4.0 Foreshore Seawalls

4.1 Background

Urbanisation has resulted in extensive replacement of natural habitats with manmade structures. These structures provide altered habitat for estuarine organisms with seawalls the most common marine habitat within urbanised estuaries and bays (Davis et al., 2002; Chapman, 2003). Seawalls and other marine structures provide surfaces for colonisation by benthic organisms and have the potential to supplement natural habitat by supporting natural assemblages in terms of species composition and relative abundances (Derbyshire, 2006).

The design and construction of intertidal habitat and fish-friendly structures is an emerging field, with new research and information progressively becoming available. Guidelines prepared by the NSW DECCW in conjunction with the SM-CMA (Wiecek, 2009) provide a comprehensive range of techniques for consideration when planning for repairs or replacement of seawalls and other structures.

Seawalls have been constructed along approximately 45% of the study area's shoreline. These seawalls are highly varied in design, age and construction material, and condition. Any requirement to maintain or replace seawalls provides an opportunity to create intertidal habitat.

4.2 Project Scope

The project's scope of works required detailed field assessment of the entire foreshore study area to:

- Visually assess all seawalls along the foreshore to identify stretches of seawall requiring replacement or upgrading due to visible signs of degradation;
- Identify and outline options to improve the environmental value of the seawall stretches found to require either replacement or maintenance and/or that would be suitable for environmental enhancement; and
- Prioritise stretches of seawalls for environmental enhancement through either replacement or maintenance based on the severity of seawall degradation and the potential to improve the biodiversity value of the seawall.

The outcomes of the assessment include prioritised actions for discrete sections of seawall for the estuary as a whole and for each LGA.

4.3 Methods

4.3.1 Inspection Methodology

Visual Inspections were carried out in August and September 2009 between mid and low tides to ensure the most critical components of the seawalls (the structure toe and the splash zone), were visible. Generally, the inspections were carried out by boat, but where boat access was not possible, inspections were undertaken from the shore.

A discrete seawall was defined as a structure distinct, either by type or condition, from those adjacent, irrespective of length. A naming convention was derived based on the LGA in which the seawall was located and a sequential numbering system assigned from east to west along the LGA foreshore. Seawalls are denoted by the letter "S" before the asset number. The code used and the number of seawalls within each LGA is presented in Table 4-1.

Tidally influenced canals were inspected on foot where public access was available. The naming convention for canals was derived from the name of the canal and whether the canal wall is located on the west or east bank of the canal as shown in Table 4-2.

Table 4-1. Seawall naming convention

LGA	Code	No. of seawall sections	Codes
Ashfield	ASH_S	3	ASH_S01 – ASH_S03
Auburn	AUB_S	13	AUB_S01 – AUB_13
Canada Bay	CAN_S	75	CAN_S01 – CAN_S75
Hunters Hill	HUN_S	19	HUN_S01 – HUN_S19
Leichhardt	LEI_S	17	LEI_S01 – LEI_S17
Parramatta	PAR_S	25	PAR_S01 – PAR_S25
Ryde	RYD_S	25	RYD_S01 – RYD_S25
Sydney Olympic Park	SOPA_S	8	SOPA_S01 – SOPA_S08

Table 4-2. Canal naming convention

Canal	Code	No. of seawall sections	Codes
Archers Creek, East	ARC	1	ARC_E01
Archers Creek, West	ARC	1	ARC_W01
Barnwell Park East, East	BPE	1	BPE_E01
Barnwell Park East, West	BPE	1	BPE_W01
Barnwell Park West, East	BPW	3	BPW_E01 – BPE_E03
Barnwell Park West, West	BPW	3	BPW_W01 – BPE_W03
Charity Creek, East	CHA	1	CHA_E01
Charity Creek, West	CHA	1	CHA_W01
Dobroyd Canal, East	DOB	4	DOB_E01 – DOB_E04
Dobroyd Canal, West	DOB	4	DOB_W01 – DOB_W04
Groves Creek East	GRO	2	GRO_E01 – GRO_E02
Groves Creek West	GRO	2	GRO_W01 – GRO_W02
Haslams Creek East	HAS	6	HAS_E01 – HAS_E06
Haslams Creek West	HAS	6	HAS_W01 – HAS_W06
Hawthorne Canal, East	HAW	4	HAW_E01 – HAW_E04
Hawthorne Canal, West	HAW	6	HAW_W01 – HAW_W06
Powells Creek, East	POW	4	POW_E01 – POW_E04
Powells Creek, East	POW	5	POW_W01 – POW_W05
Salesyard Creek, East	PCT	1	PCT_E01
Salesyard Creek, West	PCT	1	PCT_W01
Saltwater Creek, East	SAL	1	SAL_E01
Saltwater Creek, West	SAL	1	SAL_W01
Smalls Creek	SMA	1	SMA_E01
Smalls Creek	SMA	1	SMA_W01

Seawall nomenclature is illustrated in Figure 4-1, which shows the Abbotsford Bay foreshore located in the City Canada Bay LGA. In this example, each section of seawall varies by both type and condition. Logging each section as a discrete seawall allows the distinct features of each to be identified and disseminated.

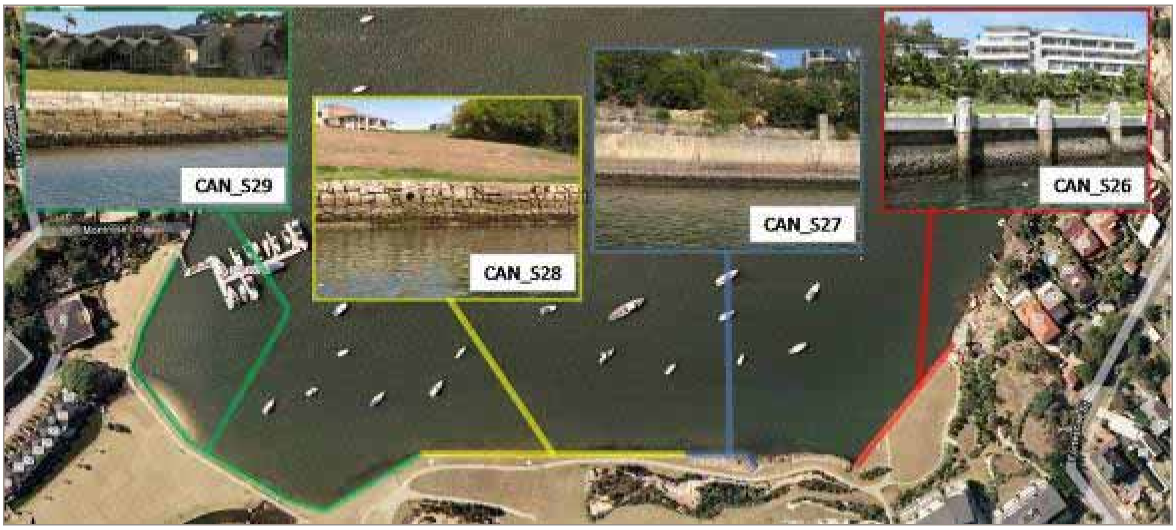

Figure 4-1. Illustration of seawall naming convention

4.3.2 Inspection Procedure

While undertaking the seawall inspections the following information was noted:

- Date, time, location, and tide level at the time of inspection;
- Type of seawall and a description of the area beyond and adjacent;
- Condition of the seawall from an engineering perspective[3] (refer Table 4-3);
- Assets supported and protected by the wall;
- Habitat provided by the seawall; and
- Representative site photographs for each seawall were taken.

Table 4-3. Seawall condition categories

Seawall Condition	Description
Excellent	• No defects observed • Structure is functioning as intended
Good	• Minor defects observed • Generally good condition • Structure is functioning as intended
Poor	• Major defects observed • Structure is at risk of failure without remedial action • Reduced functionality
Failed	• Major defects observed • Structure is no longer functioning as intended • Structure has collapsed

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[3] The condition assessment has been made solely on the visual inspections carried out. As such, there may be hidden factors that may affect the structural stability of the seawalls that could not be identified from the study.

4.4 Types of Seawalls

The following summarises the types of seawalls assessed within the study area:

4.4.1 Sandstone/Concrete Block Vertical Seawalls

Block seawalls are constructed from either worked sandstone or pre-cast concrete blocks. Both grouted and ungrouted sandstone and concrete block structures were found in the study area. Blocks ranged in length from 200mm to greater than 500mm. An example of a typical sandstone block seawall is shown in Figure 4-2.

Figure 4-2. Sandstone block vertical seawall

4.4.2 Sandstone/Concrete Block Revetments

Sandstone (Figure 4-3a) and concrete (Figure 4-3b) block revetments are present at many locations within the study area. The slope of these structures varies from around 1V:3H to 1V:1.5H[4] and both grouted and ungrouted revetments were observed. Similar to vertical block seawalls, sloping block revetments are constructed from blocks ranging in length from 200mm to greater than 500mm.

(a) (b)

Figure 4-3. (a) Sandstone and (b) concrete block revetments

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[4] V = vertical, H = horizontal

4.4.3 Concrete and Shotcrete Capped Seawalls and Revetments

These seawalls consist of a concrete capping layer over an older, usually sandstone or concrete block, seawall (Figure 4-4a). In many cases the concrete capping does not cover the full extent of the original wall with only the crest capped. Shotcrete is also used in places to cap older rubble revetments (Figure 4-4b). This maintenance is generally associated with development of the adjacent foreshore, either for recreational or residential purposes.

(a) (b)

Figure 4-4. (a)Sandstone block seawall with concrete capping layer at crest (b) and rubble revetment with shotcrete capping

4.4.4 Sandstone and Rock Rubble Revetments

Both ad-hoc and designed sandstone and rubble mound revetments are present within the study area. Ad-hoc structures are characterised by the lack of a secondary armour layer with the armour blocks placed directly on the underlying bank or fill material. Structures designed to typical engineering standards (Figure 4-5) consist of an armour layer, underlayers and in some cases a layer of geotextile fabric. Slopes are typically in the range of 1V:3H to 1V:1.5H. Armour units vary from small rubble material in the range of approx. 200-600mm to large sandstone boulders in the range of approx. 1400-1900mm.

Figure 4-5. Sandstone rubble revetment

4.4.5 Stepped Sandstone and Concrete Revetments

A number of stepped revetments were observed within the study area. These structures are characterised by medium sized (approximately 200 to 300mm in length), usually grouted, sandstone (Figure 4-6a) or concrete (Figure 4-6b) blocks which form steps to the street level beyond.


(a) (b)

Figure 4-6. (a) Stepped sandstone and (b) concrete block revetments

4.4.6 Grout Mattresses

Grout mattresses comprise a double layer of filter fabric filled with grout material. During installation the grout is pumped between the layers which are connected by an array of internal restraining ties. For revetment application, the mattress is placed on a battered bank with the grout pumped *in-situ* (Figure 4-7). This type of structure has not been used widely in the study area.

Figure 4-7. Grout mattress revetment

4.4.7 Gabion Unit Seawalls

A gabion is a wire mesh box filled with stone. Within the study area both gabion basket and gabion mattress structures are present, with the most common fill materials being rip-rap and sandstone. Gabion basket seawalls typically are stepped and extend from two to five baskets high (Figure 4-8a). Gabion mattresses have been used in places to extend the structure toe and are installed in conjunction with gabion baskets (Figure 4-8b).

Gabion structures usually are founded on the underlying bedrock regardless of whether baskets or mattresses are used at the toe. Gabion baskets are also used widely at discrete locations where failure of older seawalls or erosion has occurred.

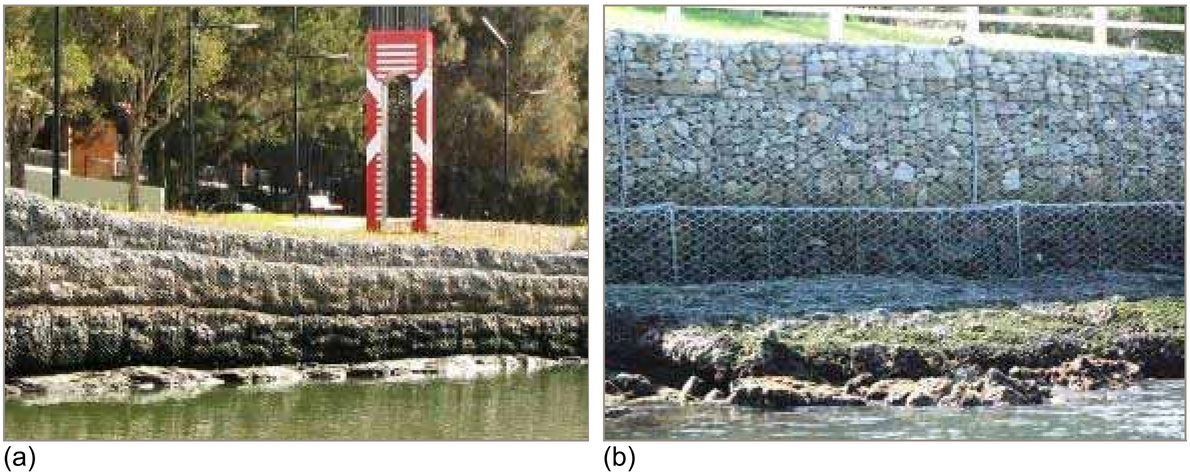

(a) (b)

Figure 4-8. (a) Gabion basket seawall founded on bedrock and (b) gabion basket seawall with gabion mattress toe extension

4.4.8 Canals

Urbanisation has lead to the canalisation of all major tributaries of the Parramatta River downstream of Silverwater Bridge. The original flow paths have largely been straightened, narrowed and lined to increase outflow of excess water and to reclaim adjacent lands for development.

Approximately 25 km of canals were assessed in the study area, most of which are characterised by a concrete bed and either vertical or sloping concrete sides (Figure 4-9).

At some locations, canal banks are constructed from sandstone blocks, bricks or shotcrete over older blocks or rubble revetments. Most canal walls have drainage at the toe or wall mid-height. Fences are present along the canal crests to prevent public access. Canals in the study area are managed by various Councils, Sydney Olympic Park Authority (SOPA) and Sydney Water.

Figure 4-9. Concrete lined canal with steel fence along crest to prevent public access

4.5 Failure mechanisms

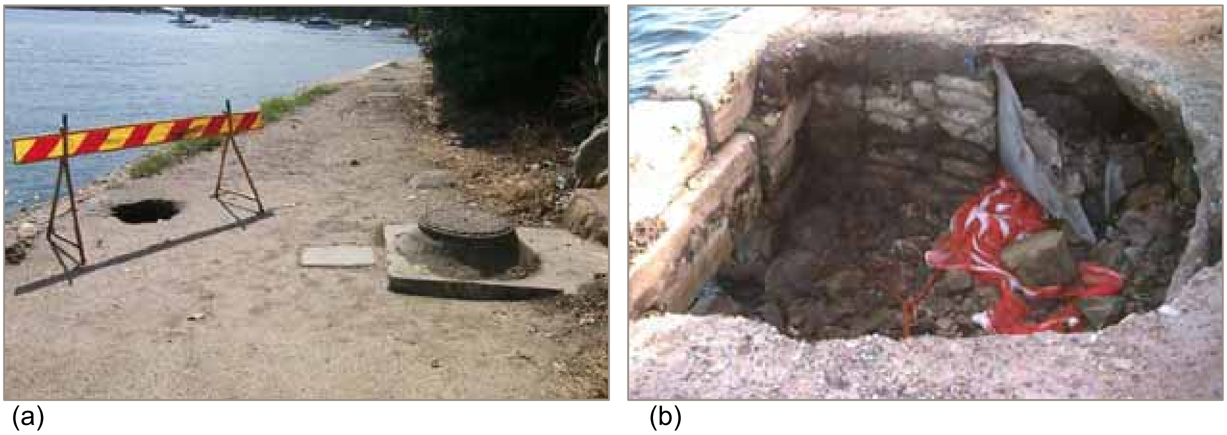
Seawalls exist in physically and chemically dynamic environments and over their lifetimes are susceptible to damage and deterioration. Damage is defined as structural degradation that occurs over a relatively short periods such as during single, or consecutive storm events. Deterioration is a gradual ageing of the structure over time (USACE, 2006).

Monitoring of coastal and estuarine protection structures is an integral component of life cycle management. Regular monitoring enables structures to be evaluated for safety, condition and functionality and also allows for timely planning of repair and replacement activities (CIRIA 2007). While undertaking visual inspections of the seawalls within the study area, varying maintenance regimes were encountered including repair of single blocks, re-grouting, concrete capping and replacement of entire lengths of seawall. It was also evident that in many cases no regular inspection or maintenance regime exists as many seawalls were in a poor condition or showed evidence of structural deterioration.

The following summarises the typical seawall failure mechanisms that are prevalent within the study area:

4.5.1 Inadequate Drainage

All seawalls and coastal revetments must be designed with appropriate filter layers to retain fine sediments on the landward side of the seawall and provide adequate drainage. Loss of fine sediments from behind the wall results in the development of sinkholes (Figure 4-10a) and the ultimate collapse of the seawall or revetment can occur when filter layers are not incorporated (Figure 4-10b). Inadequate drainage also leads to the build up of excessive pore water pressure behind the wall, which may result in lateral movement and compromise structural integrity.


(a)

(b)

Figure 4-10. (a) relatively small sink hole with larger cavity underneath (b) sudden collapse of unsupported pathway (North Sydney Council 2002)

4.5.2 Overtopping

Overtopping of seawalls and coastal revetments occurs due to inadequate crest height (Figure 4-11a). Overtopping, due to the combined influence of large tides, wave run up and storm surge can result in a loss of fines or a build up of excessive pore water pressure in the soil behind the wall. Conversely, some seawalls are designed to facilitate over topping at various tidal ranges to provide habitat for intertidal biota (Figure 4-11b).


(a)

(b)

Figure 4-11. (a) King tide overtopping crest, Hawthorne Canal, Ashfield LGA (b) Seawall design that allows overtopping of high tides to inundate saltmarsh vegetation Claydon Reserve, Kogarah LGA

4.5.3 Toe Scour

The foundations of seawalls and coastal revetments often incorporate toe protection to prevent scouring and undermining. Toe scour occurs due to currents from wind and vessel-induced waves. Where inadequate toe protection is provided, scour can lead to undermining of the wall (Figure 4-12a). In the case of block seawalls, undermining can result in individual block failures reducing the structural capacity of the seawall (Figure 4-12b). For rubble revetments, if the toe armour mass is insufficiently sized to resist currents, individual units may become dislodged exposing the material beneath the revetment, altering the structure profile and causing instabilities in the armour units above.


(a) (b)

Figure 4-12. (a) Undermining of seawall stairs and wall at Rodd Point, Canada Bay LGA (b) Individual block failure upstream of John Whitton Bridge, Ryde LGA

4.5.4 Differential Settlement

Differential settlement may occur if the structure is located on unconsolidated sediments and has inadequate foundations. Settlement can cause grout and concrete to crack and individual seawall units to move relative to each other, compromising the integrity of the structure.

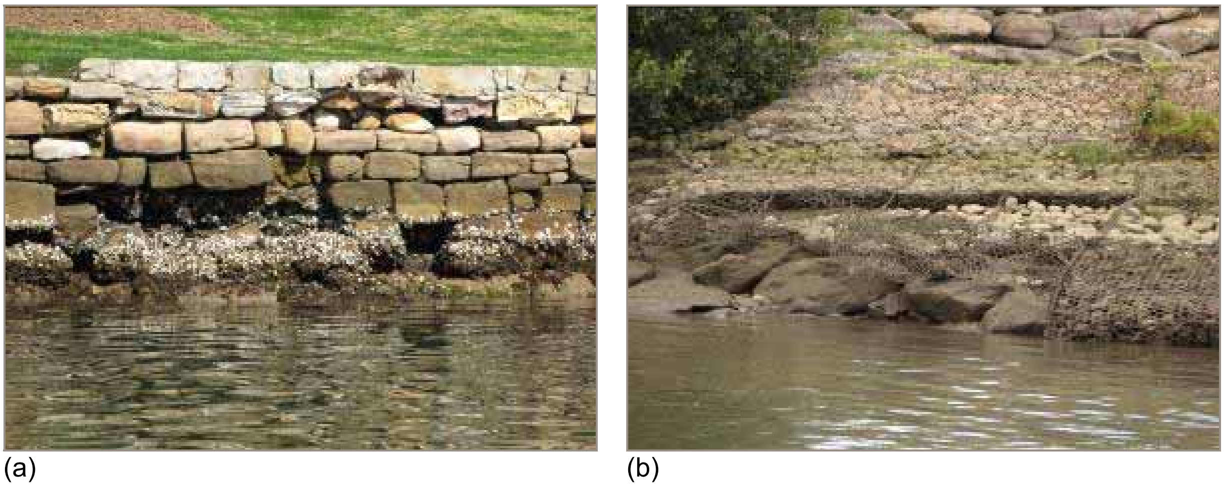

(a) (b)

Figure 4-13. (a) Movement of gabion wall units in Parramatta LGA (b) Relatively new seawall treatment showing differential settlement

4.5.5 Unit Failure

The individual units that form seawalls may deteriorate over time and, eventually, affect the structure's function.

- Sandstone and concrete weathers over time (Figure 4-14a).
- Where revetment armour material has been inadequately specified or has been installed in an ad-hoc manner, local wind-generated waves, currents or waves may displace the units.
- The wire mesh that forms gabion units corrodes over time leading to a loss of gabion fill material and ultimately failure of the structure (Figure 4-14b).


(a)

(b)

Figure 4-14. (a) Weathered sandstone blocks adjacent newly developed residential area in Canada Bay LGA (b) Loss of materials from gabion mesh units on the River in Parramatta LGA

4.6 Condition Assessment

4.6.1 Seawalls

Thirty six kilometres of seawalls were assessed in the study area, as follows:

- 45% (16.2 km) in the Canada Bay LGA;
- 13.8% (5.0 km) in the Parramatta LGA;
- 9% (3.2 km) in each of Auburn and Leichhardt LGAs;
- 8.4% (3 km) in Ryde LGA;
- 6.1% (2.2 km) in each of Hunters Hill LGA and Sydney Olympic Park; and
- 2.8% (1.0 km) in Ashfield LGA.

Nearly half of all seawalls inspected were found to be in poor condition (42%) or had some form of major defect (7%), while just over half of all seawalls were either in good (41%) or excellent condition (10%). Table 4-4 provides a summary of the various lengths of seawalls inspected within each LGA and their condition category.

Table 4-4. Seawall lengths inspected by LGA

LGA	Excellent	Good	Poor	Failed	Total Length of Seawalls in LGA (m)
Ashfield	0.0	438.3	551.6	0.0	989.9
Auburn	0.0	1,786.3	502.2	931.8	3,220.3

LGA	Excellent	Good	Poor	Failed	Total Length of Seawalls in LGA (m)
Canada Bay	3,381.4	5,772.3	6,124.1	905.2	16,183.0
Hunters Hill	0.0	604.8	1,550.1	19.0	2,173.9
Leichhardt	84.4	639.5	2,283.1	187.0	3,194.0
Parramatta	0.0	1,629.1	2,786.5	539.0	4,954.6
Ryde	49.3	1,692.5	1,195.2	66.6	3,003.6
SOPA	0.0	2,143.5	0.0	31.3	2,174.8
Total Length	**3,515.1**	**14,706.3**	**14,992.8**	**2,679.9**	**35,894.1**

4.6.2 Canals

Approximately 25 km of canals were assessed in the study area, as follows:

- 18.3% (4.5 km) in the Ashfield LGA;
- 2.0% (0.5 km) in the Auburn LGA;
- 29.4% (7.2 km) in the City of Canada LGA;
- 8.3% (2.1 km) in the Leichhardt LGA;
- 14.1% (3.5 km) in Ryde LGA;
- 13.3% (3.3 km) in Sydney Olympic Park; and
- 14.6% (3.6 km) in Strathfield LGA.

Sixty five percent of all canals inspected were in good (63%) or excellent (2%) condition, only 3% had some form of major defect, while the remaining 32% were categorised as in poor condition (Table 4-5).

Table 4-5. Canals lengths inspected by LGA

LGA	Excellent	Good	Poor	Failed	Total Length of Canals in LGA(m)
Ashfield	324.0	1,365.4	2,822.1	0.0	4,511.5
Auburn	0.0	0.0	498.3	0.0	498.3
Canada Bay	269.7	4,542.9	1,601.2	834.8	7,248.5
Leichhardt	0.0	1,028.3	1,027.3	0.0	2,055.7
Ryde	0.0	2,908.4	568.0	0.0	3,476.4
SOPA	0.0	2,733.8	561.2	0.0	3,295.0
Strathfield	0.0	2,855.2	744.9	0.0	3,600.1
Total Length	**593.7**	**15,434.0**	**7,823.1**	**834.8**	**24,685.5**

4.7 Sea Level Rise

Sea levels are projected to rise due to thermal expansion of the world's oceans and the melting of terrestrial ice sheets. There is strong national and international evidence supporting a projected rise of up to 40 cm by 2050, and 90 cm by 2100, for the NSW coastline. CSIRO modelling (McInnes et al. 2007), undertaken on behalf of DECCW, indicated a further local (NSW) increase associated with a strong warming of the sea surface in the region and a strengthening of the East Australian Current.

To support sea level rise adaptation, the NSW Government has prepared a Sea Level Rise Policy Statement. The Policy Statement includes sea level planning benchmarks which have been developed to support consistent consideration of sea level rise in land-use planning and coastal investment decision-making. The adopted benchmarks are for a rise relative to 1990 mean sea levels of 40 cm by 2050 and 90 cm by 2100. These benchmarks represent the Government's guidance on sea level rise projections for use in decision-making. Components of the sea level rise planning benchmarks adopted for NSW are shown in Table 4-6.

Table 4-6. Components of sea level rise planning benchmarks for NSW (DECCW 2009b)

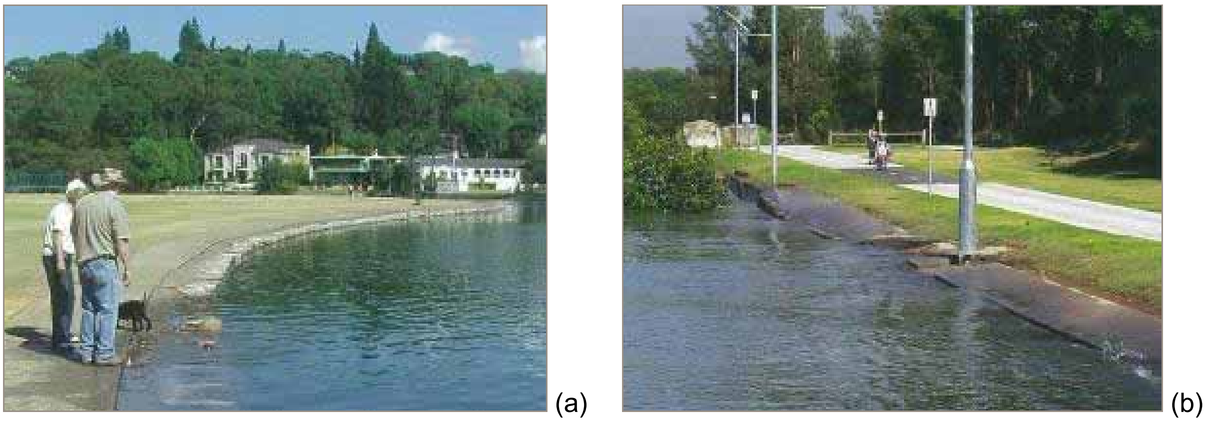
Component	Year 2050	Year 2100
Sea level rise	30cm	59cm
Accelerated ice melt	(included in above value)	20cm
Regional SLR variation	10cm	14cm
Rounding	0cm	-3cm
Total	**40cm**	**90cm**

The benchmarks adopted imply that seawalls with low crest levels will be overtopped on a more frequent basis as the extreme elevated water level events of today will become more common water levels by 2100 (Watson and Frazer, 2009). Overtopping is an identified seawall failure mechanism, and, should seawalls be overtopped on a regular basis, it can be assumed that increased monitoring, maintenance and, ultimately, replacement would be required.

Unless specifically designed to be inundated, frequent overtopping would compromise the function of the seawalls within the study area (i.e. seawalls that have been constructed to protect foreshore assets, guard against inundation and support reclaimed parklands) and may infiltrate potential contaminated land leaking toxicants into the estuary.

In January 2009, a high tide of 2.05m was predicted for the NSW coast. Although the tide did not reach the predicted level, a level of 1.96m above chart datum was recorded at Fort Denison which is only exceeded a small number of times per year. This high tide level will become a more frequent event with rising sea level.

DECCW facilitated a photographic record (January 2009) of the tide throughout NSW. Photographs taken at Tarban Creek in Hunters Hill (HUN_S11, Figure 4-15a) and Meadowbank in Ryde (RYD_S23, Figure 4-15b) indicated the vulnerability of low crested seawalls to overtopping with elevated water levels.



(a) (b)

Figure 4-15. King tide event at Tarban Creek in Hunters Hill, HUN_S11 (a) and Meadowbank in Ryde, RYD_S23 (b) (Watson and Frazer, 2009)

4.8 Environmental Enhancement

4.8.1 Habitat Creation Options

Options to improve the environmental value of seawalls are based on the principles and guidelines provided by the NSW DECCW in conjunction with the SM-CMA (Wiecek, 2009) and AECOM project experience of similar scope and nature. The following concepts should be considered for future seawall works in the study area. However, more detailed analysis is required on a site by site basis so that improvements are designed to suitably accommodate constraints and maximise any opportunities.

Riparian establishment (RE)

Establishment of native riparian vegetation upslope of existing or new seawalls where space is available landward of seawall, or where existing seawall is vulnerable to overtopping (i.e. incorporation of saltmarsh vegetation would then be suitable).

When establishing riparian vegetation, only low groundcover species should be used immediately adjacent public path / cycle ways to ensure that established vegetation does not become a safety hazard.

Mangrove establishment (ME)

Establishment of mangroves seaward of existing seawalls (i.e. plant mangrove seedlings to provide habitat and encourage sediment deposition and toe protection), where a beach or mud flat is present at low tide, and the seawall does not directly front deep waters.

Establishment of mangroves would not be appropriate if the exposed mud flat is recognised as important shorebird habitat.

Artificial reef habitat (ARH)

Creation of artificial reefs using boulders of various size and shape, woody debris, rock clumps or installation of reef balls, incorporating rubble toes for vertical seawalls (Figure 4-16). Artificial reef creation would be appropriate for a range of seabed depths, particularly where landward space is constrained, but not appropriate where existing established habitat occurs (e.g. seagrasses).

Figure 4-16. Incorporation of various sized rock boulders at toe of seawall Pearl Bay, Mosman LGA

Seawall surface treatment (SST)

Increasing the roughness and texture of seawall surfaces where vertical seawalls require repair or replacement and space constraints occur both landward and seaward. This can be achieved through the attachment of objects (i.e. incorporation of protruding / indented blocks, concrete panels with indentations and exposed aggregate). Also appropriate for addition to existing vertical seawalls.

Low profile sill (LPS)

Incorporation of intertidal vegetation using a low profile sill (i.e. rock fillet or barrier) and providing a suitably elevated growth medium behind the sill for planting or natural colonisation of intertidal vegetation (Figure 4-17). This technique would be appropriate where the existing seawall does not directly front deep waters and / or sufficient space is available seaward for installation of sill and planting area. Where landward space is available, Riparian Establishment (RE) can be incorporated upslope (refer Claydon Reserve example provided in Figure 4-11b). Not appropriate where existing habitat occurs (e.g. seagrass, or mud flat where shorebirds are known to feed).

Figure 4-17. Intertidal saltmarsh area between rock sills, and upland riparian groundcover (Claydon Reserve, Kogarah LGA)

Sub-tidal cave habitat (SCH)

SCH involves the addition of cavities, or not grouting between blocks, to create small habitat pockets and crevices. SCH creation would be appropriate for addition to existing vertical seawalls (where structurally possible), or the repair or replacement of seawalls where landward and seaward space is constrained (Figure 4-18a).

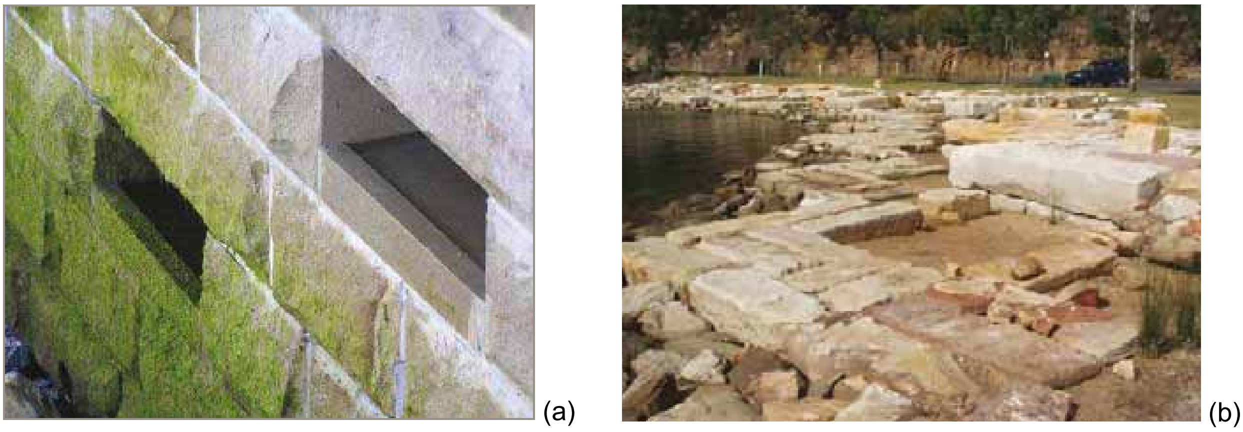


Figure 4-18. (a) seawall purposely designed to include pools in the structure for habitat (b) seawall created to incorporate a diversity of intertidal habitat including rock pools (Source: Weicek 2009)

Rock pools (RP)

Creation of habitat complexity by constructing rocky shorelines with pools and ledges, which remain damp at low tide pools that retain water at low tide (Figure 4-18b, Figure 4-19). RP creation would be suitable for gently sloping shorelines and seabeds, or where existing seawalls already provide terraces.

Figure 4-19. Pools that hold water at low tide created against existing seawall adjacent Spit Bridge, Mosman LGA.

4.8.2 Seawall Prioritisation

To determine the most appropriate locations for habitat creation (as part of repairs or replacement), seawall sections categorised as ‘poor’ or ‘failed’ were further assessed to understand the following:

(c) Existing function of the seawall, and

(d) Future potential value each seawall section might provide following environmental enhancement works

The most common functions of seawalls in the study area are the provision of support for other foreshore structures and reclaimed land. Failure of seawalls that structurally support other foreshore facilities (e.g. pathways, jetties) may result in replacement costs of more than just the seawall, and also impact on aesthetics, public amenity and so on.

Where seawalls protect reclaimed land, seawall failure may result in the liberation of ‘potentially contaminated’ landfill. This in turn would impact on water quality and aquatic biota. Furthermore, the potential for loss of land to the estuary may result where unconsolidated landfill is no longer supported.

Some seawalls have been constructed to mitigate erosion and/or protect native vegetation, and therefore support of existing vegetation is also considered as a function.

Potential values were based on the function of the surrounding environment and therefore opportunities that could be capitalised on in the future, for example:

- Public access, in particular multi-directional access (i.e. the site can be entered and exited from different directions and is potentially linked to other foreshore areas);
- Aesthetic and passive recreational amenity; and
- Education / interpretation opportunities (e.g. high usage area).

Ecological outcomes were considered too complicated for use as an attribute without further investigation. Therefore ecological benefits of creating habitat in seawalls were assumed as constant for all sites.

Eighty four (84) seawall sections either categorised as ‘poor’ or ‘failed’ were assessed in this manner. Table 4-7 provides a summary of 37 seawall sections which are considered to be the most appropriate for environmental enhancement.

Further information is provided for all seawalls (including canals) within the project GIS database and individual LGA management summaries provided in Section 9.0.

Table 4-7. Seawall sections, categorised as ‘failed’ or ‘poor’, most likely to benefit from environmental enhancement works

Priority	Asset Name	Locality	Functions			Potential		Habitat Creation Options[5]
			Assets	Reclaimed land	Upslope Vegetation	Access (multi-direction)	Adjacent open space	
High	CAN_S60	Mortlake Point, River South	√	√	√	√	√	LPS, ARH
High	PAR_S16	Macarthur St Bridge, River South	√	√	√	√	√	SST, SCH
High	RYD_S06	Morrison Bay, River North	√	√	√	√	√	LPS, ARH
Med-High	ASH_S03	Dobroyd Point, Iron Cove Bay	√	√	√	√		ME, ARH
Med-High	CAN_S23	Drummoyne, Five Dock Bay	√	√		√	√	LPS, ARH
Med-High	CAN_S63	Concord West, Yaralla Bay	√		√	√	√	RE
Med-High	CAN_S66	Rocky Point, River South	√	√		√	√	ARH
Med-High	HUN_S11	Tarban Creek	√	√		√	√	SST, SCH
Med-High	LEI_S08	Balmain, Iron Cove Bay	√	√		√	√	SST, SCH
Med-High	LEI_S09	King George Park, Iron Cove Bay	√	√		√	√	RP
Med-High	LEI_S11	Callan Park, Iron Cove Bay	√	√		√	√	LPS
Med-High	LEI_S13	Callan Park, Iron Cove Bay	√	√		√	√	LPS, ARH
Med-High	LEI_S14	Callan Park, Iron Cove Bay	√	√		√	√	SCH
Med-High	LEI_S15	Callan Park, Iron Cove Bay	√	√		√	√	SCH
Med-High	LEI_S16	Leichhardt Park, Iron Cove Bay	√	√		√	√	SCH, ARH
Med-High	PAR_S06	Silverwater Bridge, River North	√	√		√	√	ME, RE
Med-High	PAR_S09	Rydalmere Rail Bridge, River North	√		√	√	√	ARH
Med-High	PAR_S17	Macarthur St Bridge, River South	√	√		√	√	SST, SCH
Med-High	RYD_S23	Meadowbank, River North	√	√		√	√	ARH

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[5] Refer Section 4.8.1 for explanation of option codes.

Priority	Asset Name	Locality	Functions			Potential		Habitat Creation Options[5]
			Assets	Reclaimed land	Upslope Vegetation	Access (multi-direction)	Adjacent open space	
Med-High	RYD_S24	Meadowbank, River North	√	√		√	√	RP
Medium	CAN_S03	Rodd Point, Iron Cove Bay	√		√	√		ME
Medium	CAN_S04	Rodd Point, Iron Cove Bay	√		√	√		VSS
Medium	CAN_S06	Russel Lea, Iron Cove Bay	√		√	√		LPS
Medium	CAN_S14	Drummoyne, River South	√		√	√		SST
Medium	CAN_S16	Drummoyne, River South	√	√			√	ARH
Medium	CAN_S18	Drummoyne, River South	√	√			√	SST
Medium	CAN_S28	Chiswick, Abbotsford Bay		√		√	√	ARH, SCH
Medium	CAN_S37	Kings Bay, Hen and Chicken Bay	√	√	√			ME, ARH
Medium	CAN_S62	Majors Bay			√	√	√	RP
Medium	CAN_S64	Concord West, Yaralla Bay			√	√	√	ME, RE
Medium	CAN_S68	Rhodes, Brays Bay		√		√	√	LPS, ARH
Medium	LEI_S01	Birchgrove, River South	√	√		√		SCH, RP
Medium	LEI_S12	Callan Park, Iron Cove Bay		√		√	√	LPS
Medium	RYD-S22	West of Ryde Bridge, River North	√	√	√			ARH
Medium	SOPA_S01	Homebush Bay	√	√			√	ARH
Medium	SOPA_S02	Homebush Bay	√	√			√	ARH