for both risk to life and property separately (i.e. individual risk to life and risk to property assessments required).

For flood risk assessments, the risk to life must also be assessed separately for areas within the property and for the access to the property (i.e. in total two separate risk to life assessments).

Table 9 Erosion risk matrix (adapted from AS 5334-2013)

Likelihood	**Consequences**				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	Extreme	Extreme
Possible	Low	Low	Medium	High	Extreme
Unlikely	Very Low	Low	Medium	High	High
Rare	Very Low	Very Low	Low	Medium	High

Table 10 Flood safety risk matrix (adapted from AS 5334-2013, DELWP 2019)

Likelihood	**Consequences related to Hazard Vulnerability Classification**				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium	High	High	Extreme	Extreme
Likely	Medium	High	High	Extreme	Extreme
Possible	Medium	High	High	Extreme	Extreme
Unlikely	Low	Medium	High	High	Extreme
Rare	Very Low	Low	Medium	High	High

Table 11 Risk level implications adapted from AGS (2007c)

Risk Level	Tolerability and Implications[2]
Extreme	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options are essential to reduce risk to Low.
High	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low.
Medium	Unacceptable without treatment. Requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable. Mornington Peninsula Shire Council may accept a medium risk level for Risks to Property for erosion risks only, but this is not acceptable for Risks to Life for either erosion or flooding.
Low	Usually acceptable to Council. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required. Mornington Peninsula Shire Council requires the risk level for Risks to Life to be Low to be acceptable. Melbourne Water will assess the acceptability of flood risks separately to Council and the assessment will be based on the criteria outlined in the DELWP (2019) Guidelines.
Very Low	Acceptable to Council. Mornington Peninsula Shire Council requires the risk level for Risks to Life to be Low to be acceptable. Melbourne Water will assess the acceptability of flood risks separately to Council and the assessment will be based on the criteria outlined in the DELWP (2019) Guidelines.

The erosion risk tolerance levels applicable to the Mornington Peninsula Shire Council are summarised in Table 12 and Table 13.

Table 12 Erosion Risk to Property (damage) tolerance levels for Mornington Peninsula Shire Council

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Acceptable	Tolerable	Not acceptable	Not acceptable	Not acceptable
Likely	Acceptable	Tolerable	Not acceptable	Not acceptable	Not acceptable
Possible	Acceptable	Acceptable	Tolerable	Not acceptable	Not acceptable
Unlikely	Acceptable	Acceptable	Tolerable	Not acceptable	Not acceptable
Rare	Acceptable	Acceptable	Acceptable	Tolerable	Not acceptable

[2] The implications for a particular situation are to be determined by all Agencies that are party to the risk assessment and may depend on the nature of the property at risk.

Table 13 Erosion Risk to Life (safety) tolerance levels for Mornington Peninsula Shire Council

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Acceptable	Not acceptable	Not acceptable	Not acceptable	Not acceptable
Likely	Acceptable	Not acceptable	Not acceptable	Not acceptable	Not acceptable
Possible	Acceptable	Acceptable	Not acceptable	Not acceptable	Not acceptable
Unlikely	Acceptable	Acceptable	Not acceptable	Not acceptable	Not acceptable
Rare	Acceptable	Acceptable	Acceptable	Not acceptable	Not acceptable

The flood risk tolerance levels applicable to the Mornington Peninsula Shire Council are summarised below:

- Where the flood depth exceeds the H2 threshold values as detailed in DELWP (2019) the flood safety risk will be deemed **Not Acceptable**.
- As stated in Section 5.2.2, any floor levels set below the FFL as specified by Melbourne Water or less than +0.6m above the 1% AEP flood level at 2100 if no FFL has been specified by Melbourne Water, will be deemed **Not Acceptable.**

5.2.4. Other Considerations

In addition, when assessing the acceptability of risk levels, the following additional considerations may also inform whether overall a proposal is acceptable or not:

- The practicality and reliability, over the likely lifetime of a development, of any proposed strategies to minimise or mitigate risks of flooding or erosion damage or safety hazards.
- Whether the development will likely result in persons and property being exposed to unsafe flood depths and velocities.
- Whether the proposed development maintains existing flood storage capacity and flow paths.
- The likely or modelled extent of any likely or modelled impact development on floodwaters, including the specific and cumulative nature and extent of impact on surrounding properties.
- The individual and cumulative cost to the community of the likely tangible and intangible flood damages, over time.
- Whether the proposal appropriately responds to the identified site-specific flood risk to the satisfaction of the relevant floodplain management authority.
- Whether the development and design response manage the flood or erosion risk appropriately.

5.3. Evaluating Erosion Hazard Exposure

For any CHVRA the basic assessment approach for evaluating exposure to coastal erosion hazard(s) is outlined in Figure 7. This desktop level assessment is based on existing information and data, predominantly from the WPLCHA for sites within Western Port. The outcomes are then used to inform the likelihood and consequence ratings for the risk assessment.

Identify the shoreline class	• Locate the shoreline class(es) closest to the development. • Use the shoreline class GIS layer from the WPLCHA.
Understand the shoreline class	• Understand key processes & drivers, historical change and future responses for the shoreline class and specific shoreline location. • Review the WPLCHA and Victorian Coastal Hazards Extended Guideline.
Map the Erosion Hazard Zones	• Map the erosion hazard layers from the WPLCHA for current, +0.2m, +0.5m, and +0.8m sea level rise. • A detailed description of how each component of erosion was derived and mapped is provided in the WPLCHA report.

Figure 7 Coastal Erosion Hazard Exposure (Basic Assessment)

Depending on the scale and cost of the proposed development, the exposure to coastal erosion hazards, and the resultant risk rating, the erosion hazard extents and impacts may need to be refined by taking into consideration locally specific information, as described in Table 14.

Recommendations on appropriate assessment approached for detailed coastal erosion assessments is provided in the Victorian Coastal Hazard Extended Guidelines. Any geotechnical assessment must be completed in accordance with the Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning (AGS, 2007)[3].

[3] https://landsliderisk.org/resources/guidelines/

Table 14 Opportunities for refinement of the WPLCHA coastal erosion hazard extents

Shoreline Type / Class	Opportunities to refine the coastal erosion hazard extents
Coastal wetland fringed shorelines (Estuarine environmental / coastal floodplains)	Revised understanding of the response of coastal wetlands to sea level rise.
Low earth cliff (Low earth scarp)	Revised assessment of historic rates of shoreline recession for locality.
Hard rock cliff and shore platform (Hard / soft rock cliffs with platform and / or beach)	Geotechnical assessment of slope stability and landslide potential for the hard rock material (AGS, 2007a). The assessment must assume wave impacts will occur at the cliff toe.
Platform beach and bluff (Hard / soft rock cliffs with platform and / or beach)	Reassessment of the beach response to storm erosion, long term trends and sea level rise. Geotechnical assessment of slope stability and landslide potential for the hard/soft rock material (AGS, 2007a). The assessment must assume wave impacts will occur at the cliff toe.
Sandy spit shorelines (Sandy shorelines)	Reassessment of the beach response to storm erosion, long term trends and sea level rise.
Estuarine and tidal channels (Estuarine environments / coastal floodplains)	Revised understanding of the response of estuarine and tidal channels to sea level rise.

5.3.1. Worked Example 1 - Sandy shoreline

Example 1 is a property located on a section of shoreline classified as sandy in the WPLCHA (Figure 8). A detailed description of this shoreline type is provided in Section 3.7 of the report. These sandy shores typically comprise an offshore sandy bed, backshore migrating sand lobes, and a series of parallel/sub-parallel dune ridge sequence which have formed successively as foredunes behind a prograding sandy beach. The backshores migrating sand lobes are a pronounced feature of sediment transport processes in Western Port and reflect an intermittent transport regime. The main drivers of change on these shorelines are shoreline recession due to sea level rise through equilibrium profile adjustment and the ongoing shoreline variability associated with backshore migrating sand lobes. The predicted coastal erosion hazard extents are shown in Figure 8 and shows that the property is Possible (refer

Table 5) to be exposed to coastal erosion for sea level rise increments of > 0.5 m.

Given the sandy shoreline type and the potential for site disturbance, a check is also completed for the presence of coastal acid sulphate soils (Figure 9) which indicates CASS could be present on the site. Further evaluation of the risk associated with CASS on the proposed development must be undertaken in accordance with the Victorian Coastal Acid Sulphate Soils Strategy (DSE, 2007) and Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulphate Soils (DSE, 2010).

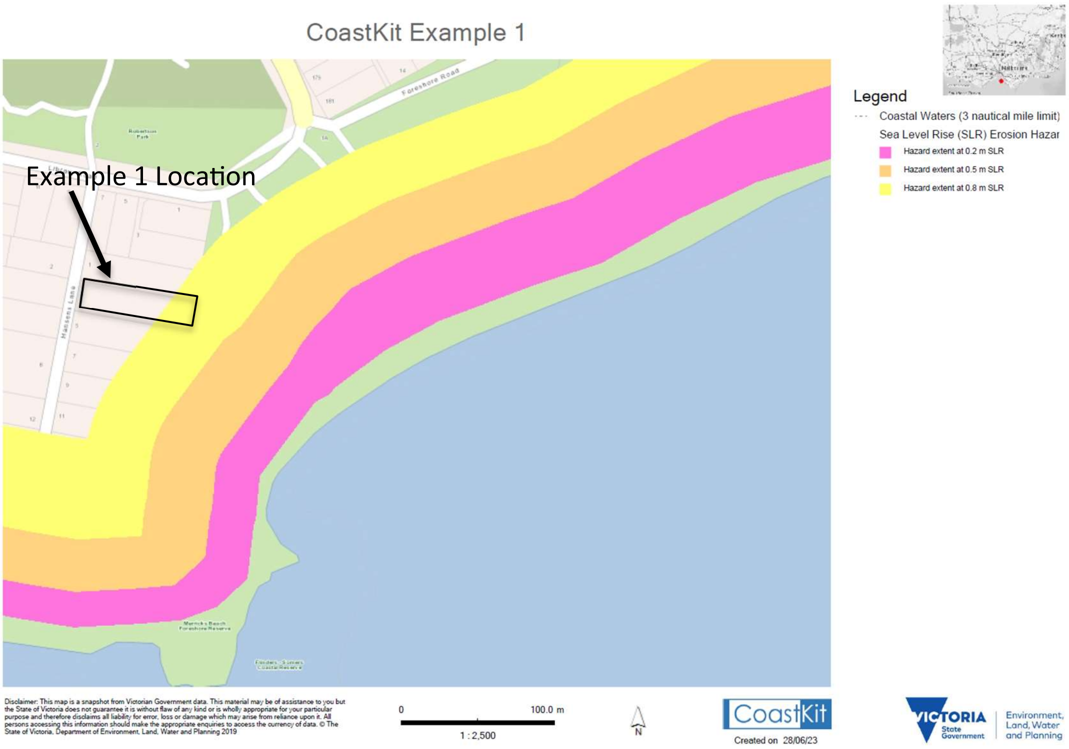

Figure 8 Erosion hazard extents for Example 1 – sandy shoreline

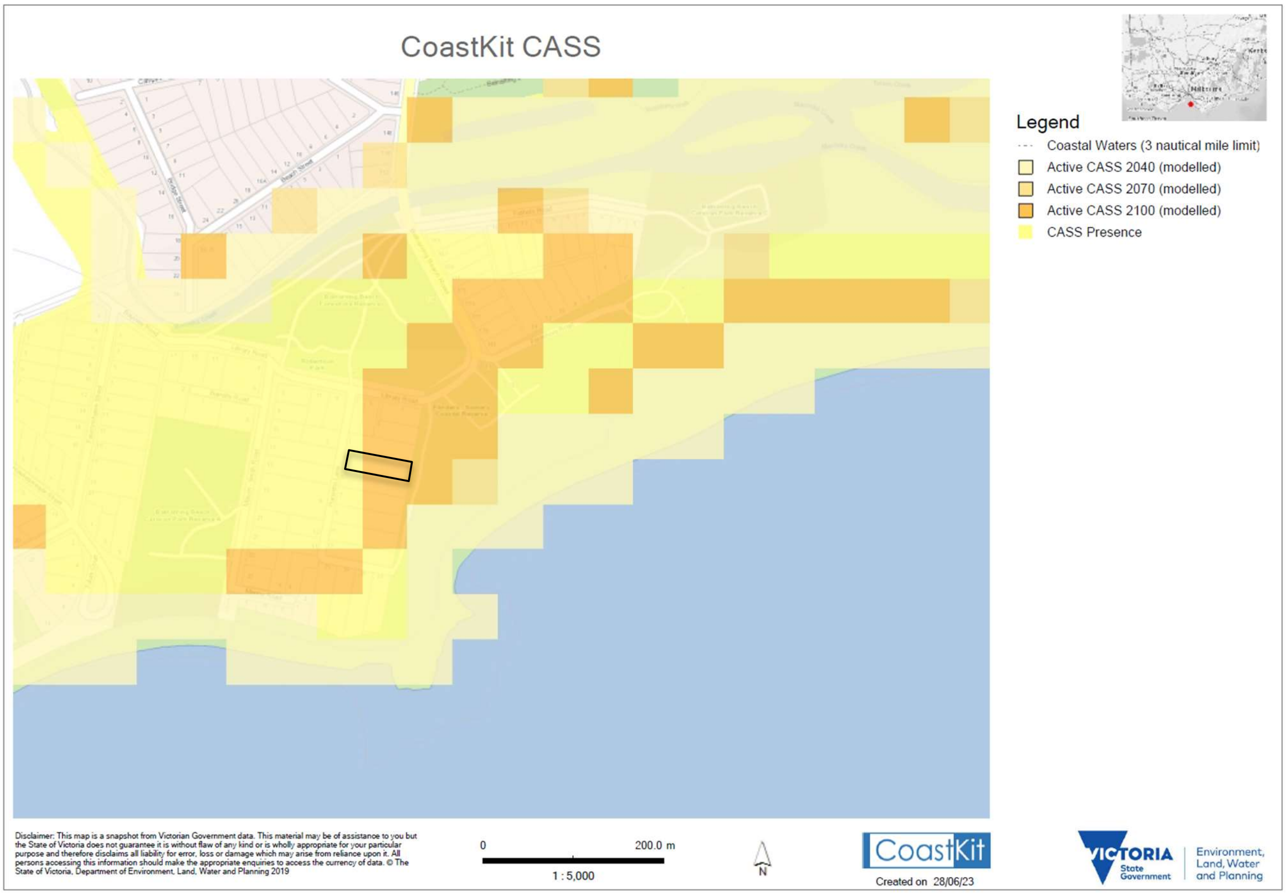

Figure 9 Presence of CASS for the check for the property

5.3.2. Worked Example 2 - Bluff and beach shoreline

Example 2 is a property located on a section of shoreline classified as bluff and beach in the WPLCHA (Figure 10). A detailed description of this shoreline type is provided in Section 3.5 of the report. Important features of these shorelines are the sandy beach sitting upon a rock platform. The beach volume is limited. Behind the beach lie bluffs that are not currently active (i.e., not subject to tidal or wave action), as they are protected from direct marine driven processes by the beach (and sometime a sandy plain) in front. A bluff refers to a "non-active cliff". These bluffs were active marine cliffs in the past when sea levels were higher. The material is highly weathered and potentially erodible should it be subject to marine processes.

As described in the WPLCHA report, the critical control on the extent of the erosion hazard on these shorelines into the future is expected to be related to the width and volume of the sandy platform beach that exists between the sandy shoreline and the toe of the bluff. Where the plain is wide, recession of the sandy shorelines may proceed relatively linearly with sea level rise. However, where the sandy plain is narrow (such as at this location) sea level rise is likely to result in marine influences impacting the toe of the bluffs, then the reflection of wave energy from the bluffs is likely to dramatically increase the rates of potential sand transport in front of the bluff. This scenario is analogous to the frequently observed impact to beaches following the construction of seawalls, where the reflection of wave energy from the seawall results in rapid sediment transport and lowering of the beaches in front of the seawall.

A rapid, non-linear loss of the sandy platform beach fronting the bluffs along these shorelines is possible where sea level rise results in significant reflection of wave action from the base of the bluffs. Once the sandy shorelines are removed from the toe of the bluff, marine processes could be expected to begin to erode the material comprising the bluff.

Increases in mean sea level will increase the duration over which the platform beach shorelines are exposed to wave action as well enable larger waves to impact these shorelines due to the greater depths available across the shore platforms. The increase in wave energy may potentially both modify the equilibrium beach slope and increase the rates of longshore sediment transport.

Depending on the sea level rise scenario and the initial width of the sandy beach and/or plain, it is considered likely that at some point, marine influences associated with storm tides and wave action will once again interact with the toe of the bluff and would then be expected to reactivate the bluff as a marine cliff. Cliff erosion processes, including mass movements would then dominate further shoreline response to sea level rise along these shorelines. The weather material of which the bluffs comprise is vulnerable to mass movement failures once destabilised.

The predicted coastal erosion hazard extents are shown in Figure 8 and show that is it Possible (refer

Table 5) that the property is exposed to coastal erosion for sea level rise increments of > 0.2 m.

Given the highly weathered and potentially erodible bluff material at the backshore, available topography and aerial imagery was reviewed to assess whether mass movement or landslips are visible within the hazard zone, Figure 11. Given the presence of an erosion scarp, potentially a landslip surface, within the hazard extent close to the property a landslip hazard and risk assessment report would be required if the risk assessment indicates the risk to safety or property is medium or above.

There is no mapped CASS for the property or surrounds.

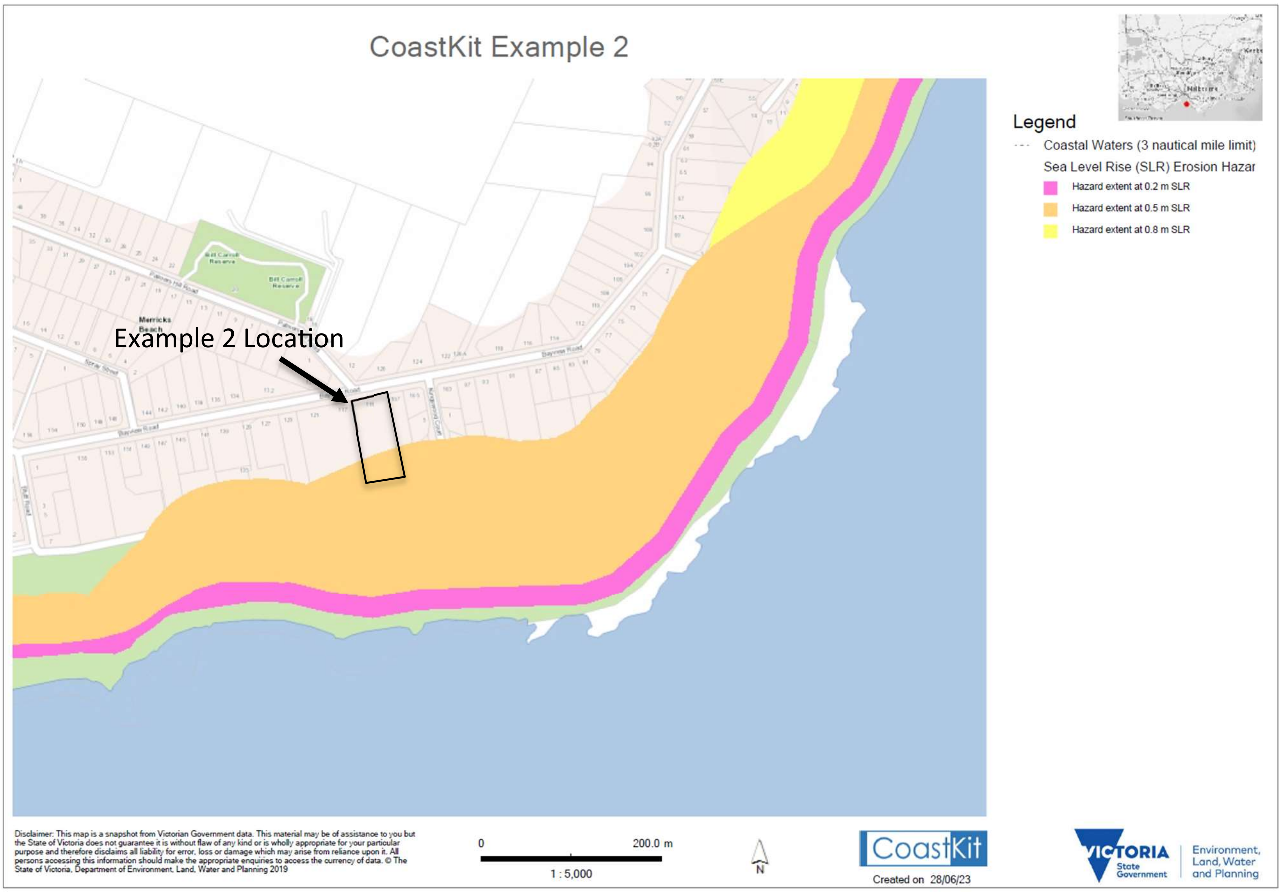

Figure 10 Erosion hazard extents for Example 2 – bluff and beach shoreline

Figure 11 Example of potential landslip feature within coastal hazard zone

5.3.3. Worked Example 3 - Hard rock cliff and shore platform

Example 3 is a property located on a section of shoreline classified as hard rock cliff and shore platform in the WPLCHA (Figure 12). A detailed description of this shoreline type is provided in Section 3.4 of the report.

Important features along the Flinders and Shoreham shoreline where this type is present include a steep tall rock cliff with a very narrow sand and/or gravel beach with fallen rock material at the foot of the slope, overlying a wide rock shore platform. The rock is deeply weathered and/or poorly consolidated material, with some exposure of hard rock material in places.

The rate of slope retreat and profile re-shaping is determined by the accumulation and rate of removal of slope-foot debris by wave action. Cliff recession processes are caused by a combination of the internal structure, joints, fractures and faults of the rocks, rates of sub-aerial weathering and associated mass movements including slumping, cliff falls and landslides and the rates of basal erosion and the removal of collapsed material from the cliff base by the hydraulic action of waves. The rates of change on these shorelines are generally highly episodic and may be associated with extremes of wet and dry climatic conditions and phases of strong wave attack and elevated coastal water levels. The rates of change are also highly variable laterally and vertically based on the resistance and other properties of the rock formations.

Mass movements are the most significant process for assessment of the potential extent of hazards along these shorelines. Increases in mean sea level will increase the duration over which the cliff base is exposed to wave action as well enable larger waves to impact these cliff bases due to the greater depths available across the shore platforms. The increase in wave energy is likely to both increase the rates of hydraulic weathering and abrasion processes on the basal cliff sections and the rates at which slumped material can be removed from the regolith steeped sloped cliff sections.

The rate at which mass movements occur for this shoreline class is not expected to be significantly enhanced by sea level rise over the time frames considered in this assessment. This means the erosion zone is the same for all sea level rise scenarios considered. Essentially, the hazard zone is constant for all sea level rise scenarios and is controlled by the height of the cliff and therefore the potential failure slope surface.

The predicted coastal erosion hazard extent has a Possible likelihood rating (refer

Table 5) that the property is exposed to coastal erosion for current mean sea level and with any future sea level rise.

A landslip hazard and risk assessment report would be required if the risk assessment indicates the risk to safety or property is medium or above for any proposed development within the hazard extent.

Coastal acid sulphate soils are not relevant to this shoreline type.

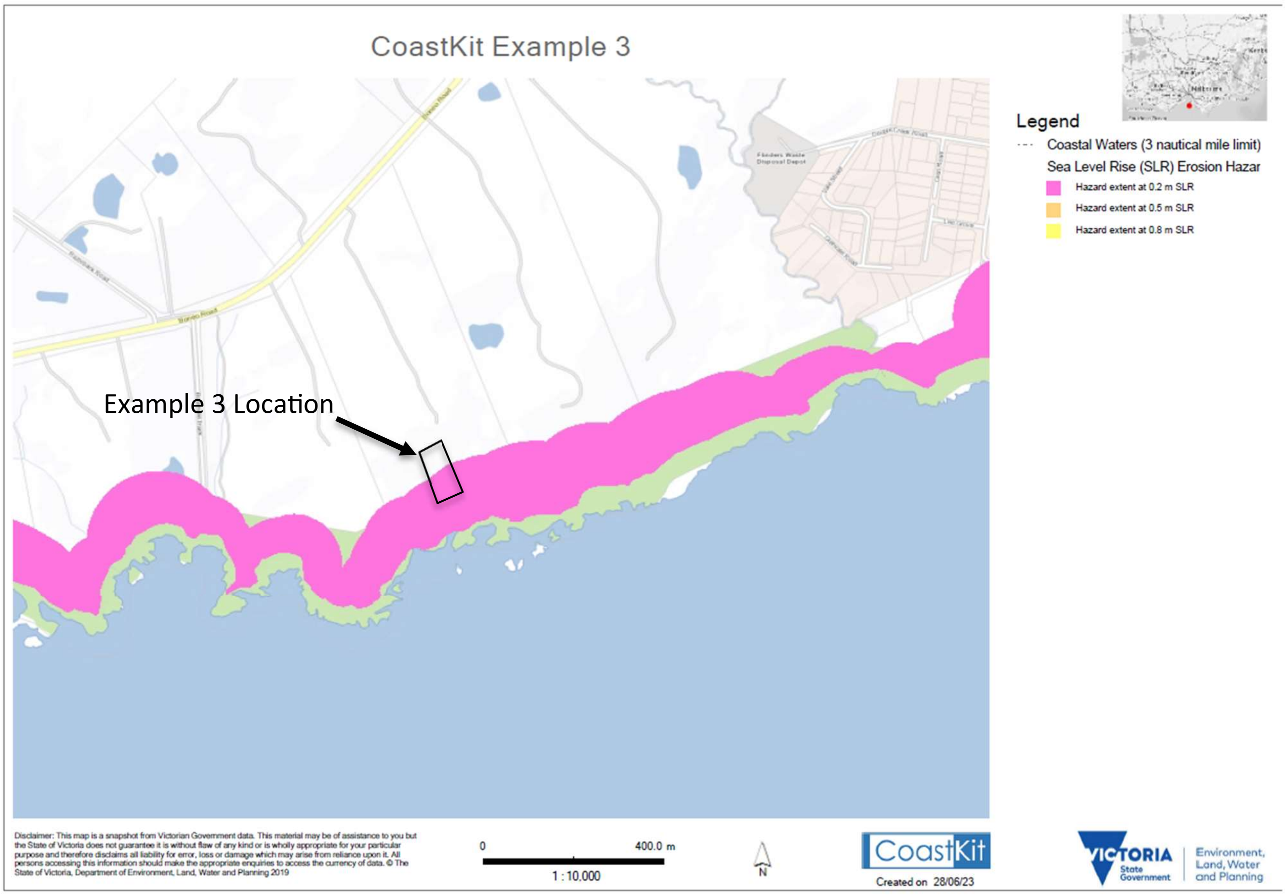

Figure 12 Erosion hazard extents for Example 3 – hard rock cliff and shore platform

5.4. Evaluating Inundation Hazard Exposure

For any CHVRA the basic assessment approach for evaluating exposure to coastal inundation hazard(s) is outlined in Figure 13. This desktop level assessment is based on existing information and data, predominantly from the WPLCHA but advice must be sought from Melbourne Water on the current adopted flood levels and FFL requirements for the location. The outcomes are then used to inform the acceptability of the proposed development.

Depending on the location it may also be relevant for estimates of wave run-up to be provided and considered within the risk assessment process.

Depending on the scale and cost of the proposed development, the exposure to coastal inundation hazards, the resultant risks and acceptability, the inundation hazard extents and impacts may need to be refined by taking into consideration locally specific information. This would involve coastal flood modelling of the property.

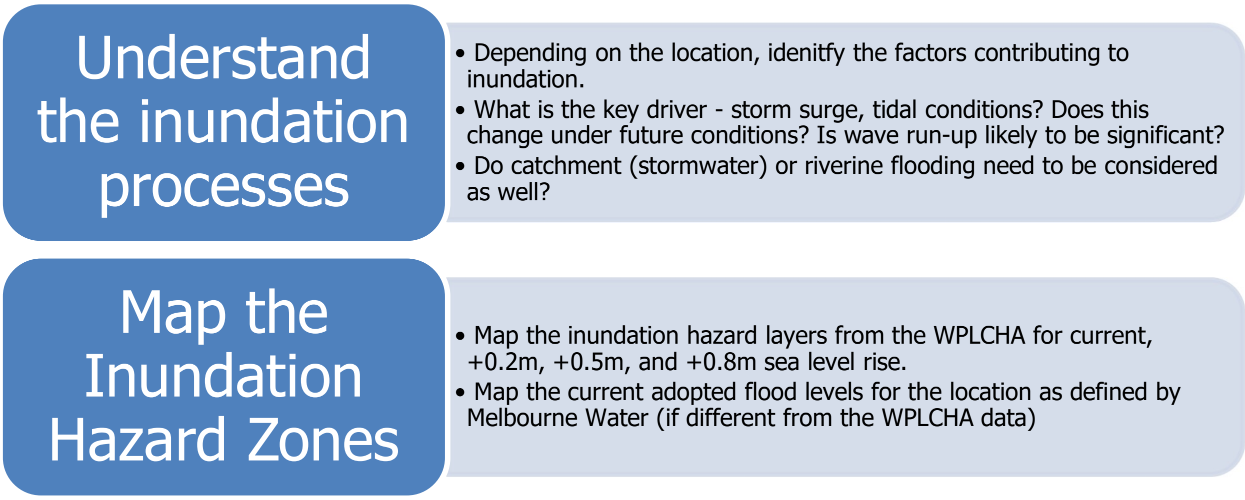

Figure 13 Coastal Inundation Hazard Exposure Assessment (Basic Assessment)

5.4.1. Worked Example 1 - 1% AEP storm tide inundation

The relevant flood levels, extents and FFL requirements should first be confirmed with the Melbourne Water to ensure the most up to date information is included in the assessment. The property in this example is located with the predicted flood extent, Figure 14. The peak storm tide level under existing mean sea level at this location is around 2.2 m AHD.

The predicted inundation hazard extents indicates that the coastal margin of the property is at the level of the 1% AEP storm tide under current mean sea level, and for all increments of sea level rise additional inundation across the property is experienced.

The storm tide levels should be mapped across the property, considering the local topography so that the depth of inundation on the site and for access and egress routes can be assessed.

Wave runup effects should also be considered and estimates of additional inundation as a result of wave runup included by the coastal specialist.

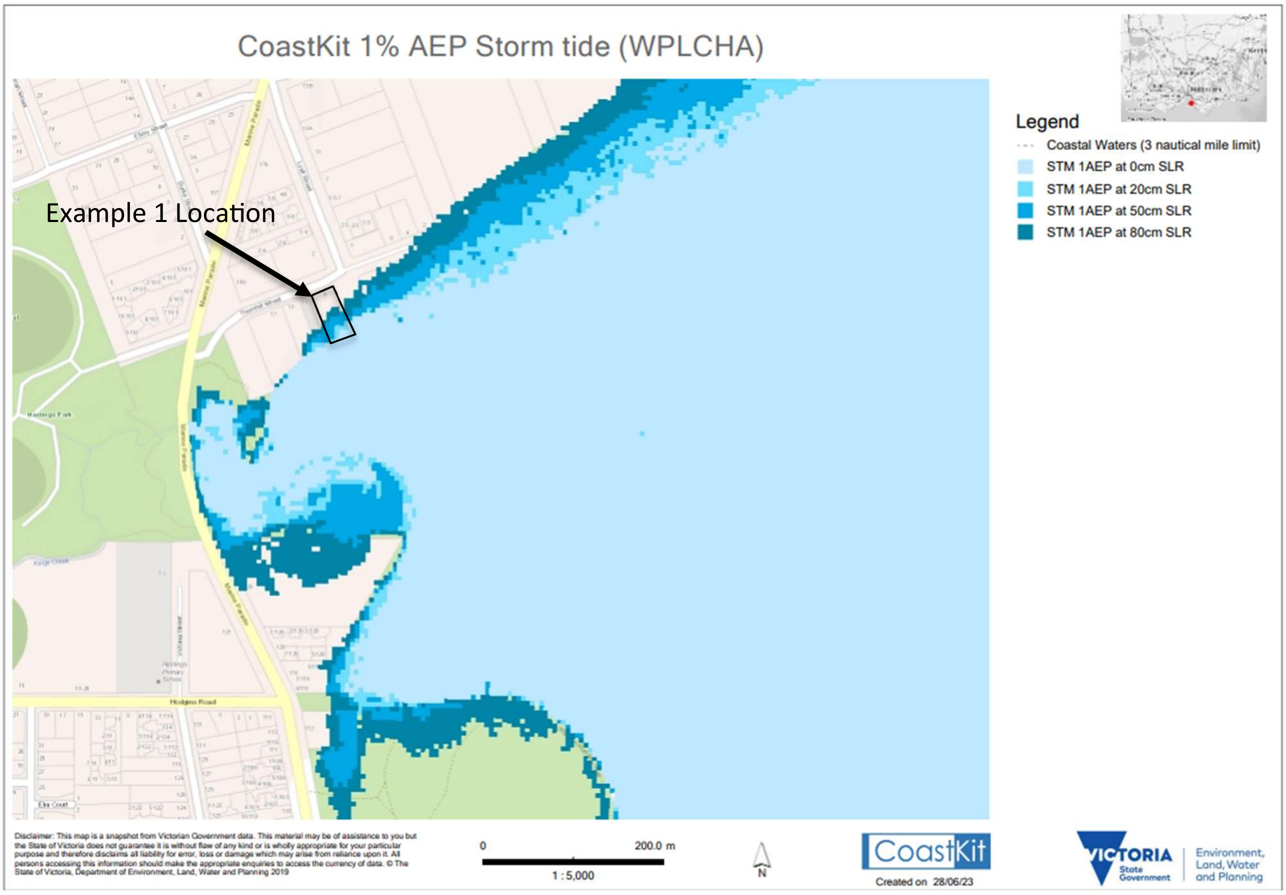

Figure 14 Inundation hazard extents for Example 1

5.5. Additional Considerations

5.5.1. Coastal Acid Sulphate Soils

Where there is erosion and where there is likely to be disturbance of the ground through earthworks, a check must be undertaken for the presence of coastal acid sulphate soils (CASS), Figure 15. This was shown for Worked Example 1 - Sandy Shoreline.

If the presence of CASS is indicated, then further assessment is required. Refer to the Victorian Coastal Acid Sulphate Soils Strategy (DSE, 2009) and Guideline (DSE, 2010) for further information.

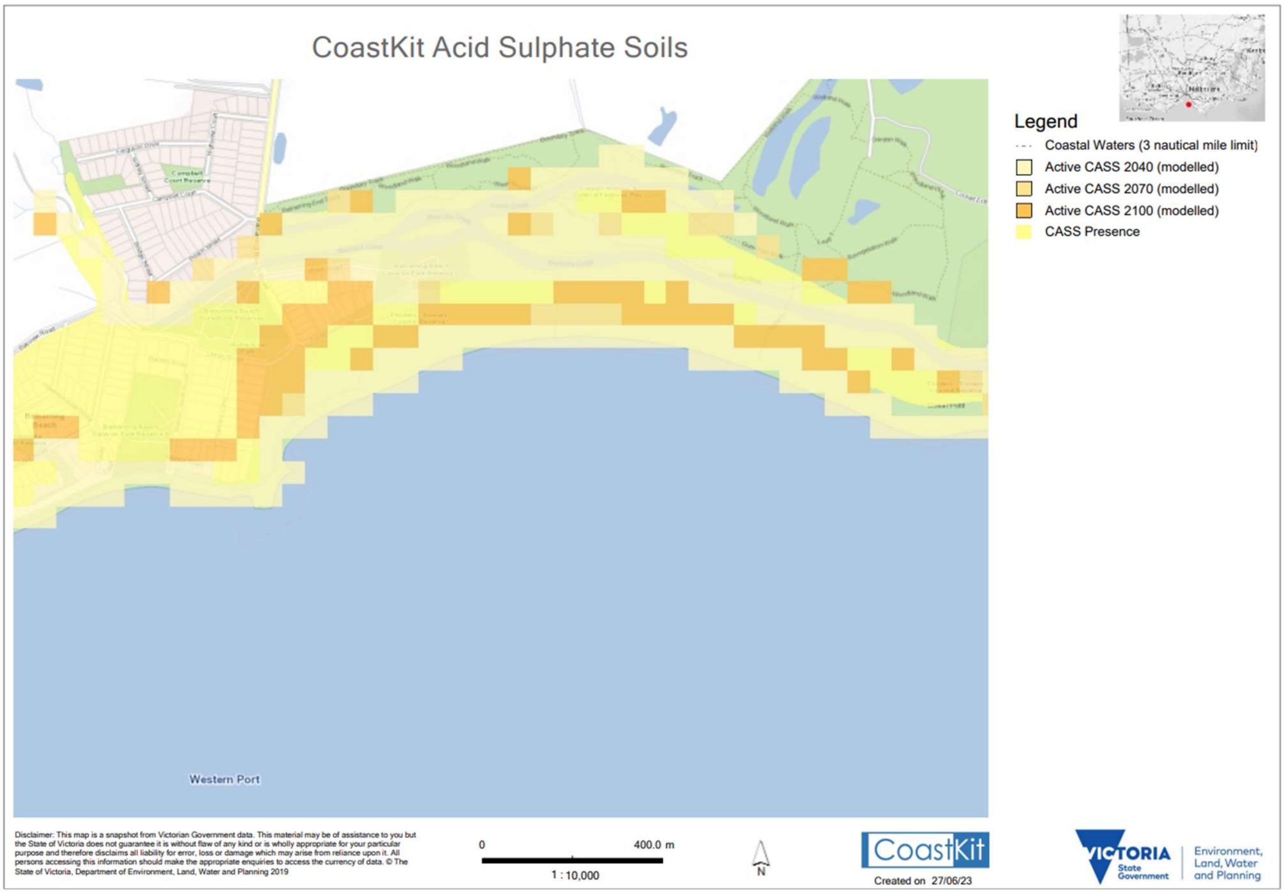

Figure 15 Example of coastal acid sulphate soil mapping

5.5.2. Offsite Impacts and Floodplain Protection

As well as inundation risks to property and people, and inundation focussed CHVRA must consider the remaining key principles of the Guidelines for Development in Flood Affected Areas (DELWP, 2019) which align with the Marine and Coastal Policy (2020).

- **Off-site impacts**: maintain free passage and temporary storage of floodwaters.
- **Floodplain protection**: protect and enhance the social and environmental values and benefits of coastal floodplains.

These aspects are briefly described below can be qualitatively assessed for a basic CHVRA provided the information submitted is sufficient for Melbourne Water to assess it. Further discussion with Melbourne Water on these requirements should be sought.

Off-site impacts
Changes to flood conveyance or flood storage areas can increase the risk of property damage to adjacent properties. Considerations include whether the flood depth or velocities are increased, whether there is a change in flow direction and what is the cumulative impact of lost flood storage. The development should not:

- divert floodwaters to the detriment of any adjoining property.
- increase the flood velocity on any adjoining property.
- increase flood levels on any adjoining property.
- result in a detrimental loss of flood storage.

Further locally specific flood modelling may be required to assess these impacts to the satisfaction of Council and Melbourne Water.

Floodplain protection
Protecting the form and function of coastal floodplains also protects their environmental values and benefits. Developments which may impact on coastal floodplains should:

- Maintain or improve floodplain conditions.
- Allow access to maintain coastal vegetation.
- Maintain or improve water quality.
- Maintain the natural function of floodplains in storing and conveying floodwater.
- Retain or improve significant vistas or landscapes within the coastal zone.

Further locally specific flood modelling may be required to assess these impacts to the satisfaction of Council and Melbourne Water.

5.6. Evaluating Risk

Using the results of the hazard exposure assessments, the risk posed to the proposed development by coastal hazards can then be analysed, Figure 6.

Based on the CHVRA risk assessment framework outlined in Section 5.2, the main steps are:

- Consequence Analysis - determines the level impact of consequence from a hazard assuming it occurs. When undertaking coastal hazard assessment this includes an estimation of exposure and sensitivity of an element at risk. When combined with adaptive capacity then is then termed vulnerability and is a measure of consequence in broader risk assessment terminology. Consequence ratings were presented in Section 5.2.2.
- Risk Estimation - the combination of the likelihood of a particular hazard occurring and the consequence gives an estimate of risk for the asset or people being considered. The recommended erosion risk matrix was presented in Table 9. Flood risks are based on exceedance of specific consequence thresholds, as discussed in Section 5.2.2 and 5.2.3.
- Risk Evaluation – is the process by which estimates of risk levels are compared against an organisation’s criterion for risk acceptance. As such, risk may be deemed either acceptable, tolerable, or unacceptable. Table 12 and Table 13 outline the erosion risk tolerance levels to be utilised for the CHVRA assessment. As discussed previously, flood risks are based on exceedance of specific consequence thresholds, as discussed in Section 5.2.2 and 5.2.3. Any flood levels, velocities, or VxD that exceed the relevant thresholds are considered Not Acceptable.

Each of these elements must be assessed for impacts on life (safety) and property (damage). Impacts on the environment should be included where relevant or required and separate risk matrices must be developed for each aspect assessed.

An example of a risk analysis and assessment for erosion hazards is presented in Section 5.6.1 while an assessment for inundations hazards is outlined in Section 5.6.2. In both examples consequences for life and property are assessed separately, and the worst case is used to give the overall consequence rating for the risk assessment process. Separate risk assessment matrices should also be provided. The overall acceptability of a proposal will be assessed on the risks to life and property under the +0.8m sea level rise scenario.

5.6.1. Coastal Erosion Risk Analysis and Assessment

As an example of how this may be applied, we can revisit the case of a single dwelling residential development along a sandy shoreline like in the previous example (see Section 5.3.1). Exposure to coastal erosion has been assessed and mapped for sea level increments up to +0.8 m, and the potential extent and consequences extrapolated for a sea level rise increment of +1.4 m. In Figure 16 we have indicated the location of a proposed dwelling and the consequence ratings for each sea level increment.

To assess risk, we look at the potential consequences of erosion in terms of the safety of the occupants and damage to the building. We assume the building and its contents are highly vulnerability to damage or loss as a result of coastal erosion - for example, the foundations are not piled and could be readily undermined. Any occupants could be injured or killed if they are present either in the building or on the erosion affected portion of the property when the erosion occurs.

In the example,

- Under current mean sea level, the erosion hazard has yet to impact the edge of the property with no damage expected to the building and the occupants or their access / egress = Insignificant consequence rating.
- Then, with +0.5m of sea level rise the erosion hazard impacts have moved closer to the property but there is still no direct impact = Insignificant consequence rating.
- By +0.8m of sea level rise the erosion extent has reached the proposed dwelling footprint, with a portion of the dwelling within the footprint and the potential for collapse which would affect both the dwelling and the occupants = Major consequence rating.

Based on the sandy shoreline class, the likelihood rating of erosion being within the predicted hazard zones for each sea level rise increment is given a **Possible** likelihood rating.

Impact	Consequence		Consequence (overall)
	Safety	Damage	
+0.8	Major	Moderate	Major
+0.5	Insignificant	Insignificant	Insignificant
Current	Insignificant	Insignificant	Insignificant

Figure 16 Example of consequence assessment for coastal erosion incorporating vulnerability and increasing impact magnitude

The resultant risk matrix ratings for the different sea level scenarios are then presented in Table 15 along with the risk tolerability rating. The risk ratings show that:

- The risks are Low and therefore broadly acceptable under current mean sea level and for sea level rise to +0.5m.
- Beyond +0.5 m of sea level rise, the risk is increased to High and risk treatment measures are required to reduce the risk to Low for risk to life (safety) or Medium for risk to property (damage) which are the acceptable levels for Mornington Peninsula Shire Council.

Table 15 Example risk ratings and tolerability for different sea level scenarios

Impact	Consequence Ratings		Consequence (combined)	Likelihood	Risk Level	Risk Tolerance
	Safety	Damage				
+0.8	Major	Moderate	Major	Possible	High	Tolerable
+0.5	Insignificant	Insignificant	Insignificant	Possible	Low	Broadly Acceptable
Current	Insignificant	Insignificant	Insignificant	Possible	Low	Broadly Acceptable

5.6.2. Inundation Risk Analysis and Assessment

As an example of how this may be applied, in Figure 17 we have a single dwelling residential development located near the coastline. Exposure to coastal inundation has been assessed (see Section 5.4.1) and mapped.

To assess flood risk, we look at the potential consequences of inundation in terms of safety of the occupants and damage to the building. The vulnerability of the occupants is considered within the flood hazard / vulnerability thresholds, where we compare the flood depths, velocities and VxD results to the relevant criteria when assessing risks to life, and to the FFL requirements for risks to property.

Flood Safety	Above / Below Threshold		Acceptable (Y/N)
	Within the property	Access Routes	
+0.8	Above	Above	N
+0.5	Below	Below	Y
Current	Blow	Below	Y

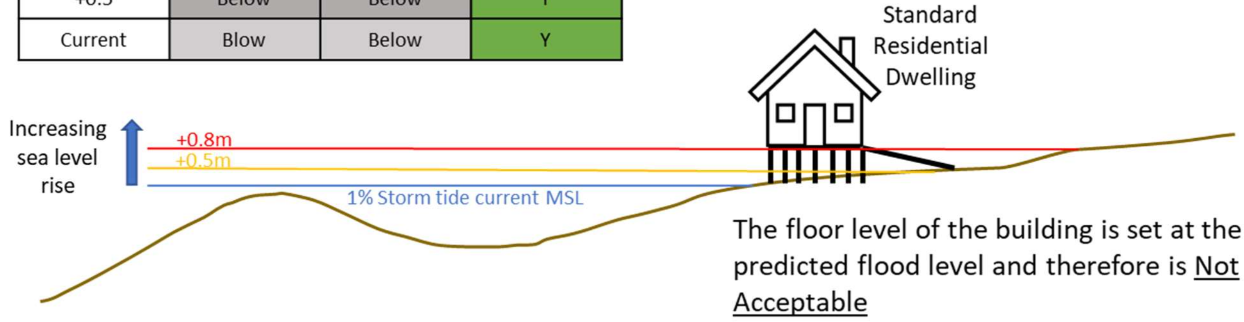

Figure 17. Example of assessment for coastal flooding incorporating vulnerability and increasing impact magnitude for flood safety

In the example,

- Under current mean sea level, the 1% AEP storm tide impacts the edge of the property but there is no damage to the building and if the occupants and access / egress is not impacted and flood depths on the property are below the relevant safety threshold (see
- Table 8).
- Then, with +0.5m of sea level rise the flooding limits the access and egress options but depths are below the relevant safety thresholds (see
- Table 8). The floor level is > 0.6m above the predicted flood level.
- By +0.8m of sea level rise the flooding requires the occupants to pass through deep water = exceeds the threshold for safety and has reached the floor level (no longer meets the FFL requirements).
- The effect of wave run-up has not been explicitly considered given the distance from the shoreline.

The resultant flood risk assessment is as follows:

- The risks are broadly acceptable under current mean sea level.
- With +0.5 m of sea level rise, the risk is increased but below the relevant threshold values and therefore acceptable.
- **However, for +0.8 m of sea level rise scenario, upon which the flood risk is assessed, the risks are intolerable and risk treatment measures must be implemented or the risk eliminated to reduce the risk to an acceptable level.**

To complete the coastal inundation risk assessment, the following additional aspects should also be assessed and documented in the reporting.

- The effect of the development on redirecting or obstructing floodwater, stormwater or drainage water and the effect of the development on reducing flood storage and increasing flood levels and flow velocities.
- The effects of the development on floodplain and coastal including wetlands, natural habitat, shoreline stability, erosion, water quality and sites of scientific significance.

5.7. Risk Treatment and Re-Evaluation

The overarching principle for coastal risk management is to ensure that new development will be located, designed, and protected from potential coastal hazards to the extent practicable and that future management arrangements will ensure ongoing risk minimisation.

Feasible methods for treating the coastal hazard risks must be identified and discussed where the risk level is Medium or above or Above the relevant flood hazard thresholds. The risk rating/acceptability is then re-evaluated based on the adoption of one/some/all the feasible methods. As mentioned previously, only Low or Very Low risk ratings are acceptable to Mornington Peninsula Shire Council.

As coastal erosion and inundation hazards will increase for foreshore areas with increasing sea level rise, a precautionary approach to future development aligns with the Coast and Marine Policy (2020) hierarchy of adaptation actions, namely (Figure 18):

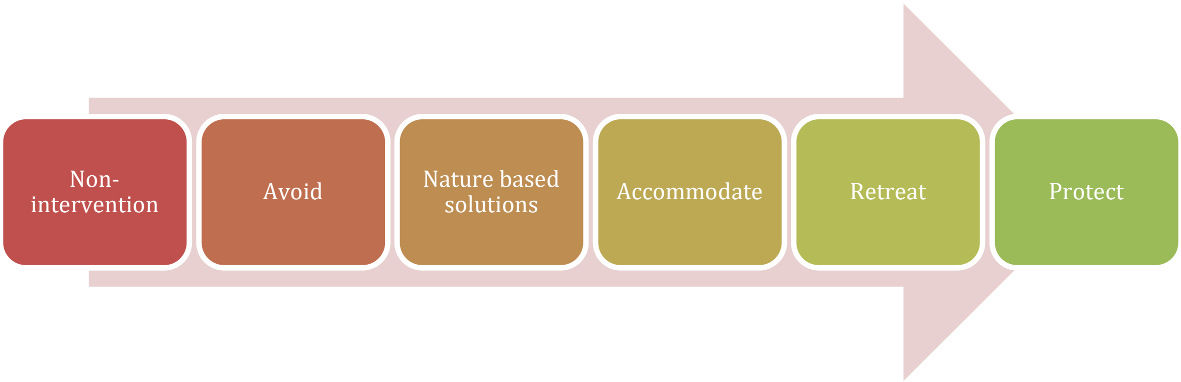

Figure 18 Hierarchy of adaptation options (Marine and Coastal Policy, 2020)

Description of adaptation options

1. Non-intervention.
2. Avoid (includes relocation of the proposed development/works or revised form of the development to be outside the hazard extent).
3. Nature-base methods (includes for example dune protection, beach nourishment, sand fencing. Typically, not as relevant for small scale developments).
4. Accommodate (for example, flood resilience design principles).
5. Retreat (relates to alterations or changes to existing development only, whereby the works will result in the development no longer being within the hazard extent or at risk from the hazard e.g., relocation. Like "Avoid" in this context, the consequence is reduced).
6. Protect (includes for example meeting the freeboard and floor level requirements of Melbourne Water, resilient flood design, and physical works such as slope stabilisation measures. These actions aim to reduce the likelihood and/or consequence of the coastal hazard).

All risk treatment measures will need to be evaluated according to this hierarchy with details provided as to how and why each element of the hierarchy has been considered with clear justification for any options proposed.

Useful resources for identifying risk treatment methods includes the following:

- Under the Victoria' Resilient Coast program, a Compendium of Adaptation Measures (BMT WBM, 2023) has been developed and provides a useful reference.
- AGS (2000) Australian Geomechanics Society “Landslide Risk Management Concepts and Guidelines” Australian Geomechanics, Vol35 No1 March 2000 pp49-92, and reprinted in Vol37 No2 May 2002.
- Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia), 2019
- Melbourne Water Sea Level Rise Guidelines - Interim Development Assessment Principles

Inclusion of adaptation options does not constitute acceptance of the option by Council (or Melbourne Water). The appropriateness of any adaptation actions proposed must consider the scale of the action, any reliance on third parties (e.g. Council infrastructure), and whether the action is likely to be acceptable under relevant regulations or Approvals processes (e.g. Building Regulations).

The acceptability to Council of different risk treatments will depend on whether the hierarchy of adaptation options has been considered, as well as factors such as:

- The practicality and reliability over the likely lifetime of the development.

- Any impacts on erosion or floodwaters including the specific and cumulative nature and extent of impacts on surrounding properties.
- Any residual risk that remains.
- Whether there is an individual or cumulative cost to the property or community over time.

Any works to protect a private property must occur on the property and be shown to **not** have any impact on adjoining land. Works proposed on Council or Crown land will not be considered acceptable.

Any proposed flooding related adaptation actions must be acceptable to Melbourne Water.

The CHVRA report must clearly document how the proposed risk treatment lowers the risk to an acceptable level and addresses the factors above and any additional factors that may be identified by Council or the relevant Referral Authority.

5.7.1. Erosion Example Revisited

With +0.8 m of sea level rise at 2100 being the adopted planning horizon, the coastal erosion risk rating for the property in the previous example is in the "Generally Intolerable" range and the proposed development would not be supported. Risk treatment options to mitigate the risk and move it into the acceptable range could include:

- Move the dwelling footprint outside the mapped +0.8 m erosion hazard zone. The minimum distance for setback beyond the erosion hazard zone can be calculated based estimating the zone of reduced foundation capacity (refer to the concept described in Neilsen et al, 1992; also detailed in Department of Environment Climate Change and Water NSW, 2010).
- Use of piled foundations based on resilient design principles.

However, when reporting on risk treatment options the hierarchy of options must be considered, reviewed, evaluated, and reported with clear justification as to why a specific option is proposed. The risk ratings must then be re-evaluated to determine whether the risk treatments have reduced the risk to the tolerable or acceptable region, Figure 19 and Table 16. If we assume that the proposal is revised, and the building footprint is now located at the minimum required setback for stability for +0.8 m sea level rise the risk level for +0.8 m sea level rise is now Low, which is "broadly acceptable".

Table 16 Example re-evaluated risk ratings and tolerability for different sea level scenarios

Impact	Consequence Ratings		Consequence (combined)	Likelihood	Risk Level (with treatment)	Risk Tolerance
	Safety	Damage				
+0.8	Minor	Minor	Minor	Possible	Low	Broadly Acceptable
+0.5	Insignificant	Insignificant	Insignificant	Possible	Low	Broadly Acceptable
Current	Insignificant	Insignificant	Insignificant	Possible	Low	Broadly Acceptable

The submission should provide an assessment of the setback requirements considering foundation capacity, which may require the involvement of a qualified geotechnical engineer.

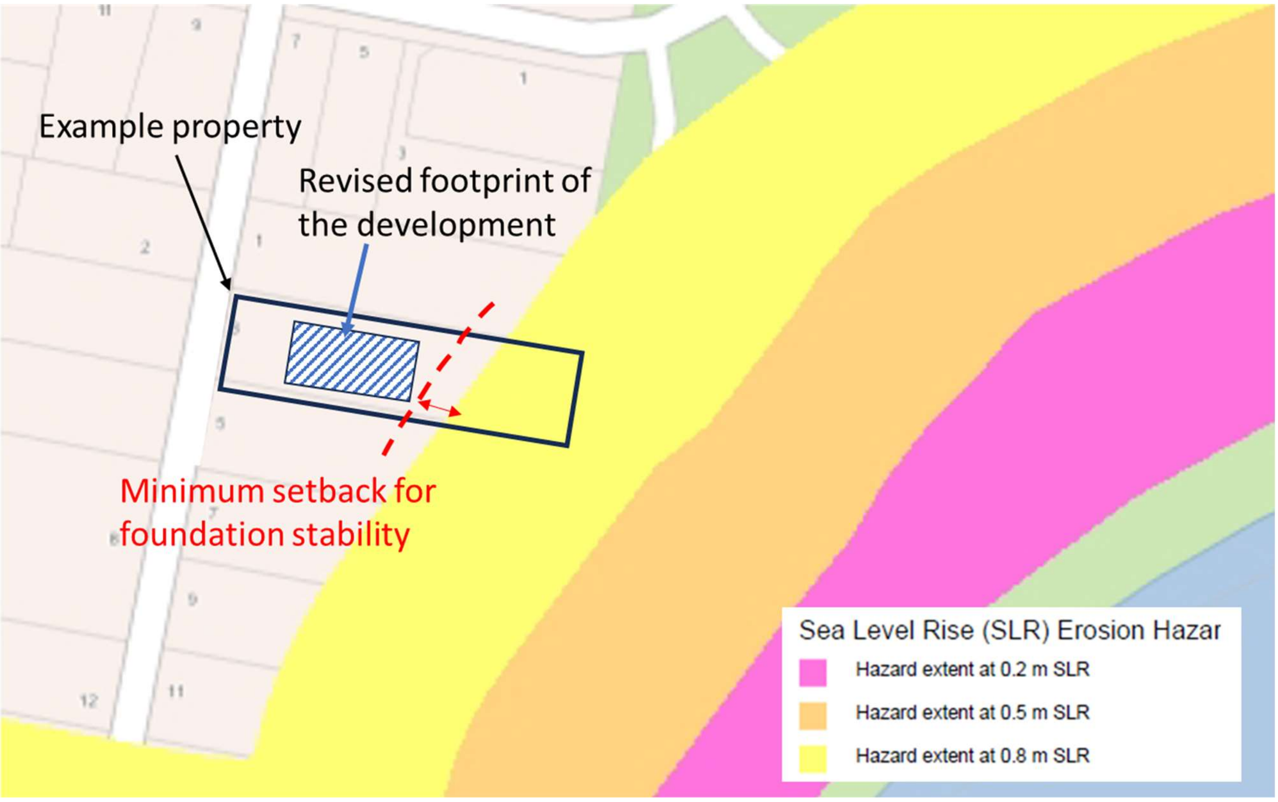

Figure 19 Revised development layout to "avoid" the erosion hazard

5.7.2. Inundation Example Revisited

As +0.8 m of sea level rise at 2100 is the adopted planning horizon, then the coastal inundation risk rating for the property in the previous example is Not Acceptable and the proposed development / redevelopment would not be supported. Risk treatment options to mitigate the risk and move it into the acceptable range could include:

- The dwelling must be designed and constructed to meet the structural building requirements of buildings in flood prone areas. This includes resilient building principles to minimise exposure to wave forces and resistance to scour where the dwelling is sited on sandy or erosion prone materials.
- The finished floor level (FFL) is set at the elevation of the 1% AEP storm tide at 2100, plus +0.6m freeboard or as advised by Melbourne Water.
- Safe access and egress must be provided to and from the dwelling based on the 1% AEP storm tide level at 2100.

The risk must then be re-evaluated to determine whether the risk treatments have reduced the risk below the relevant thresholds. If the safety thresholds cannot be met, then the risk would remain intolerable, and the development would not be supported. In this instance, the risk rating for the +0.8 m sea level rise conditions is likely to remain Not Acceptable due to the lack of feasible options to manage the safety risk to life and the proposed development would not be supported.

6. Peer Reviews

The purpose of the peer review is to provide Council confidence in the technical work being undertaken for and the outputs of the CHVRA process. A peer review is only required for a detailed CHVRA and all the comments provided by the peer reviewer must be addressed.

The Peer Reviewer must be a suitably qualified coastal specialist, as described in Section 1.4 who is independent of the consultant who prepared the CHVRA. Their role is to (DELWP, 2017):

- Assess methods and assumptions used to deliver the outputs.
- Assess the quality of the outputs in relation to their intended end use.
- Check that the outputs meet the requirements of these CHVRA guidelines.

The peer reviewer will review the work detailed in the CHVRA report and provide feedback on its quality, accuracy, and appropriateness. The feedback may include suggestions for improvements, corrections, or recommendations for further work.

A peer review should be considered as a constructive process to assist Council in approving an application which is supported by a CHVRA report. It may also assist the coastal specialist preparing the CHVRA in ensuring that all matters, especially the justification of expert judgement, are adequately addressed. A peer review should assist rather than hinder the CHVRA process.

Peer reviewers are obliged to maintain confidentiality of the review including the contents of the CHVRA report and other documentation supplied.

Generally, the peer review process can have several outcomes:

- The CHVRA adequately documents the erosion and/or inundation risks and supports the outcomes, including any risk treatments and risk re-evaluation proposed.
- Although the CHVRA outcomes including risk treatment and re-evaluation appear to be acceptable, it is not adequately supported by the evaluation. In this case it should be relatively straightforward for the coastal specialist to satisfy the requirements of the reviewer.
- The CHVRA has fundamental flaws, or the wrong analysis has been adopted. In such cases, the analysis needs to be repeated in whole or part before the acceptability of the outcomes can be determined.

The report from the reviewer needs to be explicit and constructive in its approach so that any of the deficiencies in the CHVRA analysis and reporting can be readily addressed.

As detailed in
Figure 1, the comments from the Peer Review must be addressed and the updated CHVRA re-submitted to the peer reviewer for final approval before submission to Council.

7. Further Submission Requirements

In addition to the analysis outlined in the proceeding sections of these Guidelines, the following information must be submitted together with or as part of the CHVRA report particularly where the site is within the LSIO2-4 to assist with the referral process to Melbourne Water:

- An existing conditions survey plan taken by or under the direction and supervision of a licensed land surveyor showing boundaries and dimensions of the site, showing the layout and location of existing building and works with all relevant ground and floor levels to Australian Height Datum (AHD).
- A development plan which includes:
  - layout and location of proposed building and works including all relevant dimensions of the site.
  - proposed finished natural surface levels, building floor levels, building entry points and basement ramps to Australian Height Datum (AHD).
  - proposed overland flow paths to ensure overland flow paths are maintained.
- Cross section elevations and section drawings (1:50 or 1:20) to Australian Height Datum (AHD). The cross-section elevations and section drawings are to include survey levels of the site including building floors, building entry points, basement ramps and ground levels along access and egress routes within the property boundary and within LSIO2-4, flow paths for the passage of overland flows to Australian Height Datum (AHD). The elevations and section drawings must clearly show the Annual Exceedance Probability (AEP) Flood Level and the Nominated Flood Protection Level (NFPL) as determined by the floodplain management authority; and
- A written Flood Risk Statement which must include the following:
  - A flood assessment of the site which includes reference to the Design Flood Event (1% AEP) and other flood characteristics, including velocities and depths of flooding on the site and access routes, overland flood paths and the duration of flooding; and
  - A written description of the design response which demonstrates how the proposed development responds to the flood characteristics which affect the site and surrounds, including an assessment against the four objectives as defined in the Guidelines for Development in Flood Affected Areas (the Department of Environment, Land, Water and Planning, 2019).

All submissions must consider the requirements of the Building Regulations, and all relevant coastal and floodplain policy and standards.

8. References

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