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R1245 Rev 0 October 2019 **City of Bayswater Bayswater 2019 Foreshore Inspection** & 10 Year Priority Plan

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K1673, Report R1245 Rev 0 Record of Document Revisions

Rev	Purpose of Document	Prepared	Reviewed	Approved	Date
А	Draft for MRA review	J Costin	T Hunt	J Costin	11/09/2019
0	Issued for Client use	J Costin	T Hunt	T Hunt	1/10/2019

Form 035 18/06/2013

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1. Introduction

The City of Bayswater manage approximately 9.5 km of foreshore in the upper reaches of the Swan River. M P Rogers & Associates (MRA) were commissioned by the City of Bayswater (City) to carry out a visual condition inspection of the City's foreshore and prepare a 10-year foreshore works priority plan.

The City's foreshore includes both natural shorelines and constructed shoreline protection. A number of additional assets are also present, including boat ramps, jetties and boardwalks. Inspections of these structures was not included in this scope.

The extent of the City's foreshore is shown in Figure 1.1. It extends from the foreshore riverside of St John of God Hospital, Mt Lawley in the west, to the northern end of Claughton Reserve in the east.



Figure 1.1 City of Bayswater Foreshore Area

The scope for this assessment included the following:

- Visual inspection of the City's foreshore and rating of the condition of the shoreline; for both natural shoreline areas and constructed shoreline protection.
- Review of changes of the foreshore over approximately 3 decades.
- Review of the risks to the foreshore and development of a hierarchy of management options.
- Development of a 10-year foreshore works priority plan, including associated high-level cost estimates and estimated timeframes.

This report summarises the methodology of the completed works and the critical items identified in the inspection. The condition inspection data will be provided electronically to the City in GIS format.

2. Site Description

2.1 General

The City's foreshore is largely made up of undeveloped land which is predominately comprised of:

- Low lying wetland and bushland areas including the bushland area west of Bardon Park, Berringa Park wetlands, Maylands Samphire Flats, the Baigup Wetlands and the bushland area west of the Tonkin Highway Bridge.
- Turfed parkland areas including Berringa Park, Maylands Reserve, Clarkson Reserve, Tranby Reserve, Tranby House Reserve, Hinds Park, Bayswater Riverside Gardens and Claughton Reserve.

The Maylands Peninsular Public Golf Course also lies within the City's foreshore.

The following areas were not inspected and hence have not been included in this report:

- Maylands Amateur Boat Building Yard.
- Privately-owned sections of shoreline to the north of Bath St Reserve.

Shared footpath runs along the majority of the City's foreshore. The buffer between the footpath and the shoreline of the river varies in width from 150 m to as narrow as 5 m in some areas.

2.2 Site Conditions

Sections of the foreshore lie on land reclaimed and filled during foreshore works and deepening of the Swan River carried out during the late 1960s to 1970s (Riggert et al. 1978). The riverbank material includes sands, muds/silts, debris and uncontrolled fill. A map of historical dredging, reclamation and foreshore works along the City's foreshore is shown in Figure 2.1.



Figure 2.1 Historical Dredging, Reclamation & Foreshore Works (Riggert 1978)

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Though not shown in Figure 2.1, additional foreshore works are known to have occurred throughout the study area prior to the 1960s.

Typical riverbank conditions are shown in Figures 2.2 and 2.3.



Figure 2.2 Silt Overlaying Sands at the Shoreline West of Bardon Park



Figure 2.3 Uncontrolled Fill at Berringa Park (left) & Tranby Reserve (right)

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2.3 Acid Sulfate Soils

MRA reviewed the Department of Water & Environment Regulation (DWER) Acid Sulphate Soils (ASS) risk mapping of the City's foreshore. These maps are available at http://www.der.wa.gov.au/yourenvironment/acid-sulfate-soils/65-ass-risk-maps/. The relevant map

showing the site is provided in Figure 2.4.



Figure 2.4 ASS Risk Mapping of the City of Bayswater Foreshore

The maps show a High (red) to Moderate (orange) risk (Class 1) of ASS occurring within 3 m of the natural surface level over the study entire of the City's foreshore. Therefore, an ASS investigation would be required if soil or sediment disturbance of greater than 100 m³ is to occur.

2.4 Contaminated Sites

MRA reviewed the DWER Contaminated Sites Database mapping of the study area. These maps are available at <u>https://www.der.wa.gov.au/your-environment/contaminated-sites</u>.

The search did not identify any Registered Contaminated Sites intersecting the City's foreshore. However, the ground conditions are noted to be "contaminated" with rubble and debris, including concrete, rocks and bricks. This is evidence of uncontrolled fill.

Some areas of the City's foreshore are known to be historical industrial sites and contaminated soils can be anticipated in these areas. For example, pyritic cinders have been identified at Maylands Reserve and planned works in this area require management of this contamination.

2.5 Aboriginal Heritage

MRA completed an online search of Registered Aboriginal Sites and Heritage Places using the Department of Planning Lands and Heritage (DPLH) Inquiry System. The search portal can be found at: <u>https://maps.dia.wa.gov.au/AHIS2/</u>.

The search returned a number of Registered Aboriginal Sites and Aboriginal Heritage Places including:

- The Swan River (Site #3536).
- The Maylands Scarred Tree (Site #3520).
- Registered Site (Site #3753).
- Bardon Park (Site #3170).
- Wyatt Road (Site #4090).

It is noted that there may also be other sites of Aboriginal Heritage significance along the foreshore. Any works with the potential to impact these sites will need to receive approval from DPLH under Section 18 of the Aboriginal Heritage Act (1972).

3. Review of Historical Foreshore Stability

The historical stability of the foreshore was determined by assessing historical aerial photographs and mapping the shoreline to compare the location and assess change. It is noted that mapping the shoreline via the vegetation line can be influenced by factors such as extent of vegetation growth, canopy and other factors but provides a good indication of the stability of the shoreline and demonstrate areas of erosion and accretion.

The location of the vegetation line along the City's foreshore was compared over historical aerial photography from 1995, 2008 and 2019. The approximate overall shoreline movement for various areas of the foreshore, from 1995 to 2019 is shown in Figure 3.1.

Figure 3.1 indicates that erosion of at least 5 m has occurred over much of the City's foreshore. Notable areas of erosion are shown in Figures 3.2 to 3.9.



Figure 3.1 City of Bayswater Vegetation Line Movement 1995-2019



Figure 3.2 Maylands Reserve Shoreline 1995 (top) to 2019 (bottom)



Figure 3.3 Tranby Reserve Shoreline 1995 (left) to 2019 (right)



Figure 3.4 Hinds Park Shoreline 1995 (top) to 2019 (bottom)



Figure 3.5 Claughton Reserve Shoreline 1995 (left) to 2019 (right)



Figure 3.6 Berringa Park Wetlands Reserve Shoreline 1995 (left) to 2019 (right)



Figure 3.7 Maylands Samphire Flats Shoreline 1995 (top) to 2019 (bottom)



Figure 3.8 Clarkson Reserve Shoreline 1995 (left) to 2019 (right)



Figure 3.9 Maylands Peninsular Golf Course Shoreline 1995 (left) to 2019 (right)

3.1 Historical Surveys

Historical surveys were sourced but due to incomplete and unreliable information limited conclusions could not be drawn.

Comparison between 1997 and 2017 surveys show patterns of erosion and deepening throughout the City's reach of the Swan River generally consistent with erosion identified from the aerial photos. This includes:

- Deepening of the shallow areas of the river (between 0 and -1 mCD).
- Deepening of waters in the vicinity of:
 - Maylands Peninsular.
 - Tranby House Reserve.
 - Claughton Reserve.

3.2 Future Changes

Historical aerial photography indicates that erosion has occurred over the majority of the City's foreshore since 1995. Though limited, conclusions drawn from historical surveys are generally consistent with this.

This confirms that the City's foreshore is subject to ongoing erosive pressures.

These erosive pressures are expected to continue into the future. With increased boat traffic and sea level rise, erosion forces may be exacerbated in some areas.

4. Condition Inspection Methodology

4.1 DBCA Shapefiles

GIS shape files with the data from previous condition inspections were provided by the Department of Biodiversity Conservation and Attractions (DBCA). These previous inspections were completed by a range of reviewers across various times. The criteria used to rate sections of the shoreline is unknown. In this regard, comparison of the 2019 condition inspection with previous inspections needs to be considered carefully.

4.2 Shoreline Types

The DBCA shape files categorised the shoreline into several different types. This included two primary types of shoreline; natural and built (i.e. man-made structures). For consistency, MRA maintained these categories during the 2019 condition inspection.

The categories of natural shoreline provided by DBCA are:

- Sedimentary Exposed Bank.
- Sedimentary Beach.
- Sedimentary Scarp.
- Vegetated Sedges.
- Vegetated Tree Lined.

The categories of built shorelines are:

- Revetment.
- Wall.

It is noted that the differences between some of the natural shoreline types, for example exposed bank and beach, is somewhat unclear. Examples of each shoreline category, as understood by MRA, are provided in Figures 4.1 - 4.4.

4.3 Condition Inspection & Consequence Rating Matrix

The condition inspection was carried out using the Condition Inspection and Consequence Rating Matrix and Rating System presented in Tables 4.1, 4.2 and 4.3. This is based on previous work completed by MRA using guidelines from the US Army Corps of Engineers and is consistent with previous shoreline condition inspections completed by MRA for other local governments around the Swan River.

Rating	Condition	Structure Condition Description	Natural Shoreline Condition Description	Consequence Name	Consequence Description
NA	Not Assessed	Not Assessed	Not Assessed	Not Assessed	Not Assessed
1	Excellent	Sound Physical Condition No Work Required	Excellent vegetation health No evidence of erosion	Insignificant	No Injures Loss of \$0-\$1,000 Impact resolved; can be repaired within 1 month Unlikely to be raised in public; Complaints unlikely to be received No effect on other assets
2	Good	Acceptable Physical Condition; minimal short- term failure risk but potential for deterioration No Work Required	Good vegetation health. No undercutting. Minimal erosion evident	Minor	First Aid Treatment required Loss \$1,000 - \$10,000 Impact repairable; can be repaired within 1-6 months Local adverse media coverage; some complaint received Isolated effect on low value asset
3	Average	Significant deterioration evident; failure unlikely in near future but further deterioration likely Work Required but asset is still serviceable Joints have voids or blocks eroding, or voids present behind wall	Average vegetation health. Some undercutting. Some erosion evident	Moderate	Medical Treatment Required Loss \$10,000-\$100,000 Environmental damage; can be repaired within 6-12 months. Adverse media coverage; coordinated representation demand additional resource Affects Medium Value Assets
4	Poor	Failure likely in the short term Substantial work required in short term; asset barely serviceable Large voids or crack in wall, blocks eroded	Poor vegetation health. Severe undercutting and uprooting of fringing vegetation. Extensive erosion Rubble and debris	Major	Serious Injury Loss \$100,000-\$1.0M Long term environmental damage; will require at least 12 months to repair Affects High Value Assets
5	Very Poor	Failed or failure imminent / Safety risk Major work or replacement required urgently Footing undermined or blocks/ joints heavily eroded	Severely degraded vegetation. Trees recently lost Severe erosion Public safety hazard	Catastrophic	Death Loss of more than \$1.0M Irreversible impact; cannot be repaired or restored. Inquiry, dismissal or prosecution Long term reputation damage at state level Affects High Value Assets and Infrastructure

Table 4.1 Condition/Consequence Rating & Qualification

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		Condition Rating					
		1	2	3	4	5	
	5	5	10	15	23	25	
Rating	4	4	9	14	20	24	
duence l	3	3	8	13	19	22	
Conse	2	2	7	12	18	21	
	1	1	6	11	16	17	

Table 4.2 Combined Rating Matrix

Table 4.3 Approximate Works Timing

Combined Rating	Works Timing
1-3	15 Yrs+
4-6	
7-11	8 - 15 Yrs
12-17	4 – 8 Yrs
18-21	1 – 4 Yrs
22-25	Urgent <1 Yr



Figure 4.1 Sedimentary Shorelines, Left: Exposed Bank, Right: Beach



Figure 4.2 Sedimentary Shoreline – Scarp



Figure 4.3 Vegetated Shorelines, Left: Sedges, Right: Tree Lined



Figure 4.4 Built Shorelines, Left: Revetment, Right: Wall

5. Condition Inspection Results & Recommendations

5.1 Condition Assessment

A visual inspection of the City's foreshore was carried out by MRA engineers Jake Costin and Ben Turner on 16 July 2019. The DBCA GIS shapefiles from previous inspections provided asset IDs and ratings for separate stretches of the foreshore. MRA maintained these shapefiles and asset IDs where possible.

Whilst built shoreline protection structures such as river walls and revetments were included in this assessment, the ratings are limited to a summary of the asset's condition. A full structural assessment is beyond the scope of this survey.

The natural sections of the shoreline were rated based on the visible severity of erosion and the general health of the existing vegetation along the shoreline.

Condition ratings for each section of foreshore are provided based on the worst area of the section, as this, combined with the consequence, provides an assessment of the requirement of works timing. It is often the case that some sections of the asset are in better condition than the condition rating that has been assessed.

Consequence ratings are based on the risk associated with continued erosion, or degradation of built protection, over a 10-year timeframe.

Appendix A provides the outcomes of the condition assessment and combined ratings for each section of shoreline.

Management of areas with combined ratings of 12 and above are discussed in more detail below.

5.2 Foreshore Management Options

Options for management of eroding and/or deteriorating sections of foreshore include either:

- Retreat the relocation or removal of assets within an area identified as likely to be subject to intolerable risk of damage from erosion; or
- Stabilisation techniques that directly modify the bank to mitigate erosive forces.

Implementing stabilisation should only be considered if retreat is deemed to not be a viable option. In this regard, MRA recommends that the City consider the strategy of managed retreat as a primary option where possible. This strategy would involve allowing natural processes to continue and relocating foreshore assets inland as required. It could be combined with "softer" stabilisation options such as revegetation to slow the rate of erosion.

With the challenges present along City's foreshore, this is likely to be the simplest and most costeffective option for many areas.

5.2.1 Stabilisation Methods

If stabilisation is deemed necessary, both the approach and method need to be considered carefully. DBCA provides a comprehensive list of possible stabilisation approaches and methods in the *Best management practices for foreshore stabilisation. Approaches and decision-support framework* (Swan River Trust 2009). These options are presented in Table 5.1.

Table 5.1 Stabilisation Options

Approach	Method
Revegetation	Ground covers
	Combined multistorey vegetation
Bio-engineering (with	Coir logs
revegetation)	Jute matting
	Brushing/bunding
	Soil replacement (gravel/sand mix)
	Brush mattressing
Gabions	Stepped
	Mattress
Revetments	Rock toe with re-sloping
	Tipped rock
	Interlocked rock
	Layered
	Cellular system
	Block revetment
	Flexmat
	Geotextile Sand Containers
Riverwalls	Baffles
	Timber walling
	Sand bag walls
	Limestone block (gravity)
	Piled walls
	Concrete panel
	Sheet-piling
Renourishment	Without associated structures
	Combined with hard structures
	With sacrificial/temporary structures
	Construction of secondary features
Groynes/Headlands	Single short-groyne
	Single long-groyne
	Headland field
	Short groyne field
	Long groyne field
Flow modification	Riffles
	Flow baffles
	Channel excavation
	River training
	Spurs
	Large woody debris

When selecting the stabilisation approach(es), natural approaches such as revegetation and bioengineering should be incorporated where possible.

The following factors should also be considered in the selection of stabilisation method(s):

- Cost considerations.
- Dominant erosive processes wave, wind, current.
- Scale of the erosion.
- Space restrictions.
- Other relevant risks such as constructability, nearby infrastructure, safety, amenity & environmental impact.

The techniques outlined in Table 5.1 have been assessed at the critical areas identified from the condition assessment.

5.3 Critical Areas

5.3.1 Tranby House Reserve Timber Walling Table 5.2 Tranby House Reserve Timber Walling - Condition Summary

Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRMay02 Tranby Reserve.B08	Built	5	5	25	Urgent < 1 Yr

The Tranby House Reserve timber walling has a combined rating of 25. The critical rating means that actions are recommended within 1 year.

The timber walling is in very poor condition, with many beams falling away from the structure. Sand has recently been placed between the wall and the riverbank. The wall was holding some this material in place at the time of the inspection.

An approximately 1.5 m high vertical scarp exists landward of the wall and the riverbank above this scarp is steep. Trees on the riverbank are growing outwards at an approximately 45-degree angle towards the river. Two sets of stairs providing access to the shoreline are damaged. Warning signage is in place along the path to access the northern stairs, however both sets of stairs remain easily accessible.



Figure 5.1 Failed Tranby House Reserve Timber Walling



Figure 5.2 Tranby House Reserve Damaged Stairs & Warning Tape

Recommendations for the Damaged Stairs

Due to the erosion and the damage, the stairs present an unacceptable risk to public safety. The warning tape currently in place is not a sufficient barrier to the public. **MRA recommends the stairs are closed and appropriate barricading is installed to prevent public access.**

Although only approximately 5 m of erosion has occurred since 1995, erosion is likely to continue at this rate into the future. This places the infrastructure on the foreshore at risk. In this regard, a high consequence rating has been applied.

Peninsular Farm lies on this section of foreshore. The site is heritage listed historic farming land owned by the Australian National Trust. The site includes buildings and a seating area, which currently lies at the top of the riverbank and will likely become undermined as erosion continues.

The timber walling was previously inspected in 2014 and the structure had failed at this time. The inspections recommended urgent repairs be carried out to the timber walling. It does not appear that any repair works have been completed since 2014.

Recommended Management Option

A decision tree of management options for the Tranby House Reserve Timber Walling is presented in Figure 5.3. The options considered are primary managements options. Options noted as inappropriate may still be included as additional stabilisation measures. For example, revegetation of the riverbank may be included in addition to a revetment, despite revegetation not being an appropriate primary stabilisation method.



Figure 5.3 Tranby House Reserve Timber Walling –Decision Tree

Figure 5.3 indicates that a revetment or riverwall would be an appropriate stabilisation option. MRA recommends the foreshore stabilisation at the Tranby Reserve North Timber Walling include:

- Stabilisation at the base of the riverbank.
- Rehabilitation and revegetation of the riverbank.

In order to provide a budget cost estimate, a rock revetment and riverbank revegetation has been assumed.

The stabilisation would require further consideration in order to develop a concept and subsequent detailed design. Some of these considerations would include:

- Access to the site.
- Determination of key design parameters ie crest height, toe level and materiality.

The design would also benefit from input from a landscape architect and an arborist. A landscape architect would inform the riverbank revegetation and an arborist would advise the health, stability and value of the existing trees.

MRA also recommends that the City commence discussions with the National Trust and DPLH to start the process for approvals. There may also be a potential opportunity to obtain Government funding for protection of the Peninsular Farm site, as a heritage conservation initiative.

5.4 High-Risk Areas

The high-risk sections of shoreline are those with a combined rating of 18 - 21, meaning actions are recommended within 1 to 4 years. These sections are listed and discussed below:

- Maylands Reserve.
- Hinds Park.
- Tranby House Reserve North of Peninsular Farm.

5.4.1 Maylands Reserve Rock Revetment & Natural Shoreline Table 5.3 Maylands Reserve Rock Revetment & Natural Shoreline- Condition Summary

Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRMay04 Maylands Reserve.N02	Natural	4	4	20	1 – 4 Yrs
SRMay04 Maylands Reserve.B01	Built	3	5	13	4 – 8 Yrs

Rock Revetment

The rock revetment is in average condition. Slumping is evident and the armour rocks generally appear smaller than what would be expected for a revetment with this level of exposure to boat wake. An anchor block for the floating jetty is located at the crest of the revetment. Continued slumping of the revetment may compromise the stability of the anchor block and potentially cause it to fail.

Natural Shoreline

Erosion is occurring along 100 m of natural shoreline to the east of the revetment. As shown in Figure 5.8, this has led to scarping and undercutting of the foreshore. Continued erosion of the shoreline could lead to undermining of the revetment and could potentially compromise a nearby drainage asset.

Up to approximately 10 m of erosion has occurred since 1995. This erosion is likely to continue if shoreline stabilisation is not implemented. MRA has recently provided the City with a design for stabilisation and rehabilitation of the shoreline. It is understood that this will be implemented within the short term.



Figure 5.4 Maylands Reserve Rock Revetment



Figure 5.5 Maylands Reserve Natural Shoreline



Figure 5.6 Maylands Reserve Drainage Asset Natural Shoreline

Revetment Upgrades

In addition to the planned shoreline works, MRA recommends that the rock revetment is upgraded within the next 4 to 8 years. This would likely include repacking and placement of additional armour rocks around the anchor block.

While the maintenance of the revetment and anchor block is not a high priority at the moment, there may be an opportunity to complete this work with the remainder of the Maylands Reserve shoreline stabilisation.

5.4.2 Hinds Park Table 5.4 Hinds Park Shoreline - Condition Summary

Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRBay03 AP Hinds Park.N0	Natural	3	2	12	4 – 8 Yrs
SRBay04 Garret Road Bridge.N01	Natural	3	2	12	4 – 8 Yrs

Table 5.5 Hinds Park Sea Scout Hall Block Wall - Condition Summary

Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRBay03 AP Hinds Park.B01	Built	4	2	18	1 – 4 Yrs

Hinds Park Sea Scout Hall Block Wall

The base of the block wall in front of the Sea Scouts Hall has become exposed. Erosion was noted at this location during previous inspections. Rip rap has been placed in front of the block wall. The rocks are small and do not bound appear to be secured in place either through grout or sound interlocking. Some rocks have rolled out, particularly at the eastern end where erosion at the base of the block wall is worse.

Ongoing erosion of the beach in front of the block wall will lead to further loss of rip rap and subsequent further degradation of the block wall.

Hinds Park Shoreline

Erosion is occurring along the Hinds Park sandy shoreline. This has led to undercutting of trees near to the shoreline. Two trees at the eastern end have been completely undercut and have fallen over. The erosion has resulted in a narrow beach in front of the Sea Scouts Hall.

Up to approximately 10 m of erosion has occurred at some locations since 1995, including in front of the Rowing Club. Erosion is expected to continue at this rate into the future. The Rowing Club is not deemed to be at risk over next 10 years, however the inshore sections of the jetty and footpath may become undermined.

The shoreline at Hinds Park to the west of the Rowing Club was in average condition, with generally no immediate cause for concern. However, erosion has reduced the width of turf between the playground sand pit to less than 1 m. This will require management in the short term.



Figure 5.7 Block Wall in front of Sea Scouts Hall



Figure 5.8 Sandy Shore in front Sea Scouts Hall



Figure 5.9 Undercut Trees Adjacent to Rowing Club Jetty

Recommended Erosion Management Option for Hinds Park

A decision tree for management options at Hinds Park is presented in Figure 5.10. The figure indicates that a range of stabilisation options would potentially be appropriate.

MRA has previously provided a concept sketch of remedial works at Hinds Park which included a universal access ramp to the beach, sand nourishment either side of the jetty and rock protection around the trees east of the jetty. This concept was prepared with the aim of improving access to the beach and protecting the trees.

However, the entire stretch of Hinds Park is clearly eroding to some degree and is expected to continue to erode into the future. MRA recommends that the City consider a master planning exercise to develop a long-term vision for the area. This could include a plan for the Rowing Club, Sea Scouts Hall, playground, jetty and beach access. A master plan would then inform the selection and design of stabilisation.

In order to provide a budget cost estimate, the following stabilisation methods have been assumed:

- Repairs and upgrades to the block wall and rip rap re-mortaring and grouting of the rip rap.
- Sand nourishment.
- Up to four nodal headlands (rock protection) along the shoreline to protect the existing trees hold the sand in place

Although stabilisation is recommended the entire stretch of Hinds Park, the repairs and upgrades to the block wall are a higher priority than stabilisation of the shoreline. Repairs to the block wall are recommended within the next 1 - 4 years. Hence the City could initially repair the block wall independently to the rest of the area.

In addition to stabilisation, MRA recommends that the City consider removing the rubble and debris from the shoreline in front of the Sea Scouts Hall.



Figure 5.10 Hinds Park Decision Tree

5.4.3 Tranby House Reserve – North of Peninsular Farm

The section between Peninsular Farm and Bath Street Reserve has been rated as high risk. This approximately 275 m long stretch of foreshore consists of a sandy shore in front of a steep riverbank, with erosion scarps of up to 4 m high in some areas. Four separate sections of rock revetment lie on intermittent lengths on the shore.

Many trees on the riverbank and shoreline have died and have fallen into the water. Some trees on the riverbank are growing outwards at an approximately 45-degree angle towards the river.

The impacts of erosion can be seen along the footpath alignment. As shown in Figure 5.11, the elevation of the footpath is lower nearer to the edge of the riverbank. Continued erosion may

impact other infrastructure including drainage and potentially other services in the area. As shown in Figure 5.12, a Water Corporation asset has already been exposed.

Aerial photography indicates that up to 5 m of erosion has occurred in this area since 1995. This rate of erosion is expected to continue into the future. This does not pose a significant risk to the apartment buildings over a 10-year timeframe. However, it is expected that protection will eventually be required.

Table 5.6	Tranby House Reserve North of Peninsular Farm – Shoreline Condition
	Summary

Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRMay02 Tranby Reserve.N03	Natural	4	3	19	1 – 4 Yrs
SRMay02 Tranby Reserve.N02	Natural	3	3	13	4 – 8 Yrs
SRMay02 Tranby Reserve.N01	Natural	3	3	13	4 – 8 Yrs

Table 5.7 Tranby Reserve North of Peninsular Farm – Revetments Condition Summary

Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRMay02Tranb y Reserve.B07	Built	4	3	19	1 – 4 Yrs
SRMay02 Tranby Reserve.B06	Built	4	3	19	1 – 4 Yrs
SRMay02 Tranby Reserve.B05	Built	3	3	14	4 – 8 Yrs
SRMay02 Tranby Reserve.B03	Built	3	3	14	4 – 8 Yrs
SRMay02 Tranby Reserve.B02	Built	3	3	13	4 – 8 Yrs



Figure 5.11 Low Footpath & Apartment Buildings to the West of the Footpath



Figure 5.12 Eroded Riverbank & Exposed Water Corporation Asset



Figure 5.13 Rock Revetments & Dead Trees along the Shoreline

Recommended Erosion Management Option

A decision tree of management options for Tranby House Reserve – North of Peninsular Farm is presented in Figure 5.14.



Figure 5.14 Tranby House Reserve - North of Peninsular Farm Decision Tree

MRA recommends managed retreat in this location. This will require relocation of the footpath further inland. This may also require relocation of drainage and other assets.

It is noted that ongoing erosion will result in loss of vegetation and trees from the riverbank. Additional revegetation could be considered to slow the rate of erosion and mitigate the vegetation loss.

Additional Actions

In addition to managed retreat and relocation of assets, MRA recommends the following actions are undertaken:

- Consider upgrading the drainage infrastructure in this area. This may reduce erosion due to runoff.
- Ongoing monitoring of the foreshore width between the apartment buildings and the riverbank.
- City to notify Water Corporation of the exposed asset and the City's adopted erosion management strategy.
- Consider placement of material in isolated pockets of increased erosion. This could include planting on top of the placed material. Figure 5.12 is an example of a potential location for

isolated infilling and planting. This would improve the visual appearance of the riverbank, providing a more consistent edge, along with some additional resilience.

5.5 Medium Risk Areas

The medium risk sections of shoreline are those with a combined rating of 12 - 17, meaning actions are recommended within 4 to 8 years. These sections are listed and discussed below:

- Tranby Reserve.
- Claughton Reserve.
- Riverside Gardens Beach.
- Maylands Peninsular Golf Course Hole 5.
- Maylands Reserve Timber Riverwalls.
- Samphire Flats.

5.5.1 Tranby Reserve Table 5.8 Tranby Reserve Shoreline

Asset Name	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRMay03 Clarkson Reserve.N01	Natural	3	2	12	4 – 8 Yrs
SRMay02 Tranby Reserve.N06	Natural	3	2	12	4 – 8 Yrs
SRMay02 Tranby Reserve.N05	Natural	2	2	7	8 – 15 Yrs

Erosion is occurring along Tranby Reserve. This has led to vertical scarps of 2 - 3 m in height and undercutting of trees and grass. Many of the trees appear to be in poor health and some trees, along with a number of limbs, have fallen into the river.

The eroding shoreline has exposed general building rubble and debris including concrete, rocks and bricks. This is evidence of the uncontrolled fill used during historical filling of this area. Exposure of this material is likely to continue as erosion continues. Due to the uncontrolled nature of this fill, there is a risk of contamination and release to the river as the foreshore erodes.

The buffer between the footpath and the erosion scarp reduces to less than 5 m through some of this area.

The gazebo near to the northern end of this area, shown in Figure 5.16, is at risk of becoming undermined. Rocks have been placed on the shoreline on the southern side of the gazebo which

are providing some protection however, erosion is occurring on the sandy shore the northern side of the gazebo.

Up to approximately 10 m of erosion has occurred since 1995 in some areas along this stretch of foreshore. Although the erosion has slowed since 2008 in some areas, erosion is likely to continue into the future. This places the footpath at risk.



Figure 5.15 Tranby Reserve Eroded Riverbank



Figure 5.16 Gazebo, Left: Northern Side, Right: Eastern Side

Recommended Erosion Management Option

A decision tree of management options for Tranby Reserve is presented in Figure 5.17.

MRA recommends managed retreat for Tranby Reserve. This will require relocation of the footpath as required, once it is under threat of erosion. Other infrastructure is located at the southern end of Tranby Reserve including the Maylands Tennis Club and car park, toilet block and a drainage outlet. Erosion is less pronounced in this area and hence the car park and toilet block are unlikely to require management actions within the next 10 years. However, the drainage outlet may need to be relocated inshore if erosion continues and the outlet becomes undermined.

Over the next 10 years, erosion is not expected to impact the building and garden area, located inland from the gazebo. However, erosion is expected to continue beyond the 10-year timeframe and the City will eventually need to consider this.

Recommendations for the Gazebo

Due to the risk to public safety, MRA recommends the following actions:

- Barricading off the entrance to structure to prevent public access. The existing warning does not provide a sufficient barrier.
- Undertaking a structural inspection of the gazebo to determine the structural capacity and safety risks.
- If the City wishes to retain the gazebo, undertake:
 - Measures determined by a structural assessment which may include repairs or replacement.
 - Local shoreline stabilisation to prevent undermining.
- Removal of the gazebo, if decided by the City.



Figure 5.17 Tranby Reserve Decision Tree

Additional Actions

In addition to the considerations noted above, MRA recommends the City consider removing the debris from the shoreline.

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5.5.2 Claughton Reserve Table 5.9 Claughton Reserve - Condition Summary

Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRBay01 Claughton Reserve.N02	Natural	3	3	13	4 – 8 Yrs

Table 5.10 Claughton Reserve Revetment - Condition Summary

Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRBay01 Claughton Reserve	Built	2	2	7	8 – 15 Yrs

Claughton Reserve covers an approximately 500 m long stretch of foreshore extending north from the Tonkin Highway bridge. The area is made up of embayed retreats of sandy beaches which lie between sections of tree lined foreshore. Some stabilisation has been installed with a number of small headlands around the trees and revegetated areas which have been fenced off.

Erosion is occurring along the sandy shores which has led to scarping of approximately 0.5 m in height and undercutting of trees and vegetation. Many of the trees appear to be in poor health and some have fallen into the river. The buffer between Katanning Street and the vegetation line narrows to as little as 5 m in some areas. Claughton Reserve is a popular location for fishing and dog walking and as a result, public traffic is likely contributing to the erosion of the sandy beaches.

Public infrastructure including barbeques and bench seats lie between Katanning Street and the shoreline. The Bayswater Boat Ramp and carpark are situated towards the southern end of the area.

The existing rock protection structures were generally in good condition.

Up to 10 m of erosion has occurred at some locations since 1995. This erosion is expected to continue into the future.



Figure 5.18 Claughton Reserve

Recommended Erosion Management Option for Claughton Reserve

A decision tree of management options for Claughton Reserve is Figure 5.19. The figure indicates that a range of stabilisation options could potentially be appropriate.

Design of stabilisation measures would benefit from a site landscaping plan. This would inform the overall site layout which could include enhanced beach access in addition to areas for native vegetation, turf, public infrastructure (barbeques, benches, gazebos etc.).

Works at Claughton Reserve are included during year 5. Due to the limited buffer to Katanning Street, ongoing monitoring of the shoreline is warranted.

In order to provide a budget cost estimate the following stabilisation methods have been assumed:

- Sand nourishment.
- Up to three nodal headlands (rock protection) along the shoreline to protect the existing trees hold the sand in place
- Revegetation of the riverbank.

Given that some stabilisation and revegetation has already been carried out on the site, this appears consistent with current measures accepted by the City and DBCA.



Figure 5.19 Claughton Reserve Decision Tree

5.5.3 Riverside Gardens Beach Table 5.11 Riverside Gardens Beach - Condition Summary

Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRBay03 AP Hinds Park.N03	Natural	3	2	12	4 – 8 Yrs

The beach at the Riverside Gardens area, located to the east of Hinds Park, received a combined rating of 12 due to the average condition of the beach and erosion to the turfed areas at the back of the beach. This means that management actions are recommended within the next 4 to 8 years. The erosion has led to steepening of the beach and undercutting of the turf at the rear of the beach.

The area is a popular dog beach. Human (and canine) activity is likely the cause or an exacerbator of this erosion, particularly undercutting of the turf. In this regard, MRA recommends rehabilitation of this area and addressing of this. MRA recommends that the City consider undertaking a master planning exercise to develop a long-term vision for the area. This could include landscaping works and beach access ramps etc to focus human traffic over the turfed areas.

In order to provide a budget cost estimate, sand nourishment, replanting of turf and installation of three beach access ramps has been assumed.



Figure 5.20 Riverside Gardens Beach

5.5.4 Maylands Peninsular Golf Course – Hole 5 Table 5.12 Maylands Peninsular Golf Course Erosion Scarp - Condition Summary

Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRMay05 Maylands Peninsular Golf.N02	Natural	3	2	12	4 – 8 Yrs

Erosion is occurring at an approximately 50 m long stretch of the shoreline of the Maylands Peninsular Golf Course. This section of shoreline has eroded by approximately 10 m since 1995. The erosion has led to an approximately 1 m high erosion scarp along this section of shoreline.

This erosion is likely to encroach towards the Hole 5 Tee-off Area over the next 10 years.



Figure 5.21 Erosion at the Maylands Peninsular Golf Course (Nearmap)



Figure 5.22 Erosion Scarp at the Maylands Peninsular Golf Course – Hole 5

MRA recommends the management of the erosion at Maylands Peninsular Golf Course – Hole 5 include:

- Stabilisation of the shoreline.
- Rehabilitation and revegetation.

To provide a budget cost estimate, re-profiling of the riverbank, stabilisation with coir matting and revegetation has been assumed.

Table 5.13 Maylands Reserve Timber Riverwalls – Condition Summary							
Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing		
SRMay04 Maylands Reserve.B03	Built	4	1	16	NA		
SRMay04 Maylands Reserve.B02	Built	5	1	17	NA		

5.5.5 Maylands Reserve Timber Riverwalls Table 5.13 Maylands Reserve Timber Riverwalls – Condition Summary

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Su	mmary				
Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRMay04 Maylands Reserve.N04	Natural	3	1	11	NA

Table 5.14 Shoreline Between Maylands Reserve Timber Riverwalls - Condition

The timber riverwalls located approximately 300 m west of the Maylands Reserve Boat Ramp are in very poor condition. Erosion is occurring behind the riverwalls which has undercut the trees. The shoreline between the walls is also eroding and currently lies approximately 3 m inshore from the trees.

Aerial photography indicates that approximately 3 m of erosion has occurred since 1995. With anticipated loss of these trees, erosion is likely to increase into the future.



Figure 5.23 **Undercut Trees at Maylands Timber Riverwalls**

Other than the riverwalls themselves, no infrastructure appears to be located on this section of foreshore. Hence ongoing erosion does not pose a threat to any infrastructure.

On this basis, MRA recommends that the City allow this area to erode and simply remove the remnants of the riverwalls as required. Additional revegetation and replacement tree planting could be considered to slow the rate of erosion and assist in stabilising the shoreline.

5.5.6 Maylands Samphire Flats Table 5.15 Maylands Samphire Flats - Condition Summary

Asset ID	Shoreline Type	Condition Rating	Consequence Rating	Combined Rating	Works Timing
SRMay03 Clarkson Reserve.N03	Natural	3	2	12	NA

The Maylands Samphire Flats is a low-lying area of foreshore located between Maylands Reserve and Clarkson Reserve. The area appears to be a historical drainage area for Lake Brearley and Lake Bungana to north. Drainage channels were dug through this area during the late 1950s/early 1960s.

Today the area is home to saltmarsh and samphire plant communities which are understood to be of high environmental value.

Vegetation along the shoreline of the Maylands Samphire Flats in average condition. Ongoing erosive pressures are likely be contributing to this. Up to 20 m of erosion has occurred in some locations on this shoreline since 1995. Some of this erosion is attributable to natural erosive processes of the Swan River. Erosion due to boat wake would also be a contributing factor.

These erosive pressures are likely to increase into the future due increased boat traffic and sea level rise. The area is particularly susceptible to erosion due to sea level rise and flooding.

Given that the Maylands Samphire Flats is a relatively natural area and the ongoing erosive pressures are, at least in part, due to natural erosive processes, MRA does not recommend any action be taken for this area.

Recommendations for Saltmarsh & Samphire Preservation

Due to the expected continued erosion, MRA recommends that future saltmarsh and samphire preservation efforts focus on areas at least 10 - 20 m inland of the shoreline.



Figure 5.24 Maylands Samphire Flats

5.6 Loss of Trees & Vegetation

In addition to the undercut and fallen trees noted throughout the critical, high and medium risk areas discussed above, there are many undercut and fallen trees along the City's foreshore. The sections of shoreline that these trees lie on have been rated based on the general health of the natural shoreline, or condition of the built erosion protection, and on the anticipated consequence if the erosion continues without intervention.

This approach has resulted in many areas of the City's foreshore with undercut or fallen trees, but with a relatively wide buffer between the shoreline and nearby assets, receiving a consequence rating of 3 (Moderate) or lower. This has yielded low combined ratings for these areas. This is considered appropriate as the alternative would result in a large number of areas being rated as

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high-risk when the issue is the loss of a limited number of trees, rather than any key infrastructure.

There are significant environmental and public amenity values associated with retaining and improving tree numbers and vegetation along the City's foreshore. MRA recommends that the City considers whether protection of specific trees is a requirement and if so, in which areas. This is particularly applicable to the open space and parkland areas.

The following examples of foreshore areas with at-risk trees are shown below.

- Berringa Park.
- Grassy foreshore west of the Maylands Reserve Boat Ramp
- Vegetated shorelines at Hinds Park & Riverside Gardens



Figure 5.25 Berringa Park At-Risk Trees



Figure 5.26 Undercut Trees at Maylands Timber Riverwalls



Figure 5.27 Vegetated Shorelines at Hinds Park & Riverside Gardens

Protection of these trees would require stabilisation of the immediate area around each tree. The simplest version of this would consist of small rock protection. An example of this is shown in Figure 5.28.



Figure 5.28 Localised Tree Protection Example

In addition, tree replacement and revegetation is recommended to offset losses and improve stabilisation.

6. 10 Year Priority Plan

A detailed 10-year priority plan for management of the City's foreshore is presented in Table 6.2. The table outlines the sections of shoreline expected to require management over the next 10 years, the recommended management options and key details, timeframes and budget costs. For completeness, the areas where retreat has been recommended have also been included.

A summary of the 10-year priority plan and budget costs is provided in Table 6.1.

Item	Foreshore Area	\$	Subtotal	Ann	ual Subtotal
4	Maran A			•	050.000
1	Year 1 Tranhy House Reserve Timber Walling	\$	850.000	\$	850,000
1.1	Inampy house reserve himber waning	Ψ	000,000		
2	Year 2			\$	580,000
2.1	Maylands Reserve Rock Revetment	\$	50,000		
2.2	Maylands Reserve Natural Shoreline	\$	440,000		
2.3	I ranby House Reserve North of Peninsular Farm -	\$	90,000		
	RETREAT (Relocate Footpath)				
3	Year 3			\$	290,000
3.1	Hinds Park Block Wall	\$	40,000		
3.2	Hinds Park Natural Shoreline	\$	250,000		
				•	
4	Year 4	¢	00.000	\$	180,000
4.1	Remove Gazebo)	Ф	90,000		
4.2	Riverside Gardens Beach	\$	90.000		
		Ť	,		
5	Year 5			\$	375,000
5.1	Claughton Reserve	\$	375,000		
				•	50.000
6	Year 6 Maylanda Daningular Colf Course Hala 5	¢	50,000	\$	50,000
0.1	Mayianus Peninsulai Goli Course Hole 5	Φ	50,000		
7	Year 7			\$	215.000
7.1	Berringa Park Riverwall & Spillway	\$	180,000		
7.2	Bardon & Berringa Park - RETREAT (Relocate Yacht Club	\$	35,000		
	Tower)				
0	Voor 9			¢	120.000
8 2	Tonkin Highway Bridge Abutment	\$	130.000	Э	130,000
0.2	Forkin highway bhage Abathent	Ŷ	100,000		
9	Year 9			\$	110,000
9.1	Garrett Road Bridge	\$	110,000		
4.0	No 40			•	4 000 000
10 1	Tear Tu Maylands Peninsular Golf Course – Western Shoreline	¢	500.000	2	1,000,000
10.1	Maylands Peninsular Golf Course Hole 14	Ф S	500,000		
10.1		Ŷ	000,000		
	Total Estimated Cost			\$	3,780,000

 Table 6.1
 Bayswater Foreshore 10 Year Priority Plan Summary

Key Allowances & Assumptions

The 10-year priority plan has been prepared based on the following key allowances and assumptions:

- The timings have been determined based on the combined condition and consequence ratings. The foreshore areas with the highest combined ratings are prioritised.
- The combined ratings are based on the consequence rating, which is determined by the risk of continued erosion over the next 10 years. Erosion rates may increase in some areas and this may require the City to reconsider the priority areas.
- Due to the likely budget realities, it is assumed that the City would be able to complete 1 2 projects per year, depending on size of project. This means some structures and shorelines may deteriorate further before action is taken.
- The cost estimates provided are based on an assumed stabilisation method and are budget level only, determined from a visual inspection of each site. The costs would be refined during design of the erosion protection following a detailed site inspection. The erosion protection method may also change during further design.
- The cost estimates are for construction costs only and do not include additional design or approvals costs.
- No additional allowances have been made for management of acid sulphate and contaminated soils. This would be confirmed in design, in conjunction with environmental investigations.
- Nominal costs have been estimated for a handful of recommended additional actions. These are:
 - Removal of gazebo \$10,000 (exc. GST).
 - Relocation of Hinds Park playground sand pit \$15,000 (exc. GST)
 - Relocation of the Maylands Yacht Club start tower \$35,000 (exc. GST). It is unclear if this is a City asset or the responsibility of the Yacht Club.
 - Stabilisation of the Tonkin Highway bridge abutment shoreline \$130,000 (exc. GST). This is likely the responsibility of Main Roads WA but has been included for completeness.
- Removal of debris and failed structures is assumed to be able to be completed by the City's internal work crews and hence a nil cost has been assumed for these actions. These have mainly been included for managed retreat.

Table 6.2 Bayswater Foreshore 10 Year Priority Plan

Asset ID	Asset Name	Shoreline Type	2019 Combined Rating	Image	Recommended Mgmt. Option	Works Timing	Budget Cost (exc. GST)
				Year 1			
SRMay02 Tranby Reserve.B08	Tranby House Reserve Timber Walling	Built	25		Stabilisation: Stabilisation at toe of riverbank. Assume rock revetment. Rehab & reveg. of riverbank.	< 1 Yr	\$850,000
				Year 2			
SRMay04 Maylands Reserve.B0	Maylands Reserve Rock Revetment & Natural Shoreline	Built	20		<u>Stabilisation:</u> Upgrade revetment Re-secure anchor block	1 – 4 Yrs	\$50,000
SRMay04 Maylands Reserve.N02	Chorenne	Natural	13		Stabilisation: Composite slope	4 – 8 Yrs	\$440,000
SRMay02 Tranby Reserve.N03	Tranby House Reserve	Natural	19		<u>Retreat:</u> Relocate footpath	1 – 4 Yrs	\$90,000
SRMay02 Tranby Reserve.N02	Peninsular Farm	Natural	13				
SRMay02 Tranby Reserve.N01		Natural	13				
SRMay02Tra nby Reserve.B07		Built	19				
SRMay02 Tranby Reserve.B06		Built	19				
SRMay02 Tranby Reserve.B05		Built	14				
SRMay02 Tranby Reserve B03		Built	14				

SRMay02	Built	13
Tranby		
Reserve.B02		

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Asset ID	Asset Name	Shoreline Type	2019 Combined Rating	Image	Recommended Mgmt. Option	Works Timing	Budget Cost (exc. GST)
				Year 3			
SRBay03 AP Hinds Park.N0 SRBay04	Hinds Park	Natural	12		Stabilisation: Beach nourishment. Stabilisation. Assume buried	4 – 8 Yrs	\$250,000
Birdge.N01							
SRBay03 AP Hinds Park.B01		Built	18		Stabilisation: Block wall repairs	1 – 4 Yrs	\$40,000
				Year 4			
SRMay03 Clarkson Reserve.N01	Tranby Reserve	Natural	12		<u>Retreat:</u> Relocate footpath Remove gazebo	4 – 8 Yrs	\$90,000
SRMay02 Tranby Reserve.N06			12				
SRMay02 Tranby Reserve.N05			7				
SRBay03 AP Hinds Park.N03	Riverside Gardens Beach	Natural	13		Stabilisation: Access ramps & stairs. Nourishment. Replanting turf	4 – 8 Yrs	\$90,000
				Year 5			
SRBay01 Claughton Reserve.N02	Claughton Reserve	Natural	13		Stabilisation: Beach nourishment. Stabilisation. Assume rock protection. Revegetation & turfing	4 – 8 Yrs	\$375,000
SRBay01 Claughton Reserve		Built	7		unng		

SRMay04 Maylands Reserve.B03	Maylands Reserve Timber Riverwalls	Built	16	<u>Retreat</u>	4 – 8 Yrs	Nil
SRMay04 Maylands Reserve.B02			17			
SRMay04 Maylands Reserve.N04		Natural	11			

Asset ID	Asset Name	Shoreline Type	2019 Combined Rating	Image	Recommended Mgmt. Option	Works Timing	Budget Cost (exc. GST)
				Year 6			
SRMay05 Maylands Peninsular Golf.N02	Maylands Peninsular Golf Course – Hole 5	Natural	12	<image/>	Stabilisation: Regrade and rehabilitate riverbank with planting.	4 – 8 Yrs	\$50,000
SRBay03 AP Hinds Park.N03	Maylands Samphire Flats	Natural	13		Retreat	4 – 8 Yrs	Nil
				Year 7			
SRMay 06 Berringa Park.B1	Berringa Park Riverwall & Spillway	Built	8		Stabilisation Upgrade or replace structure like for like	8 – 15 Yrs	\$180,000
SRMay06 Berringa Park.N0	Berringa & Bardon Park	Natural	8		Retreat Relocate Maylands Yacht Club start tower	8 – 15 Yrs	\$35,000
SRMay06			8				



Asset ID	Asset Name	Shoreline Type	2019 Combined Rating	Image	Recommended Mgmt. Option	Works Timing	Budget Cost (exc. GST)
				Year 8			
SRBay02 Redcliffe Bridge.N01	Claughton Reserve South	Natural	7		Retreat	8 – 15 Yrs	Nil
SRJul-19 Tonkin Highway.B01	Tonkin Highway Bridge Abutment	Built	8		Stabilisation: Re-mortar edge Add rock armour	8 – 15 Yrs	\$130,000
				Year 9			
SRBay04 Garrett Road Bridge.N02	Garrett Road Bridge	Natural	7		Stabilisation Beach nourishment. Buried stabilisation. Assume rock protection.	8 – 15 Yrs	\$110,000
				Year 10			
SRMay04 Maylands Peninsular Golf.No1	Maylands Peninsular Golf Course – Western Shoreline	Natural	7		Stabilisation Bioengineering with revegetation.	8 – 15 Yrs	\$500,000

SRMay04 Maylands Reserve.N05	Maylands Peninsular Golf Course Hole 14	Natural	6	Stabilisation Bioengineering with revegetation.	8 – 15 Yrs	\$500,000

7. Conclusion

The City engaged MRA to complete a visual inspection of the City's foreshore and develop a 10year foreshore works priority plan. The following outcomes have been delivered as part of these works.

- Inspection of the City's foreshore and rating of the condition of the shoreline.
- Review of changes to the City's foreshore since 1995, based aerial photography and available survey data.
- Review of the risks to the foreshore, in light of the condition assessment and erosion patterns.
- A 10-year foreshore works priority plan, including estimates of budget costs and timeframes.
- Recommendations regarding ongoing foreshore maintenance, monitoring and planning for future projects.

In addition to the recommendations made earlier in this report, MRA also recommends that the periodic inspections of the City's foreshore are carried out over the next 10 years. These inspections would help to review and update the 10-year foreshore works priority plan as required.

8. References

- Riggert, T. L., 1978. *The Swan River Estuary Development, Management and Preservation*. Swan River Conservation Board 1958-1976.
- Swan River Trust, 2009. Best management practises for foreshore stabilisation. Approaches and decision-support framework. Swan River Trust.

9. Appendices

Appendix A 2019 Condition & Combined Rating Maps

Appendix A 2019 Condition & Combined Rating Maps



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BAYSWATER FORESHORE 10 YEAR PRIORITY PLAN

		GEND: COLOUR		NATUR/ BUILT <u>CONDITI</u> 1 2	al Shorelin Shoreline On Rating	ΙE
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			/	BERRINGA PARK WETLANDS	/	
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	, chi			STREET LAYO		An
(1673 CoB —	SCALE AT A3	1:4,000 ore Plan\5 MRA	\ Dwgs\:	SEF Sketches\SK16	PTEMBER 20 SK1673-0 73 -Condition R	19 1A atinG







m p rogers & associates pl	Suite 1, 128 Main Street	drawn R BORJA	CONDITION RATING - SHEET 4 OF 4
coastal and port engineers	Osborne Park 6017 t: +61.8 9254 6600 Western Australia admin@coastsandports.com.au	CHECKED J COSTIN	BAYSWATER FORESHORE 10 YEAR PRIORITY PLAN

L	E	<u>G</u>	E	Ν	D	:
_						

NATURAL SHORELINE
BUILT SHORELINE
CONDITION RATING
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3
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N/A



SEPTEMBER 2019

SK1673-04A

scale at a3 1:4,000

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m p rog	ers a	& ass	sociat	tes pl	
coastal	and	port	engir	neers	

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Osborne Park 6017	t: +61 8 9254 6600
Vestern Australia	admin@coastsandports.com.au

drawn R BORJA checked J COSTIN

COMBINED RATING - SHEET 1 OF 4 BAYSWATER FORESHORE 10 YEAR PRIORITY PLAN

	LEGEND:	NATURAL SHORELINE BUILT SHORELINE
		<u>COMBINED_RATING</u> 1-3 4-6 7-11 12-17 18-21 22-25 N/A
	BERRINGA F WETLAND	PARK S MARCH UNIT
		MATCH LINE OG
		·
		07 06 06 SHEET LAYOUT
SCAL AT A	e 3 1:4,000	SEPTEMBER 2019 SK1673-05A







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coastal and port engineers	Usborne Park 6017 t: +61.8 9254 6600 Western Australia admin@coastsandports.com.au	CHECKED J COSTIN	BAYSWATER FORESHORE 10 YEAR PRIORITY PLAN

	NATURAL SHORELINE BUILT SHORELINE
COLOUR	COMBINED RATING 1-3 4-6 7-11
	12-17 18-21 22-25 N/A



SEPTEMBER 2019 SK1673-08A

scale at a3 1:4,000

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