

Task Force on Water-Land Interface

For discussion
on 19 May 2015

TFWL/02/2015

An Overview of Design of Public Seawalls within Victoria Harbour

PURPOSE

This paper provides an overview of design of public seawalls within Victoria Harbour.

BACKGROUND

2. Seawalls are commonly used as foreshore protection structures with aims of armouring the shore against erosion and preventing inundation of low-lying areas. However, the traditional design of seawall structures using rock or concrete has limited potential to provide habitats and other environmental services along the shorelines. To improve the environmental value of existing seawalls and create new seawalls with greater habitat potential, it is noted that there are some successful examples of seawall projects, such as step-type seawalls and eco-shoreline, being implemented overseas in Australia, the Netherlands and Singapore.

3. At the meeting on 2 March 2015, members of the Task Force on Water-Land Interface (the “Task Force”) raised some questions about the design of public seawalls within Victoria Harbour. Members were also interested in possible improvement of seawall design in future with a view to enhancing the waterfront and facilitating harbourfront activities. Civil Engineering and Development Department (“CEDD”) was invited to give the Task Force with a general overview of the design of public seawalls for information to facilitate further discussion.

Task Force on Water-Land Interface

TFWL/02/2015

FUNCTIONS AND DESIGN CONSIDERATIONS OF SEAWALL

4. To protect the existing hinterland or to form land by reclamation, it is necessary to build seawalls along the new coastline. Main functions of seawall are to serve as :

- a boundary of newly reclaimed land;
- a soil retaining structure of the reclamation; and
- a sea defense structure to protect the reclaimed land from erosion against wave and current actions, and coastal flooding.

5. As recommended in the Port Works Design Manual, the following main factors are to be considered when designing and selecting the type of seawalls :

- (i) Layout of the coastal development;
- (ii) Environmental conditions (such as winds, wind waves, ship waves and sea level);
- (iii) Operational conditions (such as whether vessel berthing and cargo handling are needed);
- (iv) Navigation and berthing requirements;
- (v) Costs and time of construction;
- (vi) Maintenance requirements; and
- (vii) Statutory requirements (such as Protection of the Harbour Ordinance and Environmental Impact Assessment Ordinance).

TYPES OF SEAWALLS

6. Traditionally, there are two types of seawalls; vertical seawalls and sloping seawalls. Vertical seawalls have the advantage that they can provide marine frontage for vessel berthing and cargo handling but they have the problem of higher wave reflection. Sloping seawalls however dissipate wave energy

Task Force on Water-Land Interface

TFWL/02/2015

better along the slope of the seawall and thus reduce reflected wave agitation. To the detriment of a wider clearance has to be provided for marine traffic due to the underwater slopes, which may not be practicable sometimes when water space is limited. In recent years, a special type of vertical seawall, vertical wave-absorbing seawall, has been adopted in Hong Kong. Vertical wave-absorbing seawalls with lower wave reflection coefficient can not only reduce wave agitation but also occupy less water space. These seawalls contain specially designed wave absorption chamber with perforated front wall that allows water flow into and out of the chamber so as to dissipate the wave energy inside the chamber. However, the cost of vertical wave-absorbing seawalls is relatively higher.

7. Vertical seawalls normally consist of concrete blockwork seawalls or reinforced concrete caisson type of seawalls. Vertical wave-absorbing seawalls are also caisson type of seawalls but with the provision of wave absorption chamber units at the front face. Sloping seawalls are usually rubble mound seawalls of which the slope of the seawalls is generally protected by rock armour. The typical details of these three types of seawalls are shown in **Annex A**¹.

8. Nowadays, a variety of techniques can be adopted in the design of seawalls to increase the environmental and habitat values of both existing and new seawalls. There are some successful examples of seawall projects being implemented overseas. For example, in Australia, (1) mangroves are established directly in front of seawalls to provide valuable habitat, (2) a native riparian vegetation buffer is provided immediately landward of seawalls, (3) boulders are placed immediately in front of seawalls to provide artificial reef habitat, (4) cavities and pools are added to seawalls to provide sheltered habitat and increase overall surface area for colonization, (5) step-type seawalls which

¹ Port Works Design Manual: Part 4 – Guide to Design of Seawalls and Breakwaters

Task Force on Water-Land Interface

TFWL/02/2015

incorporate a bench of mangroves and saltmarsh are used, and (6) low-sloping seawalls which can help mimic natural foreshores more closely are adopted. Some photos of these innovative designs of seawalls are attached in **Annex B**.

9. In addition, a new idea of eco-shoreline has been applied successfully in some overseas coastal development projects with a view to establishing a sustainable and environmentally friendly shoreline. Eco-shoreline is a shoreline which provides beneficial functions to the local ecosystem through a range of active or passive solutions, whilst providing coastal protection. It can also provide beautiful and natural space for public enjoyment. By applying eco-shoreline in the design of seawalls, it could increase surface complexity of seawalls for organisms to settle in by using different size of boulders, to establish a vegetation zone to improve visual amenity, to attract foraging birds by construction of tidal pools, and to provide food and shelter to the fish population by putting in artificial reefs. A typical section of a preliminary and conceptual eco-shoreline is attached in **Annex C**².

10. There are a number of options available when considering an eco-shoreline to provide coastal protection. For example, in the Netherlands, oyster reefs are developed in intertidal flats to protect them from erosion and to create new habitats. Also, water retaining pools are built in front of seawalls to increase biodiversity in the intertidal zone and to provide shelter habitats for shrimps and small fishes. Some photos of these examples are attached in **Annex D**³. In Singapore, eco-shoreline is being considered for future coastal development of the offshore landfill at Pulau Semakau⁴. However, it must be

² “Environmentally Friendly Seawalls” published by Department of Environment & Climate Change, New South Wales, Australia, 2009

³ Source: Ecoshape (http://www.ecoshape.nl/en_GB/oyster-reefs-eastern-scheldt.html) and Deltares (<https://publicwiki.deltares.nl/display/BWN/Case+++Rich+Revetment>)

⁴ “Habitats in Harmony: The Story of Semakau Landfill” published by National Environment Agency, 2009

Task Force on Water-Land Interface

TFWL/02/2015

emphasized that eco-shoreline can only be considered in areas with suitable hydraulic regime and where sufficient water space is available.

CURRENT SITUATION IN HONG KONG

11. At present, there are about 51 km long seawalls being maintained by the Government along the coastline of Hong Kong Island, Kowloon and Tsing Yi within Victoria Harbour. Of which, 69% are vertical seawalls, 28% are sloping seawalls and 3% are vertical wave-absorbing seawalls. Some photos showing general view of different types of seawalls are attached in **Annex E**. In addition, a total of about 75 numbers of public piers, ferry piers, ferry terminals and landings have been built to provide marine access for public within Victoria Harbour.

12. Land resources are always limited in Hong Kong particularly in the areas surrounding Victoria Harbour. Since the early days of development, Hong Kong relied on reclamation as one of the principal solutions to meet the growing needs for economic and population growth in Hong Kong, to provide additional land for housing, essential transport infrastructure, port activities, community facilities, public open space and waterfront promenade. Recent major reclamations within Victoria Harbour since 1980s include Central and Wan Chai Reclamation, West Kowloon Reclamation, etc., which have been or will be completed.

13. As mentioned in paragraph 4 above, the main purpose of seawalls is to protect the reclaimed land behind the seawalls from erosion against wave actions particularly during typhoons. For the sake of public safety, structural stability and elevation of seawalls are always key concerns when designing the seawalls, especially along the shoreline of Victoria Harbour which is one of the busiest sections of harbour in the world. Besides, most of the

Task Force on Water-Land Interface

TFWL/02/2015

land behind seawalls has been fully developed into commercial, residential, industrial and recreational areas. Hence, adaptation of the aforesaid techniques in the design of seawalls in the Harbour to improve the environmental values of both existing and new seawalls may not always be feasible and cost-effective.

14. With the Protection of the Harbour Ordinance in force, an over-riding public need should be established for any reclamation within Victoria Harbour. This need must be a compelling and present need with no reasonable alternative to reclamation. Unless there is any further reclamation development within the harbour, there is little room for reconstruction of existing seawalls. On the landward side, there is existing usage immediately behind the seawalls and it is difficult to retreat the seawalls landward for any reconstruction. Furthermore, a project of reconstructing seawall without a planned reclamation development will prove to be uneconomical and unjustified. Hence there is no planned seawall reconstruction work in the near future within Victoria Harbour.

15. Public landings are currently provided along vertical seawalls at selected locations based on planned usage of the land beyond the seawalls to facilitate embarkation and disembarkation of public. As these works are heavy duty civil engineering construction, there is no flexibility to provide landing to the vertical seawall at a later stage without involving large scale partial reconstruction of the seawall at the landing location.

WAY FORWARD

16. In view of growing environmental consciousness in the society, innovative design of seawalls adopting elements of eco-shoreline is being studied for incorporation into the new seawall design for the proposed reclamations outside Victoria Harbour. It can not only enhance the ecological function of

Task Force on Water-Land Interface

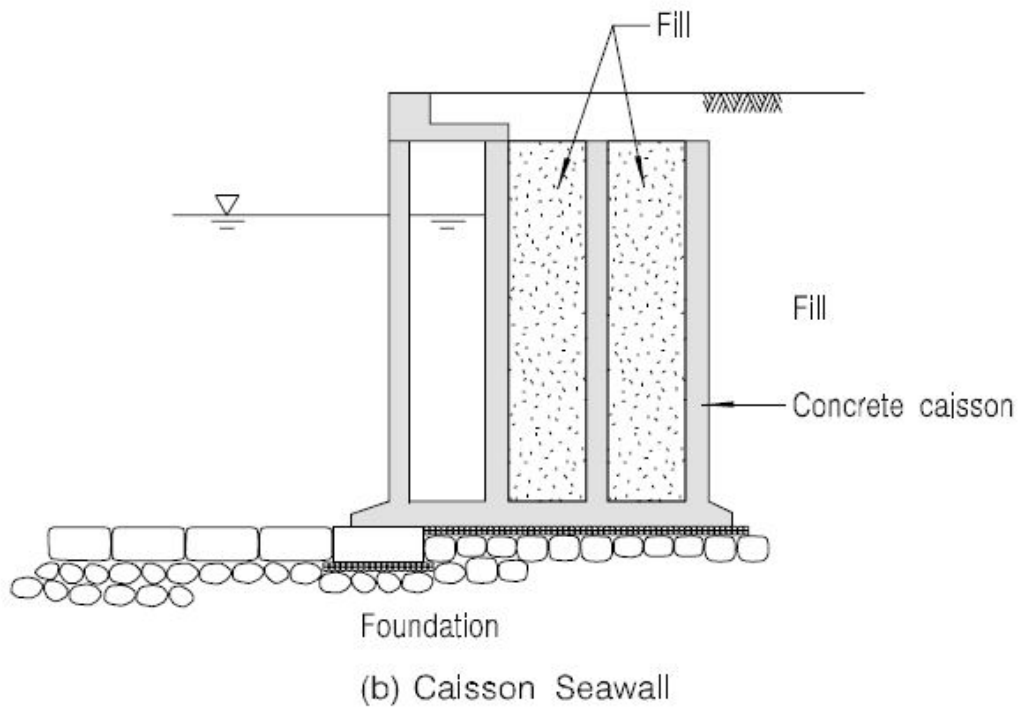
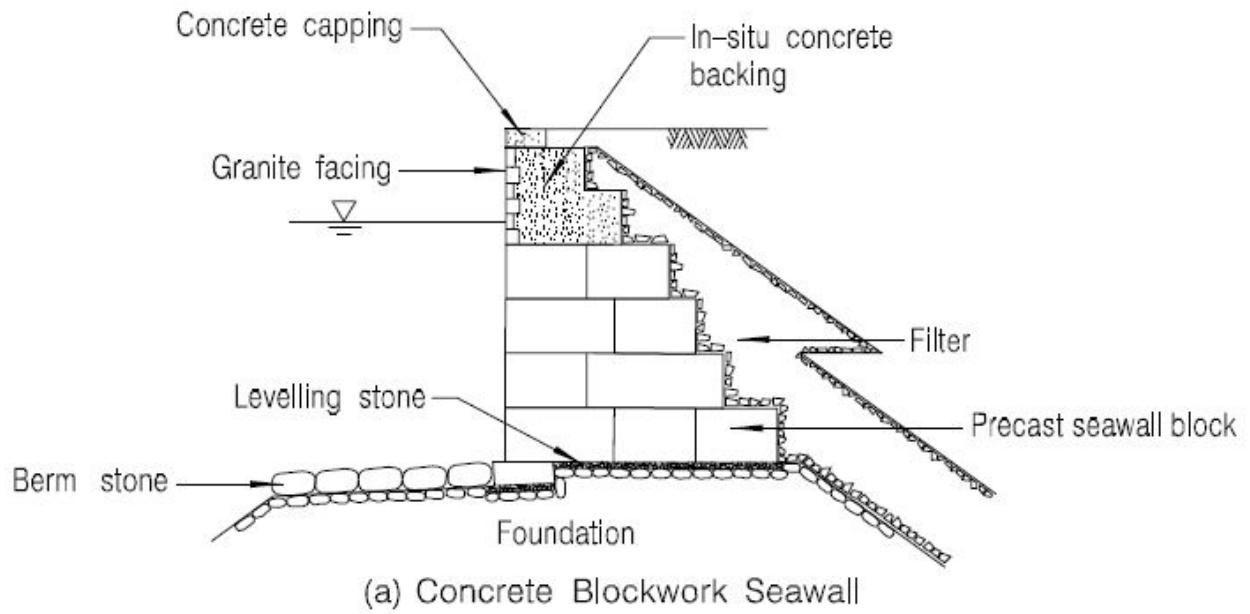
TFWL/02/2015

seawalls but also restore the damaged soft shore such as sandy shore and mud flat to improve the marine environment and to allow public enjoyment.

17. As mentioned in paragraph 15 above, provision of landings on existing seawalls may involve large scale partial reconstruction of the seawall at the landing location. Nevertheless, if there is any innovative design of landings which could be installed on existing seawalls, design proposals to relevant Government departments for consideration and advice are always welcome.

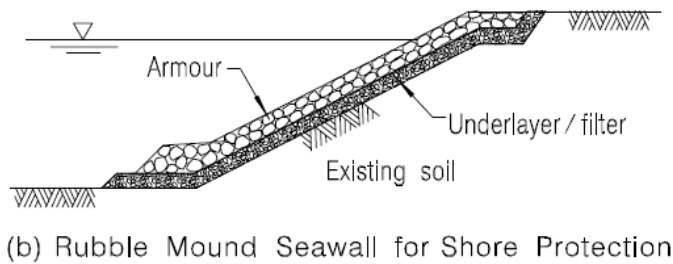
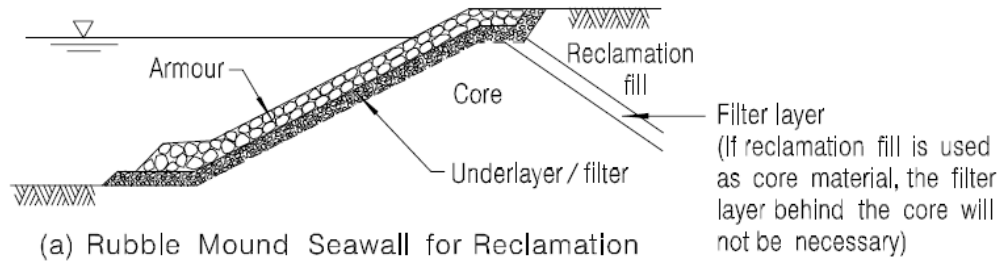
**Civil Engineering and Development Department
May 2015**

Typical Details of Vertical Seawall

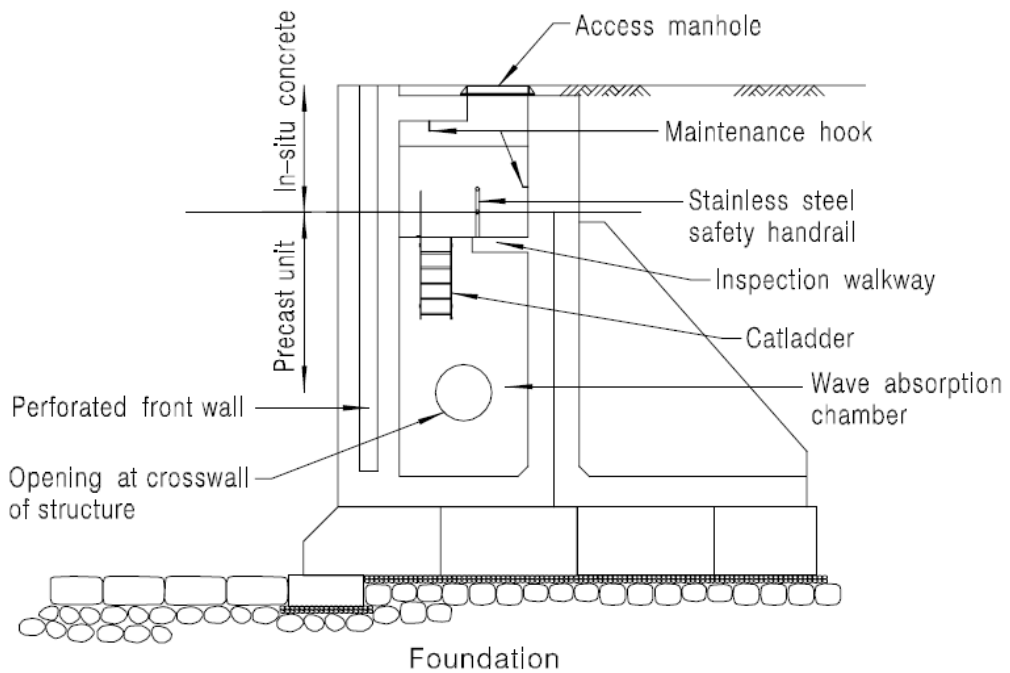


Source : Port Works Design Manual (Part 4)

Typical Details of Sloping Seawall



Typical Details of Wave-absorbing Seawall



Innovative Designs of Seawalls - Examples



← Parramatta River, Australia
Seawalls with mangroves planting

Quakers Hat Bay, Sydney, Australia →

Boulders have been added to the front of seawall to improve total habitat surface area



← Kogarah Bay, Australia
A step-type seawall with a bench of saltmarsh vegetation

Innovative Designs of Seawalls - Examples

Bobbin Head, Cowan Creek, Hawkesbury → River New South Wales, Australia

A low-sloping seawall with a variety of habitats



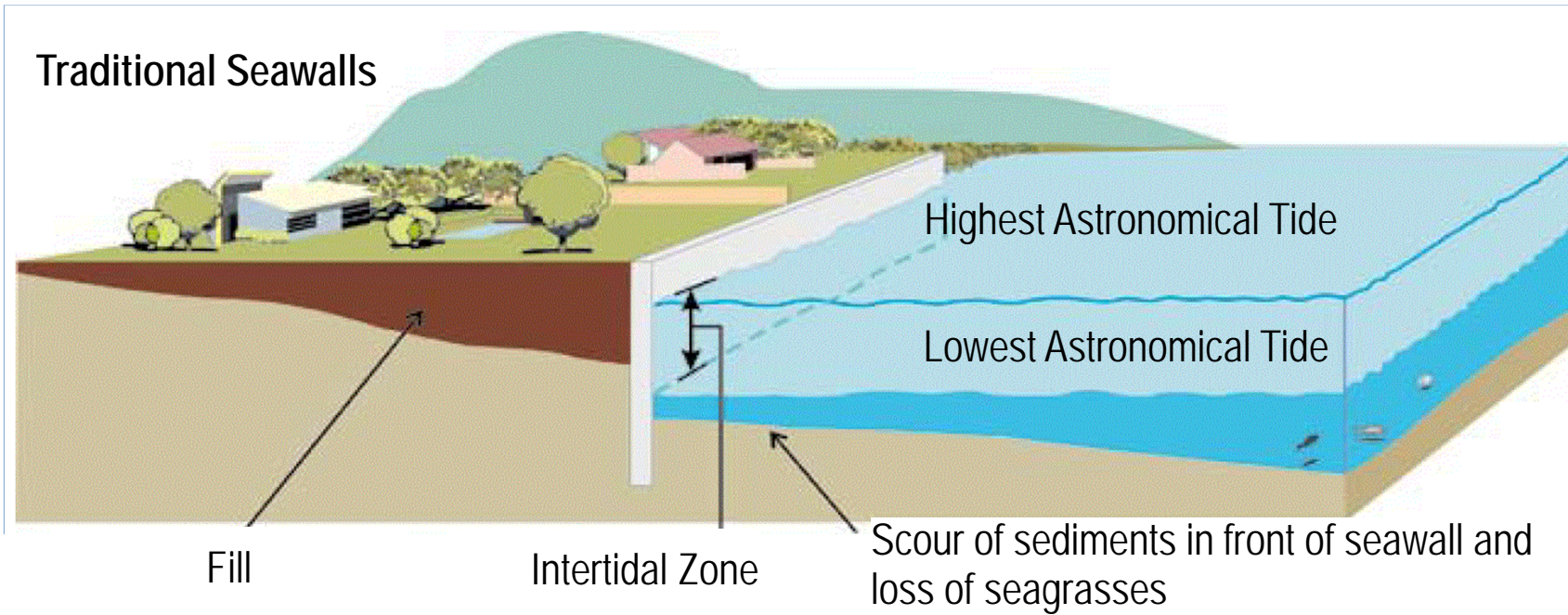
← McMahons Point, Sydney Harbour, Australia

Seawall with pools in the structure for habitat and boulders at toe for additional habitat

Gough Whitlam Park Cooks River, → New South Wales, Australia

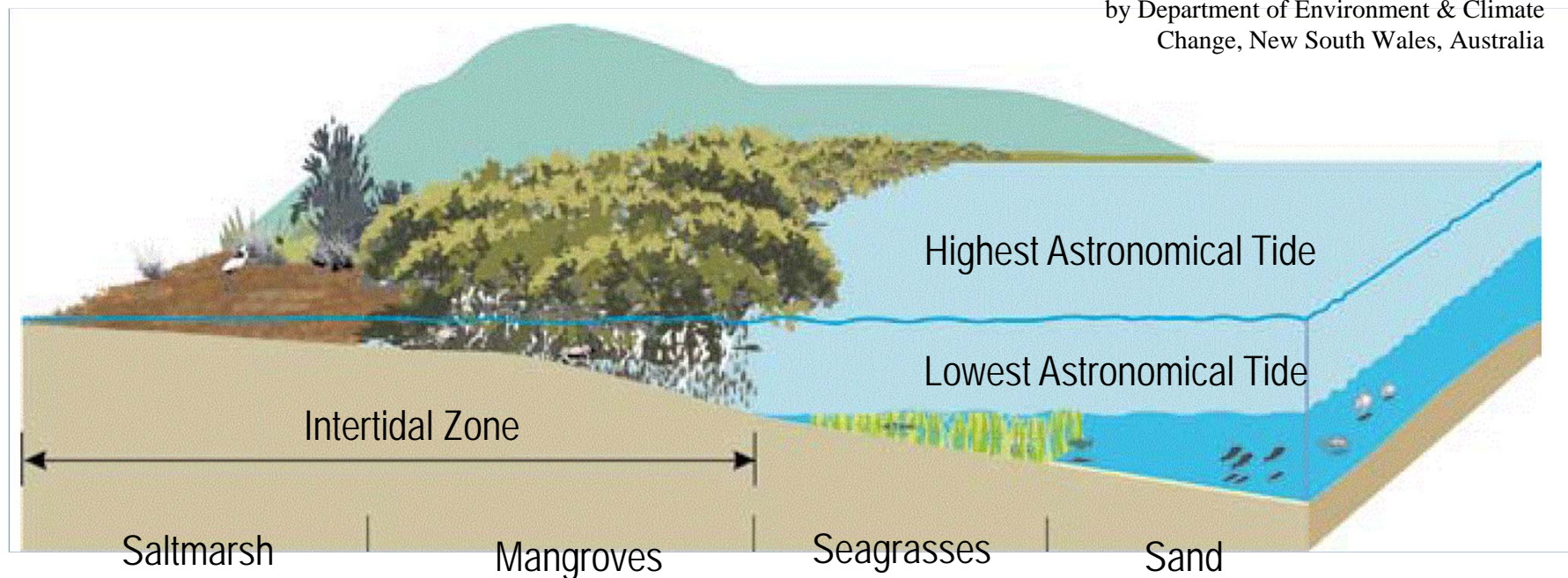
Seawalls with a native riparian vegetation buffer zone, benefits in bank stabilisation, water quality improvement and habilitate provision





Source: "Environmentally Friendly Seawalls"
by Department of Environment & Climate
Change, New South Wales, Australia

Eco-Shoreline





← Eastern Scheldt, the Netherlands
Oyster reefs to protect intertidal flats and create new habitats

Source: Ecoshape (http://www.ecoshape.nl/en_GB/oyster-reefs-eastern-scheldt.html)

Between Wemeldinge and Yerseke, →
the Netherlands
Water retaining pools are built in front of seawalls



Source: Deltares (<https://publicwiki.deltares.nl/display/BWN/Case+--+Rich+Revetment>)

Kwun Tong Promenade (Vertical Seawall)



Kai Tak Development (Sloping Seawall)



Central Reclamation (Vertical Wave-absorbing Seawall)



Typical Details of Vertical Wave-absorbing Seawall

