MASON PARK WETLAND

MANAGEMENT PLAN

DECEMBER 2021

DOCUMENT VERIFICATION

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Contents

Vision Statement

Mason Park Wetlands to be remediated to provide habitat for migratory waders and other shorebirds by restoring a more natural hydrology and managing vegetation including mangroves and casuarinas, while protecting saltmarsh and threatened species in the wetlands.

White-faced Heron (*Egretta novaehollandiae)*, Mason Park Wetlands August 12, 2021. Applied Ecology ©

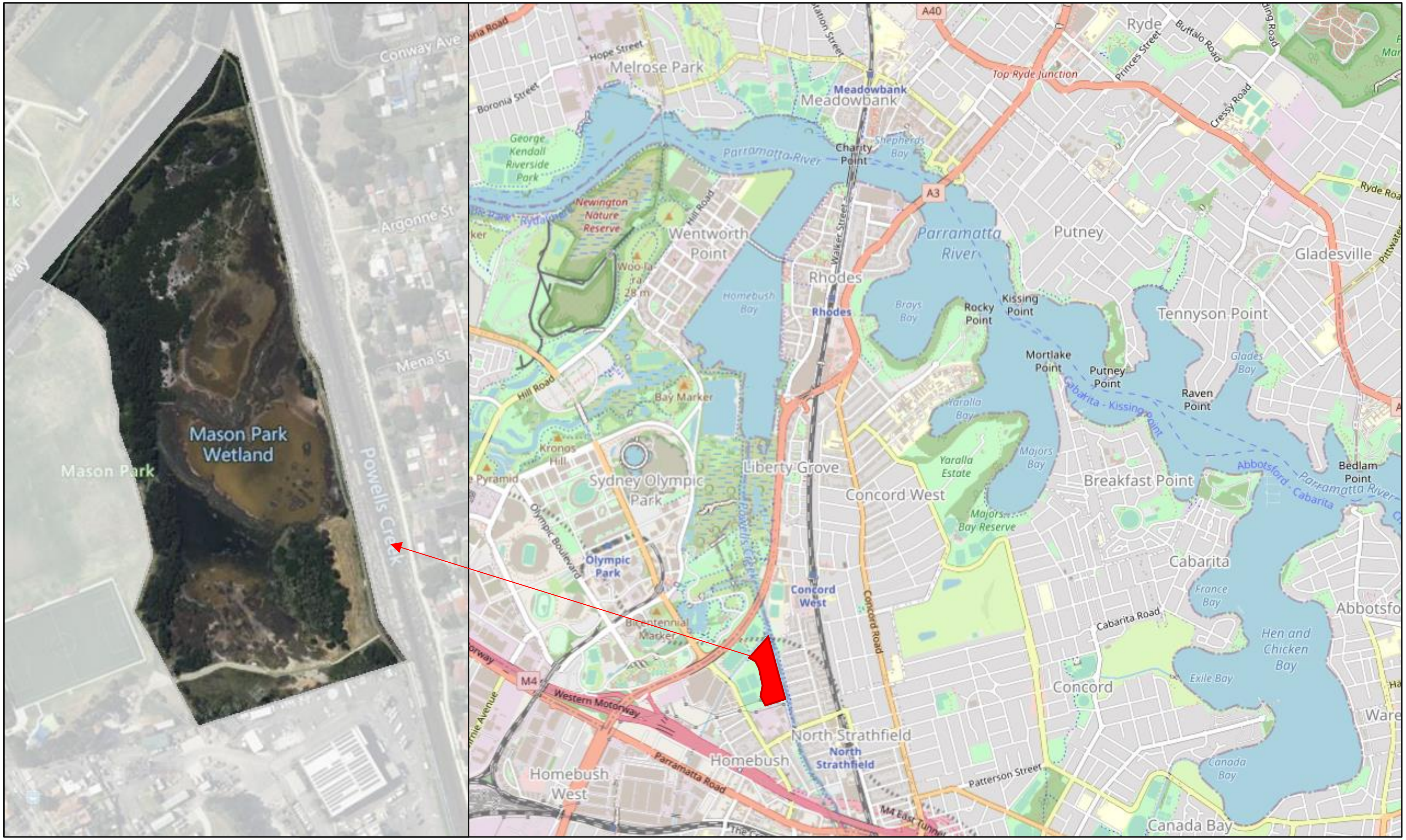

Figure 1 Mason Park Wetland context

1 Introduction

1.1 Scope of Plan

This plan has been prepared to ensure the values of the Mason Park Wetland (hereafter called 'the wetland' in this plan) are recognised, and to conserve and enhance its values. This plan is a separable part of the Plan of Management (PoM) for Mason Park.

The Management Plan contains a summary of relevant sections of the ecological assessment of the wetland, prepared to underpin the Mason Park PoM, and includes a description of the wetland and an examination of its hydrology, environmental values, heritage values, and social values. Relevant policies, acts and strategies are also considered. Threats to the wetland are identified along with management strategies to address them and to augment the wetland assets. Management objectives and actions are prioritised and costed, and potential funding sources identified. A monitoring plan for wetland management is also presented.

The plan aims to identify values and threats to the wetland. Management strategies and actions have been developed to address threats and promote identified values.

The Management Plan should be reviewed and revised within three months of lodgement of the final plan. The plan is then to be revised within twelve months and henceforth at three yearly intervals. The reviews enable the effectiveness of the recommended management actions to be considered and updated with new information or technology and community concerns, however, this plan does not have a specific term and will stay in force until it is replaced.

1.2 Location, reservation and regional setting

Features	Description
Location	The wetland is located within Mason Park within Strathfield Local Government Area. The wetland is bound by Powells Creek to the east and Saleyard Creek to the north and the confluence of these two creeks forms the north-eastern boundary of the wetland. Powells Creek flows in a northerly direction to the Parramatta River via Homebush Bay. The wetland is located in the estuarine reaches of Powells Creek. Coordinates WGS84: Lat -33.854579, Lon 151.082192
Reservation and tenure	The wetland and buffering vegetation is 7.2 hectares in area. The site is located primarily on freehold land over four lots, with one additional Crown Land lot and one under the control of the Local Government Authority. The wetland is zoned RE1 Public Recreation (LEP 2012). Crown: DP752023 Lot 118 Freehold: DP914879 Lot 1, DP129388 Lot 1, DP176625 Lot 1 Local government authority: DP1187064 Lot 7496 The wetland is managed by Strathfield Council.
Regional Context	
Biogeographic region	The wetland is located within the Cumberland Subregion of the Sydney Basin Bioregion.
Wetland type or Category	Originally an intertidal wetland, now hydraulically disconnected except for periodic inundation flows through a floodgate weir; originally with areas of freshwater and brackish ponds and channels, now completely saline
Surrounding land use	Grassed open space-recreation, formalised sportsfields including a synthetic turf field, light industrial/commercial, residential dwellings, additional park space, several channelised waterways, and major roads

Features	Description
Other authorities	Sydney Water, Crown Land, Department of Primary Industries, Transgrid

1.3 What is special about the park

Mason Park Wetlands are located in the eastern section of Mason Park, and are remnant from the days when the area was all tidal mudflats, mangroves and saltmarsh.

History

Like much of the intertidal zones along the southern side of Parramatta River, large parts of the foreshores around Homebush were subjected to ongoing infilling and development for industrial purposes (UBM 1994), including the area around Powells Creek. Prior to that the entrance to Powells Creek was fringed by mangroves and mudflats. The area around Mason Park was known locally as "The Mangroves" and subject to tidal inundation. Freshwater was discharged into this area from Powells Creek, which also formed the boundary between Strathfield and Canada Bay Councils. The boundaries of Powells Creek changed continually depending on the level of rainfall (Cathy Jones, undated), which complicated management of council boundaries.

A concrete channel known as Saleyards Stormwater Channel was constructed in 1934 to drain stormwater from the Homebush Cattle Saleyards, now the site of Sydney Markets. This channel cut through the swamp lands at a point roughly in the middle of the swamp. At the same time, Powells Creek was realigned and moved to its present location east of its old channel, and canalised by the Water Board. The large concrete channel reduced but did not eliminate tidal flooding of the land.

Both Homebush Council and later Strathfield Council supported land reclamation of areas they referred to as 'swamp' land, and around half of Mason Park was filled with garbage and the level raised to current levels. "The remainder is the original mud flat covered with swamp grass" (as described by Strathfield Council Town Clerk James Mathews in 1963 in Cathy Jones, undated). The concrete channels for Saleyards Creek and Powells Creek completely changed the hydrology of the area, while the ongoing landfill changed the landform for the surrounding areas.

Natural heritage

During the 1970s Australia became a signatory on the International Wetlands Convention (1971) and the Migratory Bird Treaty (1974; now JAMBA) with Japan. A combination of local and international pressure led to the cessation of rubbish dumping in the Mason Park area and it became preserved as a feeding and resting place for birds.

The formalised creek channels were further amplified in 1987. Unfortunately, major habitat destruction was caused during maintenance work on Saleyard Creek stormwater channel. UBM (1994) described the current flood regime at Mason Park as the result of works carried out by the Sydney Water Board as an attempt to remediate the damage. "The Water Board installed two concrete pipes connecting a small stand of mangroves and the saltmarsh to Powell's Creek at high tide. This action partially rectified damage to vegetation and the salt content destroyed by freshwater flooding during maintenance work."

Prior to that time, Mason Park had been described as "one of the best places in Sydney for migratory shorebirds (Roberts 1993, cited in UBM 1994), with interest in the waterbirds of this areas stretching back to the 1960's. The international migratory bird agreements signed by Australia with Japan, China, and later Republic of Korea came about as a direct result of this interest in migratory waders.

In 1998 Strathfield Council installed a single-vent dropboard weir inlet at the north-east corner of the wetland to reinstate tidal flow and flushing of the wetland from Powells Creek. Water entering the wetland is kept there for extended periods by placing boards in the weir. Benefits of the weir include a better water bird habitat, and reduction in the production of acid sulfate soils, and more neutral soil acidity. At that time most of the wetlands were saltmarsh, with only a very small patch of mangroves at the northern end. Tidal inundation of the lower (northern) quarter of the saltmarsh has increased invasion of mangroves so they now cover a significant portion of the wetlands.

Extensive areas of saltmarsh are still retained including the following species: Samphire (*Sarcocornia quniqueflora*); New Zealand Spinach (*Tetragonia tetragonioides*); Seabite (*Suaeda australis*); Streaked Arrow-grass (*Triglochin striata*), Sand Couch (*Sporobolus virginicus*); Sea Rush (*Juncus kraussii*); Lampranthus (*Lampranthus tegens*) and Waterbuttons (*Cotula coronopifolia*). Lampranthus and Waterbuttons are now believed to be native to South Africa. Wilsonia (*Wilsonia backhousei*) is listed under the Biodiversity Conservation Act 2016 as Vulnerable and is patchily distributed in the southern sections of the wetland.

Social values

Mason Park wetlands are an important birdwatching site which has been the focus of attention for its diverse array of shorebirds since the 1960s. Birdlife Australia, along with individuals from the birding community, have undertaken regular surveys of these shorebirds for several decades. Casual birdwatchers are also regularly sighted enjoying the wetland.

Over recent decades, a footpath/cycleway has been constructed along the edge of Powells Creek, adjoining Mason Park wetlands, with a connecting boardwalk crossing the southern end of the wetlands near the main area of Wilsonia. The footpath/cycleway connects with a wider network within the LGA and the Inner West of Sydney, linking with facilities at Sydney Olympic Park and regional cycleways along the southern side of Parramatta River. Locally, the footpath/cycleway connects residents with facilities in Mason Park. The shared path provides users with immersion in the wetland environment and provides opportunities for engagement with estuarine flora and fauna not available anywhere else in the LGA.

Scientific values

The Park provides ongoing research potential in the fields of climate change impacts, estuarine and freshwater wetland rehabilitation, shorebird behaviour and habitat requirements and the management of threatened species and communities. The proposed management actions provide an innovative approach to intertidal wetland management by encompassing a two system approach to regulating inundation regimes – one during the breeding season of shorebirds for approximately 8 weeks, and one for the optimisation of saltmarsh habitat. Increased depth and duration of inundation during breeding provides safer nesting sites on small islands within the wetland, with the result that shorebirds are more likely to breed successfully and in safety from predators.

Birdlife Australia have an ongoing involvement in the site, actively contributing to the monitoring of shorebirds using the site. They assist with maintenance of the wetland with regular working bees to control encroachment from mangroves and swamp oaks, and regular monitoring of macrobenthic organisms that form a key component of shorebird diets.

Additional scientific values are provided by the Estuarine Mangrove Forest, Estuarine Saltmarsh, and mudflats, present in a complex mosaic maintained by regularity of inundation, salinity levels (elevated by evaporation), and very minor differences in bed levels. This has also created conditions to suit the threatened saltmarsh species, Wilsonia (*Wilsonia backhousei*), present in the upper margins of the wetland.

1.4 Goals for Wetland Management

The NSW Wetlands Policy promotes the sustainable conservation, management and use of the state's wetlands. It stresses the need for all stakeholders to work together to protect wetlands and their catchments. There are 12 principles that guide the way wetlands are looked after and preserved. All government agencies should adopt these principles, and all stakeholders should refer to them when making decisions on wetland management and conservation.

1) Wetlands are valued as significant parts of NSW landscapes – their conservation and management are most appropriately considered at the catchment scale.
2) Water regimes needed to maintain or restore the ecological resilience of wetlands should be provided through water management planning, water recovery and water purchase, recognising that a balance between environmental and human requirements must be reached.
3) Floodplains should be managed to maintain the natural distribution of water to and from wetlands, and to allow for the movement of aquatic biota (animal and plant life).
4) Wetlands of international, national and regional significance should be identified and given priority for conservation and investment.
5) Land management practices should maintain or improve wetland habitats, ecosystem services and cultural values.
6) Wetlands should be recognised as places with important cultural values, in particular that wetlands are an important part of Country for Aboriginal people.
7) Degraded wetlands and their habitats should be rehabilitated and their ecological processes improved as far as is practicable.
8) The potential impacts of climate change should be considered in planning for wetland conservation and management.
9) Research into wetland ecology should be encouraged to better support water and land-use planning and management.
10) Natural wetlands should not be destroyed or degraded. If social or economic imperatives in the public interest result in a wetland being degraded or destroyed, the establishment and protection of a wetland offset that supports similar biodiversity and ecological functions will be needed.
11) Cooperation and incentives among land managers, government authorities, catchment management authorities, non-government organisations and the general community are essential for effective wetland management.
12) Regular reporting of wetland extent and condition is vital to assess management performance and understand wetland dynamics.

2 Management context

2.1 Actions and the legislative framework

The Coastal Management Act 2016 includes mapping of the four coastal management areas to which the provisions of the Act apply. One of these management areas is applicable to Mason Park Wetland. This is:

- coastal wetlands and littoral rainforests area

Coastal wetlands and littoral rainforests area are areas which display the characteristics of coastal wetlands or littoral rainforests that were previously protected by SEPP 14 and SEPP 26. In addition there is a 100-metre buffer around mapped wetlands that is called the proximity area. The proximity area applies to all land zones around coastal wetlands and littoral rainforests (Appendix A, Figure 30).

In the coastal wetlands most works will require development consent including the following (Division 1 cl10):

- clearing of native vegetation
- harm to marine vegetation (includes mangroves)
- environmental protection work

However, environmental works may be carried out by or on behalf of a public authority without development consent if the development is identified in—

- the relevant certified coastal management program, or
- a plan of management prepared and adopted under Division 2 of Part 2 of Chapter 6 of the Local Government Act 1993, or
- a plan of management under Division 3.6 of the Crown Land Management Act 2016.

For development in the proximity area Council must be satisfied that development would not impact:

(a) the biophysical, hydrological or ecological integrity of the adjacent coastal wetland or littoral rainforest, or

(b) the quantity and quality of surface and ground water flows to and from the adjacent coastal wetland or littoral rainforest

Under the Fisheries Management Act 1994 Powells Creek is mapped as key fish habitat (Appendix A, Figure 31). This is because key fish habitat includes all oceanic, bay, inlet and estuarine habitats up to the level defined by High Water Solstice Spring tides (so called 'King tides' or Highest Astronomical Tide). A Part 7 Fisheries Management Act permit is generally required for works in areas mapped as key fish habitat, hence a permit is likely required for inlet works or the construction of a second inlet at Mason Park.

For any works not identified in the Plan of Management (or in supporting plans such as this Management Plan) the provisions of the State Environment Planning Policy Infrastructure 2007 are likely to apply. Some works would be exempt or assessed as activities by Council under part 5 of the Environmental Planning and Assessment Act 1979.

Management direction and actions should be underpinned by Australia's obligations under bilateral migratory bird agreements with Japan in 1974, China in 1986 and most recently the Republic of Korea in 2007 aimed at conservation of migratory birds in the East Asian - Australasian Flyway (the Flyway). Each of these agreements provides for the protection and conservation of migratory birds and their important habitats, protection from take or trade except under limited circumstances, the exchange of information, and building cooperative relationships.

Birds listed on the annexes to these three agreements, together with those on Appendices I or II of the Bonn Convention, are also be placed on the migratory species list under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Australia has further international commitments to protect migratory birds under the Ramsar Convention and the Bonn Convention.

2.2 Management directions for Mason Park wetlands

The following specific management directions apply to the management of the wetland:

- Install second inlet, automate both inlets so the inundation levels can be managed as required: one regime to suit breeding shorebirds (approx. 8 weeks), and one regime to provide suitable conditions for the ongoing persistence of Estuarine Saltmarsh and *Wilsonia backhousei*
- Increase shorebird breeding and feeding habitats through water management and mangrove and swamp oak removal.
- Rehabilitate saltmarsh wetlands through water management and mangrove removal.
- Reinstate freshwater component in wetlands
- Implement appropriate pest and weed control programs.
- Monitor for leaching from soils and landfill in adjoining areas
- Provide signage and educational opportunities that are consistent with the wetland's conservation significance.
- Construct bird hide to aid with monitoring bird populations and to enable local residents to better understand the importance of these species and Mason Park wetlands in their survival
- Protect *Wilsonia backhousei* from trampling and machinery
- Work with and continue to support volunteers and educational institutions to undertake research projects and monitoring activities in the park.

3 Values

3.1 Hydrology

3.1.1 Description of site values

Inflow and Outflows

One inlet/outlet structure currently regulates the water flows into and out of Mason Park wetlands, with some additional inflows during king tides when the naturalised bank is overtopped under the boardwalk, and water rushes directly into the southern end of the wetland.

The current flow regime at Mason Park was initially established as the result of works carried out by the Sydney Water Board in an attempt to remediate the damage to the wetland in 1987 (UBM, 1994). The Water Board installed two concrete pipes connecting a small stand of mangroves and the saltmarsh to Powell's Creek at high tide. This action partially rectified damage to vegetation and the salt content destroyed by freshwater flooding during maintenance work. This was largely an unplanned structure, and was aimed simply to provide some sort of hydraulic connection for the mangroves and saltmarsh.

In 1998 Strathfield Council installed a single-vent dropboard weir inlet at the north-east corner of the wetland to reinstate tidal flow and flushing of the wetland from Powells Creek. Water entering the wetland is kept there for extended periods by placing boards in the weir. The dropboard regulator is operated manually by council staff. The PoM states that it has not been operated as specified in the Plan of Management. It has become obvious that the regulator is not large enough to allow unrestricted tidal inflow to Mason Park.

This was later replaced in 2010 with a new weir floodgate that opens to allow water in at higher tides (in response to water pressure), and remains closed to keep water in as the tides runs out (again in response to water pressure). The structure remains in place to date, but has rusted and the flow gates have become damaged.

Figure 2 Historic aerial imagery of Mason Park Wetlands, 1930 (left), 1951 (middle), 1986 (right), blue line shows current extent 2021

Wetland Bathymetry

The wetlands are broken into several zones by low earth bunds. Previous studies identified six key wetland zones at Mason Park as shown in Figure 2. The northernmost part of the is a zone dominated entirely by mangroves. Just south of this zone a is relatively large flat area, the northern mudflats. An earthen bund cuts the wetland in half creating the southern mudflat area. Southwest of the southern mudflats is a relatively deep water body. The southernmost wetland zone is the disturbed saltmarsh section which contains a patch of the rare Wilsonia backhouseii.

Field surveys were carried out as part of this study to gain data on the wetlands bed levels and understand the relationship between the water levels in Powells Creek and in the wetlands. The surveyed levels and several aerial images were used to delineate water surface areas at different water level elevations (Figure 3).

The wetlands water surface areas were used to develop an approximate stage storage volume relationship for the wetlands, shown in Figure 4. This stage storage relationship was utilised to estimate flow rates and the relationship between water level in the wetlands and Powells Creek during high tides.

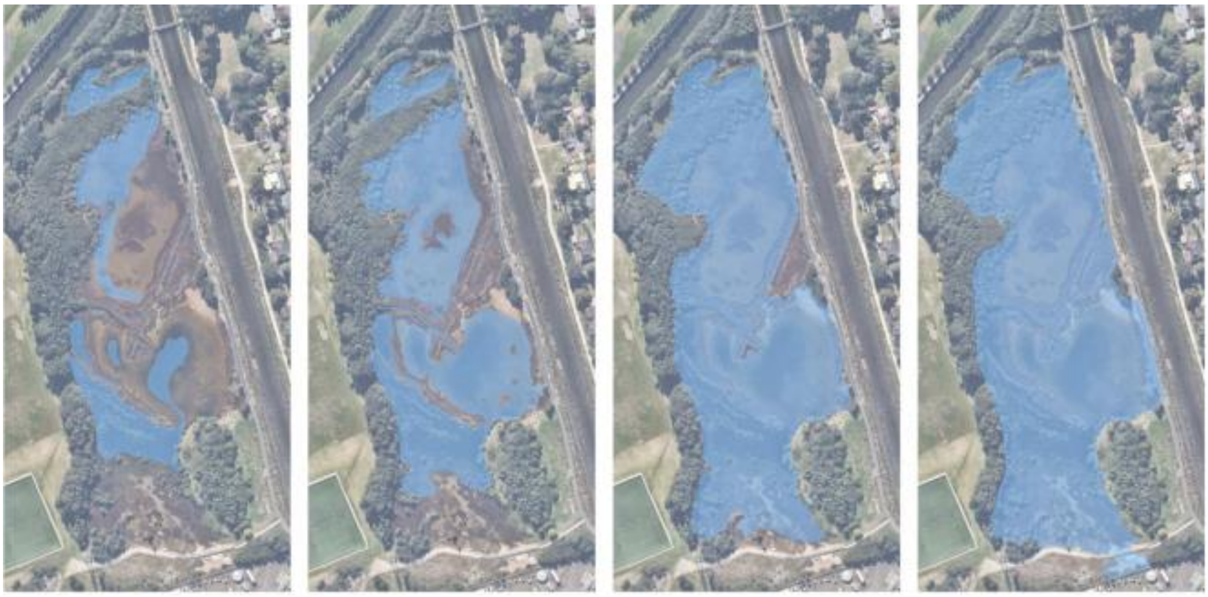

Figure 3 Wetlands approximate water surface areas at different water levels, 0.6, 0.75, 0.9, 1.1 m AHD

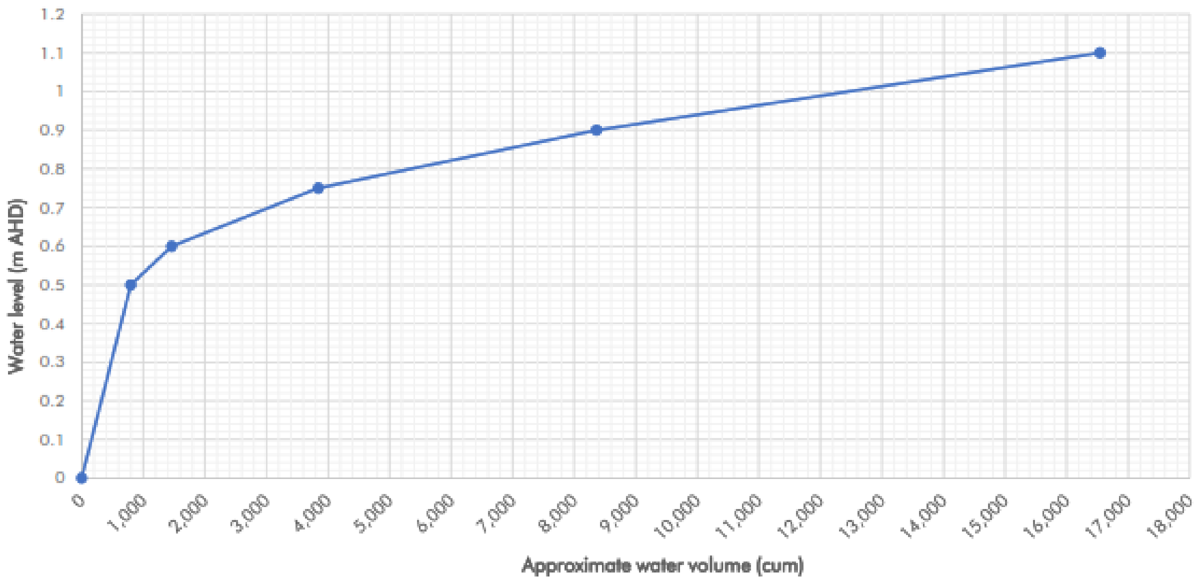

Figure 4 Wetlands approximate stage-storage volume chart

Flow Regime

Flow regimes in Mason Park wetlands are largely regulated by the floodgate weir. At the time of installation, the new floodgate was supposed to be accompanied by a second inlet, and provide the following benefits:

- productivity of the estuarine wetland.
- increasing water movement through the system.
- promoting soil conditions that saltmarsh species require to thrive.
- providing a pathway for marine life between the estuary and Mason Park resulting in re-establishment of invertebrates and fish.
- [reduce] hypersalinity where evaporation results in soils with high concentrations of salt in which some saltmarsh plants notably *Lampranthus tegens* does not thrive.
- [reduce] dead zones in swards of *Juncus kraussii*.

- [reduce] drying out of the wetland.
- Increased and regular tidal flushing, pushing water to higher areas at the back of the wetland.
- Provide conditions for the mix of micro saltmarsh biota to develop
- Enable the free movement of nekton in and out of the estuary.
- Discourage human access to the mudflat.
- Reduce the potential for isolated water pooling and opportunities for mosquito larvae to mature.
- Ameliorate acid and hypersaline conditions to improve productivity and plant growth.
- Expand the extent of *Wilsonia backhousei*.
- Limit the expansion of mangroves.

The design intent from these observations and recommendations appears to be different for different parts of the wetlands:

(i) Irregular inundation of saltmarsh areas at higher tides, which is appropriate for this vegetation community

(ii) Retention of water in open water ponding areas and mudflats to prevent drying – which harms or kills the vitally important macroinvertebrates that are the food for migratory waders

(iii) Reduced opportunity for introduction of mangrove propagules, and reduced chance of establishment

The original design had an infrared sensor to regulate automated opening and closing of the floodgates. The constructed design addressed part of the proposed changes – no second inlet was constructed, and the existing inlet has floodgates that are designed to open and close in response to flow pressures. A step up weir regulates the level of tides that can flow into the wetland, even after the inlet has been flooded there is no flow into the wetland until the tides reach around 1.7m.

Tidal Influence

Powells Creek is a tidal waterway that joins the Parramatta River estuary at Homebush Bay. SOPA provided Powells Creek water level monitoring data for the assessment of tidal exchange in Mason Park wetlands and a chart showing one month of the data is provided in Figure 5. The chart and analysis of the water level data show that Powells Creek has a diurnal tidal environment, with two high tides per day. The high tide levels for a 12 month period are provided in Figure 6 which can be directly compared to the bathymetry of the wetlands.

Water from Powells Creek is able to enter the wetlands at certain tidal levels through an inlet/outlet structure and through the naturalised bank of Powells Creek. The tidal nature of the wetland has facilitated the growth of some specialised flora, such as saltmarsh and mangroves. This tidal habitat has supported a rich diversity of migratory birds. The composition of vegetation in the wetlands is dependant on the frequency that vegetation is inundated with tidal water. Mangroves outcompete saltmarsh in tidal zones where shorelines are inundated daily or near daily. This means that saltmarsh is restricted to areas in the upper tidal zone.

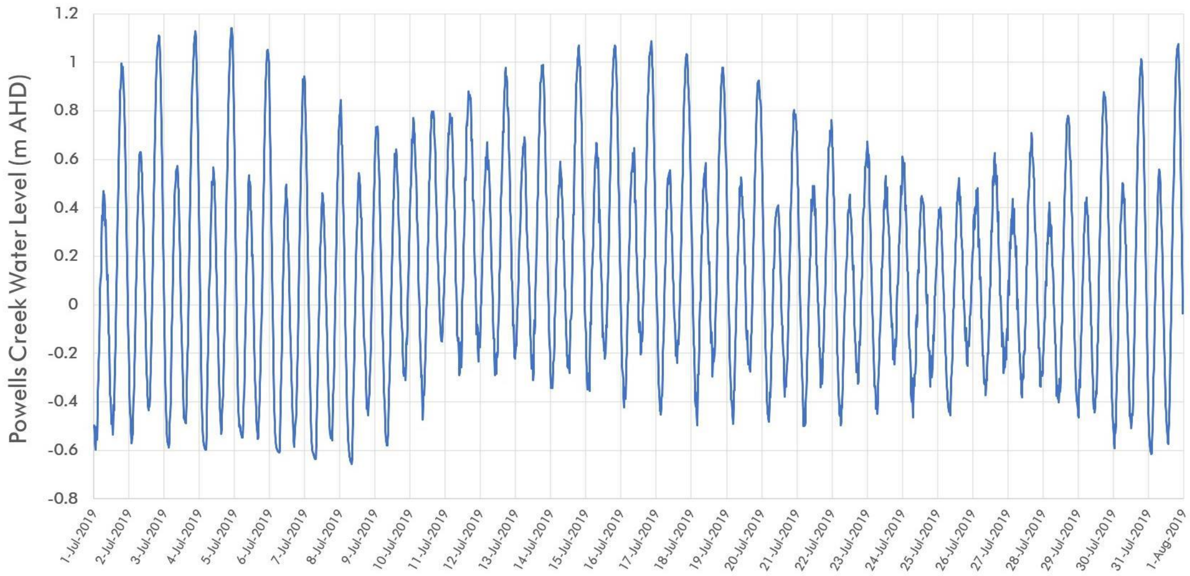

Figure 5 Tidal water level fluctuation over 1 month in Powells Creek

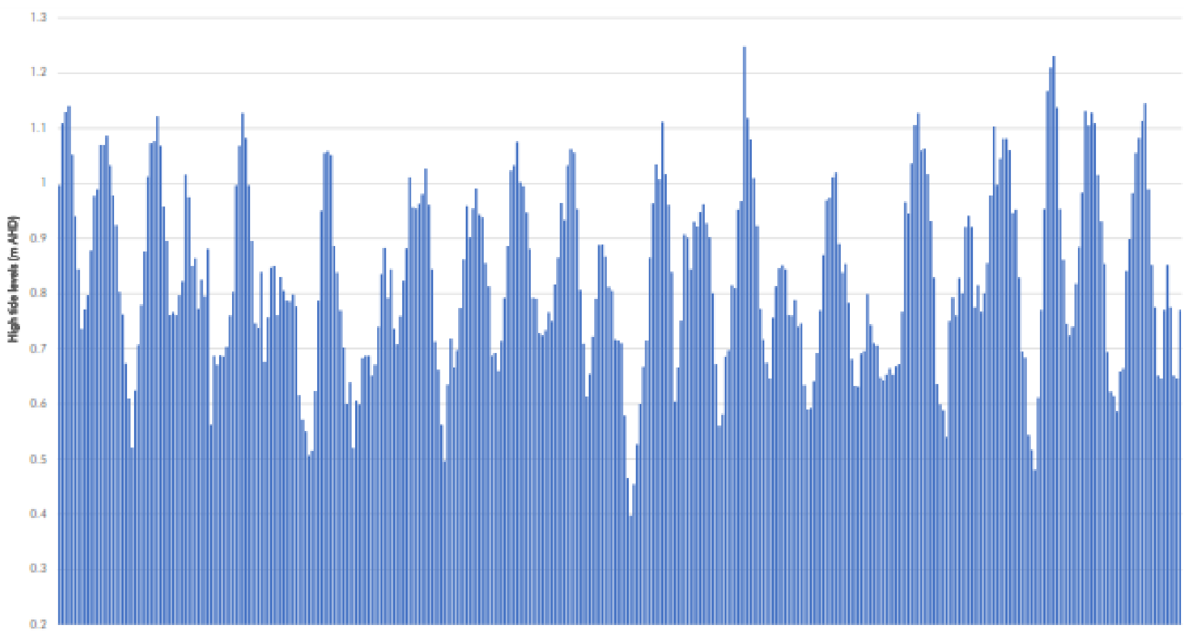

Figure 6 High tide levels in Powells Creek for 2019-2020

The inlet structure was upgraded around 2009 to its current configuration. The aim was to increase the size of the connection and install two 'flap gates', with each flap over a 450mm diameter penetration. The flap gates are fitted with hinges such that water can enter the wetlands during a high tide, if the water level in the wetlands is lower than the high tide level. The indicative diagram in Figure 8 shows flow into the wetlands occurring when the water level in Powells Creek is higher than the water level in the wetlands.

Figure 7 Existing inlet/outlet structure, at wetlands (L), grate over culvert on Powells Creek side (R)

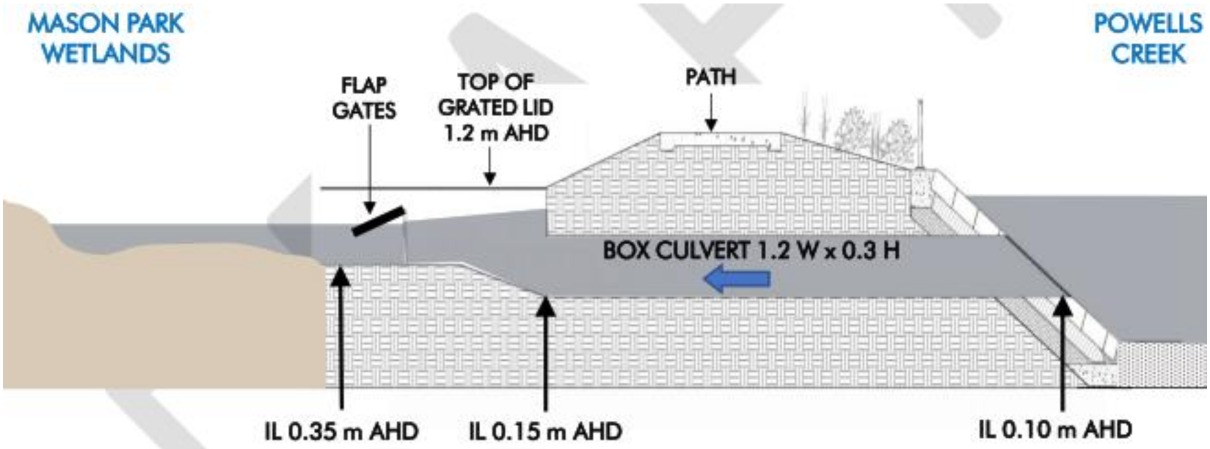

Figure 8 Existing inlet/outlet structure on Powells Creek at Mason Park

When the flap gates are under normal operating conditions, during low tides (when the water level in Powells Creek drops) the flap gates remain closed such that water is held at a higher level for an extended period of time. The top of the flap gates is at RL 0.95m AHD which is the standing/full water level in the wetlands when the flap gates are in place. With reference to the high tide data in Figure 6, around 15% of high tides result in a water level higher than 0.95m AHD. Thus if the wetlands are full to the standing water level many of the high tides would not cause any water to flow into the wetlands.

The flap gates have created a unique artificial water environment where the water is generally held in the wetlands throughout the low tides. A natural tidal bench positioned at the same elevation as the wetlands would ordinarily be allowed to freely drain during low tides to expose the sediment.

The flow rate passing through the culvert is a function of the difference in water level on each side. The flow rate varies but the existing culvert could be considered as having a nominal capacity of around 300 – 400 L/s. If an objective for water management was for the water level in the wetlands to mirror the water level in Powells Creek then a connection with a capacity of around 2000 – 3000 L/s would be required.

Give the constrained culvert connection between Powells Creek and the wetlands the volume of water required for full tidal exchange in high and low tides is not possible. Using the approximate wetlands bathymetry and the details of the pipe connection to Powells Creek the water level data has been utilised to review the current flow rates. Figure 9 shows that when the water level in the wetlands is low, it takes several very high tides for the water levels in the wetlands to reach the standing water level.

Due to evaporation, some leakage through the flap gates and some assumed infiltration/exfiltration through the wetlands bed the water level in the wetlands gradually reduces to expose and dry out the bed sediments.

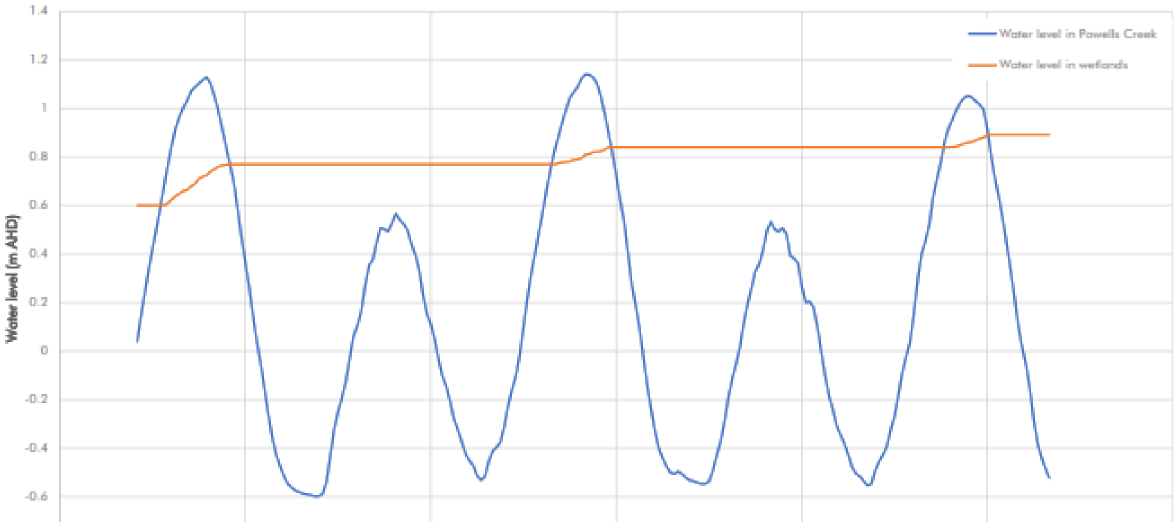

Figure 9 Inflows to wetlands over several high high tides

In 2018, Sydney Water conducted creek bank naturalisation works where the existing concrete channel walls of Powells Creek were removed and replaced with sandstone bounders and native plants (Figure 11). The naturalised edge introduced a new source of tidal water input to Mason Park through the eastern boundary. The naturalised bank was constructed using sandstone pieces which are permeable and act as a 'leaky' wall, enabling water to travel into the wetland when the tides are high enough, as shown in Figure 10.

Based on design drawings provided by Sydney Water it appears that water flows through the naturalised sandstone edge into the wetlands at the base of the sandstone boulders, approximately 1.05 mAHD (Figure 11). Flows have been observed passing through the naturalised bank during a 'king tide'.

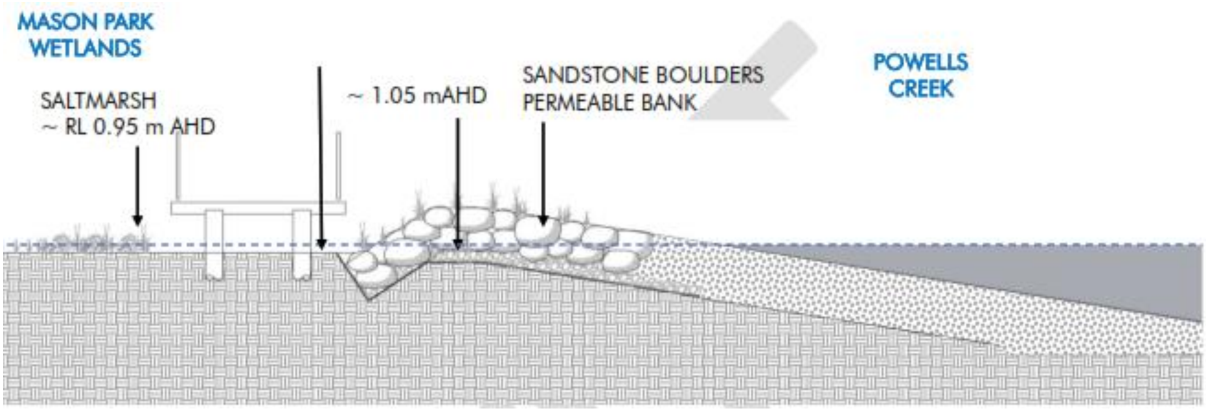

Figure 10 Indicative section through a portion of the naturalised section of Powells Creek

Figure 11 Powells Creek naturalised edge, looking north, with indicative flows

Water Quality

General water quality issues include:

- Salt scalding from hypersalinity is commonly noted, especially in summer.
- ASS/PASS has been reported for the area.
- Leachates from landfill may affect the diversity of macrobenthos

3.1.2 Issues

- Undocumented/poor understanding of original design intent (1980s) and ongoing changes to local drainage (eg from synthetic fields, adjoining properties and improvement works in Powells Creek).
- Damaged and malfunctioning inlet/outlet, which is undersized for the site and required flows

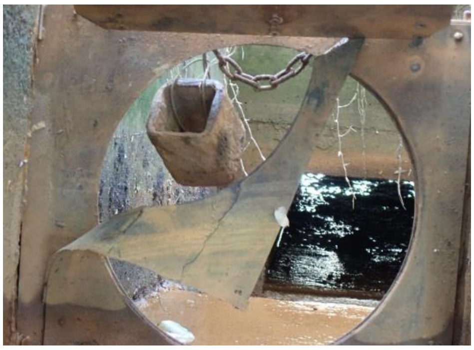

Figure 12 (left) in and outflows can be regulated with floodgates; (right) the floodgates are rusty and have fallen into disrepair

- Inappropriate hydrological regime
    - Over drying of mudflat areas
    - Low diversity of benthic macroinvertebrates
    - Hypersaline areas

    - Mangrove proliferation
    - Contraction of areas of threatened species *Wilsonia backhousei* possibly due to changes in hydrology and salinity regimes (or see section 3.2.2)

3.1.3 Desired outcome

- Automated inlet gates installed in existing inlet
- Correctly sized second supplementary inlet constructed towards the southern end of the wetland, integrated into Powells Creek naturalisation works, and also with automated inlet gates
- Perched freshwater wetland created to replace the lost freshwater/brackish intergrading wetland areas
- Operations manuals are prepared for each structure and each inundation regime used
- Significant reduction in salt scalding/acid sulphate buildup
- Improved inundation regime for nesting birds – duration approx. 6-8 weeks (regime can be adaptive in response to breeding events)
- Improved inundation regime for saltmarsh establishment
- Tidal flushing maintains healthy benthos in mudflats
- Areas of mangroves that are preventing good access for inundation flows need to be removed and managed as absent from some areas
- Vehicles (including motor vehicles and bicycles) do not cross through the wetland/saltmarsh area)

3.1.4 Management response

- Upgrade existing inlet/outlet structure
- Construct additional inlet/outlet structure (see Appendix A, Figure 39)
- Construct new freshwater wetland (see Appendix A, Figure 40)
- Improve sight lines
- Implement inundation regimes that favour:
    - Protection from foxes,
    - Mosaic of habitat patches, and
    - Healthy and diverse macrobenthic assemblages
- Improved health and increased extent of TECs and threatened flora species
- Implement regular monitoring regime to include water levels, patch sizes and weeds
- Mangrove removal, thinning of Swamp Oaks, removal of swarming seedlings
- Install screens to prevent mangrove propagules washing in with tidal flushing

3.2 Native flora and vegetation

3.2.1 Description of site values

The extant vegetation on site occurs in several patch types, including:

- Estuarine wetland communities
    - Estuarine Mangrove Forest, which is spreading into other areas of the wetland
    - Estuarine Saltmarsh, which is affected by the management of the tidal regime

- Forested wetland communities
    - Estuarine Swamp Oak Forest, which is the result of ongoing colonization by Swamp Oaks
    - An unmapped riverflat paperbark/eucalypt forest resulting from ongoing revegetation planting. Riverflat Eucalypt Forest EEC is likely to have been historically present on this site
- Previously planted mixed urban exotics and native species, such as occur along the edges of Saleyards Creek and Mason Park carpark

Wilsonia

One threatened flora species is present on site - *Wilsonia backhousei*. Wilsonia is listed as Vulnerable under the NSW Biodiversity Conservation Act 2016. It is a slow growing prostrate species growing to a height of several centimetres, capable of forming a rich green lawn under ideal conditions (Figure 13).

Figure 13 Wilsonia backhousei is a slow growing prostrate species growing to a height of one or two centimetres

Figure 14 Wilsonia backhousei *are damaged by trampling and vehicle use, and recovery from damage is slow*

Mats of *Wilsonia backhousei* are damaged by trampling and vehicle use, and recovery from damage is slow (Figure 14). A boardwalk was recommended in 2008 and constructed 2017, and the apparent reduction in extent of Wilsonia may be attributable to the construction process. However, there are ongoing impacts from vehicle access, and the boardwalk only provides for pedestrians and cycles.

Figure 15 Wilsonia can occur in pure stands, such as near the substation fence (left) or as a component in a mixed saltmarsh (right)

Figure 16 Higher in the saltmarsh it grows with sedges and grasses (left), while lower in the saltmarsh it grows with Suaeda australis and Sarcocornia quinqueflora (right)

At Mason Park the distribution of Wilsonia is somewhat varied (Figure 16). Higher in the saltmarsh it grows surrounded by grasses and sedges, whereas lower in the saltmarsh it grows among *Suaeda australis* and *Sarcocornia quinqueflora* plants. Areas where it grows as a pure stand are very similar to other locations nearby, where Wilsonia tends to grow in upper marsh areas in fine grained soils forming a shallow layer upon sandstone bedrock.

Wilsonia backhousei is a slow growing prostrate species growing to a height of one centimetre, capable of forming a rich green lawn under ideal conditions. Wilsonia is intolerant to flooding and prefers permanently moist conditions, but can persist where the soil becomes dry for much of the year. It can tolerate irrigation by seawater but probably prefers brackish water. In 1994 the site was described as having a sizeable turf of Wilsonia grows against the fence at the southern boundary.

The extent of Wilsonia on site was mapped in 2008/9 in the SEE prepared by Sainty and Associates and again in 2020 during current surveys (Figure 17). It appears that one part of the patch of Wilsonia has continued to expand, possibly as a result of some reduction in the level of trampling following construction of the boardwalk. Despite this, there is ongoing impacts from vehicle access across the southern end of the wetlands and this has and will continue to impact Wilsonia, along with other saltmarsh species in the area. The larger patch near the substation fence appears to have reduced in size, possibly due to localised changes in hydrology, including removing or relocating the drainage pipe to Powells Creek from the substation property.

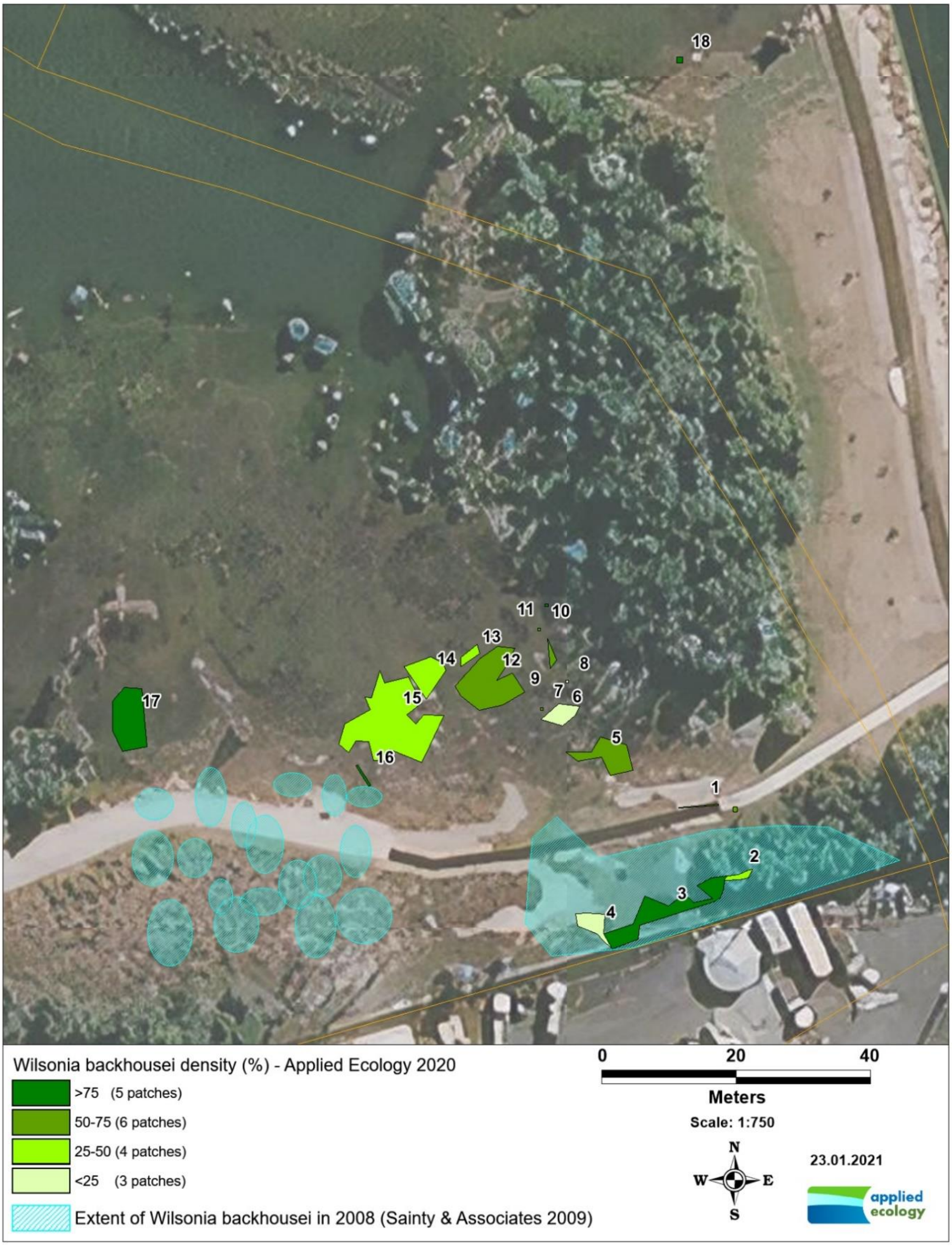

Figure 17 Extent of Wilsonia backhousei *in 2008 (redrawn from Sainty & Associates 2009) vs 2020 (current study)*

As well as being a listed threatened flora species, Wilsonia forms part of the Estuarine Saltmarsh EEC, described below.

Saltmarsh

Estuarine Saltmarsh is part of Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions, an Endangered Ecological Community in NSW. Saltmarsh typically forms in coastal areas that already have mud flats. They usually form in areas that are well sheltered, such as creeks, inlets and estuaries where fine sediments can be deposited. They also form behind spits and artificial sea defences where tidal waters can flow gently and deposit fine sediments. Saltmarsh sediments generally consist of poorly-sorted anoxic sandy silts and clays. Carbonate concentrations are generally low, and concentrations of organic material are generally high. The sediments may have salinity levels that are much higher than that of seawater as a result of evapoconcentration of ponded tidal surges.

While the extent of saltmarsh at Mason Park wetland has decreased over the last few decades, there are still large areas of saltmarsh within a mosaic of mangroves, mudflats and salt scalds from areas of hypersalinity (Figure 18). Diversity of plants within the saltmarsh contributes to diversity in the macrobenthos, providing more in the way of food resources for shorebirds.

Figure 18 Saltmarsh at Mason Park wetlands forms a mosaic of saltmarsh species, tidal mudflats and salt scalds

Mangroves occur in areas with regular tidal inundation, while Saltmarsh typically occurs in areas with irregular tidal inundation. Within the irregular inundation zone, the minor differences in water levels and salinity result in zonation in saltmarsh species. Samphire (*Sarcocornia quinqueflora*) and Seablite (*Suaeda australis*) are typically found in areas more regularly inundated that Sea Rush (*Juncus kraussii*) and Wilsonia (*Wilsonia backhousei*).

Mangroves

Mangroves have colonised the area around the inlet, and spread from there across the northern end of the wetlands. Mangroves in Mason Park wetland do not fulfil their traditional roles within the estuary environment. The trend of mangrove encroachment into saltmarsh has been the dominant cause of saltmarsh decline in the Sydney basin (Saintilan and Williams, 2000). Mangrove encroachment is limited by periodicity of inundation, which is usually related to depth of inundation. As mangroves encroach into saltmarsh areas they tend to accumulate additional sediments which in turn raises the surface level of the wetland, favouring saltmarsh rather than mangroves. Mason Park, however, is not a typical wetland as the frequency and depth of inundation are determined by the inlet/outlet structure.

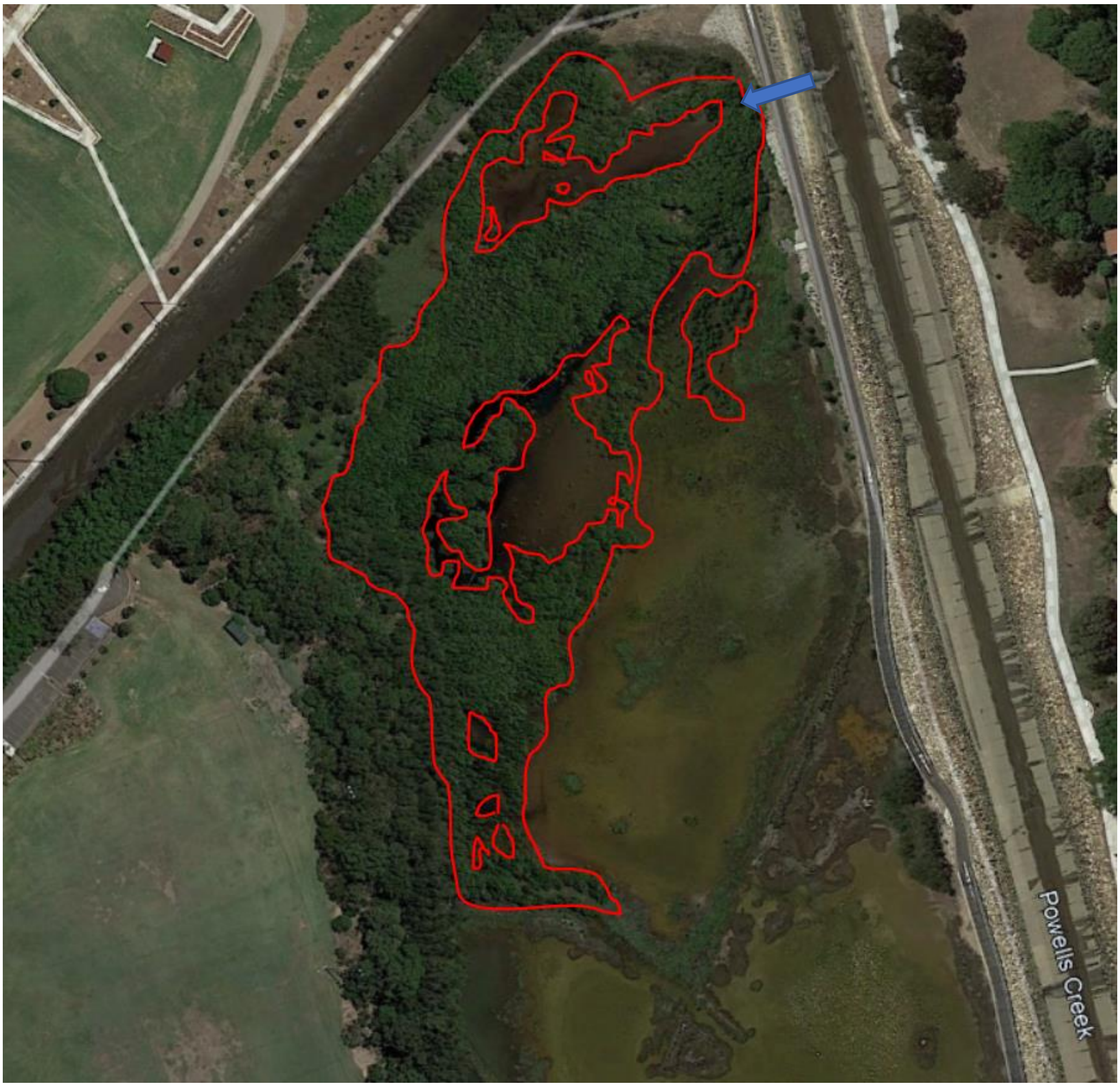

Figure 19 Mangroves have colonised the area around the inlet and spread from there across the northern end

Mangroves in an estuary tend to grow on the seaward edge of the intertidal zone, with saltmarsh slightly further landward. The mangroves have an extensive root network which holds the edge of the land together, reducing erosion from wave action. In Mason Park wetland, however, there is no wave action. The mangrove's aerial roots are well recognised as fish nurseries, but do not perform this function in Mason Park wetland due to its poor hydraulic connection with the main estuary. Mangroves have a very high fecundity, producing numerous seeds on each plant each year, with more washing in on the incoming tides, so that their capacity to be invasive within the wetland is high, and well recognised. The permissible extent of the mangrove patches needs to be determined, and marked on site, so that ongoing management of mangroves can be accurately managed under this Plan.

3.2.2 Issues

- Damage from vehicles crossing mudflats where the core *Wilsonia backhousei* population used to exist (note: original damage may have occurred during the construction of the boardwalk crossing)

Figure 20 Damage to mudflats and areas of Wilsonia backhousei *population by vehicles*

- Encroachment and domination of mangroves and swamp oaks within the saltmarsh
- Establishment of introduced saltmarsh species, including Lampranthus (*Lampranthus tegens*) and Waterbuttons (*Cotula coronopifolia*), and Coast Barb Grass (*Parapholis incurva*)
- Loss of freshwater reedlands
- Loss of brackish reedlands and sedgelands, including *Juncus kraussii*, which provided important foraging habitat for migratory shorebirds
- Dense areas of weeds - particularly fringing the wetland in the southern section
- Areas of unmapped riverflat forest around the northern end of the wetland

3.2.3 Desired outcomes

- Hydrology is managed to promote healthy saltmarsh over a significant portion of the wetland
- Areas occupied by mangroves are clearly defined and colonising seedlings are removed if they establish outside this area to prevent invasion of saltmarsh

- Inundation regimes are managed to promote a complex mosaic of saltmarsh with mudflats and zonation within the saltmarsh, remembering that diverse floristics in saltmarsh promotes greater diversity in macrobenthos
- Wilsonia is protected from trampling and encroachment
- Swamp Oaks are removed from the eastern edge of the wetland to prevent invasive colonisation and encroachment

3.2.4 Management response

- Fence southern end of wetlands or *Wilsonia backhousei* patches
- Finalise agreement with other stakeholders regarding access requirements to stanchions
- Install markers to delineate approximate extent of wetland ecosystem patches
- Implement regular monitoring regime to include water levels, patch sizes and weeds
- Mangrove removal, thinning of Swamp Oaks, removal of swarming seedlings
- Install screens to prevent mangrove propagules washing in with tidal flushing
- Weed control in surrounding forested wetland vegetation

3.3 Native fauna

3.3.1 Description of site values

Mason Park wetlands provides breeding habitat for migratory shorebirds for several months of the year. The rest of the year, it is home to a range of other fauna, including other wetland birds, microbats, and until about 20 years ago there were 6 species of frogs reported from the area. As freshwater sections of the wetlands became more saline the frogs left the area, but many of the other birds and animals remain.

Migratory waders

The numbers of shorebirds using the wetland since records have been kept have fluctuated with the conditions on the site over time. In the past this wetland has been one of the most important shorebird feeding and roosting sites in the Sydney area, and until recently has had more shorebirds per hectare than any other site in the region. Shorebirds that use Mason Park move between similar wetlands at the Waterbird Refuge and Newington Wetlands in Sydney Olympic Park, and the intertidal areas of the Parramatta River estuary such as Hen and Chicken Bay.

Migratory waders that have been regularly recorded at Mason Park wetland include:

- Curlew Sandpiper, listed as Endangered in NSW and Critically Endangered under EPBC Act
- Pacific Golden Plover, listed federally - Migratory (Bonn, CAMBA, JAMBA, ROKAMBA)
- Sharp-tailed Sandpiper, listed federally - Migratory (Bonn, CAMBA, JAMBA, ROKAMBA)
- Latham's Snipe, listed federally - Migratory (Bonn, CAMBA, JAMBA, ROKAMBA)

The 2008 PoM notes that five other species occur in small numbers (one or two birds) from time to time including Red-necked Stint, Common Greenshank, Pectoral Sandpiper, Marsh Sandpiper, and rarely the Wood Sandpiper.

Other wetland birds

White-headed [Black-winged/Pied] Stilt, nest on Mason Park Wetland on a regular basis. The site provides suitable habitat in the form of small islands, which are remnants of clumps of Juncus species which have died off in the past, and constructed berms. The success of breeding depends on the amount of water around these islands; drying out allows predators such as foxes and feral cats to reach the nests. The roost site must be sufficiently elevated to ensure a viable roosting area on the highest of spring tides. Wading species, and to some extent ducks, roost on islands of bare mud or low vegetation.

For the open mudflats to remain viable as shorebird habitat they must be regularly inundated. This keeps the microbenthic fauna alive, which provides the valuable food resources also needed by the migratory shorebirds. Without food, the wetlands lose a lot of their value for these species – many of which are subject to migratory species agreements with other countries. When the tidal flats are allowed to dry out completely (Figure 21) the result is a combination of hypersalinity, mobilisation followed by crystallization of toxic compounds in the soils, changes in pH, cracking of the surface, all of which contribute to the loss of infauna, with flow on impacts for saltmarsh species and the migratory shorebirds. Compaction following drying makes the process of reestablishment of macrobenthos almost impossible.

Figure 21 Large expanses of tidal flats are adversely impacted by poor management of the tidal regime

Other fauna

Mason Park wetland is the primary habitat for fauna (Figure 22), however, adjoining advanced revegetation works between the wetland and Saleyards Creek (Figure 23) provide habitat for a different suite of species. Powells Creek provides complementary habitat to the wetland, with many species using both the wetlands and the creek to forage while some species, such as the Great Cormorant, are restricted to the deeper waters of Powells Creek.

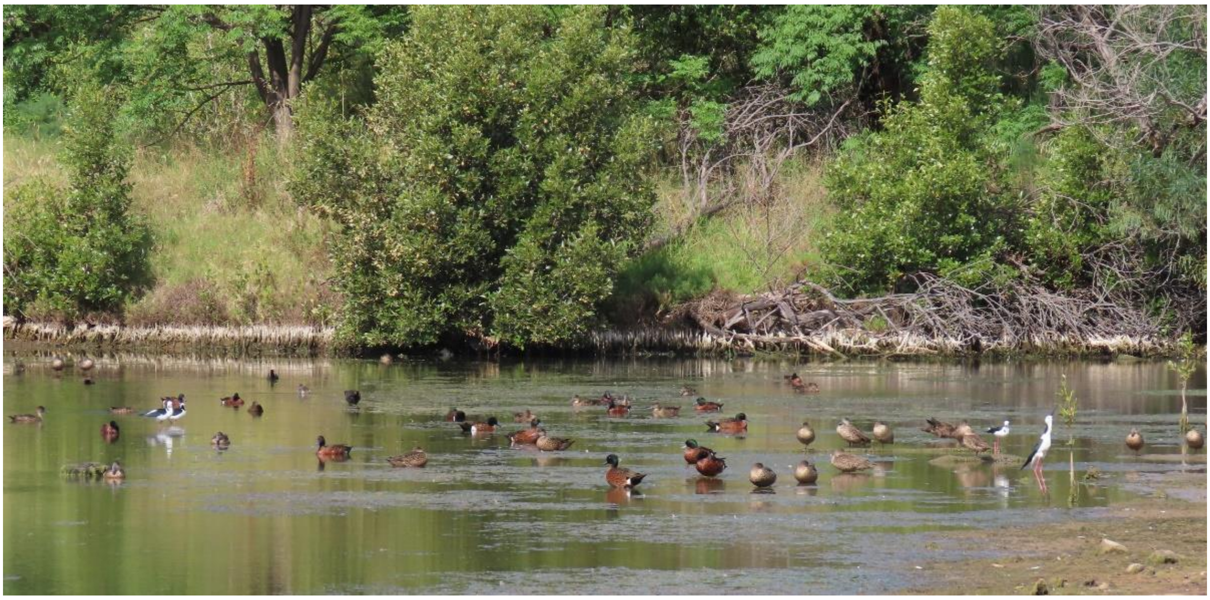

Figure 22 Good numbers of Grey Teals, Chestnut Teals, and White-headed Stilts were commonly observed on the wetland in Spring 2020 and 2021.

Figure 23 Powells Creek provides complementary habitat to the wetland and is utilized, on occasion, by many of the same species observed in the wetland. Note the Little Egret in the channel above.

A variety of smaller passerine birds frequent the wetland edges and adjoining Casuarina and woodland revegetation including: the Superb Fairy-wren, (Figure 24); Olive-backed Oriole (Figure 25); Yellow Thornbill (Figure 26); and Rufous Whistler (Figure 27).

Figure 24 Left- Superb Fairywren (male) on the path near the carpark

Figure 25 Right - Olive-backed Orioles were observed breeding in the Casuarinas adjoining the carpark

Figure 26 Left -Yellow Thornbills were regularly observed foraging in the Casuarinas on the north perimeter of the wetland

Figure 27 Right - Rufous Whistler in the Casuarina stands that fringe the northern portion of the wetland (left). Willie Wagtails utilized a variety of habitats across Mason Park wetland.

3.3.2 Threatened Fauna

Site surveys undertaken in 2020-21 detected 65 species of vertebrate animals at the wetland including 4 threatened species (BC Act 2016) and 3 listed marine species (EPBC Act 1999). The threatened species below are species detected during the current survey and are a subset of threatened species likely to utilize the wetland as foraging and roosting habitat on occasion.

3.3.2.1 Eastern Bent-winged Bat Miniopterus orianae oceanensis

This species is cave dwelling, but also use abandoned mines and culverts. Populations are centred on a maternity cave that is used annually. Each population disperses to other caves during the rest of the year. In the south, bats overwinter in hibernation caves, while in the north they remain active and forage nightly. They are a high flying species that forages from just above the canopy to many times canopy height. Also forages in open areas where they forage just above the ground. They are fast flying and may forage long distances from the roost site (up to 65km in one night). This species was detected most nights at Mason Park foraging across the wetland as well along the edge habitats.

3.3.2.2 Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris*

Widespread in wet to dry sclerophyll forests, woodlands, grasslands, mangroves, agricultural and urban areas. Migrates to southern Australia in January to April. It roosts in large tree hollows in mixed sex groups, usually around six but up to 30 and usually forages above the canopy but lower in open spaces. This species was detected on several nights foraging at Mason Park.

3.3.2.3 Grey-headed Flying Fox *Pteropus poliocephalus*

Feeds on nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines. Also gardens and crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. This species was heard and observed foraging in eucalypts in Mason Park. Mason Park Wetland is not an important habitat for this species.

3.3.2.4 White-bellied Sea-eagle *Haliaeetus leucogaster*

This species feeds mainly on aquatic animals, such as fish, turtles and sea snakes, but it takes birds and mammals as well. It is a skilled hunter, and will attack prey up to the size of a swan. It was observed cruising over the site, and was chased aggressively by Noisy Miners and Pied Currawongs. A pair nest and breed at Homebush annually and this was likely one of the adults.

Listed marine species observed during the current survey include Great Egret *Ardea alba*, Little Egret *Egretta garzetta* and White-headed Stilt *Himantopus leucocephalus.*

Figure 28 Great Egret Ardea alba (left), Little Egret Egretta garzetta (centre) and White-headed Stilt Himantopus leucocephalus (right).

3.3.3 Issues

- Pest animal presence including European Red Fox incursions onto mudflats/disturbance to birds/nesting birds
- Domestic dog prints across mudflats indicating inappropriate activities by some park users/disturbance to birds/nesting birds

Figure 29 Dog prints on the mudflats

- Loss of shorebird feeding habitat due to colonisation by mangroves
- Reduction in access for shorebirds due to proliferation of swamp oaks and mangroves that interfere with sight and flight lines

3.3.4 Desired outcome

- Improved breeding success of nesting species
- Increased diversity of bird species
- Increased abundance of irregular visitors (eg. Lathams Snipe)
- Return of migratory waders that previously utilised the site including:
    - Curlew Sandpiper,
    - Sharp-tailed Sandpiper,
    - Pacific Golden Plover,
    - Red-necked Stint,
    - Common Greenshank,
    - Pectoral Sandpiper,
    - Marsh Sandpiper, and rarely
    - the Wood Sandpiper.

3.3.5 Management response

- Improve sight and flight lines
- Reinstate a freshwater influenced habitat
- Implement inundation regimes that favour:
    - Protection from foxes,
    - Mosaic of habitat patches, and
    - Healthy and diverse macrobenthic assemblages

3.4 Visitor experiences

3.4.1 Description of site values

Mason Park wetlands are primarily managed for ecology, not visitation, thus visitor access to wetlands is limited to the surrounding areas. These currently include:

- An off-road section of the Bay to Bay Cycleway within Strathfield LGA, with the cycleway running along the edge of the wetlands and beside Powells Creek
- A boardwalk forms part of the cycleway and allows visitors to see directly into the wetlands to the area where shorebirds are likely to forage; at king tides the incoming tide overtops the naturalised bank section of Powells Creek, and rush into the wetlands
- A second, smaller boardwalk crosses the southern section of the wetlands, connecting the cycleway with the sportsfields and childrens play area in the developed part of Mason Park
- A viewing area off the cycleway with seating and information signage about the migratory shorebirds that and local wetland species that visit or live in Mason Park wetlands
- The area to the north of the wetlands has a second linking footpath, connecting the Mason Park carpark with the cycleway and the pedestrian bridge across Powells Creek. There are views from this footpath to the mosaic of mangroves and saltmarsh in this part of the wetlands
- A second viewing area has been created towards the southern corner of the wetland with a grassed open space area that remains largely undeveloped other than signage

3.4.2 Issues and opportunities

The main issues associated with visitor infrastructure relate to the boardwalk at the southern end of the wetlands. This area has the core population of the threatened saltmarsh species, *Wilsonia backhousei*, and adjoins the electricity substation. This is the highest part of the wetland and is least regularly inundated. The boardwalk is designed to prevent impacts on the Wilsonia, but is only suitable for foot traffic and bicycles, and not at the same time. Tyre tracks in the saltmarsh next to the boardwalk indicate that it is not achieving its design purposes. At this stage it is unclear who is crossing the saltmarsh and why, but it is causing damage to the Saltmarsh TEC and to the threatened flora species.

Opportunities for the site include greater visitor involvement with the ecological values of the wetlands – for example through the installation of a viewing hide with additional signage that informs visitors about the key values of the wetlands and the migratory shorebirds that fly here from East Asia and Russia each year.

3.4.3 Desired outcome

- Trampling impacts on Wilsonia reduced or eliminated
- Trampling impacts on Estuarine Saltmarsh EEC reduced or eliminated
- Educational opportunities combined with improved visitor facilities

3.4.4 Management response

- Prevent trampling of Wilsonia by providing alternate access route to key utilities infrastructure on site (eg power line stanchion, sewer pipes, rising mains etc)
- Prevent further damage to saltmarsh by installing bollards or similar to reduce opportunities for access. Consider fully fencing this part of the wetland
- Construct bird hide and link to existing boardwalk or new boardwalk to discourage through-walkers on the south side
- Combine bird hide with information signage

3.5 Information, education and research

3.5.1 Description of site values

Previous management plans for Mason Park wetlands have clearly identified the ecological importance of the site. During the 1970s Australia became a signatory on the International Wetlands Convention (1971) and the Migratory Bird Treaty (1974; now JAMBA) with Japan. A combination of local and international pressure led to the cessation of rubbish dumping in the Mason Park area and it became preserved as a feeding and resting place for birds.

Prior to that time, Mason Park had been described as "one of the best places in Sydney for migratory shorebirds (Roberts 1993, cited in UBM 1994), with interest in the waterbirds of this area stretching back to the 1960's. The international migratory bird agreements signed by Australia with Japan, China, and later Republic of Korea came about as a direct result of this interest in migratory waders.

From a waterbird perspective, Mason Park saltmarsh suffers from inadequate inundation for a large part of the tidal cycle. This, coupled with the expansion of Grey Mangrove, has resulted in a reduction of mudflats and Saltmarsh area. Mason Park has been an important site for migratory shorebirds in Sydney for many years. As a result of changes to the landscape there has been a dramatic decline in some waders between the 1960s and early 1990s. As a result of proactive management by Strathfield Council some of these species temporarily increased in numbers, only to decline when conditions could not be maintained. Some species have not recovered in numbers, for example (Sainty et al, 2009):

- Pacific Golden Plover, which used to occur in numbers of up to 100 at Hen and Chicken Bay and Mason Park, but declined to a maximum of 24 birds up until 1993, 6 in 2004, and 2 in 2006/7.
- Curlew Sandpiper counts of up to 860 declined to maximum counts of 240 in 1992, 27 in 2003/2004, and 11 in 2006/07.
- Red-necked Stint was up to 147 in the 1960s. Now it is very rarely observed, and then only as single birds.

Birdlife Australia have been responsible for most of the monitoring that has occurred in Mason Park wetlands. They are currently undertaking monitoring of visiting migratory shorebirds and local native aquatic species, removal of mangrove seedlings from saltmarsh and mudflat areas, removal of swamp oaks from sight and flight lines used by shorebirds to access the site, and macrobenthic sampling to better understand the abundance and diversity of organisms in the mudflats that provide forage for visiting shorebirds.

The wetlands are hydraulically separate from the normal tidal movements within the Parramatta River estuary. Sea level rise, for example, will provide better tidal connection between the wetlands and the estuary. The site provides the opportunity to trial the regulation of tidal inundation using different inundation regimes that are prescribed to promote saltmarsh establishment while retaining core areas of mudflats throughout most of the year, and a different inundation frequency and duration when shorebirds are breeding in the area.

There are considerable linkages with Sydney Olympic Park, including being part of the same original complex mosaic of estuarine wetland communities. Land reclamation has removed most of this, but the two are still ecologically connected. Shorebirds that are frequent visitors to SOPA's wetlands may also use Mason Park wetlands. Developing a research based relationship with SOPA will provide opportunities for collaborative research, building on the experiences by SOPA with artificially manipulating tidal inundation regimes.

3.5.2 Issues

- Council has lacked the resources to support community members who are involved in surveys and research
- As well, the necessary maintenance activities have been underfunded and unsupported
- Educational opportunities have been largely unrecognised, especially in relation to the site's EEC and threatened species

3.5.3 Desired outcome

- Establish collaborative research projects
- Undertake ongoing surveys led by volunteers from Birdlife Australia
- Ensure the long term results of improved inundation are well documented, in particular, the effects of short term variations in inundation regimes to promote breeding success for migratory shorebirds
- Develop opportunities to share the ecological story of Mason Park wetlands with local residents, encourage involvement in the surveys and maintenance activities

3.5.4 Management response

- Implement regular monitoring regime to include water levels, patch sizes and weeds
- Install markers to delineate approximate extent of wetland ecosystem patches
- Monitor incursions into core habitat areas by reserve users or dogs off leash
- Establish official bushcare/wetland care group of volunteers to ensure ongoing weed control and other site maintenance
- Continue memorandum of understanding with Birdlife Australia

3.6 Climate change

3.6.1 Description of potential impacts

Mangroves and saltmarshes are considered sentinel species in their response to climate change, being sensitive to changes in temperature, sea-level, rainfall and atmospheric CO^2. The capacity of mangroves and saltmarsh to respond to sea level rise through landward encroachment is generally constrained by topography in some estuaries, and development in others, such as Parramatta and Duck Rivers (Saintilan et al, 2013). Saltmarsh may respond to sea-level rise by migrating upslope, or increasing their elevation through processes of vertical accretion or sediment accumulation so that they remain within the same tidal range.

As a generalisation, coastal saltmarsh is not keeping track with sea level rise as quickly as mangroves sites are, and this makes the former particularly susceptible to encroachment by the latter (Rogers et al. 2013, 2014). In south-eastern Australia, the encroachment by mangroves is consistent with changes in relative sea level.

The predicted impacts of sea level rise are different on open coastline to within estuaries. In general, mean sea level rise will amplify factors that contribute to coastal flooding. NSW coastal catchments such as Parramatta River can flood as a result of either catchment runoff, coastal inundation or a combination of both factors.

Tidal propagations inland through an estuary can differ greatly as well. The length, width and depth of the estuary affects the propagation of tides along the water body (Smith & Davey, 2013). For Drowned River Valley estuaries, such as Parramatta River, the ocean tide range is reduced towards the upstream end of the tidal river.

Coastal Risk Australia has prepared 'Predicted Coastal Flooding Resulting from Climate Change', presented in the IPCC Sixth Assessment Report Update 2021. This uses predictive modelling to show various possible sea level rise scenarios by 2100. The high scenario is in line with recent global emissions and observations of sea-level rise. This high scenario aligns to RCP 8.5, which has a median sea level rise of 0.84 metres by 2100. For the wetland this will completely inundate the whole area, including Powells Creek banks and the Bay to Bay cycleway (Appendix A, Figure 33).

3.6.2 Issues

Mason Park wetlands include mangroves and saltmarsh at elevations that are higher than in the main estuary (see section 3.1.1). The result is hydraulic disconnection at the present point in time, but may provide a valuable opportunity to ensure that saltmarsh is conserved within Strathfield LGA.

3.6.3 Desired outcome

Ongoing preservation of saltmarsh during extreme climate change and sea level rise outcomes

3.6.4 Management response

- Implement regular monitoring regime to include water levels
- Install markers to delineate approximate extent of wetland ecosystem patches and use these to:
    - Adapt inundation regimes in response to sea level rise
- Monitor bed levels to determine rates of accretion of sediment (if any)

4 Implementation

This plan of management proposes a series of management actions for the wetland. Implementation of this plan will be undertaken within the annual program of Strathfield Council with additional funding for one off actions sourced from grant providers. Identified activities for implementation are listed in Table 7. Relative priorities are allocated against each activity as follows:

- High priority activities are those imperative to achievement of the objectives and desired outcomes, and must be undertaken in the near future to avoid significant deterioration in natural, cultural or management resources.
- Medium priority activities are those that are necessary to achieve the objectives and desired outcomes but are not urgent.
- Low priority activities are desirable to achieve management objectives and desired outcomes but can wait until resources become available.
- Ongoing is for activities that are undertaken on an annual basis or statements of management intent that will direct the Management response if an issue that arises.

4.1 Detailed actions, performance targets and costing

4.1.1 Actions for flora and vegetation management

Table 1 Recommended actions for management of flora and vegetation communities in the wetland

ITEM	VALUES	ACTION	ECOLOGICAL BENEFIT	PRIORITY	EXAMPLE COST	IMPLEMEMATION NOTE
1	Flora protection	Fence southern end of wetlands or *Wilsonia backhousei* patches	Prevent vehicle (bicycles, dogs, foot traffic etc) damage to saltmarsh and the threatened *Wilsonia backhousei*	Low- see options	$100m Wood/wire, $500 metal pm	Temporary fencing could be installed pending actioning items 2 and 11
2	Flora protection	Finalise agreement with other stakeholders regarding access requirements to stanchions	Prevent vehicle damage to saltmarsh and the threatened *Wilsonia backhousei*	High	$ph Council officer liaison	
3	Flora management	Install markers to delineate approximate extent of wetland ecosystem patches	Ensure wetlands do not become over colonised by mangroves and that saltmarsh and Wilsonia are maintained at agreed patch size minimums	High	$700	See monitoring forms in this plan to be completed by Council staff - includes maintenance of markers
4	Flora management	Implement regular monitoring regime to include water levels, patch sizes and weeds	Support ongoing commitment to the site by council, provide evidence to grant providers of ecological values etc	High	Operational staff ph $	See monitoring forms in this plan to be completed by Council staff. There is potential for involvement of citizen scientists in monitoring programmes via community development program.
5	Flora management	Mangrove removal	Reduce invasion of other sections of wetland	High/ongoing	$20,000 phase 1 with $5000	

ITEM	VALUES	ACTION	ECOLOGICAL BENEFIT	PRIORITY	EXAMPLE COST	IMPLEMEMATION NOTE
			Create additional space for saltmarsh or mudflats for migratory waders		follow up pa/ As per existing contract rates	Extent at markers (see item 3 and Appendix A, Figure 34)
6	Flora management	Weed control in surrounding forested wetland vegetation	Improved condition of EEC vegetation	Medium	$5000pa	
7	Flora management	Install screens to prevent mangrove propagules washing in with tidal flushing	Manage the spread of mangrove propagules within the wetlands, reduced ongoing costs for management of establishing mangroves, reduced need for human activity and disturbance within the wetlands	High	See item 19	High priority pending final design. May not be required with installation of two inlets.
8	Flora management	Thinning of Swamp Oaks, removal of swarming seedlings	Improved sight lines for waterbirds and migratory waders Reduce incursion into saltmarsh at northern end of wetlands	High/ongoing	$2000 pa	See Appendix A, Figure 34 Consider staged replacement planting with low shrubs/ small trees such as Melaleucas for screening from the path (northern end only) to max heigh 4-5 metres

4.1.2 Actions for fauna management and visitor education

Table 2 Recommended actions for management of fauna and habitat, and for visitor education

ITEM	VALUES	ACTION	ECOLOGICAL BENEFIT	PRIORITY	EXAMPLE COST	IMPLEMEMATION NOTE
9	Fauna and citizen science	Inoculate mudflats with larger macroinvertebrates	Improve food resources within the wetlands, improve overall health and resilience of mudflats and saltmarsh ecosystems	Medium	$ph Council officer liaison and supervision	Liaison with SOPA wetland management staff for advice
10	Fauna	Monitor incursions into core habitat areas by reserve users or dogs off leash. If this becomes an issue consider simple fencing (eg single cable) to delineate no go zones along the wetland side of existing formal paths.	Less disturbance to wetland flora and fauna	Ongoing/moderate	$ph Council officer	See monitoring forms in this plan to be completed by Council staff. There is potential for involvement of citizen scientists in monitoring programmes via community development program.
11	Visitor experience and Flora protection	Formalise path across southern end of wetlands/ replace existing boardwalk with wider boardwalk to accommodate two way foot traffic with prams and dogs, children etc	Reduce impacts on saltmarsh and *Wilsonia backhousei*	Medium	$700 per m	Maintain access to stanchions (see item 2)
12	Flora and fauna and visitor experience enhancement	Earthworks to reshape southern grassy knoll/weedy area	Reinstate wetland area for saltmarsh or mudflats Potential for brackish/fresh habitat with Typha and Phragmites (as per 2004 aerial photos)	Low	$150,000	Implement as alternative to option below (the preferred option)

ITEM	VALUES	ACTION	ECOLOGICAL BENEFIT	PRIORITY	EXAMPLE COST	IMPLEMEMATION NOTE
			Create additional foraging habitat for waterbirds			
13	Flora and fauna and visitor experience enhancement	Create freshwater wetland (perched), brackish swale	Create additional foraging habitat for waterbirds Recreate frog habitat evident in 2008 PoM surveys Utilise stormwater harvesting tank storage water	Medium	$600,000	See Appendix A, Figure 39
14	Visitor experiences	Install bird hide near southern boardwalk or perched wetland	Provide opportunities for birdwatching without impacting migratory waders and other waterbirds. Community education opportunities.	Medium	$ 30,000	See section 5.1.1 and Appendix A, Figure 35 to Figure 38 Both locations are suitable for 2 direction viewing

4.1.3 Actions for management of hydrology and tidal inundation

Table 3 Recommended actions for management of hydrology and tidal inundation

ITEM	VALUES	ACTION	ECOLOGICAL BENEFIT/ OPERATIONAL BENEFIT	PRIORITY	EXAMPLE COST	IMPLEMEMATION NOTE
15	Hydrology	Create second tidal flushing inlet (single tidal regime)	• Improved tidal flushing for upper sections (southern end), reduced incidence of hypersalinity/drying out and its impacts on saltmarsh and Wilsonia backhousei • Council would have remote operation of two gates, and monitoring of water level in both northern and southern mudflats. Gate could	High	$700,000	See Section 3.1 and Appendix A, Figure 40 for details

ITEM	VALUES	ACTION	ECOLOGICAL BENEFIT/ OPERATIONAL BENEFIT	PRIORITY	EXAMPLE COST	IMPLEMEMATION NOTE
			be adjusted for adaptive management of sea level rise. • With two connections turnover of water can be achieved, improving tidal flushing of wetland.			
16	Hydrology	Upgrade existing inlet/ Outlet structure at Northeastern side of wetlands a) flap gates with automated motorised gate system	Floodgates can respond to changing tides at any time, improved regulation of tidal regimes within the wetlands, improved conditions within wetlands for migratory shorebirds. Council would have remote operation of gate, and monitoring of water level in northern mudflats. Gate could be adjusted for adaptive management of sea level rise. Allows some control of water levels during breeding seasons reducing predation risk	High	$150,000	
		b) replace existing box culvert with larger box culvert	• Larger volume of water able to enter on incoming tides • Reduced frequency of wetlands drying out		$250,000	Works to existing box culvert may be more straightforward for approvals
17	Hydrology	Create second inlet and regulate water levels with two tidal regimes (ie two ponds)	Creation of sustainable inundation regimes to promote healthy mangroves in one pond and healthy saltmarsh in the other, with mudflats	Low	$600,000	low priority – not preferred option

ITEM	VALUES	ACTION	ECOLOGICAL BENEFIT/ OPERATIONAL BENEFIT	PRIORITY	EXAMPLE COST	IMPLEMEMATION NOTE
18	Hydrology	Create berm mid marsh to reduce potential for mangrove propagule movement and establishment	Manage the spread of mangrove propagules within the wetlands, reduced ongoing costs for management of establishing mangroves, reduced need for human activity and disturbance within the wetlands	Low	See Item 19	
19	Hydrology	Remove mangroves from around inlet channel	Reduced inhibition of tidal flows, improved tidal flushing of wetlands	High/ ongoing	As per current contracts	Yes
	Hydrology	Improve hydraulic links within wetland	• Water able to circulate between mudflat basins, • Improves wetland flushing • improved health of saltmarsh • Reduced frequency of wetlands drying out • Internal screening of mangrove propagules could be included	Medium	$150,000	see monitoring and adaptive management approach

4.1.4 Actions for general management and community engagement

Table 4 Recommended actions for general management and community engagement

ITEM	VALUES	ACTION	ECOLOGICAL BENEFIT	PRIORITY	EXAMPLE COST	IMPLEMEMATION NOTE
20	Community engagement	Establish official bushcare/wetland care group of volunteers to ensure ongoing weed control and other site maintenance and/**OR**	Maintain ongoing community involvement, Increase community awareness of wetland values	Low- Medium	$ph Council officer supervision/admin and insurances	

ITEM	VALUES	ACTION	ECOLOGICAL BENEFIT	PRIORITY	EXAMPLE COST	IMPLEMEMATION NOTE
		continue memorandum of understanding with Birdlife Australia		In place		
21	General wetland management	Manage crumb rubber particulates to prevent their entry into the wetland	Maintain ecological health and prevent environmental degradation		$500-750k (not part of wetland funding stream)	At end of life of current field (generally require replacement after 8-10 years) replace with generation 4 woven turf (or better) that does not require crumb rubber infill.
22	General wetland management	Formalise boundary with boundary lot adjustment		Low		
23	General wetland management	Rename wetland	Generate interest in wetland increase	Low		Example “Mason Park Shorebird Sanctuary”

Table 5 Potential sources of funding for major works in the wetland

Type	Name	Description	Note
NSW	West Invest	A new $5 billion investment by the NSW Government will help secure a brighter future for western and south-western Sydney families and residents, helping build new and improved facilities and local infrastructure to help communities hit hard by COVID-19. The government will put $2 billion from the fund towards high priority projects to be developed in consultation with local communities, while $3 billion will be for future projects in six areas including parks, urban spaces and green space	Strathfield LGA is eligible for funding under this fund
NSW	Environmental Trust	To assist community and government organisations to contribute to the ongoing sustainable management and stewardship of significant environmental assets and services in New South Wales.	Stream 1 – New applicants up to $115,000 2–3 years

Type	Name	Description	Note
		Applications to the 2021–22 Environmental Restoration and Rehabilitation program were required to address at a practical level, how their project will contribute to the delivery of either one or both of the following 2 immediate funding priorities from the NSW Environmental Trust Strategic Plan 2020–24: • supporting threatened species recovery • addressing climate change impacts on the natural environment – both mitigation and adaptation.	Stream 2 – Experienced applicants up to $170,000 3–4 years
NSW	NSW Government's Coastal and Estuary Grants Program	The program aims to help: • manage risks from coastal hazards, such as coastal erosion • restore degraded coastal habitats • improve the health of estuaries, wetlands and littoral rainforests across New South Wales. As part of the coastal reforms, a funding package of $83.6 million is available for coastal management. The Coastal and Estuary Grants Program is part of this package. The program supports coastal and estuary planning projects and the implementation of works identified in certified coastal zone management plans or coastal management programs. Grant offers are subject to statewide priorities and availability of funds each financial year.	
NSW	Metropolitan Greenspace Program	The Metropolitan Greenspace Program (MGP) commits grant funding to local councils in Greater Sydney and the Central Coast for projects that improve and increase access to regionally significant open space. The program aligns with the NSW Government's Greater Sydney Region Plan, A Metropolis of Three Cities, and the Green Grid strategy, helping to create a network of high-quality green space that connects town centres, public transport hubs, and major residential areas. Grants are offered on a dollar-for-dollar basis for capital and planning works. Eligible capital works projects include shared pedestrian and cycle pathways, new or improved parks and open spaces, improved signage and accessibility. The funding will support councils in the delivery of projects that: • enhance access to regionally significant public open space	All 33 councils in the Greater Sydney region are eligible to apply for grant funding, along with Central Coast Council.

Type	Name	Description	Note
		• contribute to the Green Grid and the priorities listed in the Greater Sydney District Plans.	
Agency	Sydney Water's Community Grants Program.	Liveable cities stream - Build a resilient and water sensitive Greater Sydney through projects that support healthy waterways, cool green open spaces, and deliver health, cultural, social, economic, heritage and/or environmental benefits Citizen science stream	Councils who can facilitate grassroots water literacy and research with community groups within the Sydney Water area of operations can apply
Federal	Environmental Restoration Fund	The aim of the Environment Restoration Fund is to support a range of activities that will improve environmental outcomes. Projects will focus on three priority areas: 1. Protecting threatened and migratory species and their habitat 2. Protecting Australia's coasts, oceans and waterways by addressing erosion, improving water quality and protecting coastal threatened and migratory species, and 3. The clean-up, recovery and recycling of waste.	

4.2 Monitoring and reporting

4.2.1 Monitoring

Monitoring needs to be conducted on a regular basis, ranging from quarterly to annually. Minimum requirements are annual monitoring to note changes in intertidal health, composition and distribution in the catchment, and to report against compliance with the recommended actions, priorities and timeframes.

Aspects for monitoring include:

- Areas of *Wilsonia backhousei*
- Areas of saltmarsh
- Areas of mangroves
- Activities to reduce mangrove and/or swamp oak encroachment
- Weed control
- Trash collected
- Macrobenthic surveys
- Species and abundance of waders visiting the wetlands
- Evidence of breeding success by migratory waders
- Vandalism to infrastructure and/or the wetland
- Compliance with other actions recommended in the MP

> For Baseline Monitoring, use Level 1 protocols.
>
> For Rehabilitation Monitoring, use Level 2 or Level 3 protocols.
>
> For areas where changes are suspected due to adverse catchment impacts, use Level 3 or Level 4 protocols.

Set realistic goals based on the available budget. Prioritise this against works priority and timeframe provided in section 4.1, Table 1 to Table 4. Decide on specific target figures, for example, we will create X metres^2 of saltmarsh, control weeds in Y hectares of saltmarsh, construct one new boardwalk or other capital work.

4.2.2 Evaluation strategy

Evaluate performance against the specific targets identified in the previous section – did we achieve the target. Evaluate against specific targets annually as part of the budget allocation process. Evaluate against outcome targets (see Section 4.1), for example no net loss of saltmarsh, at 5 yearly intervals for the life of the plan.

Estimate cover using site markers for mangroves. For saltmarsh, use up to date satellite imagery to map extent of cover. For Wilsonia use fine scale grid surveys (eg 1m2 or 2m x 2m) to accurately map abundance.

4.3 Saltmarsh monitoring strategy

(Adapted from DECC, 2008; Wells NERR, 1999)

Baseline and Rehabilitation Monitoring follow the same general approach. The main difference is the reason for changes that the monitoring aims to detect. For this reason there are differences in the timing of monitoring sessions, as well as the variables that need to be monitored.

Implementation follows a ranked approach:

- **Level 1: Minimal monitoring** of hydrology, soils and sediments, and vegetation core variables should occur at all sites. This can be used for Baseline and long term follow-up monitoring.
- **Level 2: Recommended monitoring** includes Level 1 Core Variables plus one faunal indicator (birds, invertebrates or bats). Use this for rehabilitation monitoring.
- **Level 3: Intensive monitoring** of all Core Variables should occur at a relatively small number of sites. Use this for establishment baseline monitoring.
- **Level 4: Research** to diagnose cause-effect relationships should include all Core Variables and Additional Variables as appropriate. Use this when baseline monitoring (or rehabilitation monitoring) indicates an unfavourable change is occurring/has occurred.

Many of these sampling tasks can be completed by trained volunteers with appropriate supervision. Alternately, councils made designate an officer to undertake these as part of normal duties, or a suitably qualified and experienced consultant engaged to conduct sampling, and data analysis and reporting.

4.3.1 Core variables for baseline monitoring

Table 6. Core variables for sampling as part of a saltmarsh monitoring program.

VARIABLE NAME	DESCRIPTION	SAMPLING METHOD	ANNUAL SAMPLING FREQUENCY (Before and five consecutive years after rehabilitation actions, except as noted)
HYDROLOGY			
Changes to water level	Pattern of water-level change with respect to a reference point	Continuous water-level recorders upstream of impacted/restored site and downstream (reference) OR Permanent wells or piezometers for groundwater level at major restoration projects only	For tides, one 2-4 week period of operation (before and 1-year after rehabilitation) OR For groundwater, at low tide between early spring and mid-summer (6 times per year)
Changes to area of inundation	Land survey of areas inundated to provide early indication of climate change impacts in the catchment	Photographic record Permanent markers	For all projects, once before plus yearly
Elevation	Marsh-surface elevation at contour intervals of 15 centimeters or less	Permanent sampling points using depth gauge to produce: Contour map OR Hypsometric curve (cumulative frequency distribution of elevation points on marsh surface)	For all projects, once before plus: yearly (2 years) OR yearly (5 years) after excavation projects
SOILS AND SEDIMENTS			
Pore-water salinity	Parts dissolved salts per thousand of soil water collected from 5-25 centimeter depths	Groundwater wells, soil cores, or sippers at impacted/restored and reference sites (minimum 3 samples per site, with samples minimum 5m apart)	At low tide between spring and summer, including spring/neap tides (6 times per year, at 2 week intervals)
VEGETATION			
Composition	Identity of all plant species occurring per square metre	Permanent or temporary plots (0.5-1 square meter) positioned random-systematically across the entire marsh or	At time of maximum standing biomass: late summer, once per year, including once before rehabilitation activities

VARIABLE NAME	DESCRIPTION	SAMPLING METHOD	ANNUAL SAMPLING FREQUENCY (Before and five consecutive years after rehabilitation actions, except as noted)
Abundance	Percent cover per square metre by species	stratified by elevation (low marsh, high marsh, and upland edge) along transects running perpendicular to the main tidal channel at > 10-meter intervals starting at a random distance within first interval, at impacted/restored and reference sites.	
Height	Mean height of 3 tallest individuals of each species of concern per square meter		
Density	Number of shoots per quadrat in plots restricted to species of concern	Permanent plots established within distinct stands of species of concern; quadrats are to be sized appropriately for each species sampled	
NEKTON (two faunal groups per sample)			
Molluscs	Changes in diversity and abundance over time	Number of species, identity of species, number of individuals for each species per square metre, minimum 3 samples or 2 samples per identified stratum in zoned saltmarsh	At low tide during summer, once before rehabilitation, and then once per year (max 5 years)
	Changes in biomass over time	Length and width of 15-20 individual animals randomly selected per species (measure to nearest 0.5mm) Wet weight of 15-20 animals per species (already measured)	
Crabs (require reintroduction)	Changes in diversity and abundance over time	Number of species, identity of species, number of individuals for each species per square metre, minimum 3 samples or 2 samples per identified stratum in zoned saltmarsh	At low tide during summer, once before rehabilitation, and then once per year (max 5 years)
	Changes in biomass over time	Length and width of 15-20 individual animals randomly selected per species (measure to nearest 0.5mm) Wet weight of 15-20 animals per species (already measured)	
BIRDS			
Density	Number of birds per hectare or wetland section, by species	20-minute observation periods in the morning from site-specific vantage points that provide an uninterrupted view	

VARIABLE NAME	DESCRIPTION	SAMPLING METHOD	ANNUAL SAMPLING FREQUENCY (Before and five consecutive years after rehabilitation actions, except as noted)
Guild richness	Number of birds per guild: eg. waterfowl, shorebirds, wading birds, aerial foragers, or passerines	of at least a portion of the salt marsh, at impacted/restored and reference sites	At high and low tides: fortnightly, 4 times in October-November and March-April for migration; (minimum 7 times per year)
INVERTEBRATES			
Mosquitoes	Number of mosquito larvae and pupae per square meter	Permanent stations in pool/wet areas, with 3 dips of 350-milliliter cup in 3-meter-radius circles, at impacted/restored and reference sites (10 dip stations/site)	At low tide, monthly from October to March (6 times per year, for one year unless further sampling is required)
Insects and spiders	Changes in diversity and abundance	Sweep netting or sticky traps (yellow and blue) Laboratory sorting and identification of insects and spiders	3 times per year, during spring-summer, once before rehabilitation, and yearly afterwards (max 5 years)

4.3.2 Additional variables for rehabilitation monitoring

Table 7. Additional variables for sampling as part of a detailed saltmarsh monitoring program.

VARIABLE NAME	DESCRIPTION
HYDROLOGY	
Surface water chemical and physical characteristics	Water quality parameters sampled in main tidal channel: dissolved oxygen, salinity, temperature, and pH
Surface water nutrient loading	Turbidity, total dissolved solids (TDS), total nitrogen (TN) and phosphorus (TP) in water
Current profiles	Tidal current in main channel assessed over several tidal cycles
SOILS AND SEDIMENTS	
Organic matter	Organic content of 20cm soil cores sectioned into 5cm segments
Sediment accretion rate	Accumulation of inorganic and organic material above a marker horizon over a known time interval

VARIABLE NAME	DESCRIPTION
Sediment elevation	Short-term changes in sediment elevation measured with Sediment Elevation Tables
Redox potential	Redox potential at 1 cm and 15 cm depths
Sulfides	Concentration of sulfide in pore water
VEGETATION	
Photo stations	Panoramic views of entire wetland from permanent stations from several compass bearings
Above-ground biomass	Biomass of living, above-ground plant material collected from additional, randomly positioned quadrat in vicinity of permanent or temporary quadrat
Stem density	Number of shoots per m^2, by species, within permanent or temporary quadrats
Proportion flowering	Proportion of shoots of each species that are flowering within permanent or temporary quadrats
BIRDS	
Species richness	Total number of avian species represented
Feeding/breeding behavior	Type of behavior (e.g., feeding, roosting, breeding, preening) per observation interval, by species
Habitat suitability link	Habitat types used by bird species (e.g., mud flats, pool, creek, submerged aquatic vegetation, algal mats, marsh zone, etc.)
Small passerines and other cryptic species	20-minute observation periods from center of 50-meter-radius counting circles established in the salt marsh
Birds in the buffer	20-minute observation periods from center of 50-m radius counting circles established in the habitat adjacent to the salt marsh
Waterfowl in winter	20-minute observation periods from site-specific vantage points continued throughout the winter (as long as marsh is ice free)
INVERTEBRATES	
Macroinvertebrate density	Number of macroinvertebrates per sample area
Macroinvertebrate richness	Number of macroinvertebrate taxa per sample area

4.3.3 Checklists for operation staff

Table 8 Example six monthly general inspection checklist

Six monthly inspections	
Inspected by	
Date and time	

Item Inspected	Satisfactory (Y/N/NA)	Details of Action Required/ notes
Sediment accumulation at inflow points?		
Sediment accumulation within inlet zone (record depth, remove if > 2/3 full)?		
Litter or debris within inlet structure?		
Litter within inlet or aquatic plant (macrophyte) zone?		
Overflow structure integrity satisfactory?		
Outlet structure free of debris?		
Mangrove extent markers in good condition?		
Settling or erosion of bunds or batters present?		
Terrestrial vegetation condition satisfactory? (density, weeds, disease, pest infection, stunted growth or dead plants)		
Aquatic vegetation condition satisfactory? (density, weeds, disease, pest infection, stunted growth or dead plants)		
Replanting required?		
Evidence of damage or vandalism?		
Evidence of dumping (building waste, oils)		
Evidence of algal scums?		
Evidence of odours?		

Take photos in support of report.

Use maps to mark up locations of additional observations

4.3.4 Data Storage

Data may be stored in a variety of forms, including hard copies of field and laboratory notes and computer spreadsheets and databases. Retain raw data sheets even when the data has been transferred to computer in the event of computer failures or errors in data entry. Spreadsheets are an appropriate form of data storage for the manipulation of small data sets, calculation of simple summary statistics, and presentation of data in basic graphical formats.

Data should be stored in databases, which can sort and present data according to specific criteria. This can be useful for generating reports on various parameters and sites over time. Data sets can be exported into statistical packages for detailed analysis and presentation of data. Spatial data, such as that collected using GPS should be stored in databases compatible with the GIS to be used.

5 Appendix A: Additional report maps

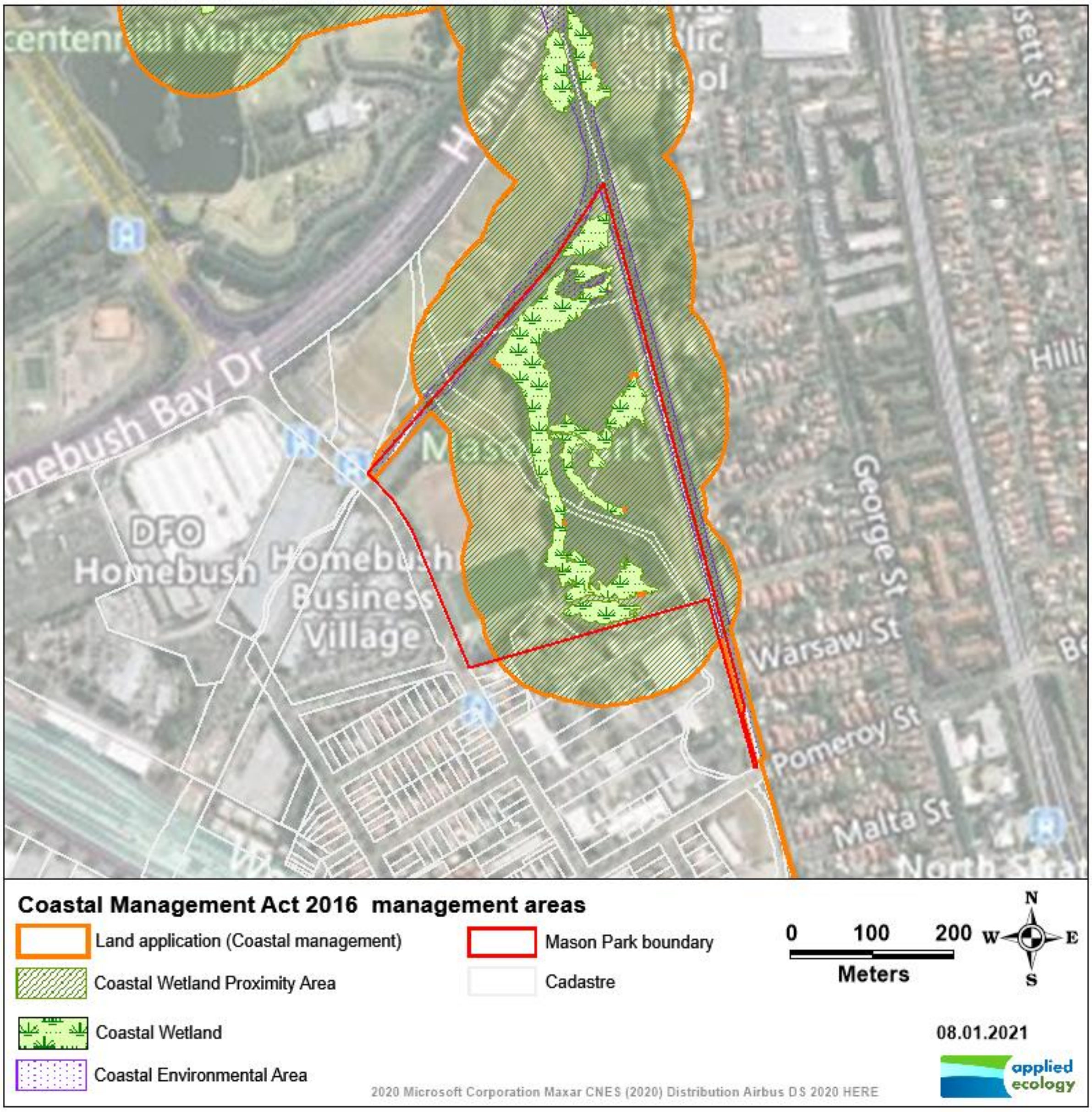

Figure 30 Coastal Management Act 2016- coastal management areas

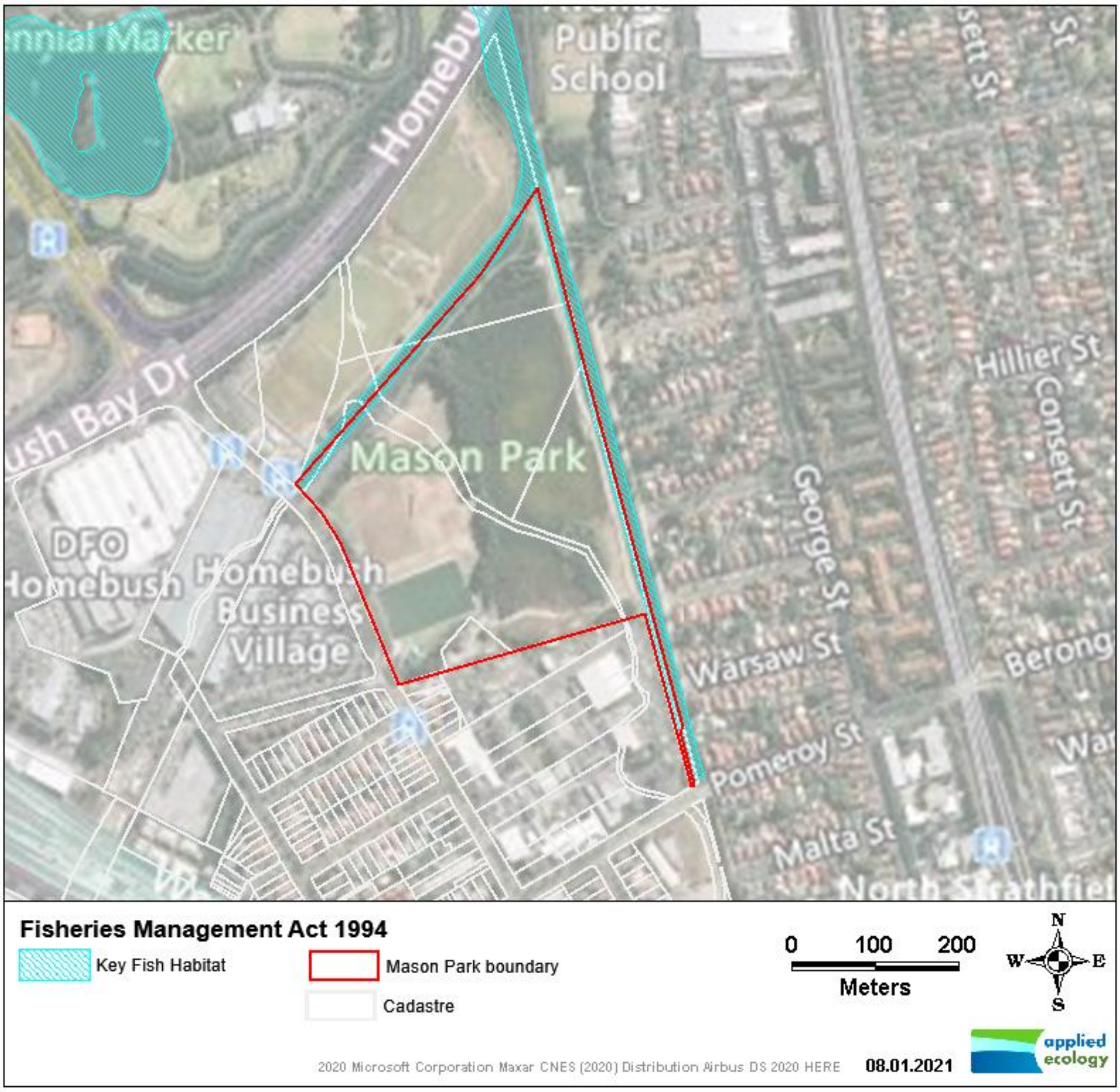

Figure 31 Fisheries Management Act 1994 – key fish habitat

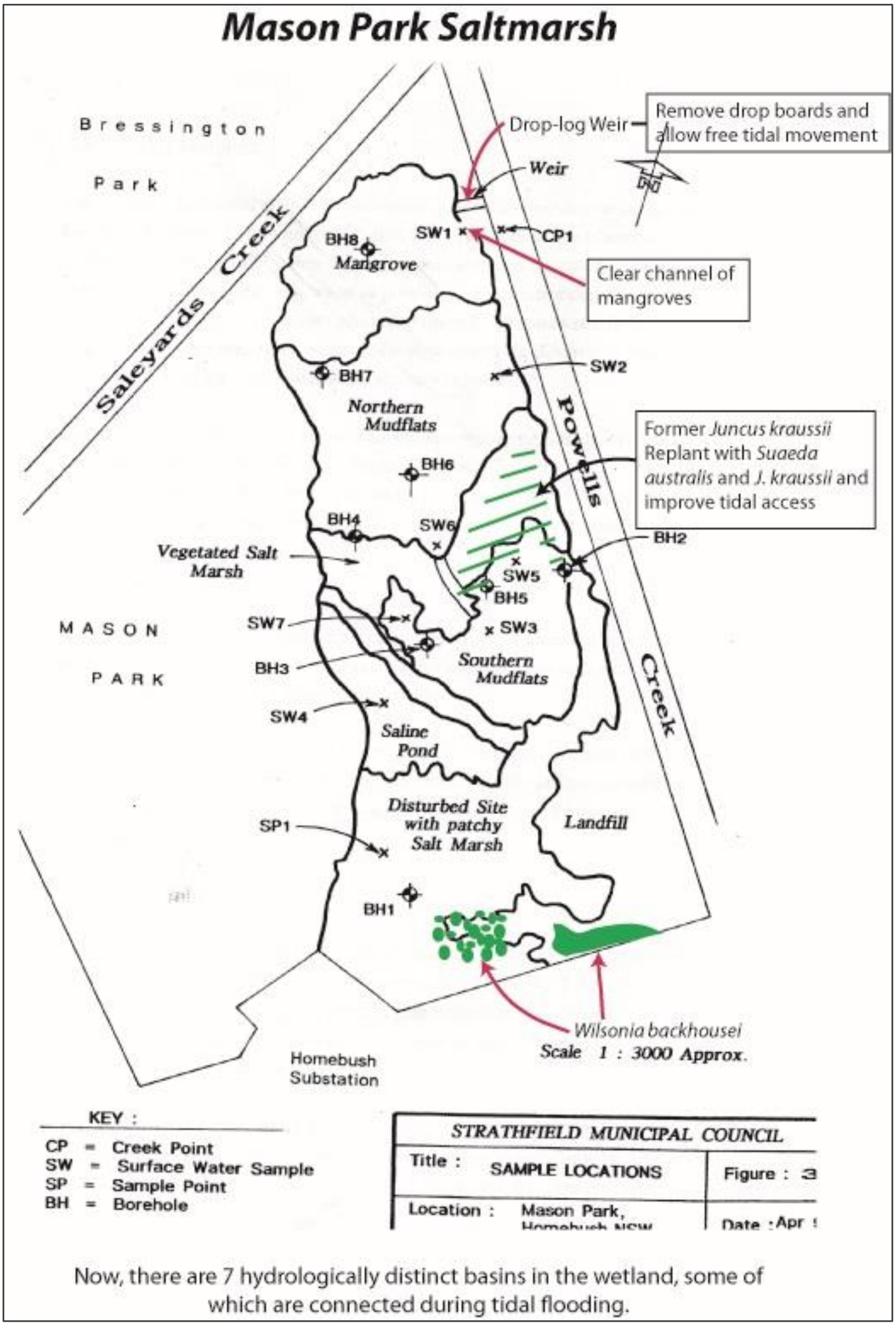

Figure 32 Updated mapping of wetland basins in Statement of Environmental Effects (Sainty & Associates, 2009)

Figure 33 Highest tide inundation levels: dark blue = current day, light blue = 2100 with SLR = +0.84m (Coastal Risk Australia)

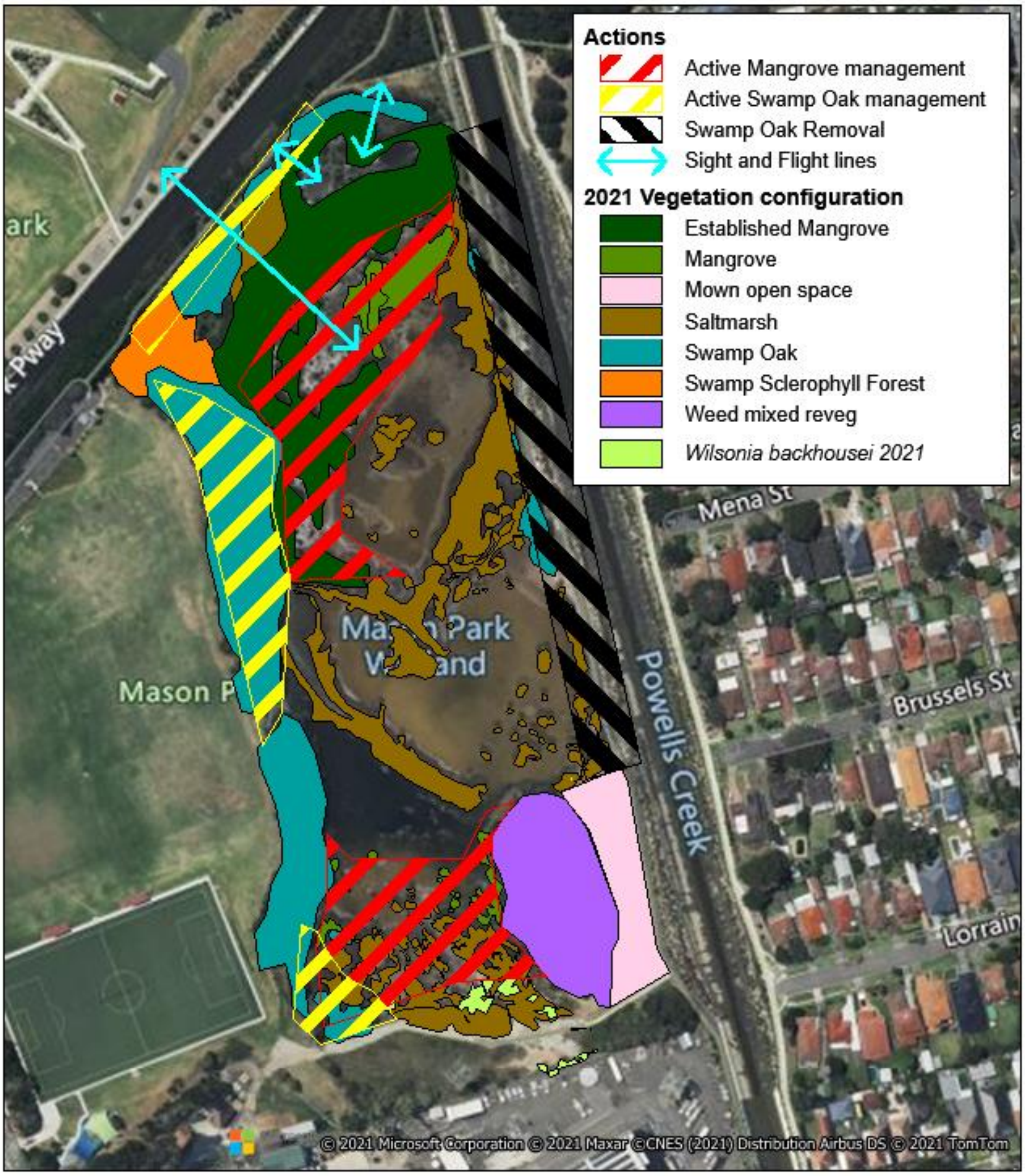

Figure 34 Activities for management of vegetation – locations and extent

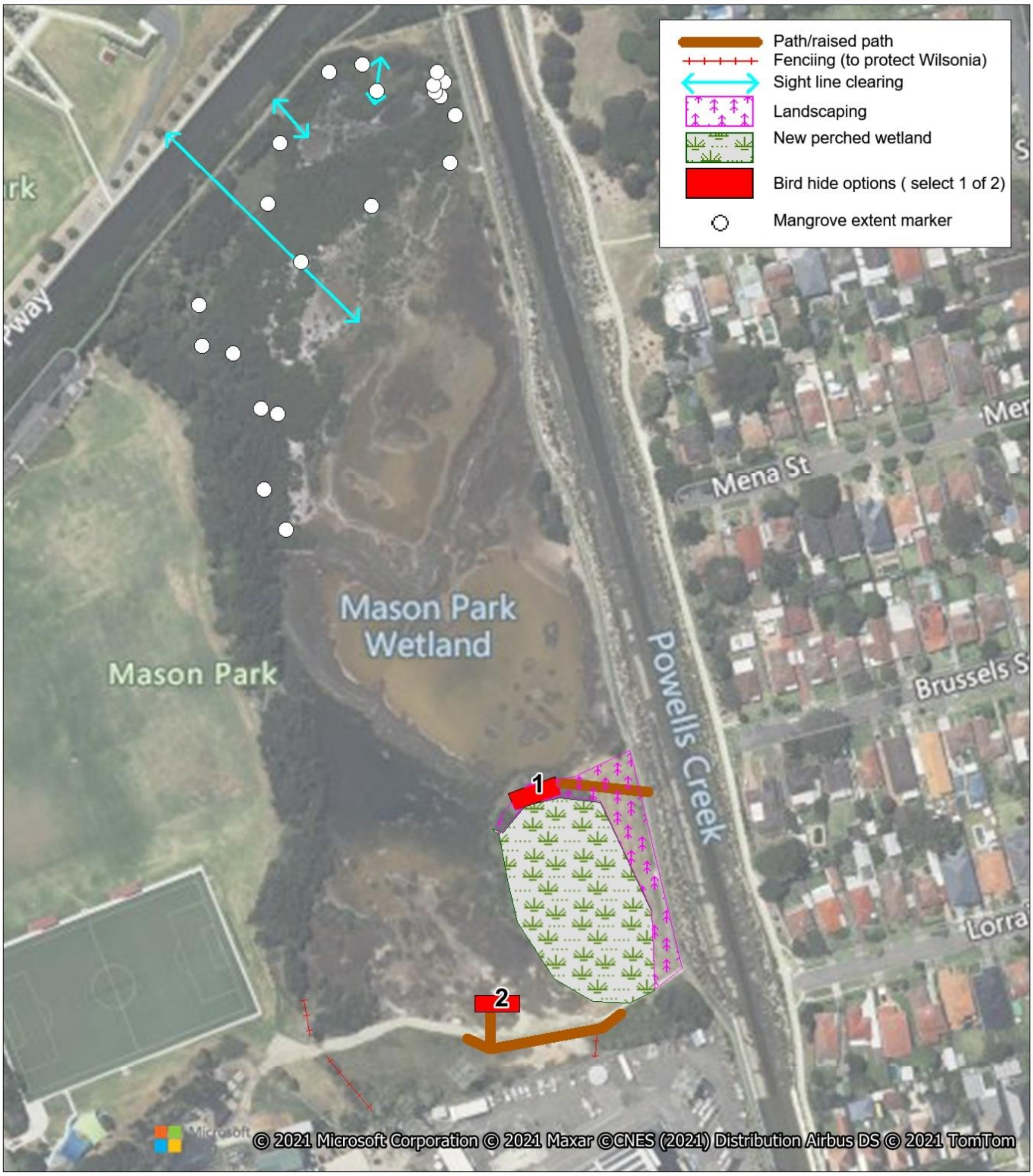

Figure 35 General location of asset additions (excluding inlet structures)

5.1.1 Ethical birding and the Bird Hide

- Due to the high number of breeding species and nest locations site signage should include clear instructions to stay within formal pathways, particularly during breeding season. Dogs (on leash) to remain on formal paths.
- Site signage should include clear instruction to birdwatchers that flushing and call playback are not acceptable. Modification of vegetation is not acceptable. Intrusion into the wetland is not acceptable. Photographing nesting birds (or fledglings) within their observed zone of tolerance is not acceptable.

- Monitor incursions into the wetland by visitors or dogs off leash. If this becomes an issue consider simple fencing (eg single cable) to delineate no go zones along the wetland side of existing formal paths.

Figure 36 Concrete and metal open hide allowing viewing in two directions.

Figure 37 Open hide with information sign

Figure 38 Left- Inside a closed hide; top right - Simple hide with high and low observation slots bottom right - Closed hide overlooking grassland

5.2 Review of Hydrology - figures

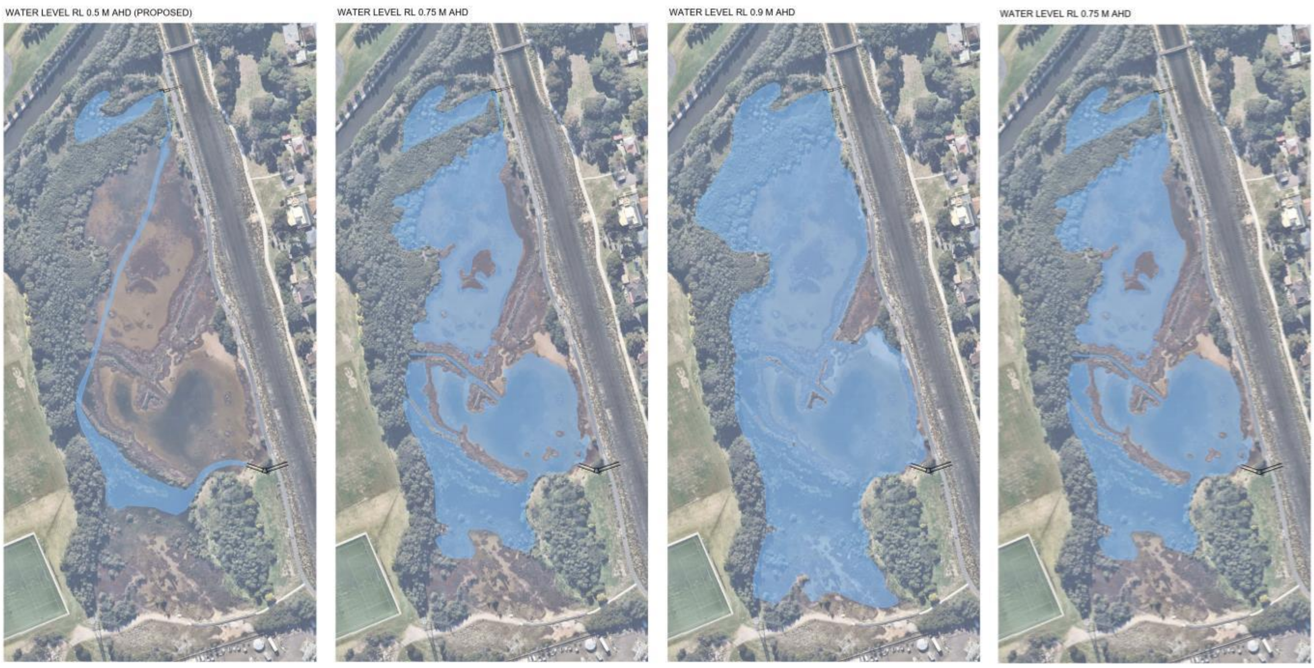

Figure 39 Indicative flows with staggered operation of two automated gates

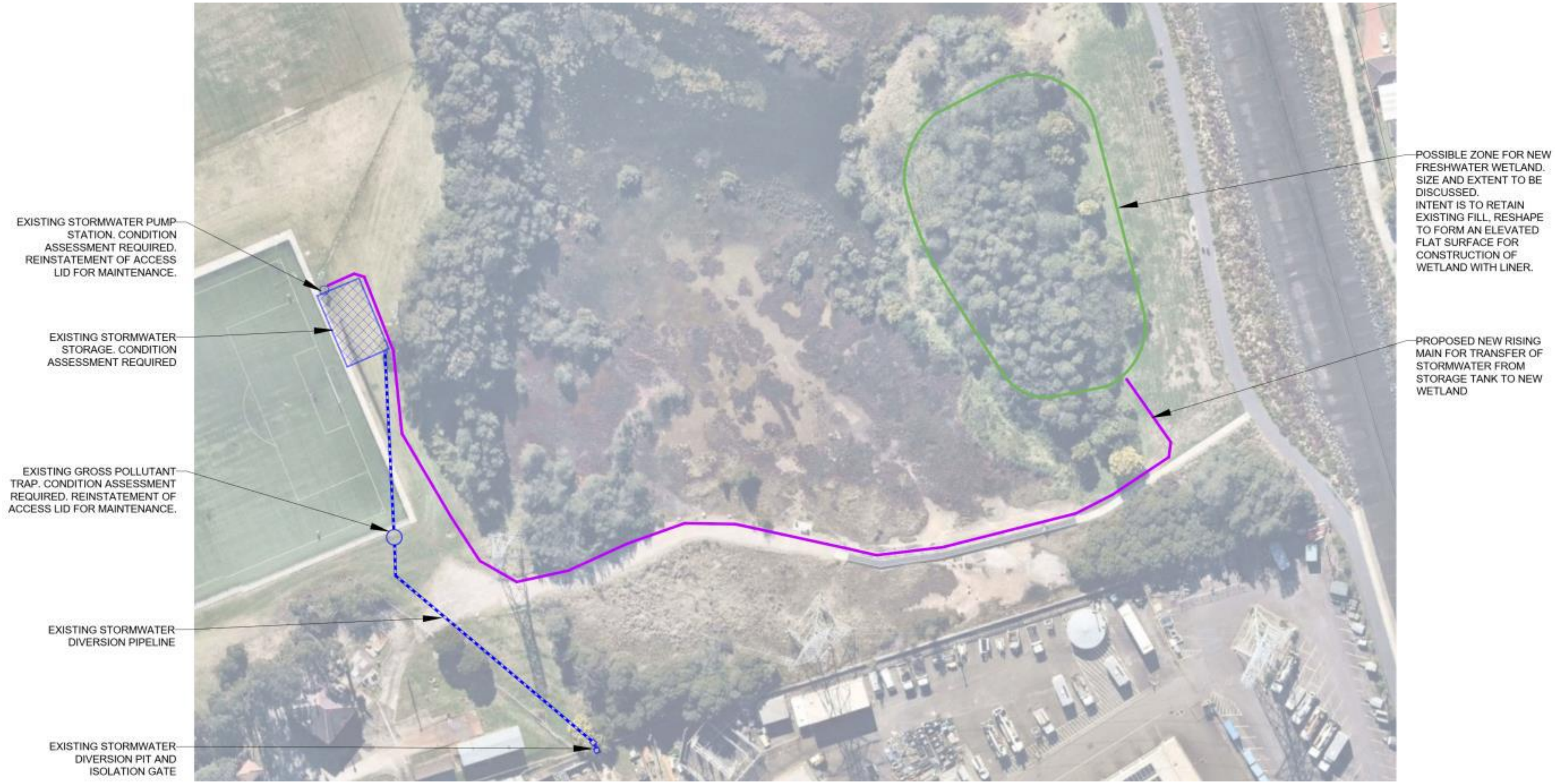

Figure 40 Indicative plan for new constructed wetland

6 Appendix B: Mason Park Wetlands Review of Hydrology – technical appendix

Mason Park Wetlands – Review of Hydrology

PREPARED FOR APPLIED ECOLOGY

January 2022

Civille

Suite 104
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Chippendale NSW 2008

Client: Applied Ecology (for Strathfield Council)

Project name: Mason Park Wetland

Project number: 2131 (Civille)

Date: 31 January 2022

Report contact: Andrew McMillan

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TABLE OF CONTENTS

1 WATER & HYDROLOGY CONDITIONS

A full description of the Mason Park wetlands site as well as the historical changes that have occurred can be found in the main plan of management and other referenced documents. This report focuses on the key aspects relating to water management, as well as new information and analysis to investigate options for water management improvements.

1.1 SITE HISTORY

Mason Park wetlands (the wetlands hereafter) are located adjacent to Powells Creek in the Strathfield Council local government area (LGA). The wetlands area is bound by the Saleyards Creek concrete stormwater channel to the north, a naturalised channel to the east (Powells Creek), Ausgrid's Homebush depot to the south and Mason Park sports fields to the west.

Prior to the powells Creek channelisation the area currently occupied by the wetlands was previously traversed by the natural Powells Creek waterway fringed by mangroves benches and with saltmarsh floodplain areas beyond the mangroves. Works to channelise Powells Creek and Saleyards Creek were conducted by the Metropolitan Water Board between 1934-37 causing changes to the inundation of the remnant saltmarsh and mangrove areas. Mason Park was mostly used as a landfill from the 1930's to the 1970's. The site became a significant habitat for migratory birds in the 1970's. The community and ecologists petitioned to halt landfilling and migratory bird agreements were signed to protect and conserve migratory visitors. The site became one of the best places to observe migratory birds in Sydney, but bird numbers have since declined, a pattern that is inconsistent with numbers recorded at other similar sites in Sydney.

Works have been carried out in the vicinity of the wetlands that have caused changes to the hydrology of the Mason Park wetlands since Powells Creek was channelised. These include:

- In 1987, there were works to Saleyards Creek which led to the diversion of stormwater runoff from the upstream catchment (fresh water) into the current Mason Park wetlands.
- In 1988, a drop-log weir was installed to the Powells Creek connection, to allow water to flow into and out of the wetlands, and to allow water to be held in the wetland for habitat purposes as well as managing potential acid sulfate soils.
- In 2009, the drop-log weir was upgraded to a flap gate and weir in the existing structure connecting to Powells Creek, to promote tidal flows entering and being held in the wetlands.
- In 2018, Sydney Water conducted works to 'naturalise' the existing Powells Creek concrete stormwater channel. Works were conducted between the existing footbridge and the southeast corner of Mason Park, to approximately 450 m of the channel. These naturalisation works provide a new input of saline water during very high tides.

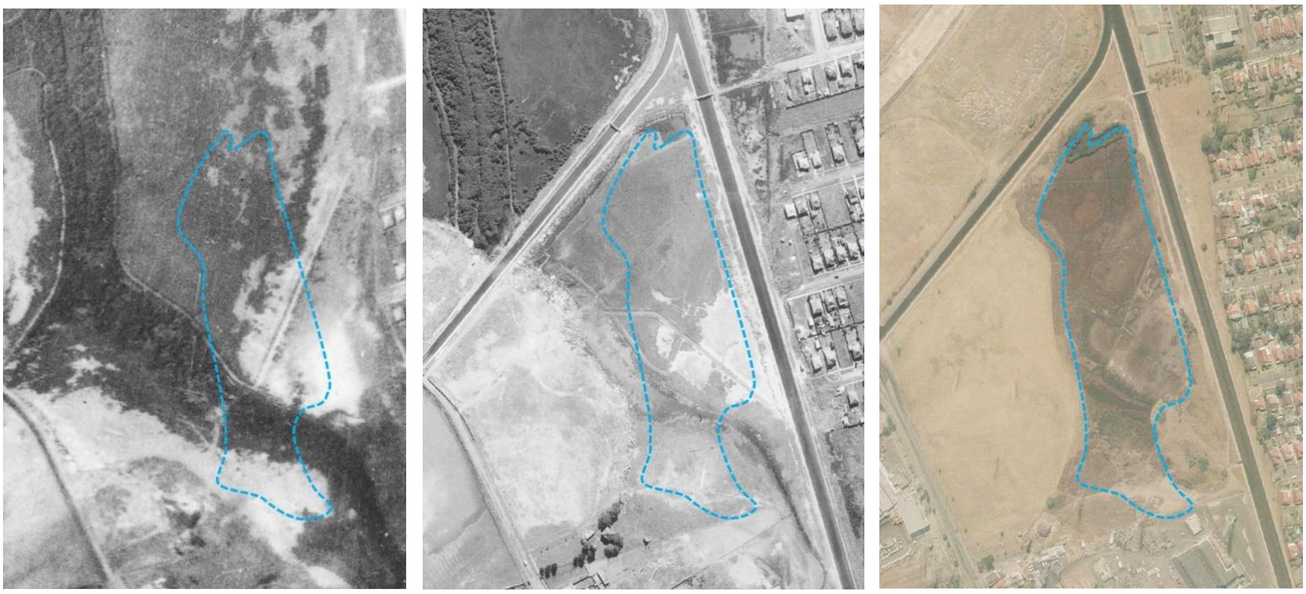

Figure 1 Historic aerial imagery of Mason Park Wetlands, 1930 (left), 1951 (middle), 1986 (right).

1.2 ARRANGEMENT AND BATHYMETRY OF WETLANDS

The key features relating to hydrology aspects of the wetlands are shown in Figure 2, including the main hydraulic links and the five key wetland zones identified in previous studies (Sainty). The northernmost part of the wetlands is dominated entirely by mangroves. Just south of this zone a is relatively large flat area, the northern mudflats. An earthen bund cuts the wetland in half creating the southern mudflat area. Southwest of the southern mudflats is the deepest area of water in the wetlands, likely part o the original Powells Creek and now referred to as the 'pond'. The southernmost zone is the 'disturbed saltmarsh' area which contains a patch of the rare *Wilsonia backhouseii*.

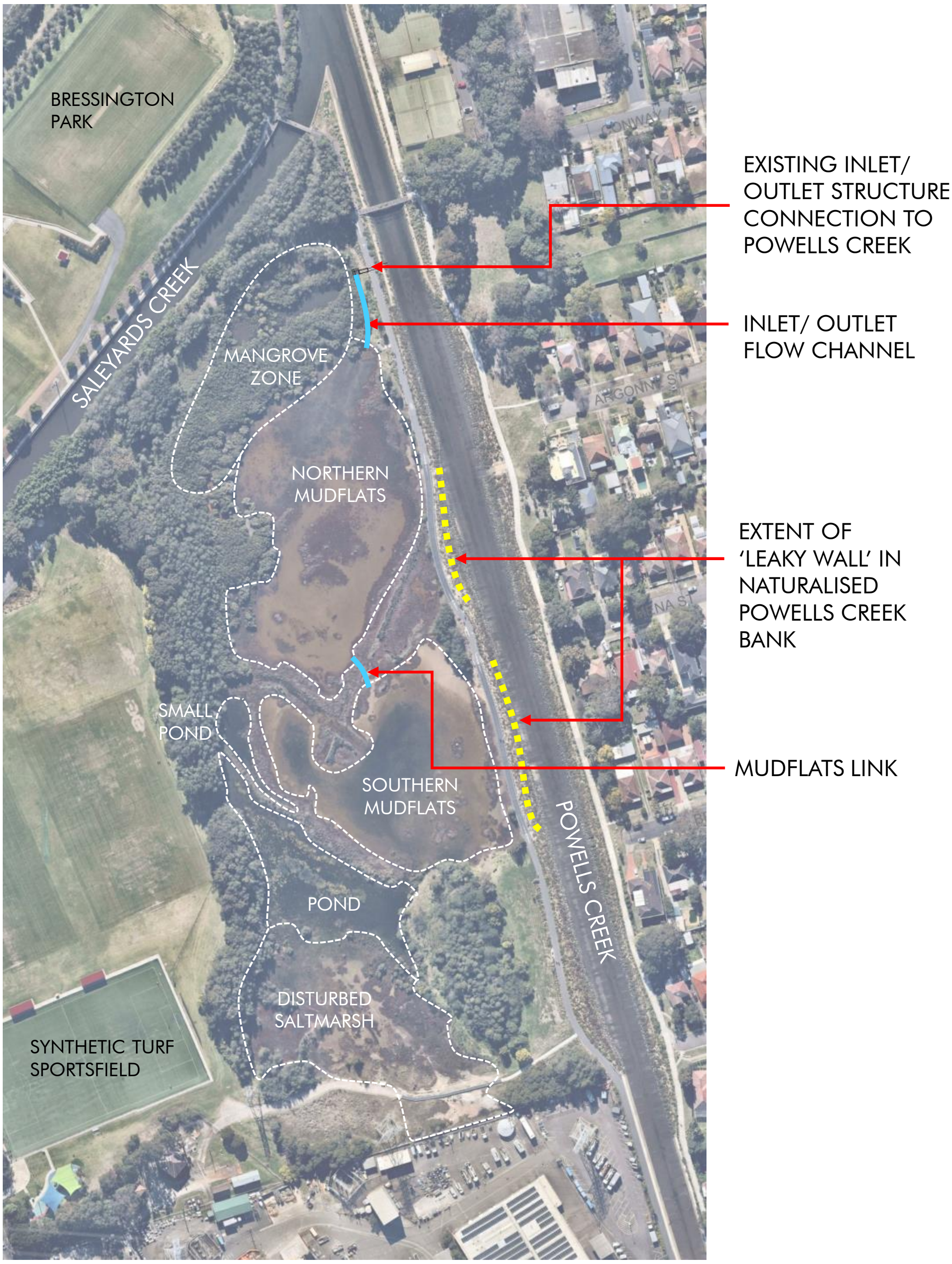

Figure 2 Key hydrology related features of Mason Park wetlands

The connections between the different zones of the wetlands are typically informal and of limited capacity, and are only engaged when water levels are relatively high. With the current single inlet/outlet connection to Powells Creek at the north-eastern side of the wetlands, the northern mudflats need to fill before tidal flows would subsequently spill over into the southern mudflats, as shown in Figure 3.

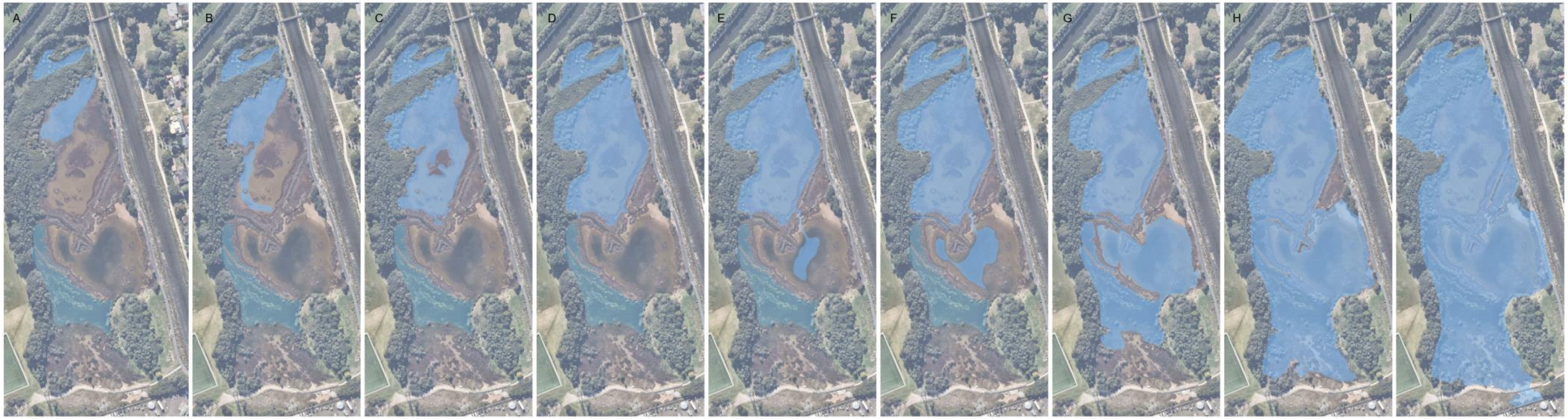

Figure 3 Wetlands indicative filling sequence, gradually extending from north to south

If the wetlands become fully dried out, the indicative filling sequence shown in Figure 3 is estimated to require around five high-high tide cycles to fill. Water flows within and across the wetlands are restricted by the constrained links between the zones, in particular the link between the northern and southern mudflats (location shown by 'mudflats link' in Figure 2) pictured in Figure 4.

Figure 4 'Mudflats link'

A limited amount of field survey was carried out as part of this study to gain some data on the wetlands bed levels and better understand the relationship between the tidal water levels in Powells Creek and flows into the wetlands. The surveyed levels and several aerial images were used to estimate water surface areas at different water level elevations (Figure 5).

The wetlands water surface areas were then used to develop an approximate total stage-storage volume relationship for the wetlands, shown in Figure 6. This stage storage relationship was utilised to estimate flow rates and the relationship between water level in the wetlands and Powells Creek during high tides, described in Section 1.5.

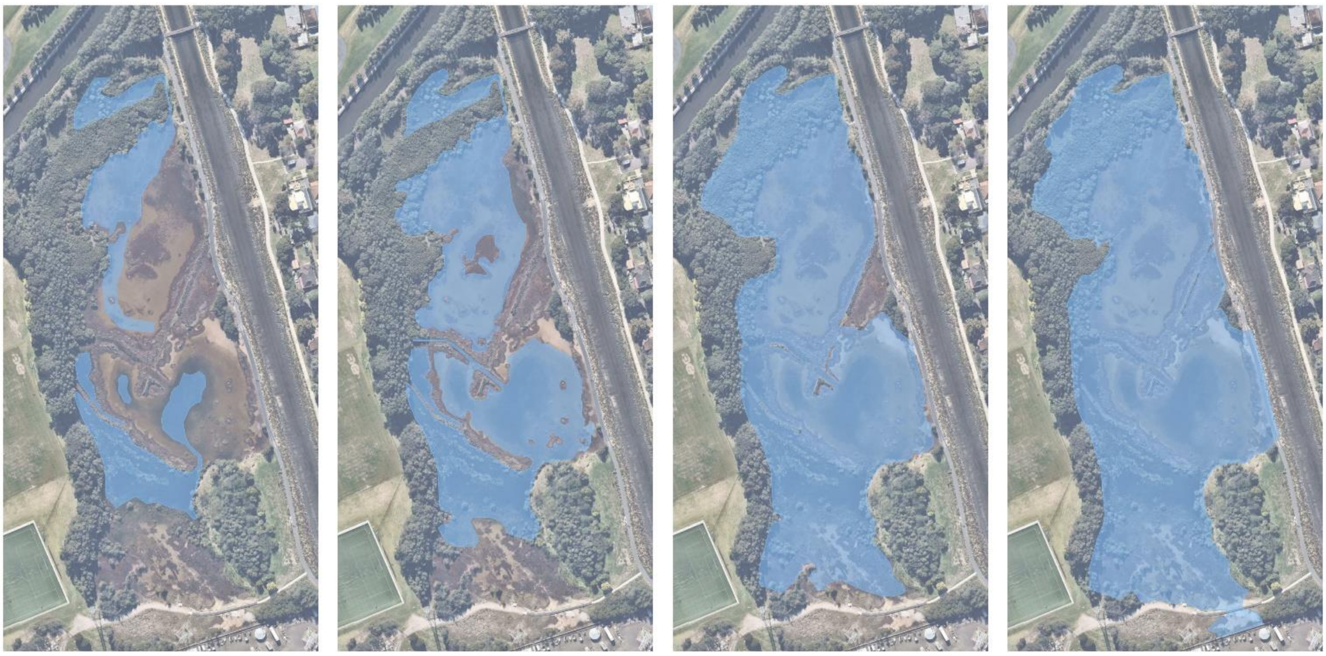

Figure 5 Wetlands approximate total water surface areas at water levels 0.6, 0.75, 0.9, 1.1 m AHD

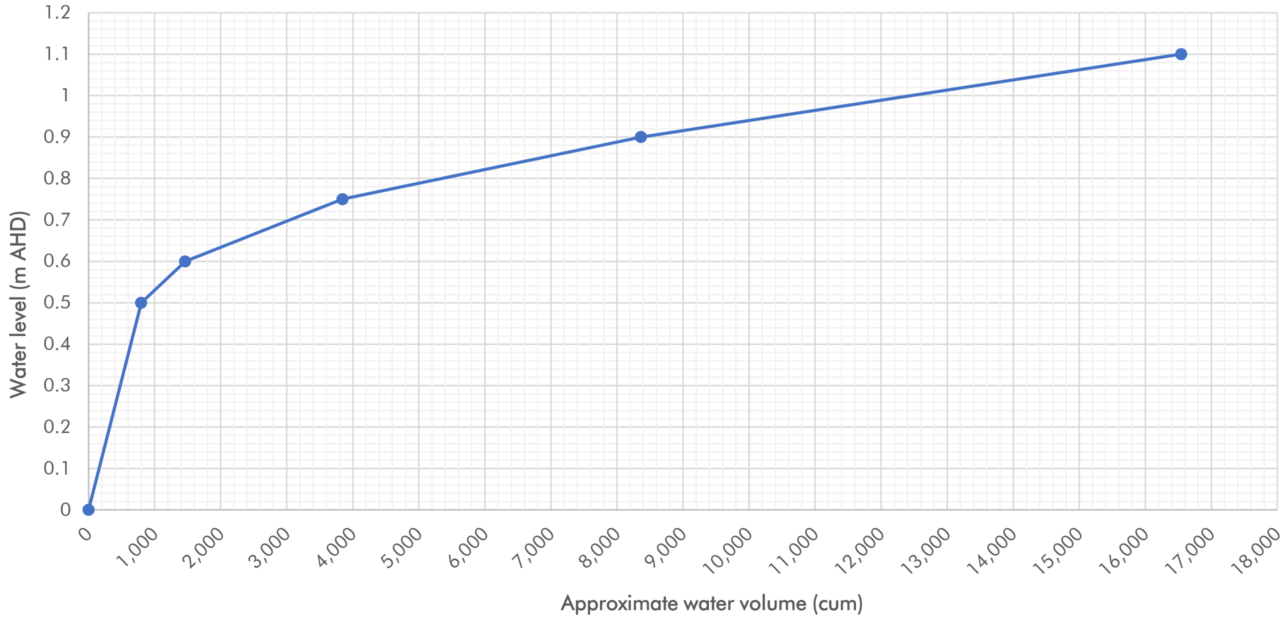

Figure 6 Wetlands approximate total stage-storage volume chart

1.3 TIDAL ENVIRONMENT

Powells Creek is a tidal waterway that joins the Parramatta River estuary at Homebush Bay. SOPA provided Powells Creek water level monitoring data for use in assessing tidal exchange in Mason Park wetlands, and a chart showing one month of the data is provided in Figure 7. The chart and analysis of the water level data show that Powells Creek has a diurnal tidal environment, with two high tides per day. The high tide levels for a 12 month period are provided in Figure 8 which can be directly compared to the bathymetry of the wetlands. Note that a mean high tide water level (nominally RL 0.6 m AHD) is equivalent to a relatively limited coverage of water in the wetlands as shown on the left side of Figure 5.

Figure 7 also shows that if the wetlands had an unrestricted connection to Powells Creek that they would beholding no water for a large portion of each day.

Water from Powells Creek is able to enter the wetlands at certain tidal levels through an inlet/outlet structure (See Section 1.5 for further details) and through the naturalised bank of Powells Creek. The tidal nature of the wetland has facilitated the growth of some specialised flora, such as saltmarsh and mangroves which has supported a rich diversity of migratory birds. The composition of vegetation in the wetlands is dependant on the frequency that vegetation is inundated with tidal water. Mangroves outcompete saltmarsh in areas where saline water regularly inundates the soil (daily or near daily). This means that saltmarsh is restricted to areas where the soil level is in the upper tidal zone. Saltmarsh species therefore have a preference for areas that are inundated on the highest spring tides.

The Powells Creek monitored water level data has been utilised to estimate the rates of tidal water flow into the wetlands through the inlet structure, as described in Section 1.5.

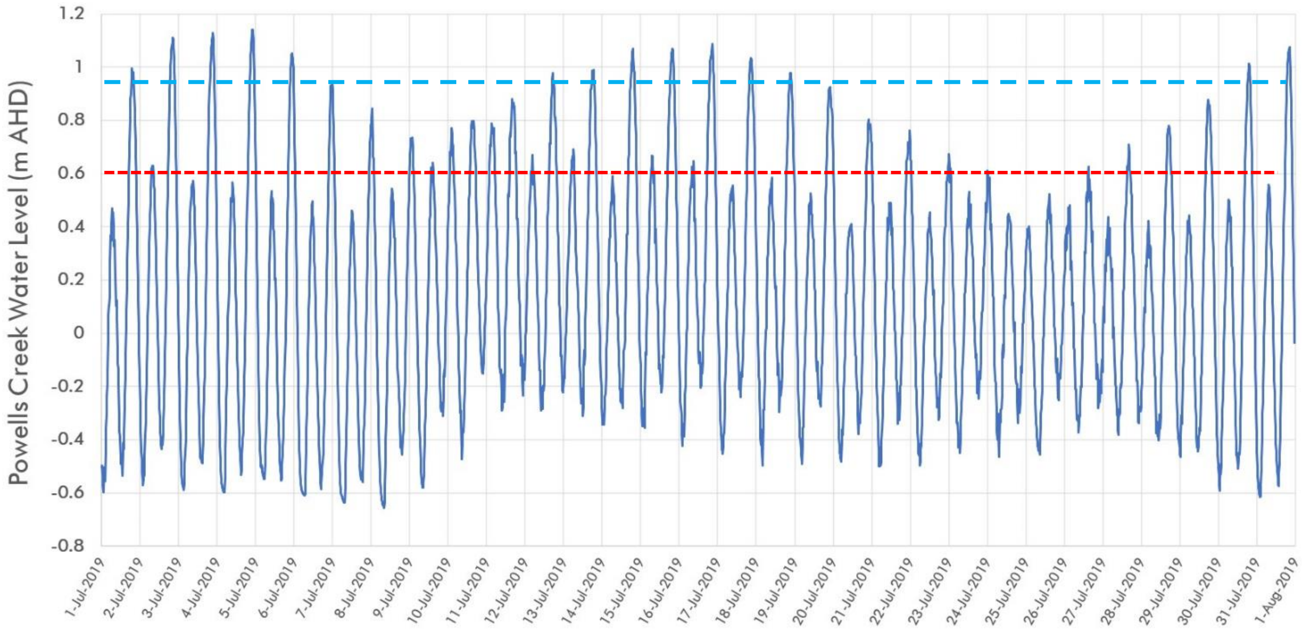

Figure 7 Tidal water level fluctuation over 1 month in Powells Creek, with nominal wetlands bed level (red dashed line) and 'full standing water level' (blue dashed line)

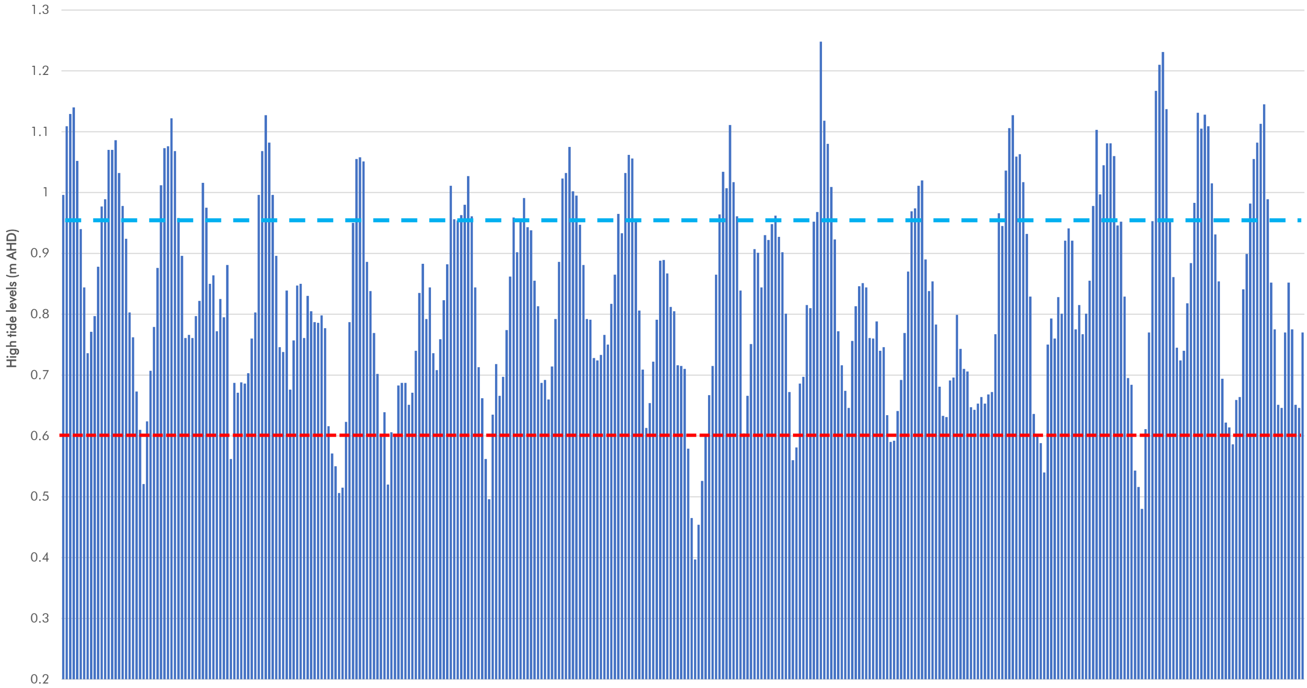

Figure 8 High tide levels in Powells Creek for 2019-2020, with nominal wetlands bed level (red dashed line) and 'full standing water level' (blue dashed line)

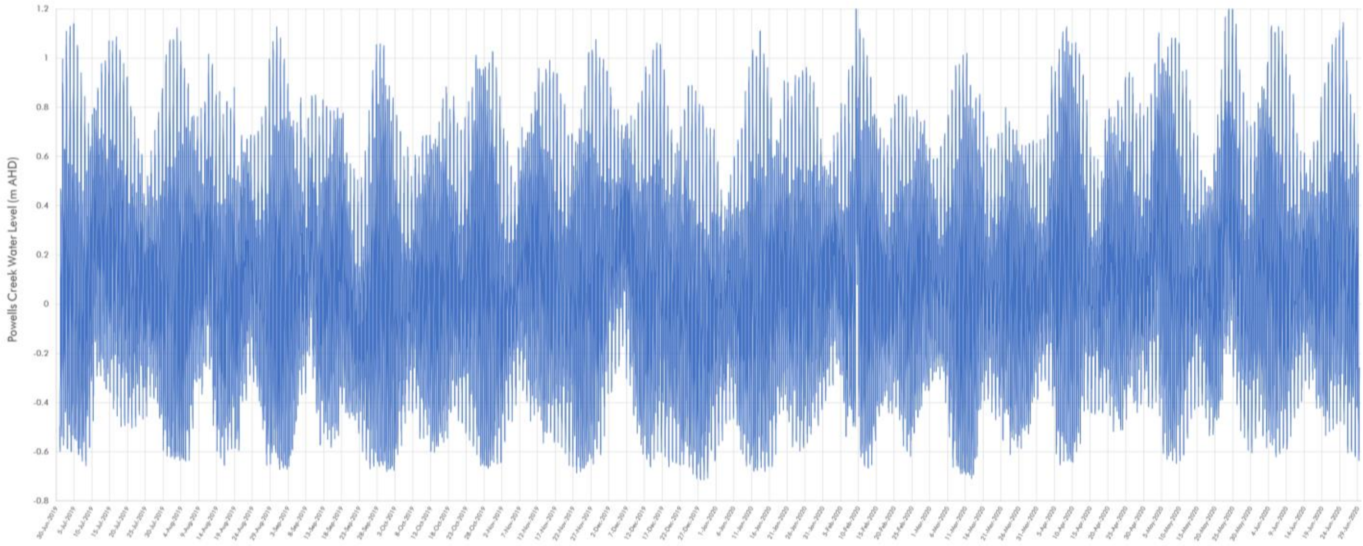

Figure 9 Powells Creek monitored water levels for 2019-2020

1.4 METEOROLOGICAL CONDITIONS

The evaporation conditions are worth considering due to the potential water losses from the wetlands in comparison to the amount of water that can enter the wetlands through the existing inlet/outlet structure. Evapotranspiration data for Sydney Olympic Park is provided in Figure 10, showing that during summer daily evapotranspiration can exceed 8mm. The actual loss from the wetlands is likely to be even more than this due to much of the wetland being more like pan evaporation.

When the water level in the wetlands is at the full standing water level (RL 0.95m AHD) the wetted surface area is estimated to be around 40,000 sqm. With a daily evaporation of 5mm, typical for summer months, the water lost from the wetlands by evaporation would be around 200 cum.

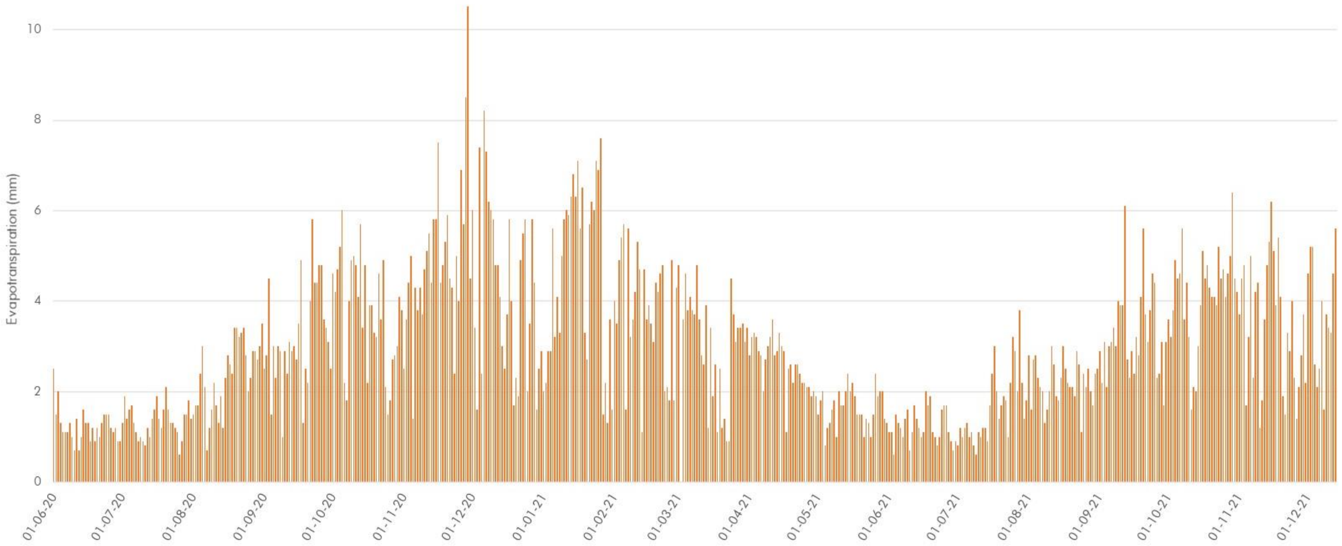

Figure 10 Evapotranspiration data for 2020-21, SOPA archery centre

1.5 CONNECTION TO POWELLS CREEK

As noted in Section 1.1, around 1988 a pipe connection was constructed at the north-eastern corner of the wetlands to allow water to enter the wetlands during high tides and drain out during high tides with some control using stop-logs.

The structure was upgraded around 2009 to increase the size of the connection and install two 'flap gates' (refer Figure 13), with each flap over a 450mm diameter penetration.

Figure 11 Existing inlet/outlet structure, at wetlands (L), grate over culvert on Powells Creek side (R)

The flap gates are fitted with hinges such that water can enter the wetlands during a high tide, if the water level in the wetlands is lower than the high tide level. The indicative diagram in Figure 12 shows flow *into* the wetlands occurring when the water level in Powells Creek is higher than the water level in the wetlands.

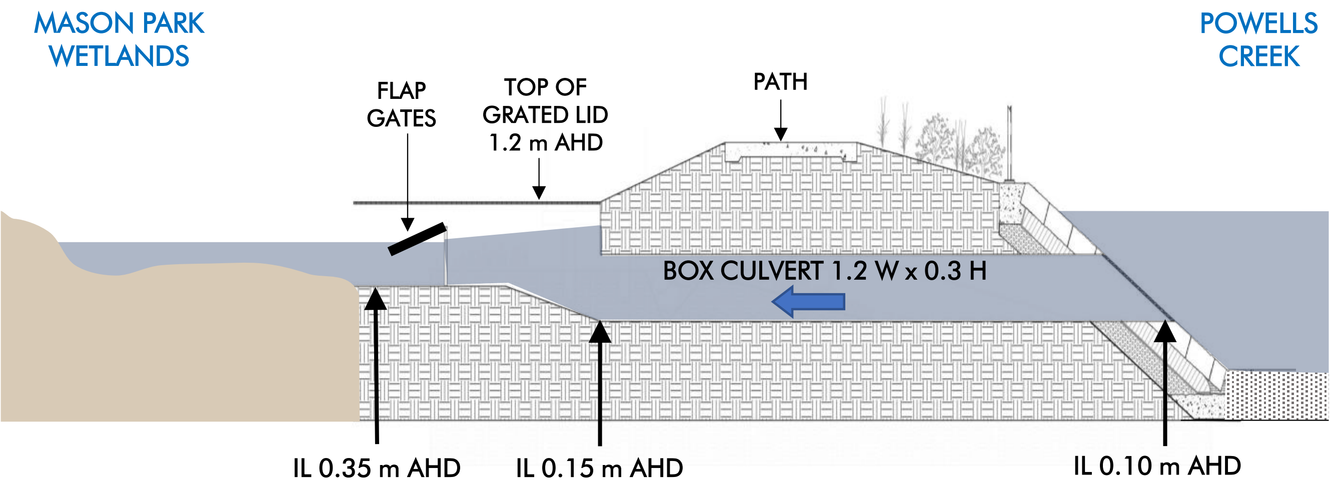

Figure 12 Existing inlet/outlet structure on Powells Creek at Mason Park

When the flap gates are left under normal operating conditions, during low tides (when the water level in Powells Creek drops) the flap gates remain closed and almost sealed, such that water is held at a higher level for an extended period of time (shown in the image on right side of Figure 13). The top of the flap gates is at RL 0.95 mAHD which is the normal standing/full water level in the wetlands when the flap gates are in place. With reference to the high tide data in Figure 8, around 15% of high tides result in a water level higher than 0.95m AHD. Thus if the wetlands are full to the standing water level most high tides in Powells Creek would not cause any water to flow into the wetlands.

The image on the left side of Figure 13 shows that the flap gates have at times been manually tied open to allow wetlands to fully drain.

 

Figure 13 Internal view of inlet/outlet structure, looking from wetland side when drained (L), looking from Powells Creek side with water held in the wetlands (R)

The flap gates have created a unique artificial water environment where the water is generally held in the wetlands throughout the low tides. A natural tidal soil bench positioned at the same elevation as the wetlands would ordinarily be allowed to freely drain during low tides to expose the sediment.

The flow rate that passes through the culvert is a function of the difference in water level on each side. The flow rate varies but the existing culvert could be considered as having a nominal capacity of around 300 – 400 L/s. If an objective for water management was put in place whereby the water level in the wetlands is to mirror the water level in Powells Creek then a connection with a nominal capacity of around 2000 – 3000 L/s would be required.

Give the constrained culvert connection between Powells Creek and the wetlands the volume of water required for full tidal exchange in high and low tides is not possible. Using the approximate wetlands bathymetry and the details of the pipe connection to Powells Creek the water level data has been utilised to review the current flow rates. Figure 14 shows that when the water level in the wetlands is low, it takes several very high high tides for the water levels in the wetlands to reach the standing water level, even with an assumption of all zones of the wetland being freely hydraulically connected.

Due to evaporation, some leakage through the flap gates and some assumed infiltration/exfiltration through the wetlands bed the water level in the wetlands gradually reduces to expose and dry out the bed sediments.

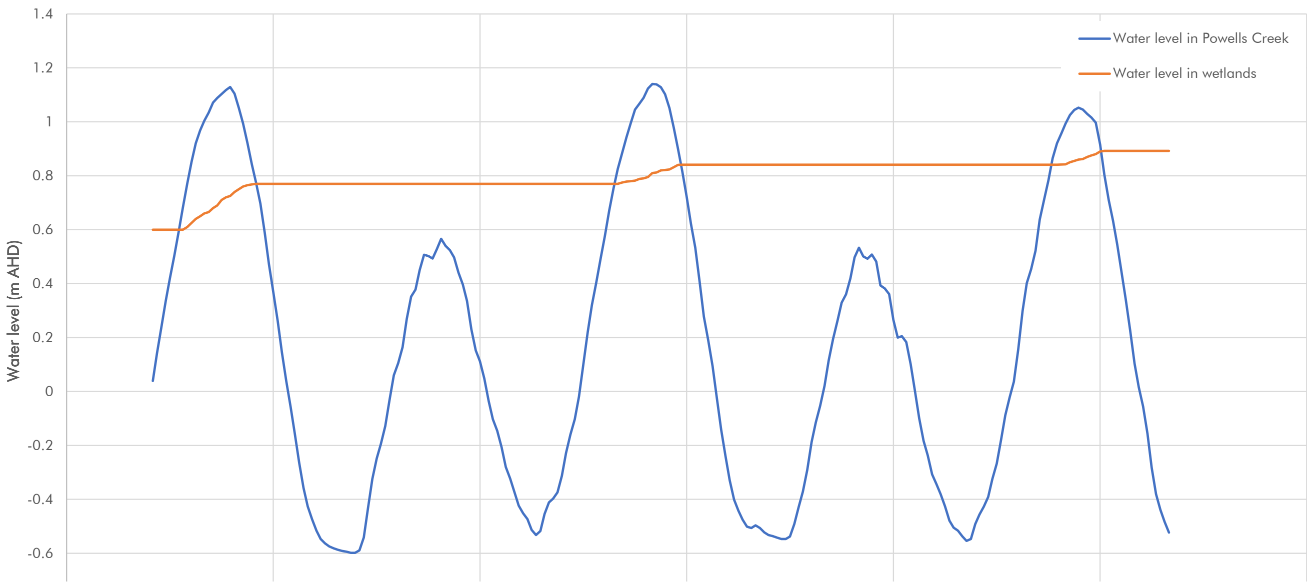

Figure 14 Inflows to wetlands over several high high tides

1.6 POWELLS CREEK NATURALISED EDGE

In 2018, Sydney Water conducted creek bank naturalisation works where the existing concrete channel walls of Powells Creek were removed and replaced with sandstone boulders and native plants (Figure 16).

The naturalised edge provides an additional means for tidal water input to Mason Park through two lengths (refer Figure 2) along the eastern boundary of the wetlands. The naturalised bank was constructed using sandstone pieces which are permeable and act as a 'leaky' wall, enabling water to travel into the wetland when the tides are high enough, as shown indicatively in Figure 15.

Based on design drawings provided by Sydney Water it appears that water flows through the naturalised sandstone edge into the wetlands at the base of the sandstone boulders, when the water level in Powells Creek is above 1.05 m AHD (Figure 15). Flows have been observed passing through the naturalised bank into the wetlands during a 'king tide' (Figure 17).

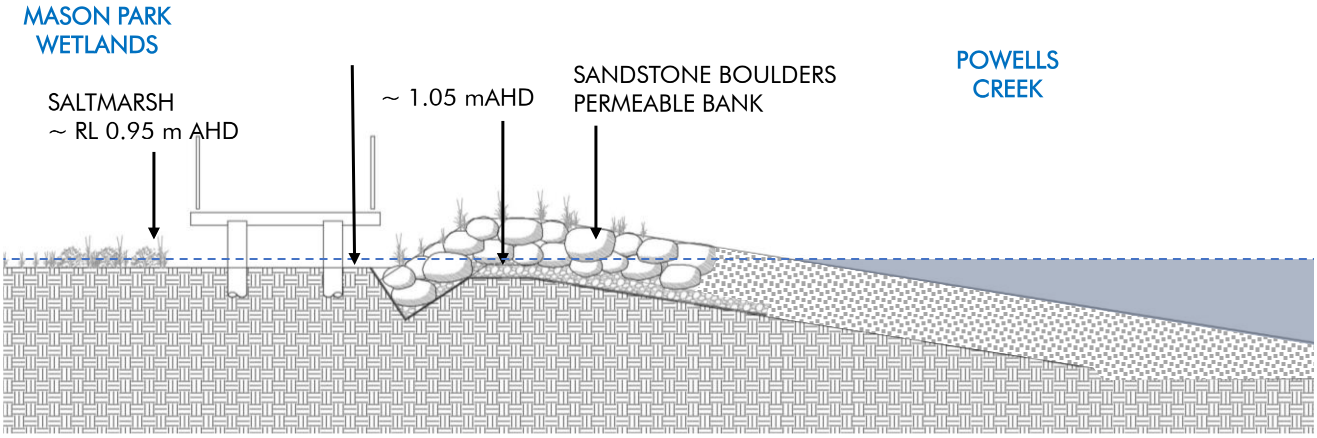

Figure 15 Indicative section through a portion of the naturalised section of Powells Creek

Figure 16 Powells Creek naturalised edge, looking north, with indicative flows

Figure 17 Water flowing into the wetlands during king tide via Sydney Water naturalised bank, looking south (June 2021)

1.7 WATER QUALITY

Water quality data has been collected periodically at various locations across Mason Park wetlands. In 1998, water quality monitoring was conducted at Mason Park Wetland between 5th June and 22nd September 1998. Results are provided below in Figure 18, Figure 19 and Figure 20.

Results from 1998 show that pH at the Wetland varied between 4-8.5 and generally sits at 6-6.5. Turbidity was moderately high and ranges between 35-89 NTU, to be expected in mudflat ecosystems. Dissolved oxygen was highly variable with values as low 1.5 mg/L and as high as 8.5 mg/L.

Date	5 June 1998	15 June 1998	26 June 1998	2 July 1998	23 July 1998
Time	10.00am	2.20pm	8.45am	8.55am	1.40pm
Recorders Name	Group Test	Jamie/Rob	Jamie/Louise	Jamie/Kristy	Jamie/Alana
Rainfall in last week - none, a little, a lot	A little	-	A little	Average	Average
Weather today	Mild, sunny	Overcast	Mild, sunny	Mild, overcast	Mild, overcast
Air temperature (C)	N/a	19	13.5	8.5	17
Water colour – clear, milky, brown, grey, black, green, muddy	Muddy/ semi clear	Clear/semi clear	Murky Brown/Green	Milky Brown	Semi clear Milky brown
Odours – rotten egg gas, fishy, earthy, musty, chlorinous, petroleum, sewage, chemical	None	Earthy	N/a	Earthy	Not tested
Surface film/scum – oily, green, red, black, coloured sheen, foamy	None	Green/Brown (very slight)	Slight	Scum a oil residue patch	Scum
Type of floating debris	Paper/plastic	Feathers	Feathers/paper	Feathers/paper	Moss scum
Type of rubbish on banks	Plastics	Plastic/paper	Paper/plastic	Paper/plastic	Plastic/paper
Water level	Average	Low	Average	Very low	Very low
Water velocity (m/s)	Slow/still	Slow/still	Slow still	Very very slow	Quick
Max depth at site (m)	1-2ft	1-2ft	1-2ft	1-2ft	1-2ft
Max width of water (m)	50m+	50m+	50m+	50m+	50m+
DO (mg/L)	7.1	8.5	5.7	8.2	7.0
DO (% saturation)	77%	84%	50%	68%	76%
BOD (mg/L)	Not tested	4.5	5.1	Not tested	Not tested
Temperature (C)	16.5	14.5	9	7	18
pH	4	6.4	6.5	6.0	6.0
TDS (ppm)	1960	1990	1990	1960	1990
Turbidity (NTU)	35	29	32	24	82
Available phosphates (mg/L)	0.1	0.16	0.11	0.03	0.06

Figure 18 Water quality results from 5th June to 23rd July 1998

Date	10 Aug 1998	19 Aug 1998	1 Sept 1998	11 Sept 1998	22 Sept 1998
Time	2.00pm	11.50am	11.25am	11.15am	11.50am
Recorders Name	Jamie/Heidi	Jamie/Lorraine	Jamie/Jordan	Jamie/Debbie	Jamie/Louise
Rainfall in last week - none, a little, a lot	A lot 98mm	A lot	Average	Little	Little
Weather today	Clear, sunny	Overcast showers	Hot, sunny	Overcast, showers	Partial cloud, hot & sunny
Air temperature (C)	22	21.5	22	20.5	26
Water colour – clear, milky, brown, grey, black, green, muddy	Muddy creamy/milky mud	Milky brown	Clear	Clear, muddy brown	Browny green
Odours – rotten egg gas, fishy, earthy, musty, chlorinous, petroleum, sewage, chemical	None.	Sewerage rotten egg gas salty earthy	None.	None.	None.
Surface film/scum – oily, green, red, black, coloured sheen, foamy	Sticks/leaves	None.	None.	None.	None.
Type of floating debris	Sticks/leaves	Scum off bottom	Pond scum	Mangrove seeds, sticks, algae	Algae.
Type of rubbish on banks	Wood/paper debris	Wood/paper	Wood/paper	Bottles, paper	Leaves/wood.
Water level	Very High	High	Average	Medium	Average
Water velocity (m/s)	Negligible	Slow	V slow	U slow	U slow
Max depth at site (m)	1-2ft	1-2ft	1-2ft	1-2ft	1-2ft
Max width of water (m)	50m+	50m+	50m+	50m+	50m+
DO (mg/L)	6.5	4.0	2.9	1.5	2.0
DO (% saturation)	68%	42%	30%	15%	22%
BOD (mg/L)	2.1	Not tested	Not tested	Not tested	Not tested
Temperature (C)	18	17.5	19.5	17	22
pH	6.0	6.0	6.5	7.3	7.3
TDS (ppm)	1760ppm	1810ppm	4.5ppt	7.7ppt	16.4ppt
Turbidity (NTU)	73	52	32	32	14
Available phosphates (mg/L)	0.48	0.24	0.1	0.08ppm	0.05ppm

Figure 19 Water quality results from 10th August to 22nd September 1998

AREA		10 AUG	19 AUG	1 SEPT	11 SEPT
1	TDS	1760PPM	1810PPM	4.5PPT	7.7PPT
	PH	6	6	6.5	7.3
2	TDS	-	-	-	8.3PPT
	PH	-	-	-	6.7
3	TDS	2.7PPT	1260PPM	5.5PPT	8PPT
	PH	-	-	8	6.7
4	TDS	2.6PPT	1150PPM	5.1PPT	7.1PPT
	PH	-	-	8	7
5	TDS	2.5PPT	1360PPM	4.5PPT	6.5PPT
	PH	-	-	8.5	7
6	TDS	-	-	-	15.4PPT
	PH	-	-	-	>5

Figure 20 Additional results for pH and total dissolved solids (TDS)

Water quality data was also collected by Applied Ecology in two locations at Mason Park Wetland on 27th August 2021 with the results provided in Table 1. Site 2 is located at the inlet/outlet structure in the northeast corner of the wetland. Site 7 is located at the rear of the Wetland adjacent to the footpath in the southwest corner of the mudflat area. Powells Creek sampling was completed at the footbridge northeast of the Wetland.

In comparison with Powells Creek, the Mason Park Wetland sites appear to be slightly more acidic, sitting at pH 6-7 and Powells Creek at pH 8.6. Dissolved oxygen was generally similar between site 2 and Powells Creek (3.66 and 4.20 mg/L respectively), but substantially lower at site 7.

Table 1 Physicochemical water quality data collected by Applied Ecology, 27th August 2021

	Site 2	Site 7	Powells Creek
Temperature (°C)	19.29	15.42	15.34
SPC	36.5	53	33.5
DO (mg/L)	3.66	0.98	4.20
pH	6.76	7.63	8.6
Salinity	22.8	34.52	20.48
DO (%)	23.85	11.8	45.7

Potential acid sulfate soils in mudflat areas have been a concern for Mason Park Wetland. However, the limited available data shows that water quality tends be relatively good, including for pH. Given the limited data available it is recommended that further water quality monitoring be undertaken to improve understanding of the impacts of potential acid sulfate soils at the site.

1.8 STORMWATER CATCHMENTS

Previous reports described a freshwater wetland zone at the southeastern corner of the wetlands. This is likely to have been a result of stormwater runoff into the wetlands from the sportsfields. Based on site observations stormwater runoff from the synthetic sportsfield would still be flowing into the wetland during larger rainfall events.

The stormwater generated within the Ausgrid site discharges to Powells Creek via a stormwater pipeline that runs along the southern boundary of the Mason Park wetlands. A scheme was constructed in 2015 to divert stormwater from this pipeline into a storage tank in Mason Park. The stormwater diversion, GPT, and storage tank have been partially covered by the synthetic field works and the current condition is unknown.

2 OPTIONS FOR WATER MANAGEMENT IMPROVEMENTS

2.1 UPGRADE EXISTING INLET/OUTLET STRUCTURE

As outlined in Section 1.5 the existing pipe connection between the wetlands and Powells Creek has limitations both in the rate of flow that can pass through, as well as the functionality and operability.

The existing flap gates appear to cause additional hydraulic loss, reducing the flow rate, during very high tide events. The existing two 450mm diameter openings provide an open area of approximately 0.32 sqm and the cross sectional area of the existing box culvert that runs from Powells Creek under the footpath is 0.36 sqm. Given this only a limited increase in flow rate could be achieved through the replacement of the gates. The primary driver for installing new gates would be to improve the operability of the system such that Council staff could remotely monitor the water levels and operate the gate when required.

Figure 21 shows the existing elements that are recommended to be replaced within the existing inlet/outlet structure. A new system is recommended to be retrofitted to the existing pit including a motorised single leaf gate, water level sensors, and a control system with PLC and remote telemetry. A new power supply would be required, with the possibility of a stand-alone solar-battery powered system.

An upgraded motorised and automated gate control structure would facilitate flexibility in operation of the wetlands and allow Council staff to easily monitor the water level in the wetlands and Powells Creek and take appropriate management actions.

The installation of an automated gate to the existing inlet/outlet structure could be undertaken as an interim stage of the more significant wetland improvement works, as the installed equipment would also be used in conjunction with an additional inlet structure as outlined in Section 2.2.

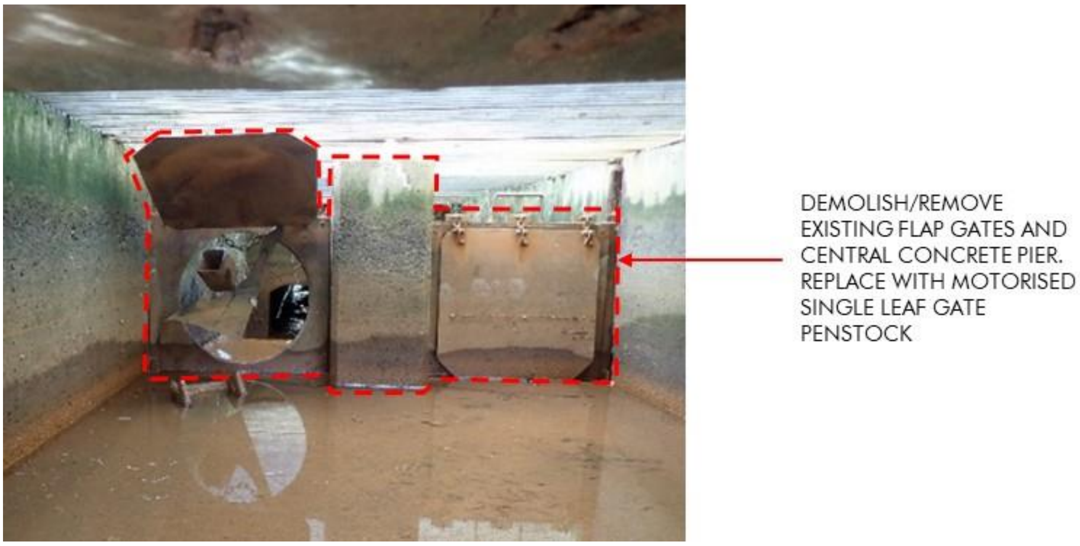

Figure 21 Components to be removed and replaced in existing inlet/outlet structure

2.2 IMPROVE WATER CONVEYANCE WITHIN THE WETLANDS

As described in Section 1.2, the volume of water that enters the wetlands during a high tide is limited partially by the connections between the different wetland zones.

Improving the hydraulic capacity within the wetlands would aid in the replenishment of water to the wetland after a drying out episode.

The contamination and potential acid sulfate soils conditions would be a constraint for these works, but it would likely be feasible to undertake some embellishment of existing constrained linkages with minor excavation whilst following appropriate contamination and PASS management controls. Four key links between wetland zones are shown in Figure 22.

Figure 22 Key locations for possible hydraulic link embellishment

2.3 CONSTRUCT ADDITIONAL INLET/OUTLET STRUCTURE

As outlined in Section 1.5 the existing 0.3 x 1.2m box culvert does not provide sufficient hydraulic capacity for the water level in the wetlands to rise at the same rate as the water level in Powells Creek. Previous studies have also recommended that an additional structure be installed to connect the wetlands to Powells Creek.

The sizing of the new connection will need to be carried out based on the objectives for how water is to move in and out of the wetlands which are still to be resolved. If the objective is for the water level in the wetlands to closely mirror the water level in Powells Creek then a large connection with a cross sectional area of approximately 2 – 3 sqm would be required. This may be provided via a series of box culverts or an open channel connection through the SWC naturalised bank.

With a new inlet/outlet structure located at the southern side of the wetlands then additional benefits could be achieved through the sequencing of the two gates. Figure 23 shows an indicative operational sequence where water flows *into* the wetlands during a rising tide via the new southern gate structure and water flows *out of* the wetlands via the northern structure during a falling tide. This operation would allow for better turnover/flushing of the water volume within the wetlands and an associated improvement in water quality.

The new connection with greater hydraulic capacity and automated gate control system would:

- Limit the frequency of the wetlands drying out, and limit the potential for hypersaline conditions
- Increase inundation of the *Wilsonia* area during 'king tides'
- Allow for fine control of water level in the wetlands. This may be used for other management objectives, for example, the water level may be held at a higher level at night time during nesting season, to discourage foxes from entering the wetlands.

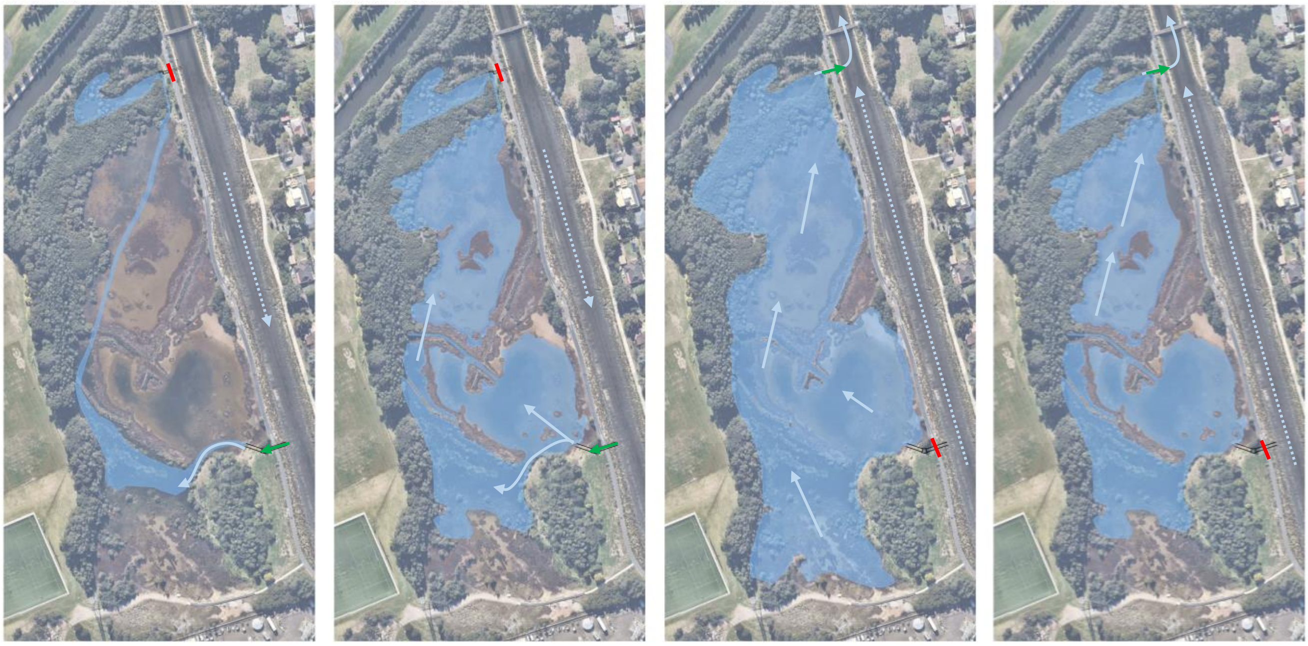

Figure 23 Indicative flows with staggered operation of two automated gates

Figure 24 Example of automatic water control gate systems

The two preliminary options for the new connection shown indicatively in Figure 25 are an open channel option and a box culvert option. Both would require further modelling and assessment and consultation with Sydney Water. An open channel in the location shown may allow for a smaller excavation volume, and would provide an obvious visual connection between the wetlands and Powells Creek below the boardwalk. A box culvert option would keep most of the new infrastructure hidden but may require a higher budget than the open channel option.

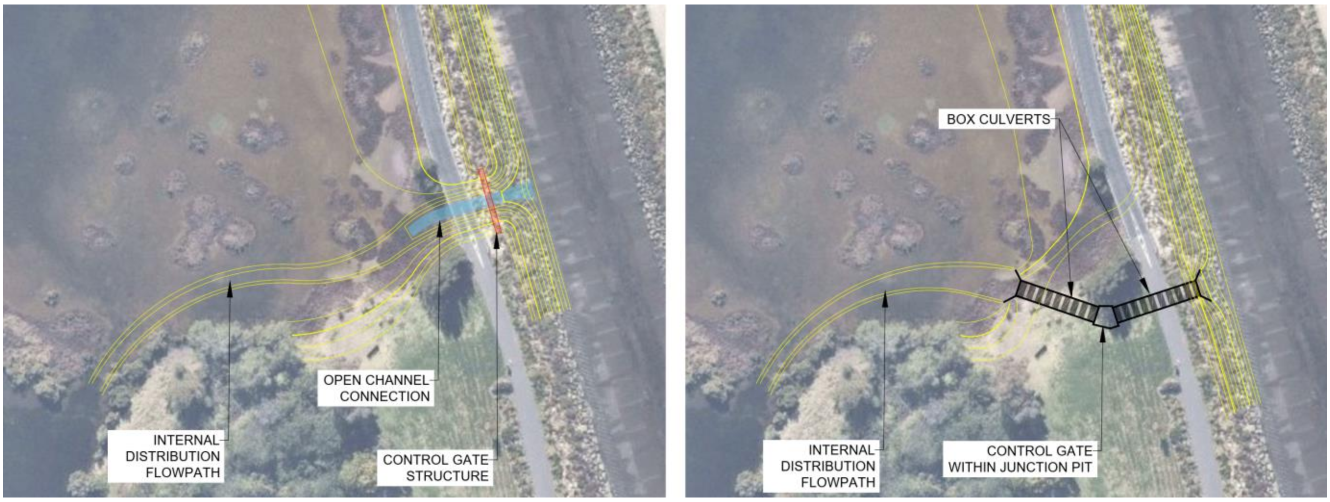

Figure 25 Indicative preliminary options for new inlet structure

2.4 CONSTRUCT NEW FRESHWATER WETLAND

As outlined in Section 1.8, past studies have reported that an area of freshwater (*cumbungi*) wetland existed at the southwestern side of the wetlands, and Applied Ecology have indicated that there would be some benefits from reintroduction of a freshwater habitat within Mason Park.

With the existing stormwater harvesting infrastructure already in place at the sportsfields and not being used an opportunity exists to utilise this infrastructure for supply of harvested stormwater to a new constructed freshwater wetland, as shown in Figure 26.

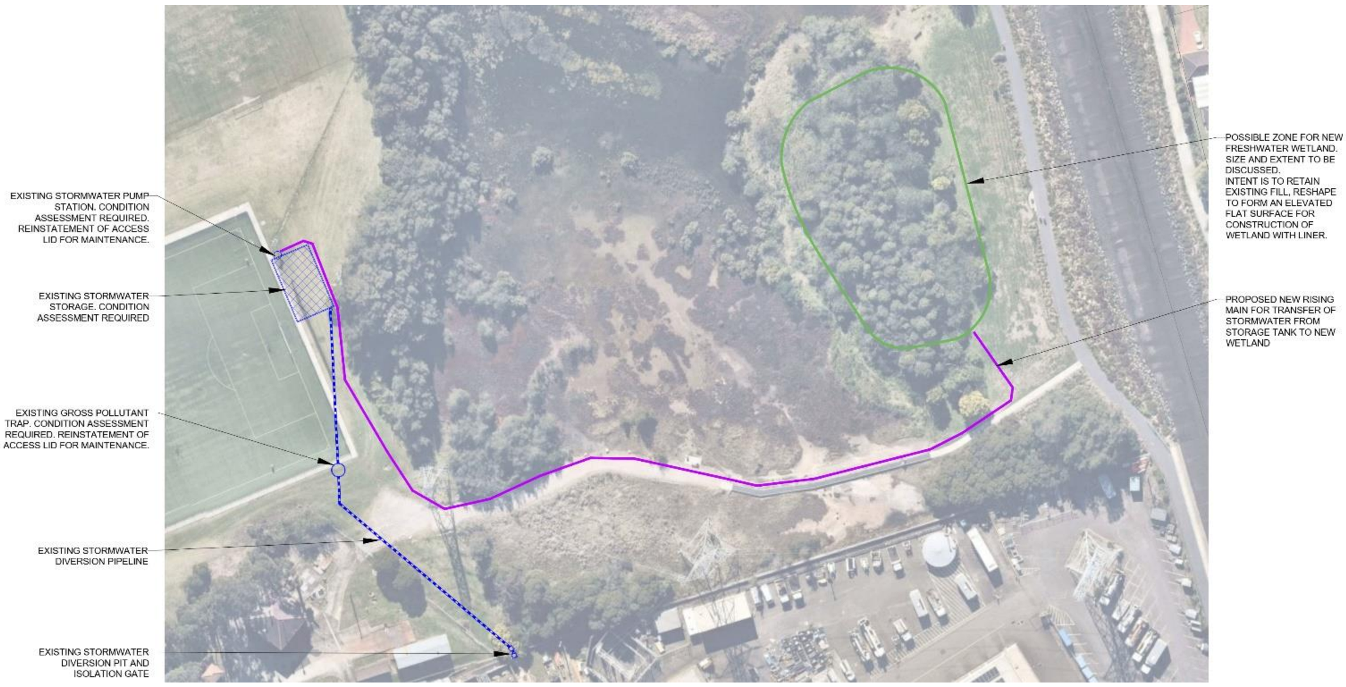

Figure 26 Indicative concept for new constructed freshwater wetland

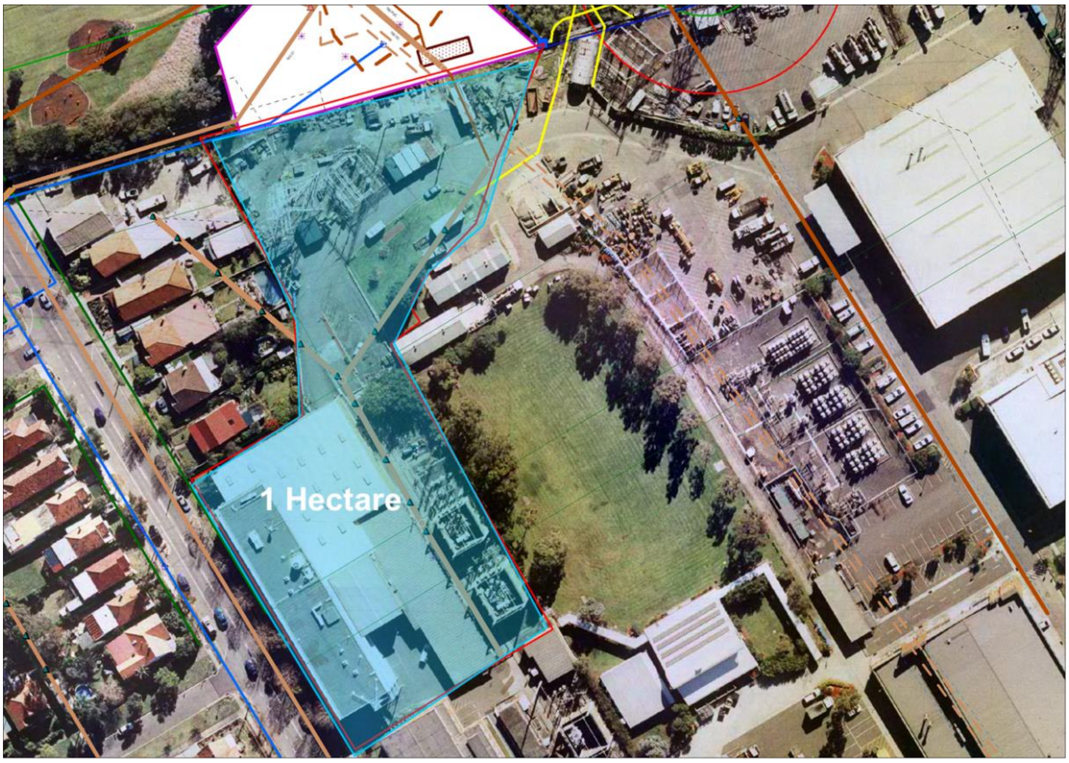

Figure 27 Approximate extent of stormwater catchment for existing harvesting system

3 DISCUSSION

Mason Park wetlands is an intertidal mudflat ecological community. The tidal nature of the wetlands along with the artificial control of water levels has created a unique environment allowing the growth of specialised flora, primarily saltmarsh and mangroves. Tidal flushing is an important process in estuarine environments that drives productivity. It has been demonstrated that structures that impede the tidal flushing process impact adversely on vegetation, fish, invertebrates and plankton in estuarine wetlands (Sainty 2008). The existing inlet/outlet structure has promoted growth of mangroves (*Avicennia marina*) in the northern and western portions of the wetland where they are encroaching into saltmarsh areas due extended inundation and poor tidal flushing. The wetlands support a number of saltmarsh species including Beaded Samphire (*Sarcocornia quinqueflora*), Seablite (*Sueda australis*), Little Noon-flower (*Lampranthus tegens*) and the locally rare Narrow-leaved Wilsonia (*Wilsonia backhousei*).

Like other estuarine wetlands, the hydrology of the Mason Park wetland dictates the distribution and composition of flora across the site. The composition of vegetation at the wetlands is dependent on the frequency and period that vegetation is inundated with tidal water. Mangroves outcompete saltmarsh in tidal zones where shorelines are inundated daily or near daily. This means that saltmarsh is restricted to areas in the upper tidal zone. Saltmarsh species therefore are supported by inundation only on the highest spring tides.

The two most dominant vegetation types/communities in Mason Park wetlands are mangroves and saltmarsh. There is an opportunity to manage the hydrology of Mason Park wetlands to support or suppress either one of the two vegetation communities. For example, a management strategy that only allows water to flow into the wetlands during the highest spring tides will facilitate saltmarsh growth across the site. Alternatively, a water management strategy that enables the wetland to be inundated entirely on a daily basis would support the expanse of mangroves across the site.

Different water management regimes support different vegetation assemblages which in turn support different faunal compositions. The site has historically supported a rich diversity of migratory waders. The site has been home to 20 migratory birds species listed in the Japan Australia Migratory Bird Agreement (JAMBA) and 19 species listed in the China Australia Migratory Bird Agreement (CAMBA). Species are likely to have different requirements but generally migratory waders require open tidal mudflats to forage for macroinvertebrates and clear sight lines to enable early detection of predators.

Historically, tidal flushing and drying out has been a major issue for the Mason Park wetland. The box culvert at the existing inlet/outlet structure is undersized, and does not allow enough water to enter and leave the wetlands during tidal cycles. The high-level options proposed in this review can provide different levels of intervention and are summarised in Table 2.

Table 2 Summary of potential works for improved water management in wetlands

Option			Indicative cost	Intended outcomes			Other consider-ations
				Improved management/ operability of wetland water	Improved water penetration/ circulation	Ecological Aspects	
1a	Upgrade existing inlet/ outlet structure at northeastern side of wetlands	… replace flap gates with automated motorised gate system	$150,000	✓ Council would have remote operation of gate, and monitoring of water level in northern mudflats. Gate could be adjusted for adaptive management of sea level rise.	N/A	✓✓ Allows some control of water levels during breeding seasons reducing predation risk	
1b		… and replace existing box culvert with larger box culvert	$250,000	N/A	✓✓ Larger volume of water able to enter on incoming tides	✓ Reduced frequency of wetlands drying out	Works to existing box culvert may be more straight-forward for approvals
2	Improve hydraulic links within wetland		$150,000	N/A	✓✓ Water able to circulate between mudflat basins, improves wetland flushing	✓ Reduced frequency of wetlands drying out	
3	Construct new larger inlet/outlet structure to Powells Creek at southern side of wetlands		$700,000	✓✓✓ Council would have remote operation of two gates, and monitoring of water level in both northern and southern mudflats. Gate could be adjusted for adaptive management of sea level rise.	✓✓✓✓ With two connections turnover of water can be achieved, improving tidal flushing of wetland.	✓✓✓ Reduced frequency of wetlands drying out. Would allow for better inundation of *Wilsonia*.	
4	New freshwater wetland on fill mound		$600,000	N/A	N/A	✓ Diversify habitat at the site for different species	

4 REFERENCES

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