TECHNICAL REPORT

CLONTARF FORESHORE RESTORATION PLAN

DECEMBER 2016

FOR
CITY OF SOUTH PERTH

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REPORT DETAILS:

Version No.	Date	Author	Reviewer	Comment
0	10.09.2014	RT	TS	Internal Review of Draft 1
1	23.09.2014	RT		Draft 1 Issue to City of South Perth
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	Signature		Signature
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GLOSSARY

The following terms used in this report have the meanings ascribed below:

Word or phrase	*Description*
Bioengineering	The use of both engineering and biological techniques in environmental remediation processes. Involves both “hard” and “soft” approaches each with varying levels of non-biological structure involved. Typically involves the use of flora to replace the need for heavier structure.
Brush wall	Erosion control technique that uses a log made from brush (brush log or fascine) (usually form *Kunzea glabrescens*) to reduce wave energy upon impact with a shoreline whilst retaining soil and plants. The brush is wired in a log bundle and then anchored to the ground using Jarrah stakes. Brush logs can be stacked up to form a revetment for the riverbank or in steps to form palisades.
Dual Use Path	Refers to a path designed for use by both pedestrians and cyclists.
Riparian	Riparian (Latin origin meaning of river bank) is the zone of interface between land and river. It contains fringing vegetation of plants that are able to withstand harsh condition such as erosion and saline conditions. Destabilisation of the Riparian zone can cause increased levels of erosion.

ABBREVIATIONS

The following abbreviations have been used in the report.

Abbreviation	What It Stands For
AASS	Actual Acid Sulphate Soils
CoSP	City of South Perth
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DoH	Department of Health
DER	Department of Environment Regulations
DoW	Department of Water
DPaW	Department of Parks and Wildlife
DUP	Dual Use Pathway
EH&S	Environmental Health and Safety
PASS	Potential Acid Sulphate Soils
WA	Western Australia

PART 1: CONTEXT

1.0 INTRODUCTION

Clontarf Foreshore (the project area) is a 0.4 hectare (ha) section of the Canning River Foreshore in Waterford, City of South Perth, located approximately 8 kilometres (km) south-east of the Perth Central Business District (CBD). The site is located directly behind Clontarf Aboriginal College sporting grounds and forms a part of Bush Forever Site 333. Previously this section of the foreshore was named 'Clontarf Central Zone' as part of the Clontarf Foreshore Management Plan (City of South Perth, 1993). The location of the project area is presented in Figure 1.

Figure 1 Project area location (Imagery: NearMaps November, 2016)

The project area has been subject to change since European settlement most notably as a result of Clontarf buildings establishment in the early 1900s, land infill for the sports ovals and the rubble disposal along the foreshore.

In recent years several areas of the foreshore have been impacted by the changing water levels due to storm surges which in combination with the lack of vegetation cover and the modified soil profile have resulted in erosion of topsoils and exposure of fill material. This fill material is largely made up of building rubble; including hazardous materials such as asbestos cement sheeting and various scrap metal items.

The fill material prevents the establishment of vegetation particularly the sedges which are essential for attenuation of wave energy and prevention of shore erosion. Given that the future climate change effects will influence shoreline stability further if no action is taken, the City of South Perth (the City) wishes to stabilise the foreshore through revegetation and erosion control works in the near future.

Department of Parks and Wildlife (previously Swan River Trust) has classified the Clontarf Foreshore as the area of high management priority – "Priority 1" as part of the Swan and Canning River Foreshore Assessment and Management Strategy (2008). The high importance for the preservation of the shore is based on the contiguity with the regionally significant remnant vegetation of Bush Forever Site 333, its amenity and cultural values. The site is a part of two Registered Aboriginal Sites of high importance to Wadjuk people: Wadjup (Site ID 24319) and the Swan / Canning River (Site ID 3536).

This Foreshore Restoration Plan (FRP) aims to provide site specific background information and details on factors which influence erosion, their predicted effect in the future and outline restoration protocols which will help establish vegetation and stabilise the foreshore. The document should be read in conjunction with the Technical Specifications and Drawings (Syrinx Environmental PL, 2016 issued with this report) which provide in depth detail on the restoration techniques, materials and procedures required to create a stable foreshore.

Note: this plan was prepared prior to foreshore remediation for asbestos and updated once the remediation was completed.

1.1 PROJECT OBJECTIVES AND SCOPE OF WORKS

The main project objectives are to:

- Stabilise foreshore and mitigate and prevent further erosion;
- Establish a dense native (indigenous to site) vegetation layer that will assist with erosion protection and provide a habitat for fauna.

The scope of works for the development of this FRP incorporated:

- Desktop and preliminary site investigations;
- Preparation of the FRP;
- Preparation of the detailed design and technical specifications (including monitoring and maintenance requirements);
- Stakeholder review of the final document including submission of the FRP including drawings and specifications; and
- Detailed cost estimate, bill of quantities and indicative timelines for implementation.
- Update of the plan following site remediation works to remove asbestos completed in November 2016.

2.0 EXISTING NATURAL ENVIRONMENT

2.1 LANDFORM AND TOPOGRAPHY

The site has a very gently to moderately inclined slope grading down towards the Canning River, with a maximum elevation of approximately 1.4 mAHD (metres Australian Height Datum) near the dual use path (DUP). The site is undulating due to the presence of landfill material, with the western section of the project area being slightly higher than the eastern section; however, the differences in elevation are often small (less than 200mm). The areas adjacent to site are of similar topography with the area to the north of the site (i.e. the sports oval) being relatively flat, up to the elevated sandy outcrop on which the College buildings are situated.

2.2 GEOLOGY AND SOILS

Jordan (1986) describes the geology of the site as that of Unit S14; Alluvium, which is described as white to pale grey, medium to coarse-grained quartz sand with abundant shell fragments.

Current and previous investigations of the site and the surrounding areas including that of the Cygnia Cove development (Coffey, 2009) to the east of the site have identified large deposits of fill material along the foreshore. The fill was used to form level ground for the ovals (City of South Perth, 1993) and to suppress the growth of sedges. The infill of the project area and the jetty started approximately in 1954. Paul Bradshaw, one of the Clontarf Old Boys, was involved in the infill activities in 1954 and described that "*the rubble used to get to site in truckloads near handball courts where the boys would chip away mortar to recycle bricks for construction projects at Clontarf and Castledare*". Any remaining rubble was taken to the edge of the football oval and towards the river and used to suppress the growth of *"reeds as they came up half way up the oval. We* (the boys) *dragged the brick rubble in sugar bags and then used wooden or metal rods to stamp the bricks and rubble down into the soft ground until the bricks would sink no more and the black mud was all over our faces*". Some infill was taken to the jetty area and cemented *in situ* to use as a foundation to build the concrete platform of the jetty which is currently in disrepair.

The foreshore infill of the western end of the site occurred later (Old Clontarf Boys, *pers. comm.*) and possibly as a result of demolishing buildings on the Clontarf grounds; however, this could not be confirmed with great certainty as no record of infill activities were kept and the aerial photography records for the 1954 – 1960 period are scarce.

Observations of the historical photograph from 1953 show large sections of the area north of site still vegetated most likely by sedges. Anecdotal evidence provided by the Old Clontarf Boys indicates that prior to infill, trees at the end of the football oval were removed and the

infill started at the edge of the oval. On the basis of this information, an estimated area for uncontrolled fill has been extrapolated (Figure 2). It is estimated that the depth of fill material would be between 0.1 – 0.5m deep for the majority of site; however, greater depths are probable in the western section (note: western section of the site is outside of red rectangle drawn in Figure 2).

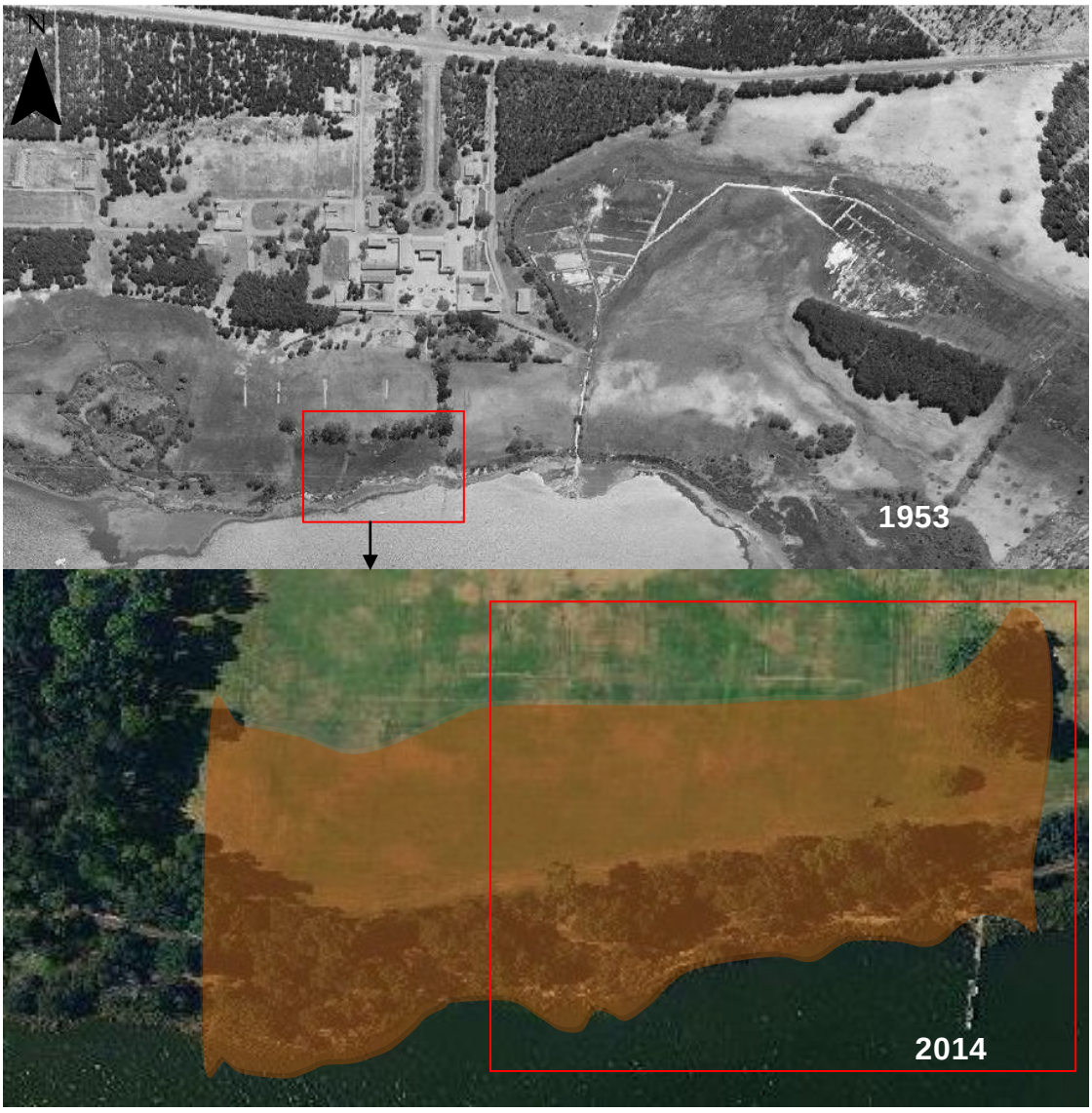

Figure 2 Estimated extent of fill extent surrounding the site based on anecdotal evidence

Natural soils encountered during site investigations included sands consistent with the description of alluvium sand by Jordan (1986) on lower slopes where sand mobilisation by waves is present. Small pockets of clayey silt have been identified adjacent to the jetty where a large clump of *Baumea articulata* is found.

Most of the upper slope of the site particularly the areas adjacent to the DUP and up to 5m down slope have a layer of limestone road base mixed with sand fill, added over a black

plastic liner. The liner has some perforations; however, these are not sufficient for roots of most plants particularly herbs and sedges to penetrate. The thickness of soil on top of liner varies with average depth being between 100 – 250mm. The soil thickness on the lower slopes varies between 20 – 200mm, with density and the size of rubble increasing towards the western end of the site.

2.2.1 Contamination

As outlined in the previous section, large amounts of rubble are present on site often with very little to no natural soils. The rubble consists predominantly of bricks and cement slabs with some metal, wood, and cement asbestos sheet fragments.

A black plastic liner is also present on the majority of the upper slope of the site. The liner is overlain with crushed limestone/sand mix for the most part except in the areas where wave erosion has removed the top layer of soil and the liner is exposed. No records of when or why the plastic liner was installed could be found (Julie Ophel, City of South Perth, *pers. comm.*); however, based on the photographic evidence available on Landgate (2014), it has most likely been installed during the DUP construction in 2010. The location, extent and type of contaminant materials on the site are shown in Figure 3.

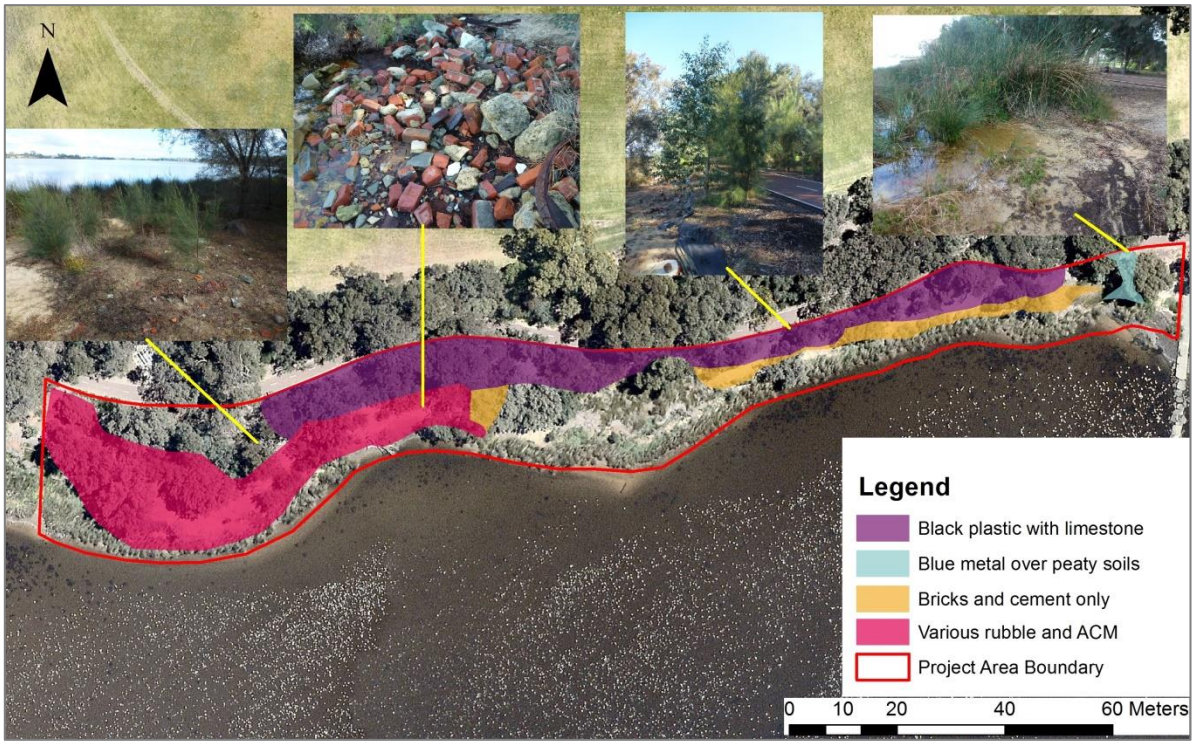

Figure 3 Location and extent of contamination materials in the project area

2.2.1.1 Asbestos

A **preliminary site investigation** conducted by Syrinx Environmental PL (Syrinx) in May and June 2014 was undertaken to assess the type and extent of contamination. The methodology employed in the investigations and the detailed analytical results for the soil and collected asbestos containing materials is presented in Appendix 1. The collected material confirmed presence of Asbestos Containing Materials (ACM) on site, however, no soil samples were taken as the sampling procedure required a ground disturbance permit (under Section 18). To ensure the safety of public and to prepare the ground for restoration works, the City had engaged a specialist consultant to remediate and validate the removal of known ACM and surface building rubble once permits and the funding was available for this task to occur.

Detailed Site Investigation

Detailed site investigations and the remediation and management plan for the ACM within the project area was completed in March 2016 by ER Consultants (ERC) (ERC, 2016a). ERC identified two potential options available to the City to mitigate the potential risks to human health identified as a result of detailed site investigations and based on an understanding of the application of Department of Health (DoH) guidelines (DoH, 2009):

1) Management of asbestos in-situ

2) Remediation and Validation of asbestos (removal from the site).

Site Remediation

The remediation and validation of asbestos (Option 2) was chosen as a preferred option by the City, and the ERC engaged to conduct the remediation of the site alongside a specialist asbestos removal contractor. The remediation works started in June 2016 and were completed on 29th November 2016. The works involved removal and disposal (at an approved facility) of the ACM and removal of most of the exposed builder's rubble present along the foreshore. The different stages of works, methodology and the results of validation tests have been published in the *Remediation and Validation Report* (ERC, 2016b). Any future ground disturbance works should refer to this report to gain a better understanding of the location of remediated areas.

The known asbestos hotspots within the project area have been remediated, and the concentration of residual asbestos in the soils do not exceed the adopted Department of Health (DoH) criteria.

The risk of exposure to residual ACM on the site will be further reduced by the import of topsoil required for revegetation works. These soils will provide a barrier between any remaining ACM, the public and the workers conducting bank stabilisation, revegetation and maintenance works. Once the revegetation activities are complete and vegetation is

established, this will provide an ongoing barrier layer provided the vegetation is maintained and any erosion of the bank mitigated (erosion will be significantly reduced once the plants establish).

2.2.2 Acid Sulfate Soils

A desktop review of available information has indicated that the site is located within an area classified to have 'high to moderate risk of acid sulfate soils occurring within 3m of the natural soil surface' (also Class 1). Field observations identified no apparent visual indicators that are suggestive of the presence of ASS on site; however, further soil testing may indicate otherwise.

The Department of Environment Regulations (DER) states that developing within a Class 1 ASS risk area automatically triggers a condition imposed by the Western Australian Planning Commission (WAPC). In order to clear this condition, an Acid Sulfate Soil (ASS) self-assessment form (available from the DER http://www.planning.wa.gov.au/dop_pub_pdf/Acid_Sulfate_Soils_version6.pdf) needs to be completed and submitted to the DER. This form relates to development plans whereby any form of dewatering, drainage works or excavation of more than 100m^3 of soil will trigger the need to carry out an ASS investigation. If the ASS investigation identifies the presence of ASS at the site, the preparation of an ASS management plan will be required and submitted to the DER for approval prior to the commencement of site works.

Given that the revegetation and erosion control activities do not involve digging deep into the soil profile or the removal of soils, it is unlikely that the ASS will be encountered. However, in the unlikely event that this occurs, management procedures will be in place to mitigate any risks (e.g. liming of sands, etc.).

2.3 HYDROLOGY

2.3.1 Surface Water

The site borders Canning River which is the only surface water body directly adjacent to the site. To the north east are the Cygnia Cove retained and constructed wetlands, however, they do not interact with the project area by surface flow due to distance and the surrounding landform (groundwater interaction is possible).

Rainfall and stormwater are infiltrated on site. There are no stormwater pipes within the project area boundary and none are located adjacent to the site.

2.3.2 Groundwater

The site is located on the northern bank of the Canning River within the Cloverdale groundwater flow area of the superficial aquifer formation (Davidson, 1995) (Figure 4). This aquifer extends to a depth of approximately 25m below AHD and is underlain by the Leederville Formation aquifer which is approximately 300m thick. The direction of groundwater flow in the superficial formation is south and west towards the Canning River.

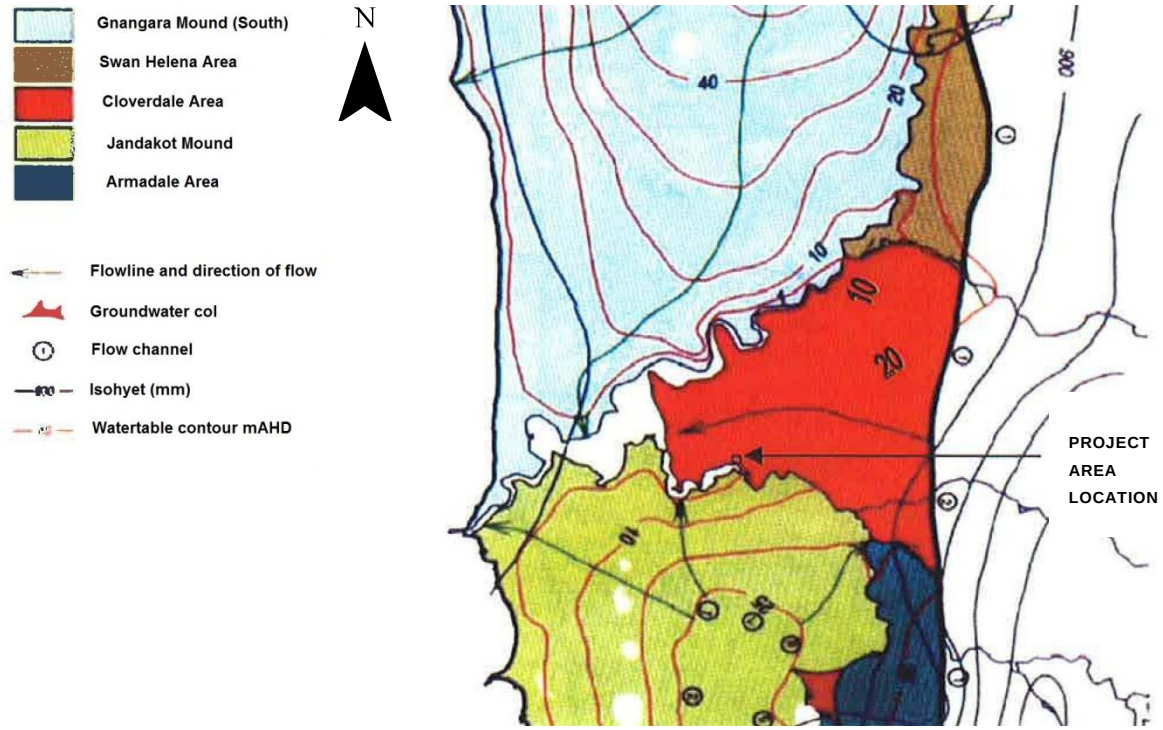

Figure 4 Superficial aquifers in the Perth Metropolitan region (Davidson, 1995)

Davidson (1995) indicates that an upward head between the two aquifers exists in the vicinity of the site indicating that the groundwater discharges from the Leederville to the superficial aquifer resulting in the formation of springs or groundwater seeps. One such spring has been described for Cygnia Cove wetland north east of the site and indications exist that groundwater seeps are present within the project area near the jetty where a large clump of *Baumea articulata* is found and the soil substrate is very soft. Similar vegetation indicative of springs or seeps was observed at Brother Keaney's gardens to the north west of the site. An article in the Western Mail (7th May 1925) describing a field day at Clontarf records the presence of springs: "*The gardens were then visited, everything looked flourishing there... A bubbling spring of cold water rises at the edge of the garden and flows through it*."

Based on the topography and the regional minimum and maximum groundwater levels, much of the site would have groundwater at less than 0.5m below ground level.

2.3.3 Wetlands

The site was once a part of a much larger complex of wetlands called Canning River Flats which extended closer to Manning Road (or southern boundary of the Curtin University).

The geomorphic wetland mapping (Figure 5) classifies the project area as an Estuary-Peripheral wetland or a seasonally flooded flat and shows an outline to the historic extent of the flats.

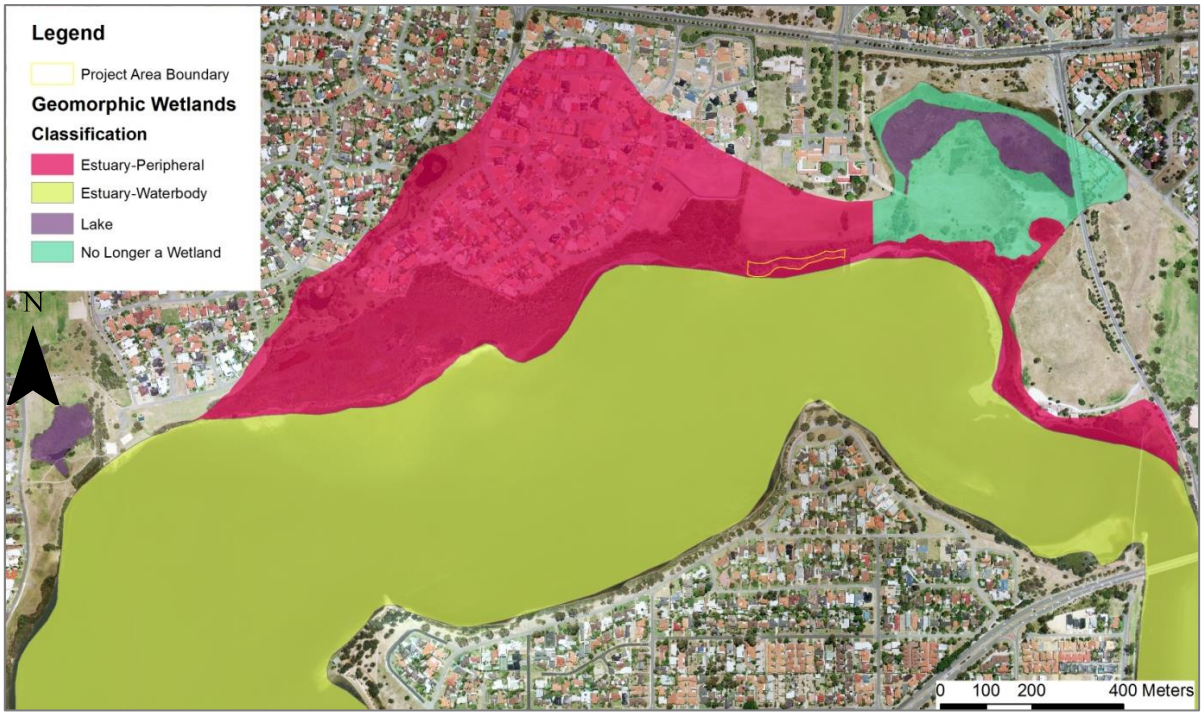

Figure 5 Geomorphic wetland classification of the project area and the surrounds (DPaW)

Note: DPaW's Swan Coastal Plain Geomorphic Wetlands dataset has not been updated to reflect recent changes to lakes shown in Figure 5 above. The lakes have been modified or are no longer present as is the case with the right lobe of Cygnia Cove.

The wetland evaluation process of assessing the level of significance of wetlands (Hill et al., 1996) for management purposes classifies the project area in a Conservation Management Category. This category includes wetlands which have a high level of ecological attributes and functions and are most valuable for conservation. Any works in these areas should be focused on rehabilitation, and any development that may lead to further loss of vegetation or degradation is prohibited.

2.3.4 Bathymetry

The section of the Canning River adjacent to the site is relatively shallow with an average bathymetry of less than 1.5 meters (Department of Transport, 2014).

2.4 CLIMATE

The site experiences typically warm Mediterranean climate characterised by wet, mild winters and dry, hot summers. The closest meteorological station to the site with reliable long term data that would likely be similar to the site is located at Perth Metro (009225) weather station approximately 8km north west of the project area.

The mean minimum and maximum winter (July) temperatures are 7.7°C and 18.4°C whilst the mean minimum and maximum summer (February) temperatures are 18.4°C and 31.7°C. The average annual rainfall is 728.1mm, with 54% (393.8mm) falling in the winter months (June to August). The historical climate data for Perth Metro weather station, showing annual rainfall and mean temperature maxima for years 1994 to 2015 is summarised in Figure 6.

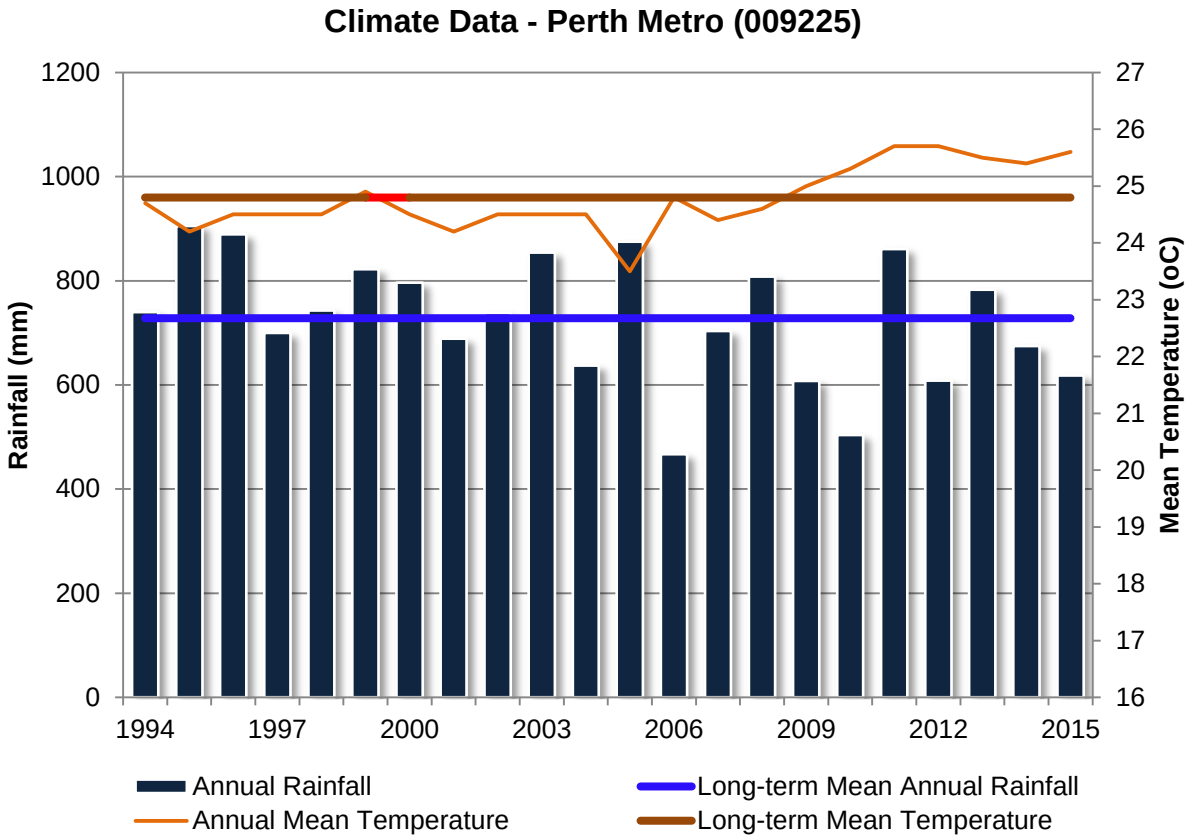

Figure 6 Mean rainfall and mean temperature maxima for Perth Metro (009225) weather station for years 1994 to 2016 (BoM 2016)

When observing recent temperature and rainfall trends particularly since 2008 the mean annual temperature maxima have consistently exceeded the long-term average by 0.2 to 0.9°C. This trend is likely to continue in the future, and as such any revegetation works need to take these changing conditions into consideration.

2.5 FLORA AND VEGETATION

2.5.1 Native vegetation and flora

Historical vegetation mapping of the site was only done on a broad scale using geology and remnant vegetation as a guide. This broad mapping identifies the site as part of the Bassendean Complex Central and South (Department of Conservation and Environment, 1980). This complex is highly variable and incorporates woodlands of Jarrah *(Eucalyptus marginata*), Sheoak (*Allocasuarina fraseriana*) and Banksia species (*Banksia* spp.) as well as sedgelands and herblands in the moist depressions and wetlands.

The foreshore vegetation of the project area consists of a mosaic of *Juncus kraussii – Baumea juncea* sedgelands with *Suaeda australis* and *Sporobolus virginicus* (Marine Couch) and a canopy of and *Casuarina obesa, Eucalyptus rudis* and *Melaleuca rhaphiophylla* which is more congruent with the Swan Complex. The Clontarf Foreshore Management Plan (City of South Perth, 1993) refers to the vegetation of the area as *Juncus* complex due to the dominance of the sedge *Juncus kraussii.*

Due to a long history of disturbance, the vegetation condition on the site is largely degraded, with some of the sections of the foreshore particularly that of the western end being severely affected, resulting in a high level of erosion for that portion of the site. No specific records exist for significant flora on site for the same reasons.

The vegetation on the site has been mapped as a groundwater dependant ecosystem (GDE), reliant on subsurface groundwater in the broad scale mapping (see Figure 7, BoM, 2012). Evidence of groundwater seeps or springs exists on site near the jetty where large clump of *Baumea articulata* and *Bolboschoenus caldwellii* are found. These species require an input of fresh water throughout the year as is the case with *Melaleuca rhaphiophylla*. Having these species so close to the river and in the tidal zone indicates that the supply of freshwater to the plants is permanent.

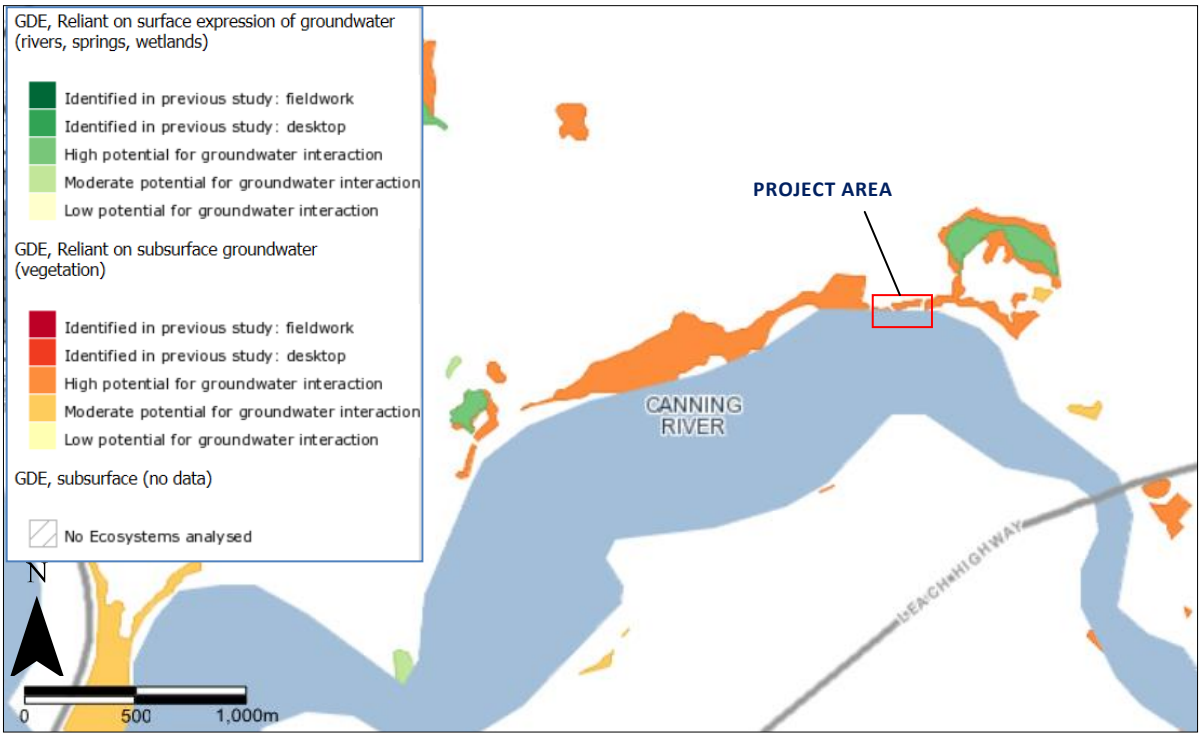

Figure 7 Groundwater Dependent Ecosystem Map of the site and the surrounding areas (Source: BoM, 2012)

2.5.2 Introduced Flora

The loss of vegetation cover on site has resulted in the establishment of environmental weed species such as Couch (**Cynodon dactylon*) Kikuyu (**Cenchrus clandestinum*) and several other annual herbs and grasses (* indicates a weed species).

Some effort has been placed in controlling weeds in the past which has been largely successful in reducing their cover; however, this reduction in cover may have caused a more accelerated mobilisation of soils in the areas denuded of vegetation.

Because of the introduction of limestone / sand fill on the upper banks of the foreshore, native species not indigenous to the site have been planted such as *Templetonia retusa*, *Melaleuca huegelii, Grevillea thelemanniana* and *Conostylis candicans.* These species are performing moderately well but do not provide a good soil stabilisation in the foreshore environment. All of these species are more suited to limestone outcrops and drier environments. In 2014 additional shrub species have been planted on the upper part of the shore including *Bossiaea eriocarpa* and *Acacia pulchella* as part of the annual supplementary planting of the foreshore by the City of South Perth. No specific plan as to the species selection or implementation of planting works for the area was available prior to preparation of this Plan.

2.5.3 Ecological linkages and conservation significance of vegetation and flora

The site forms a part of a significant regional ecological linkage and has been incorporated within the Bush Forever Site 333. The vegetation found on site is currently not listed as Threatened or Priority at the State and Federal levels and likewise, no Threatened or Priority flora were found. Despite this, the vegetation on site is conservation significant as it forms a part of a riparian habitat along the banks of the Canning River. As such the site is classified as an Environmentally Sensitive Area (ESA). ESA's are protected under the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (Schedule 1) Clause 4 (i) and are selected for their environmental values at state or national levels.

2.6 TERRESTRIAL FAUNA

2.6.1 Native fauna

Several bird species particularly water birds are seen daily using the areas adjacent to site, particularly the jetty area and the Clontarf Bay to the east of the site. The birds are known to congregate in the bay due to the availability of fresh water, and the jetty is often used as a resting place for birds particularly pelicans and cormorants. In May 2014 during the site visit following bird species were seen on the river in adjacent to site: Black Swan (*Cygnus atratus*), Pacific Black Duck (*Anas superciliosa*), Eurasian Coot (*Fulica atra*), Musk Duck (*Biziura lobata*), Australasian Darter (*Anhinga novaehollandiae*), Little Pied Cormorant (*Phalacrocorax melanoleucos*), Australian Pelican (*Pelecanus conspicillatus*) and in the trees Honeyeaters (*Phylidonyris novahollandiae* and *Phylidonyris niger*), Wattle Birds (*Anthochaera carunculata*), Galahs (*Cacatua roseicapilla*) and Willy Wagtail (*Rhipidura leucophrys*).

Figure 8 Some of the avifauna near Clontarf Foreshore resting on the remains of the jetty

Bush Crickets and orb weave spiders were also recorded in the *Juncus kraussii* band in the past along with four species of ants (City of South Perth 1993). Adjacent grassy areas are likely to provide habitat for lizards such as skinks (City of South Perth, 1993) and snakes may also be present.

Given that the moaning frogs were recorded in the Brother Keaney Gardens it is possible that the site may provide habitat for these or other amphibians; however, none were seen during field investigations by Syrinx in May 2014 and site visit in August 2014.

Of mammals, anecdotal evidence suggests that dolphins pass the site regularly; however, they do not come too close to the shore. Rakali or Water Rat (*Hydromys chrysogaster*) may also be using the site given the contiguous stretch of vegetation between Waterford wetlands and the site; however, no evidence of this mammal was recorded on site currently or in the past (City of South Perth, 1993).

2.6.2 Introduced fauna

City of South Perth (1993) recorded the presence of the introduced house mouse (*Mus musculus*) and the black rat (*Rattus rattus*) occurring along the foreshore, and these are likely to be on site as well. Other introduced fauna that is likely to be using the area are cats and foxes. Dogs frequent the site regularly with some owners allowing the dogs to walk off the leash. This practice has contributed to a significant number of dog scats being present on site.

Of the invertebrates, bees were recorded as being present in the past (City of South Perth, 1993). No bee hives or tree trunks with hollows were recorded directly on site indicating that whilst the bees may visit the site they do not reside on site. It has not been confirmed if beehives which were once located at the western end of the Brother Keaney's Gardens are still in use.

3.0 SOCIAL CONTEXT

3.1 LAND USE HISTORY

Prior to European settlement the project area was part of an extensive freshwater wetland system that stretched between Salter Point and the Riverton Bridge. The site was used by Noongar people, and it was of considerable importance as it was a site of fresh water. After European settlement, the site was developed into an orphanage with farmland which has since become a site of the Clontarf Aboriginal College.

3.1.1 Aboriginal Heritage Values

Two registered Aboriginal Heritage Sites are recorded on site and are of high importance to Wadjuk Nyungar people: Wadjup (Site ID 24319) and the Canning River (Site ID 3538). The location of the project area with respect to the mapped boundary of heritage sites is provided in Figure 9.

The **Canning River (Site ID 3538)** is a widely recognised heritage site which includes the entire length of the Canning River and associated creeks, tributaries and springs. This site is of high cultural and spiritual significance to Nyungar Wadjuk people being the path created in dreaming by a great serpent spirit called Waakal (alternative spelling Waugal, Wagul, Wagyl, Waagal) or Rainbow Serpent. This path (or river bed, associated springs, wetlands and lakes) should not be disturbed and wherever possible the areas adjacent to the river bed should be kept is their natural formation and vegetation composed of locally indigenous species. If the ground is to be disturbed an aboriginal monitor must be present in case the excavations unearth artefacts.

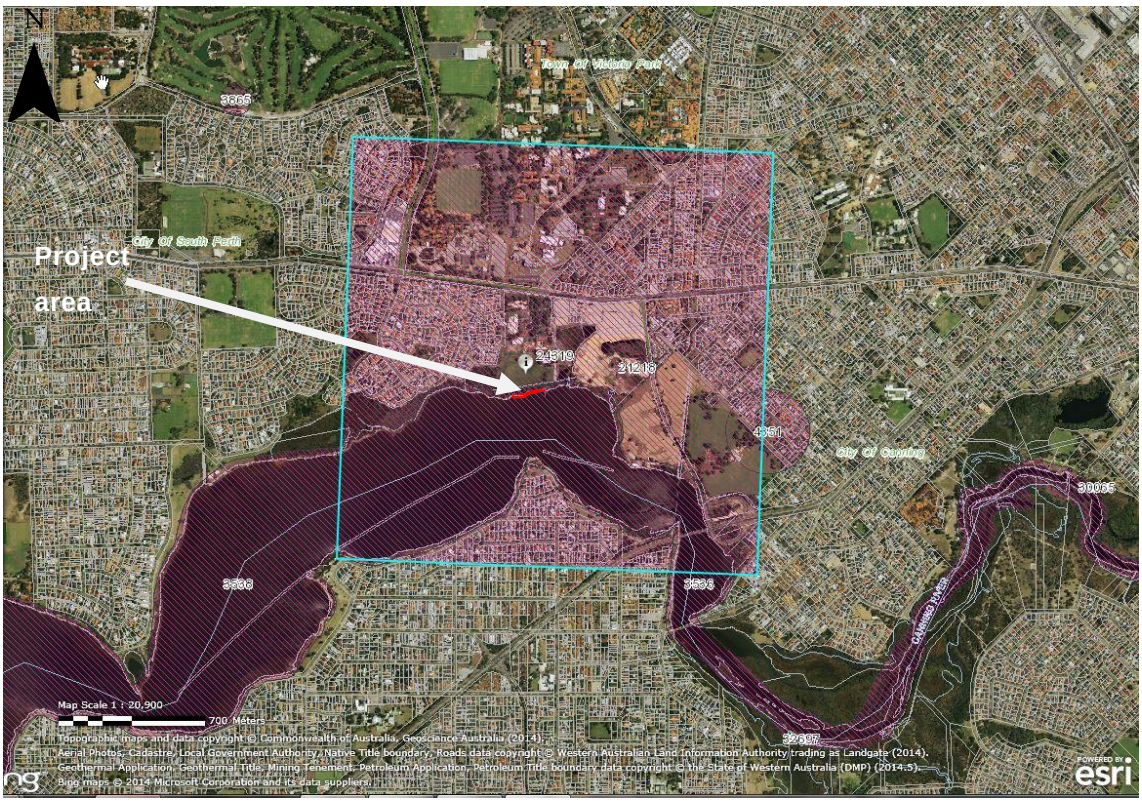

Figure 9 Aboriginal Heritage Registered sites for the project area (Source DAA, 2014)

Wadjup (Site ID 24319) is the indigenous name referring to the wetlands of Canning Flats which once stretched from Salter point to Riverton Bridge. According to Aboriginal consultant Richard Wilkes, “Wadjup” refers to land associated with or connected to fresh water (Harris, 1913). Wadjup is a men’s site reserved for ceremonial purposes and was the southern and eastern extent of the Beeloo people (Hill, 2013).

Any areas with freshwater were usually highly productive in terms of food and were often the sites of important gatherings and camp sites. An important festival known as the Mungyt or Sweet Water Festival of the River people (Beeloo or Canning Mills people) was held in South Perth near the South Perth Mill (Bates, 1929). The nectar laden inflorescences of Mungyt (*Banksia menziesii*) were used to make a sweet beverage at the festival by soaking numerous inflorescences in fresh water soak (Bates, 1929). The festival time allowed people to trade, carry out law and religious business, hold friend making ceremonies and apprentice teenage boys for instruction to adjacent tribes before initiation (Bates, 1992; Hill, 2013). Therefore, it is likely that the project area was used by men during the festival or otherwise to access the ceremonial grounds to conduct ceremonies or to hunt for birds, fish, turtles, and kangaroo or other mammals that would have frequented the area to access the fresh water.

Because the waters surrounding the project area are shallow, they were used for fishing in the past. It is likely that the fish traps (stick fish mongers) were used for this activity (Mrs Kerry –Ann Winmar, *pers. com*. City of South Perth Aboriginal Reference Group). Birds which are also plentiful in the area would have provided meat and eggs.

Many plants in the area would have also been used for food, medicine or other purposes. These plants still persist in the area. One of the medicine plants found on site is the Sheoak or (Kwel): ”*What old people used to say is:- go and sit under the Kwelly tree, and you will find rest..... It’s a bush medicine tree* (Mrs. Winmar, *pers. comm*)”*.*

Melaleuca rhaphiophylla (Swamp Paperbark or Yowarl) also found in the area had multiple uses: to carry or hold food or as a roofing material for mia mias (Perth Region NRM, 2013).

The dominant rush found in the area, *Juncus kraussii* (Sea Rush) is likely to have been used for weaving or to carry food like fish because it has strong fibrous leaves (Kalotas, 2009, City of Joondalup, 2011). The Nyungar names for specific species of rushes and sedges are not known. However, many are referred to as Waakal Ngarnak, named after the Waakal. Stories from the Nyungar Dreaming tell of how pieces of the Waakal’s beard fell off as he twisted and wound his way through the country. Where his beard fell off, the rushes and sedges grew. Many rushes and sedges are therefore known as Waakal Ngarnak (Waakal Beard) (City of Joondalup, 2011).

Large cylindrical leaves of *Baumea articulata* (Jointed Rush) once hollowed out were used as a snorkelling pipe when hunting yerderap (ducks) and other water fowl (City of Joondalup, 2011). This plant is present in the project area near the jetty and it is possible that the Beeloo people would have used this plant in the same way to hunt for waterfowl in the area.

This Foreshore Restoration Plan endeavours to incorporate opportunities for cultural awareness through maintaining and planting species indigenous to the project area which

will enable future interpretive signage installation and opportunities for education on the Nyungar way of understanding nature.

3.1.2 European Heritage

The project area has been subject to pressure from the European settlers from the early settlement years most significantly after the purchase of land by the Christian Brothers in 1897 (City of South Perth, 2006). The clearing of land and construction of the main building progressed shortly after and the building at Clontarf was constructed in 1901 with smaller out-buildings such as bakehouse, laundry, toilets and storeroom also constructed during this time. In the 1920s and 1930s construction of the Keaney Gardens also impacted on the native flora and fauna to the western end of the site.

The building was originally used as a boy orphanage up until the World War II when Royal Australian Airforce occupied the buildings until 1945. After the war many changes occurred to the buildings and their function and many outbuildings were demolished. It is likely that the rubble from these buildings was used as the infill for foreshore together with other builder's infill which arrived to site from elsewhere. After serving mainly as an education institution for orphans and migrant boys in 1950s and 1960s, the main building became a treatment centre for adolescents with problems in the 1970s before closing in 1984. In 1986 the building was redeveloped as Clontarf Aboriginal College which functions to this day.

Because the main building and other associated buildings at Clontarf date from different periods and they are well preserved, they have a historical and rarity value representing a range of architectural styles. For this reason the buildings have been placed on the WA State Register of Heritage Places as a Category A+ site (City of South Perth, 2006).

The site visit with the Old Clontarf Boys committee in May 2014 has confirmed that the Clontarf Foreshore site (i.e. the project area) does not contain any visible objects or materials of heritage value. However, the cement bricks which were once made by the Clontarf boys were mentioned as something that would be worth saving (if intact bricks are found) so that they could possibly be used for the future projects such as the support pillars for interpretive signage or artwork. The example of the cement brick is presented in Figure 10.

Figure 10 Cement brick made by the Clontarf Boys during late 1940s early 1950s (Old Clontarf Boys *pers. comm.*)

3.2 FACILITIES AND CURRENT USE OF THE SITE

The project area is accessible by a DUP along the northern boundary adjacent to the Clontarf Aboriginal College sporting ovals. To the Clontarf College side of DUP are two seating locations which allow views to the river across the project area. One of the seating areas closest to the jetty side has a Plaque No. 3 installed by the Old Clontarf Boys which forms a part of the 'Pathway to Clontarf Memories" trail and which indicates the location of the sporting facilities and the jetty.

The jetty which is currently in a derelict state and closed off to the public is located at the eastern boundary of the site. Despite the fencing, fisherman and walkers access the jetty, and the water birds roost on the broken concrete slabs. Syrinx has also observed walkers accessing the jetty to feed waterbirds (May 2014).

Occasionally kayakers use the areas adjacent to the jetty and the eastern access point to gain river access as no specific facilities for these activities exist within or close to the project area.

The DUP path is used by walkers, joggers and less frequently cyclists. It was observed that many walkers have dogs that are often walked without the leash and access water by running across the project area, particularly in the more open areas such as that near the jetty. Several areas of the project area and the immediate surrounds have exposed dog feces and no dog refuse, or other bins are present on or in close proximity to the site.

Boats pass the shore at a distance due to the water depth near shore being too shallow. The boat traffic is not considered to be significant in the area as most boats access the river at Como or Mount Pleasant where boat launching ramps are available.

4.0 EROSION IMPACTS

This section of the report provides information as to the current erosion impacts on site and gives a better understanding of the possible effects of climate change on the foreshore stability. The information is used as a rationale behind the selection of particular restoration techniques which will help stabilise the foreshore in the foreseeable future. Syrinx recognises that the current data on climate change is relatively generic and that no site specific long term data is available which would better describe potential for change in the future. Therefore, a conservative approach has been taken in estimation of future impacts to ensure that the recommended restoration approaches will be sustainable.

The comparison of historical photographs between 1953 and 2013 (Figure 11) was made in order to detect changes in the foreshore outline. This analysis has revealed that for most part the shoreline shape or extent has not changed significantly during this time period. The shoreline infill and the construction of the jetty have helped establish vegetation a little lower in the shore profile than was present in 1953; however, considering that the area was subject to clearing from late 1890s and especially during Clontarf main building construction in 1901, it is likely that the extent of the original sedgelands would have either matched the current outline or been slightly greater.

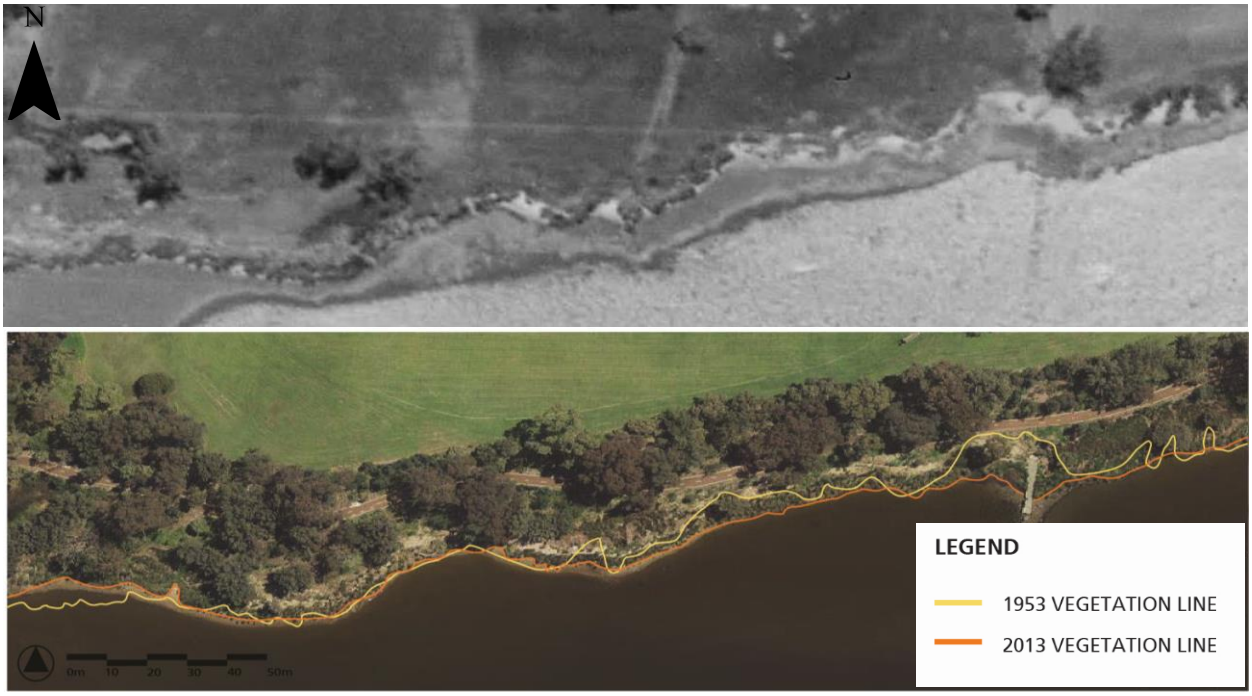

Figure 11 Changes in shoreline vegetation extent between 1953 and 2014 (Imagery: Landgate, 2014)

There are several factors that influence shoreline stability at the Clontarf Foreshore. The key factors affecting the project area are described in the sections that follow.

4.1 ANTHROPOGENIC INFLIENCES

Arguably, the most influential force in the decline of shoreline condition and enhancement of erosion processes on site is the disturbance caused by human impact. The most significant change to the Clontarf shoreline occurred after the introduction of builder's rubble and the construction of the jetty. Both of these have influenced vegetation establishment and sediment transport on site. In addition, introduction of foreign flora particularly grass species such as Couch and Kikuyu have further exacerbated the problem.

Rubble, (especially where thick layers are present) does not leave sufficient space for soil to accumulate which is necessary to support the stability and nutritional needs of vegetation. In the foreshore areas where other conditions such as water levels and light favour growth of *Juncus kraussii*, the rubble interferes with the spread of rhizomes and roots which prevents plants from spreading further upslope. Lack of soil also prevents seedling establishment. Any vegetation that establishes in the thin layer of soil overlaying the dense rubble infill does not have any protection from high wind and wave action particularly during the storm events so it is easily lost by wave wash or by trampling.

The jetty protrudes perpendicular to the shoreline and the dominant wind direction (south westerly winds). As such the sediment movement has been altered and the sand has accumulated surrounding the jetty particularly on its eastern side. The jetty in its construction (cement slabs on top of loosely held brick and building material rubble) acts as a groyne. As the rubble foundation deteriorated over time, the shift in the amount of sand on both sides of the jetty has occurred, with less sand being deposited on the western side of the jetty.

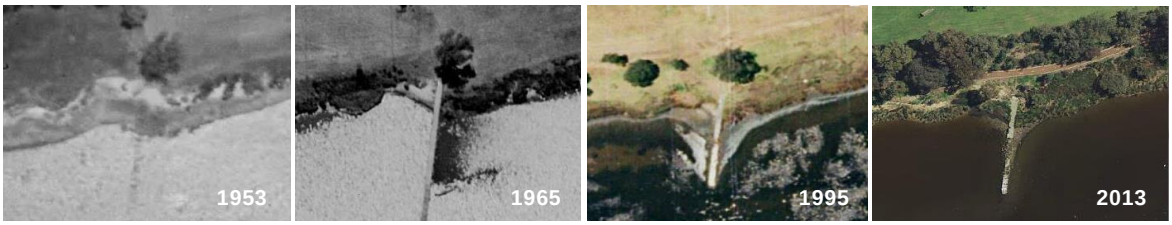

Figure 12 Changes in sand accumulation due to jetty construction (Imagery: Landgate, 2014)

In addition, to jetty, regular access of the western section of the site for access to fish or to walk has caused some vegetation loss and subsequent erosion to the shore.

4.2 WAVES

The site is subject to prevailing light to moderate north easterly winds in the mornings and moderate to strong south westerlies in the afternoons for majority of the year. These winds particularly the south westerlies are predominantly responsible for sediment transport on site, although winter north westerlies also have some impact.

The size of the wind waves at Clontarf Foreshore spit are influenced by a moderate to long fetch to the south west and south east and shallow water producing waves of low to medium intensity. Figure 13 presents two recent images of the site with the wave pattern on the river surface generated by some of the prevailing winds and areas where most erosion has occurred.

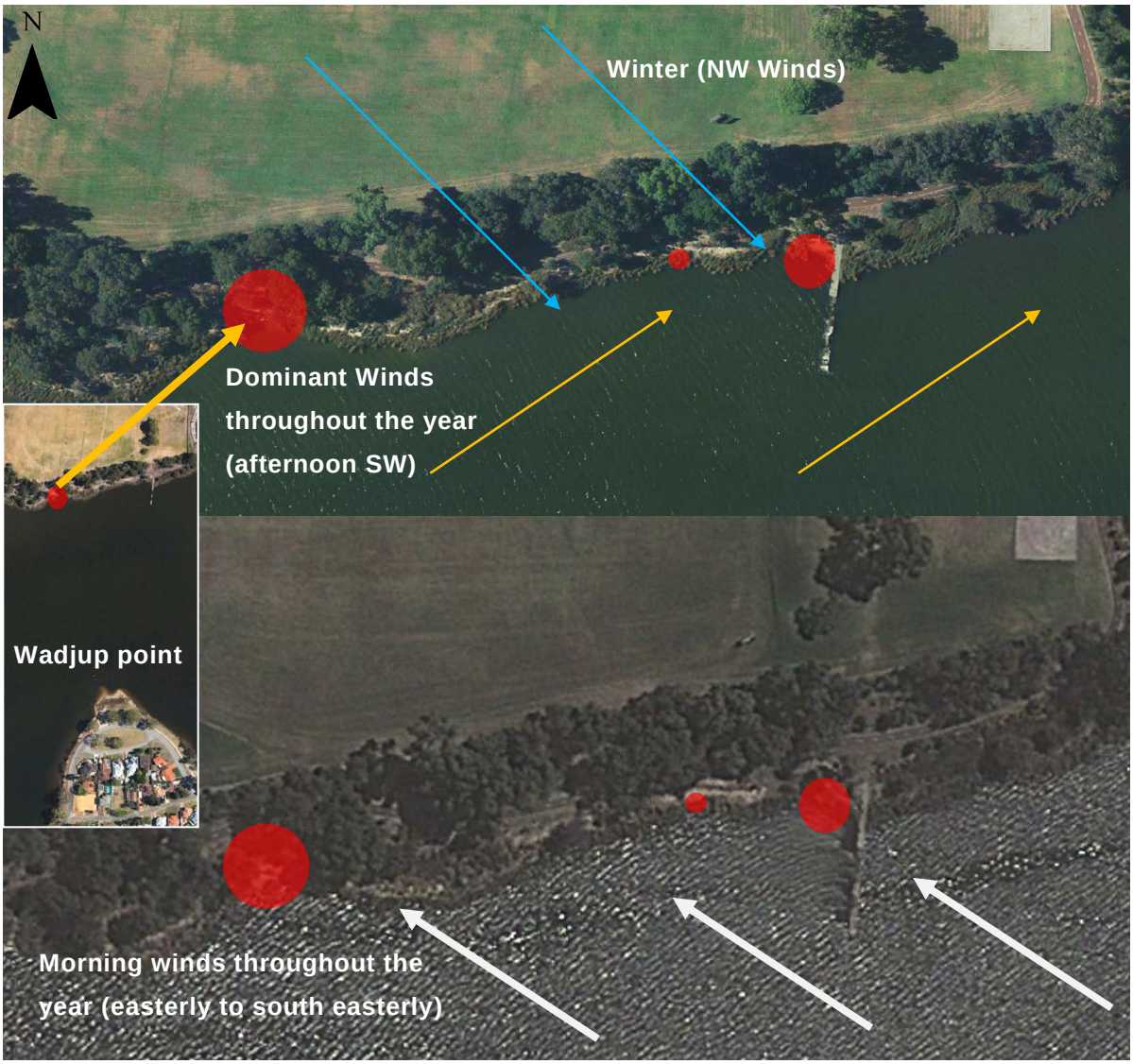

Figure 13 Wind and wave pattern on site (Imagery: a) Landgate, 2013 and Google Earth 2014) (red circles indicate sites affected by erosion)

Because the river basin is shallow, the wind effect on wave generation is somewhat attenuated thus reducing its erosive power. However, the areas to the west of the jetty, particularly the area opposite the Wadjup Point (see insert in Figure 13) and the jetty structure are most affected by waves. The exact affect natural landforms such as Wadjup Point have on the erosion on the western shore of the project area has not been investigated

in the desktop study; however, it is likely that the shape of this headland focuses wind waves and boat wake to the area which is currently showing highest erosion.

When wind speed is high and water levels rise (due to tides and the storm surge events) the height and the period of waves increase causing them to reach areas of upper foreshore that are usually not subject to wave action. Given that the areas behind the band of fringing sedges is denuded of vegetation (with the exception of some planted trees), and the soils altered by the addition of infill, erosion has penetrated deeper into the foreshore profile. This is most evident in the western section of the site as indicated in Figure 13.

4.3 CLIMATE CHANGE

The significant and lasting change to weather patterns based on statistical analysis of yearly, decadal or longer periods of data is collectively termed as the climate change. The report on the State of Climate – 2014 (CSIRO, 2014) indicates that Australia's climate has warmed by 0.9°C since 1910, and the frequency of extreme weather has changed, with more extreme heat and reduction in rainfall for the south west of Australia, particularly in the last 20 years. This trend is projected to continue in the future with more prominent increases in temperature, decrease in rainfall and an increase in sea level rise (CSIRO, 2014).

The combination of drying and increased evaporation results in decreased soil moisture which adversely affects establishment and persistence of vegetation cover particularly in the dryland or upper foreshore areas. This in turn has a direct impact on the functioning of ecosystems at large. Similarly, prolonged inundation and increased salinity also has a negative impact on the sustainability of the ecosystems which were once adapted to a milder climatic regime.

4.3.1 Effect of Mean Sea Level Rise on the Project Area

Flood prone areas exist adjacent to the Clontarf Foreshore and the eastern bank of Shelley Bridge (SPCC, 1989). At Clontarf, there is a predicted 100-year flood level of 1.47 metres, which indicates that the entire foreshore strip at Clontarf would be submerged up to Brother Keaney's Garden (also known as Cat's Island).

Flooding along the Swan and Canning Rivers can occur after significantly heavy or prolonged rainfall which produces large amounts of runoff (WRC 2000, McMullen, 2012). Whilst flooding due to freshwater input has occurred in the past in both Swan and Canning River floodplains (McMullen, 2012, Middlemann *et al*, 2005) nowadays particularly with reference to the drier climate, the flooding is caused most frequently by storm surges and high tides. The Department of Water (DoW) recently assessed the Swan and Canning River tidal and storm surge levels (URS, 2013) in order to incorporate the predicted sea level rise due to climate change and produce the new 100 year ARI flood levels. These levels include

the maximum water level for the area of the river next to Clontarf including the mean sea level rise wind set up. The wind set up refers to the effect of the wind on tide levels during storm surges (i.e. elevation in the direction towards which the wind is blowing).

100 year ARI "Present Day"	1.47 mAHD
100 year ARI Future (2110)	2.27 mAHD

The mapped 100 year floodway and the flood fringe boundaries for the project area are presented in Figure 14 (DoW, 2013).

Figure 14 Extent of current and predicted flooding due to mean sea levels (Source: DoW, 2013)

The increase in water levels will likely cause erosion and loss of vegetation as well as the shift in vegetation communities over time. For this reason, any planning for restoration works must take into consideration selection of species capable of adapting to these changes. This should be a staged process as the changes in water levels due to sea level rise are incremental and not sudden.

4.3.2 Effect of Storm Surges

The increase in maximum water levels in the Canning River are also attributed to the storm surges. Currently, the site is subject to flooding between 1 to 1.2 mAHD during storm surges which includes the average wind set up. The difference between the flooding of the shoreline due to the normal tidal range and the storm surges is shown in Figure 15 together with the 100 year ARI flood levels and the flood fringe as indicated by DoW (2013).

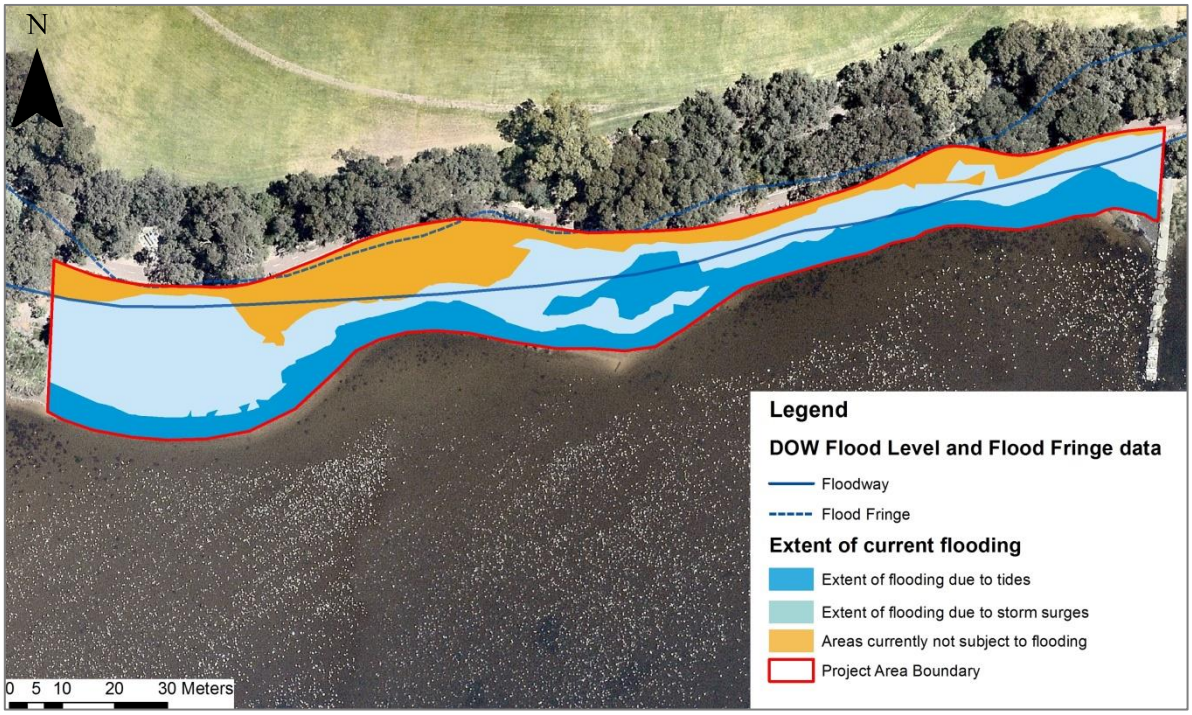

Figure 15 Extent of flooding due to storm surges

Most recently recorded significant storm surges occurred on 17th June 2014 and 10th and 13th June 2012. The readings recorded at Barrack Street Jetty on these days show tides in excess of 1.6m Chart Datum (m CR) (equivalent to 0.85 mAHD) with the tide peak of 0.96 mAHD recorded on 10th and 11th June (BoM, 2012). The frequency of storm surges appears to have increased in the last five years resulting in shoreline erosion and vegetation loss. It is likely that this pattern will continue in the future further destabilising the shoreline particularly in the areas already affected by erosion and having poor vegetation cover.

4.3.3 Drought

It is likely that the increase in temperatures and particularly the duration of dry periods would result in high evapotranspiration rates which could affect the growth of vegetation negatively. The establishing vegetation (seedlings or newly planted stock) would be at most risk as the root systems would not be adapted to access water deeper in the profile. Hence, all planting works will need to be carefully planned in the future and supplementary watering or soil amendments made to help the establishment of new plants.

PART 2: RESTORATION APPROACH

5.0 VISION AND OBJECTIVES

The Clontarf Foreshore and its remnant vegetation form an important part of the fringing riparian ecosystem of the Canning River and have a high cultural, conservation and amenity values. The erosion of the shoreline currently poses a threat to these values. Therefore, restoration plan should be developed and implemented to prevent the shoreline from further degradation.

It is envisaged that the implementation of this Restoration Plan will significantly contribute to the protection and enhancement of the biodiversity and aesthetic values of the site with the aim to:

- Mitigate further erosion of foreshore areas within the project site through protection of existing vegetation and the re-establishment of native riparian vegetation;
- Improve the condition of foreshore vegetation through the staged revegetation and weed control; and
- Implement a long-term management of the site including on-going maintenance and monitoring programs.

6.0 PRELIMINARY CONSIDERATIONS

There are a number of preliminary items to consider prior to implementing a comprehensive restoration project, and these are outlined below. In order to ensure effective and efficient implementation, logistical coordination is a key task and should be given utmost importance prior to the commencement of any restoration works and continue to be a priority during all phases of works. A designated project officer should be assigned to coordinate the project and ensure sufficient communication with the project team and stakeholders.

6.1 PERMITS AND AUTHORISATION

Prior to any on-ground works commencing, all permits and authorisation from relevant authorities will be required. Sufficient time must be allocated for the approval process to progress and any delays in approvals must be accommodated in the plan. The City already has a Section 18 Approval under the *Aboriginal Heritage Act 1972* for revegetation and maintenance work. The works proposed in this restoration plan fall under this approval.

Failure to seek appropriate approvals can slow down work progress causing costly delays.

In addition, a Dial-Before-You-Dig enquiry will be required to ensure no underground services will be affected during implementation works as this service has limited validity.

6.2 SITE ACCESS AND STORAGE

Adequate site access and storage is essential for the efficient implementation of works. Due to the limitations on vehicle access to the site, any implementation works will require sufficient traffic management along the adjacent DUP. Authorisation will also need to be sought from the Main Roads Western Australia and the City of South Perth for any significant vehicle movement along the DUP. In addition, access via Clontarf College Grounds might be required and arrangements need to be in place with the College prior to using this as a pathway. Given that southern section of the sports oval becomes waterlogged during winter, this area will not be used for site access during the planting period.

The two possible access ways are via DUP from Waterford Avenue from the west and via Clontarf Aboriginal College carpark and the DUP from the east (Figure 16).

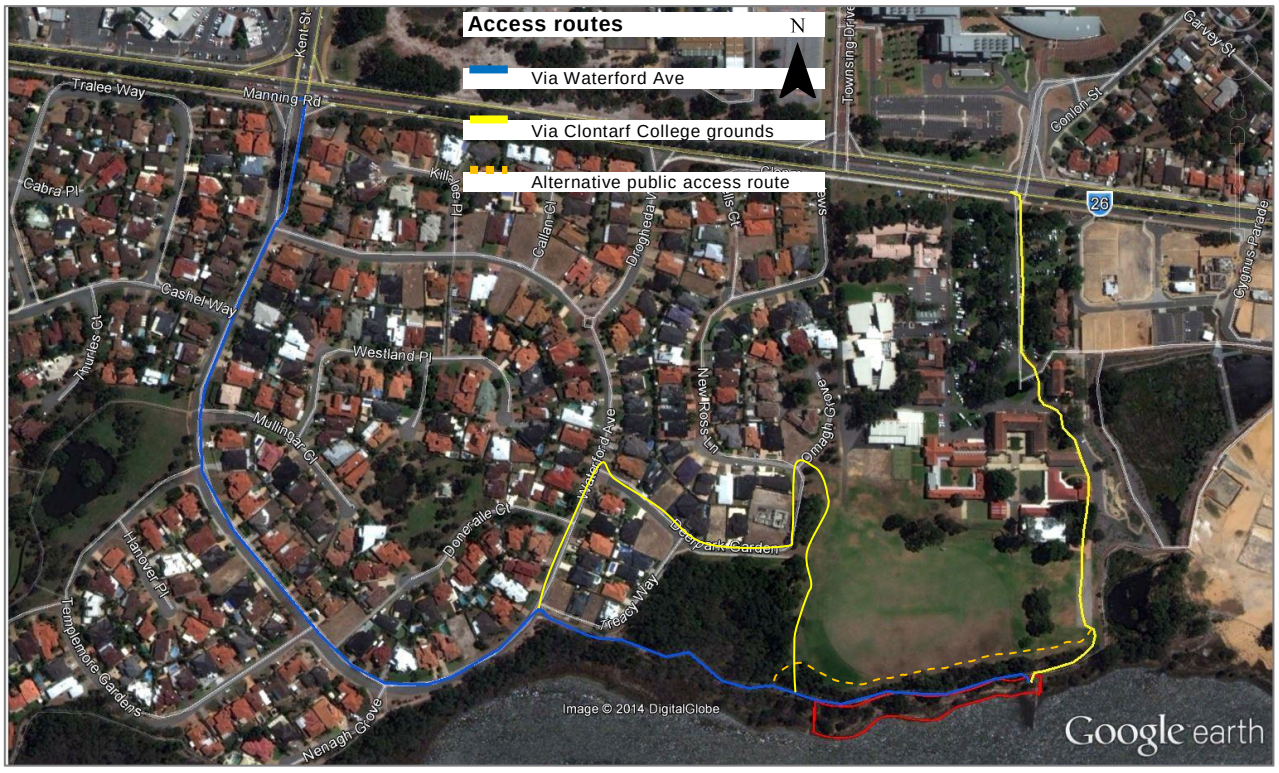

Figure 16 Site access pathways

Significant logistical input is required to ensure the safety of the public and personnel when transporting staff, materials, and equipment to and from the site.

Storage of materials on site is difficult due to the narrow nature of the site; however, a possibility of using a small container at the western edge of the Clontarf sporting field is an option for a short term during the works. Otherwise, the materials should be delivered on site

in small loads as required for a particular day of works using small utility vehicles with trailers. The gross weight of any vehicle with the load accessing the path should be less than three (3) tonnes.

6.2.1 Public access

Public access may be hindered along the DUP during times of vehicle transit (e.g. to deliver materials and equipment to site) or by parked vehicles.

To avoid any issues with public assess all vehicles should not travel more than 5km per hour along the DUP and should preferably have one person walking at the front of the vehicle to warn any walkers or cyclists of the vehicle approaching. Orange flashing light (beacon) should be used whilst transiting on the DUP.

Both a star picket fence with a simple three rows of galvanised wire and the high visibility bunting fence should be used to fence off the project area to deter any access for the duration of the works and at a minimum three months after completion of works. A traffic management plan shall be prepared as part of the Construction Management Plan (CMP) for the site.

7.0 RESTORATION PLAN

To facilitate effective implementation and management of the restoration activities on site, the plan has been divided into the following sections:

- Site preparation;
- Foreshore erosion control works;
- Foreshore revegetation;
- Weed management; and
- Monitoring and maintenance.

7.1 SITE PREPARATION

Prior to commencement of works the entire project area should be declared safe to work with no visible dangerous materials (e.g. metal scrap, large rubble and or cement sheeting – this was removed from the site as part of the asbestos remediation works. However, there is still a possibility of these materials occurring on the site.

Appropriate dust management must be in place prior to the commencement of works and all workers on site inducted in dangers of working in the area where asbestos may potentially still occur.

7.1.1 Fencing

The project area must be fenced off to prevent public accessing the site during the construction works and the plant establishment phase. Appropriate safety signage in accordance with the Australian Standards and the project information signage should be erected at both ends of the site to inform the public of the works and explain the project objectives and duration.

7.1.2 Weed control and vegetation removal

Weed control (both chemical and manual) should be completed where required and undertaken at least two weeks prior to start of construction works by a qualified contractor.

Any trees and shrubs designated for removal in the Construction Management Plan should be marked and cut and treated appropriately to prevent their future growth. The roots should remain *in situ* and not be removed as they will help with the foreshore stabilisation until the establishment of newly planted vegetation.

Any dead or otherwise damaged trees that do not interfere with the implementation of works should only be removed from the area if they pose threat to public safety. Some of the planted shrubs and trees that are not appropriate to the location and conditions on site will be removed to facilitate new plantings.

Any removed vegetation should be mulched and the mulch taken for composting or reuse to the City's depot.

7.1.3 Foreign material removal

Any visible rubbish (often brought by river tides) and organic matter should be removed to facilitate the implementation of erosion works and soil infill.

Any large bricks and rubble which are exposed in their entirety and loosely sitting on the soil surface should be taken off site and disposed of at an appropriate construction material disposal site. Any concrete handmade bricks in good condition should be saved and passed onto the Old Clontarf Boys for possible artwork or future interpretive signage projects.

Black plastic liner should be removed to facilitate future growth of plants. This should only be undertaken after soil testing is complete which will investigate any dangers in removing the plastic with regards to the asbestos fibres.

7.1.4 Soil infill

Clean river sand from an appropriate supplier must be used for infill areas where topsoil has been washed off or where topsoil is missing (e.g. in areas where rubble is removed) and where bank re-grading is needed.

A mix of the River sand with clean Bassendean grey sands could also be used. However, this is more preferable for the upper foreshore areas closer to the path.

The sands should be lightly compacted on site and kept damp during construction and planting works. The infill activities should occur in parallel with the erosion control works to keep the soil profile stable prior to planting. Areas of soil infill are shown on the drawing set provided with the Technical Specifications (Syrinx, 2014) for the implementation of this Plan.

7.2 FORESHORE EROSION CONTROL

Based on the results obtained during the preliminary site assessment the need for erosion control varies based on the level of disturbance that has affected these areas. Two different erosion control methods are proposed to help with stabilisation of soils depending on the severity of wave impact and the status of the current erosion. These methods are:

1. **Foreshore Treatment 1:** - installation of erosion fabric in combination with brush wall and coir logs for high impact areas, and
2. **Foreshore Treatment 2:** - installation of erosion fabric for low impact areas.

Figure 17 shows the proposed extent of the areas where foreshore treatments will be applied (e.g. Zone 2 and 5 are to undergo Foreshore Treatment 1, and Zone 1 and 4 are to undergo Foreshore Treatment 2. Zone 3 has adequate protection from the existing vegetation and will not require specific erosion control method).

Figure 17 Approximate extent of the foreshore treatment areas

7.2.1 Foreshore Treatment 1

The areas that have been selected for this treatment have been identified to have the highest degree of erosion and hence are given the highest priority for erosion mitigation.

The bioengineering works will be comprised of:

- Infill of the undercut bank with river sand to create a 1:6 gradient slope where possible;
- Installation of Coir Mesh erosion fabric;
- Installation of brush wall at the toe of the embankment; and
- Foreshore planting.

The brush wall is a bioengineering technique utilised to minimise effect of wave impact on the shore. It consists of brush bundles or 'logs' approximately 200 to 300mm in diameter stacked on top of each other and supported by the Jarrah wooden stakes and galvanised wire. The brush wall dissipates the wave energy whilst creating a permeable barrier allowing water movement but retaining any soil on the landward side.

In order to mitigate erosion via wave impact, the brush wall structure has to be constructed at a height that exceeds maximum water levels (~0.75mAHD) and extend a minimum of 1m into the unaffected areas of the foreshore. A simple diagram indicating the components of this method of erosion control are outlined in Figure 18.

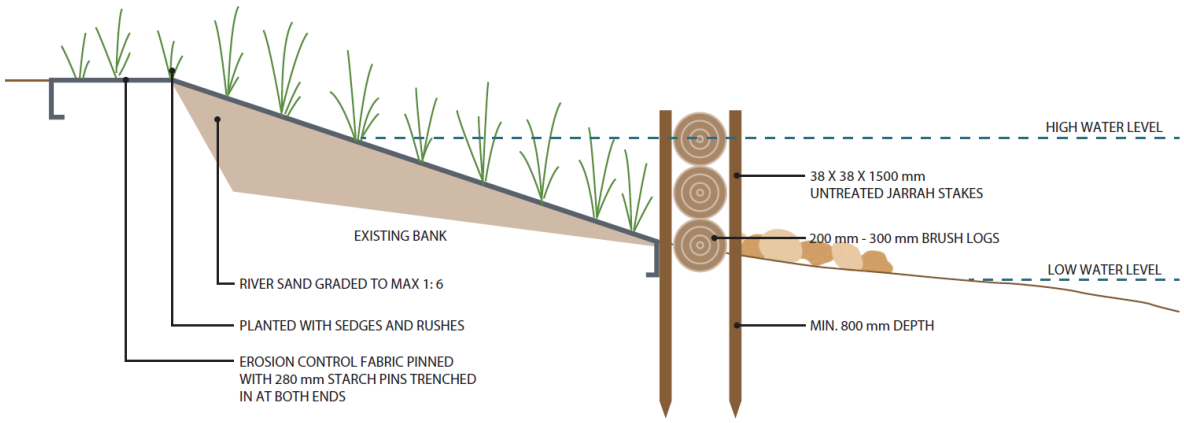

Figure 18 Foreshore Treatment 1 – Brush wall and Coir Mesh fabric (Figure not to scale)

The planting in areas with this method of erosion control will be comprised of *Juncus krausii* the species native to the intertidal zone of the river. Large stock (140 mm pots or equivalent) will be plated directly behind the wall and smaller tubestock (50mm pots or Forestry tubes) will be planted on the slope to minimise the need to cut through the erosion fabric Provided the structure is maintained well and regulalry, the brush wall structure will protect

establishing vegetation for up to 7 years, slowly breaking down and allowing the riparian vegetation to assume the main protective function.

Limestone spalls along the toe of the brush wall on the river side need to be installed to provide protection to the structure and to ensure that the erosion fabric (installed the shoreward side of the brush wall) remains in place. This small rock toe only needs to extend approximately 0.5m from the base of the brush wall into the river.

7.2.2 Foreshore Treatment 2

The areas outlined for the Foreshore Treatment 2 (Figure 17) have experienced erosion and vegetation loss behind a remnant band of *Juncus kraussii* at the water's edge. Either mature or semi mature trees and shrubs are growing on the upper parts of the embankment.

To restore these areas, a low-impact bioengineering technique will be implemented. This includes:

- Installation of coir mesh erosion fabric along the eroding face of the slope; and
- Foreshore planting.

Because Foreshore Treatment 2 will be installed in areas behind remnant J*uncus kraussii* populations, (see Figure 19) the application of toe protection is not considered necessary. However, to improve the longevity of the erosion control measures it is recommended that the edges of the erosion fabric be folded over (50 mm is sufficient) at the foot of the slope before pinning to allow for sediment capture just behind the sedges (trenching at the foot of the slope is not recommended as disturbance to the existing plants would occur).

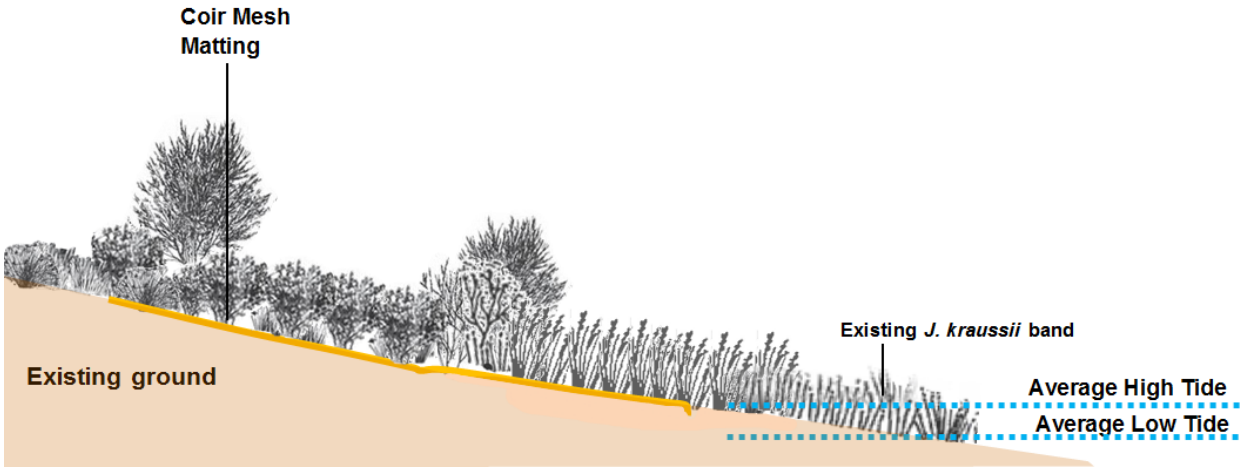

Figure 19 Foreshore Treatment 2 –Coir mesh fabric behind existing *Juncus kraussii* plants

The erosion fabric will be secured using starch pins and 300mm long steel pins where starch pins are unable to penetrate the ground due to rubble being present at depth. The steel pins should be removed once the vegetation is established (usually three (3) years after initial planting. Steel pins can be left *in situ;* however, these pins rust and may form sharp ends potentially causing harm to the public informally accessing the river's edge for fishing or kayaking.

7.3 FORESHORE REVEGETATION

Revegetation of the foreshore areas is essential for the long term protection of the banks from erosive wave action, provide habitat for fauna and increases aesthetic values of the area.

7.3.1 Species selection

The species selection for revegetation was based on the existing indigenous flora and vegetation on site and the adjacent foreshore areas as well as their growth characteristics and ability to cope with the abiotic conditions present on site (i.e. the wave erosive impact, growth conditions, etc.). Careful delineation in planting mix selection was made with respect to topography, tidal and storm surge water levels, predicted climate change and the remnant vegetation on and surrounding the site.

The proposed planting plan is presented in Figure 20, and the associated species selection for each planting area is presented in Table 1.

Please note that due to the high presence of limestone rubble adjacent to the path, *Acacia lasiocarpa* and *Ficinia nodosa* was chosen for the planting mixes to ensure plant establishment. Both of these species are not riparian in nature, but do occur on limestone escarpments and coastal dunes and are used widely in landscaping due to good form and tolerance to modified soil profile.

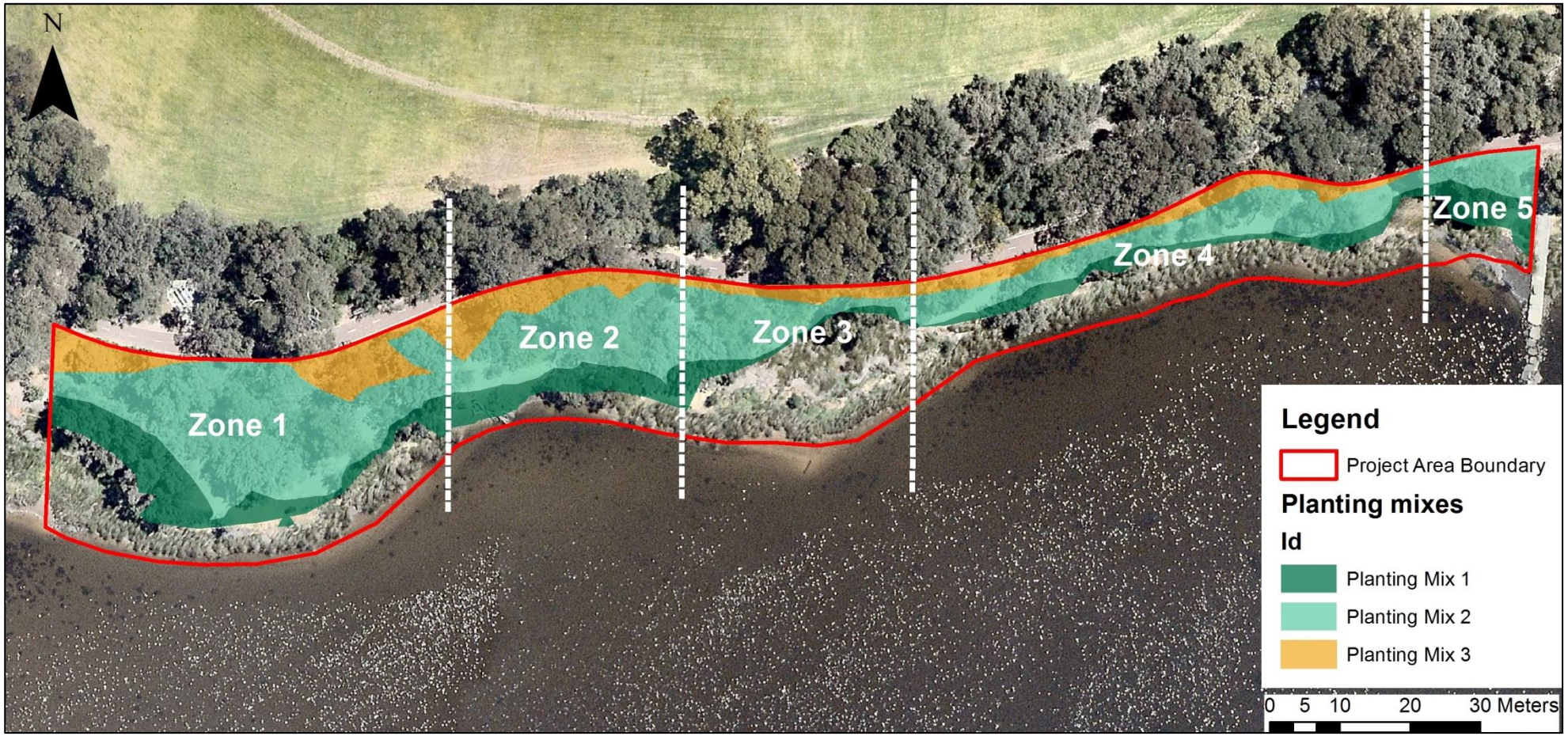

Figure 20 Planting plan indicating planting zones

Table 1 Planting mix selection for the Clontarf Foreshore

Botanical name	Common name	Planting mix 1	Planting mix 2	Planting mix 3
TREES				
Casuarina obesa	Swamp Sheoak			
Eucalyptus rudis	Flooded Gum			
Melaleuca rhaphiophylla	Freshwater Paperbark			
SHRUBS				
Shrubs 1 - 2 m				
Acacia lasiocarpa	Panjang			
Acacia stenoptera	Narrow Winged Wattle			
Astartea scoparia				
Hypocalymma angustifolium	White Myrtle			
Melaleuca lateritia	Robin Redbreast Bush			
Shrubs < 1 m				
Bossiaea eriocarpa	Common Brown Pea			
Gastrolobium capitatum				
Hibbertia racemosa	Stalked Guinea Flower			
Rhagodia baccata	Berry Saltbush			
Suaeda australis	Seablite			
SEDGES AND RUSHES				
Juncus kraussii	Sea Rush			
Baumea juncea	Bare Twigrush			
Gahnia trifida	Coast Saw-sedge			
Schoenus subfascicularis				
HERBS				
Conostylis aculeata	Prickly Conostylis			
Dianella revoluta	Blueberry Lily			
Patersonia occidentalis	Purple Flag			
GRASSES				
Sporobolus virginicus	Marine Couch			

Note: The technical specifications and drawings have the numbers of plants for planting zone as well as their proposed planting arrangement and densities within each zone.

7.3.2 Sourcing plants for revegetation

Local provenance seed and vegetative material should be used whenever possible to generate required plants for revegetation. Local provenance stock will have better adaptation to local conditions resulting in higher plant survival. Vegetative material (cuttings, rhizomes or roots) and seeds from the foreshore reserves within the City of South Perth would be considered most appropriate. Failing this, the Swan Coastal Provenance seed and vegetative material should be used.

Plants should be ordered at least 6 to 12 months prior to planting to allow adequate growth time for stock to satisfy recommendations given in the Technical Specifications. It is understood that the City of South Perth nursery will be growing the vegetation stock for this project. It might be necessary to seek assistance from a commercial nursery to propagate

some of the stock which will be required in high numbers (e.g. *Juncus kraussii*) to ensure that the supply of plants is ensured at the time of planting. Whilst, the staged approach to restoration works may allow for all of the plants to be propagated by the City's nursery, it would be preferable to plant larger areas of the site at once to allow for faster establishment of *Juncus kraussii* beds in particular prior to erosion control methods losing their efficacy as they are designed to degrade with time (e.g. coir mesh which lasts up to 4 years depending on the level of impact on the fabric and its exposure to sun).

7.3.3 Planting densities

The planting densities will vary between 1 to 6 plants per m^2 depending on the level of cover by existing vegetation and the size of stock planted. For the areas denuded of vegetation and where establishment of the thick sedgeland is required the planting densities are higher than those of the upper foreshore areas.

7.3.4 Size of plant stock and hardening off prior to planting

Tube stock (50 x 50 x 125mm) will be suitable for propagation of most plants; however, it is recommended that larger stock be used in the foreshore areas with Foreshore Treatment 1 to help establish vegetation quicker and combat the wave impact. Larger plants (140mm pots) would have a better chance of survival than small plants given that the plants have well developed root systems and have been adequately hardened off by watering seedlings with brackish water in the nursery at least two weeks prior to being planted on site.

7.3.5 Implementation works

The revegetation plan should be implemented by a specialist consultant team familiar with restoration work in riverine environments and in collaboration with the City of South Perth and DPaW in order to achieve the best environmental outcome.

Weed control works will need to be completed prior to planting using a suitable herbicide (e.g. Round-up Biactive ®) that will not affect the growth and health of newly planted seedlings, remnant native vegetation, and the fauna or water quality of the area.

The erosion control works, and associated earthworks should be completed in summer to early autumn when water levels are generally low and the tides are more predictable.

The general planting arrangement will involve installation of dense strands of *Juncus kraussii* at the water's edge with very sparse plantings of *Casuarina obesa, Melaleuca rhaphiophylla* and *Eucalyptus rudis* slightly higher upslope between 0.75 and 1.4m AHD. This layer would have sparser *Juncus kraussii* planting (to 0.8m AHD) with the introduction of *Baumea juncea* at 0.8m AHD which would then be planted densely all the way to the path. Shrubs such as

Astartea scoparia, Melaleuca lateritia and *Hypocalymma angustifolium* should be planted sparsely along with *Baumea juncea*. The areas with *Baumea articulata* and *Bolboschoenus caldwellii* should be protected and the existing clumps allowed expanding to the outer edges. It is important to note that the conditions for growing of these species are connected to the availability of fresh water close to surface throughout the year. For that reason these species are not recommended for planting throughout the site.

In addition, the stems of *Baumea articulata* are relatively rigid and do not bend with the wave action, thus having a lower wave attenuating (energy absorbing) capacity. *Bolboschoenus caldwellii* dies back to underground parts in winter and re-sprouts in spring, reducing its ability to control erosion over winter and results in some nutrient release into the river (Department of Water, http://www.water.wa.gov.au/PublicationStore/first/84811.pdf). Planting of *Juncus kraussii* band on the river frontage will result in the formation of a more permanent vegetation cover and better shore protection over time.

The site already has a large number of trees, hence, only a very small number of trees is recommended for planting. This will ensure sufficient light will reach the understorey vegetation and maintain views to the river.

7.3.6 Irrigation

In order to encourage seedling growth particularly in the first year of establishment, some watering will need to take place during the times of extended drought (summer – autumn).

To allow for the best plant establishment, planting should be conducted in late autumn to early winter, when there is a high probability of adequate rain occurring post planting that would maintain moist conditions on site during the establishment phase. If the plants are installed in late winter – early spring or later, irrigation will most likely be required on a fortnightly basis despite groundwater availability.

Early (April) to late (October – November) planting will only be suitable for *Juncus kraussii* on the lower foreshore as these plants will have an adequate water supply all year round.

7.4 WEED MANAGEMENT

The site is susceptible to weed introduction as it is exposed to wind and water transported seeds and has a high degree of public access. Thus, weed control must be carried out with an emphasis on timing and frequency. For example, weeds must be treated with herbicide prior to flowering as herbicides have no effect on viable seeds and may even facilitate their dispersal from the plant.

Several weed species were recorded during the initial site assessment by Syrinx. Currently, there is a weed control program conducted by the City that targets exotic grasses and herbs in close vicinity of the site.

The recommended management and timing of weed control works for each of the species recorded on the site are given in Table 2.

Table 2 Introduced flora and their proposed management at Clontarf Foreshore

Botanical name	Common Name	A/P	Summer	Autumn	Winter	Spring
Avena barbata	Bearded Oat	A			**	*
Brassica tournefortii	Wild Radish	A			**	*
Cenchrus clandestinus	Kikuyu Grass	P	***	****	***	***
Chenopodium album	Fat Hen	A	**	**	**	***
Cynodon dactylon	Couch	P	***	***		****
Ehrharta calycina	Perennial Veldt Grass	P	***	***	**	**
Euphorbia peplus	Petty Spurge	A			**	***
Fumaria capreolata	Whiteflower Fumitory	A		**	***	***
Gladiolus caryophyllaceus	Wild Gladiolus	P		**	*	**
Hypochaeris glabra	Smooth Catsear	A	*		**	***
Medicago polymorpha	Burr Medic	A		**	**	*
Oxalis pes-caprae	Soursob	A		**	***	
Sonchus asper	Rough Sowthistle	A	*	*	**	***
Sonchus oleraceus	Common Sowthistle	A	**	**	**	***
	LEGEND					
	Annual	A				
	Perennial	P				
	Optimum treatment time					
	Germinating/emerging	*				
	Active growth	*				
	Reproductive phase	*				
	Rhizomatous sprawling	*				

The management of weeds along the Clontarf Foreshore will involve the application of low toxicity herbicides such as Glyphosate with the lowest concentration necessary to successfully control the weeds while limiting unnecessary exposure to the surrounding environment. Follow-up control is required regularly throughout the year in order to control any further emergence. Effective weed control implementation will include:

- Glyphosate application via pressurised spray hoses;
- Direct application of undiluted Glyphosate to cut shrub or tree stumps; and
- Manual weed removal (whole plant or seed heads prior to Glyphosate application).
- Establishment of planted native sedges, shrubs and trees.

Manual weed control may be necessary for the areas where weed infestation is low, and the established native cover is high. The manual control is best conducted when the weeds are small to minimise disturbance to the soil and before flowering and set seed.

It is important to note that small infestations of Couch (*Cynodon dactylon*) may not be easy to remove manually in which case exemption to the above rule applies. Where Couch is present, it is best to sacrifice few native plants due to off target damage than hand weed, as the likelihood of containing the Couch spreading through hand weeding is unlikely, and may result in the infestation of a much larger area. Supplementary planting will be essential to offset any losses of native vegetation in areas where of target damage occurred.

The Lemon Scented Gum (*Eucalyptus citriodora*) present on site is also an introduced species as well as several shrubs in the area (shrubs more suited to Mount Henry limestone outcrops (e.g. *Templetonia retusa*). These species may be removed depending on the construction requirements in the future; however, in the short term these plants provide habitat and increase the biodiversity of the area and should be kept until the required materials and plants specified for restoration works are obtained and ready for installation.

E. citriodora tree is the only non indigenous tree on site and is growing close to the path, the City may consider removing it as part of the general bushland maintenance works well in advance of any restoration works. Some species such as *Bossiaea eriocarpa, Patersonia occidentalis* and *Conostylis aculeata* will be kept or transplanted to the upper parts of the shore not subject to inundation as they are suited to the site's hydrological conditions.

7.5 MAINTENANCE AND MONITORING

A minimum of a two (2) year maintenance period is recommended after completion of all restoration works to ensure successful restoration of the project area. Monthly site inspections and remediation tasks should be undertaken by appropriately qualified personnel in order to maintain the function of the applied erosion control measures and to ensure plant establishment.

7.5.1 Maintenance

A schedule of proposed maintenance tasks and progress reports on completed tasks should be provided to the City of South Perth on a monthly basis. Reference site photographs which show the condition of the site should be included in the reports together with the checklist and follow-up actions from previous month maintenance/ inspection. Maintaining regular records will help with the development of any contingency measures should this be required.

7.5.1.1 Bioengineering

The maintenance tasks must include, but not be limited to ensuring all bioengineering work (termed as Foreshore Treatment 1 and 2 in this document) is maintained in good condition. Regular maintenance helps to ensure erosion control works function until the plants are well established and able to cope with the erosive action of the waves without extra protection from the bioengineered structures and materials.

The primary bioengineering maintenance task is the securing of bioengineering structures through stake (re)-placement and wire tensioning. Erosion control fabrics will also be maintained by ensuring fabrics and stakes are properly secured, and tears or subsurface erosion are managed. Any further erosion or undercutting following implementation of erosion control works will also be assessed and the appropriate control methods devised to mitigate any soil and or vegetation losses.

7.5.1.2 Weed Control

Suppression of weeds for an extended period of time has a positive effect on the long term sustainability of the restored areas and should be incorporated as part of the weed control plan. This is important as it promotes an integration of restored vegetation with the adjacent natural areas. The weed control should be regular and focused on priority weeds with the majority of works to occur during the appropriate times of year to reflect active vegetative weed growth. Please refer to Section 7.4 for further information.

7.5.1.3 Vegetation Maintenance

Plant health will be monitored during monthly site inspections, and supplementary planting will occur if deemed necessary to maintain appropriate densities. It is advisable to water revegetated areas during summer in the first year of growth to allow for successful establishment and to minimise plant losses.

7.5.2 Monitoring

A well designed monitoring program is important to measure the success of completed restoration works and to identify the most effective restoration approaches for the future works. Monitoring will also aid in determining strategies for combating effects of climate change expressed on site in terms of flooding.

Monitoring will be conducted monthly as part of the maintenance programme and is not a big tasks; however delivers highly useful information. Monitoring will consist of recording plant growth, increase in plant cover or plant deaths and taking photographs from the designated photo monitoring points. The monitoring points are established prior to restoration works and

provide a good evidence of the progress of works, efficacy of erosion control methods and the success of plant establishment.

7.5.2.1 Erosion Monitoring

To accurately monitor erosion on site, it is recommended that established foreshore profiles are measured and compared to the baseline data (shoreline immediately after construction and planting works have been completed). This will be in addition to the photo monitoring from a designated photo monitoring point (recorded using GPS and a Jarrah stake) and erosion stakes that have been strategically located along the slope gradient in the most erosion prone areas. Another important aspect of monitoring is taking into account major storm events throughout the year. This would require additional monitoring after such events to provide perspective on how much of the area is altered by such events and also how the area responds thereafter.

7.5.2.2 Vegetation Monitoring

Regular vegetation monitoring will provide insight into how successful the restoration works are in terms of achieving the completion criteria. Survival rate and species cover should be used to compare against baseline data (data collected immediately after construction works are complete).

Monitoring should be carried out monthly following planting to determine the need for supplementary planting for the upcoming winter and identify any issues with the growth of the planted stock and the invasion of introduced flora.

The following suggested completion criteria are provided for vegetation monitoring:

1. Survival rate of the planted stock is 70 % or greater from that originally planted after 2 years of maintenance and monitoring;
2. The total vegetation cover of the restored foreshore area dominated by *Juncus kraussii* has increased by 50% or more after 2 years;
3. The site is geotechnically stable (i.e. no additional erosion has occurred in the restored areas;
4. The weed cover is less than 5 weeds per m^2 and 5% of the site;
5. The plants must be in good condition or ‘resilient’ as evidenced by well-developed root systems and flowers. Shrubs will be well established and in a “young” age class at a minimum (e.g. not comprised of seedlings that may not survive until the following year.

Particular attention should be given to the foreshore monitoring close to the water line, and the increase in water levels noted. Should notable changes arise, contingency plans must be in place to deal with these changes (i.e. plant more *Juncus kraussii* upslope (above 0.8 m AHD).

7.5.2.3 Weed Monitoring

Weed monitoring should be conducted on a regular basis at monthly inspections following commencement of restoration works to measure the effectiveness of weed control efforts and plan for subsequent weed control events. Monitoring will involve a record of all weed species observed on traverses of the site.

Any location of Couch or Kikuyu should be marked and monitored carefully to determine if the applied weed control methods are working. Appropriate weed control should be applied based on the regular monitoring finds.

PART 5: TIMELINES AND COSTS

The stability of the Clontarf Foreshore is largely influenced by the erosive action of the waves on the shore with large quantities of building rubble. Both prevent the native vegetation from the establishment and facilitates losses of remnant vegetation particularly *Juncus kraussii* which is essential in stabilising the foreshore environment.

The changing climatic condition and anthropogenic influences further threaten losses of vegetation which is not only significant for the fauna habitat, shoreline stabilisation and conservation of biodiversity but also has a high cultural and historical significance. For these reasons implementation of restoration techniques outlined in this restoration plan is deemed essential in maintaining the high ecological, cultural and social values of the area.

Given that the restoration works will require significant funds to be secured in order to be completed in their entirety and to specifications, the City will need to collaborate with the DPaW or other interested stakeholder to secure funds. A preferable outcome would be to complete works in one continuous operation. However it is more likely that funding will be obtained over a 2 to 3 year period.

Restoration costs have been calculated, so they are congruent with the foreshore treatment and planting zones as indicated in Figure 17 with zones listed in order of priority from high to low: Zone 2, Zone 4, Zone 5, Zone 1 and Zone 3.

7.6 SCHEDULES, COSTS AND TIMELINES

The schedule outlined in Table 3 should be referred to for guiding timing of works within any given calendar year. However, the timing of works such as planting, for example, should be planned in accordance with climatic conditions to ensure plant establishment and survival in the long term. Therefore the schedule given in Table 3 is indicative only.

Table 3 Implementation schedule for restoration works

Activity	Autumn			Winter			Spring			Summer		
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Gathering native plant seed												
Propagate native plant seedlings												
Planting native seedlings												
Weed control – chemical												
Weed control – manual												
Erosion control works												
Monitoring												

The extent of works and the quantities of plants planted each year will depend on the funds available, the seasonal conditions and the availability of the suitable material for propagation. Therefore, the numbers of plants for each planting Zone given in Table 4 and the costs (as supplied by the City of South Perth Nursery) are indicative only.

Table 4 Indicative plant stock supply schedule and costs for restoration of Clontarf Foreshore

Priority level	Botanical name	Common name	Growth form	Size	Price	Quantity	Total cost
Zone 1	*Acacia lasiocarpa*	Panjang	Shrub	70mm	$ 2.50	30	$75.00
	Acacia stenoptera	Narrow Winged Wattle	Shrub	70mm	$ 2.50	20	$50.00
	Astartea scoparia		Shrub	50mm	$ 1.20	140	$168.00
	Hypocalymma angustifolium	White Myrtle	Shrub	70mm	$ 2.50	160	$400.00
	Melaleuca lateritia	Robin Redbreast Bush	Shrub	50mm	$ 1.20	80	$96.00
	Bossiaea eriocarpa	Common Brown Pea	Shrub	70mm	$ 2.50	10	$25.00
	Gastrolobium capitatum		Shrub	70mm	$ 2.50	10	$25.00
	Hibbertia racemosa	Stalked Guinea Flower	Shrub	70mm	$ 2.50	20	$50.00
	Rhagodia baccata	Berry Saltbush	Shrub	50mm	$ 1.20	20	$24.00
	Suaeda australis	Seablite	Shrub	50mm	$ 1.20	80	$96.00
	Juncus kraussii	Sea Rush	Rush	50mm	$ 1.20	350	$420.00
	Baumea juncea	Bare Twigrush	Sedge	50mm	$ 1.20	160	$192.00
	Gahnia trifida	Coast Saw-sedge	Sedge	70mm	$ 2.50	120	$300.00
	Conostylis aculeata	Prickly Conostylis	Herb	70mm	$ 2.50	10	$25.00
	Dianella revoluta	Blueberry Lily	Herb	50mm	$ 1.20	20	$24.00
	Patersonia occidentalis	Purple Flag	Herb	50mm	$ 1.20	10	$12.00
			Total plants and costs for Zone 1			***1240***	***$1,982.00***
Zone 2	*Casuarina obesa*	Swamp Sheoak	Tree	70mm	$ 2.50	2	$5.00
	Melaleuca rhaphiophylla	Freshwater Paperbark	Tree	70mm	$ 2.50	3	$7.50
	Acacia lasiocarpa	Panjang	Shrub	70mm	$ 2.50	40	$100.00
	Acacia stenoptera	Narrow Winged Wattle	Shrub	70mm	$ 2.50	10	$25.00
	Astartea scoparia		Shrub	50mm	$ 1.20	70	$84.00
	Hypocalymma angustifolium	White Myrtle	Shrub	70mm	$ 2.50	120	$300.00
	Melaleuca lateritia	Robin Redbreast Bush	Shrub	50mm	$ 1.20	50	$60.00
	Bossiaea eriocarpa	Common Brown Pea	Shrub	70mm	$ 2.50	20	$50.00
	Gastrolobium capitatum		Shrub	70mm	$ 2.50	10	$25.00
	Hibbertia racemosa	Stalked Guinea Flower	Shrub	70mm	$ 2.50	30	$75.00
	Rhagodia baccata	Berry Saltbush	Shrub	50mm	$ 1.20	40	$48.00
	Juncus kraussii	Sea Rush	Rush	50mm	$ 1.20	400	$480.00
	Juncus kraussii	Sea Rush	Rush	140mm	$ 4.00	250	$1,000.00
	Baumea juncea	Bare Twigrush	Sedge	50mm	$ 1.20	300	$360.00
	Gahnia trifida	Coast Saw-sedge	Sedge	70mm	$ 2.50	80	$200.00
	Schoenus subfascicularis		Sedge	70mm	$ 2.50	40	$100.00
	Conostylis aculeata	Prickly Conostylis	Herb	70mm	$ 2.50	40	$100.00
	Dianella revoluta	Blueberry Lily	Herb	50mm	$ 1.20	40	$48.00
	Patersonia occidentalis	Purple Flag	Herb	50mm	$ 1.20	40	$48.00
	Sporobolus virginicus	Marine Couch	Herb	70mm	$ 2.50	200	$500.00
			Total plants and costs for Zone 2			***1785***	***$3,615.50***
Zone 3	*Acacia lasiocarpa*	Panjang	Shrub	70mm	$ 2.50	20	$50.00
	Acacia stenoptera	Narrow Winged Wattle	Shrub	70mm	$ 2.50	20	$50.00
	Astartea scoparia		Shrub	50mm	$ 1.20	100	$120.00
	Hypocalymma angustifolium	White Myrtle	Shrub	70mm	$ 2.50	30	$75.00
	Melaleuca lateritia	Robin Redbreast Bush	Shrub	50mm	$ 1.20	10	$12.00
	Bossiaea eriocarpa	Common Brown Pea	Shrub	70mm	$ 2.50	10	$25.00
	Gastrolobium capitatum		Shrub	70mm	$ 2.50	10	$25.00
	Hibbertia racemosa	Stalked Guinea Flower	Shrub	70mm	$ 2.50	20	$50.00
	Rhagodia baccata	Berry Saltbush	Shrub	50mm	$ 1.20	10	$12.00
	Juncus kraussii	Sea Rush	Rush	50mm	$ 1.20	520	$624.00
	Baumea juncea	Bare Twigrush	Sedge	50mm	$ 1.20	200	$240.00
	Gahnia trifida	Coast Saw-sedge	Sedge	70mm	$ 2.50	40	$100.00
	Schoenus subfascicularis		Sedge	70mm	$ 2.50	80	$200.00
	Conostylis aculeata	Prickly Conostylis	Herb	70mm	$ 2.50	10	$25.00
	Dianella revoluta	Blueberry Lily	Herb	50mm	$ 1.20	20	$24.00
	Patersonia occidentalis	Purple Flag	Herb	50mm	$ 1.20	10	$12.00
			Total plants and costs for Zone 3			***1110***	***$1,644.00***

Priority for restoration

High | Medium | Low

Priority level	Botanical name	Common name	Growth form	Size	Price	Quantity	Total cost
Zone 4	*Casuarina obesa*	Swamp Sheoak	Tree	70mm	$ 2.50	2	$5.00
	Eucalyptus rudis	Flooded Gum	Tree	70mm	$ 2.50	1	$2.50
	Melaleuca rhaphiophylla	Freshwater Paperbark	Tree	70mm	$ 2.50	2	$5.00
	Acacia lasiocarpa	Panjang	Shrub	70mm	$ 2.50	40	$100.00
	Acacia stenoptera	Narrow Winged Wattle	Shrub	70mm	$ 2.50	40	$100.00
	Astartea scoparia		Shrub	50mm	$ 1.20	130	$156.00
	Hypocalymma angustifolium	White Myrtle	Shrub	70mm	$ 2.50	160	$400.00
	Melaleuca lateritia	Robin Redbreast Bush	Shrub	50mm	$ 1.20	120	$144.00
	Bossiaea eriocarpa	Common Brown Pea	Shrub	70mm	$ 2.50	20	$50.00
	Gastrolobium capitatum		Shrub	70mm	$ 2.50	40	$100.00
	Hibbertia racemosa	Stalked Guinea Flower	Shrub	70mm	$ 2.50	40	$100.00
	Rhagodia baccata	Berry Saltbush	Shrub	50mm	$ 1.20	30	$36.00
	Suaeda australis	Seablite	Shrub	50mm	$ 1.20	40	$48.00
	Juncus kraussii	Sea Rush	Rush	50mm	$ 1.20	500	$600.00
	Baumea juncea	Bare Twigrush	Sedge	50mm	$ 1.20	650	$780.00
	Gahnia trifida	Coast Saw-sedge	Sedge	70mm	$ 2.50	20	$50.00
	Schoenus subfascicularis		Sedge	70mm	$ 2.50	200	$500.00
	Conostylis aculeata	Prickly Conostylis	Herb	70mm	$ 2.50	80	$200.00
	Dianella revoluta	Blueberry Lily	Herb	50mm	$ 1.20	40	$48.00
	Patersonia occidentalis	Purple Flag	Herb	50mm	$ 1.20	100	$120.00
					Total plants and costs for Zone 4	***2255***	***$3,544.50***
Zone 5	*Astartea scoparia*		Shrub	50mm	$ 1.20	30	$36.00
	Hypocalymma angustifolium	White Myrtle	Shrub	70mm	$ 2.50	20	$50.00
	Melaleuca lateritia	Robin Redbreast Bush	Shrub	50mm	$ 1.20	20	$24.00
	Suaeda australis	Seablite	Shrub	50mm	$ 1.20	20	$24.00
	Juncus kraussii	Sea Rush	Rush	50mm	$ 1.20	200	$240.00
	Juncus kraussii	Sea Rush	Rush	140mm	$ 4.00	100	$400.00
	Baumea juncea	Bare Twigrush	Sedge	50mm	$ 1.20	200	$240.00
	Patersonia occidentalis	Purple Flag	Herb	50mm	$ 1.20	20	$24.00
					Total plants and costs for Zone 5	***610***	***$1,038.00***
					Year 1 total costs	**7000**	**$11,824.00**
			Supplementary planting Year 2				
All Zones	*Acacia lasiocarpa*	Panjang	Shrub	70mm	$ 2.50	40	$100.00
	Hypocalymma angustifolium	White Myrtle	Shrub	70mm	$ 2.50	40	$100.00
	Baumea juncea	Bare Twigrush	Sedge	50mm	$ 1.20	300	$360.00
	Juncus kraussii	Sea Rush	Rush	50mm	$ 1.20	400	$480.00
	Juncus kraussii	Sea Rush	Rush	140mm	$ 4.00	100	$400.00
					Year 2 total costs	**880**	**$1,440.00**
					TOTAL PROJECT COST (ex GST)	**7880**	**$13,264.00**

Priority for restoration

High	Medium	Low
Supplementary Planting		

The summary of overall costs of bioengineering works including removal of rubble and supply and installation of sand infill, access management works (inc. fencing), maintenance works (inc. repairs to bioengineering works, weed control and watering) are outlined in Table 5. These costs apply if the restoration works are completed within one year.

Table 5 Indicative cost for materials and labour for restoration of Clontarf Foreshore

Item	Task	Total
All areas		
1.1	Preliminaries	$ 8,660.00
1.2	Removal and disposal of plastic sheeting	$ 8,000.00
1.3	Removal and disposal of vegetation	$ 3,000.00
1.4	Topsoil import and fill	$ 8,000.00
1.5	Foreshore treatment 1	$ 15,600.00
1.6	Foreshore treatment 2	$ 13,200.00
1.7	Zone 1 plant supply and installation	$ 5,082.00
1.8	Zone 2 plant supply and installation	$ 8,453.00
1.9	Zone 3 plant supply and installation	$ 4,419.00
1.10	Zone 4 plant supply and installation	$ 9,182.00
1.11	Zone 5 plant supply and installation	$ 2,713.00
1.12	Monthly monitoring and reporting	$ 3,000.00
1.13	Additional project costs inc. project management and administration	$ 5,000.00
Year 1 Total		**$ 94,309.00**
All Areas		
2.1	Fencing (star picket fence with 3 rows of galvanised wire) installed	$ 4,796.00
2.2	2nd year monthly maintenance inc. all equipment and consumables (e.g. chemicals and equipment for spraying)	$ 9,600.00
2.3	Monthly monitoring and reporting	$ 3,000.00
2.4	Additional project costs inc. project management and administration	$ 1,260.00
2.5	Supplementary planting - lower foreshore (plant mix 1)	$ 2,280.00
2.6	Supplementary planting - upper foreshore (plant mixes 2 and 3)	$ 1,525.00
Year 2 Total		**$ 22,461.00**
PROJECT TOTAL (ex. GST)		**$ 116,770.00**

The Bill of Quantities (BOQ) detailing the costs presented above is provided in Appendix 2.

The differences in costs between completing works in their entirety versus completing them in sections arise from additional mobilisation costs and equipment hire to manage rubble disposal and sand infill.

Whilst the prioritisation process has been made in this document on the basis of the current impacts to shoreline stability (i.e. Zone 2 has highest and Zone 3 lowest priority), the decision as to the prioritisation of sections of any given planting area in the future can be made based on the information provided in this report and the site conditions at that time. A consultation with an experienced environmental consultant may assist in selection of the most appropriate sections and help justify the allocation of funds to those areas.

It is recommended that in short term the City of South Perth should:

- Apply for funding indicated in the cost tables (Order of Magnitude Cost only) to assist with the implementation of this plan. Collaboration with the DPaW will be essential to potentially secure funds for the restoration works.
- Obtain approval under Section 18 of the Aboriginal Heritage Act 1972 to conduct restoration works and soil testing for asbestos particles;
- Prepare an Asbestos Management and Remediation Plan if asbestos particles are found in soils on site (Note this cost has not been included in the overall costs for the project);
- Implements as a minimum restoration works in Zone 2 (implementing bioengineering works without planting is also possible) if funds are limited;
- Continue weed control at the entire site;
- Monitor performance of the Zone 2 bioengineering works; and
- Work with the community groups and schools to investigate opportunities for reducing maintenance and planting costs.

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APPENDICES

Appendix 1 Results of Asbestos containing material testing

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: EP1403432	Page	: 1 of 3
Client	: SYRINX ENVIRONMENTAL PL	Laboratory	: Environmental Division Perth
Contact	: PETE ZAFIROPOULOS	Contact	: Scott James
Address	: 12 MONGER ST PERTH AUSTRALIA 6000	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: pzafiropoulos@syrinx.net.au	E-mail	: perth.enviro.services@alsglobal.com
Telephone	: 08 9227 9355	Telephone	: +61-8-9209 7655
Facsimile	: 08 9227 5033	Facsimile	: +61-8-9209 7600
Project	: 1404; 1421 - SOUTH PERTH COSPSFRP	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 09-MAY-2014
Sampler	: Syrinx Team	Issue Date	: 15-MAY-2014
Site	: ----		
		No. of samples received	: 2
Quote number	: EP/049/13	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Descriptive Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Christopher Owler	Team Leader - Asbestos	Newcastle - Asbestos

syrin

Page	: 2 of 3
Work Order	: EP1403432
Client	: SYRINX ENVIRONMENTAL PL
Project	: 1404; 1421 - SOUTH PERTH COSPSFRP

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EA200 Legend**
- **EA200 'Am' Amosite (brown asbestos)**
- **EA200 'Ch' Chrysotile (white asbestos)**
- **EA200 'Cr' Crocidolite (blue asbestos)**
- **EA200 'Trace' - Asbestos fibres detected by trace analysis per AS4964. The result can be interpreted that the sample contains detectable 'respirable' asbestos fibres**
- **EA200: 'UMF' Unknown Mineral Fibres. "-" indicates fibres detected may or may not be asbestos fibres. Confirmation by alternative techniques is recommended.**
- **EA200: Asbestos Identification Samples were analysed by Polarised Light Microscopy including dispersion staining.**
- **EA200: Negative results for vinyl tiles should be confirmed by an independent analytical technique.**
- **EA200Q: ALS laboratory procedures and methods used for the identification and quantitation of asbestos are consistent with AS4964-2004 and the requirements of the 2013 NEPM for Assessment of Site Contamination**
- **EA200Q: Asbestos weights and percentages are not covered under the Scope of NATA Accreditation.**
  Weights of Asbestos are based on extracted bulk asbestos, fibre bundles, and/or ACM and do not include respirable fibres (if present).
  Percentages for Asbestos content in ACM are based on the 2013 NEPM default values. All numerical results under this method are approximate and should be used as a guide only.

Page : 3 of 3
Work Order : EP1403432
Client : SYRINX ENVIRONMENTAL PL
Project : 1404; 1421 - SOUTH PERTH COSPSFRP

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ACMVAL001	ACMVAL002	----	----	----
				Client sampling date / time	09-MAY-2014 14:00	09-MAY-2014 14:00	----	----	----
Compound	CAS Number	LOR	Unit		EP1403432-001	EP1403432-002	----	----	----
EA200: AS 4964 - 2004 Identification of Asbestos in bulk samples									
Asbestos Detected	1332-21-4	0.1	g/kg		Yes	Yes	----	----	----
Asbestos Type	1332-21-4	-	--		Ch + Am + Cr	Ch + Am + Cr	----	----	----
Sample weight (dry)	----	0.01	g		284	67.8	----	----	----
APPROVED IDENTIFIER:	----	-	--		C.OWLER	C.OWLER	----	----	----

Analytical Results

Descriptive Results

Sub-Matrix: SOIL

Method: Compound	Client sample ID - Client sampling date / time	Analytical Results
EA200: AS 4964 - 2004 Identification of Asbestos in bulk samples		
EA200: Description	ACMVAL001 - 09-MAY-2014 14:00	Several pieces of asbestos cement sheeting approximately 120 x 70 x 5mm.
EA200: Description	ACMVAL002 - 09-MAY-2014 14:00	Several pieces of asbestos cement sheeting approximately 70 x 60 x 5mm.

Appendix 2 Bill of Quantities (BOQ)

BILL OF QUANTITIES

Item	Task	Unit	Quantity	Total quantity	Rate ($)	Total
All areas						
1.1	**Preliminaries**					
1.1.1	Mobilisation/demobilisation	**item**	1	1	$ 1,500.00	$ 1,500.00
1.1.2	Preparation and meetings	**item**	1	1	$ 800.00	$ 800.00
1.1.3	Storage and amenities including installation of safety bunting fence	**lm**	1	218	$ 20.00	$ 4,360.00
1.1.4	Traffic management plan and execution	**item**	1	1	$ 2,000.00	$ 2,000.00
1.2	**Removal and disposal of plastic sheeting**	**item**	1	1	$ 8,000.00	$ 8,000.00
1.3	**Removal and disposal of vegetation**	**item**	1	1	$ 3,000.00	$ 3,000.00
1.4	**Topsoil import and fill**	**item**				
1.6.1	Topsoil import	**item**	1	1	$ 4,500.00	$ 4,500.00
1.6.2	Fill labour and equipment	**item**	1	1	$ 3,500.00	$ 3,500.00
1.5	**Foreshore treatment 1**					
1.5.1	Supply and installation of Coir Mesh	**m²**	1	300	$ 22.00	$ 6,600.00
1.5.2	Supply and installation of brush wall	**lm**	1	50	$ 120.00	$ 6,000.00
1.5.3	Supply and installation of limestone spalls	**m³**	1	1	$ 3,000.00	$ 3,000.00
1.6	**Foreshore treatment 2**					
1.6.1	Supply and installation of Coir Mesh	**m²**	1	600	$ 22.00	$ 13,200.00
1.7	**Zone 1 plant supply and installation**					
1.7.1	Supply of plants (tubestock)	**item**	1	1240	$ 1.60	$ 1,982.00
1.7.2	Installation of plants (tubestock)	**item**	1	1240	$ 2.50	$ 3,100.00
1.8	**Zone 2 plant supply and installation**					
1.8.1	Supply of foreshore plants (advanced stock)	**item**	1	250	$ 4.00	$ 1,000.00
1.8.2	Installation of foreshore plants (advanced stock)	**item**	1	250	$ 4.00	$ 1,000.00
1.8.3	Supply of plants (tubestock)	**item**	1	1535	$ 1.70	$ 2,615.50
1.8.4	Installation of plants (tubestock)	**item**	1	1535	$ 2.50	$ 3,837.50
1.9	**Zone 3 plant supply and installation**					
1.9.1	Supply of plants (tubestock)	**item**	1	1110	$ 1.48	$ 1,644.00
1.9.2	Installation of plants (tubestock)	**item**	1	1110	$ 2.50	$ 2,775.00
1.10	**Zone 4 plant supply and installation**					
1.10.1	Supply of plants (tubestock)	**item**	1	2255	$ 1.57	$ 3,544.50
1.10.2	Installation of plants (tubestock)	**item**	1	2255	$ 2.50	$ 5,637.50
1.11	**Zone 5 plant supply and installation**					
1.11.1	Supply of foreshore plants (advanced stock)	**item**	1	100	$ 4.00	$ 400.00
1.11.2	Installation of foreshore plants (advanced stock)	**item**	1	100	$ 4.00	$ 400.00
1.11.3	Supply of plants (tubestock)	**item**	1	510	$ 1.25	$ 638.00
1.11.4	Installation of plants (tubestock)	**item**	1	510	$ 2.50	$ 1,275.00
1.12	**Monthly monitoring and reporting**	**month**	1	12	$ 250.00	$ 3,000.00
1.13	**Additional project costs inc. project management and administration**	**item**	1	1	$ 5,000.00	$ 5,000.00
Year 1 Total						**$ 94,309.00**
All Areas						
2.1	**Fencing (star picket fence with 3 rows of galvanised wire) installed**	**lm**	1	218	$ 22.00	$ 4,796.00
2.2	**2nd year monthly maintenance inc. all equipment and consumables (e.g. chemicals and equipment for spraying)**	**month**	1	12	$ 800.00	$ 9,600.00
2.3	**Monthly monitoring and reporting**	**month**	1	12	$ 250.00	$ 3,000.00
2.4	**Additional project costs inc. project management and administration**	**item**	1	12	$ 105.00	$ 1,260.00
2.5	**Supplementary planting supply - lower foreshore (plant mix 1)**	**item**	1	500	$ 1.76	$ 880.00
2.6	**Supplementary planting installation - lower foreshore (plant mix 1)**	**item**	1	500	$ 2.80	$ 1,400.00
2.7	**Supplementary planting - upper foreshore (plant mixes 2 and 3)**	**item**		380	$ 1.51	$ 575.00
2.8	**Supplementary planting installation - upper foreshore (plant mixes 2 and 3)**	**item**	1	380	$ 2.50	$ 950.00
Year 2 Total						**$ 22,461.00**
PROJECT TOTAL (ex. GST)						**$ 116,770.00**