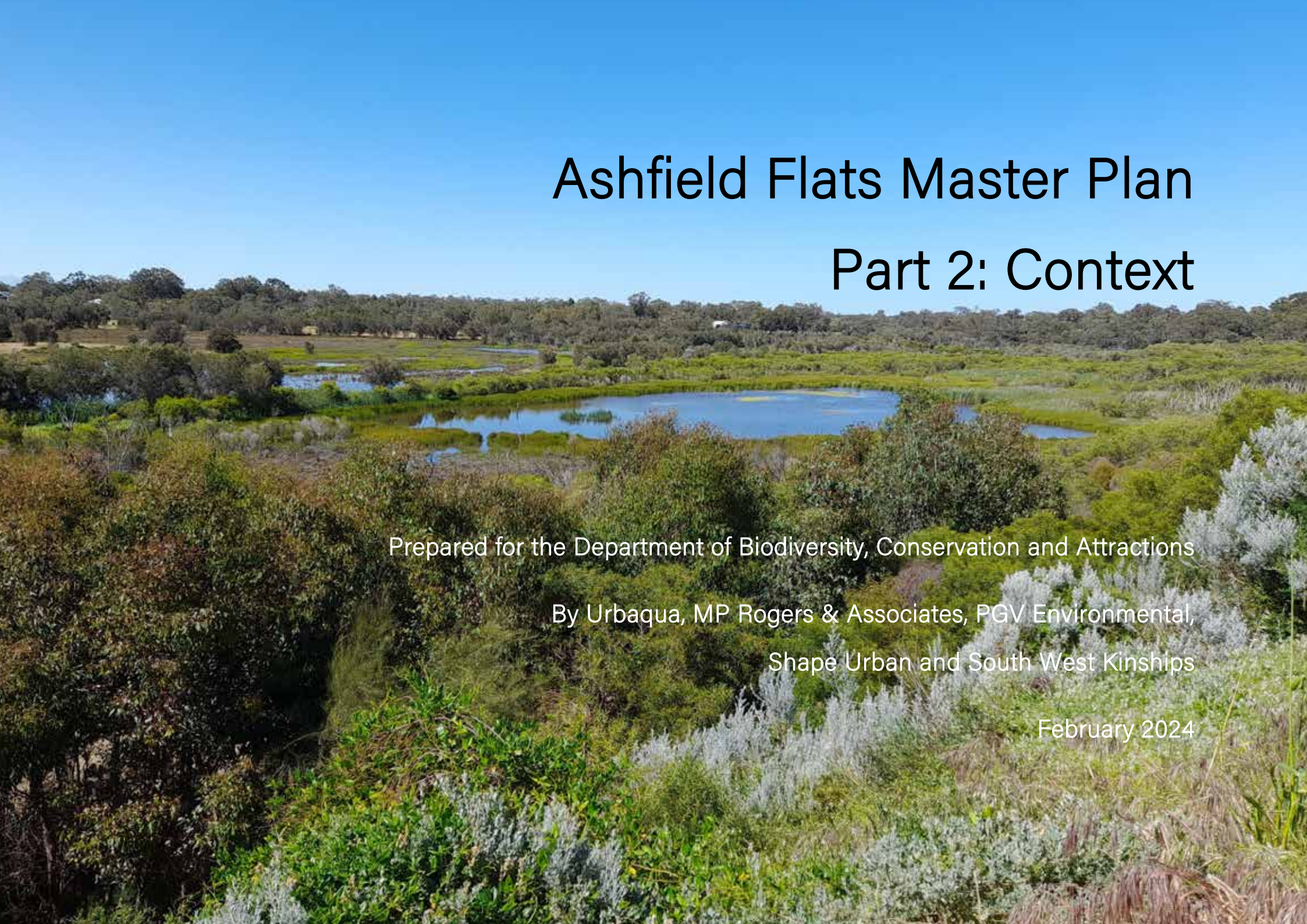

Ashfield Flats Master Plan

Part 2: Context

Prepared for the Department of Biodiversity, Conservation and Attractions

By Urbaqua, MP Rogers & Associates, PGV Environmental,
Shape Urban and South West Kinships

February 2024

Acknowledgements

The project team would also like to acknowledge the significant input and guidance provided by the Project Steering Group:

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- Greg Comiskey - DBCA
- Brett Kuhlmann - DBCA
- Hayley Williams - DBCA
- Tim Ryan - DPLH
- Damien Agnew - DPLH
- Alice Benz - DPLH
- Agni Bhandari - DWER
- Amanda Best - Water Corporation
- Phil Adams - Town of Bassendean
- Nicole Davey - Town of Bassendean
- Alex Snadden - Town of Bassendean
- Caitlyn White - Town of Bassendean

Thank you to the Whadjuk and Nyungah people who shared their knowledge of the area and contributed to the development of the Plan. Please note that the spelling of Aboriginal words in this document is reflective of the preferences of the Aboriginal participants.

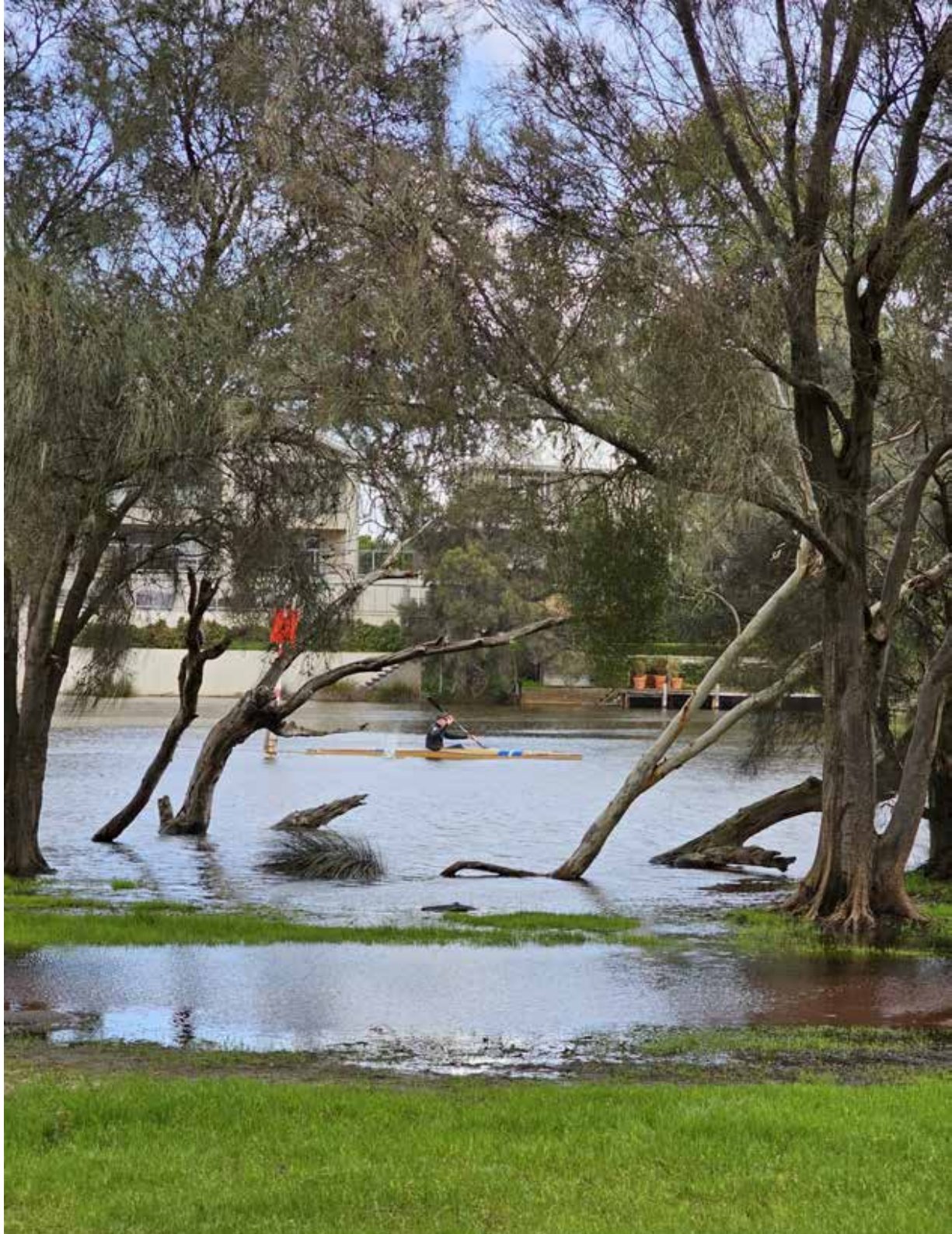
Thanks also to all the community members who participated in focus groups and online, as well as the Bassendean Preservation Group, Ashfield Community Action Network, SUPtonic and the Swan Rotary Club. Your input was invaluable.

This document has been prepared by Urbaqua together with PGV Environmental, MP Rogers & Associates, South West Kinships and Shape Urban.

We acknowledge the Whadjuk and Nyungah people as the Traditional Owners of the lands, waters and skies of the Country of Boorloo.

We acknowledge and respect their enduring culture, their custodianship of Country and continuing connections, their contribution to the life of the Perth, Swan Coastal Plain area, and Elders, past and present.

PART 2: CONTEXT



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1 INTRODUCTION

The Ashfield Flats Master Plan has been prepared for the Department of Biodiversity, Conservation and Attractions (DBCA), together with the Department of Planning, Lands and Heritage (DPLH), the Department of Water and Environmental Regulation (DWER), Water Corporation and the Town of Bassendean to provide guidance for the management of Ashfield Flats in Bassendean (Figure 1).

The Master Plan aims to achieve the objectives and principles of the *Swan and Canning Rivers Management Act 2006*, relevant Swan Canning Planning and Development Policies, Plans and Procedures, the draft Lower Swan Locality Plan, draft State Planning Policy 2.9: Planning for Water, and the Swan Canning River Protection Strategy.

Part 1 of the Master Plan outlines the strategies and actions to be implemented over the next 20 or so years, to provide a foundation for the longer term management of ecological systems, community, recreational and cultural uses, infrastructural requirements, and other issues, constraints and opportunities including in response to climate change.

This document, Part 2, provides a summary of the key considerations including policy context, ownership and management, environmental conditions and social context, as well as considerations for future approvals and implementation.

Additional technical information is provided in the *Ashfield Flats Master Plan Context Analysis Report* (Urbaqua, 2023).

1.1 Master Plan area

Ashfield Flats (the study area) is the largest remaining river flat in the Perth Metropolitan area in the suburbs of Ashfield and Bassendean, covering approximately 64 hectares. It lies on the banks of the Swan River (Derbarl Yerrigan), 33km upriver from the coast as shown in Figure 1.

The Ashfield Flats Master Plan area is roughly bound by West Road, Reid Street, Hardy Road and the Swan River (Derbarl Yerrigan). On the north-west boundary is a steep rise to housing and parkland. The area is predominantly open wetland with some mature trees and shrubs.

The land is divided by a drainage channel which crosses the land in a direction approximately north-east to south-west. During winter the land is inundated with water creating a rare wetland in the metropolitan area. The reserve is accessible to the public for passive recreation (Government of WA, 2019).

The Ashfield Flats Master Plan area contains extensive areas of public open space including the Sandy Beach Reserve and areas of remnant vegetation. It contains a range of built and natural features, including a jetty, boardwalk, lookout, large playground, dog beach, a Bush Forever site and the largest remaining occurrence of a Subtropical and Temperate Coastal Saltmarsh community in the Swan and Canning River Estuary.

Figure 1: Ashfield Flats Master Plan area

2 KEY CONSIDERATIONS

The natural, cultural and recreational values of the Master Plan area are significant. The protection and maintenance of these important values is dependent on appropriate consideration of the following important conditions.

2.1 Climate change

The impacts of climate change are considered to pose a significant threat to Ashfield Flats, primarily relating to increased risk of flooding and sea level rise. These are addressed in more detail below.

The predicted warmer and drier conditions are also expected to have an impact on survival and persistence of native flora and fauna resulting in changes in the structure and composition of vegetation and fauna communities (e.g. opportunistic exotic species may replace native species or dominance of certain native species may increase causing a shift in diversity).

The condition of the remnant vegetation is likely to decline, and the protection of vulnerable foreshore areas is likely to be impacted further by the increasing mean sea level, storm surges, changes in streamflow and groundwater levels, and changes in water chemistry (e.g. salinity). Revegetation programs will become an ongoing challenge and restoration programs will need to adapt to ensure plant survival.

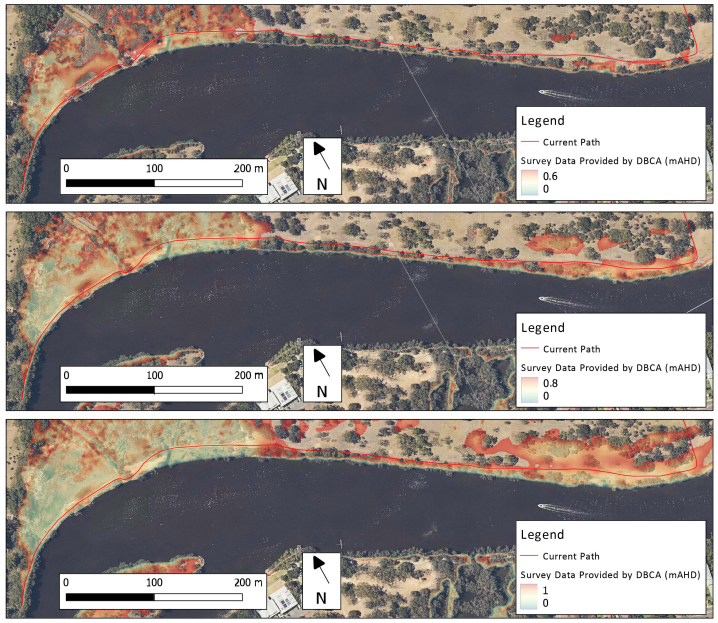
2.2 Sea level rise and tidal inundation

Sea level rise will ultimately lead to increased water levels in the Swan River (Derbarl Yerrigan), increased erosive pressures on the Ashfield Flats foreshore and increased flooding of Ashfield Flats.

The current path along the foreshore is not accessible at all times of the year and DBCA has advised that:

- the water level exceeds 0.6 mAHD around 30 times per year, mostly during winter.
- the water level exceeds 0.8 mAHD around 5 times per year.
- the water level exceeds 1 mAHD around 2 times per year.

These locations are shown in Figure 2.



Shaded areas show where the water level is.... above 0.6 mAHD around 30 times per year

...above 0.8 mAHD around 5 times per year

...above 1 mAHD around 2 times per year

Figure 2: Locations inundated at various times of the year

As the level of the river increases as a result of climate change, this will increase the times at which the current path is inaccessible to pedestrians. According to Biodiversity Conservation and Science (2021) full flooding of the Ashfield Flats wetlands occurs during river water levels above 0.6 mAHD. The lowest points are at around +0.6 mAHD. These are located (refer to Figure 3):

- near to the Roy Hookway fishing platform (~CH 60 m).
- just to west of the boardwalk (~CH 250 m).
- just to east of the boardwalk (~CH 360 m).
- west of the bend heading north/south (~CH 840 m).

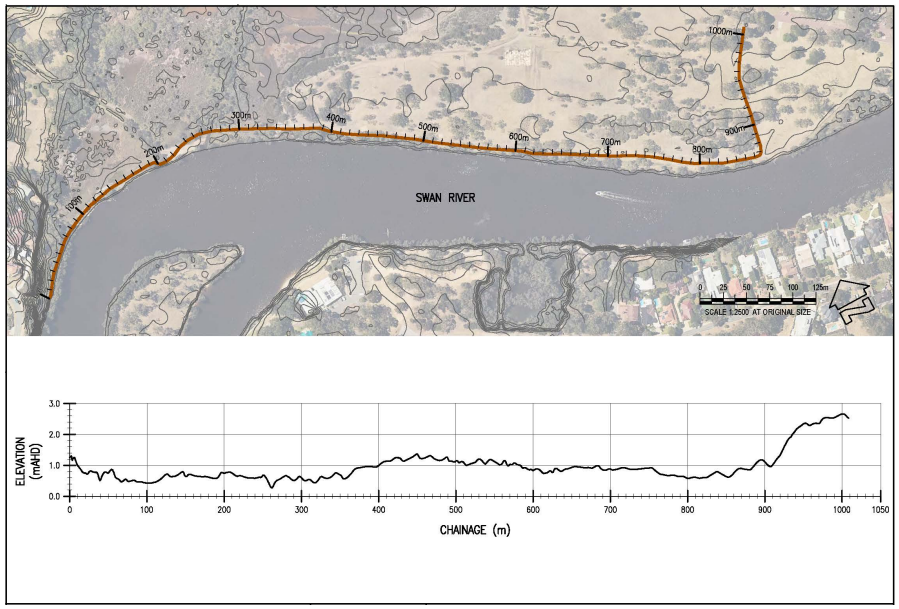


Figure 3: Path elevation (source: DBCA)

As sea levels rise and local water levels at Ashfield Flats increase, this +0.6 mAHD level will be exceeded more often, and hence the hydrology of the area is expected to change. With the rising river water levels, the wetland system is expected to switch from a seasonally wet salt flat to a brackish system in future, permanently flooded and connected with the Swan River (Derbarl Yerrigan) as shown in Figure 4.

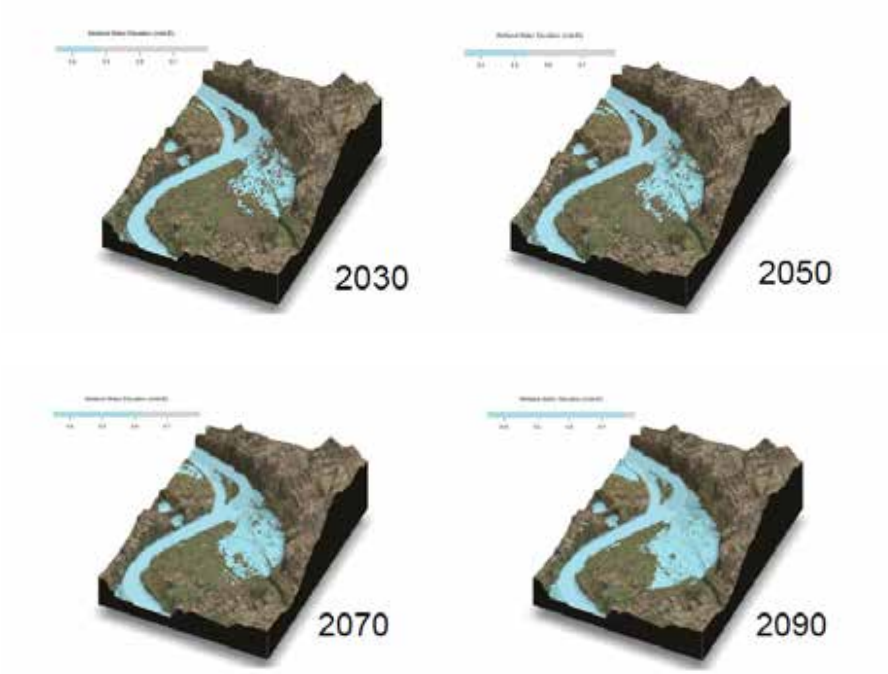


Figure 4: Potential impact of climate change and sea level rise on Ashfield Flats (DBCA, 2021)

2.3 Altered hydrology from drainage discharges

In addition, with projected sea level rises, the drainage system may have a more significant direct impact on the TEC in the coming decades. There will be a gradual change in the duration of water held within the wetland with less drying time between floods for the wetland to dry out in summer. This increasing inundation duration will start to alter the ecology of Ashfield Flats within the next 20 years.

Anecdotal evidence indicated by a change in vegetation species including an increase in sedges and Melaleuca, suggests that the salinity within the wetland area is reducing. This is likely to be the result of increased freshwater discharge from the drains that bisect the wetland, as well as from the Woolcock Ct Drain which discharges into the western portion of the wetland.

The Chapman and Kitchener Street drains have been previously observed to have a minimal interaction with the wetland. Information provided by the agencies for this Master Plan indicated that the Chapman Street drain occasionally overtops into the reserve, causing freshwater to inundate the site for a period of time. Monitoring of the drainage system undertaken in 2019/20 observed overtopping only once during the monitoring period.

In July 2023, a breach occurred in the banks of the Chapman St Drain, enabling freshwater to infiltrate the northern tidal pools within the TEC boundary. This is partly due to the age of the open drain infrastructure and was exacerbated by a proliferation of *typha orientalis* downstream of the "dog leg" section of the drain.

Advice from the DWER has suggested that clearing of the *typha orientalis* is likely to mobilise Monosulphidic black oozes into the river (pers comm, S Appleyard, Principal Hydrogeologist, Contaminated Sites DWER, 2023), as these along with acid sulphate soils have been identified in the hydrological study undertaken by DBCA. As monosulphidic black oozes and acid sulphate soils mobilisation into the river could have devastating consequences on river ecology, modification may be required to drainage system to enable conveyance of stormwater, without removal of the typha.

2.4 Foreshore condition and erosion

Historical aerial photography indicates that erosion of much of the riverbank at Ashfield Flats has occurred since 2003. This confirms that the foreshore is subject to ongoing erosive pressures from waves and river currents. These erosive pressures are expected to continue into the future and will likely be exacerbated due to effects of climate change and continued or increased boat traffic on the Swan River (Derbarl Yerrigan).

Current erosion control mechanisms at the site include a rock toe along the foreshore section of the remnant wetland, as well as brush log walling, palisading, brush mattressing and coir matting.

2.5 Flood events

The Ashfield Flats Hydrological Study (2021) states that "forecasting future water levels, incorporating climate change impacts, including sea-level rise, suggests the wetland could be at risk of becoming permanently flooded before 2090 and changes to the hydroperiod are likely to be seen within the next 30 years." As stated previously, these changes to submergence and salinity will start to alter the ecology of the site placing pressure on the saltmarsh species.

Whilst the Swan River (Derbarl Yerrigan) has not experienced any major floods in recent decades, the occurrence of a significant flood would be likely to result in significant impacts on Ashfield Flats. This may be particularly relevant to ageing and deteriorating structures which may exhibit a reduced structural capacity. It can also impact the vegetation communities. Significant floods are also often associated with considerable erosion damage to natural foreshores and large-scale sediment movements.

2.6 Urban pollution

Past land use and practices within the upstream drainage and groundwater catchments has resulted in a number of contamination risks. These include the registered contaminated sites in the study area as well as other areas where uncontrolled fill or rubbish dumping may have led to a risk of contamination. Further risks are associated with the potential for contaminated groundwater to affect the quality of water in the drainage system and where groundwater intersects within the study area.

In addition, the drainage system is a known source of contamination which is likely to be impacting on the health of the TEC and Swan River (Derbarl Yerrigan).

2.7 Soils and contamination risks

Ashfield Flats is known to contain acid sulphate soils and potential acid sulphate soils (PASS) (RPS, 2020). Consistent with Government requirements, if more than 100 m3 of material is planned to be excavated during any management works, an acid sulphate soils investigation will be required and, depending on the outcomes, an Acid Sulphate Soils Management Plan may be needed. This will have significant cost implications for any works which include excavation.

In addition to acid sulfate soils, monosulphidic black oozes have been identified in the hydrological study undertaken by DBCA. The mobilisation of monosulphidic black oozes and acid sulphate soils into the river or wetland could have devastating consequences on the ecological values. Accordingly, the implementation of any recommendations within the Master Plan should seek to minimise soil disturbance where possible. This is critical in areas where soils have already acidified or are subject to periodic inundation by river water.

The Master Plan area contains two contaminated sites that have been remediated for restricted use. It is likely that some contamination may exist within the parkland near Hamilton St through which the Chapman St drain runs. Site investigations for contamination are likely to be required prior to undertaking works in these areas.

2.8 Mosquitoes

Mosquitoes are known to affect the study area. Currently the Town of Bassendean Environmental Health Officers undertake mosquito monitoring and management however this is resource intensive, particularly due to the restriction on mechanical methods of treatment to minimise disturbance on the TEC and the ability to access the main breeding areas due to overgrown vegetation.

2.9 Weed invasion and plant pathogens

Weeds will likely be a persistent issue within the flats, due to the high level of disturbance and high soil moisture. Ongoing weed control will be essential to prevent the condition rating from degrading, and to protect remnant vegetation, however care will need to be taken in areas where soils have already acidified or are subject to periodic inundation by the river due to the potential to mobilise monosulphidic black oozes and acid sulphate soils.

Currently there is no reported evidence of any plant pathogens such as dieback (*Phytophthora sp*) (ToB, 2022).

2.10 Feral and uncontrolled animals

The area is known to contain foxes, due to the evidence of scats and diggings (ToB, 2022). It is believed that the foxes are more transitionary, passing through, rather than creating dens and using the site as home. Cameras have been installed in the past, however due to the high frequency of dogs and cats visiting the area, commonly off lead, it has been too difficult to implement trapping. There has not been much evidence of rabbits in the area.

The main issue lies around dogs and cats, whether domesticated or feral, and the unrestricted access to Ashfield Flats, particularly the TEC area, as this impacts on wildlife and the health of the vegetation.

2.11 Fire risk management

Increasing temperatures are likely to result in increased risk of fire weather that has the potential to result in a wildfire in Ashfield Flats. It is important, however, to ensure that fire risk mitigation activities do not significantly impact on the ecological values of the TEC and Bush Forever Site. Accordingly, coordinated management responses should focus on maintaining good access for emergency vehicles and appropriate buffers around the Master Plan area which may incorporate strategies such as underpruning to reduce contiguous fire fuel loads.

Any revegetation activities will consider the likelihood of increasing the risk of wildfires. It is noted, however, that the increased occurrence of inundation resulting from increased sea levels and tides will reduce the risk of wildfires.

2.12 Illegal dumping and access

There has been no evidence of illegal dumping at the site according to discussions with the land owners (ToB, 2022; DPLH, 2022; DBCA; 2022e). However, the area, particularly the foreshore is heavily utilised by the public, and there has been evidence of damage to revegetation along the foreshore, either deliberate or unintentional. Appropriate management of the area will be required to ensure public enjoyment of Ashfield Flats is supported whilst advancing conservation works.

The wetland was closed off from motorbikes and four wheel drives in the late 1970s (Quinton, 2009). The Ashfield Flats area is enclosed and restricted to public vehicular access. Public access is only possible by foot as the perimeter is protected by the river, fences, residential houses, bollards and gates. Locked entry gates exist for emergency services to access all areas of the Ashfield Flats area (Fancote, 2017).

The Town of Bassendean has reported that occasionally there has been a car burnout at some of the neighbouring reserves in Bassendean, and on the day of the site visit during November 2022 there was a motorbike which illegally drove through the wetland.

3 OWNERSHIP AND MANAGEMENT

Ashfield Flats is reserved as Parks and Recreation under the Metropolitan Region Scheme (MRS). The site falls under the ownership and management of three bodies — the majority is vested with the Western Australian Planning Commission (WAPC)(and managed by DPLH); the two main drains found within the site are managed by the Water Corporation; and the remainder is vested with the Town of Bassendean (Figure 5).

The *Ashfield Flats 10 Year Management Plan* (ToB, 2021) states that "sections managed by the Town of Bassendean include Iveson Place (1.8 ha), Hamilton Street Reserves (4.4 ha), Whitfield Street public open space (1.02 ha), Whitfield Forest (1.08 ha), the fire access track behind 25-39 Hardy Road (1.4 ha) and a remnant wetland block in the south west of the flats (1.9 ha).

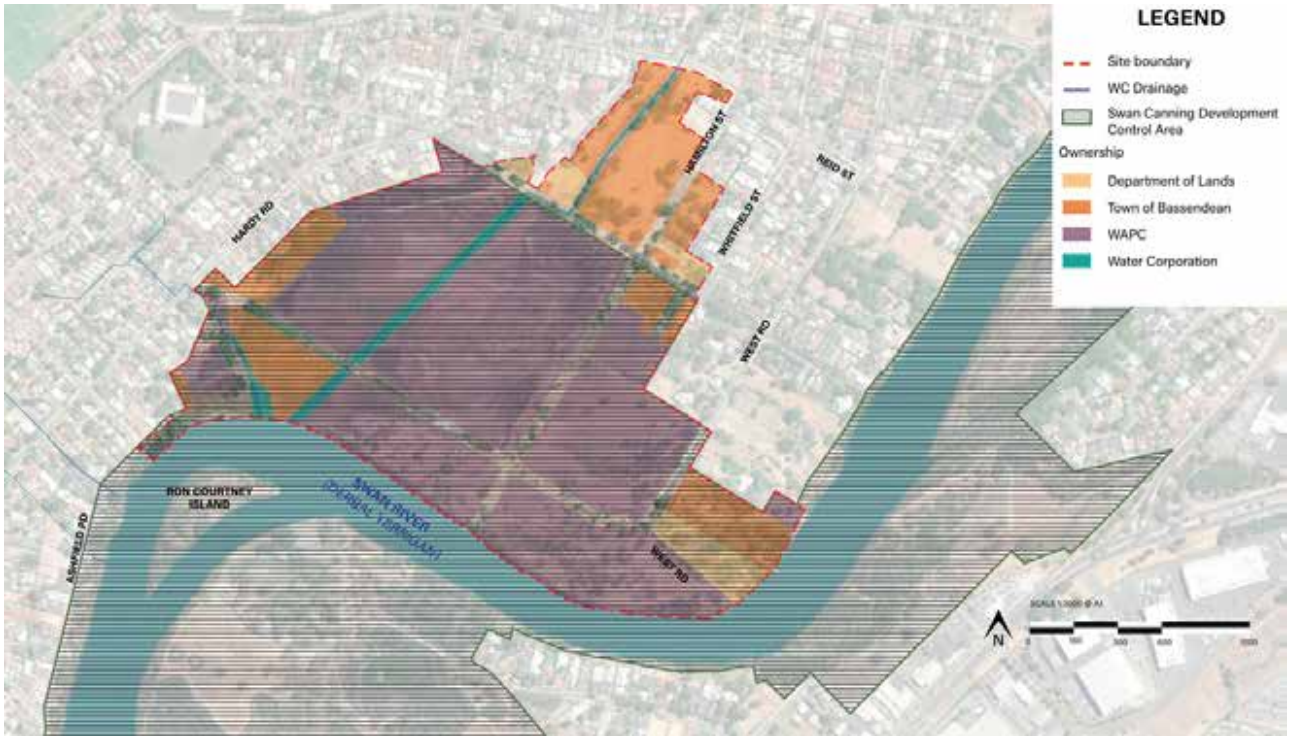


Figure 5: Ownership and management responsibility of the study area

4 POLICY CONTEXT

The *Swan and Canning Rivers Management Act 2006* created the Swan Canning Riverpark encompassing the waters and foreshores of the Swan Canning river system. Under the Act, the DBCA is vested with the care, control, and management of the River reserve with various responsibilities including developing policies, and preparing and reporting on strategic documents relating to the Riverpark.

Ashfield Flats is located wholly within the Swan Canning Riverpark and its associated Development Control Area (DCA), as seen by the brown hatching in Figure 5. Accordingly, this Master Plan has been prepared in accordance with the *Swan and Canning Rivers Management Act 2006*, *Swan and Canning Rivers Management Regulations 2007* and DBCA policies for planning and development.

5 ENVIRONMENTAL CONDITIONS

5.1 Climate

The climate of the suburb of Ashfield is typical of the south-western region of Western Australia, which has a Mediterranean climate, with hot dry summers and mild wet winters. Maximum temperatures range between 18 degrees Celsius (°C) in July and 32°C in February, while average monthly minimum temperatures range between 8.1°C in July and 17.6°C in February (BoM, 2022). Rainfall generally occurs between May and October, with an annual average of around 760mm.

5.2 Soils and landform

The site consists of three main landforms: 1) the escarpment, 2) the floodplains and 3) the foreshore. The topography of the study area is bowl shaped and ranges from one (1) to twelve (12) metres AHD (Figure 6). This bowl-shaped morphology is consistent with theories of saltmarsh morphodynamics (Friedrichs and Perry, 2001).

The soils at Ashfield Flats are mapped as predominately Pinjarra Zone (DAFWA, 2012) described as alluvial deposits between the Bassendean Dune Zone and Darling Scarp, clayey to sandy alluvial soils with some wet areas (Figure 6). A small area in the west of the reserve is mapped as Bassendean Sand Zone, described as fixed sand dunes made of calcareous sand and podsolised soils with low lying wet areas.

Recent investigations (DWER, 2021) have indicated that sulfidic soil and sediment materials underlie much of the Ashfield Flats (Figure 6). These materials have the potential to release significant amounts of acidity and metals into drainage water if disturbed by excessive drainage or by excavation.

Potential Acid Sulfate Soils, in the form of pyrite with isolated pockets of potential mono sulphidic black ooze, have been identified within sediment along the length of the Chapman St Drain. Disturbance of these materials would have the potential to cause significant anoxia-related fish-kill events in the Swan Estuary near the drain outlet. Monitoring of the Woolcock Court drain out flow, prior to it entering the reserve, measured pH values as low as 3.2, however pH of surface waters in the reserve were recorded as near neutral (DWER, 2021).

These factors indicate that the disturbance of soils and drain sediments in the reserve would have to be carefully managed to prevent adverse impacts taking place on vegetation and fauna in the area, and on water quality in the Swan Estuary which receives discharges from the area.

The site also contains two locations identified on the DWER Contaminated Sites Database that have are indicated as "remediated for restricted use" (Figure 6). This includes the area known as "The Lookout" and parts of The Town of Bassendean land on Reid St and Hamilton St. Additional contamination is known to exist on land outside the study area but within the surface and groundwater catchments of Ashfield Flats.

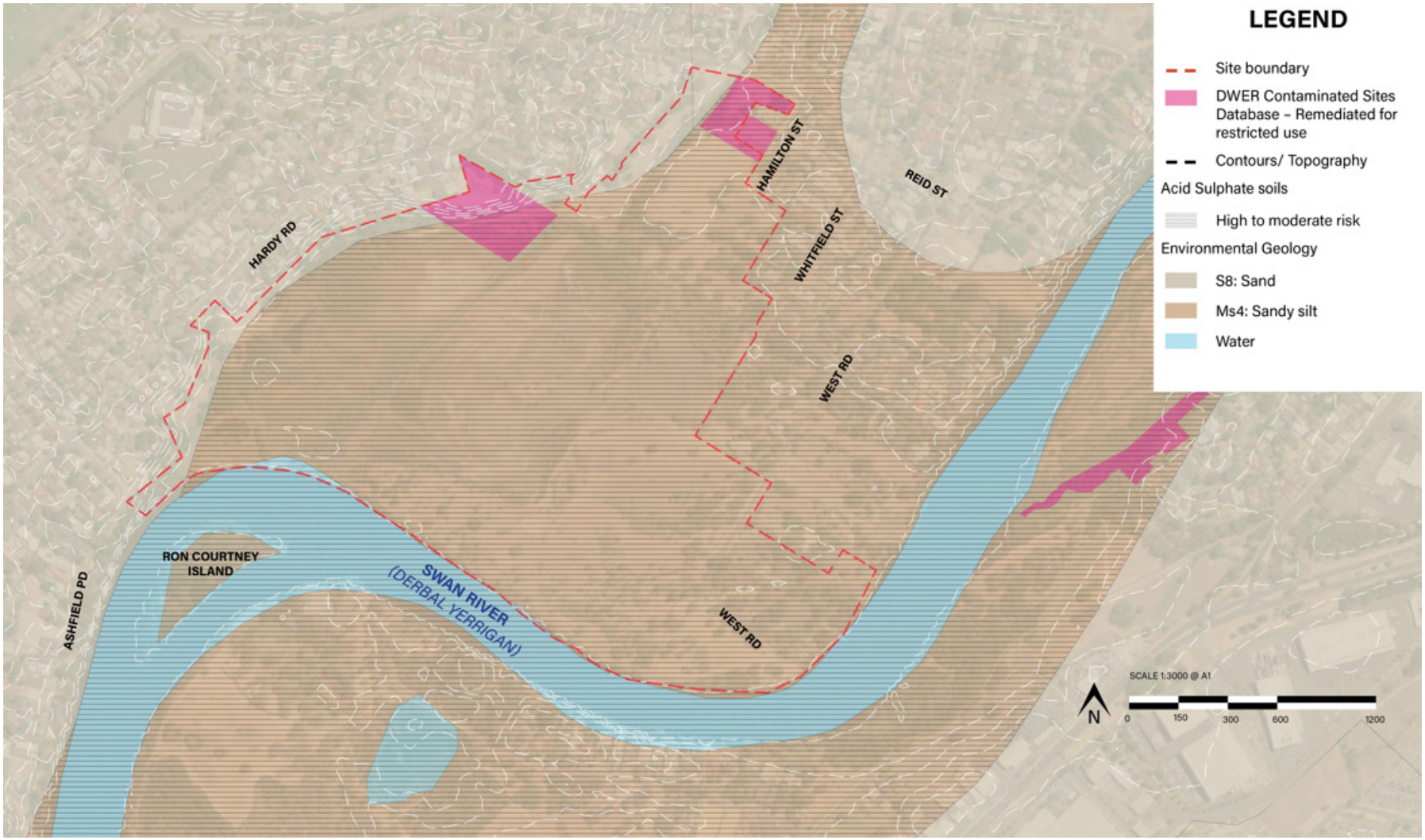


Figure 6: Soils and landform

5.3 Natural resources

5.3.1 Vegetation

Native vegetation occurs on about 22.5ha of the 60ha site. The other 37.5ha consists of informal parkland with scattered trees and grassland. The vegetation is Swan Complex, consisting of *Melaleuca* dominated wetlands, Samphire flats and *Eucalyptus rudis* woodlands (Syrinx, 2005).

The river edge section forms part of the Perth Regional Ecological linkages (Perth Biodiversity Project 2003) and most of the site is classified as an Environmentally Sensitive Area (ESA) under the *Environmental Protection (Environmentally Sensitive Areas) Notice 55 (2005)*, largely due to the presence of the Swan River (Derbarl Yerrigan) and a TEC. Environmentally Sensitive Areas are declared by the Minister for the Environment under section 51B of the *Environmental Protection Act 1986*. Any clearing of vegetation within an Environmentally Sensitive Area requires a permit from the Department of Water and Environmental Regulation.

Most of the site is recognised as regionally significant vegetation as it is Bush Forever site 214: Ashfield Flats (Figure 7). The northern part of the Master Plan area extends outside the Bush Forever site boundary and includes a section of the Chapman Street Main Drain and grassed parklands.

Subtropical and Temperate Coastal Salt Marsh Threatened Ecological Community

The majority of the native vegetation on the site contains the vegetation types considered by DBCA to be the Coastal Saltmarsh Community, listed as a Threatened Ecological Community (TEC) (Vulnerable), which is protected under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as a Matter of Environmental Significance. Ashfield Flats contains the largest remaining occurrence of a Temperate Coastal Saltmarsh community in the Swan and Canning Rivers Estuary (DBCA, 2021).

The vegetation in the Coastal Saltmarsh community consists mainly of salt-tolerant shrubs, rushes, sedge, herbs and grasses predominantly from the Chenopodiaceae (Samphire) and Poaceae (Grass) families. The species occurring in the community are specially adapted to tolerate the difficult saltmarsh environment. In the south-west of Western Australia there is a high diversity of species in the genera *Tecticornia, Triglochin, Samolus* and *Puccinellia*. The vegetation composition in the Coastal Saltmarsh community can be influenced by groundwater hydrology as well as the periods of tidal water inundation.

The TEC vegetation community is currently contained on DPLH land, however the Town managed areas form part of the mapped TEC boundary and buffer zone (Figure 7).The *Ashfield Flats Hydrological Study* (DBCA, 2021) suggested that the TEC would alter and may retreat, where space is available towards the east of the reserve; this land is also currently under the management of DPLH.

Remaining vegetation

Modelling for pre-1750 vegetation suggests that the Town managed areas of the site would have historically been Swan Complex according to the Vegetation Complexes of the Swan Coastal Plain data set (DBCA, 2022d). This complex is described as fringing woodland of *Eucalyptus rudis-Melaleuca rhaphiophylla* with localised occurrence of low open forest of *Casuarina obesa* and *M. cuticularis*.

Much of the vegetation has been historically cleared, and several areas are now mowed grass with a few remnant trees. The Town manages some remnant vegetation present off Hardy Road. The Whitfield Forest area to the east was converted from a paddock area to a vegetated area through the efforts of the Bassendean Preservation Group.

Figure 7: Protected flora, fauna and communities

Surveys

A flora and vegetation survey of the site was undertaken by DBCA botanists from September 2018 to June 2019 (DBCA, 2019). The survey identified all native and introduced plant species on the site as well as mapped the vegetation types and condition.

A total of 112 flora species were recorded from the site, including 47 native and 65 introduced species. No flora of conservation significance were recorded on the site.

Twenty vegetation units were described in the DBCA 2018/19 flora and vegetation survey. The 20 units were compiled into seven mapping units as shown in and described below:

- *Tecticornia*
- Sedges
- *Casuarina*
- *Melaleuca rhaphiophylla*
- *Melaleuca viminea*
- *Eucalyptus*
- Parkland

Ten introduced plant species were rated as having a high priority for weed control.

The vegetation mapping unit 'Eucalyptus' included areas containing *Eucalyptus rudis* Woodland to Open Forest over *Melaleuca rhaphiophylla* Low Open Forest.

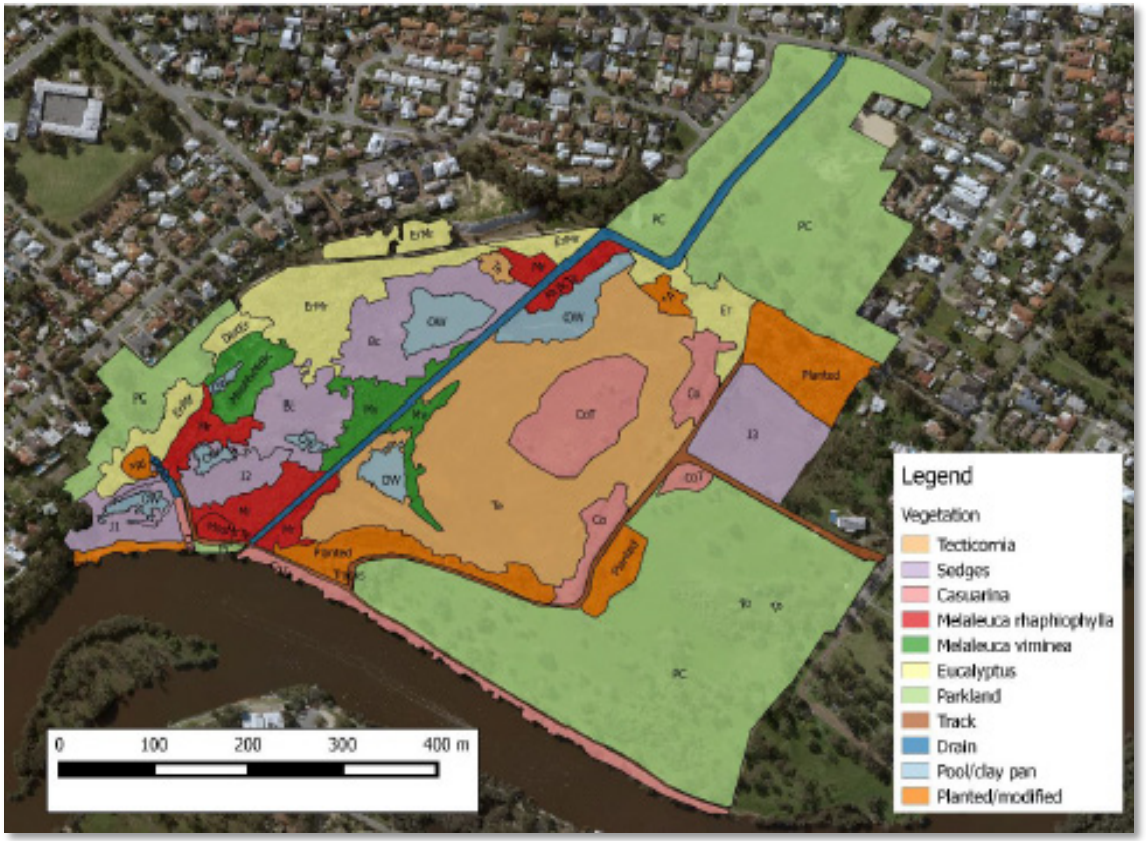


Figure 8: DBCA vegetation mapping (source: DBCA, 2021)

The tree species that occur on the grassy parklands are include naturally occurring species particularly *Eucalyptus rudis* (Flooded Gum), *Corymbia calophylla* (Marri), *Casuarina obesa* (Sheoak) and *Melaleuca rhaphiophylla* (Paperbark) as well as a large number of non-local species including *Eucalyptus camaldulensis* (River Red Gum), the hybrid *E. rudis x E. camaldulensis* and *Casuarina glauca.*

DBCA (2019) considered that all the vegetation units mapped as *Tecticornia, Casuarina, Melaleuca rhaphiophylla, Eucalyptus* and *Melaleuca viminea* are part of the Threatened Ecological Community 'Subtropical and Temperate Coastal Saltmarsh'. Vegetation Units not included in the Coastal Saltmarsh community by DBCA were all areas containing Sedges and Parkland and specific units of *Casuarina obesa* growing next to the Kitchener Drain and along the river banks. An area of disturbed *Eucalyptus rudis/Melaleuca rhaphiophylla* vegetation near the outlet of the Woolcock Return Drain was also excluded.

5.3.2 Fauna and habitat

The vegetation communities provide habitat for a wide variety of native fauna, predominately tertiary feeders such as water birds (Syrinx, 2005). The site is also listed as a potential Carnaby's Black Cockatoo (CBC) feeding area and a possible breeding area (DPAW 2009). A study by Ron Van Delft in 1986 noted;

"The flooded gums (Eucalyptus rudis) are mature and have many holes used by birds for nesting. Sacred Kingfishers, Striated Pardalotes, Tree Martins, Port Lincoln Ringnecks, Laughing Kookaburras and Galahs have all been nesting or looking for suitable holes. The marri trees have been used by Yellow-rumped Thurnbills for nesting and some flooded gums were used as nesting sites in 1986 by Black-shouldered Kite and White-faced Herons. Rainbow Bee-eaters build their nests underground at Sandy Beach. Nesting was recorded in 1985 and 1986 and probably took place unobserved for many years before then."

A list of birds surveyed at Ashfield Flats is contained in Appendix 2.

The site also contains potential Quenda (*Isoodon obesulus fusciventer*) habitat (Ramalho et al 2013).

In 1985 four frog species all endemic to south-west WA were observed in the area including the Moaning Frog, Western Banjp Frog, Slender Tree Frog and Froglets (Hinkley, 1990).

The wetland system supports a variety of invertebrates and macroinvertebrates, which are an important food source for birds and frogs. Macroinvertebrates are also used a biological indicators of water quality. In 1978 Blair and Batchford recorded that small crustacea were observed in the shallower, more vegetated waters of the flats. The drains and deeper flooded areas lacked visible small organisms such as crustacea.

As part of the *Ashfield Flats Hydrological Study* (2021), a search of the online NatureMap database was undertaken to identify conservation listed flora and fauna species that exist within the site and within vicinity of the site. The search identified a total of 183 species, of which 169 species are listed as non-conservation taxon. Those with conservation status and protected by the *Biodiversity Conservation Act 2016* are listed in Table 1 and shown in Figure 7.

Table 1: Threatened, Extinct and Specially Protected fauna or flora species known to utilise Ashfield Flats

Common name	Scientific name	Conservation code
Fauna		
Common Sandpiper	*Actitis hypoleucos*	Protected under international agreement
Caspian Tern	*Hydroprogne caspia*	Protected under international agreement
Osprey, Eastern Osprey	*Pandion cristatus*	Protected under international agreement
Crested Tern	*Thalasseus bergii*	Protected under international agreement
Forest Red-tailed Black Cockatoo	*Calyptorhynchus banksii subsp. Naso*	Threatened
Baudin's Cockatoo, White-tailed Long-billed Black Cockatoo	*Calyptorhynchus baudinii*	Threatened
Carnaby's Cockatoo, White-tailed Shortbilled Black, Cockatoo	*Calyptorhynchus latirostris*	Threatened
White-tailed black cockatoo	*Calyptorhynchus sp.*	Threatened
Chuditch, Western Quoll	*Dasyurus geoffroii*	Threatened
Water-rat, Rakali	*Hydromys chrysogaster*	Priority 4
Quenda, southern brown bandicoot	*Isoodon fusciventer*	Priority 4
Blue-billed Duck	*Oxyura australis*	Priority 4
Peregrine Falcon	*Falco peregrinus*	Other specially protected fauna.
Flora		
River bulrush	Bolboschoenus fluviatilis	Priority 1

Note:

- Priority 1; Species that are known from one or a few locations (generally five or less) which are potentially at risk.
- Priority 4; Classified as rare, near threatened and other species in need of monitoring.

5.3.3 Bushfire risk

Ashfield Flats is a Bushfire Prone Area (DFES 2019). Fire management will be important to protect residential properties and remnant vegetation. Ensuring sufficient access for fire management vehicles, control of weeds and management of fuel loads will aid in managing fire risks within Ashfield Flats. Inappropriate fire regimes can alter vegetation and increase weed colonisation, in addition to threatening infrastructure and wildlife.

On 5 March 2015 a wildfire swept through Ashfield Flats in the vicinity of Hardy Road and Fisher Street, Bassendean. A firebreak/access limestone track was then installed along the back of the properties bordering the flats to improve access for fire emergency services.

Fire management in the Town of Bassendean managed areas of Ashfield Flats includes:

- Mowing and slashing of grassed sites by the Parks and Gardens team; this typically includes one mowing event every 2-3 weeks between spring and autumn.
- Weed control to reduce presence of annual weeds, particularly along the fire track.
- Ongoing removal of tree seedlings in the Whitfield Forest area that are germinating within 21 metres of the adjacent property line to keep the Bushfire Attack Level (BAL) rating as low as practicable.
- Ongoing removal of dead vegetation posing a fire risk. Not all dead vegetation shall be removed, as logs/fallen branches provides habitat for native species. Fire risk versus habitat benefits shall be assessed prior to any deadwood removal.
- To protect properties adjacent to the Fire Track, Iveson Blocks and Villiers Street Gully, revegetation works shall follow the standards for Asset Protection Zones outlined in the Guidelines for Planning in Bushfire Prone Areas (WAPC 2017). Only groundcover planting shall occur in the Fire Track (Property side), Iveson Blocks and Villiers Street Gully; species used in these areas shall be of relatively low flammability (Hollick 2010) and be under 10 cm.

5.4 Water resources

5.4.1 Wetlands

The Swan River (Derbarl Yerrigan) is a Nationally Important Wetland (Directory of Important Wetlands in Australia, 2005), an Environmentally Sensitive Area (*Environmental Protection Act, 1986*) and a Conservation Category wetland in the Geomorphic Wetlands (Swan Coastal Plain) database (DBCA, 2023) (Figure 9). Conservation category wetlands are wetlands that support a high level of environmental attributes and function (Environmental Protection Authority, 2008) (i.e. highest priority wetlands).

DBCA's current Geomorphic Wetland dataset categorises the wetlands as Conservation Category and Multiple Use (Figure 9). Investigations of the site indicate that the identified wetland values and functions of Ashfield Flats are more commensurate with a larger portion functioning as Conservation Category wetland, and the disturbed areas functioning as Resource Enhancement and Multiple Use wetlands (DBCA, 2019).

TEC Hydrology

Land managers identified that gaining an understanding of the site's hydrology was a crucial first step to informing its future management. Accordingly, The *Ashfield Flats Hydrological Study* (2021) aimed to identify the dominant hydrological processes at the reserve by undertaking a two-year monitoring program of water flows, surface and groundwater levels, water and sediment quality, and develop hydrological models (DBCA, 2021).

The results of the hydrological study showed the wetland has shallow groundwater and a strong tidal interaction with the Swan River (Derbarl Yerrigan) (DBCA, 2021) as well as other inter-related contributions from surrounding urban drainage systems. Key findings from this study included:

- River and tidal levels are the main driver in the hydrology of the wetland.
- Chapman St MD and Kitchener St MD do not frequently interact with the surrounding wetland except when high tide events cause the area to be generally flooded, although this has changed recently due to breaching of the Chapman St Drain bund near the "dog leg" as a result of increased pressure on the drain from the growth of *typha orientalis* in the drain.
- Woolcock drain discharges directly into the western portion of the wetland and has contributed to the freshening of wetland pools since its construction.
- The western portion of the wetland is likely to become permanently inundated within 90 years, if sedimentation rates do not keep pace with rising river levels.
- Chapman St MD, Kitchener St MD and Woolcock Drain all flow continuously indicating a significant component of drained groundwater within the flow.
- Groundwater does not contribute significantly to surface water levels in the wetland but is an important underlying hydrological component.
- Salinity in the wetland is controlled by two principal mechanisms:
  - groundwater flowing upwards and evaporating during summer causing high salinity levels in the sediments and shallow groundwater
  - winter inundation from the brackish Swan River (Derbarl Yerrigan) and saline high tide events and floodwaters mixing with the in-situ concentrated brine developed over summer.

Figure 9: Water Resources

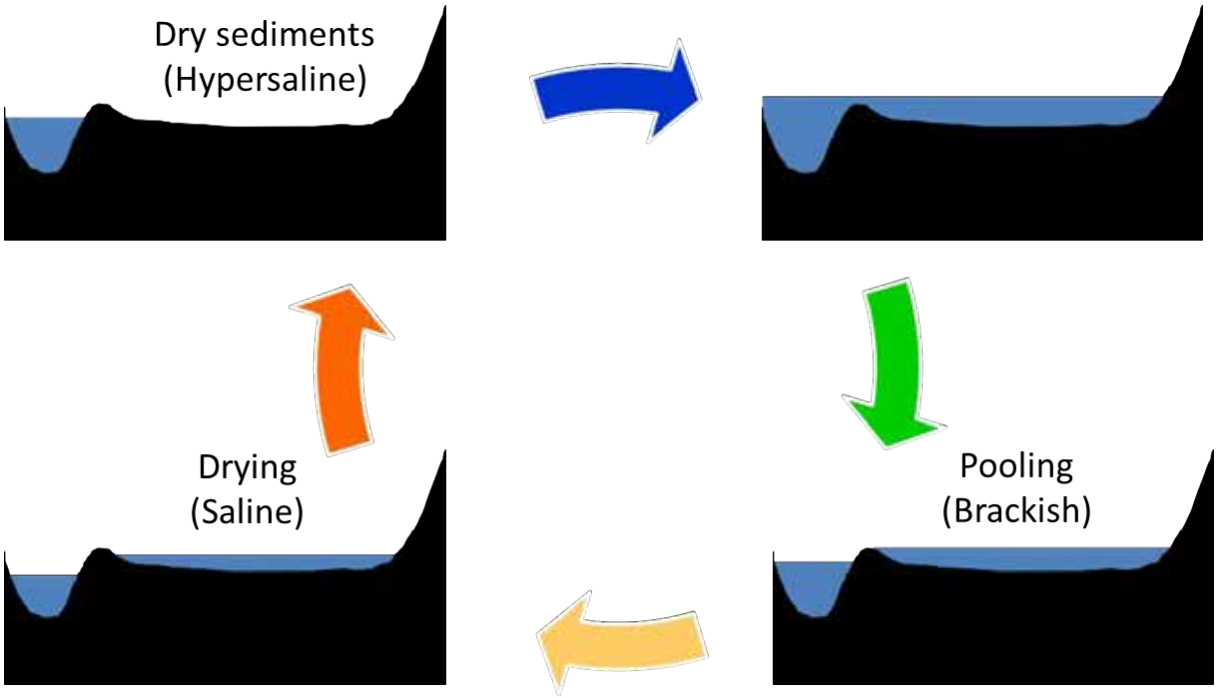


Figure 10: Conceptual seasonal surface water cycle demonstrating how the key processes contribute to salinity in the wetland.

The river water level is the main driver affecting the wetland's hydrology. The wetland is very flat and low in elevation. Therefore, it floods frequently each year and stores much of the flood water for many months, drying completely over most of the reserve by mid-summer. This cycle of wetting and drying, predominantly from a mix of brackish river flows and more saline tidal waters is critical to the site both in terms of providing water to sustain the wetland habitat and to maintain the right salinity ranges necessary to support the TEC.

Any future changes to the balance between fresh, brackish, and saline inflows to the site are likely to influence the types and distribution of samphires and other TEC species.

The study area lies within a floodplain and along two bends of the Swan River (Derbarl Yerrigan). Flooding can be caused by extreme flood events in the Swan River (fluvial flooding) and most of the area will flood in a 10% Annual Exceedance Probability (AEP) event (DWER, 2020). Whilst on average elevated river levels due to river runoff occur infrequently, they are important for generating the largest floods and flooding the site completely (DBCA, 2021). The Iveson Place and Hamilton Street road reserves are not expected to flood in a 10% AEP event.

Flooding from a combination of high tides in the Swan River estuary and normal winter river flows is much more common, occurring multiple times per year, and is the dominant flooding mechanism at the site (Figure 11). Low pressure systems producing storm surges are also important contributions although these again occur less frequently. River flooding, from catchment runoff, is more significant only during major rainfall events when river levels exceed 1.1m AHD.

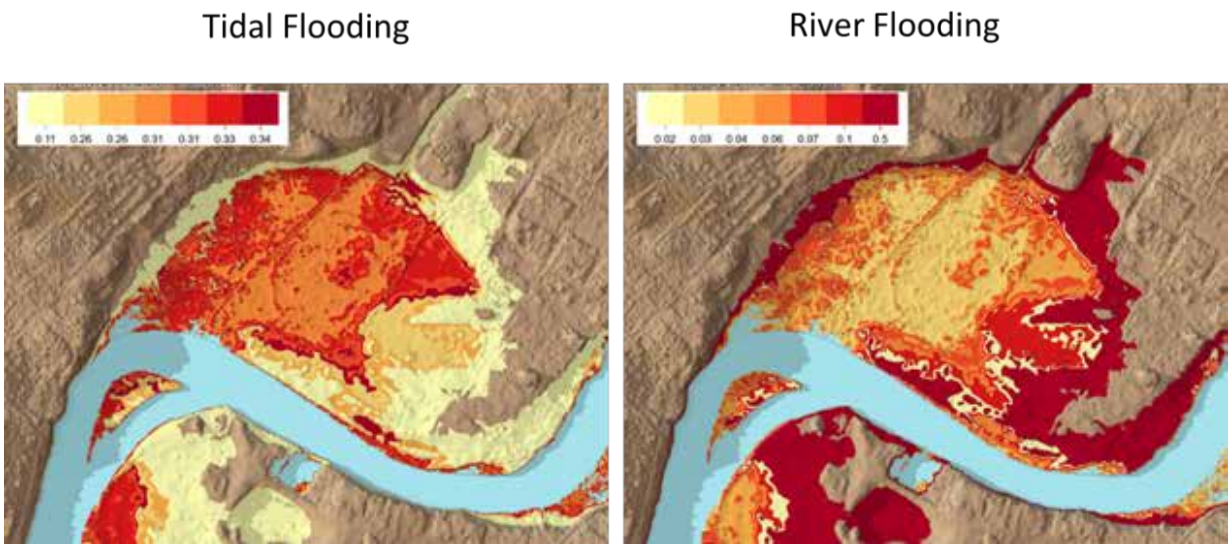


Figure 11: Mean contributions to flood levels in the wetland from tidal and river flooding

Water level monitoring undertaken as part of the *Ashfield Flats Hydrological Study* (DBCA, 2021) showed the strong interaction with the Swan River (Derbarl Yerrigan) and established a river level at the Meadow St gauge, Guildford, of ~0.5 mAHD, at which Ashfield Flats begins to flood. When the river level rises to 0.6 mAHD, it floods to its northern extent.

On average river levels exceed the flooding threshold 208 hours each year, however the wetland retains this flood water in its ephemeral pools for many weeks to several months (26 weeks a year on average) (DBCA, 2021). During this time the surface waters evaporate and concentrate the originally brackish river water, drain inflow and groundwater to a brine. Some pools on the western side of the site remain wet throughout the year, while those on the east tend to dry by mid spring and are completely dry by the end of summer (DBCA, 2021).

The study states that "forecasting future water levels, incorporating climate change impacts and sea-level rise, suggests the wetland could be at risk of becoming permanently flooded before 2090 and changes to the hydroperiod are likely to be seen within the next 30 years" (DBCA, 2021).

5.4.2 Groundwater

According to the Perth Groundwater Map, groundwater ranges from 0.0 - 5.5 m below ground level, corresponding to approximately 1.0 – 7.0 mAHD. Groundwater generally flows from the west and north across the site to the southeast, towards the Swan River (Derbarl Yerrigan) with the groundwater at it deepest point along Hardy Rd (DBCA, 2021).

The Superficial Aquifer is recharged at a rate of 5% of annual rainfall and groundwater flows to the southeast towards the Swan River (DBCA, 2021). It is also thought that the Mirrabooka Aquifer flows upwards to the Superficial Aquifer. The *Ashfield Flats Hydrological Study* (2021) states that "A hydrogeological characterisation suggests the aquifers beneath the wetland comprises a thin surficial layer of organic rich wetland sediments overlaying a semiconfined aquifer consisting of Bassendean sand, Guildford Clay and alluvial deposits. The wetland sediments likely act as a weak aquitard with groundwater flowing upwards and evaporating during summer and then switching to flow downwards during winter." This causes high salinity levels in the sediments and groundwater over summer, and during winter the aquifers are recharged by Swan River tides and floodwaters and the concentrated brine developed over summer.

Groundwater does not appear to contribute significantly to maintaining surface water levels, although according to the report "groundwater is a significant contributor to flow in the Woolcock Ct and Chapman St drains, at ~65% of annual discharge. As a result of the groundwater contribution, these drains flow perennially. Even during rainfall events groundwater is a significant contributor to discharge."

A groundwater spring exists along the escarpment. Significant amounts of water have been observed to pond there seasonally, which suggests the groundwater spring is contributing to the TEC communities (DBCA, 2021).

The Town of Bassendean holds a current groundwater license (GWL: 166452) for 179,150 kL/year from the Leederville Aquifer which is used for irrigation of the parkland at Sandy Beach.

5.4.3 Stormwater and drainage

The *Ashfield Flats Hydrological Study* (2021) identified nine stormwater catchments that discharge to or through Ashfield Flats Reserve and a total of 11 stormwater catchments 'of relevance' to Ashfield Flats. These catchments can be further grouped as subcatchments of the two main drainage (MD) catchments; Chapman St MD and Kitchener St MD managed by the Water Corporation, and two local drainage catchments: Woolcock Ct drain, and the Lookout drain. There is also one additional local drainage catchment, West Rd drain, that discharges into a basin in the eastern portion of the reserve. The extent to which Woolcock Ct drain functions as a stand-alone drainage catchment is not clear since there are at least two locations where some interaction with the Kitchener MD system is possible.

Two main drains bisect Ashfield Flats and are managed by the Water Corporation; Chapman St drain and Kitchener St drain.

The Chapman Street MD has a total catchment area of approximately 200 hectares which extends beyond the railway to the west, taking in mixed residential, commercial and industrial areas. The drain discharges into the Swan River (Derbarl Yerrigan) through a channel crossing the Ashfield Flats reserve, entering from the north via culverts beneath Reid Street and flowing to the southwest between Iveson Place and Hamilton Reserve.

Kitchener St MD has a much smaller catchment area which is approximately 10 hectares of mixed residential. The drain discharges into the Swan River (Derbarl Yerrigan) via a channel crossing the Ashfield Flats reserve, entering from the west and flowing south eastwards.

The Chapman St MD near the bend at the top of the wetland has recently broken its embankments and contributes to flooding of the wetland (DBCA, 2021). This has been exacerbated recently by the growth of *typha orientalis* within the drain. Advice from the DWER has suggested that clearing of the typha is likely to mobilise monosulphidic black oozes into the river (pers comm, S Appleyard, Principal Hydrogeologist, DWER, 2023), as these along with acid sulphate soils have been identified in the hydrological study undertaken by DBCA. As monosulphidic black oozes and acid sulphate soils mobilisation into the river could have devastating consequences on river ecology, modification may be required to drainage system to enable conveyance of stormwater, without removal of the typha.

Woolcock Ct Drain is the largest of three drainage catchments discharging directly into the study area. The catchment is approximately 20 hectares of predominantly residential land uses. The drain discharges through an outlet situated at the western end of the limestone fire track and has been observed to flow perennially. The Ashfield Flats Hydrological Study (2021) states that "it is evident that the construction of the Woolcock Ct drain has led to a freshening of the wetland water pools on the western side of the TEC as well as contributed to a more perennially inundated state. This drain has likely already impacted fringing salt-marsh species and favoured the proliferation

of sedges and Melaleuca in this western half of the Reserve."

All three drains appear to have an interaction with ground water and are constantly flowing. The recent Ashfield Flats Hydrological Study (2021) found that there was limited interaction between stormwater passing through the Chapman and Kitchener Street drains and the surrounding salt marsh unless there was a high tide event and the areas were flooded, whilst Woolcock Drain had a direct interaction with the area.

5.4.4 Water quality

A study by Syrinx Environmental in 2005 stated that "water quality is poor with high levels of nutrients and heavy metals present." Water quality data (fortnightly public health monitoring) is also available from the jetty at Sandy Beach, Success Hill and Point Reserve. Anecdotal evidence suggests that the water quality at Sandy Beach is variable, poor at Point Reserve and good at Success Hill. In addition, there are occasional sewer overflows, including two in Bassendean this year that have flowed into drains. Investigation of the incidents by the Water Corporation showed no visual signs of contamination entering the open channel drains or flats, and sampling showed that the impacts to the river were low (pers comm, Amanda Best, Water Corporation).

As part of the Ashfield Flats Hydrological Study (DBCA, 2021), a surface water monitoring program was conducted between August 2018 to November 2020, with the aim of developing a better conceptual understanding of the wetland's interaction with the Swan River (Derbarl Yerrigan) and its likely sources of water. The study confirmed that Kitchener St MD and Chapman St MD are significant sources of metals and nutrients loads to the Swan River (Derbarl Yerrigan). The water chemistry of stormwater and nearby groundwater is consistent with a pollutant source related to fertiliser use, fertiliser production and sulphuric acid production.

A former fertiliser and sulphuric acid manufacturing facility and an iron works were located to the north of Guildford Road are known to have significantly contaminated soils and groundwater which flow toward Ashfield Flats Reserve (DWER, 2019; 2020). Pyritic cinders and demolition wastes were encapsulated within a purpose-built containment cell at one site. Contaminated groundwater reportedly discharged to the adjacent open Chapman Street Drain at the Tonkin Industrial Estate (EPA, Ashfield Flats Reserve Hydrological Study Department of Biodiversity, Conservation and Attractions, 1999). An acidic groundwater plume is thought to have migrated to the Reserve, liberating metals in the aquifer, and may possibly be intercepted by the drains discharging to the site (Kellenberger, 1998).

The Woolcock Crt drain is a significant source of pollutants to the wetland, including zinc and cobalt which are discharged by this drain and accumulate in the wetland sediments. This drain also has a constant base flow of water with elevated nutrient levels discharging into the western side of the flats. The wetland is therefore performing a significant ecosystem service by trapping and storing these pollutants before they enter the Swan River (Derbarl Yerrigan), whilst providing some level of nutrient treatment.

Based on the Perth Groundwater Map, salinity concentrations in groundwater range from 500 - 1,000 mg/L (DBCA, 2021). This corresponds to a salinity classification of "marginal" (DoE, 2005). Given the nature of the site, i.e. "salt flat" with salt tolerate species, salinity concentrations were expected to sit within this range or higher.

From the river water quality perspective, the Chapman St MD is delivering nutrients and contaminants directly to the river so it would be the highest priority. The Kitchener St MD is also delivering nutrients and metals directly to the river, at lower volumes. The Woolcock Street drain discharges directly into the wetland, therefore as mentioned above, the wetland is storing and somewhat treating these pollutants before they enter the Swan River (Derbarl Yerrigan).

5.4.5 Mosquitos

The largest site is Bassendean is Ashfield Flats which is a tidal driven saltmarsh mosquito-breeding habitat located on the northern bank of the Swan River (Derbarl Yerrigan). Mosquito and midge breeding is a natural occurrence in these environments, however the last couple of years has seen an increase in complaints and numbers.

On average, the past numbers of mosquito complaints received by the Town per financial year between 2014-2020 ranged anywhere from 3-18. These were during El Niño climate conditions. During 2020/21 and 2021/22, 40 and 31 complaints were received by the Town respectively, and it should be noted that this was during La Niña. There were 4 notified cases of Ross River Virus in the Town of Bassendean during 2021/22. The following species have been recorded over 2020/21 and 2021/22:

- Aedes camptorhynchus
- Aedes notoscriptus
- Aedes vigilax
- Anopheles annulipes species A
- Culex annulirostris
- Culex australicus
- Culex globocoxitus
- Culex quinquefasciatus

The flight range of these species can vary from 1 km to 10 km and a number are vectors of Ross River virus and potential vectors of Barmah Forest virus. In particular: *Ae camptorhynchus, Ae notoscriptus, Ae vigilax* and *Cx annulirostris.*

Due to the nature of the wetland being a TEC, no mechanical treatment is permitted in order to protect the vegetation and access to the main breeding sites is restricted due to dense vegetation . The Town is looking into the use of drones as part of the treatment process, however, this is a costly exercise.

5.5 Riverine processes

5.5.1 Foreshore conditions

The foreshore can generally be characterised by separating the approximately 1.2 km length into four sections, based on the existing infrastructure, level of erosion and conditions (shown in Figure 12. Further details of the four sections are described below.

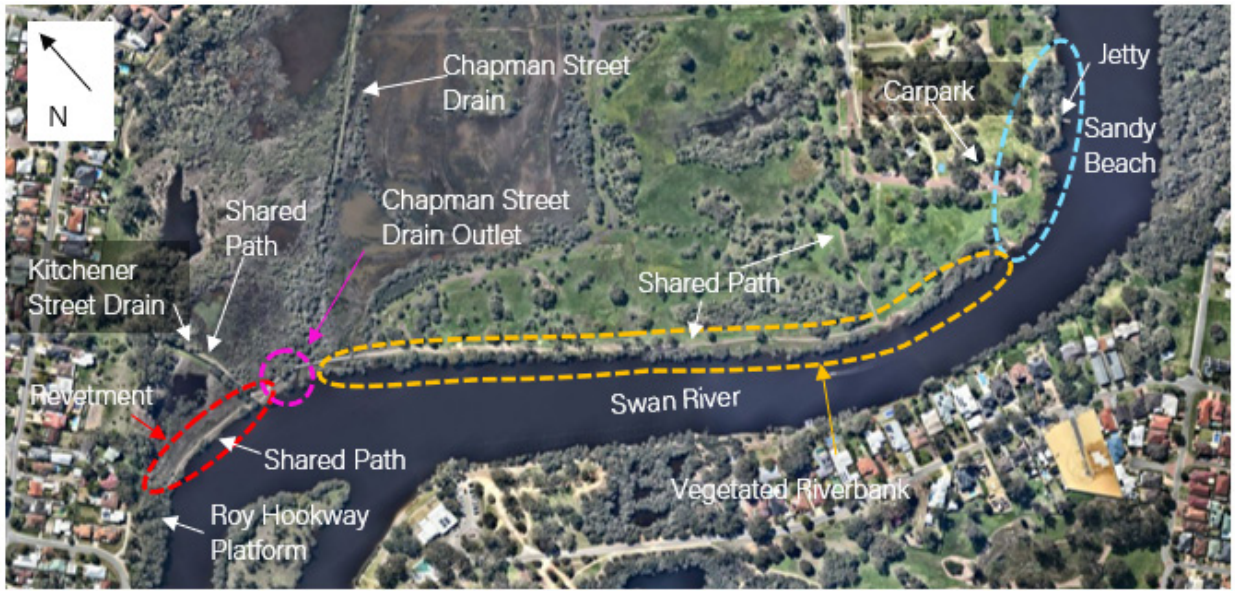


Figure 12: Layout and foreshore sections

Sandy Beach

Sandy Beach is a popular area for recreating, including for kayak and canoe launching and dog walking, with a grassed foreshore area fronting a large public carpark. A plan showing the area and the various stretches of shoreline is provided in Figure 13.

Figure 13: Sandy Beach

A number of built assets are located within the vicinity of the carpark. As outlined in MRA (2022), these built assets are currently mostly in poor to average condition.

The Sandy Beach Jetty has recently been replaced by DBCA. The new jetty appears to have been implemented with a relatively short design life, estimated to be in order of 10-20 years.

The Town has separately engaged consultants to complete a concept design for upgrades to the Sandy Beach foreshore and/or replacement of relevant structures. The Town has advised that the design is expected to include managed retreat for the beach and tree lined shorelines located at the northern and southern ends of the site, and, stabilisation measures to protect the carpark and adjacent areas.

Vegetated Riverbank

The approximately 750 m long stretch of riverbank extending north west of Sandy Beach is predominately vegetated with trees and sedges, and one small section of beach. DBCA (2019) has described the vegetation through this areas as "*...fringing Casuarina obesa and Eucalyptus sp. trees over scattered Juncus kraussii subsp. australiensis and Schoenoplectus tabernaemontani sedges (including plantings) on river banks...*" This stretch of foreshore is understood to be highly valued by the local community. Public uses of the area include walking, dog-walking, cycling and bird watching.

The extent of this stretch of foreshore and associated assets are shown in Figure 14. As outlined in MRA (2022), the shoreline fronting Ashfield Flats is in poor condition, as erosion of the shoreline, scarping of the bank and undercutting of trees is evident throughout the riverbank.

A shared path runs parallel to the riverbank. This path is located relatively close to the river. The buffer between the path and the riverbank decreases to 1-2 m in some areas and the path is considered to be at risk of erosion.

Figure 14: Ashfield Flats vegetated riverbank

The foreshore in this area is low lying and known to be subject to inundation from to time to time. Photographs from inundation of the area during 2021 are provided in Plate 1 and Plate 2.

Plate 1: Foreshore inundation during 2021

Plate 2: Inundation at Ashfield Flats in 2022

Chapman Street Open Drain Outlet

The location of the Chapman Street Open Drain Outlet is shown in Figure 15. This section of foreshore includes the man-made (ie cut) open drain and the low lying area of beach to the east. This stretch of foreshore is considered to be in poor condition as the shoreline is visibly eroded, trees are undercut and the open drain appears to be clogged with sediment and debris.

The drain outlet and adjacent beach are areas of the Ashfield Flats foreshore with the lowest elevation. This area floods frequently each year.

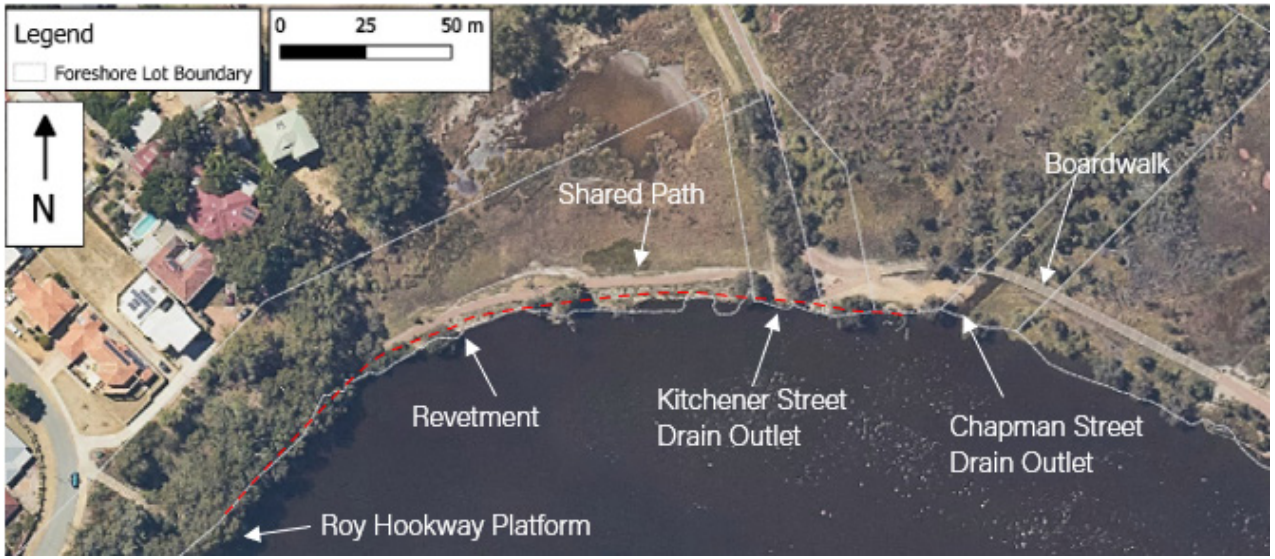


Figure 15: Kitchener Street drain outlet and Ashfield Flats western revetment

Ashfield Flats Western Revetment

The western end of the site is fronted by an approximately 180 m long revetment which spans from the Kitchener Street drain to the Ron Hookway Platform (Figure 15). As outlined in MRA (2022), the revetment is in average condition and several hardwood stakes are located in front revetment and appear to be remnant from previous stabilisation measures (ie brush mattress wall). These stakes are recommended to be removed as they pose a safety hazard and their removal is not anticipated to significantly increase the degree of erosion which will continue to occur due to rising river levels (see section 5.5.3).

The level of the shared path and crest level of the revetment through this area are relatively low. Levels range from around +0.5 to 0.7 mAHD. Inundation of the shared path is known to occur from time to time.

There appears to be voids in the revetment surrounding the Kitchener Street Drain Outlet. The adjacent section of footpath is damaged with considerable cracking evident. This damage may be due to loss of material, or movement of the drain pipe.

The condition of the foreshore overall is shown in Figure 16.

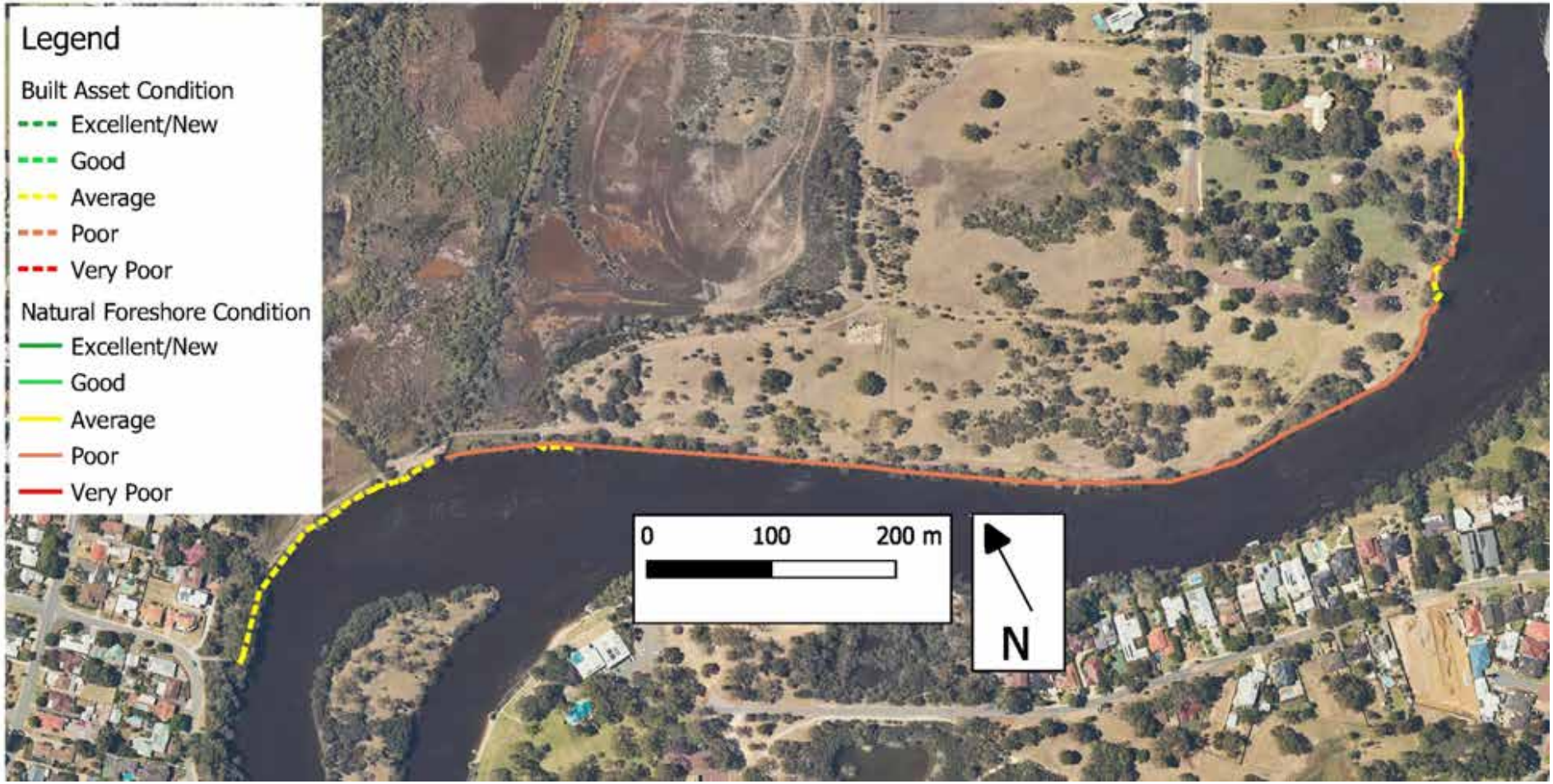


Figure 16: MRA (2022 & 2022a) Ashfield Flats Foreshore Condition Rating Plan

5.5.2 Waves

Wind generated waves

The site is partly protected from wind generated waves from the south and south-west winds due to the presence of Ron Courtney Island to the south west. Wind waves are therefore not considered a dominant factor at the site.

Boat wake

The predominant waves impacting the site are those generated by boats. Ashfield Flats is located on a 'power bend' in the river, therefore the impact of boat wash and natural tidal influence is a large contributor to the foreshore erosion that is occurring. Anecdotal evidence suggests that most boats also tend to stick to the Town of Bassendean side of the river, as it is deeper. This exacerbates the erosion issues caused by the frequency of vessel generated waves.

The Department of Transport (DoT) Swan Canning Riverpark Boating Guide (DoT, 2021) dictates a 5 knot vessel speed limit in the vicinity of Ashfield Flats. It is understood that River Cruises are exempt from this speed limit, however, they usually stay within the limit for passenger comfort and experience.

The resultant wave field from a vessel is largely dependent on the vessel shape, speed, and the water depth in the area (AMC 2009). The DBCA (formerly as the Swan River Trust) investigated vessel wake generation and propagation in the river for a number of vessels at different speeds (AMC 2009 & CMST 2010). Given the 5 knot vessel speed limit, the expected design boat wash wave conditions along the shoreline of the site is consist of a wave height of approximately 0.4 m and a wave period of 3 s.

The Sandy Beach Reserve foreshore has a jetty/mooring which is likely to experience vessel generated waves with the frequency of users. The Department of Transport has installed a fixed speed camera at Sandy Beach Reserve and Garvey Park to assist with the control of boat speed, with the aim to reduce the impact of boat wash as a contribution to riverbank erosion at Ashfield Flats.

5.5.3 Water levels

Ashfield Flats is located 33 km upriver from the river mouth towards the upper extent of the Swan River Estuary (Derbarl Yerrigan). Water levels in the river are influenced by both river and ocean (tidal) influences.

Tides

A tide gauge is located at Barrack Square, which is approximately 9 km to the south-west of the site. A tide gauge is also located at Meadow Street Bridge in Guildford, which is approximately 3.5 km to the north-east of the site. Key tidal levels for each of gauges are provided in Table 2.

Table 2: Tidal characteristics

Key Tidal Level	Barrack Square Tide Gauge Level (mAHD)	Meadow Street Bridge Tide Gauge Level (mAHD)1
Highest Astronomical Tide (HAT)	0.54	~0.5
Mean Higher High Water	0.28	0.36
Mean Sea Level (MSL)	-0.01	0.08
Mean Lower Low Water	-0.29	-0.2
Lowest Astronomical Tide (LAT)	-0.45	-0.49

Notes: 1. Tidal characteristics are based on the Meadow Street Bridge Tide Gauge Submergence Curve prepared by Seashore (2018).

The riverine water levels at Ashfield are expected to be closer to those recorded at Meadow Street than Barrack Street due to their vicinity and the geometry of the river (Biodiversity Conservation and Science 2021).

5.5.4 Riverine influences & flooding

River flows in the Swan River (Derbarl Yerrigan) are generally restricted to the winter months following heavy rainfall (Brearley 2005). These freshwater flows diminish as stream flows in the catchment area stop in the drier months.

The Swan River estuary is subject to flooding when flows in the Swan and/or Canning Rivers are greatly increased. Flood levels have been recorded along the Swan River from the mid 1800's. The Waters & Rivers Commission (2000) collated the major flood events on record along the Swan River Estuary (Derbarl Yerrigan).

BMT WBM (2017) also considered reviewed the 1983 and 2017 flood events as part of their Swan and Canning Rivers flood study. It is noted that there has not been a significant flood event on the Swan River (Derbarl Yerrigan) since 1983 until an approximately 10 year ARI event in early 2017.

Joint estuarine influences

The BMT WBM (2017) Swan and Canning Rivers flood study considered the joint probability of both marine and riverine influences on flooding throughout the estuary. The data which is pertinent to the Ashfield Flats foreshore (site S38) is presented in Table 3 below.

Table 3: Extreme water levels at Ashfield Flats foreshore (BMT WBM, 2017)

ARI (years)	Water level (mAHD)
10	1.94
20	2.28
50	2.69
100	3.43
500	4.98

Sea Level Rise

Ambient and extreme water levels are expected to increase over the years with sea level rise as a result of climate change. Recommendations on the appropriate allowances for sea level rise to be used in coastal planning and development around Western Australia have been provided by the DoT and are presented in Figure 17 (DoT, 2010).

The DWER have previously advised that these figures are appropriate for use in planning on the Swan River (Derbarl Yerrigan). This figure shows a projected sea level rise of 0.9 m in the coming 100 years.

The recommended allowances for future sea level rise over each of the planning timeframes have been determined and are presented in Table 4. The increases in sea level are referenced to 2022.

Table 4: Sea level rise (SLR) allowances

Planning Timeframe	SLR Allowance (m)
2032 (10-year)	0.05
2047 (25-year)	0.15
2072 (50-year)	0.39
2112 (90-year)	0.87
2122 (100-year)	0.97

Flood currents

As part of its detailed flood study of the Swan River BMT WBM (2017) determined flood current velocities throughout the Swan River (Derbarl Yerrigan) for various ARI events. BMT WBM's peak current speeds associated the 20 year ARI flood event are presented in Figure 18. The flow patterns provide an indication of the areas where the erosive pressures of the typical currents as well as flood currents are expected to be highest. As shown in Figure 18, higher current speeds occur along Sandy Beach and the western end of Ashfield Flats. This coincides with areas of increased historical erosion.

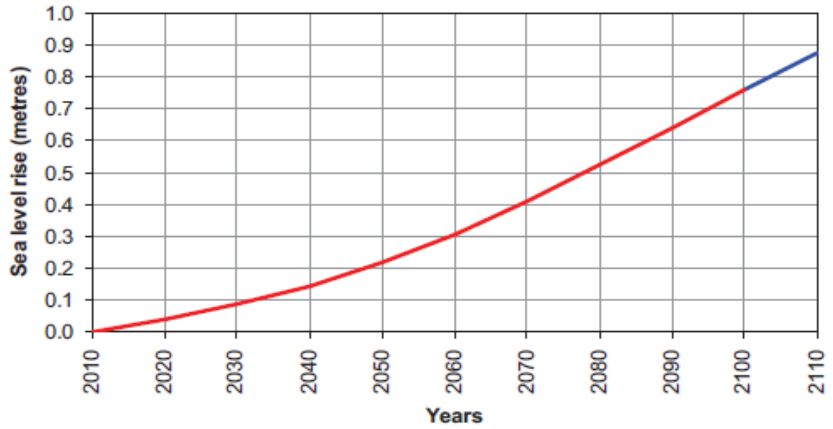


Figure 17: Recommended sea level rise allowances (DoT, 2010)

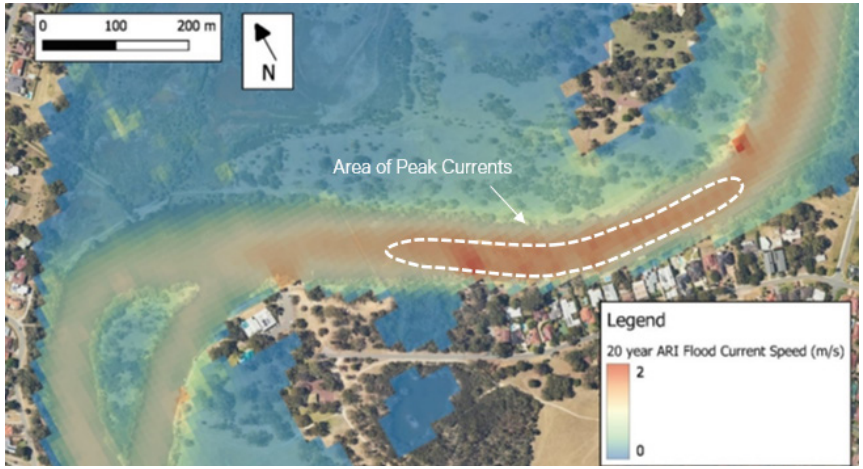


Figure 18: 20-year ARI flood current speeds (BMT WBM 2018)

5.5.5 Historical shoreline movement

In absence of sufficient historical survey information covering the foreshore and riverbanks, the historical stability of the foreshore has been reviewed by assessing historical aerial photographs and mapping the shoreline to compare the location and assess change. It is noted that mapping the shoreline via the vegetation line is a crude indicator of erosion as it can be influenced by factors such as extent of vegetation growth, canopy. And clearing, among other factors.

The location of the vegetation line along the Ashfield Flats foreshore was compared over 18 years of historical aerial photography from 2003, 2008 and 2021. The approximate overall shoreline movement for various areas of the foreshore, from 2003 to 2021 is shown in Figure 19.

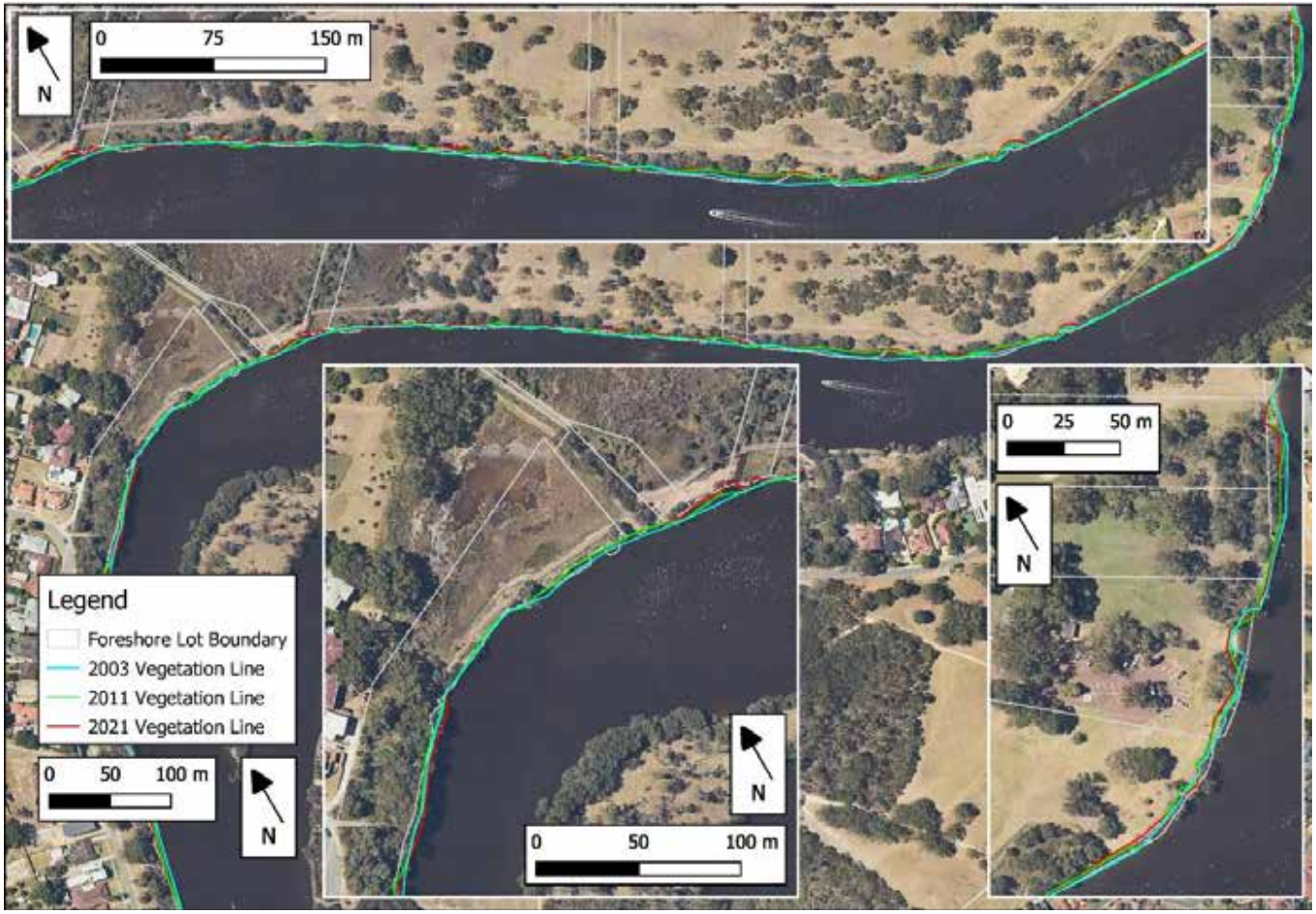


Figure 19: Ashfield Flats vegetation line movement 2003 to 2021

The following observations are noted.

- 5 to 7 m of erosion has occurred between 2003 and 2021 in a handful of locations at Sandy Beach.
- 3 to 5 m of erosion has occurred between 2003 and 2021 in various locations towards the eastern end of the Ashfield Flats Vegetated shoreline. Eroded areas tend to coincide with locations where trees and riverbank vegetation has been lost.
- Erosion is less pronounced towards the western end of Ashfield Flats, where the riverbank vegetation is the most dense. Up to 2-3 m of has occurred between 2003 and 2021 in various locations.
- Up to 5 m of erosion has occurred between 2003 and 2021 at the Chapman Street Open Drain outlet.
- The Ashfield Flats Revetment appears to have stabilised the riverbank however the aerial photos indicate some vegetation behind the revetment has been lost over time.

Historical surveys

Comparison between the DBCA 2017 survey and DoT 1997 survey soundings indicates patterns accretion and shallowing throughout much of the Swan River (Derbarl Yerrigan) at Ashfield Flats. This includes:

- In the order of 0.3 to 0.5 m of accretion through much of the area of peak currents (refer Figure 2.15). This coincides with the deeper areas. Up to 0.8 m of shallowing has occurred in an isolated pocket at the deepest (approx. -3.5 mAHD) area of river.
- In the order of 0.5 to 0.8 m of accretion in deeper parts of the river to west of Ron Courtney Island, adjacent to Ron Hookway platform.

These deeper areas of river may have been scoured out to depth during previous significant flood events. Shallowing may have occurred in these deeper areas due to gradual accumulation of sediment, particularly in deeper areas, during the relatively calm period of river flows since the last significant flood event in 1983.

Accretion in the shallower areas of the river towards the riverbanks may be attributable to settlement of sediment eroded from the riverbanks, onto the riverbed.

5.5.6 Previous Stabilisation Works

A selection of previous stabilisation works implemented at Ashfield Flats are discussed below. The various structures at Sandy Beach are not discussed as these are expected to be modified as part of the Sandy Beach foreshore concept design.

2015 Restoration Works

The 2015 restoration works were located over an approximately 30 m long stretch of foreshore located at the western end of the vegetated stretch of riverbank, adjacent to the boardwalk. Based on the design drawings, the works appear to have involved regrading the eroded and scarped riverbank, placement of coir matting, vegetation planting (trees, shrubs, sedges and herbs), placement of brush log wall in front of the planting to provide temporary protection and fencing.

The works appear to have performed reasonably well and the planted vegetation is now well established. The brush mattress wall is in poor condition and the remnants are recommended to be removed.

Ashfield Flats Western Revetment

Minimal information regarding the Ashfield Flats Western Revetment is available. The structure appears to have been originally constructed during the 1980s and extended further east during the late 1990s. Extension of the revetment appears to have involved modifications to the Kitchener Street Drain outlet including installation of a culvert through reclaimed land and the revetment extension.

As outlined in MRA (2020), upgrades to this revetment are recommended within the next 7 to 9 years.

5.5.7 Proposed stabilisation works

The Town of Bassendean has been working with with DBCA through the Riverbank Grants Scheme to address existing erosion of the Sandy Beach Reserve foreshore. The project will consider potential repairs or replacement of the timber river retaining wall either side of the jetty, as well as revegetation along the foreshore.

The Sandy Beach foreshore project is being delivered separately to, but concurrently with the development of the Ashfield Flats Master Plan. It is expected that land use initiatives from the Ashfield Flats Master Plan will be complemented by the Sandy Beach foreshore works.

5.5.8 Erosion and deposition

The site is subject to natural erosion process, which have been exacerbated by the lack of remnant vegetation and anthropogenic use of the flats and the Swan River (Derbarl Yerrigan). The western region of the Ashfield Flats foreshore is more vulnerable to the natural erosion forces of the river because it is situated on the outside of a meander. Conversely, the eastern section is situated on the inside of a meander and thus represents a depositional zone (Blair and Blatchford, 1978). Bank erosion is also caused throughout the area by wash from boats.

The Sandy Beach 10 Year Management Plan states the following:

"The timber walling at Sandy Beach Reserve is degraded; around the southern unfenced bushland pocket, the wall has failed completely and there are signs of degradation of the northern section of wall surrounding the middle bushland pocket, including erosion behind the structure. Reactive maintenance works were undertaken in January 2021; installing additional geotextile and fill material behind the failed sections of timber walling in the northern section. An assessment of the foreshore undertaken by MP Rogers and Associates PL in 2021 assessed the 'natural' areas of the foreshore as in 'Average' condition, and the timber walling as 'Poor' to 'Very Poor' condition. However, the consequences of potential erosion in the area were minor, giving a generally lower combination rating score. Recommended actions from the report include engaging a consultant to undertake a detailed design for erosion protection mechanisms and implementation of the design, with the likely outcome of the design process to include a combination of rock headlands, sand renourishment and revegetation.

In 2021, the Town successfully applied for funding from the DBCA's Riverbank funding program to design a foreshore restoration plan for the area.

6 SOCIAL CONTEXT

The site is heavily utilised by the public, and is now a popular destination for passive recreational activities, bike riders, walkers, bird watching, dog owners and fishing. The newly developed Sandy Beach play space is attracting lots of visitors to the area, along with the existing barbeques, and jetty.

Current access to the study area is by car, bus, walking, cycling or by water (boat, kayak). The closest bus route is along Reid St (Transperth Route No 55). The key access routes through the study area is via the existing foreshore path network which includes a boardwalk across the drainage outlets, as well as the informal access network of fire access tracks. Most of the path network is inundated at certain times of the year, with the exception of the boardwalk.

The site also contains physical infrastructure such as the playground, toilets, jetty, bridges, walkways (paths), drains, roads, fences, bollards, bins, drink fountains and lights. The key areas of use are shown in Figure 20and include:

- Ashfield Flats Reserve – the parkland setting is well used by pedestrians and dog walkers. While most people stay on the path network, many dogs are allowed to roam freely over the remaining area including through the wetland and into the river.
- Roy Hookway Platform – Used principally by the local community as it provides river access for swimming and fishing. Public access to this area is via a staircase at the corner of French Street and Ashfield Parade, and from the foreshore walking trail that extends from the remaining study area.
- The Lookout - A valued community vista and contemplation space atop the escarpment in the northern port of the study area. The banks of the escarpment were affected by a bushfire in 2015. The bank was revegetated by DPLH in 2019 and the vegetation has established very well. There is a fire access track at the base of the escarpment. The site was a former contaminated site but has been remediated for restricted use.
- Sandy Beach Reserve – The site contains recreational facilities (BBQs, picnic tables, toilets), the Sandy Beach Reserve Nature Play Space, and a shoreline with multiple points of beach access that have the capacity to launch light watercraft (i.e., kayaks, stand up paddleboards, canoes). It is predominantly a parkland environment with remnant and regrowth eucalypt with some planting of native species. Foreshore revegetation projects have been conducted selected areas. The site also contains significant vegetation, which is not locally native, such as Jacaranda which may have cultural or inherent community value. The site has been filled to some degree since colonialisation. There are plans to undertake foreshore restoration activities adjacent to the recently refurbished jetty, with the end-of-service timber log wall to be replaced.
- Kitchener North – Predominantly parkland setting bordered to the west by the Kitchener Street open drain, which is a source of polluted stormwater discharge. The site contains a carpark and formal entrance that connects to the main walking trail of the study area. This location is often used by Kayakers and provides a linkage for cyclists between the Ashfield Flats path network and the surrounding road network. Woolcock Court Drain is situated in the eastern portion of Kitchener North.
- Chapman North – The area is predominantly parkland setting bordered to the west by the Chapman Street open drain. It can be accessed from Whitfield and Hamilton streets via well-utilised informal paths and contains Iverson Place Reserve, Hamilton Street Reserve, and Whitfield Street public open space. The site is filled with potentially contaminated material although the northern portion (Lot 8111) is remediated for restricted use.

The facilities and activities undertaken in Ashfield Flats are summarised in Table 5.

Figure 20: Main areas of use

Table 5: Facilities and activities in Ashfield Flats

Facilities / Infrastructure	Location	Activity
River and sandy beach area	Swan and Canning River	Water birds, kayaking, dog walking, walking, sitting and reflecting, fishing, boating
Trails	Ashfield Flats Loop (2.3km): paths from Sandy Beach along the foreshore to the jetty and further	Walking, running, cycling, bird watching
Formal walking path	From Sandy Beach to Ashfield Parade	Walking, running, cycling
Dog beaches	Sandy Beach	Dog walking
Playgrounds	Sandy Beach Reserve	Playing, climbing, swinging,
Boardwalks	Over Chapman St Drain	
Jetties	Sandy Beach Reserve	Fishing, boating
Stairs and fishing platform	Ashfield Parade	Fishing
Limestone track firebreak access	Behind properties 25-39 Hardy Road	Firebreak access
Barbecues, drink fountains, benches, picnic areas	Sandy Beach Reserve	Picnicking
Bike racks	Sandy Beach Reserve	Cycling
Public toilets	Sandy Beach Reserve	
Parking Areas	End of West Rd	
Bus transport	Reid St, West Rd	
Roads	West Rd	Scenic driving / viewing
Interpretive Signage	Along the boardwalk	
Lookout	Hardy Road/Kenny Street	Viewing platform, indigenous interpretive signage/ benches
Gauging Station	Chapman Street drain	DWER monitoring
Pumping Station	End of Chapman Street drain	Water Corporation
Monitoring bores	Throughout Ashfield Flats	Groundwater monitoring

6.1 Aboriginal heritage

Archaeological evidence indicates that Ashfield Flats and the greater Bassendean area was used historically by the Whadjuk people 30,000 years before pre European colonisation when James Stirling and his exploratory expedition arrived in Western Australia in 1827. The Whadjuk people would have likely used the marshy river flats and camped on higher ground.

6.1.1 Registered heritage sites

The DPLH is responsible for assessing the impact of development on Aboriginal Heritage sites. A search of Registered Aboriginal sites using the DPLH Registered Aboriginal Heritage Places Database revealed two sites within the study area, neither with gender restrictions, as shown by the hatched area in Figure 21.

- Registered Aboriginal Site 3536: the Swan River (Derbarl Yerrigan) is a mythological site
- Registered Aboriginal Heritage Site 3671: Ashfield Parade artefacts / scatter

The Swan River (Derbarl Yerrigan) is an integral part of the Aboriginal culture as a site of significance to the Whadjuk and Nyungah people and all impacts to the river are to be carefully considered.

Registered Aboriginal Site 3671 was "a small artefact scatter recorded by Ms. Sylvia Hallam near Ashfield Parade in 1973" (R. & E.O'Connor Pty Ltd, 2005). Discussions during the onsite meeting on the 2nd of November 2022 with Vaughn (Josh) McGuire a local Whadjuk man born in Balladong Country, confirmed the presence of these artefacts from S:3671 as including "spearheads, stone axes and boomerangs".

The extent of the registered site means that approval is expected to be required from the DPLH to undertake any works which have an impact on the river.

6.1.2 Previous surveys

An archaeological survey was undertaken to investigate Aboriginal sites for the Ashfield Flats in 2005 (Quartermaine Consultants, 2005). The field investigation showed that there were no newly discovered archaeological sites located within the project area. However, the survey also states that "there is some possibility that subsurface archaeological material may be present within the alluvial terrace of the Swan River (Derbarl Yerrigan) at this point.

Any ground disturbance of excavation should take this into consideration and monitoring of earthworks is recommended" (Quartermaine Consultants, 2005).

An ethnographic survey was also undertaken across the site by R & E O'Connor Pty Ltd in March 2005. This included a consultative process with the Wilkes Family sub-group and the Bropho family, Swan Valley Fringedwellers and Garlett family sub-groups of the Combined Metropolitan Working Group of native title claimants as well as the Ballaruk native title claimant group. The outcome of the consultation was that three of the groups approved the proposed works, but requested a further meeting to discuss proposals for a cafe, open auditorium and proposed extensions to the jetty facilities at Sandy Beach Reserve. They also requested that Aboriginal people should be involved in the revegetation work.

Figure 21: Registered Aboriginal Heritage Sites (DPLH-001)

A further project by Curtin University student, Debra Hughes-Hallett, investigated the Indigenous history of the Swan and Canning rivers in 2010. This study identified the Derbal Naral as a site of Nyungar Significance and also noted a number of places with "other Australian Community Significance" within the subject land, including the Bassendean Homestead, Stoke Farm and Binuri's vineyard and livestock run (Figure 22).

6.2 Post colonial heritage

Ashfield Flats has historic value and is on the State Register of Heritage Places as "an example of the physical environment in the early 20th century which may contain traces of past agricultural uses" (Place number 26173, Heritage Council, 2019).

Ashfield Flats, contained within the larger Bassendean Estate, was purchased in 1905. The majority of the estate was subdivided into quarter acre lots for residential purposes, while the larger lots, which comprise the 'Ashfield Flats' portion of the estate, were used for a variety of functions including market gardening or stock grazing. During World War II a small commercial sand quarry was established on the northern boundary of the 'flats' (InHerit, accessed 2023).

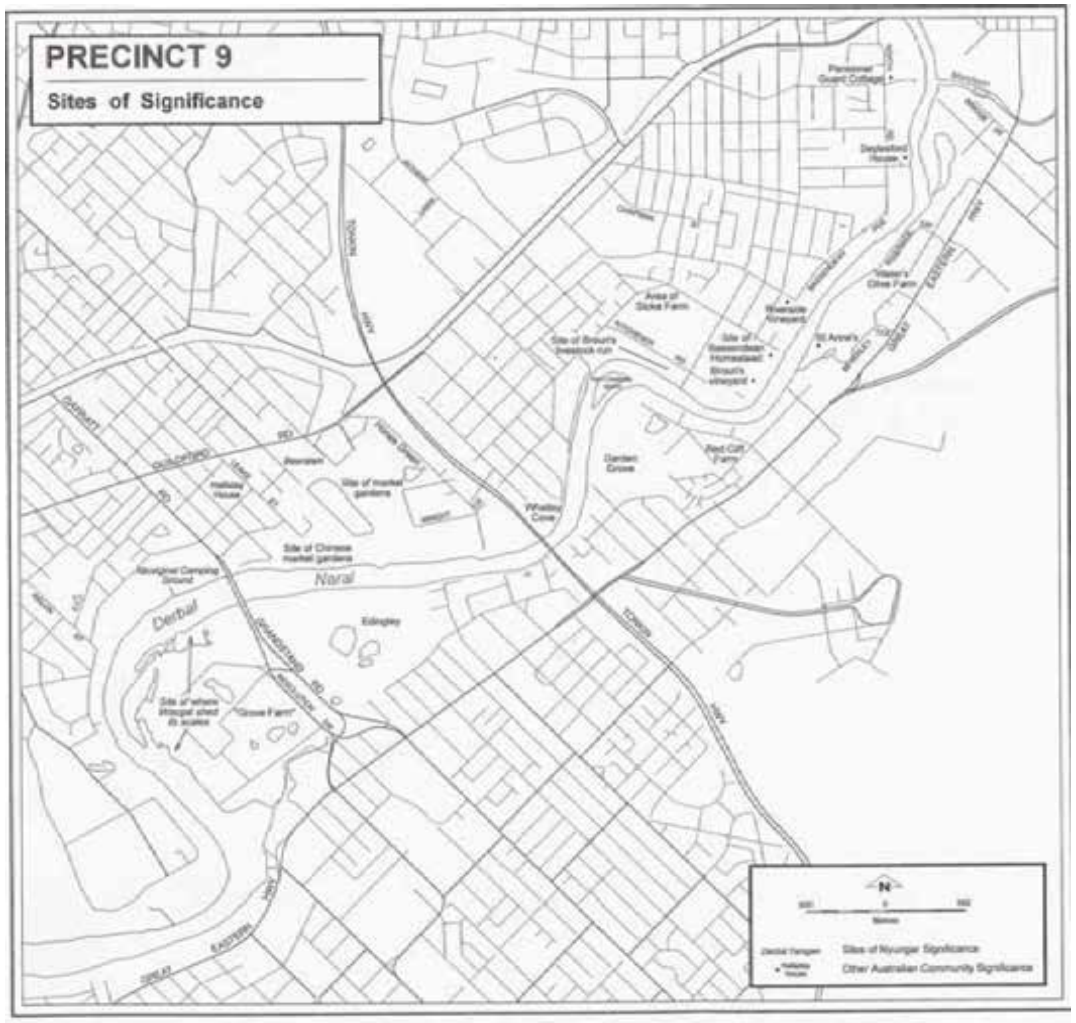


Figure 22: Sites of heritage significance (source: Hughes-Hallett, D, 2010)

7 FUTURE APPROVALS

There are a number of key stakeholders or approval agencies that have some responsibility for decisions within Ashfield Flats. Guidance should be sought from these agencies prior to undertaking any works within the study area, and appropriate approvals sought where required.

7.1 DBCA approval

Proposals that may affect the waters of the Swan Canning Development Control Area (DCA) include, but are not limited to, developments that might mobilise sediment, nutrients and non-nutrient contaminants to the DCA via streams, stormwater or groundwater management infrastructure, or groundwater flows; or may alter the hydrology of the DCA (WAPC, 2021b). Approval from DBCA under the *Swan and Canning Rivers Management Act 2006* typically involves the submission of either a Form 7 Permit Application or a Form 1 Development Application, depending on the scope and magnitude of the works.

7.2 Environmental approval

Any potential impact on the TEC will need to be assessed by the DBCA and referred to the Federal Department of Climate Change, Energy, the Environment and Water under the *Environment Protection Biodiversity Conservation Act 1999*.

In addition, the majority of the site boundary is within an Environmentally Sensitive Area (ESA). In accordance with the *Environmental Protection Act 1986*, a clearing permit is required to authorise any clearing of native vegetation within ESAs unless an exemption in Schedule 6 of the *Environmental Protection Act 1986* is applicable.

7.3 Aboriginal Cultural Heritage approval

In August 2023, the State Government announced it will change the legislative framework that is currently in place for Aboriginal heritage. The *Aboriginal Cultural Heritage Act 2021* will be repealed and an amended version of the *Aboriginal Heritage Act 1972* will be presented to Parliament.

The *Aboriginal Heritage Act 1972* establishes a Register of Aboriginal Sites, which contains information about Aboriginal sites of cultural heritage significance that meet certain requirements. The Swan River (Derbarl Yerrigan) is a Registered Aboriginal Heritage Site. Under the *Aboriginal Heritage Act 1972,* anyone wishing to carry out activities that may impact Aboriginal heritage sites or objects must obtain the necessary permits and approvals. This includes activities such as excavation, construction, and land development.

7.4 Planning approval

Under Clause 13 of the Metropolitan Region Scheme, approval of the WAPC is required for any development on land reserved for Parks and Recreation. However, there are a number of exemptions for development approval which include proposals for the use of reserved land that is owned by or vested in a public authority and that public authority is proposing to use the land for:

- the purpose for which it is reserved under the Scheme

- any purpose for which it was lawfully used before the coming into force of the Scheme
- any purpose for which the land may be lawfully used by the public authority.

Approval is also not required for development undertaken by a public authority on reserved land owned by or vested in a public authority, where the development is:

- permitted and does not involve the clearing of regionally significant bushland in a Bush Forever area
- expressly authorised under an Act to be commenced or carried out without the approval of the WAPC.

The Town of Bassendean is the local authority and would provide development approval for any proposed modifications or works onshore (outside the DCA) and to the carparks. Where development is proposed within a floodplain, contamination exists or an ASS management plan is required, approvals from DWER are also usually required.

8 REFERENCES

BMT WBM, 2017. Swan and Helena Rivers Flood Study and Floodplain Management Plan: Hydraulic Modelling Final Report, R.B22428.003.01. Prepared for Eastern Metropolitan Regional Council.

Bureau of Metrology (BoM), 2022. Monthly Climate Data Statistics. Accessed 27 October 2022 from BOM Climate Data. Commonwealth of Australia.

Delft, R.V, 1986. Ashfield Flats, An Environmental Photo Essay on the Ashfield Flats.

Department of Agriculture and Food WA (DAFWA), 2012. *Soil Landscape mapping zones. A*vailable from: https://maps.agric.wa.gov.au/nrm-info/

Department of Biodiversity Conservation and Attractions (DBCA), 2019. *Ashfield Flats Flora and Vegetation Report*. Species and Communities Program, DBCA, Perth.

Department of Biodiversity Conservation and Attractions (DBCA), 2021. *Ashfield Flats Hydrological Study*. DBCA, Perth

Department of Biodiversity, Conservation and Attractions (DBCA), 2022a. Ashfield Flats Master Plan. Available from: https://www.dbca.wa.gov.au/swan-canning-riverpark/ashfield-flats-master-plan

Department of Biodiversity, Conservation and Attractions (DBCA), 2022b. *Corporate Policy Statement No. XX – Planning for Localities Along the Swan Canning Development Control Area*. Draft for Public Comment. Western Australia.

Department of Biodiversity Conservation and Attractions, 2022c. Lower Swan Locality Plan, Draft. DBCA, Perth.

Department of Transport (DoT), 2010. *Sea Level Change in Western Australia – Application to Coastal Planning*. Coastal Infrastructure, Fremantle.

Department of Transport (DoT), 2022. *Boating Guide: Swan Canning Riverpark*. Marine Safety.

Department of Water and Environmental Regulations (DWER), 2017. *Acid Sulphate Soil Risk Map, Swan Coastal Plain* (DWER-055). Available from: https://catalogue.data.wa.gov.au/dataset/acid-sulphate-soil-risk-map-swan-coastal-plain-dwer-055.

Environmental Protection Authority, 2008, *Environmental Guidance for Planning and Development, Guidance Statement No. 33*, Environmental Protection Authority, Perth.

Hughes-Hallett, D, 2010, Indigenous history of the Swan and Canning rivers, a Project with the Swan River Trust, Student work placement: Curtin University: Various works compiled and presented by: Debra Hughes-Hallett

Government of Western Australia, 2006. *Swan and Canning Rivers Management Act 2006.* Western Australia.

Government of Western Australia, 2007. *Swan and Canning Rivers Management Regulations 2007.* Western Australia.

Government of Western Australia, 2019. Heritage Council. Ashfield Flats. Available from: Heritage Council. 27th October 2022.

MRA 2022. *Bassendean 2021 Foreshore Inspection & 10 Year Priority Plan*, R1511 Rev 2. Prepared for the Town of Bassendean.

MRA 2022a. Town of Bassendean Foreshore Condition Inspection State Government Managed Areas. R1568 Rev 1. Prepared for the Town of Bassendean.

Pattiaratchi C, 2011. *Coastal Tide Gauge Observations: Dynamic Processes Present in the Fremantle Record*, pp 185 – 202, in Operational Oceanography in the 21st Century, ed. A. Schiller, G. B. Brassington, Springer, London, doi:10.1007/978- 94-007-0332-2.

Quartermaine Consultants, 2005. Report on an Archaeological Investigation of Aboriginal Sites, Ashfield Flats Project Area.

Rate, A.W and McGrath, G.S., 2022. Data for assessment of sediment, soil, and water quality at Ashfield flats reserve, Western Australia. *Data in Brief,* 41, 107970.

R. & E.O'Connor Pty. Ltd, 2005, Report on an Ethnographic Survey of Ashfield Flats Reserve, Ashfield Parade Reserve and Sandy Beach Reserve, Prepared for the Town of Bassendean, March 2005

RPS, 2020. Acid Sulfate Soils Detailed Site Assessment: Ashfield Flats. RPS Group Pty Ltd, West Perth.

Shape Urban, 2022. Ashfield Flats Master Plan- Communications and Stakeholder Engagement Plan. On behalf of the Department of Biodiversity, Conservation and Attractions.

Syrinx Environmental, 2005. *Ashfield Flats Preliminary Weed Management Plan, Technical Report*. For Department of Planning and Infrastructure and Town of Bassendean.

Western Australian Planning Commission, 2010. *State Planning Policy 2.8: Bushland Policy for the Perth Metropolitan Region.* Government of Western Australia, Perth.

Western Australian Planning Commission, 2013. *State Planning Policy 2.6, State Coastal Planning Policy*. Government of Western Australia, Perth.

Urbaqua, MP Rogers & Associates, PGV Environmental, South West Kinships and Shape Urban, 2022. Ashfield Flats Master Plan- Context Analysis Report. On behalf of the Department of Biodiversity, Conservation and Attractions.

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Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Draft	V1	SSh	JSh	Electronic	14 Sept2023
Draft for advertising	V2	SSh	REp	Electronic	13 October 2023
Final draft for advertising	V3	SSh	JSh	Electronic	10 November 2023
Final	V4	SSh	HBr	Electronic	26 February 2024

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