Cape to Cape Resilience Project

Factsheet #7: Adaptation actions

This fact sheet provides a summary of some of the adaptation actions available to manage coastal hazard risk. It considers how each action works, the hazard risks they help manage and how they fit with Victoria's policy approach to adaptation.

> Further information about how we are strategically planning our coastal hazard adaptation in Victoria can be found in ***Factsheet #6 A strategic approach to adaptation***

There is a wide range of adaptation actions that can be used to assist with managing coastal hazard risk.

This document presents information on a range of adaptation actions. These actions have been classified under three main types, as shown in the table below.

Type	Adaptation action
Land management, planning and design Use policy, planning instruments, guidance materials, communication, capacity building and strategic processes to enact change.	**Land use** Planning scheme amendments, planning overlays, rolling easements, land acquisition, access control
	Resilient design / development Design standards, materials, setbacks
Nature-based Use the creation or restoration of coastal habitats for hazard risk reduction. This may be achieved through restoration of habitat alone ("soft" approach), or in combination with hard structures that support habitat establishment ("hybrid" approaches).	**Coastal wetlands / blue carbon ecosystems** Mangroves, seagrass, saltmarsh
	Dune ecosystems Dune protection / vegetation, beach nourishment*/scraping
	Hybrid actions Sand fencing, living shorelines
Engineering Use engineering and design to develop coastal structures, engineered changes to landform, and infrastructure modifications. Includes both "hard" and "soft" engineering and can be used in conjunction with some nature-based methods.	**Beach nourishment*** Beach scraping, cart and place, dredging, sand bypassing
	Seawalls
	Groynes
	Breakwaters
	Flood / tidal barriers
	Drainage network Pipes, valves (size, functionality, network location, materials)
	Road network Network, material, drainage

**Beach nourishment is only considered nature-based if design includes focus on habitat creation. Otherwise, it is engineering.*

The following tables in this document have been framed around the three types of actions - land management, planning and design, nature-based and engineering.

For each adaptation action, these tables outline:

- Adaptation action description
- Coastal hazard risk managed by this action
- Considerations (Pros / Cons)
- Where it fits with the MAC Policy

Adaptation options are different strategic approaches to managing coastal hazard risk, and in Victoria are considered in the order of non-intervention, avoid, nature-based, accommodate, retreat and protect.

Adaptation actions are the range of tools, decisions and works that can be implemented to create adaptation pathways aligned to the strategic options.

Adaptation action description

A high-level description has been provided for each action, outlining how it acts to reduce hazard risk along with some examples of different designs and types, and possible materials.

Coastal hazard risk managed by this action

Some actions can help to reduce both erosion and inundation risks, while others are intended to manage just erosion or just coastal flooding. The type of hazard risk that each action can influence has been considered, and looks at the following hazard types:

- Short term erosion
- Long term erosion
- Storm tide inundation
- Permanent inundation
- Estuary dynamics
- Saline intrusion

Considerations (Pros / Cons)

While adaptation actions might work well to reduce coastal hazard risk, there are many other things that also need to be considered when choosing the most suitable actions at an at-risk location.

We have highlighted some of the pros and cons of different actions. This includes consideration of some other impacts the action may have at or away from the sites, challenges or complexities associated with its implementation, and opportunities and additional benefits the action may provide.

Where it fits with Marine and Coastal Policy

As we plan how we manage (mitigate) coastal hazard risk and suitability of different actions, the Marine and Coastal Policy requires us to take a strategic approach.

There are six **adaptation options** (different strategic approaches) to consider when developing an adaptation planning. Each adaptation option must be considered in the policy-defined order when planning a suitable adaptation response.

We have shown where each adaptation action fits within these adaptation options

Example - where this action fits with both Avoid and Accommodate strategies

MAC Policy approach	
1. Non intervention	
2. Avoid	✓
3. Nature-based methods	
4. Accommodate	✓
5. Retreat	
6. Protect (major engineering works)	

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Land management, planning and design

Use policy, planning instruments, guidance materials, communication, capacity building and strategic processes to enact change.

Action	Description	What hazards can it help to manage?	Considerations (pros/cons)	Where it fits with MAC Policy
Land use Uses a range of planning and development mechanisms, controls and tools informed by understanding of coastal hazard risk to guide and control current and future development. Aims to limit inappropriate use and development and transitioning existing at-risk areas.  	**Planning scheme amendments** Planning schemes identify various policies and provisions that guide land use and development. Guiding the measures that control how land can be used (i.e. setbacks, overlays, zones), integrating up-to-date understanding of coastal hazards into planning schemes will assist in mitigating risk. **Planning overlays** Used to identify land that has special protection / requires permits, including potential issues needing management like erosion or flooding risks. They establish additional requirements and considerations for development within the overlay area. **Rolling easements** Reduce coastal hazards risk to people and assets over time by changing the way the land covered by the easement can be used. **Land acquisition** Involves transferring land at unacceptable risk from coastal hazards from private ownership to public ownership. Can use individual or combinations of mechanisms, such as land buy-backs (voluntary or compulsory), land swaps or land lease-backs. **Relocating infrastructure** Planned landward migration of assets on public land that are in coastal hazard areas to reduce their exposure to coastal hazards. **Access control** Implementing restrictions on the volume, timing, or mode of access to sensitive or hazardous area.	• Short term erosion • Long term erosion • Storm tide inundation • Permanent inundation • Estuary dynamics • Saline intrusion	**Pros** • Ensures decisions made on future development are informed • Proactive management for future conditions to avoid and limit future costs • Can provide a clear, robust process and guidance to inform decision making, important for communication and compliance • Prompts consideration of longer term now, providing for pre-planning and preparation **Cons** • Can have potential impacts on individuals (home/asset owners) • Potential for mechanisms/tools and decisions they inform to be challenged or disputed if seen as unfavourable • Approvals requirements for land acquisition or swap schemes are complex, lengthy and costly (i.e. require planning scheme amendments such as for compulsory acquisition) • Potential legal implications and costs	MAC Policy approach 1. Non intervention 2. Avoid ✓ 3. Nature-based methods 4. Accommodate ✓ 5. Retreat 6. Protect (major engineering works)

Land management, planning and design

Use policy, planning instruments, guidance materials, communication, capacity building and strategic processes to enact change.

Action	Description	What hazards can it help to manage?	Considerations (pros/cons)	Where it fits with MAC Policy
Resilient design / development Using smart and informed design and siting (placement) for development in the coastal zone, that considers and accounts for marine and coastal surrounds and dynamic conditions. 	**Design standards, materials** Standards to guide appropriate and resilient design for development in marine and coastal environments. Guidance to support adaptable design for changing conditions (raising floors, movable structures) and accounts for impacts of surrounding environment on materials, longevity and maintenance. **Setbacks** Used to create designated areas to limit development, providing space for shoreline to move over time, including further landward under the influence of coastal processes and sea level rise (i.e. set house/structures back a certain distance from the coast).	• Short term erosion • Long term erosion • Storm tide inundation • Permanent inundation • Estuary dynamics • Saline intrusion	**Pros** • Proactive design for future conditions to avoid and limit future costs (i.e. damages, maintenance) **Cons** • Costs associate with resilient design • Can have potential impacts on individuals (home/asset owners) • Potential for design requirements to be challenged if seen as unfavourable	MAC Policy approach 1. Non intervention 2. Avoid ✓ 3. Nature-based methods 4. Accommodate ✓ 5. Retreat 6. Protect (major engineering works)

Nature-based

Use the creation or restoration of coastal habitats for hazard risk reduction.

This may be achieved through restoration of habitat alone ("soft" approach), or in combination with hard structures that support habitat establishment ("hybrid" approaches).

Action	Description	What hazards can it help to manage?	Considerations (pros/cons)	Where it fits with MAC Policy
Coastal wetlands / blue carbon ecosystems Resilience via natural systems, stabilising shorelines, absorbing wave energy, slowing and limiting flooding, providing nearshore buffers. These "blue-carbon" ecosystems also absorb carbon from the atmosphere. 	Natural systems can play an important role in providing natural resilience for coastal areas. Mangroves, seagrass, saltmarsh communities and kelp forests can each limit impacts of coastal hazards. Coastal wetland systems and estuaries support these communities and can also act as a physical natural buffer between more built up and developed.	• Short term erosion • Long term erosion • Storm tide inundation • Estuary dynamics	**Pros** • Ecosystem benefits • Natural amenity – look and feel • Can be used to create and enhance habitat • Increases buffer between the sea and more built-up/developed areas from storms and wave attack **Cons** • Establishment takes time • Can be severely impacted in extreme events • Uncertainty around performance and response of these ecosystems, especially under climate change • Requires space set aside to enable landward migration	MAC Policy approach 1. Non intervention 2. Avoid 3. Nature-based methods ✓ 4. Accommodate 5. Retreat 6. Protect * (major engineering works) *Methods may use hybrid approaches with structures and engineering
Dune ecosystems Protecting, building, and maintaining healthy dune habitats which trap sand and act as a buffer against short-term storm erosion. 	Dune management is a nature-based measure that aims to mitigate impacts of coastal hazards. This can be achieved through a combination of vegetation management and access control. Beach nourishment and sand scraping can also be used to add/redistribute sand in the dune system.	• Short term erosion • Storm tide inundation	**Pros** • Ecosystem benefits • Natural amenity – look and feel • Can be used to create and enhance habitat • Increases dune buffer from storms and wave attack **Cons** • Establishment takes time • Can be severely impacted in extreme events • Relies upon sediment supply in the system • Can impact where people can/can't go and how people interact with their coast	MAC Policy approach 1. Non intervention 2. Avoid 3. Nature-based methods ✓ 4. Accommodate 5. Retreat 6. Protect * (major engineering works) *Methods may use hybrid approaches with structures and engineering

Nature-based

Use the creation or restoration of coastal habitats for hazard risk reduction.

This may be achieved through restoration of habitat alone ("soft" approach), or in combination with hard structures that support habitat establishment ("hybrid" approaches).

Action	Description	What hazards can it help to manage?	Considerations (pros/cons)	Where it fits with MAC Policy
Hybrid actions Combinations of natural and engineered solutions ("hybrid" approaches) to help support ecosystems, such habitat establishment and enhancement. 	Complementing features and structures that aid the establishment and performance of nature-based solutions. Engineered support can vary. Examples include creating surfaces/foundations and conditions for aquatic and marine growth, sheltering to reducing wave action and water level impacts, as well as physical structural support allowing ecological communities and systems time to grow and establish. Living shorelines, artificial reefs and sand fencing are examples of hybrid actions.	• Short term erosion • Long term erosion • Storm tide inundation • Estuary dynamics • Offshore sediment dynamics	**Pros** • Ecosystem benefits • Some natural amenity – look and feel • Can be used to create and enhance habitat **Cons** • Establishment takes time • Cost and local and off-site impacts of larger scale hard structures • Uncertainty around performance and response of these ecosystems, especially under climate change scenarios	MAC Policy approach 1. Non intervention 2. Avoid 3. Nature-based methods ✓ 4. Accommodate 5. Retreat 6. Protect (major engineering works) * *Methods may use hybrid approaches with structures and engineering

Engineering

Use engineering and design to develop coastal structures, engineered changes to landform, and infrastructure modifications.

Includes both "hard" and "soft" engineering and can be used in conjunction with some nature-based methods.

Action	Description	What hazards can it help to manage?	Considerations (pros/cons)	Where it fits with MAC Policy
Beach nourishment Artificially moving sand onto the beach. 	**Beach scraping** Moving sand from lower beach to upper beach areas. **Cart and place, dredge and pump** Relocating or importing sand. **Sand bypass** Pumping sand around a natural or constructed obstacle to restore or enhance natural sediment flow.	• Short term erosion • Long term erosion • Accretion • Estuary dynamics • Offshore sediment dynamics	**Pros** • Increases beach width and the sand available as a buffer for storms and wave attack • Natural amenity – sandy look and feel • Can be used to create and enhance habitat **Cons** • Expensive, temporary	MAC Policy approach 1. Non intervention 2. Avoid 3. Nature-based methods 4. Accommodate 5. Retreat 6. Protect ✓ (major engineering works)

Engineering

Use engineering and design to develop coastal structures, engineered changes to landform, and infrastructure modifications.
Includes both “hard” and “soft” engineering and can be used in conjunction with some nature-based methods.

Action	Description	What hazards can it help to manage?	Considerations (pros/cons)	Where it fits with MAC Policy
Dredging Removal of sediment to manage offshore channels and hydrodynamics. 	**Mechanical dredgers** Use machinery (excavators) to move and place sand. Examples include bucket, bucket ladder, grab, backhoe dredgers. **Hydraulic dredgers** Moves sand in a liquid form, pumping dredged material from/to locations. Examples include suction dredgers, trailing suction hopper, water injection dredgers.	• Estuary dynamics • Offshore sediment dynamics	**Pros** • Dredged material can be used for beach nourishment. • Can improve channels navigability and alignment **Cons** • Impacts water quality - increases turbidity • Destructive to benthic habitats • Sediment-bound pollutant transport/spread • Complex to confidently model and design • Expensive • May require regular program to maintain alignment	MAC Policy approach 1. Non intervention 2. Avoid 3. Nature-based methods 4. Accommodate 5. Retreat 6. Protect (major engineering works) ✓
Seawalls Structures built along shores to stabilise shoreline and protect land behind either by absorbing or reflecting wave energy . 	**Revetment walls** Multi-layered, sloped structures that absorb wave energy. Generally made of rock armour or sand filled geo-fabric bags and designed to have some voids between units. **Vertical seawall** Vertical or near vertical walls, with a solid and impervious design that reflect waves. Generally use materials such as rock, concrete, masonry, timber, iron sheet piling.	• Short term erosion • Long term erosion • Storm tide inundation • Permanent inundation • Estuary dynamics	**Pros** • Long-lasting (if rock, concrete etc.) • Effective protection of assets **Cons** • Expensive • Requires ongoing maintenance and upgrade • Can impact natural coastal processes structures modify/restrict dune and sand dynamics • Can increase erosion at the end of structure • Can lead to narrow / no beach in front of structure.	MAC Policy approach 1. Non intervention 2. Avoid 3. Nature-based methods 4. Accommodate 5. Retreat 6. Protect (major engineering works) ✓
Groynes Structures built perpendicular the shore to trap sand that moves along the shore.	Structure/s help to trap sand, resulting in sand build up and increasing beach width on the updrift side. Groyne can be built as a single structure, or as a “groyne field” with multiple groynes at regular spacing. Generally use materials such as geo-fabric bags, rocks or timber.	• Short term erosion • Long term erosion • Estuary dynamics	**Pros** • Can increase beach width updrift • Can be used to stabilise river and creek entrances (training walls) **Cons** • Expensive	MAC Policy approach 1. Non intervention 2. Avoid 3. Nature-based methods 4. Accommodate 5. Retreat

Engineering

Use engineering and design to develop coastal structures, engineered changes to landform, and infrastructure modifications.
Includes both “hard” and “soft” engineering and can be used in conjunction with some nature-based methods.

Action	Description	What hazards can it help to manage?	Considerations (pros/cons)	Where it fits with MAC Policy
			• Can starve downdrift shoreline of sediment supply leading to recession • Significant impact on visual amenity	6. Protect (major engineering works) ✓
Breakwaters Structures built in or on the water which intercept waves and reduce wave energy reaching the shoreline, aiding sand build-up. 	Aimed at reducing wave energy and limiting waves, breakwater designs and features include: • “attached” to the shore, or “detached” (offshore) • protruding above the water (“emergent”), or sitting below water surface (“submerged “) • made of various materials - rock, concrete or synthetics (incl. geo-fabric bags, polymer units) • fixed/rigid or floating structures	• Short term erosion • Long term erosion • Storm tide inundation	**Pros** • Near/offshore position limits structure footprint on beach • Long-lasting • Effective protection of assets • Opportunities for habitat creation and ecosystem enhancement (e.g. artificial reefs) **Cons** • Expensive • Complex to confidently model and design • Can result in scouring at and around structures • Can significantly alter natural coastal processes, especially sediment transport • Often bigger and more expensive than onshore structure as need to cope with bigger waves and deeper water conditions • Complex to build structure in offshore environment	MAC Policy approach 1. Non intervention 2. Avoid 3. Nature-based methods 4. Accommodate 5. Retreat 6. Protect (major engineering works) ✓

Engineering

Use engineering and design to develop coastal structures, engineered changes to landform, and infrastructure modifications.
Includes both “hard” and “soft” engineering and can be used in conjunction with some nature-based methods.

Action	Description	What hazards can it help to manage?	Considerations (pros/cons)	Where it fits with MAC Policy
Flood / tidal barriers Structures used to protect low-lying coastal land from inundation by preventing water from flooding a specific area. 	Structures that prevent land from being inundated from flood events. Includes: Elevated mounds or walls, such as **levees** or **dykes**. Generally made from earth, rock, concrete, geo-fabric bags or other materials. Levees aim to prevent low-lying land from being inundated in flood events, while dykes can prevent areas becoming permanently inundated (regular inundation due to tides). **Storm surge barriers** are physical barriers that prevent storm surges travelling inland along rivers, lagoons, inlets or other waterways.	• Storm tide inundation • Permanent inundation • Saline intrusion	**Pros** • Effective protection of assets **Cons** • Can be expensive, especially region wide earth works or large physical barriers • Designs needs to be suitable to the hazard type i.e.– short-term and long-term flooding require different approaches. • Potential for structure to fail in an event (if condition not maintained).	MAC Policy approach 1. Non intervention 2. Avoid 3. Nature-based methods 4. Accommodate 5. Retreat 6. Protect (major engineering works) ✓
Infrastructure networks Modifications and upgrades to the infrastructure (including reconfiguration, relocation and resilient design) to ensure functionality, capacity and performance of the network/s into the future, with projected coastal hazard risk. 	Infrastructure network changes could include: **Drainage network-** pipe sizing, material types, network configurations, and location, siting of critical network assets, altering network gradients, outlet design to limit sea water backflows, protection and armouring. **Road network-** road surface, material types, network configurations, moving roads, providing alternate traffic corridors, improved drainage, protection and armouring.	• Short term erosion • Long term erosion • Storm tide inundation • Permanent inundation • Saline intrusion	**Pros** • Forward planning for networks may help maximise existing infrastructure and expected design life • Proactive design for future conditions to avoid and limit future costs (i.e. damages, maintenance) • Effective protection of assets **Cons** • Can be expensive to retrofit and modify existing network • Complexity in relation to networks where siting and proximity of infrastructure to coastal areas is linked to network functionality (i.e. drainage outlets) • Moving roads requires long term strategic planning significant funding	MAC Policy approach 1. Non intervention 2. Avoid ✓ 3. Nature-based methods 4. Accommodate ✓ 5. Retreat ✓ 6. Protect (major engineering works) ✓