



# MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS

## J. WYNDHAM PRINCE



**Catchment Management  
Authority**  
Sydney Metropolitan



## Still Creek Wetland Management Plan

*Final Report February 2012*







# **Still Creek Wetland Management Plan**

## **FINAL REPORT**

for

**Sutherland Shire Council and Sydney Metropolitan Catchment  
Management Authority**

by

**Molino Stewart Pty Ltd**

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**and**

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## GLOSSARY

**AMSL** – above mean seal level

**Anthropogenic:** caused or produced by humans ([www.dictionary.com](http://www.dictionary.com))

**AHD** – Australian Height Datum: a common national surface level datum approximately corresponding to mean sea level.

**ANZECC** – Australian and New Zealand Environment Council

**ARI** – Average Recurrence Interval: is the average or expected value of the period between exceedances of a give discharge.

**Catchment** - an area of land from which all runoff water flows to a low point (river, creek harbour, etc). ([www.stormwater.net.au/definitions](http://www.stormwater.net.au/definitions))

**Climate Change** - is a long-term change in the statistical distribution of weather patterns over periods of time that range from decades to millions of years. (Wikipedia accessed 16/11/10).

**Endangered Ecological Community** – a group of species that occur together in a particular area of the landscape that are listed on Schedule 1 of the *NSW Threatened Species Conservation Act 1995*

**GPT** - gross pollutant traps are used to prevent large items from polluting waterways

**HAT** – Highest Astronomical Tide: is the highest tide which can be predicted under any combination of astronomical conditions and average meteorological conditions. Higher tides can occur under extreme meteorological and oceanographic conditions. (*NSW Tide Charts 2009, NSW Public Works*)

**Hydrology:** the science dealing with the occurrence, circulation, distribution, and properties of the waters of the earth and its atmosphere. ([www.dictionary.com](http://www.dictionary.com))

**Impervious** surfaces that do not allow water to penetrate, such as roof, driveways, paths, paving etc. (adapted from “Stormwater Detention” [www.stormwater.net.au/definitions](http://www.stormwater.net.au/definitions))

**ISLW** – Indian Spring Low Water: is the lowest level to which a tide will fall under exceptional, predictable, astronomical conditions. It seldom occurs. Meteorological and oceanographical influences, which cannot be predicted, can cause the tide to fall even lower. (*NSW Tide Charts 2009, NSW Public Works*)

**LAT** – Lowest Astronomical Tide: is the lowest tide which can be predicted under any combination of astronomical conditions and average meteorological conditions. Lower tides can occur. (*NSW Tide Charts 2009, NSW Public Works*)

**MHW** – Mean High Water: The average elevation of all high waters recorded at a particular point or station over a considerable period of time, usually 19 years. For shorter periods of observation, corrections are applied to eliminate known variations and reduce the result to the equivalent of a mean 19-year value. All high water heights are included in the average where the type of tide is either semidiurnal or mixed.

**MHWS** – Mean High Water Springs: is the average level of the Spring high tides which occur in the New and Full Moon. (*NSW Tide Charts 2009, NSW Public Works*)

**MSL** – Mean Sea Level: the average height of the surface of the sea for all stages of the tide over a 19-year period, usually determined from hourly height readings.

**OSD** – On Site Detention: is the temporary on site storage of stormwater with a controlled release into the drainage system. (adapted from “Stormwater Detention” [www.stormwater.net.au/definitions](http://www.stormwater.net.au/definitions)).

**PMP** – Probable Maximum Precipitation: the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of year. (BOM, 1994).

**PMF** – Probable Maximum Flood: is the flood that occurs as a result of the runoff generated by the Probable Maximum Precipitation.

**RAMSAR** – The international convention on wetlands, an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their wetlands of international importance.

**SLR** – Sea Level Rise: as oceans warm, they expand and take up more space; therefore, any increase in global temperature will result in sea level rise, which relates specifically to the long term trend in movement of mean sea level.

**SSC** - Sutherland Shire Council.

**SSDCP** - Sutherland Shire Development Control Plan.

**SSLEP** - Sutherland Shire Local Environmental Plan.

**SWaMP** - Strategic Water Monitoring Program.

**VMP** - vegetation management plan.

**WSUD** – Water Sensitive Urban Design: the planning and design of urban environments that is ‘sensitive’ to the issues of water sustainability and environmental protection.

## ACKNOWLEDGEMENTS

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## EXECUTIVE SUMMARY

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Still Creek Wetland was constructed in 1995 by the developer of the adjacent residential subdivision to control sediment in runoff during the civil construction stage of the subdivision. Upon completion of the civil works the sediment control basin was decommissioned and then re-commissioned as a constructed wetland with the goals of improving the water quality in Still Creek and attenuating the runoff from the Mina Road residential subdivision.

The wetland has a surface area of approximately 1,800 square metres and a maximum depth of about 2 metres. It is situated within the upper reaches of Still Creek within a 55 hectare residential catchment. Native vegetation adjoins the eastern side of the wetland and extends upstream as a riparian corridor to MacMahon Place. This vegetation contains species consistent with those representative of a Shale Sandstone Transition Forest, an endangered ecological community (EEC) listed at the State level in the *NSW Threatened Species Conservation (TSC) Act 1995* and at the National level in the *Environment Protection and Biodiversity Conservation Act 1999*. Unfortunately urban development has adversely impacted on the vegetation and it has become heavily infested with weeds.

The community have placed a high value on Still Creek Wetland; for visual amenity, as a natural area adjacent to their homes, for the presence of open water and as an area for passive recreation particularly for young families. However there was not a high level of understanding of the potential direct impact local residents may have on Still Creek Wetland. For example it was not well understood that water from the roofs, local roads and yards entered Still Creek and the wetland.

Still Creek Wetland has the capacity to store a substantial volume of runoff on top of its permanent storage volume and release this volume at a controlled flow rate over a much longer period of time. This method of storing the excess runoff and releasing it in a controlled manner is intended to prevent the peak flows within Still Creek, downstream of Mina Road, from exceeding those which would occur prior to the development of the site. The management measures outlined in this plan will not diminish the flood attenuation role afforded by the Still Creek Wetland.

Climate change projections for the Sydney Region anticipate that rainfall intensities and annual runoff volumes will increase into the next century. However, there appears to be sufficient redundant storage volume within the parkland surrounding the Still Creek Wetland, to accommodate the additional runoff volumes. This prediction is subject to confirmation by additional hydrologic and hydraulic modelling, but the obvious difference in level between the surrounding properties and the low point in Mina Road, suggests that the surrounding properties will remain flood-free and only the parkland will be subjected to more frequent flooding.

Sediment generated by the construction of houses and the erosion of Still Creek upstream of the wetland has resulted in the accumulation of sediment within the wetland and the formation of an island which has been colonised by weeds. Sutherland Shire Council (SSC) has removed this sediment in the past and has a regular cleaning program for the Gross Pollutant Trap (GPT) upstream of the wetland. These actions have helped to maintain the viability of the wetland and modifications to the GPT are recommended to improve its ability to capture and retain sediment, and gross pollutants, which in turn will provide greater protection for the wetland.

Issues critical to the sustainable management of the wetland include:

- Control of sediment, solid waste and nutrients in the inflows;
- Safe access to the wetland infrastructure for maintenance staff and control of public access to those areas which may pose a risk to public health and safety;
- Removal of the weeds from the riffle area immediately downstream of the existing GPT;
- Removal of the existing sediment island within the wetlands and the weeds that have established upon it;



- Installation of a floating reed bed consisting of native plants indigenous to the area that will assist in the removal of nutrients and suspended solids from the water column;
- Repair of the existing outlet pipes to prevent the uncontrolled draining of the wetland and possible damage to the outlet structure;
- Screen planting around the concrete high level outlet structure to reduce its starkness and visual impact on the park.

The management strategies recommended herein for the Still Creek Wetland have been developed to take into account the key issues identified for the wetland infrastructure and the environment whilst addressing the community and riparian corridor values for the wetland, park and creek line. Other issues that have been considered in the recommendations referred to herein also take into account Council's desire to improve water quality and riparian habitats within Still Creek. The actions associated with the proposed management strategies identified for Still Creek Wetland include:

- retrofitting infrastructure (GPT);
- repair low flow outlet pipe;
- dredging of the wetland;
- install floating reed bed;
- replace fencing adjacent to wetland inlet;
- water quality and macro invertebrate monitoring;
- flood attenuation and climate change;
- vegetation and weed management
- enhance the riffle zone downstream of GPT;
- outlet structure screening;
- community education;
- community consultation and engagement

The management strategies and actions have been prioritised and cost estimates have been presented in Appendix G to this Management Plan.



# 1 INTRODUCTION

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## 1.1 THE MANAGEMENT PLAN

The Still Creek Wetland Management Plan has been prepared to

*“provide Council with management options to improve the water quality, [control downstream flooding] and [enhance the] riparian habitat of the wetland and adjacent environments”*

Sutherland Shire Council (2011).

As the management plan was developed additional overarching objectives emerged, these include:

- *to enhance the function of the wetland infrastructure through an improved maintenance regime that allows the Still Creek Wetland to function efficiently;*
- *to improve riparian and aquatic habitat condition and values in and around the wetland;*
- *to maintain and improve the aesthetic and recreational values of the wetland and adjoining park land; and*
- *to raise awareness of the values of the wetland and increase the capacity of the community to care for and contribute to the management of the wetland.*

The management plan also aims to reflect the community's concerns and aspirations for the wetland and surrounding area.

The management plan contains a description of the wetland and an examination of its hydrology, environmental values, and social values. Relevant policies, acts and strategies are also considered. An issues analysis is presented along with management strategies to address issues and to enhance values. Management objectives and actions are prioritised and costed and potential funding sources identified. A monitoring plan for wetland management is also presented.

## 1.2 SCOPE OF THE PLAN

As indicated above the plan aims to document management options and identify issues around wetland management. Management

strategies and actions have been developed to improve water quality and riparian habitat. The monitoring plan provides a guide for assessing the effectiveness of management actions.

The Management Plan should be reviewed every five years to enable the effectiveness of the recommended management actions to be considered and updated with new information or technology and community concerns. Wetland management actions should be reviewed annually and reported within the framework of Sutherland Shire Council's (SSC) reporting commitments.

A companion document to this plan has been prepared, the Still Creek Wetland vegetation management plan (VMP) (Molino Stewart 2012). The VMP sets out specific vegetation management strategies and actions to improve the condition of vegetation in and around Still Creek Wetland.

## 2 SITE SETTING AND CONTEXT

### 2.1 LOCATION AND SETTING

Still Creek Wetland is located approximately 35 kilometres south west of Sydney on Still Creek adjacent to Mina Road in Menai in the Sutherland Shire. The wetland is approximately 500 metres in distance below the ridgeline at Menai Road and approximately 4 kilometres upstream of the Woronora River. The Woronora River is a tributary of the Georges River.

Still Creek Wetland is a constructed wetland that was developed in 1995 to improve the water quality in runoff from the Mina Road residential subdivision. Between 1930 and 1970, and prior to development as a residential sub division land adjacent to the Still Creek Wetland was used as a market garden between 1930 and 1970. From 1970 onwards the land was left in a natural state until residential development began in the surrounding areas between mid-1984 and the mid-1990s.

The wetland has a surface area of approximately 1800 square metres. It has been constructed within the upper reaches of Still Creek. It has a substantially residential catchment of approximately 55 hectares.

A 40 metre wide vegetated riparian corridor extends around 400 metres upstream of the wetland to MacMahon Place. The vegetation is mapped as Sydney Sandstone Gully Forest on Sutherland Shire Council's vegetation map but exhibits species consistent with Shale Sandstone Transition Forest, an endangered ecological community (EEC) listed at the state and national level (see section 5). This bushland has been subject to bush regeneration in the past (SSC 2006). The large volume of sediment that is collected by the wetland was acknowledged as far back as 2000 (SSC 2000). The location of the wetland is shown in Figure 1.

### 2.2 LAND TENURE AND ZONING

The Still Creek Wetland is owned by Sutherland Shire Council. The legal ownership description and zoning are presented below in Table 1.

Table 1: Land Ownership Still Creek Wetland

Legal Description	Owner	Zoning
Lots 442 DP854841	Sutherland Shire Council	SSLEP 2006 as Zone 13 Public Open Space

The Still Creek Wetland and upstream riparian corridor are included in the Sutherland Shire Council Local Environment Plan 2006. The wetland is covered by zone (13) Public Open Space. The upstream riparian corridor is covered by zone (14) Public Open Space (bushland). The zones are shown in Figure 2.





Figure 1: Still Creek Wetland location





Figure 2: Still Creek Wetland zoning.

The objectives of Zone 14—Public Open Space (Bushland) set out in SSC (2006b) include:

- (a) to enable development that facilitates recreation and preserves natural bushland areas located on publicly owned land,
- (b) to allow development that does not adversely affect natural bushland or wildlife corridors,
- (c) to protect public open space that is of environmental significance,
- (d) to ensure that flora and fauna habitats are protected and preserved for their aesthetic, educational and scientific value.

Bush fire hazard reduction work and bushland regeneration work is allowed in this zone without consent. A limited range of activities are allowed in this zone with the consent of SSC including:

- Beach and foreshore protection works, buildings used in association with landscaping or gardening (including vehicular access to those buildings), drainage, recreation areas, scientific research associated with native habitats, utility installations (except for gas holders or generating works).
- Demolition not included in item 2.
- Development (if authorised by a plan of management under the *Local Government Act 1993*), other than development included in item 2, for the purpose of: cycle access, educational facilities (including signage), pedestrian access, roads.

The objectives of Zone 13—Public Open Space set out in SSC (2006b) include all those listed above and:

- Development (if authorised by a plan of management under the *Local Government Act 1993*), other than development included in item 2, for the purpose of: arts and crafts centres, community facilities, food shops, passenger transport facilities, places of assembly, restaurants, tourist facilities, tourist information centres.

## 2.3 CLIMATE

The climate of Menai is typical of the Sutherland Shire, with warm to hot summers reaching an average maximum temperature of 25°C. Winter months are cool with an average maximum temperature of 16°C. The average annual rainfall is 1,015 mm with the majority falling in March (Bureau of Meteorology, 2011). January and February are generally the warmest months with the majority of rain falling in March.

Refer to the following Bureau of Meteorology graphs as shown in Figure 3, Figure 4, Figure 5 and Figure 6, for the relationships between the annual and monthly averages for the Lucas Height (ANSTO) Bureau of Meteorology weather recording station (# 066078) which is approximately 5 kms south of the Still Creek Wetland. A more comprehensive set of climate and weather information is available at:

[http://www.bom.gov.au/climate/averages/tables/cw\\_066078.shtml](http://www.bom.gov.au/climate/averages/tables/cw_066078.shtml)

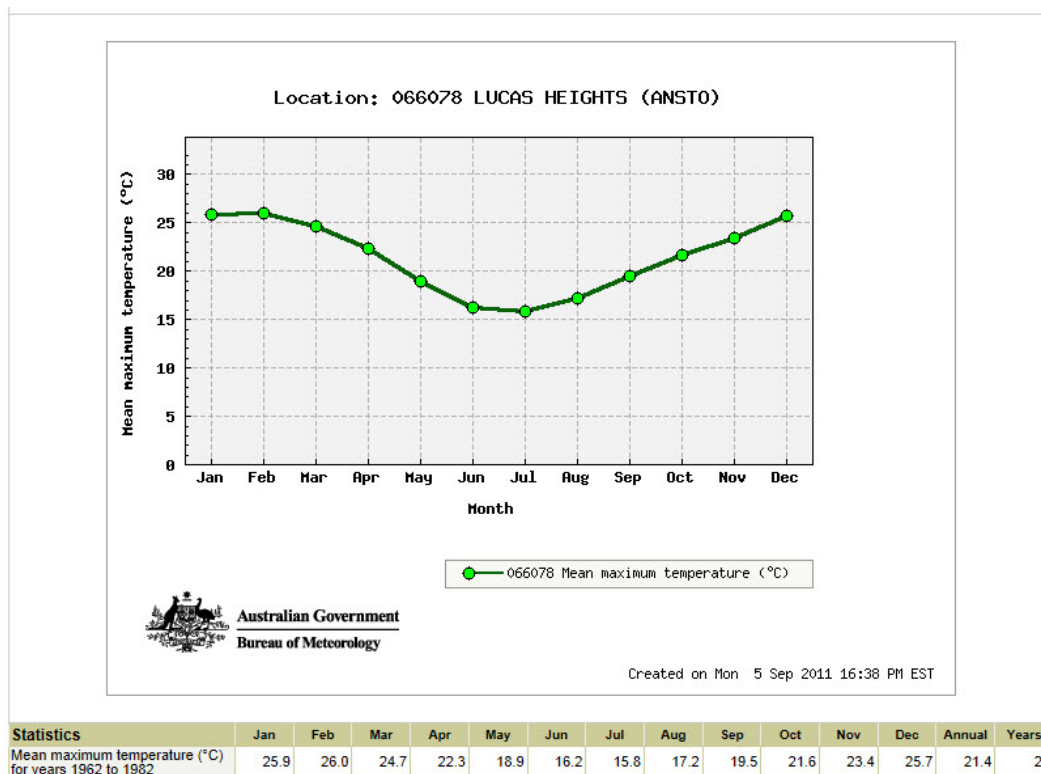
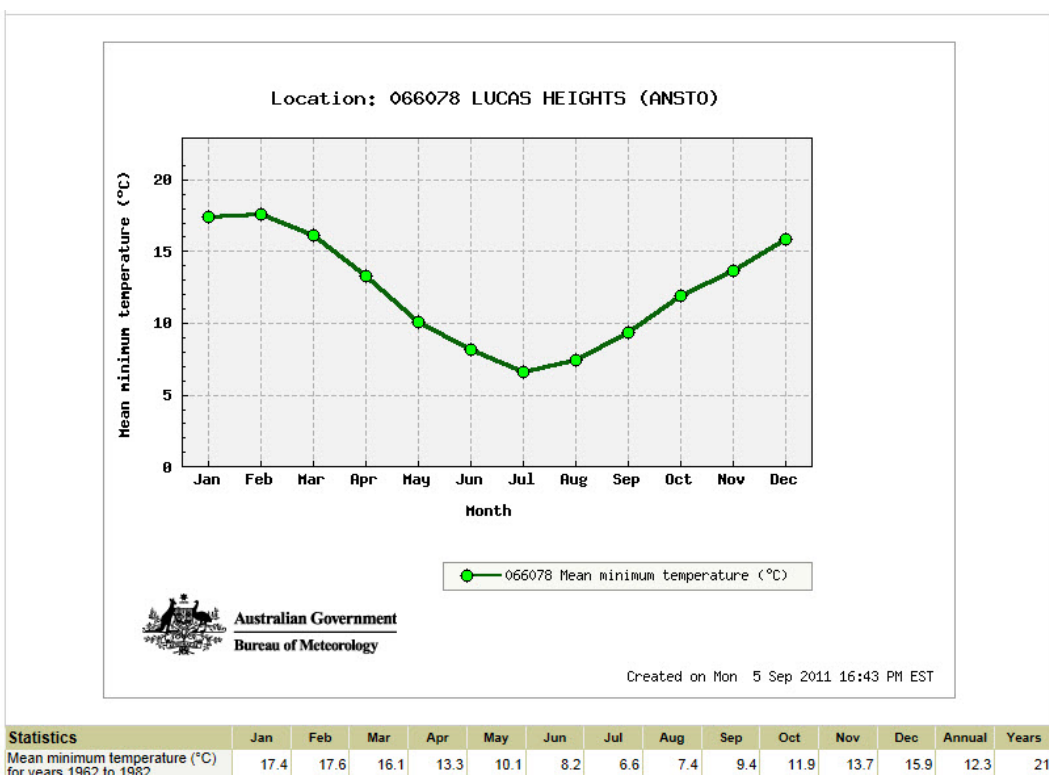


Figure 4: Mean monthly minimum temperatures.

Figure 3: Mean monthly maximum temperatures.





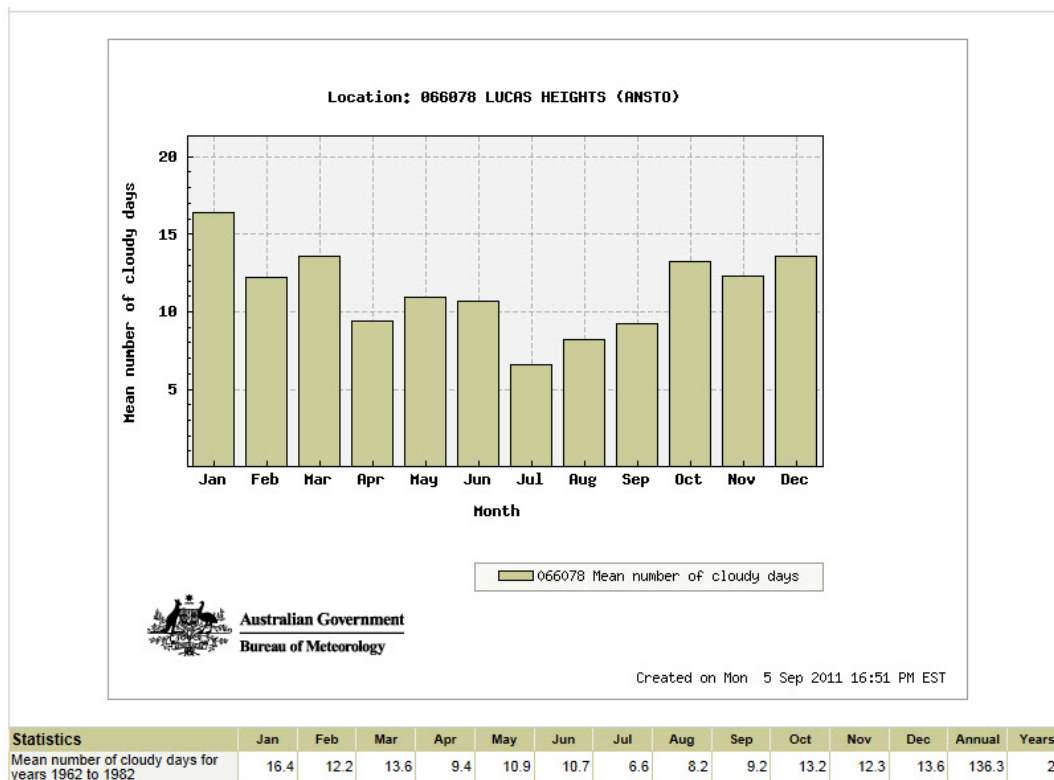


Figure 5: Mean monthly number of cloudy days.

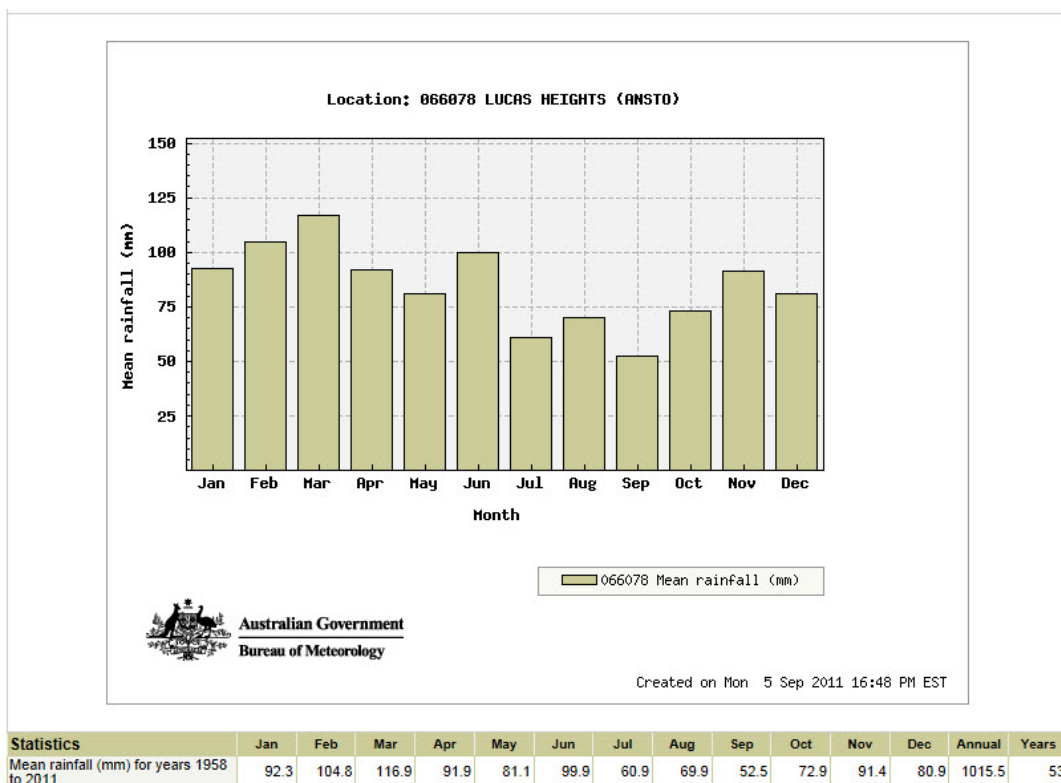


Figure 6: Mean monthly rainfall.

## 2.4 PHYSICAL GEOGRAPHY

Menai is located on the Woronora Plateau which forms the southern part of the sandstone basin surrounding Sydney (Fairley and Moore 2010). The plateau, capped by Hawkesbury sandstone rises gradually from Botany Bay to link with the rich shale and basalt of the Robertson Plateau in the southern highlands (Fairley and Moore 2010). The Woronora Plateau reaches 440 metres AMSL and is a deeply dissected sandstone plateau. Upland swamps are common along the eastern fringe of the plateau.

Isolated cappings of Wianamatta Shale occur on the Plateau between Menai and Liverpool and result in richer soils with higher nutrient levels that support a high number of uncommon plant species (Fairley and Moore 2010).

The topography around Still Creek Wetland is gently undulating. Elevation ranges from around 95 metres AHD at the wetland to around 108 metres AHD upstream at MacMahon Place. The wetland was constructed to improve water quality running off the Mina Road subdivision to the west of the wetland. Immediately to the west of the wetland is a low lying grassed park area and to the east the land rises toward Peachtree Way and Menai shopping village. Still Creek extends upstream of the wetland as a steep narrow channel incised down to sandstone bedrock.

Soils around the wetland are those of the Lucas Heights soil landscape (Hazelton et al 1990). Soils of this landscape are typically moderately deep, between 0.5 and 1.5 metres deep and associated with a residual soil profile. The soils generally consist of silty sands in the upper layers to sand clays at the base of the soil layers.

It should be noted that the wetland does occur in an area bordered closely by the Blacktown soil landscape (Hazelton et al 1990). This landscape is characterised by silty clays and clays generally found overlaying Wianamatta Shales. Still Creek Wetland is not mapped as exhibiting any probability for acid sulfate soils (SSC undated).

## 2.5 ADJACENT LAND USE

The land use adjoining Still Creek Wetland to the east and west is residential subdivision, bounded by Mina Road and residential subdivision that extends west to Alford's Point Road. Immediately to the east lies a strip of native vegetation ranging in width from 40 to 15 metres. This is bounded by a residential subdivision that extends east and upslope to Alison Crescent. The narrow riparian strip of native vegetation extends south and upstream for around 400 metres from the wetland to MacMahon Place. Downstream or north of the wetland lies Mina Road and further north the Still Creek riparian corridor widens to over 500 metres as the creek flows down stream past Illawong to the Woronora River.

## 2.6 WETLAND FLOOD MANAGEMENT

Still Creek Wetland, along with the riparian corridor extending up the MacMahon Place has been mapped in the SSC Development Control Plan (2006) as being an area subject to initial assessment which includes:

*“areas of potential flood liable land where a flood risk management plan is yet to be completed”.*

The wetland makes a contribution to flood mitigation as a flood storage basin.

## 2.7 WETLAND INFRASTRUCTURE

Still Creek Wetland is located within a public reserve at Mina Road. Infrastructure in the park includes a concrete walking path that extends from the wetland south to MacMahon Place with a number of seats located along the path.

Infrastructure within the wetland includes:

- a gross pollutant trap (GPT) immediately upstream of the wetland on line with Still Creek that consists of a concrete weir with a low flow outlet and a trash rack;
- pool fencing, along the western side of the GPT restricts unauthorised access

whilst locked gates allow maintenance access to SSC staff;

- rock walls have been constructed along both sides of the inlet channel to prevent undercutting of the embankments. Additional rockwork around the western edge of the wetland allows access to the water's edge and provides a stable edge around the wetland;
- two (2) formal outlet structures, a low flow hooded vertical riser within the open water, and a much larger high flow grated outlet pit adjacent to Mina Road controls high flows;
- the outlet structures are connected to 2 separate Helcor Aluminium pipelines: 1050 diameter low flow; and 2100 diameter high flow; under Mina Road which discharge through a large box culvert into Still Creek on the northern side of Mina Road.
- The original designs by Wallis and Moore (1995) have identified an existing sewer main located in the invert of Still Creek for the full length of the wetland. The designs required that this sewer main be concrete encased for its full length.

An aerial map of Still Creek wetland infrastructure is shown in Figure 7.

Photos of wetland infrastructure are contained in Appendix A.





Figure 7: Still Creek Wetland infrastructure

## 3 PLANNING CONTEXT

A number of state and local government strategies, policies and state legislation are influential in the management of Still Creek Wetland. These are outlined below.

### 3.1 LOCAL GOVERNMENT ACT 1993

The Management Plan has been prepared in accordance with the following requirements for specific Plans of Management detailed in Section 36 of the *Local Government Act 1993*:

- Categorising the land known as Still Creek Wetland and riparian corridor;
- Defining objectives and performance targets;
- Stating the means by which objectives and performance targets will be met;
- Stating the means by which performance targets will be measured;
- Observing the requirements of any threat abatement plans and recovery plans made under the *Threatened Species Conservation Act 1995* and the *Fisheries Management Act 1994*.

### 3.2 ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

The *NSW Environmental Planning and Assessment Act 1979 (EP&A Act)* establishes the statutory planning framework for environmental and land use planning in NSW. This is achieved through State Environmental Planning Policies (SEPPs), and Local Environmental Plans (LEPs) collectively known as Environmental planning Instruments (EPIs). The EP&A Act 1979 allows EPIs to be made to guide the development process and to regulate competing land uses; it also sets out processes for approving development applications for structures and works.

### 3.3 SUTHERLAND SHIRE CONTROL PLAN 2006

Sutherland Shire Development Control Plan (SSDCP), (SSC 2006a) applies to all land across the Sutherland Shire. It was prepared to provide more detailed provisions for the carrying out of development in lands covered by the Sutherland Shire Local Environmental Plan (SSLEP) (2006b). In particular it provides detailed objectives and controls referred to by SSC when determining applications under Section 79C of the *Environmental Planning and Assessment Act*. The SSDCP provides benchmarks to determine what is acceptable in land use, development and environmental management decisions.

#### 3.3.1 Wetlands

Chapter 4 of the SSDCP (SSC 2006a) deals with natural resource management and identifies that the natural resources of Sutherland Shire are a fundamental element of its character.

Wetlands are recognised as playing a critical function in ecological processes, providing breeding habitat for wildlife and contributing to improved water quality. The SSDCP (SSC 2006a) sets out buffer zone dimensions for natural and non-natural wetlands.

#### a) Objectives

The SSDCP (SSC 2006a) sets out objectives for development on land marked on the wetlands and waterways map. The objectives include:

- to protect, restore and maintain ecological processes, natural systems and biodiversity within wetlands and waterways;
- to minimise sedimentation and pollution of wetlands and waterways;
- to restore degraded wetlands, wetland buffer areas, waterways and riparian zones;
- to ensure appropriate fire management regimes and hazard reduction techniques for wetlands, wetland buffer areas, waterways and riparian zones.



- to encourage best practice environmental design measures so that the sustainability of wetlands and waterways is maintained or improved.

## **b) Controls**

The SSDCP (SSC 2006a) sets out controls for all development on land marked on the wetlands and waterways map.

Still Creek Wetland was constructed prior to the introduction of the SSDCP in 1995 and as a result does not reflect all of the current controls.

Controls set out in the SSDCP include:

- all development shall minimise changes to the local surface runoff and groundwater flows to ensure that appropriate water flow regimes are maintained to wetlands and waterways;
- stormwater flow is to mimic natural conditions and ensure a dispersed pattern of flow, avoiding newly created centralised or concentrated discharge points into wetland or waterway;
- disturbance to stream and wetland sediments is to be minimised by regulated discharge of stormwater and dissipation of flows at discharge locations;
- development shall not result in detrimental changes to temperature, salinity, chemical make-up and sediment loads of water entering the wetland or waterway;
- where stormwater is proposed to be discharged to a wetland or waterway, pollution is to be reduced by installation of pollution and sediment control devices. Access to and cleaning of devices shall not compromise the wetland areas function or natural attributes. The following standards are to be met:

a) Pollutant levels shall be below those outlined in the ANZECC (2000) Guidelines for the Protection of Aquatic Ecosystems.

b) Pollution control devices shall be located so that they are not within a watercourse or wetland itself.

- there shall be no clearing of indigenous vegetation within wetlands or riparian zones and clearing of indigenous

vegetation within Wetland Buffer Areas shall be minimised;

- there shall be no clearing of indigenous stream bank vegetation and aquatic habitat;
- removal of woody debris from wetlands and waterways should be minimised. Where removal is required for improved navigation, consideration should be given to provision of alternative habitat;
- there shall be no in-stream blockages to fish passage;
- lateral connectivity between waterways and riparian vegetation must be maintained. To satisfy this control, proposed landscaping will have to in part, reflect a natural environment in terms of finished levels and distribution of vegetation;
- bush fire asset protection zones must be located outside of the wetland buffer and riparian zone, except in the case of development or redevelopment of single dwellings and extended family units on existing lots or alterations and additions to existing dwellings.

## **3.4 WORONORA ESTUARY MANAGEMENT PLAN**

The Woronora Estuary Management Study and Plan (WBM 2006) presents the objectives for the long term management of the Woronora River Estuary. Management strategies to meet objectives are presented and classified on the basis of perceived importance and the time frame in which they can be achieved.

The study recognises the Woronora River Estuary contains a range of high quality habitats as well as flora and fauna species of high conservation and fisheries significance. The study recognises the major changes in saltmarsh and mangrove distribution over the past 70 years. The study recognises the close proximity of the internationally RAMSAR listed Towra Point wetlands and the significance of the estuary to migratory and resident water birds.

Key values of the estuary identified by the community included:

- high water quality;

- natural areas;
- access to waterways;
- views to water;
- heritage and cultural value; and
- recreational facilities.

Threats to estuary values are reduced due to:

- large areas of the greater catchment protected as National Park or catchment of Woronora Dam;
- steep topography limits future development potential;
- low key nature of existing foreshore development.

High priority management strategies for the Woronora estuary include:

- revegetation and protection of eroding foreshores;
- mapping and monitoring of ecological communities;
- hydrosurvey and monitoring;
- water quality monitoring;
- marking of key habitat areas on signs and delineation with marker buoys;
- community education program on ecology and heritage;
- Bushcare groups revegetating areas close to ecologically sensitive areas;
- Shakels Estate bush regeneration;
- hard protection/repair of eroding foreshores (private and public) (including structures fronting Burnum Burnum Reserve);
- review and revision of stormwater policy;
- community campaign for clean up/restoration of foreshores;
- limited navigation dredging; and
- modifications to stormwater system including end-of-pipe treatment and assessment and upgrade of sewerage system to minimise overflows.

### 3.5 GEORGES RIVER REGIONAL ENVIRONMENTAL PLAN

The Georges River Regional Environmental Plan (REP) (Department of Urban Affairs and Planning 1999) recognises activities undertaken on land in the catchment can adversely impact the catchment (and wetlands within it). The REP influences the land use, environmental planning and management decisions taken when land within the wider Georges River catchment is affected. The REP is to be considered in the planning and approval of development in the catchment.

The broad aims of the REP are:

- maintain and improve water quality and river flows in the Georges River and its tributaries;
- protect and enhance the environmental quality of the Catchment for the benefit of all users; and
- ensure consistency in the delivery of Ecologically Sustainable Development when assessing development applications.

The REP notes the following objectives:

- preservation and protection of significant environments (including mangroves, saltmarsh and seagrass), bushland and open space corridors by identification of environmentally sensitive areas and providing for appropriate land use planning and development controls;
- preservation, enhancement and protection of estuarine ecosystems;
- to ensure development is consistent with the aims of the REP;
- to identify land uses with potentially adverse environmental impacts;
- to conserve, manage and improve the aquatic environment by providing controls to reduce pollution entering the watercourses; and
- to protect the safety and well being of the local and regional community by improving water quality and river flows for health and recreation.



A range of planning principles are highlighted in the REP including 9(13) wetlands. The REP indicates:

- Wetlands must be protected through the application of consistent land use and management decisions that take into account the potential impact of surrounding land uses, incorporate measures to mitigate adverse effects and are in accordance with the *NSW Wetlands Management Policy*. Wetlands must also be protected by requiring adequate provisions where clearing, construction of a levee, draining or landscaping is to be undertaken.

### 3.6 THE NSW WETLANDS MANAGEMENT POLICY ACTION PLAN 2000/2003

This action plan (Department of Land and Water Conservation 2000) was developed by the State Wetlands Action Group to guide implementation of the NSW Wetlands Management Policy. It recognises that the majority of NSW's 4.5 million hectares of wetlands are located on private property and aims to resource and involve the community in wetland rehabilitation.

The action plan sets out four key strategies and associated actions for the NSW State Wetland Advisory Committee to promote the implementation of the policy. These strategies are:

- development of guidelines for preparing local wetland plans of management;
- development of guidelines for rehabilitation as well as compensatory guidelines for situations where social and economic imperatives require wetlands be destroyed;
- consideration of wetlands in the NSW Water and Vegetation reforms; and
- administration of the NSW Wetland Action Grants Program.

### 3.7 A WETLAND PRIORITISATION TECHNIQUE FOR THE SYDNEY METRO CATCHMENT MANAGEMENT AREA (SMCMA)

The above report was prepared as part of the Sydney Metropolitan Catchment Management Authority (SMCMA) Wetland Management Strategy (Stage 1) (Schaeper *et al* 2007). The report:

- compiled existing mapping data to identify the extent of wetlands in the SMCMA region;
- remapped wetlands that are listed in the Directory of Important Wetlands in Australia (DIWA);
- developed a wetland rehabilitation prioritisation technique, and;
- assessed the condition of the eight DIWA wetlands that occur in the SMCMA region.

A desktop wetland prioritisation technique was developed to prioritise wetlands for rehabilitation. The technique considers;

- wetland values and threats;
- the representation of the range of wetland types in Sydney;
- rehabilitation project development matters; and
- consideration of the feasibility of proposed projects.

Wetlands were assessed for their values and threats to produce a ranking of high, medium or low. Although this prioritisation technique is suitable to assess wetland condition, this assessment relied on the existence of information such as exists in a Plan of Management (PoM). In 2009, there were approximately 30 PoM's for wetlands within the SMCMA area.

It was determined that an alternate but complementary process was required to assess many more of the wetlands in SMCMA's area of operation using other available GIS data. Therefore a GIS database

was developed and completed in 2011 in order to assess 226 wetlands using the initial prioritisation method of assessment on values and threats to produce a ranking of high, medium or low (Ecological 2011). Provision of this GIS based wetland prioritisation system is utilised by the SMCMA and wetland managers to inform investment decisions.

The appendices of the initial prioritisation that summarise threats, values and scoring templates as well as the technical report for the Wetlands GIS Prioritisation are now available on the SMCMA website.

### 3.8 NSW INVASIVE SPECIES PLAN 2008-2015

The NSW Invasive Species Plan was developed through extensive consultation with a wide range of stakeholders. The NSW Invasive Species Plan aims to prevent new incursions, contain existing populations and adaptively manage widespread species. The plan aims to foster a cooperative culture where all relevant parties contribute with the aim of minimising the impacts of invasive species in NSW (Department of Primary Industries DPI 2008).

The NSW Invasive Species Plan identifies four goals:

- exclude – prevent the establishment of new invasive species;
- eradicate or contain – eliminate, or prevent the spread of new invasive species;
- effectively manage – reduce the impacts of widespread invasive species; and
- capacity building – ensure NSW has the ability and commitment to manage invasive species.

These goals aim to deliver specific measurable outcomes and actions that complement the NSW targets for natural resource management as identified in the NSW State Plan. The Plan's principles address current planning processes, efficacy and ethical issues, and is based on current commitments by the NSW Government and investment by a wide range of other stakeholders (DPI 2008).

### 3.9 WEED MANAGEMENT STRATEGY FOR THE SYDNEY METROPOLITAN CMA REGION 2007-2011

The Weed Management Strategy for the SMCMA aims to enhance and build on what is already being done by providing guidelines and recommending actions to improve allocation of resources, education and coordination of on ground work between 2007 and 2011. Many of the recommended actions have been identified by Council staff, state agency staff, volunteers and professional bush regenerators who were involved in the consultation and development phases of this strategy (SMCMA 2007).

The Strategy acknowledges that effective and long-term weed management by Councils, agencies and landholders does not consist only of removing weeds. The Strategy recommends:

- a review the weed management priorities across the SMCMA region;
- directing funding and resource allocation toward the higher priorities; and
- coordinating on ground work across land management boundaries and according to the available resources and priorities.

### 3.10 GREEN WEB SYDNEY - A VEGETATION MANAGEMENT PLAN FOR THE SYDNEY REGION

Green Web Sydney is an initiative of the combined Sydney Regional Organisations of Councils (SROCs) that promotes the establishment of a green web of native vegetation to protect, conserve and enhance remnant bushland in the Sydney region (SROCs 2009).

Sutherland Shire Council is implementing a Greenweb program which aims to protect and enhance the Shire's native plant and animal populations by identifying key areas of bushland habitat and establishing corridors to connect them (SSC 2008).

SSC's Greenweb incorporates both public and private lands. Its main target is private property owners within the Shire's Greenweb network. Council funds various initiatives to support Greenweb. This has included a program where owners of private property in Sutherland Shire's Greenweb network were able to apply for financial assistance to support ecological restoration work on bushland in their property (SSC 2008). SSC's Bushcare program is a complimentary program that undertakes bushland regeneration activities on public land in Sutherland Shire.

### **3.11 THE GEORGES RIVER COMBINED COUNCILS COMMITTEE**

Although not strictly part of the planning context for Still Creek Wetland, the Georges River Combined Council's Committee (GRCCC) is an important body that aims to

*“advocate for the protection, conservation and enhancement of the health of the Georges River, by developing programs and partnerships, and by lobbying government organisations and other stakeholders.”*

GRCCC (2011)

The GRCCC was formed in 1979 and consists of nine local council, as well as agencies and community representatives in the Georges River Catchment. The GRCCC was revamped in 2008 following a report commissioned by the Sydney Metropolitan CMA to recommend an organisational structure and operational plan to better meet current and future demands (GRCCC 2011).

The GRCCC has since 2009 aligned its works program to meet National Resource Management objectives and has collectively brought over \$8 million worth of funding and in kind value to Councils within the catchment (GRCCC 2011).

The Georges River catchment covers an area of 960 square kilometers and is one of the most highly urbanized catchments in Australia with over 1 million residents. The catchment of the Georges River includes the Woronora River.

## 4 SITE HYDROLOGY AND HYDRAULICS

### 4.1 CATCHMENT DESCRIPTION

Still Creek Wetland is located within a typical pear-shaped catchment of 55 hectares. The wetland was constructed primarily as a flood mitigation basin to attenuate the runoff from what was to become a mostly residential catchment.

The creation of a small open water body, with fringing macrophytes, within the centre of the flood mitigation basin provides a secondary water quality benefit as well as enhancing the habitat and aesthetic values of the riparian corridor and small parkland.

According to Hazelton et al (1990) soils within the catchment are shallow, sandy and typical of the Lucas Heights landscape which is based on sandstone geology. Whilst the soils around the wetland are shallow, clayey and typical of the Blacktown Soil landscape.

Still Creek, upstream of the wetland, consists of about 400 m of open channel about 1 m deep and 2 m wide with an exposed irregular sandstone invert and an overall grade estimated at between 2% and 3%. The local underground piped drainage network connects to the open channel with 2 smaller outlets connected directly to the wetland. Consequently, runoff from the catchment occurs very quickly once rainfall commences. However, without full details of the local drainage network, it has not been possible to accurately calculate the time of concentration for catchment runoff to reach the wetland. Consequently the original time of concentration calculation, by Wallis and Moore (1995) for the developed catchment, of 25 minutes has been adopted. Further Wallis and Moore (1995) have identified that the critical storm durations for the 2-year and 100-year Average Recurrent Interval (ARI) storms are 75 minutes and 90 minutes respectively.

### 4.2 WETLAND HYDROLOGY

The aim of the flood mitigation basin is to reduce the increase in peak flows generated by urbanisation of the catchment back to the peaks that could be expected from the catchment prior to urban development. This is achieved by limiting the peak outflow from the basin to pre-urbanisation rates, and storing the difference between the pre and post-urbanisation volumes. The difference in volumes is then released at a controlled rate over a much longer period of time than would have occurred prior to urbanisation of the catchment.

### 4.3 FLOW REGIME

The permanent water retained within the open water body provides the main water quality control and habitat functions of the wetland.

Peak flow attenuation is provided by the extended detention storage volume created between the permanent water level in the wetland and the level of the 2 outlet structures:

- Hooded vertical riser within the open water controls outflows from the smaller more frequent rainfall events (2-year ARI); and
- Grated outlet pit adjacent to Mina Road controls outflows from the larger less frequent rainfall events (100-year ARI).

Runoff volumes, in excess of the capacity of these 2 outlet structures, is intended to overtop the low point in Mina Road to the west of Beaumaris Drive, and re-enter Still Creek downstream without flooding adjacent properties.

Peak Flows entering the wetland, for various ARI storm events based on a time of concentration of 25 minutes and an impervious area fraction of 70% are estimated as:

- 100-year ARI – 14 m<sup>3</sup>/s;
- 20-year ARI – 11 m<sup>3</sup>/s;
- 5-year ARI – 9 m<sup>3</sup>/s;
- 2-year ARI – 7 m<sup>3</sup>/s; and
- 1-year ARI – 5 m<sup>3</sup>/s.





Figure 8: Still Creek Catchment, outlined in red (Source: SSC).



Wallis and Moore (1995) calculated that the lowflow hooded outlet riser (within the open water) and the high flow grated outlet pit (adjacent to Mina Road) had to be located approximately 1.1 m and 2.3 m above the permanent water level in the wetland. This difference in elevation was necessary to provide sufficient storage volume to attenuate the 2-year and 100-year ARI peak inflows (respectively) entering the wetland. The original designs by Wallis and Moore (1995) also identify that the maximum depth of the wetland, adjacent to the hooded outlet riser, is 1.8 metres and that it has a sloping invert tapering to water level at the junction of the main inflow channel and the permanent water level within the wetland.

Extrapolation of the information contained in the Wallis and Moore (1995) design plans indicates that at least 8,000 m<sup>3</sup> and 16,000 m<sup>3</sup> of detention storage is required to attenuate the runoff from the 2-year and 100-year ARI storms respectively. Similarly, by extrapolating the information further it is estimated that the existing permanent water storage volume within the wetland is approximately 4,000 m<sup>3</sup> with a surface area of approximately 7,000 m<sup>2</sup>. By comparison it is estimated that the average annual volume of runoff, generated from the catchment, is between 150 and 190 Mega Litres (ML), which indicates that runoff from the catchment is, on average, capable of replacing the water within the wetland fortnightly.

## 4.4 CLIMATE CHANGE

### 4.4.1 General

Research conducted by the United Nations Intergovernmental Panel on Climate Change (IPCC) (Solomon *et al.*, 2007), has shown that there has been an observable change in global climatic conditions over the last 100 years. Observed changes include an increase in global surface temperature of 0.74°C between 1906 and 2005, and a global sea level rise of 1.8 mm/yr on average (a total of 0.08m) between 1961 and 2003. Solomon *et al.* (2007) also found long term changes in precipitation for a number of continents. Based on IPCC research, ignoring ice flow melt, global sea

levels are predicted to rise between 0.18 and 0.59m by 2100.

The NSW Government Department of Environment of Climate Change and Water (DECCW) has produced a *Draft Sea Level Policy* (DECCW, 2009) document which outlines state government policy in relation to sea level rise. When the influence of ice melt and the predicted higher than global average sea level rise on the east coast of Australia are included, the predicted sea level rise on the NSW coast is up to 0.40m by 2050 and 0.90m by 2100 (DECCW, 2009). It should be noted that there are still a number of uncertainties in these predictions. World greenhouse gas emissions are currently tracking above the high level scenario.

The effects of climate change are also predicted to result in a change in average and seasonal rainfall patterns, including flood producing rainfall events. These changes have the potential to increase the frequency and severity of flooding. However, there is still much uncertainty about the specific nature of such changes on a regional basis and research continues (DECCW, 2007).

### 4.4.2 Still Creek Wetland

The Sydney Metropolitan Catchment Management Authority, in their recent literature review of *"Impacts of Climate Change on Urban Infrastructure in Metropolitan Sydney"* (SMCMA, 2011) have identified that rainfall intensities and annual runoff volumes are projected to increase in Sydney by approximately 15% and 25% respectively, by the year 2030.

Based on these projections the parkland surrounding the Still Creek Wetland can be expected to be inundated more frequently. However, the difference in level between the surrounding properties and the low point in Mina Road should provide sufficient flood protection for adjacent properties.

## 4.5 WATER QUALITY

Still Creek Wetland was originally designed to prevent sediment generated by the

construction of the surrounding developments from entering the lower reaches of Still Creek. Upon completion of the civil works and building works the sediment basin was de-commissioned and a dual outlet stormwater detention basin with a permanently wet invert was commissioned. It was never intended to perform a water quality control function.

However, by default, it still retains its original functionality as a sediment control basin and the upstream GPT and screens on the outlet structures assist in the control of gross pollutants, sediments and some of the attached pollutants.

SSC have invested in a Strategic Water Monitoring Program throughout the Shire. Still Creek Wetland has been identified as a suitable monitoring site and has been identified as Site 25A and 25B within this Program. A photo of the water quality monitoring point is contained in Appendix A

#### 4.5.1 Diffuse Pollution

Diffuse sources of pollution refer to those pollutant inputs which occur over a wide area and are associated with a particular land use. In urban catchments these inputs are generally related to runoff from roads, houses, commercial developments and landscaped areas as well as seepage into and from groundwater.

Monitoring has been undertaken on a regular basis over a five (5) year period prior to 2004.

Table 2: Water Quality Monitoring Results

Analyte	Inflow Concentration	Outflow Concentration
Ammonia (mg/L)	Max. 0.23 Min. <0.15	Max. 2.35 Min. <2
BOD (mg/L)	Max. 42 Min. <10	Max. <10 Min. <2
Metals (Max. mg/L)	Cu 0.027 Pb 0.038 Zn 0.18	Cu 0.01 Pb 0.014 Zn 0.08
Enterococci (cfu/100mL)	Max. 90,000 Min. 100	Max. 13,000 Min. 100

Grease (mg/L)	Max 10 Min. 5	Max. 7 Min. 2
Total Nitrogen (mg/L)	Max. 3.2 Min. 1.5	Max. 2.6 Min. 1
Total Phosphorus (mg/L)	Max. 0.62 Min. 0.1	Max. 0.244 Min. 0.1
Suspended Solids (mg/L)	Max. 370 Min. 100	Max. 415 Min. 100

*Note: The ranges of concentrations quoted above can be misleading and in most cases the samples taken at the outlet returned lower concentrations than at the inlet to the wetland.*

Refer to Table 6 for a summary of the results from the analytes sampled at Still Creek.

Solid pollutants such as organic matter, sediment and light litter, which have been washed off upstream catchments, are either retained in the upstream GPT or trapped within the wetland.

Table 3: Summary of Volumes Removed

	2008/2009	2009/2010	2010/2011
<b>Gross Pollutant Trap</b>			
Sediment (Tonnes)	44	29	10
Light Litter (m <sup>3</sup> )	6	10	3
Organic Matter (m <sup>3</sup> )	15	32	15
<b>Wetland</b>			
Sediment (Tonnes)	0.5	-	-
Light Litter (m <sup>3</sup> )	5.5	1	-
Organic Matter (m <sup>3</sup> )	9.5	8	-



*Pollutant loads estimated by the unit of SSC*

Refer to Table 7 for a summary of the volumes removed from the GPT and wetland.

## 4.5.2 Point Source Pollution

Point source pollution refers to those inputs which have a readily identifiable source. They are generally related to a particular industry with a single discharge point or to a specific overflow from a wastewater treatment plant or containment facility.

There are no industrial developments, chemical storages or petrol stations within the catchment and apart from unplanned spills and/or surcharges from the local sewerage system; point source pollution is not expected to be an issue.

However, sewage overflows have occurred within the catchment in the past and these have resulted in major contamination of the wetland.

Sydney Water has responsibility for maintaining the capacity of the sewers. The design recurrence interval for the sewer needs to be confirmed by Sydney Water with SSC. Any overflows from the sewerage system, will be trapped by the wetland requiring it to be drained, cleaned and decontaminated before the public are allowed back into the parkland.

## 4.6 CONCLUSIONS

For recommendations regarding each of the following actions see chapter 8.

### 4.6.1 Monitoring

The discontinued monitoring program identified a number of anomalies with respect to the water quality in Still Creek. In general it identified that the presence of the on-line wetland was beneficial to the downstream water quality.

### 4.6.2 Flood Management and Climate Change

Based on the calculations provided by Wallis and Moore (1995), it would appear that the wetland has sufficient extended detention volume to attenuate the runoff from the 100-year ARI storm. There appears to be sufficient elevation difference between surrounding properties and the overflow outlet from the basin to prevent flooding of adjoining properties.

### 4.6.3 Gross Pollutant Trap

The existing structure is constructed at right-angles to the flow direction in Still Creek. The trash rack is easily blocked and regularly surcharges leading to light litter and sediment entering the wetland.

### 4.6.4 Sediment Removal

A plume of sediment, colonised by an introduced plant commonly referred to as arrowhead *Sagittaria* spp., has developed at the inlet to the wetland. It would appear that this sediment has by-passed the upstream GPT and dropped out of the water column as a result of the still conditions within the wetland. Further, the presence of the Arrowhead could be responsible for the good visual water quality within the wetland.

### 4.6.5 Water Quality

Existing site constraints, infrastructure and sandstone bed rock, limit opportunities to improve the water quality control function of the wetland. "Rule-of-thumb" calculations suggest that for the wetland to achieve a tangible water quality benefit its surface area should be increased to about 2 hectares and its volume increased to about 15,000 m<sup>3</sup>.

## 5 ENVIRONMENTAL VALUES

### 5.1 EXISTING VEGETATION

In order to document the vegetation communities and fauna habitats present at Still Creek Wetland a desktop assessment and field assessment were undertaken. The desktop assessment included consideration of existing mapping and interrogation of various databases. The results of the desktop study are presented below.

#### a) Existing Mapping

The vegetation surrounding Still Creek Wetland has been mapped by Sutherland Shire Council in their broad scale Vegetation Communities map as Sydney sandstone gully forest. The vegetation community definition is based on the Benson and Howell (1994) descriptions for the Sydney 1: 100 000 map sheet.

The Sydney sandstone gully forest community is recognised as having a widespread geographic distribution including the Woronora plateau (Benson and Howell 1994). A number of sub units are recognised by Benson and Howell (1994) including tall open forest which includes *Eucalyptus pilularis* and *Syncarpia glomulifera* in gullies and sheltered aspects.

Council's brief for the Management Plan reflects a preliminary site assessment of the vegetation adjoining the wetland and reveals the vegetation is predominantly Shale Sandstone Transition Forest (SSTF), an endangered ecological community (EEC) listed on the *Threatened Species Conservation (TSC) Act 1995* and the *Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999*.

This assessment of the vegetation as SSTF is consistent with vegetation to the east and upslope of Still Creek Wetland, which consists of a large patch (around 4 hectares) of SSTF located behind the Menai marketplace in Allison Crescent. Further upslope and to the south of the site lies a patch of Sydney Turpentine Ironbark Forest at Menai Park.

Shale Sandstone Transition Forest is noted by Benson and Howell (1994) to occur on the transition zone between the Wianamatta Shale and the underlying Hawkesbury Sandstone on the shallow to deep podzolics of soils of the Blacktown Soil Landscape.

#### b) Environment Protection and Biodiversity Conservation Act 1999

An online search on matters of National Environmental Significance or other matters protected by the EPBC Act was undertaken for a five kilometre radius of the site.

The online search revealed a number of matters relevant to this Management Plan:

- Towra Point Nature Reserve, classified as a RAMSAR wetland if International significance is located within 10 kilometres of the Still Creek Wetland Site;
- Turpentine-ironbark forest in the Sydney Basin Bioregion (listed as Critically endangered on the EPBC Act 1999) may occur in the area;
- Shale Sandstone Transition Forest (listed as endangered on the EPBC Act 1999) may occur in the area;

Suitable habitat is present for species listed at the State (TSC Act 1995) and National level (EPBC Act 1999) and as migratory (Japan Australia Migratory Bird Agreement JAMBA) and (China Australia Migratory Bird Agreement CAMBA) including the:

- regent honeyeater *Anthochaera phrygia* listed as Endangered at the national level and as migratory (JAMBA);
- swift parrot *Lathamus discolor* listed as Endangered at the national level and at the State level 1995;
- orange-bellied parrot *Neophema chrysogaster* listed as Critically Endangered at the national level and Endangered at the State level;
- Australian painted snipe *Rostratula australis* listed as Vulnerable at the national level and as migratory (CAMBA);
- giant burrowing frog *Heleioporus australiacus* listed as Vulnerable at the national level;

- green and golden bell frog *Litoria aurea* listed as Vulnerable at the national level and Endangered at the state level;
- little john's tree frog *Litoria littlejohni* listed as Vulnerable at the national and state level;
- growling grass frog *Litoria raniformis* listed as Vulnerable at the state level;
- stuttering frog *Mixophyes balbus* listed as vulnerable at the national level and endangered at the state level;
- large-eared pied bat *Chalinolobus dwyeri* listed as Vulnerable at the national and state level;
- spotted-tail quoll *Dasyurus maculatus* the south east population listed as endangered at the national level and the species listed as vulnerable at the state level;
- southern brown bandicoot *Isodon obesulus obesulus* listed as Endangered at the national and state level;
- brush-tailed rock wallaby *Petrogale penicillata* listed as Vulnerable at the national level and Endangered at the state level;
- long-nosed potoroo *Potorous tridactylus tridactylus* south east mainland population listed as Vulnerable at the national level;
- new holland mouse *Pseudomys novaehollandiae* listed as Vulnerable at the national level;
- grey-headed flying fox *Pteropus poliocephalus* listed as vulnerable at the national level;
- downy wattle *Acacia pubescens* listed as vulnerable at the national and state level;
- thick lipped spider orchid *Caladenia tessellata* listed as Vulnerable at the national level and Endangered at the state Level;
- leafless tongue orchid *Cryptostylis hunteriana* listed as Vulnerable at the national and national level;
- small flower grevillea *Grevillea parviflora subsp. parviflora* listed as Vulnerable at the national and state level;
- biconvex paperbark *Melaleuca biconvexa* listed as vulnerable at the national and state level;

- Deane's melaleuca *Melaleuca deanei* listed as Vulnerable at the national and state level;
- *Pimelea curviflora var. curviflora* listed as Vulnerable at the national and state level;
- greenhood orchid *Pterostylis gibbosa* listed as Endangered at the national and state level;
- Sydney plains greenhood *Pterostylis saxicola* listed as endangered at the national level;
- Kangaloon sun-orchid *Thelymitra sp. Kangaloon* (D.L. Jones 18108) listed as Critically Endangered at the national level;
- broad-headed snake *Hoplocephalus bungaroides* listed as Vulnerable at the national level and Endangered at the state level.

Suitable habitat for a variety of migratory marine birds was also recognised in the broader area, species included:

- fork-tailed swift *Apus pacificus*;
- great egret *Ardea alba*;
- cattle egret *Ardea ibis*.

Migratory terrestrial bird species whose habitat may occur on the study area included:

- white-bellied sea eagle *Haliaeetus leucogaster*;
- white-throated needletail *Hirundapus caudacutus*;
- rainbow bee-eater *Merops ornatus*;
- Black-faced Monarch *Monarcha melanopsis*;
- satin flycatcher *Myiagra cyanoleuca*;
- orange-bellied parrot *Neophema chrysogaster*;
- rufous fantail *Rhipidura rufifrons*; and
- regent honeyeater *Anthochaera phrygia*.

Migratory wetland species whose habitat may occur in the study area included:

- great egret *Ardea alba*;
- cattle egret *Ardea ibis*;
- Latham's snipe *Gallinago hardwickii*; and
- painted snipe *Rostratula australis*.

### c) Threatened Species Conservation Act 1995

A spatial analysis was undertaken utilising the Office of Environment and Heritage (OEH) Wildlife Atlas of threatened species records in a ten kilometre radius of the site (the locality) between 2001 and 2011.

The search revealed a total of 17 fauna species and seven flora species listed on the TSC Act 1995. The species recorded during the database search and potentially occurring in Still Creek Wetland are shown in Appendix B.

#### i) Endangered Ecological Community

Desktop Assessment and liaison with SSC revealed that the riparian vegetation adjacent to Still Creek Wetland supports an endangered ecological community (EEC) listed on the TSC Act 1995:

- Shale Sandstone Transition Forest (SSTF) EEC.

A detailed description of the EEC is provided by DECC Threatened species profile (DECC 2005). This profile also provides advice on priority actions to help recover the EEC and references on information regarding identification and management. The advice provided by DECC (2005) was taken into account in the formulation of management strategies and actions for Still Creek Wetland (see chapter 8).

A variety of threatened fauna and flora species listed on the TSC Act have been recorded within a 10 kilometer radius of the site.

#### ii) Threatened Fauna

The results of the database search can be refined based on available habitat at Still Creek Wetland and riparian corridor. Threatened fauna species that may utilise available habitat as part of a larger home range include:

- varied sittella *Daphoenositta chrysoptera* Vulnerable. This species was recorded from Barden Ridge in 2007;
- koala *Phascolarctos cinereus* Vulnerable. This species was recorded from west of the Alfords Point Road at Menai in 2011;

- grey-headed flying fox *Pteropus poliocephalus* Vulnerable. This species was recorded for Still Creek at Illawong in 2007;
- powerful owl *Ninox strenua* Vulnerable. This species has been recorded repeatedly in the Forbes Creek valley (another tributary of the Woronora River) south of Still Creek;
- sooty owl *Tyto tenebricosa* Vulnerable has also been recorded from the Forbes Creek Valley and along the Woronora River;
- Rosenberg's goanna *Varanus rosenbergi* Vulnerable has been recorded from Still Creek north of the site in 2009;
- greater broad nosed bat *Scoteanax rueppellii* Vulnerable, southern myotis *Myotis macropus* Vulnerable and eastern bentwing-bat *Miniopterus schreibersii oceanensis* Vulnerable have all been recorded along the Woronora River south west of the site at the Needles.

Of these threatened fauna species the:

- grey-headed flying fox *Pteropus poliocephalus*;
- powerful owl *Ninox strenua*;
- sooty owl *Tyto tenebricosa*; and
- The microchiropteran bats

are considered most likely to use the Still Creek Wetland and riparian vegetation as part of a larger home range.

#### iii) Threatened Flora

Threatened flora recorded from within a 10 kilometre radius of the site in the last 10 years include:

- small pale grass lily *Caesia parviflora* var. *minor* Endangered has been recorded from Lambeth Reserve at Peakhurst Heights;
- downy wattle *Acacia pubescens* Vulnerable has been recorded from west of the Bangor Bypass near Elliot Road;
- Deane's paperbark *Melaleuca deanei* Vulnerable has been recorded south east of the site at Bangor near Akuna Oval;
- netted bottle brush *Callistemon linearifolius* Vulnerable has been recorded in the Loftus TAFE car park;

- Sydney plains greenhood orchid *Pterostylis saxicola* Endangered (sensitive species location description not provided by the NSW Wildlife Atlas) has been recorded within a 10 kilometre radius of the site;
- thick lip spider orchid *Caladenia tessellata* Endangered (sensitive species location description not provided by the NSW Wildlife Atlas) has been recorded within a 10 kilometre radius of the site.

### 5.1.2 Field Assessment

The field assessment included two visits to the site. The wetland was visited by an ecologist on the 27<sup>th</sup> May 2011, the weather was cool and sunny reaching 16 degrees Celsius. The wetland was visited again on the 11<sup>th</sup> August 2011, the weather was mild with increasing cloud and the temperature reached 18 degrees Celsius.

The field assessment involved a traverse of the wetland and the adjoining terrestrial vegetation, along with the vegetation extending upstream toward MacMahon Place.

Vegetation communities were identified on the basis of structure and dominant plant species. Plant species present were identified, recorded and assessed as indicators for endangered ecological communities (EECs) and for possible threatened plant species occurrence. The density of weeds in various vegetation communities and areas of the wetland were also noted.

Fauna habitats in the wetland were identified on the basis of vegetation structure and available habitat attributes. Threatened fauna species indicated as potentially present in the study area on the basis of wildlife database analysis were considered when searching the wetland and the existence of specific habitat for these species was assessed. A diurnal search of the wetland was undertaken on the above occasions, although the visit on the 11<sup>th</sup> of August extended into the early evening.

Field investigations reveal three vegetation communities and fauna habitats at Still Creek Wetland:

- Freshwater wetland;
- Riparian open forest; and

- Landscaped grassland.

These communities are not uniform in species composition and structure across their range at the local scale and varying levels of weed infestation occur in both communities. The freshwater wetland consists of around 60 per cent weeds, the riparian open forest around 30 per cent (but increasing upslope toward MacMahon Place and the landscaped grassland around 10 per cent weeds. A list of flora species recorded during the field assessment is provided as Appendix C to this document.

The freshwater wetland community can be divided into two sub – communities emergent macrophytes and aquatic weeds.

The forest community varies with an increasing density of weeds in the understory and turpentine *Syncarpia glomulifera* in the canopy upslope toward MacMahon Place.

Field investigations reveal the riparian open forest is consistent with the Shale Sandstone Transition Forest (SSTF) listed as an EEC on the NSW TSC Act 1995 and the commonwealth EPBC Act 1999.

The distribution of vegetation communities in and around the wetland is shown in Figure 9.

The vegetation and fauna habitat values are described below. Photos of vegetation communities are contained in Appendix A.

#### a) Freshwater Wetland

This community consists of two sub communities:

- emergent macrophytes; and
- aquatic weeds.

##### i) Emergent macrophytes

The emergent macrophyte community consists of vegetation that fringes Still Creek Wetland. It begins where Still Creek broadens out into the wetland and occurs in a series of discrete clumps (often of the same species) on the edge of the wetland.

The first clump adjacent to the Still Creek Wetland sign on the western side of the wetland consists of a large clump of the native





Figure 9: Still Creek Wetland vegetation communities.



reed *Phragmites australis* around 10 metres long and extending up to 5 metres into the wetland. This clump is fringed on the western side by a row of matt rush *Lomandra longifolia* part of the native landscaped grassland. The clump is dense and provides cover for water birds including the Australian wood duck *Chenonetta jubata*, pacific black duck *Anas superciliosa* and dusky moorhen *Gallinula tenebrosa* all observed during field investigations. Some weed infestation by purple top *Verbena bonariensis* and cobbler's peg *Bidens pilosa* on the edges of this clump is apparent.

A second clump of native reed *Phragmites australis* occurs at the north eastern corner of the wetland. This clump extends around the eastern bank of the wetland and includes bulrush *Typha orientalis*. This clump is irregular in height, reaching 2 metres at the northern end of the wetland but then decreasing in height on the eastern edge. The weeds observed previously also occur on the edges along with the native scurvy weed *Commelina cyanea* and hydrocotyle *Hydrocotyle tripartita*. The eastern edge of the wetland is quite weedy with weeds extending from the fringing terrestrial vegetation including blackberry night shade *Solanum chenopodioides* curled dock *Rumex crispus* and *Persicaria* sp., and cobbler's peg *Bidens pilosa*. This clump is bounded to the south by weeds the wetland edge is rocky with a sporadic covering of *Lomandra longifolia* on the terrestrial side and the wetland edge consisting of weeds including the noxious alligator weed *Alternanthera philoxeroides*.

The weedy eastern edge grades into a clump of baumea *Baumea articulata*. This patch extends for around 7 metres south along the eastern edge of the wetland toward the Still Creek channel. Another clump of the native reed *Phragmites australis* occurs on the eastern edge of the Still Creek channel as it enters the wetland.

This community extends up the Still Creek channel to the existing gross pollutant trap (GPT). This area is almost completely dominated by weeds reflecting the deposition of nutrient rich sediment immediately below the GPT.

#### ii) Aquatic weeds

The aquatic weed community occupies 'islands' of sediment in the wetland. This sediment has been deposited in the wetland by water flowing down the Still Creek channel carrying sediment from the catchment. In high flows the water hits the base of the weir and particularly when the trash racks become blocked the water flows over the top of the gross pollutant trap bringing large quantities of sediment into the wetland. The deposited sediment has built up forming islands suitable for aquatic plants including weeds.

The aquatic weed community is dominated by the aquatic weed sagittaria *Sagittaria graminea*. The noxious weed ludwigia *Ludwigia peruviana* has occurred in the past and alligator weed *Alternanthera philoxeroides* also noxious is present on the edge of the wetland.

### b) Riparian Open Forest

The freshwater wetland grades into the riparian open forest community on the eastern side of the wetland. As indicated this community is consistent with the definition of SSTF EEC.

The vegetation community is an open forest reaching 30 metres in height. The canopy cover is around 35 per cent and a sporadic small tree layer is present on the northern edge of this community which includes *Allocasuarina* species and canopy saplings and *Acacia* species.

The shrub layer is diverse and ranges from dense through moderate in density. It has been cleared in some patches where it is replaced with introduced grasses including kikuyu. The riparian open forest includes benching sandstone and large sandstone boulders. The ground cover includes a sporadic distribution of weeds and there is a dense covering of leaves, twigs and organic matter.

A variety of canopy species were recorded including Sydney red gum *Angophora costata*, Sydney peppermint *Eucalyptus piperita*, turpentine *Syncarpia glomulifera*, red bloodwood *Corymbia gummifera* and swamp mahogany *Eucalyptus robusta*. Black wattle



*Acacia decurrens* forms a sporadic small tree layer with black she oak *Allocasuarina littoralis*. Mid storey plants included silver stemmed wattle *Acacia parvippinnula*, tick bush *Kunzea ambigua*, hop bush *Dodonea triquetra*, bursaria *Bursaria spinosa*, eggs and bacon *Dillwynia retorta*, bearded heath *Leucopogon junipennus*, grevillea *Grevillea sericea* and bleeding heart *Omalanthus populifolius*.

The ground strata was noted as moderately disturbed and included blue flax lily *Dianella caerulea* var. *producta*, matt rush *Lomandra longifolia* and scurvey weed *Commelina cynea*. dichondra *Dichondra repens* *Conospermum taxifolium* and leafy purple flag *Patersonia glabrata* were also recorded. Kikuyu *Kikuyu Pennisetum clandestinum* has invaded the ground cover and occurs as dense pure stands in areas where the canopy is absent and the shrub layer has been disturbed. These stands were noted on the eastern boundary of this community. The noxious weed *Lantana camara* is returning to the shrub layer as immature canes.

This community extends upstream along the eastern and western edge of Still Creek to MacMahon Place as shown in Figure 9. Upstream the shale influence on the soil appears to increase with a higher density of turpentine *Syncarpia glomulifera* in the canopy. The shrub layer supports a variety of native species including heath leaved banksia *Banksia ericifolia*, broad-leaved paperbark *Melaleuca quinquenervia* and snow in summer *Melaleuca lineariifolia*. It is acknowledged that some native shrubs on the western side of Still Creek may have been part of landscape planting. The introduced morning glory *Ipomea indica* has invaded all layers of the riparian forest on the eastern side as the community narrows. It is also extending to the western side. The canopies of some larger trees are being invaded and in some sections the shrub layer are completely smothered.

### c) Landscaped Grassland

This community is located on the western side of the wetland and Still Creek, extending to the southern end of Mina Road.

The community consists of a mowed grassland with a sporadic planting of native canopy

species including turpentine *Syncarpia glomulifera* and grey gum *Eucalyptus punctata*.

On the north west corner and northern boundary of this community the landscape plantings are very dense between Mina Road and the grassland. They included *Lomandra longifolia*, Sydney golden wattle *Acacia longifolia*, broad-leaved paperbark *Melaleuca quinquenervia* and snow in summer *Melaleuca lineariifolia*, *Callistemon* sp., *Grevillea* sp., with native climbers false sarsaparilla *Hardenbergia violacea* and dusky coral pea *Kennedia rubicunda*.

### d) Fauna Habitat Values

Still Creek Wetland and riparian corridor provide a variety of shelter and foraging habitat resources for birds, mammals, amphibians and reptiles. Fauna habitat values of the vegetation communities are summarized in Table 8. A list of fauna species recorded in the Menai locality and in the wetland is presented in Appendix D to this report.

The open water and fringing vegetation provide resources for water birds including ducks and dusky moorhens using the wetland. Migratory birds known to occur in the locality may also be seasonal visitors to the wetland. An introduced Muscovy duck *Cairina moschata* known locally as "Henry" was also observed in the wetland. The ongoing presence of this duck in the area indicates that predation by the introduced fox *Vulpes vulpes* may not be occurring currently in the immediate area.

Macrophytes with adjoining riparian vegetation to aid in dispersal provide important habitat for amphibians for breeding (Voigt 2006). The common eastern froglet *Crinia signifera* and the brown striped marsh frog *Limnodynastes peroni* were also heard calling in the wetland and would utilise the emergent macrophytes for shelter and foraging.

A variety of reptiles would also be expected to utilise the freshwater wetland habitat. The wetland and adjoining riparian open forest provide sandstone outcrops for basking and crevices and patches of dense ground and shrub layer vegetation for foraging and shelter. A garden skink *Lampropholis guichenoti* was observed during field survey and other common reptiles including the common black

snake *Pseudechis porphyriacus* and eastern water dragon *Physignathus lesueurii* would be expected to occur.

The riparian open forest vegetation community provides suitable habitat for mammals and birds due to the presence of flowering Eucalypts and a diverse native shrub layer. The presence of permanent water (although variable in quality) would provide an important resource for a variety of native fauna species.

The vegetation adjoining Still Creek Wetland particularly trees on the western edge within the landscaped grassland community are frequented by a flock of sulphur-crested cockatoos *Cacatua galerita*. The flock visits the area irregularly but has damaged some of the trees in the landscape grassland and riparian open forest.

Cockatoos are known to damage germinating cereal crops and can also cause damage to:

- roost trees;
- planted tree seedlings;
- fixtures – aerials, light fittings, powerlines etc;
- soft timber on houses and outdoor furniture;
- bowling greens, ovals and golf courses (Temby 2003).

Cockatoos cause damage by eating and chewing nonfood items, this helps maintain their beaks at the correct length and condition (Temby 2003).

Tree damage can be the result of other factors including insect attack, raised nitrogen content of soils and altered soil hydrology through soil compaction. Tree pruning by cockatoos is visually obvious but does not always result in long term damage.

Cockatoos can uproot or snip off freshly planted tree seedlings. A visual screen of vegetation should be retained or planted to protect seedlings.

A range of strategies are available to reduce the damage to fixtures and recreation areas and are set out in Temby (2003).

It is important to note that although cockatoos occur in large numbers occasionally at Still Creek Wetland they are unlikely to be in

competition with other native species for fauna habitat such as tree hollows. Smaller species usually select hollows too small for Cockatoos and there is usually little interaction between species nesting alongside one another (Temby 2003). Habitat loss and removal of dead and standing trees are considered greater threats to biodiversity (Temby 2003).

Table 4: Summary of Vegetation Communities and Fauna Habitat Values

Vegetation Community	Endangered Ecological Community	Biometric Vegetation Type (DEC 2005)	Dominant Species	Condition	Habitat Values
Freshwater wetland Emergent macrophytes	No	n/a	native reed <i>Phragmites australis</i> bulrush <i>Typha orientalis</i> <i>Baumea articulata</i>	Moderate some weed invasion	Moderate to high- foraging, shelter and breeding habitat for water fowl and foraging and shelter resources for migratory birds and reptiles and amphibians
Freshwater wetland aquatic macrophytes	No	n/a	<i>Sagittaria graminea</i>  Noxious weeds: ludwigia <i>Ludwigia peruviana</i> and alligator weed <i>Alternanthera philoxeroides</i>	Low dominated by weeds	Moderate- foraging, shelter and breeding habitat for water fowl and foraging and shelter resources for migratory birds and reptiles and amphibians
Open Water	No	n/a		Moderate	Moderate water quality variable - water source for a variety of native and introduced species, foraging resources for migratory birds and some bats, breeding habitat for amphibians, habitat for aquatic species and invertebrates.
Riparian Open forest	Shale Sandstone Transition Forest EEC EPBC Act 1999 and TSC Act 1995	Red Bloodwood- Grey Gum woodland on the edges of the Cumberland plan, Sydney basin	Sydney red gum <i>Angophora costata</i> , Sydney peppermint <i>Eucalyptus piperita</i> , turpentine <i>Syncarpia glomulifera</i> , red bloodwood <i>Corymbia gummifera</i> , swamp mahogany <i>Eucalyptus robusta</i> .	Moderate to high weed invasion in shrub layer	High to Moderate -seasonal foraging and shelter resources for nectivorous birds, insectivorous birds and arboreal mammals. Foraging and shelter resources for herpetofauna, mega and micro chiropteran bat species including the Grey-headed Flying-fox and the Southern Myotis , owls and raptors
Landscaped grassland	No	n/a		Highly modified	Low to moderate – some seasonal foraging and shelter resources for birds and arboreal mammals. Cover for small ground dwelling mammals

### e) Noxious and Aquatic Weeds

A number of weeds listed as noxious in the Sutherland Shire (DPI undated). These include but may not be limited to:

- lantana *Lantana camara*;
- blackberry *Rubus fruticosus*;
- ludwigia *Ludwigia peruviana*; and
- alligator weed *Alternanthera philoxeroides*; and
- water hyacinth *Eichornia crassipes* (has occurred in the past).

The aquatic weed *Sagittaria graminea* also occurs in Still Creek Wetland.

## 5.2 BUFFER ZONE AND CONNECTIVITY

### 5.2.1 Connectivity

Sutherland Shire Council has a Greenweb strategy to conserve and enhance bushland and biodiversity by identifying and appropriately managing key areas of bushland habitat and establishing and maintaining interconnecting linkages and corridors (SSC 2010).

Still Creek Wetland has been mapped by the Greenweb strategy as restoration. This is defined by SSC (2010) as

- Restoration - areas providing opportunities for the establishment and vegetation of corridors between core areas.

The other definitions under Greenweb are:

- Support – areas containing ancillary habitat areas, secondary linkages between habitats, or lands that form a buffer between developments adjacent key habitats and corridors;
- Core – areas containing key habitat areas, linkages and threatened species, or endangered ecological communities (usually greater than 3.5 hectares).

The location of Still Creek Wetland in the Greenweb network is shown in Figure 10.

Still Creek Wetland adjoins a small area of restoration and support immediately to the north across Mina Road and along Beaumaris Drive. This connects directly to a core area which runs to the north and east along Still Creek to the Woronora River.

To the south, Still Creek Wetland adjoins an area mapped as support which runs along the upper reaches of Still Creek to MacMahon Place. This is separated by MacMahon Place and Alison Crescent from an area of core Greenweb habitat, located less than 200 metres to the east, in Menai Park and known to support the Sydney Turpentine Ironbark Forest EEC. To the west the Still Creek support corridor is separated by around 300 metres from a core Greenweb area that supports Shale Sandstone Transition Forest. Some additional street tree plantings could see a narrow link between these stepping stones of habitat.

Around 200 metres to the east a patch of core habitat occurs adjacent to Menai Market Place. This area also supports a patch of Shale Sandstone Transition forest EEC.

On the local level the area of riparian corridor that runs south from Still Creek Wetland to MacMahon Place could be enhanced by excluding mowing from the eastern side of the pathway, allowing shrub layer vegetation to regenerate to the path edge. The corridor could also be enlarged in the area around Abraham Close with additional canopy plantings (ensuring mature canopy trees will maintain canopy separation) and planting of shrubs between trees.

### 5.2.2 Buffer Zone

Buffers of natural vegetation and grassy filter strips can contribute to water quality in wetlands and creeks. Natural vegetation and grassy filter strips can trap around 90 per cent of sediment moving from upslope (DEC 2005a), and buffer strips can also control levels of bacteria in run off (Dec 2005a).

The Still Creek Wetland supports a buffer area of around 40 metres consisting of riparian vegetation extending east from the wetland (see section 5.1.2b).





Figure 10: Still Creek Wetland wildlife connectivity.

This buffer continues upstream of the wetland along Still Creek for about 400 metres to MacMahon Place.

In some sections of the eastern boundary of the riparian open forest close to Still Creek Wetland patches of grass occur as pure stands. Recommendations for the staged regeneration of these patches have been made in the vegetation management plan (VMP). The approach set out in the VMP recognises the important role buffer zones can play in contributing to water quality in Still Creek and the wetland.

A grassed landscaped area of between 40 and 60 metres provides a buffer to the wetland on the western edge between the wetland, Mina Road and the adjacent houses.

### **5.3 FAUNA HABITAT EVALUATION**

Habitat values in Still Creek Wetland and the adjoining riparian open forest range from high to low as shown in Table 8.

Within the wetland habitat, values are considered moderate to high. The emergent macrophytes and aquatic weeds provide foraging, shelter and breeding habitat for water fowl and foraging and shelter resources for migratory birds and reptiles and amphibians.

The open water provides a water source for a variety of native and introduced species, foraging resources for migratory birds and some bats, breeding habitat for amphibians, habitat for aquatic species and invertebrates.

The riparian open forest that adjoins the wetland provides moderate to high habitat values including seasonal foraging and shelter resources for nectivorous birds, insectivorous birds and arboreal mammals. Foraging and shelter resources for herpetofauna, mega and micro chiropteran bat species including the grey-headed flying fox and the southern myotis, owls and raptors.

The landscaped grassland habitat values range from low to moderate. The mowed grass would provide some foraging habitat for birds and ducks while the landscape plantings would provide some seasonal foraging and

shelter resources for birds and arboreal mammals and cover for small ground dwelling mammals.

### **5.4 FISH PASSAGE ASSESSMENT**

Currently fish passage from Still Creek Wetland to the downstream reach of Still Creek is significantly restricted by the outlet from the wetland. The outlet structure consists of a hooded and grated vertical riser which allows low flows through to Still Creek downstream of Mina Road. This effectively blocks any fish passage between the wetland and the downstream environment and does not incorporate a fish ladder.



## 6 SOCIAL VALUES

Still Creek Wetland is located in the suburb of Menai in the Sutherland Shire on the southern outskirts of Sydney. The Menai district has been developed intensely since the 1980s, and includes residential areas to the north and south of Menai Road (NSW RTA 2002). Still Creek Wetland is located on the northern side of Menai Road amongst a large residential area consisting largely of detached dwellings with some apartments.

The population of the Menai district which includes the suburbs of Alford's Point, Barden Ridge, Bangor, Illawong, Menai, Sandy Point and Woronora, was 29,182 in 1996 (NSW RTA 2002). The Menai district has the highest percentage (almost 45%) of young people in the Sutherland Shire (aged between 0 and 24 years).

The Menai town centre precinct, located on Alison Crescent is an important hub of commercial and community activity for the local and district population (NSW RTA 2002). It contains a shopping centre and community facilities including Club Menai and the Menai Community Centre.

### 6.1 EXISTING AND POTENTIAL USER GROUPS

Still Creek Wetland is a popular local park used primarily by local residents, who take advantage of the pathway for walking and feeding ducks in the wetland. A number of community groups and other associated organisations were interviewed in regards to their use of the wetland including:

- Sutherland Shire Council;
- Sutherland Shire Council Bushcare;
- Menai Wildflower group.

At the time of writing no response had been gained for the Menai Wildflower group.

The wetland is subject to regular maintenance by Sutherland Shire Council and the maintenance crews identify Still Creek Wetland as a preferred area to take their lunch break.

A Council bushcare group is active downstream of Still Creek Wetland on Beaumaris Drive.

Council's Noxious Weeds Officers have done a considerable amount of work controlling the noxious weed *Ludwigia peruviana* in the wetland in past years. Currently Council has a staff member doing some weed control up stream of Still Creek Wetland controlling morning glory.

### 6.2 VALUE OF STILL CREEK WETLAND TO THE COMMUNITY

The value of Still Creek Wetland to the community has been gauged by the responses at the community consultation workshop (see section 6.3).

In summary the wetland is highly valued by the community as:

- A natural area for passive recreation; and
- An area for families to enjoy.

### 6.3 COMMUNITY CONSULTATION

#### 6.3.1 Approach

A community consultation program was undertaken as part of this Management Plan. The objectives of the program were to:

- identify values of the wetland to the community;
- gain an understanding of community attitudes towards the wetland; their likes and dislikes; and
- provide an opportunity for community members to offer suggestions on how the wetland could be improved.

Involving the community in the preparation of the Management Plan ensures the plan reflects the needs and concerns of those who have an interest in the future of Still Creek Wetland.

A number of techniques were used to facilitate communication between the community and

the study team during the preparation of the Management Plan. These included:

- phone interviews with known user groups;
- distribution of a newsletter to the residents of the surrounding residential area of Menai;
- day to day contact through the provision of a contact name, phone number and email address; and
- two community workshops at the Menai Community Centre.

The first workshop was held during the preparation of the Management Plan so the community could directly indicate their likes and dislikes to the study team and provide input into the management strategies by identifying how they thought the wetland could be improved.

The second workshop was held after the preparation of the Management Plan to provide the community with an opportunity to comment on the document.

### 6.3.2 Results

A total of 4 residents attended the first workshop in August 2011, along with 4 Council officers a representative from SMCMA and two consultants.

A short presentation on the Management Plan process and studies being undertaken was provided by Molino Stewart and J Wyndham Prince. A series of historical aerial photos of Still Creek Wetland were also presented, dating as far back as 1930. The community members then addressed the following questions:

- what they liked most about the wetland;
- what they liked least about the wetland;
- how they thought the wetland could be improved.

Participants were asked to list these things and, where possible, rank them in order of priority.

Specific features people liked about Still Creek Wetland were:

- there are no houses opposite the wetland;

- there is a perception local residents have waterfront homes;
- the waterfall;
- the wetland provides a nice natural environment for passive recreation;
- the wetland is relaxing;
- the wetland is natural;
- residents preferred a National Park style;
- tall trees hide the adjoining development;
- residents are not overlooked, the wetland is an oasis to relax in;
- residents think Bushcare is positive; and
- the presence of birds and animals.

The group was in agreement on things they did not like about the wetland, these included;

- rubbish in the creek;
- weeds and vines up the gum trees;
- sedimentation of the wetland;
- no rubbish bins;
- the odour from sediment removed from the wetland on hot days;
- weeds and algal problems that occur as the community perceives the wetland as too shallow;
- the path has become blocked and overgrown at the north western edge of the wetland;
- overgrown bush on the corner of Mina Road at the northern end of the wetland has resulted in accidents due to limited visibility through vegetation.

The residents had clear ideas on how to improve the wetland:

- clean up the weed in the water;
- make the wetland deeper;
- concentrate duck feeding in area between the path and the wetland rock edge.

The issues of safety and lighting were raised during the first community consultation workshop. The responses from community members present indicated:

- safety was not considered an issue at Still Creek Wetland as local children using the adjacent parkland were generally well



supervised and in the company of adults when using the park or feeding the ducks;

- lighting was preferred 'left as is" so that anti-social behavior was not encouraged.

A total of nine residents attended the second workshop held at Still Creek Wetland on the 16<sup>th</sup> February 2012, along with 3 Council officers a representative from SMCMA and two consultants.

A short presentation on the final draft management plan was made by Molino Stewart and then a walk around the wetland with discussion of management strategies was facilitated by J Wyndham Prince.

The results of the facilitated discussion are summarised below.

- Residents expressed interest in the plan and in particular the timing of and funding for implementation.
- Residents indicated a high level of ongoing involvement in informal management of the area surrounding the wetland including regular rubbish collection.
- Residents were concerned over the level of weed invasion in the riparian vegetation adjoining the wetland and with aquatic weeds in the wetland.
- A suggestion was made that to reduce antisocial behavior (including littering) adjacent to the wetland an additional street light be installed in the vicinity of the access way at Number 43 Mina Road Menai.

## 7 ISSUES ANALYSIS

### 7.1 SEDIMENTATION

Still Creek Wetland was constructed during the development of the Mina Road residential estate in 1995. The developer of the estate created the wetland with the objective of providing sediment control during construction, and flood attenuation, water quality control and recreational amenity post-construction.

SSC advised that the wetland was dredged in 1995/1996 and the gross pollutant trap (GPT) on the inlet is cleaned annually, as a minimum, with the most recent clean out occurring in early May 2011. Sandstone Bedrock is very close to the surface and is exposed throughout the Still Creek channel upstream of the wetland.

The catchment of the wetland is large, in the order of 55 hectares and consists largely of land developed for urban uses. This combined with an exposed bedrock channel upstream has led to high levels of sediment accumulation in the wetland. The large volume of sediment collected by the wetland was acknowledged as far back as 2000 (SSC 2000).

Currently sediment is accumulating in the inflow area immediately upstream of the GPT. Large volumes of sediment are also bypassing the GPT and accumulating immediately downstream of the GPT and in the centre of the wetland. The sediment has formed an island in the wetland that has been colonised by the aquatic weed *sagittaria Sagittaria graminea*.

In order to address the aquatic weed problem in the wetland the sediment island will need to be removed by dredging. The current water quality function of the aquatic weeds will need to be replaced. This could be done with a floating reed bed.

The current GPT is on-line with the major inflows and orientated at right-angles to the flow direction. Its separation chamber appears to be undersized for the loads entering the GPT. The existing GPT requires modification for it to function more efficiently or replacement with a more suitable and efficient GPT.

### 7.2 VEGETATION AND WEED INVASION

Aquatic weeds have invaded and become established in Still Creek Wetland. Weed infestation is concentrated in a number of locations:

- immediately downstream of the trash rack, leading into the wetland;
- small sediment island in the centre of the wetland; and
- areas of sediment accumulation on wetland margins.

Aquatic weeds include noxious weeds:

- *sagittaria Sagittaria graminea* (not noxious);
- water hyacinth *Eichornia crassipes* (class 2) (has occurred in the past);
- alligator weed *Alternanthera philoxeroides* (class 3); and
- *ludwigia Ludwigia peruviana* (class 3).

Legally, noxious weeds must be controlled or removed under the *NSW Noxious Weeds Act 1993*. Weeds are declared noxious if they pose a significant problem to human health, the environment, livestock or the agricultural industry. In NSW, local Councils are responsible for controlling weeds in urban and rural areas under their responsibility.

Council has had a long and concerted effort to reduce aquatic noxious weeds in the wetland including a focus on the removal of *ludwigia Ludwigia peruviana* over the last few years.

In order to successfully address the noxious and aquatic weed infestation in Still Creek Wetland the existing sediment would require dredging and removal and the issue of ongoing sedimentation resulting from an inappropriate GPT at the inlet needs to be addressed.

Weed infestation in the adjoining riparian open forest is also a management issue. Riparian habitats where aquatic and terrestrial ecosystems meet are recognised as vital sites for supporting high levels of biodiversity (Jansen et al 2007). The terrestrial vegetation adjoining the wetland provides an important physical buffer against nutrients and disturbance and provides habitat for a variety

of native fauna species. The vegetation is currently subject to infestation by morning glory *Ipomea indica*. The noxious weeds lantana *Lantana camara* and blackberry *Rubus fruticosus* are also emerging as immature plants in the northern section of the open forest community. These weed infestations require ongoing management and control. Weed infestation reduces the long term viability of the SSTF EEC and compromises fauna habitat values.

Vegetation management in the landscaped grassland can contribute to visual amenity in Still Creek Wetland. The grated outlet structure for high flows could be screened with plantings of locally endemic native species that will not impede the rate of overland flow.

A vegetation management plan has been prepared for Still Creek Wetland to guide the ongoing weed control and management of vegetation and is attached as Appendix E to this document.

The landscaped area and riparian forest will require ongoing monitoring to ensure damage to trees by cockatoos does not become severe.

### 7.3 WATER QUALITY

Still Creek Wetland was originally designed to prevent sediment generated by the construction of the surrounding developments from entering the lower reaches of Still Creek. On completion of the construction works the sediment basin was decommissioned and recommissioned as stormwater detention basin. It was never intended to perform a water quality control function.

However, by default, it retains its original functionality as a sediment control basin and the upstream GPT, and screens on the wetland outlet structures assist in the control of gross pollutants, sediments and some of the attached pollutants.

Existing site constraints, infrastructure and sandstone bed rock, limit opportunities to improve the water quality control function of the wetland. "Rule-of-thumb" calculations suggest that for the wetland to achieve a tangible water quality benefit its surface area

and volume should be increased to about 2 hectares 15,000 m<sup>3</sup> respectively.

SSC have invested in a Strategic Water Monitoring Program throughout the Shire. Still Creek Wetland has been identified as a suitable monitoring site and has been designated as Site 25A and 25B within this Program. Water quality monitoring was undertaken at Still Creek for a period of 5 years up until 2004 when it was discontinued.

The discontinued monitoring program identified a number of anomalies with respect to the water quality in Still Creek. In general it identified that the presence of the on-line wetland was beneficial to the downstream water quality.

Measures recommended in this Management Plan will contribute to improving the water control function of the wetland. These include but are not limited to; dredging the wetland, replacing the GPT, improving the riffle zone and installing a floating reed bed.

Reinstatement of the water quality monitoring along with the introduction of macro invertebrate monitoring using the Georges River Combined Councils Committee's Community River Health Monitoring Program would provide an understanding of the ongoing contribution of Still Creek Wetland to water quality in Still Creek.

### 7.4 FLOOD CONTROL AND CLIMATE CHANGE

Still Creek Wetland makes a contribution to local flood mitigation as a flood detention basin. The management measures outlined in this plan will not diminish the flood attenuation role afforded by the Still Creek Wetland in its role as a local flood mitigation basin. The Sydney Metropolitan Catchment Management Authority has projected increases of 15 % in rainfall intensities and 25% in annual runoff volumes by the year 2030 (SMCMA 2011).

Based on these projections the parkland surrounding the Still Creek Wetland can be expected to be inundated more frequently. However, the difference in level between the surrounding properties and the lowpoint in

Mina Road, should provide sufficient flood protection for adjacent properties

Further detailed survey of the wetland along with modelling will contribute to an improved understanding of how the wetland will function in light of these projected changes in rainfall intensities and sea level rise with climate change.

## **7.5 WETLAND INFRASTRUCTURE**

Sedimentation, dredging and weed infestation in Still Creek Wetland are closely linked to the failure of existing wetland infrastructure to function efficiently.

A number of issues around wetland infrastructure require consideration. In summary they include:

- the need for a detailed design of a retrofitted GPT (a Baramy® Vane GPT has been recommended) or redesign of the existing GPT so it functions more efficiently;
- the need to replace and repair the broken barrier fence to the inlet area of the wetland to ensure continued safety for all wetland users and Council staff undertaking maintenance;
- the reshaping of the area immediately downstream of the GPT to replicate a riffle zone using strategically placed sandstone boulders which would reduce inflow velocities and the hard substrate should reduce colonisation by weeds;
- the introduction of a floating reed bed to address the water quality function currently carried out by the aquatic weeds taking up nutrients from the water in the wetland. This function could be carried out by a purpose designed and built floating reed bed that would address water quality and create a visual screen to their wetland outflow structure.

## **7.6 MAINTENANCE ACCESS AND REGIME**

The current maintenance regime includes regular removal of sediment from the inflow area of the wetland. This requires removal of

the existing barrier fence which has subsequently fallen into disrepair and requires disposal of damp sediment that may be contaminated with weed propagules and all manner of urban rubbish.

The GPT proposed in this Management Plan will potentially collect additional sediment in the wetland inflow area immediately upstream of the GPT. This may require an additional maintenance check and action to ensure the sediment does not accumulate beyond manageable levels.

The existing fence also requires maintenance or replacement and appropriate access provided to the wetland inflow area so the fence does not have to be dismantled for sediment removal.

Rubbish removal from the wetland is undertaken from the inflow area of the wetland. However as the GPT is not functioning at an optimum level rubbish is flowing over the top of the GPT and is deposited in the wetland. There is a need prior to the replacement or modification of the GPT to undertake regular rubbish removal from the broader wetland to improve visual and recreational amenity and safeguard fauna habitat values.

## **7.7 RECREATIONAL AMENITY**

Still Creek Wetland and the adjacent parkland and pathway along the upper reaches of Still Creek to MacMahon place are very well used by the local community.

The community values the wetland as a natural area for passive recreation and it is popular with local residents and young families.

The proposed improvements will contribute to the ongoing use of the wetland and the adjacent park and riparian vegetation through improving the visual amenity of the wetland. Proposed measures include screening of the high flow outlet structure with terrestrial vegetation and screening of the low flow outlet structure with a floating reed bed.

The local community has specifically mentioned about the presence of rubbish and weeds in the wetland and adjoining terrestrial vegetation. The proposed modified or new



GPT should reduce rubbish loads in the wetland. In the interim regular rubbish collections in and around the wetland should be undertaken.

The vegetation management plan outlines measures to reduce and control weed infestation in the adjoining riparian open forest vegetation along Still Creek upstream of the wetland.

## **7.8 COMMUNITY ENGAGEMENT, EDUCATION AND CAPACITY BUILDING**

The local Mina Road community place high levels of value on the wetland for its recreational amenity. This was made clear in the community consultation workshops held for the Management Plan.

However there was not a high level of understanding of the potential direct impact local residents may have on Still Creek Wetland. For example it was not well understood that water from the roofs, local roads and yards entered Still Creek and the wetland. It is recommended that an education initiative focused around the community's role in contributing to local water quality be developed. This could include but not be limited to articles in the local paper and information days at Still Creek Wetland and Menai Town Centre.

Sutherland Shire has a strong Bushcare community that takes an active role in the management of local bushland reserves, including reserves to the north and south of Still Creek. The local community has also indicated a positive perception of Bushcare at the first community consultation workshop.

Support for community involvement in the ongoing care and management of Still Creek Wetland will require effort and funding to be successful.

It is recommended that existing Bushcare efforts are supported along with a number of supplementary measures. Council's Bushcare team based at Beaumaris Drive should be funded to provide community days at Still

Creek Wetland. These could be combined with existing "environmental initiatives including World Wetlands day and Clean up Australia. These initiatives could be publicized in the local press and encourage people to attend to learn how to take action in the wetland or to gain skills in how they might contribute to wetland management.

The longer term goals of this program of community engagement and capacity building would be to develop a Bushcare group dedicated to the care of Still Creek Wetland.

## 8 MANAGEMENT STRATEGIES

### 8.1 MANAGEMENT STRATEGIES

The management strategies recommended for Still Creek Wetland include:

- retrofitting infrastructure (GPT);
- repair low flow outlet pipe;
- dredging of the wetland;
- install floating reed bed;
- replace fencing adjacent to wetland inlet;
- water quality and macro invertebrate monitoring;
- flood attenuation and climate change;
- vegetation and weed management
- retrofit riffle zone downstream of inlet;
- outlet structure screening;
- community education;
- community consultation and engagement

The management strategies and actions have been prioritised and costed and are presented in Appendix G to the Management Plan

### 8.2 RETROFIT INFRASTRUCTURE

#### 8.2.1 Objectives

Improve the sediment trapping efficiency of the gross pollutant trap (GPT) just below the inlet to the wetland, to reduce sedimentation in the wetland which provides habitat for the establishment of aquatic weeds.

#### 8.2.2 Actions

- Prepare concept design to modify GPT;
- Replace the existing GPT with a Barmy Vane Trap (preferred action); or
- Modify the existing GPT to function more effectively; or

- Increase the cleaning frequency of the existing structure (least preferred).
- Regularly clean new structure.

#### 8.2.3 Performance Targets

- Decrease in frequency of cleaning the GPT separation chamber;
- Reduced level of sedimentation in the wetland;
- No reestablishment of the sediment island in the centre of the wetland post dredging once GPT is replaced / improved.

#### 8.2.4 Funding Sources

- Water Sensitive Urban Design (WSUD) Program - [www.wsud.org](http://www.wsud.org) Sydney Metropolitan Catchment Management Authority has funding WSUD projects for next year (11-12) and the year after that. Projects need to be in Botany Bay Catchment and improve water quality. Projects require co-funding from council or land manager. Catchment area treated needs to be 2 hectares or greater.
- Office of Environment and Heritage Environmental Restoration and Rehabilitation Grants (as part of a broader grant application) <http://www.environment.nsw.gov.au/grants/envtrust.htm> <http://www.environment.nsw.gov.au/grants/restoration.htm>
- Sutherland Shire Council's maintenance works budget

### 8.3 REPAIR LOW FLOW OUTLET PIPE

#### 8.3.1 Objectives

Repair low flow outlet pipe to Still Creek Wetland

#### 8.3.2 Actions

- Dewater wetland;

- Expose the last 15 m of existing Aluminium pipeline;
- Remove and replace with Reinforced Concrete Pipe;
- Backfill with 42 Megapascal (MPa) concrete.

### 8.3.3 Performance Targets

- Functioning low flow outlet pipe

### 8.3.4 Funding Sources

- Sutherland Shire Council maintenance works budget.

## 8.4 DREDGING

### 8.4.1 Objectives

Reduce sedimentation and subsequent aquatic weed invasion in the wetland.

### 8.4.2 Actions

- Access the wetland and dredge the existing sediment island from the centre of the wetland that is colonised by the aquatic weeds;
- Dispose of this dredged sediment in an appropriate manner that will not result in the further distribution of weeds.

### 8.4.3 Performance Targets

- No reestablishment of the sediment island in the centre of the wetland, post replacement / improvement of the GPT and initial dredging.

### 8.4.4 Funding Sources

- Sutherland Shire Council maintenance works budget.

## 8.5 FLOATING REED BED

### 8.5.1 Objectives

To address the water quality function that weeds currently perform in the wetland in a more appropriate way.

### 8.5.2 Actions

- Have a floating reed bed designed for Still Creek Wetland that would absorb some of the nutrients from the water entering the wetland;
- Have the reed bed densely planted with native *Baumea sp.*, and *Schoenoplectus sp.*, and/ or other suitable species;
- Monitor the reed bed for invasion by *Ludwigia peruviana* (a noxious weed already present on the site) and remove before, during and after installation of the reed bed

### 8.5.3 Performance Targets

- A reduction in aquatic weed infestation levels in the wetland, including in extent and density

### 8.5.4 Funding Sources

- Water Sensitive Urban Design (WSUD) Program - [www.wsud.org](http://www.wsud.org) Sydney Metropolitan Catchment Management Authority has funding WSUD projects for next year (11-12) and the year after that. Projects need to be in Botany Bay Catchment and improve water quality. Projects require co-funding from council or land manager. Catchment area treated needs to be 2 hectares or greater.
- Office of Environment and Heritage Environmental Restoration and Rehabilitation Grants (as part of a broader grant application) <http://www.environment.nsw.gov.au/grants/envtrust.htm> <http://www.environment.nsw.gov.au/grants/restoration.htm>
- Sutherland Shire Council's maintenance works budget

## 8.6 FENCING AND SIGNAGE

### 8.6.1 Objectives

To ensure an effective barrier between the inlet area and GPT and the adjoining park that reduces the risks of falls, slips and trips to Council staff and the community through the existing fencing that is in disrepair.

Provide appropriate signage to warn users of the risks of falls greater than 2 metres from and around the fencing into the inlet area of the wetland.

### 8.6.2 Actions

- Remove the cable ties and wire used to secure the pool fencing located adjacent to the wetland inlet. Properly secure the panels and control all access points with additional panels or appropriate barriers:
- Design and erect signage so it is prominently displayed warning of the dangers of entering the area around the GPT.

### 8.6.3 Performance Targets

- Increased public safety around the inlet structure and the GPT;
- An increased awareness of local residents of the dangers posed by the drop off to the wetland inlet;
- A reduction in accidents in and around this area of the wetland.

### 8.6.4 Funding Sources

- Sutherland Shire Council's maintenance works budget.

## 8.7 FLOODING AND CLIMATE CHANGE

### 8.7.1 Objectives

To better understand and plan for the contribution of Still Creek Wetland to flood

mitigation in light of predicted changes to rainfall intensity with climate change.

### 8.7.2 Actions

- Basin profiles and volumes should be confirmed by Works As Executed survey.
- The hydrology and hydraulics of the wetland confirmed using more contemporary modelling techniques. (The rainfall intensities used should be increased by at least 15% in consideration of projected Climate Change impacts).
- In light of this further detailed assessment any risk to public safety as a consequence of the Mina Road embankment overtopping should be considered and addressed.

### 8.7.3 Performance Targets

- Works As Executed survey undertaken.
- Contemporary modelling of wetland undertaken.
- Risks to public safety predicted.

### 8.7.4 Funding Sources

- Department of Climate Change and Energy Climate Change Adaptation Grants  
<http://www.climatechange.gov.au/government/initiatives/national-climate-change-adaptation-research-facility/how-does-it-work/climate-change-adaptation-grants.aspx>
- Georges River Combined Councils Committee.
- Sutherland Shire Council.

## 8.8 WATER QUALITY

### 8.8.1 Objectives

Reduce diffuse and point source pollution in Still Creek Wetland



## 8.8.2 Actions

- Reinstatement of the water quality monitoring program that was in place in the wetland prior to 2004. This program should be based on SSC's Strategic Water Quality Monitoring Program and include the basic analytes set out in section 4.5.1 of this report.
- Introduce a macro invertebrate monitoring program to Still Creek Wetland based on the Georges River Combined Councils' Committee Community River Health Monitoring Program.
- Monitoring of the volume of litter and sediment removed from the wetland should be continued.
- Monitoring should occur as a minimum every six months and preferably monthly.
- Liaise with Sydney Water to confirm the design recurrence interval for overflows from the local sewerage system with Sydney Water with SSC.
- If a sewer overflow occurs into the wetland, drain, clean and decontaminate the wetland before the public are allowed back into the parkland.
- Confirm that regular inspections of the local sewerage system are undertaken by Sydney Water and confirm that no blockages are present in the system. If blockages are located they should be removed.
- Engage the community in a communication, education, public awareness and action program focusing on the roles and actions that can reduce diffuse and point source pollution into the wetland.
- Have a plan of action in place to respond to point source pollution spills such as sewer overflows or when the water quality monitoring program identifies specific issues.
- Provide advice and information to the local community surrounding the wetland when this occurs.

## 8.8.3 Performance Targets

- Water quality monitoring program re-established.

- Ongoing improvement in water quality within Still Creek Wetland.
- Liaison with Sydney Water undertaken.
- Sewer system inspection and maintenance carried out.
- Community engagement undertaken.
- Plan of action developed for spill or contamination occurrence in Still Creek Wetland.

## 8.8.4 Funding Sources

- Office of Environment and Heritage Environmental Restoration and Rehabilitation Grants (as part of a broader grant application)  
<http://www.environment.nsw.gov.au/grants/envtrust.htm>  
<http://www.environment.nsw.gov.au/grants/restoration.htm>
- Sutherland Shire Council's Strategic Water Quality Monitoring Program budget
- GRCCC Community River Health Monitoring program.

## 8.9 VEGETATION AND WEED MANAGEMENT

### 8.9.1 Objectives

Reduce weed infestation in and upstream of Still Creek Wetland in the riparian vegetation corridor that extends to MacMahon Place.

Promote regeneration of and revegetation with, native species in the wetland and the immediate upstream environment.

### 8.9.2 Actions

- Identify the appropriate person within Council to oversee weed removal and bush regeneration in the wetland and upstream riparian corridor;
- Prepare a vegetation management plan for the wetland and riparian corridor that makes specific recommendations that could be implemented by a bushland manager;

- Secure funding for the implementation of the vegetation management plan;
- Commission a qualified bush regeneration contractor to implement the vegetation management plan for Still Creek Wetland;
- Explore the opportunity to plant additional canopy trees and shrubs between trees around Abraham Close. Planting if undertaken should be done so with a view to having canopy separation of mature trees to reduce bushfire hazard. However it is envisaged that two or three trees may be able to be planted in this area.
- Promote Still Creek Wetland into SSC's Bushcare program to provide opportunities for local residents to join existing programs in weeding and bush regeneration activities;
- Encourage and provide some incentives to promote local residents of the Mina Road subdivision's involvement in vegetation management and bush regeneration activities in Still Creek Wetland
- Implement monitoring of vegetation management in the wetland and report in Council's State of the Environment Report.

### 8.9.3 Performance Targets

- Commissioning of a qualified bushland manager to implement the vegetation management plan prepared for Still Creek Wetland;
- Reduce weed densities in the wetland and adjacent vegetation communities;
- Undertake primary weeding in the wetland and adjacent vegetation communities following Council's acceptance of the Management Plan for Still Creek Wetland;
- Source or raise locally endemic native species for planting in the wetland and surrounding vegetation communities;
- Undertake secondary and follow up weeding in the wetland and adjacent vegetation communities;
- Include Still Creek Wetland in an area covered by an existing Bushcare group; or

- Establish a Still Creek Wetland Bushcare group.

### 8.9.4 Funding Sources

- Office of Environment and Heritage Environmental Restoration and Rehabilitation Grants (as part of a broader grant application)  
<http://www.environment.nsw.gov.au/grants/envtrust.htm>  
<http://www.environment.nsw.gov.au/grants/restoration.htm>
- Sutherland Shire Council's Greenweb strategy.
- GRCCC Riverkeeper program.

## 8.10 RIFFLE ZONE

### 8.10.1 Objectives

Reduce sediment build up and subsequent aquatic weed infestation at the inlet to the wetland.

Improve the visual quality of the upper reaches of Still Creek and enhance the recreational values of the wetland.

### 8.10.2 Actions

- Remove existing sediment, light litter and weed build up from the inlet zone of the wetland;
- Reshape this area with the aid of a small excavator to replicate a riffle zone using strategically placed sandstone boulders which would reduce inflow velocities and along with a more effective GPT, the hard substrate should reduce colonisation by weeds.

### 8.10.3 Performance Targets

- Reduced inflow velocities into the wetland;
- Reduced build-up of sediment in the inflow zone;
- Reduced weed infestation in the inflow zone.

#### 8.10.4 Funding Sources

- Water Sensitive Urban Design (WSUD) Program - [www.wsud.org](http://www.wsud.org) Sydney Metropolitan Catchment Management Authority has funding WSUD projects for next year (11-12) and the year after that. Projects need to be in Botany Bay Catchment and improve water quality. Projects require co-funding from council or land manager. Catchment area treated needs to be 2 hectares or greater.
- Office of Environment and Heritage Environmental Restoration and Rehabilitation Grants (as part of a broader grant application) <http://www.environment.nsw.gov.au/grants/envtrust.htm> <http://www.environment.nsw.gov.au/grants/restoration.htm>
- Sutherland Shire Council's maintenance works budget.
- GRCCC Riverkeeper program.

### 8.11 OUTLET STRUCTURE SCREENING

#### 8.11.1 Objectives

To reduce the visual impact of the outlet structures located within the wetland.

There are two (2) outlet structures:

- a hooded and grated vertical riser that controls low flows; and
- a much larger grated outlet to control high flows.

#### 8.11.2 Actions

- Use the floating reed bed to screen the vertical riser within the wetland;
- Use screen planting to reduce the visual impact of the high flow outlet located at the north western edge of the wetland.

#### 8.11.3 Performance Targets

- Reduced visual impact of the outlet structures, from within the wetland and the pathway along the riparian corridor

extending south from the wetland toward MacMahon Place.

#### 8.11.4 Funding Sources

- Water Sensitive Urban Design (WSUD) Program - [www.wsud.org](http://www.wsud.org) Sydney Metropolitan Catchment Management Authority has funding WSUD projects for next year (11-12) and the year after that. Projects need to be in Botany Bay Catchment and improve water quality. Projects require co-funding from council or land manager. Catchment area treated needs to be 2 hectares or greater.
- Office of Environment and Heritage Environmental Restoration and Rehabilitation Grants (as part of a broader grant application) <http://www.environment.nsw.gov.au/grants/envtrust.htm> <http://www.environment.nsw.gov.au/grants/restoration.htm>
- Sutherland Shire Council's maintenance works budget.
- Sutherland Shire Council's Greenweb Strategy.

### 8.12 COMMUNITY EDUCATION

#### 8.12.1 Objectives

To improve water quality and aesthetics in Still Creek Wetland.

#### 8.12.2 Actions

- Develop a community education program alerting the residents to issues associated with feeding the ducks bread as well as the impact that a large flock of ducks has on water quality and wetland vegetation.
- Provide some advice following discussion with Council on the use of vegetable scraps as an alternative food source for the ducks.

#### 8.12.3 Performance Targets

- Increased water quality results from water monitoring, in particular reduced nitrogen levels.

#### 8.12.4 Funding Sources

- Office of Environment and Heritage Environmental Trust grant programs, Environmental Education – Community <http://www.environment.nsw.gov.au/grants/education.htm>

### 8.13 COMMUNITY CONSULTATION AND ENGAGEMENT

#### 8.13.1 Objectives

Raise the profile of Still Creek Wetland with local Bushcare groups with a view to the development of a dedicated Still Creek Wetland Bushcare group in the longer term.

Have community members engaged with and kept informed of the ongoing implementation of wetland management actions including the implementation of a vegetation management plan.

#### 8.13.2 Actions

- Engage with Beaumaris Drive Reserve Bushcare Group with the goal of linking Still Creek Wetland with Menai Park and the downstream Still Creek core Greenweb habitat areas.
- Engage with the Parc Menai Bushcare group and highlight the potential for the Still Creek Wetland and adjoining riparian corridor to provide a link between Menai Park, Still Creek and ultimately the Woronora River.
- Provide ongoing support and incentives for existing Bushcare groups to include Still Creek Wetland in their activities.

#### 8.13.3 Performance Targets

- Inclusion of Still Creek Wetland in Bushcare activities;
- In the long term development of a dedicated Still Creek Wetland Bushcare Group.

#### 8.13.4 Funding Sources

- Sutherland Shire Council's Greenweb strategy;
- Sutherland Shire Council's Bushcare initiative;
- Office of Environment and Heritage Environmental Trust grant programs, Environmental Education – Community <http://www.environment.nsw.gov.au/grants/education.htm>



## **9 WETLAND MONITORING PLAN**

### **9.1 INTRODUCTION**

Monitoring of Still Creek Wetland will enable wetland managers to:

- Collect long term information on the success of management actions introduced as part of this Management Plan;
- Collect information on the quality of surface water in the wetland and trends in water quality;
- Collect information on the occurrence of threatened species and health of endangered ecological communities within the wetland;
- Collect information on the success of weed management actions in the wetland;
- Provide an evaluation of management actions;
- Provide recommendations for future management actions.

### **9.2 WETLAND INFRASTRUCTURE MONITORING**

#### **9.2.1 Question**

Have the changes made to wetland infrastructure reduced sedimentation and litter in Still Creek?

#### **9.2.2 Objectives**

- Determine the current volume of sediment removed from the wetland inlet area.
- Determine the current volume of litter removed from the wetland GPT and surrounding wetland area
- Compare sediment volumes removed prior to wetland infrastructure changes to volumes post changes to wetland infrastructure.

#### **9.2.3 Monitoring**

- Collect records over time of the volumes of sediment and litter removed from the inlet to Still Creek Wetland.
- Measure the volume of sediment and litter removed from the Still Creek Wetland inlet following changes to the GPT.

### **9.3 WATER QUALITY MONITORING**

#### **9.3.1 Question**

- How does water quality in Still Creek Wetland change over time with management and climate change?
- What is the response to potential issues associated with contamination of the wetland which could pose a risk to public health (eg blue green algae, faecal contamination)?

#### **9.3.2 Objectives**

- Identify the current water quality conditions;
- Monitor diffuse and point source pollution;
- Assess the state of the wetland as defined by SSC's Strategic Water Quality Monitoring Program;
- Identify trends in surface water quality;
- Identify a measurable reduction in level of contaminants in water quality in the wetland.
- Develop a macro invertebrate monitoring sampling regime to use macro invertebrates as an indicator of biological health of the Still Creek Wetland system. This would require answers to the following questions:
  - why monitoring is being undertaken,
  - who will use the data and how,
  - what will be monitored (for example presence of macro invertebrates, abundance and diversity to order or family level),
  - what data quality is required for decision making,

- what methods and equipment are used,
- where will monitoring be undertaken,
- when and how often will monitoring occur,
- who will be involved and how,
- how will the data be used and how will data be verified.

- Macro invertebrate monitoring could be developed using the Georges River Combined Councils' Committee Community River Health Monitoring Program.
- Macro invertebrate monitoring could be used during community days to demonstrate the presence of macro invertebrates to the community and begin a discussion on their monitoring.

### 9.3.3 Monitoring

- Long term water quality sampling should be reinstated at Still Creek at the existing water quality monitoring locations;
- Sampling and reporting methods should follow SSC's Strategic Water Quality Monitoring Program;
- Sampling should be undertaken every six months, preferably late summer and late winter;
- Monitoring should include those analytes listed in section 4.5.1, with an estimated cost of \$3000 per annum (including laboratory analysis);
- The monitoring results should be made accessible to all stakeholders and the broader public;
- After two years monitoring results should be reviewed to identify trends and consider requirements for ongoing monitoring.

## 9.4 MONITOR FRESHWATER WETLAND VEGETATION AND RIPARIAN EEC

### 9.4.1 Question

- How do freshwater wetland vegetation communities and endangered ecological communities in Still Creek Wetland and

adjoining riparian zone respond over time with management and climate change?

### 9.4.2 Objectives

- Monitor the health and status of the Shale Sandstone Transition Forest endangered ecological community in Still Creek Wetland.

### 9.4.3 Monitoring

- Undertake monitoring of the following using the monitoring template developed by Jansen et al (2007) contained as Appendix F to this document.
- Longitudinal continuity of vegetation;
- Width of riparian vegetation;
- Proximity;
- Vegetation cover;
- Debris;
- Features;

It is suggested this monitoring is undertaken as part of the vegetation management plan. The wetland should be divided into a series of zones. A transect, perpendicular to the channel would be undertaken in each zone and the information below recorded.

Suggested zones are east and west of the Still Creek channel just downstream of MacMahon Place; east and west of the Still Creek Channel at the southern end of Mina Road; east and west of the wetland at the mouth of the wetland (where the open water begins); and east and west at the northern end of the wetland.

Utilise the scoring sheet to calculate scores for each criteria and categorise to assist in the examination of results:

- Less than 25 very poor;
- 25-30 poor;
- 30-35 average;
- 35-40 good;
- More than 40 excellent.

The establishment of a control site in a natural freshwater wetland with adjoining vegetation and a more natural catchment would provide a

comparison for the Still Creek Wetland Monitoring program.

This information should be recorded and distributed with appropriate supporting information through Council's state of the environment reporting.

An annual inspection of the area is also recommended to assess the damage caused to existing trees and areas of revegetation by Sulphur crested Cockatoos. If damages reach a severe level where trees are declining measures including some bird scaring as set out in Temby (2003) should be considered.

#### **9.4.4 Objectives**

- Utilise photo points to monitor long term changes in vegetation

#### **9.4.5 Monitoring**

- Establish a series of photographs to cover large areas of the wetland;
- Establish permanent photo points within the area covered by the photograph;
- Photos should be taken at higher than ground level utilising a step ladder to enable greater coverage of the wetland;
- Photo points should be established where variation in vegetation communities extent, distribution and condition is likely to occur (in Still Creek Wetland this would include communities adjacent to open water and areas subject to weed eradication at the inlet structure);
- Suggested photo points for Still Creek Wetland would include between the two green garden seats on the edge of the concrete path at the northern end of the wetland looking east, standing on the NW corner of the grated high flow outlet structure looking back south, standing at the inlet structure looking north
- The date, time and weather conditions at the time of the photograph should be recorded;
- Photographs should be taken during spring.

#### **9.4.6 Objectives**

- Monitor vegetation species in floating reed bed

#### **9.4.7 Monitoring**

- Monitor the species composition in the floating reed bed;
- If aquatic weeds are observed consult with Council's Noxious Weeds Officer and take appropriate action to remove weeds.

### **9.5 MONITOR NATIVE FAUNA**

#### **9.5.1 Questions**

- What fauna species and what level of use of fauna habitats are occurring in Still Creek Wetland and do they change with management?

#### **9.5.2 Objectives**

- Monitor the diversity of fauna species and the level of use of fauna habitats within Still Creek Wetland before and after management.

#### **9.5.3 Monitoring**

- Utilise the concrete path running the western boundary of the wetland for spotlighting;
- Establish a transect running along the eastern edge of the wetland from Mina Road to MacMahon Place that can be used for small mammal trapping;
- Establish areas that can be used for collecting bird census data this would include but not be limited to the northern end of the wetland adjacent to the open water and emergent macrophytes and halfway along the riparian vegetation between the wetland and MacMahon Place. At each survey area birds are to be recorded while traversing the area with all birds recorded either through direct observation or calls. Birds should be recorded in five minute intervals and recording continue until no new species are recorded for three consecutive five

minute periods. Opportunistic recordings of bird species can also be made throughout the course of monitoring;

- Consideration should be given to supporting the local community to include Still Creek Wetland in the Birds in Backyards Program coordinated by Birds Australia <http://www.birdsinbackyards.net/>
- Establish sites to be used for frog call and owl call playback;
- Establish areas that are suitable for anabat recording;
- Undertake all the above survey methods twice annually for five years, carrying out five sessions per monitoring period.

- Requests for further information from residents/neighbours about the wetland or land management activities.

## 9.6 ENVIRONMENTAL EDUCATION

### 9.6.1 Question

- Does environmental education contribute to improved wetland management and condition?

### 9.6.2 Objectives

- Provide information through signage to the community and visitors about the values of Still Creek Wetland and the changes that have been made;
- Provide the local Menai Community with skills and knowledge to take action on their own properties to improve quality of surface run off entering the wetland;
- Resource Council's Bushcare Officer and the Beaumaris Drive Reserve Bushcare Group and the Parc Menai Bushcare group to run BBQs on "environmental days" in the park adjacent to Still Creek Wetland to provide local residents with knowledge about actions they can take to contribute to wetland health.

### 9.6.3 Monitoring

- Number of wetland environmental days;
- Number of participants at wetland environmental days;



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## **APPENDIX A - PHOTOS**

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Lowflow hooded outlet



Highflow grated outlet



Combined outlet structure



Photo of Monitoring Site ID





Fencing



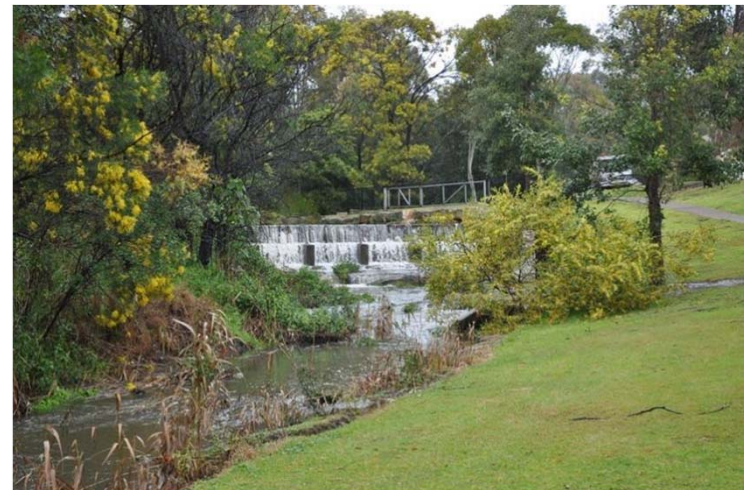
Gross Pollutant Trap



Uncontrolled inlet eastern side



Uncontrolled Inlet western side





Freshwater wetland



Freshwater wetland



Riparian Forest



Riparian Forest





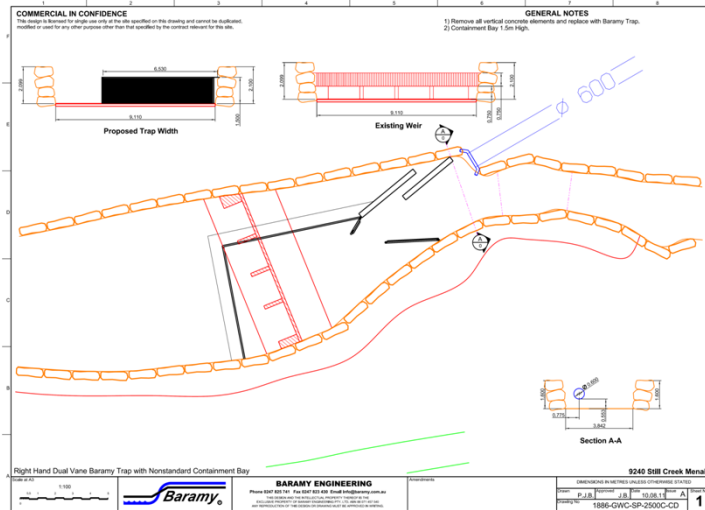
# Landscaped grassland



# Landscaped grassland



## Proposed Modification to GPT



## Similar GPT to that Proposed as a Retro-fit in Still Creek



Similar Floating Reed Bed to that  
Proposed within the Still Ck Wetland



Proposed Form of the Screen Planting  
around the Highflow Outlet Structure



## **APPENDIX B - THREATENED FAUNA AND FLORA SPECIES**

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***Still Creek Wetland Threatened Terrestrial Fauna recorded in a 10kilometre radius 2001-2011***

<i>Family</i>	<i>Species name</i>	<i>Common name</i>	<i>Conservation status NSW TSC Act 1995</i>
<b><i>AVES</i></b>			
<i>Accipitridae</i>	<i>Lophoictinia isura</i>	Square-tailed Kite	V
	<i>Pandion haliaetus</i>	Osprey	V
<i>Ardeidae</i>	<i>Ixobrychus flavicollis</i>	Black Bittern	V
<i>Ciconiidae</i>	<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E1
<i>Neosittidae</i>	<i>Daphoenositta chrysoptera</i>	Varied Sittella	V
<i>Petroicidae</i>	<i>Petroica boodang</i>	Scarlet Robin	V
<i>Strigidae</i>	<i>Ninox strenua</i>	Powerful Owl	V
<i>Tytonidae</i>	<i>Tyto tenebricosa</i>	Sooty Owl	V
	<i>Tyto novaehollandiae</i>	Masked Owl	V
<b><i>Mammalia</i></b>			
<i>Molossidae</i>	<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V
<i>Phascolarctidae</i>	<i>Phascolarctos cinereus</i>	Koala	V
<i>Pteropodidae</i>	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V

<i>Vespertilionidae</i>	<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	V
	<i>Myotis macropus</i>	Southern Myotis	V
<i>Amphibia</i>			
<i>Myobatrachidae</i>	<i>Pseudophryne australis</i>	Red-crowned Toadlet	V
<i>Reptilia</i>			
<i>Elapidae</i>	<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	E1
<i>Varanidae</i>	<i>Varanus rosenbergi</i>	Rosenberg's Goanna	V

E1 Endangered,  
E2 Endangered Population  
V Vulnerable

***Still Creek Wetland Threatened Flora recorded in a 10kilometre radius 2001-2011***

<i>Family</i>	<i>Species name</i>	Common name	Conservation status NSW TSC Act 1995
<i>Anthericaceae</i>	<i>Caesia parviflora</i> var. <i>minor</i>	Small Pale Grass-lily	E1
<i>Fabaceae</i>	<i>Acacia pubescens</i>	Downy Wattle	V
<i>Myrtaceae</i>	<i>Melaleuca deanei</i>	Deane's Paperbark	V
	<i>Callistemon linearifolius</i>	Netted Bottle Brush	V
<i>Orchidaceae</i>	<i>Pterostylis saxicola</i>	Sydney Plains Greenhood	E1
<i>Proteaceae</i>	<i>Persoonia hirsuta</i>	Hairy Geebung	E1
<i>Rhamnaceae</i>	<i>Pomaderris prunifolia</i>	P. prunifolia in the Parramatta, Auburn, Strathfield and Bankstown Local Government Areas	E2

E1 Endangered,  
E2 Endangered Population  
V Vulnerable





## **APPENDIX C - FLORA SPECIES LIST**

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## DICOTYLEDONS

### Family Aizoaceae

*Tetragonia tetragonoides*\*

### Family Alismataceae

*Sagittaria graminea*

### Family Amaranthaceae

*Alternanthera philoxeroides*\* Alligator weed

### Family Apiaceae

*Hydrocotyle tripartita*

### Family Asteraceae

*Bidens pilosa* Cobblers peg  
*Ozothamnus* spp.

### Family Casuarinaceae

*Allocasuarina littoralis*

### Family Convolvulaceae

*Dichondra repens*

### Family Epacridaceae

*Leucopogon junipennus* Bearded heath  
*Woolsia pungens*

### Family Euphorbiaceae

*Omalanthus populifolius* Bleeding Heart  
*Phyllanthus hirtellus* Thyme spurge

### Family Fabaceae

*Acacia decurrens* Black Wattle  
*Acacia longifolia* Sydney Golden Wattle  
*Acacia parvipinnula* Silver Stemmed Wattle  
*Dillwynia retorta* Heathy Parrot Pea  
*Hardenbergia violacea* False Sarsaparilla  
*Kennedia rubicund* Dusky coral pea

### Family Iridaceae

*Patersonia glabrata* leafy Purple Flag

### Family Myrtaceae

*Angophora costata* Sydney Red Gum  
*Callistemon citrinus* Crimson Bottle Brush  
*Eucalyptus piperita* Sydney Peppermint  
*Eucalyptuspunctata* Grey Gum  
*Eucalyptus robusta* Swamp Mahogany  
*Corymbia gummifera* Red Bloodwood  
*Kunzea ambigua* Tick Bush

*Leptospermum leavigatum* Coast tee Tree

*Melaleuca quinquenervia* Broad leaved paperbark

*Melaleuca linarifolia* Snow in Summer

*Syncarpia glomulifera* Turpentine

*Tristaniopsis laurina* Water Gum

### Family Onagraceae

*Ludwigia peruviana*\*

### Family Oxalidaceae

*Oxalis* sp. \*

### Family Pittosporaceae

*Bursaria spinosa*

*Pittosporum undulatum* Pittosporum

### Family Polygonaceae

*Persicaria decipiens* Slender Knotweed

### Family Proteaceae

*Banksia ericifolia*

*Grevillea sericea*

### Family Lomandraceae

*Lomandra longifolia* Spiny-headed Mat-rush

### Family Poaceae

*Imperata cylindrica* Blady Grass  
*Entolasia stricta*

### Family Polygonaceae

*Rumex crispus* Curled dock\*

### Family Rosaceae

*Rubis fruticosus*\* Blackberry

### Family Rhamnaceae

*Pomaderris lanigera*

### Family Sapindaceae

*Dodonaea triquetra* Common Hop Bush

### Family Sapindaceae

*Dodonaea triquetra* Hop Bush

### Family Solanaceae

*Solanum chenopodioides* Blackberry nightshade\*

### Family Verbenaceae

*Lantan camara* Lantana \*

*Verbena bonariensis* Purpletop \*

## MONOCOTYLEDONS

**Family Cyperaceae**

*Baumea articulata*

**Family Commelinaceae**

*Commelina cyanea*

**Family Liliaceae**

*Dianella caerulea* var *producta* Blue

Flax Lily

**Family Poaceae**

*Penisetum clandestinum* Kikyu

*Phragmites australis*

**Family Typhaceae**

*Typha orientalis*



## **APPENDIX D - FAUNA SPECIES LIST**

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***Fauna species recorded in the Menai locality***

**BIRDS**

	Bangor Bypass SIS	Current assessment
<b><i>THRESKIORNITHIDAE</i></b>		
<i>Threskiornis molucca</i> Australian White Ibis	*	
<b><i>ACCIPITRIDAE</i></b>		
<i>Haliaeetus leucogaster</i> White-bellied Sea-Eagle	*	
<b><i>CHARADRIIDAE</i></b>		
<i>Vanellus miles</i> Masked Lapwing	*	
<i>Columba livia</i> Rock Dove	*	
<i>Ocyphaps lophotes</i> Crested Pigeon	*	*
<i>Streptopelia chinensis</i> Spotted Turtledove	*	
<b><i>CACATUIDAE</i></b>		
<i>Cacatua galerita</i> Sulphur-crested Cockatoo	*	*
<i>Calyptorhynchus funereus</i> Yellow-tailed Black Cockatoo	*	
<b><i>PSITTACIDAE</i></b>		
<i>Trichoglossus haematodus</i> Rainbow Lorikeet	*	*
<i>Alisterus scapularis</i> Australian King Parrot	*	
<i>Platycercus elegans</i> Crimson Rosella	*	*
<i>Platycercus eximius</i> Eastern Rosella	*	*
<b><i>CUCULIDAE</i></b>		
<i>Cacomantis flabelliformis</i> Fan-tailed Cuckoo	*	
<i>Eudynamys orientalis</i> Pacific Koel	*	
<b><i>STRIGIDAE</i></b>		
<i>Ninox strenua</i> Powerful Owl	*	
<i>Ninox novaeseelandiae</i> Southern Boobook	*	
<b><i>AEGOTHELIDAE</i></b>		
<i>Aegotheles cristatus</i> Australian Owlet-nightjar	*	

<b>CORACIIDAE</b>		
<i>Eurystomus orientalis</i> Dollarbird	*	
<b>ALCEDINIDAE</b>		
<i>Dacelo novaeguineae</i> Laughing Kookaburra	*	
<i>Todiramphus sanctus</i> Sacred Kingfisher	*	
<b>MALURIDAE</b>		
<i>Malurus lamberti</i> Variegated Fairy-wren	*	
<i>Malurus cyaneus</i> Superb Blue Fairy-wren	*	
<b>PARDALOTIDAE</b>		
<i>Pardalotus punctatus</i> Spotted Pardalote	*	
<i>Sericornis frontalis</i> White-browed Scrubwren	*	
<i>Acanthiza pusilla</i> Brown Thornbill	*	
<b>MELIPAGIDAE</b>		
<i>Philemon corniculatus</i> Noisy Friarbird	*	
<i>Anthochaera carunculata</i> Red Wattlebird	*	*
<i>Anthochaera chrysoptera</i> Little Wattlebird	*	
<i>Manorina melanocephala</i> Noisy Miner	*	*
<i>Lichenostomus chrysops</i> Yellow-faced Honeyeater	*	
<i>Phylidonyris novaehollandiae</i> New Holland Honeyeater	*	
<i>Acanthorhynchus tenuirostris</i> Eastern Spinebill	*	
<b>PSOPHODIDAE</b>		
<i>Psophodes olivaceus</i> Eastern Whipbird	*	*
<i>Eopsaltria australis</i> Eastern Yellow Robin	*	*
<b>DICRURIDAE</b>		
<i>Grallina cyanoleuca</i> Magpie-lark	*	*
<i>Rhipidura fuliginosa</i> Grey Fantail	*	
<i>Rhipidura leucophrys</i> Willie Wagtail	*	*
<b>CAMPEPHAGIDAE</b>		
<i>Coracina novaehollandiae</i> Black-faced Cuckoo-shrike	*	



<i>ORIOLIDAE</i>		
<i>Oriolus sagittatus</i> Olive-backed Oriole	*	
<i>ARTAMIDAE</i>		
<i>Cracticus torquatus</i> Grey Butcherbird	*	
<i>Gymnorhina tibicen</i> Australian Magpie	*	*
<i>Strepera graculina</i> Pied Currawong	*	
<i>CORVIDAE</i>		
<i>Corvus coronoides</i> Australian Raven	*	
<i>ANATIDAE</i>		
<i>Anas superciliosa</i> Pacific Black Duck		*
<i>Cairina moschata</i> Muscovy Duck*		*
<i>Chenonetta jubata</i> Australian Wood Duck		*
<i>RALLIDAE</i>		
<i>Gallinula tenebrosa</i> Dusky Moorhen		*
<i>PTILONORHYNCHIDAE</i>		
<i>Ptilonorhynchus violaceus</i> Satin Bowerbird	*	
<i>PASSERIDAE</i>		
<i>Neochmia temporalis</i> Red-browed Finch	*	
<i>Passer domesticus</i> House Sparrow	*	
<i>HIRUNDINIDAE</i>		
<i>Hirundo neoxena</i> Welcome Swallow	*	
<i>Hirundo ariel</i> Fairy Martin	*	
<i>PYCNONOTIDAE</i>		
<i>Pycnonotus jocosus</i> Red-whiskered Bulbul	*	
<i>ZOSTEROPIDAE</i>		
<i>Zosterops lateralis</i> Silvereye	*	
<i>STURNIDAE</i>		

<i>Acridotheres tristis</i> Common Mynah	*	
<i>Sturnus vulgaris</i> Common Starling	*	
<u>MAMMALS</u>		
<b>Monotremes</b>		
ORNITHORHYNCHIDAE		
<i>Tachyglossus aculeatus</i> Short-beaked Echidna	*	
<b>Marsupials</b>		
DASYURIDAE		
<i>Antechinus stuartii</i> Brown Antechinus	*	
PETAURIDAE		
<i>Petaurus breviceps</i> Sugar Glider	*	
PSEUDOCHEIRIDAE		
<i>Pseudocheirus peregrinus</i> Common Ringtail Possum	*	
PHALANGERIDAE		
<i>Trichosurus vulpecula</i> Common Brushtail Possum	*	
MACROPODIDAE		
<i>Wallabia bicolor</i> Swamp Wallaby	*	
<b>Eutherians</b>		
PTEROPODIDAE		
<i>Pteropus poliocephalus</i> Grey-headed Flying-fox	*	
MOLOSSIDAE		
<i>Mormopterus sp. 1</i> A Freetail-Bat	*	
<i>Mormopterus norfolkensis</i> East-coast Freetail-bat	*	
<i>Tadarida australis</i> White-striped Freetail-bat	*	
VESPERTILIONIDAE		

<i>Chalinolobus gouldii</i> Gould's Wattled Bat	*	
<i>Chalinolobus morio</i> Chocolate Wattled Bat	*	
<i>Chalinolobus dwyeri</i> Large-eared Pied Bat	*	
<i>Scoteanax rueppellii</i> Greater Broad-nosed Bat	*	
<i>Scotorepens orion</i> Eastern Broad-nosed Bat	*	
<i>Vespadelus vulturnus</i> Little Forest Bat	*	
<b>LEPORIDAE</b>		
<i>Oryctolagus cuniculus</i> Rabbit *	*	
<b>CANIDAE</b>		
<i>Vulpes vulpes</i> Fox *	*	
<i>Canis familiaris</i> Dog*	*	
<b><u>AMPHIBIANS</u></b>		
<b>HYLIDAE</b>		
<i>Litoria fallax</i> Eastern Dwarf Tree Frog	*	
<i>Litoria peronii</i> Peron's Tree Frog	*	
<b>MYOBATRACHIDAE</b>		
<i>Crinia signifera</i> Common Eastern Froglet	*	*
<i>Limnodynastes peronii</i> Striped Marsh Frog	*	*
<b><u>REPTILES</u></b>		
<b>GEKKONIDAE</b>		
<i>Phyllurus platurus</i> Southern Leaf-tailed Gecko	*	
<b>AGAMIDAE</b>		
<i>Amphibolurus muricatus</i> Jacky Dragon	*	
<b>SCINCIDAE</b>		
<i>Tiliqua scincoides</i> Eastern Blue-tongued Lizard	*	
<i>Lampropholis delicata</i> Dark-flecked Garden Skink	*	
<i>Lampropholis guichenoti</i> Pale-flecked Garden Skink	*	*

Bangor Bypass species Connell Wagner et al (2002)



## **APPENDIX E - VEGETATION MANAGEMENT PLAN**

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# MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS



**Catchment Management  
Authority**  
Sydney Metropolitan



## **Still Creek Vegetation Management Plan**

*Final Report*







# **Still Creek Vegetation Management Plan**

## **FINAL REPORT**

for

**Sutherland Shire Council Sydney Metropolitan Catchment  
Management Authority**

by

**Molino Stewart Pty Ltd  
ACN 067 774 332**

**FEBRUARY 2012**

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## DOCUMENT APPROVAL

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# 1 INTRODUCTION

## 1.1 BACKGROUND

Still Creek wetland is located approximately 35 kilometres south west of Sydney on Still Creek adjacent to Mina Road in Menai in the Sutherland Shire. Still Creek wetland is a constructed wetland that was developed in the 1995 to improve the water quality in runoff from the Mina Road residential subdivision. The wetland has a surface area of around 1,800 square metres, it has been constructed within the upper reaches of Still Creek. It has a substantially residential catchment of approximately 55 hectares.

A 40 metre wide vegetated riparian corridor extends around 400 metres upstream of the wetland to MacMahon Place. The vegetation is mapped as Sydney Sandstone Gully Forest on Sutherland Shire Council's vegetation map. This bushland has been subject to bush regeneration in the past (SSC 2006).

A management plan has been prepared for Still Creek Wetland and the adjacent riparian vegetation. As part of the management plan the need for a vegetation management plan for the Still Creek Wetland and riparian vegetation corridor was identified.

The Still Creek Wetland includes three distinct vegetation communities:

- Freshwater wetland;
- Riparian open forest; and
- Landscaped grassland.

Preliminary investigation of the Still Creek riparian vegetation between the wetland and MacMahon Place reveals the riparian vegetation is predominantly Shale Sandstone Transition Forest (SSTF), an endangered ecological community (EEC) listed on the *Threatened Species Conservation (TSC) Act 1995* and the commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*.

This assessment of the vegetation as SSTF is consistent with vegetation to the east and upslope of Still Creek, which consists of a large patch (around 4 hectares) of Shale

Sandstone Transition Forest, located behind the Menai marketplace in Alison Crescent. Further upslope and to the south of the site lies a patch of Sydney Turpentine Ironbark Forest at Menai Park. Shale Sandstone Transition Forest is noted by Benson and Howell (1994) to occur on the transition zone between the Wianamatta Shale and the underlying Hawkesbury Sandstone on the shallow to deep podzolics of soils of the Blacktown Soil Landscape.

The vegetation on the edge of Still Creek Wetland and in the landscaped grassland has been planted as part of the wetland construction and is subject to varying levels of weed infestation.

## 1.2 AIMS OF THE VEGETATION MANAGEMENT PLAN

The aims of the vegetation management plan (VMP) are to:

- Describe the vegetation management zones present at the site;
- Provide management strategies for the removal of weeds and regeneration of the SSTF EEC;
- Provide a planting guide to screen the high flow outlet structure;
- Provide management and monitoring strategies for vegetation in the management zones including the proposed floating reed bed; and
- Provide a working document for implementation by a qualified bushland manager.

The plan aims to introduce concepts and techniques for the regeneration and reconstruction of Cumberland Plain vegetation outlined in Department of Environment and Conservation (DEC) (2005), Department of Infrastructure Planning and Natural Resources DIPNR (2003) and Department of Environment Climate Change and Water (DECCW) (2010).

## 1.3 LIFE OF THE PLAN

This vegetation management plan covers approximately 5 years from the beginning of implementation. This coincides with the life of the current management plan for Still Creek wetland. Review and updating of the plan after 5 years will enable Council to adapt management recommendations to current thinking and knowledge around vegetation and weed management.

It is envisaged that monitoring reports would be prepared at key management stages and then annually for the life of the plan. The final monitoring report for the VMP should include specific recommendations for incorporation of ongoing management actions into Council's Bushcare program.

## 1.4 SITE DESCRIPTION

### 1.4.1 Topography and Drainage

The topography around the Still Creek Wetland is gently undulating. Elevation ranges from around 95 metres AHD at the wetland to around 108 metres AHD upstream at MacMahon Place. The wetland was constructed to improve water quality running off the Mina Road subdivision to the west of the wetland. Immediately to the west of the wetland is a low lying grassed park area and to the east the land rises toward Peachtree way and Menai shopping village. Still Creek extends upstream of the wetland as a steep narrow channel incised down to sandstone bedrock.

Soils around the wetland are those of the Lucas Heights soil landscape (Hazelton et al 1990). Soils of this landscape are typically moderately deep, between 0.5 and 1.5 metres deep and associated with a residual soil profile. The soils generally consist of silty sands in the upper layers to sand clays at the base of the soil layers.

It should be noted that the wetland does occur in an area bordered closely by the Blacktown soil landscape (Hazelton et al 1990). This landscape is characterised by silty clays and clays generally found overlaying Wianamatta

Shales. Still Creek wetland is not mapped as exhibiting any probability for acid sulfate soils (SSC undated).

### 1.4.2 Land Use

The land use adjoining Still Creek Wetland to the east and west is residential subdivision, bounded by Mina Road and residential subdivision that extends west to Alfords Point Road. Immediately to the east lies a strip of native vegetation ranging in width from 40 to 15 metres. This is bounded by a residential subdivision that extends east and upslope to Alison Crescent. The narrow riparian strip of native vegetation extends south and upstream for around 400 metres from the wetland to MacMahon Place. Downstream or north of the wetland lies Mina Road and further north the Still Creek riparian corridor widens to over 500 metres as the creek flows downstream past Illawong to the Woronora River.

### 1.4.3 Vegetation Communities

Field investigations for the Still Creek Wetland management Plan (Molino Stewart 2011 in prep) reveal three vegetation communities and fauna habitats at Still Creek wetland:

- Freshwater wetland;
- Riparian open forest; and
- Landscaped grassland.

These communities are not uniform in species composition and structure across their range at the local scale and there are varying levels of weed infestation in both communities. A list of flora species recorded during the field assessment is provided as Appendix A to this document. It is envisaged this species list can be added to during the implementation of this VMP.

The freshwater wetland community can be divided into two sub – communities emergent macrophytes and aquatic weeds.

The forest community varies with an increasing density of weeds in the understory Turpentine *Syncarpia glomulifera* in the canopy upslope toward MacMahon Place.

Field investigations reveal the riparian open forest is consistent with the Shale Sandstone Transition Forest listed as an endangered ecological community on the NSW TSC Act 1995 and the commonwealth EPBC Act 1999.

The landscaped grassland community consists of mowed grassland with a sporadic planting of native canopy species including Turpentine *Syncarpia glomulifera* and Grey Gum *Eucalyptus punctata* and dense plantings of native shrubs including *Lomandra longifolia*.

The vegetation communities are described in more detail in the Still Creek Wetland Management Plan (Molino Stewart 2011 in prep).



## 2 MANAGEMENT ZONES AND STRATEGIES

A variety of actions are required to implement the VMP, these are listed below, the responsibility and timing are set out in Table 1 and the cost estimates for implementation of the plan are set out in Table 2 in the following sections. The location of the management zones is presented in Figure 1.

### 2.1 PROJECT SET UP ACTIONS

Project set up actions are listed below.

- Site Inspection by the project team to confirm site boundaries and project scope. This step is seen as essential in ensuring the bushland manager appreciates the scope of the task and the specific actions detailed in the VMP.
- Site preparation including identifying where vegetative material will be stockpiled prior to removal, confirming access points and identifying occupational health and safety issues.
- Review/ revise site map. The bushland manager should review and revise the site map contained in this VMP for use on site.
- Prepare species list. The Bushland manager should generate a species list for the Still Creek Wetland and riparian corridor. This list should be submitted to Council with each monitoring report. (The list in Appendix A forms a starting point).
- Record wildlife. The bushland manager should keep a list of any wildlife records for the study area for the life of the project. This list should be submitted to Council with each monitoring report and should inform management for wildlife.
- Select photo points for monitoring the regeneration of native vegetation in and around the wetland and along the riparian corridor (see monitoring requirements section 4).
- Liaise with Council for the life of the project. A number of management measures and changes to the Still Creek Wetland have been proposed in the

management plan. Their implementation will have a direct bearing on activities in this plan and works will need to be coordinated to ensure they are carried out in the appropriate sequence.

- Liaison should also be undertaken with Council's Noxious Weeds Officer and Bushcare Officer. Their advice should be sought on a variety of management measures including pesticide use in and around the wetland and riparian corridor.

### 2.2 MACMAHON PLACE TO MINA ROAD (ZONE 1)

This vegetation management zone occupies the eastern and western side of Still Creek. It extends north from MacMahon Place to the southern end of Mina Road. The zone supports riparian open forest with a dense and diverse shrub layer. It is currently heavily weed infested in the shrub layer and the canopy is being smothered with morning glory, there is also evidence of rubbish dumping including what appears to be a dog house in Still Creek.

#### 2.2.1 Objectives

- Weed control and management;
- Protection of the SSTF EEC including promotion of native canopy, shrub and ground cover regeneration;
- Extension of the shrub layer to the western edge of the pathway running along this vegetation management zone;
- Rehabilitation of the weed infested shrub layer;
- Protection of fauna habitat values.

Weed removal includes primary (first time), secondary (follow up) and maintenance (long term) weeding. Vegetative waste including native tree branches will be retained and mulched and utilised onsite. Vegetative waste containing weed propagules will be removed from site and disposed of at an appropriately licensed waste disposal facility.

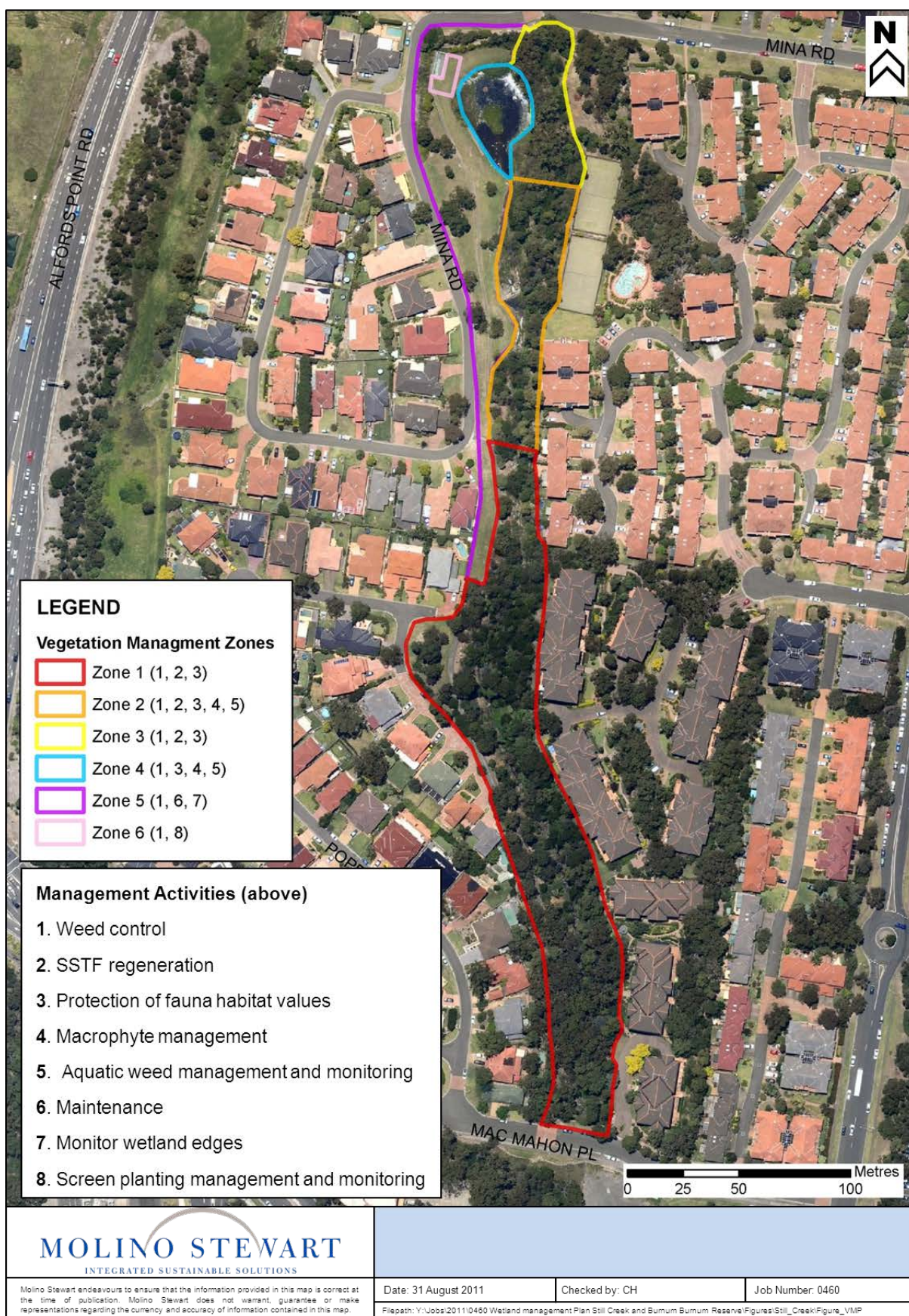


Figure 1: Management Zones



## 2.2.2 Actions

- The boundary of the SSTF community should be identified, established and clearly understood by the bushland managers. This would include the eastern boundary that is currently defined by a fence to the adjoining apartment development and the western boundary that would extend to the pathway adjoining the riparian vegetation.
- Consideration should be given to creating a no mow zone between the path edge and the riparian corridor and allowing shrub layer regeneration to occupy this area. The path edge would need to be maintained due to the high levels of human use.
- Primary weeding of the weed infestations within the riparian forest including the drainage line of Still Creek should be carried out.
- If patches of Kikyu are located in this management zone they should be treated.
- Weeds should be removed with minimal intervention using recognised bush regeneration techniques, only registered herbicides should be used in strict accordance the approved label or appropriate permit.
- Herbicides should not be used in the Still Creek channel.
- Consideration should be given to planting two or three additional canopy trees and patches of shrubs between trees in the Abraham Close area.
- The recovery of native vegetation in the riparian SSTF and within Still Creek Channel should be monitored. It is expected that native vegetation will regenerate following weeding, however if this is not the case some replanting of locally endemic native species may be required.
- Locally endemic native species should be sourced where possible from local growers (for example Sydney Wildflower Nursery Heathcote) or seed should be collected from the Still Creek Corridor and plants raised for use in revegetation.
- Care should be taken not to remove woody debris (or snags) from the stream channel only litter should be removed from the Still Creek channel.

- Secondary and maintenance weeding of the riparian SSTF and Still Creek channel should be undertaken and supplemented with revegetation where required.

## 2.3 MINA ROAD TO WETLAND (ZONE 2)

This vegetation management zone extends from the southern end of Mina Road to the southern end of the wetland. It includes the GPT and proposed new riffle zone downstream of the GPT. The zone also extends to the boundary fence on the eastern side to the pathway on the western side of Still Creek. This zone is currently heavily weed infested.

### 2.3.1 Objectives

- Weed control and management;
- Protection of the SSTF EEC including promotion of canopy, shrub and ground cover regeneration;
- Rehabilitation and or revegetation of weed infested shrub layer;
- Protection of fauna habitat values.

### 2.3.2 Actions

- The boundary of this zone should be clearly identified established and clearly understood by the bushland managers.
- Patches of pure stands of kikuyu *Pennisetum clandestinum* should be identified within this zone and targeted for staged primary weeding. These grass patches form important buffers to Still Creek. Buffers of natural vegetation and grassy filter strips can trap around 90 per cent of sediment moving from upslope (DEC 2005). Buffer strips can also control levels of bacteria in run off (Dec 2005).
- Staged primary weeding of grassy patches should aim to treat patches as part of a mosaic in order to retain the buffer function of some grassy patches while some patches are subject to regeneration or revegetation.
- This may even result in part of a grassy patch being subject to primary weeding

and regeneration and or revegetation and part of a grassy patch being left as a buffer while this occurs.

- Kikuyu patches extending from the adjoining property to the east may require slashing to ground level and spraying with Round Up Bioactive.
- Primary weeding of the weed infestations within the riparian forest should be carried out.
- Weeds should be removed with minimal intervention using recognised bush regeneration techniques, only registered herbicides should be used in strict accordance the approved label or appropriate permit.
- Primary weeding of the weed infestations within Still Creek drainage line should be carried out.
- Herbicides should not be used in the Still Creek channel.
- Liaison with Council Officers should be undertaken prior to weed removal from the Still Creek Channel downstream of the GPT as this area is proposed for remodelling as part of the Still Creek wetland management plan. If remodelling is delayed primary and secondary weeding should be undertaken and some supplementary planting on the creek edge may be required.
- Care should be taken not to remove woody debris (or snags) from the stream channel only litter should be removed from the Still Creek channel.
- Secondary and maintenance weeding of the riparian SSTF and Still Creek channel should be undertaken and supplemented with revegetation (see section 2.1) where required.

## 2.4 WETLAND TERRESTRIAL VEGETATION (ZONE 3)

This management zone extends from the mouth of Still Creek Wetland along the eastern and north eastern edge of the wetland covering the riparian forest SSTF vegetation community. This area is in a moderate condition with moderate to low levels of weed infestation in the shrub layer.

### 2.4.1 Objectives

- Weed control and management;
- Protection of the SSTF EEC including promotion of canopy, shrub and ground cover regeneration;
- Rehabilitation and or revegetation of weed infested shrub layer;
- Protection of fauna habitat values.

### 2.4.2 Actions

- The boundary of this zone should be clearly identified established and clearly understood by the bushland managers.
- Where patches of kikuyu occur they should be treated.
- Primary weeding of the riparian forest should be undertaken with a focus on ground and shrub layer weeds.
- Consideration should be given to planting a shrub layer filter strip of appropriate vegetation on the eastern edge of this zone. Currently the adjoining block is vacant and supporting native vegetation with little weed infestation however this block is zoned multiple dwellings and could be subject to future development.
- Care should be taken in this community to identify any locally significant plants, an unidentified orchid was observed during field investigation for the management plan.
- Weeds should be removed with minimal intervention using recognised bush regeneration techniques, only registered herbicides should be used in strict accordance the approved label or appropriate permit.
- Herbicides should not be used on the edge of open water in the Still Creek Wetland.
- Secondary and maintenance weeding should be undertaken in this management zone. It is anticipated that regeneration of native shrub and canopy species will occur. If monitoring reveals this is not the case supplementary planting with locally endemic native species may be required.
- Care should be taken not to remove all fallen timber or branches from this community as this material forms habitat

for native species. Some removal of smaller diameter sticks may be required to ensure the potential bushfire fuel load is maintained at an appropriate level.

## **2.5 WETLAND EDGE AND FLOATING REED BED (ZONE 4)**

This zone includes the emergent macrophyte vegetation community on the edge of the open water and the proposed floating reed bed that will be located in the centre of the wetland. Weed infestation around the entire wetland edge is moderate with a greater density of weeds occurring on the eastern edge of the wetland.

### **2.5.1 Objectives**

- Maintain a healthy emergent macrophytes community on the edge of the wetland;
- Weed control and management;
- Protection of fauna habitat values

### **2.5.2 Actions**

- The boundary of this zone should be clearly identified, established and clearly understood by the bushland managers.
- Those team members not familiar with native wetland emergent macrophytes and aquatic weeds should be provided with appropriate training and an identification guide for common aquatic weeds should be provided.
- Liaison should be undertaken with Council Officers regarding aquatic weeds currently occurring in the wetland, dredging and removal of these weeds is proposed as part of the Still Creek Wetland management plan.
- Primary weeding should be undertaken along the entire wetland edge in a staged fashion. A staged approach to weeding the wetland edge should allow for the retention of some areas to act as a wetland buffer while other areas regenerate with native species. Large

bare patches immediately adjacent to the wetland should be avoided.

- Secondary and maintenance weeding should be carried out around the entire wetland edge again in a staged fashion.
- Once the floating reed bed is installed the vegetation in the bed should be monitored for weeds and where they occur they should be removed.
- Regular and ongoing monitoring and maintenance of the emergent macrophytes vegetation both on the wetland edge and in the floating reed bed should be undertaken at a minimum of three monthly intervals for the life of this plan. This will ensure that any aquatic weeds that occur in the wetland are identified and addressed before they become established.

## **2.6 LANDSCAPE ZONE (ZONE 5)**

This management zone occupies the north and western edges of the park like area adjoining Still Creek Wetland. It extends from the pathway at the southern end of Mina Road to the northern end of the wetland at Mina Road.

### **2.6.1 Objectives**

- Weed control;
- Maintenance of wetland buffer vegetation
- Maintenance of mowed grass subject to high levels of human use;
- Maintenance and protection of wetland edges.

### **2.6.2 Actions**

- The boundary of this zone should be clearly identified, established and clearly understood by the bushland managers.
- Undertake primary weeding of landscape plantings located at the North West corner and the northern edge of the area that adjoins Mina Road.
- Undertake secondary and maintenance weeding in these areas.



- Undertake mowing of the grassland in this zone, however mowing should not be undertaken on the eastern side of the pathway that extends from the southern end of Mina road (see section 2.2.2).
- Monitoring of the wetland edge should be undertaken and Council informed if any of the rock edge becomes degraded.
- The no mow zone at the north eastern corner of this zone should be extended to create a buffer to the SSTF. The revised edge should be understood by bushland managers and Council maintenance team to ensure the maximum development of a native shrub layer within the SSTF EEC. This edge could be informally marked out with fallen logs.

with narrow aromatic leaves, feathery purple flowers in spring and naturally occurring on moist soils on swamp and heath margins on sandstone and clay.

- An alternative planting scheme is using Gynea Lillies *Doryanthes excels* which grows in open forest and woodland sandy soils containing some clay.
- The area of new plantings should be monitored for weeds and where they are discovered they should be removed. Any bare soil areas should be kept mulched to reduce the likelihood of weeds becoming established.

## 2.7 HIGH FLOW OUTLET ZONE (ZONE 6)

This management zone is located directly in front and to the south of the high flow outlet for Still Creek Wetland, located at the north western corner of the park adjoining Still Creek Wetland. This zone has been created as an opportunity to provide a visual screen to the outlet structure while maintaining flood mitigation.

### 2.7.1 Objectives

- To create a visual screen to the high flow outlet for Still Creek Wetland;
- To maintain the structures flood mitigation purpose.

### 2.7.2 Actions

- Mark out the area that will be replanted with a visual screen. This will include across the front (or eastern face) and the southern edge of the structure.
- The southern face of the structure could be screen planted with *Lomandra longifolia* up against the edge of the structure;
- The eastern face which is in the overland flow path should be planted out 3 metres from the structure with Thyme Honey Myrtle *Melaleuca thymifolia*. This is a low shrub with corky bark and dense foliage

### 3 TASK SEQUENCE

Table 1 Task Sequence

Action	Responsibility	2012				2012				2013	2014	2015
		Jan	April	Aug	Nov	Jan	April	Aug	Nov			
Site Inspection	CO, BM											
Site preparation	BM											
Review/ revise site map	BM											
Prepare species list	BM											
Record wildlife	BM											
Select photo points	BM											
Liaise with Council	BM											
Review the location of each management zone identified in the VMP	BM											
Identify key areas on site (including kikuyu patches) and key habitat elements	BM											
Review the intended use of herbicides in and adjacent to the wetland, creek line and riparian corridor, liaise with Council Officers prior to pesticide purchase and use	BM, CO, CBO											
Undertake Primary weeding	BM											

Undertake revegetation where required (including sourcing locally endemic native species)	BM											
Undertake secondary weeding	BM											
Undertake maintenance weeding	BM											
Undertake weed monitoring inspections (3 monthly)	BM											
Undertake monitoring	BM											
Prepare monitoring reports	BM											
Review monitoring reports	CO, CBO											
Handover plan to Bushcare	BM											

CO Council Officers, BM Bushland Manager, CBO Council Bushcare Officer

## 4 MONITORING REPORTING AND PERFORMANCE EVALUATION

A monitoring plan has been developed for the Still Creek Wetland management plan. The monitoring plan focuses on the assessment of riparian vegetation. The monitoring plan should form the basis of monitoring for the VMP, however in addition the Bushland manager should prepare monitoring reports that reflect the work carried out on site. This is indicated in section 4.1 below.

Sections 4.2 and 4.3 reflect the monitoring requirements for the Still Creek Wetland management plan that can be undertaken as part of the VMP.

### 4.1 MONITORING

Monitoring is required to determine if management objectives are being met and the effectiveness of management measures. A useful approach involves monitoring changes to the wetland and adjoining EEC as work proceeds. As noted in DIPNR (2003) this provides the flexibility to reorder priorities frequently as the site and the behaviour of weeds and vegetation to various strategies and actions are better understood.

The bushland manager engaged to implement the VMP should undertake regular monitoring at each stage. It is envisaged monitoring would be carried out post primary weeding and then at the end of the first 12 months of implementation. Monitoring would then occur annually. This will enable the bushland manager to review the objectives of the VMP against what is actually occurring on the ground and to respond accordingly with revised or updated management strategies.

Key objectives of the VMP are:

- Weed control;
- Regeneration of canopy, shrub and ground cover species in the SSTF EEC; and

- Provision of a planting guide to screen the high flow outlet structure.

A short concise monitoring report should be prepared following the primary weeding, then annually for the life of the plan. These reports should be provided to the Council Officer managing implementation of the plan and a review of management measures should be undertaken in consultation with the bushland manager.

The monitoring report should include:

- A works summary;
- An evaluation of management actions;
- Before and after photos (see section 4.2.4 and 4.2.5);
- Any recommendations for future management actions.

The final report should include specific recommendations for incorporation into the Council's Bushcare program and general wetland maintenance program.

### 4.2 MONITOR FRESHWATER WETLAND VEGETATION AND RIPARIAN EEC

#### 4.2.1 Question

- How do freshwater wetland vegetation communities and endangered ecological communities in Still Creek Wetland and adjoining riparian zone respond over time with management and climate change?

#### 4.2.2 Objectives

- Monitor the health and status of the SSTF EEC and fringing macrophyte vegetation in Still Creek Wetland.

#### 4.2.3 Monitoring

- Undertake monitoring of the following using the monitoring template developed by Jansen et al (2007) contained as Appendix B to this document.
- Longitudinal continuity of vegetation;
- Width of riparian vegetation;

- Proximity;
- Vegetation cover;
- Debris;
- Features;

The wetland should be divided into a series of zones (corresponding with the management zones set out in this VMP). A transect, perpendicular to the channel would be undertaken in each zone and the information listed above recorded.

Suggested zones are east and west of the Still Creek Channel just downstream of MacMahon Place; east and west of the Still Creek Channel at the southern end of Mina Road; east and west of the wetland at the mouth of the wetland (where the open water begins); and east and west at the northern end of the wetland.

Utilise the scoring sheet to calculate scores for each criteria and categorize to assist in the examination of results:

- Less than 25 very poor;
- 25-30 poor;
- 30-35 average;
- 35-40 good;
- More than 40 excellent.

The establishment of a control site in a natural freshwater wetland with adjoining vegetation and a more natural catchment would provide a comparison for the Still Creek wetland Monitoring program.

This information should be recorded and distributed with appropriate supporting information through Council's state of the environment reporting.

An annual inspection of the area is also recommended to assess the damage caused to existing trees and areas of revegetation by sulphur crested cockatoos. If damage reaches a severe level where trees are declining measures including some bird scaring as set out in Temby (2003) should be considered.

#### 4.2.4 Objectives

- Utilise photo points to monitor long term changes in vegetation

#### 4.2.5 Monitoring

- Establish a series of photographs to cover large areas of the wetland;
- Establish permanent photo points within the area covered by the photograph;
- Photos should be taken at higher than ground level utilising a step ladder to enable greater coverage of the wetland;
- Photo points should be established where variation in vegetation communities extent, distribution and condition is likely to occur (in Still Creek Wetland this would include communities adjacent to open water and areas subject to weed eradication at the inlet structure);
- Suggested photo points for Still Creek Wetland would include between the two green garden seats on the edge of the concrete path at the northern end of the wetland looking east, standing on the North West corner of the grated high flow outlet structure looking back south, standing at the inlet structure looking north
- The date, time and weather conditions at the time of the photograph should be recorded;
- Photographs should be taken during spring.

#### 4.2.6 Objectives

- Monitor vegetation species in floating reed bed

#### 4.2.7 Monitoring

- Monitor the species composition in the floating reed bed;
- If aquatic weeds are observed consult with Council's noxious weeds officer and take appropriate action to remove weeds.



## 5 COSTINGS

<i>Project Requirements/Objectives</i>	<i>Specific Tasks</i>	<i>Group Responsible</i>	<i>Approximate Cost</i>
<i>Site Inspection</i>	Site inspection with Bushland Manager and Council Officer	BM CO	\$1500
<i>Site Preparation / Sediment Control</i>	Site preparation, Install any required sediment and erosion controls and stockpile areas	BM,	\$1200
<i>Liaise with Council</i>	Ongoing liaison with Council Officers regarding implementation of Still Creek Wetland management plan	BM, CO	\$1500
<i>Project set up</i>	Review/ revise site map	BM	\$1800
	Prepare/ develop species list	BM	\$1800
	Record wildlife	BM	
	Select photo points	BM	\$500
	Review the location of each management zone identified in the VMP	BM	\$600
	Identify key areas on site (including kikuyu patches) and key habitat elements	BM	\$600
	Review the intended use of herbicides in and adjacent to the wetland, creek line and riparian corridor, liaise with Council Officers prior to	BM	\$500

	pesticide purchase and use		
<i>Bush Regeneration</i>	Primary weeding	BM	\$8000
	Secondary Weeding	BM	\$6000
	Undertake revegetation where required (including sourcing locally endemic native species)	BM	Market rates
	Maintenance	BM	\$4500
<i>Monitoring and reporting</i>	Prepare monitoring report for vegetation management	BM	\$600
	Prepare riparian vegetation assessment	BM	\$1000
	Undertake photo point monitoring	BM	\$600
	Undertake weed monitoring inspections (3 monthly) (20 inspections over the life of the plan)	BM/CO	\$6000
	Monitoring reports x 5	BM	\$3000
	Final Report	BM	\$1000
<i>Review of monitoring reports by Council</i>	Review of 5 reports (as listed above)	CO	\$1200
<i>Handover Still Creek Wetland Vegetation Management to Bushcare</i>	Meeting with Council officer, Bushland manager and Council Bushcare officer to determine ongoing management requirements	BM, CO CBO	\$1500
<i>Total</i>			\$43 400
<i>NB all costs are approximate</i>			

## 6 REFERENCES

- Department of Environment and Conservation DEC (2005) Recovering Bushland on the Cumberland Plain. Best practice guidelines for the management and restoration of bushland, Goulburn St. Sydney, NSW. <http://www.environment.nsw.gov.au/resources/nature/RecoveringCumberlandPlain.pdf>
- Department of Infrastructure Planning and Natural Resources DIPNR (2003) Bringing the Bush Back to Western Sydney. Best Practice Guidelines for bush Regeneration on the Cumberland Plain, Valentine St. Parramatta, NSW. [http://www.aabr.org.au/images/stories/resources/manuals/bringing\\_the\\_bush\\_back.pdf](http://www.aabr.org.au/images/stories/resources/manuals/bringing_the_bush_back.pdf)
- Department of Environment Climate Change and Water (DECCW) (NSW) (2010) Cumberland Plain Recovery Plan, Department of Environment, Climate Change and Water (NSW), Sydney. <http://www.environment.nsw.gov.au/resources/threatenedspecies/20100501CumberlandPlain.pdf>
- Hazelton P.A., Bannerman S.M. and Tille P.J. (1990) *Soil Landscapes of Wollongong – Port Hacking 1:100 000 Sheet 9029-9129* Department of Land and Water Conservation Sydney
- Jansen et al (2007) Rapid Appraisal of Riparian Condition Technical Guideline for the southern tablelands of New South Wales Land Water and Wool Canberra ACT <http://www.act.waterwatch.org.au/Files/Library/RARC.pdf>
- Molino Stewart (2012) Still Creek Wetland Management Plan prepared for Sutherland Shire Council and Sydney Metropolitan Catchment Management Authority
- Sutherland Shire Council (2006) State of the Environment Report 2006/07 [http://www.jazzandshiraz.com.au/ssc/rwpattach.nsf/viewasattachmentPersonal/20062007\\_SOE\\_Report\\_web.pdf/\\$file/20062007\\_SOE\\_Report\\_web.pdf](http://www.jazzandshiraz.com.au/ssc/rwpattach.nsf/viewasattachmentPersonal/20062007_SOE_Report_web.pdf/$file/20062007_SOE_Report_web.pdf)
- Sutherland Shire Council (undated) maps accessed 9<sup>th</sup> June 2011 <https://mapping.ssc.nsw.gov.au/Sutherland/>
- Temby (2003) Reducing cockatoo damage to trees, fixtures, houses, sports grounds and the environment Landcare notes prepared for State of Victoria Department of Sustainability and Environment [http://www.surfcoast.vic.gov.au/Community%20Safety/Documents/Pest%20Control/Cockatoo\\_damage\\_DPI\\_Info\\_Note.pdf](http://www.surfcoast.vic.gov.au/Community%20Safety/Documents/Pest%20Control/Cockatoo_damage_DPI_Info_Note.pdf)

## **APPENDIX A – FLORA SPECIES LIST**

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## DICOTYLEDONS

### Family Aizoaceae

*Tetragonia Tetragonoides*\*

### Family Alismataceae

*Sagittaria graminea*

### Family Amaranthaceae

*Alternanthera philoxeroides*\* Alligator weed

### Family Apiaceae

*Hydrocotyle tripartita*

### Family Asteraceae

*Bidens pilosa* Cobblers peg  
*Ozothamnus* spp.

### Family Casuarinaceae

*Allocasuarina littoralis*

### Family Convolvulaceae

*Dichondra repens*

### Family Epacridaceae

*Leucopogon junipennus* Bearded heath  
*Woolsia pungens*

### Family Euphorbiaceae

*Omalanthus populifolius* Bleeding Heart  
*Phyllanthus hirtellus* Thyme spurge

### Family Fabaceae

*Acacia decurrens* Black Wattle  
*Acacia longifolia* Sydney Golden Wattle  
*Acacia parvipinnula* Silver Stemmed Wattle  
*Dillwynia retorta* Heathy Parrot Pea  
*Hardenbergia violacea* False Sarsaparilla  
*Kennedia rubicund* Dusky coral pea

### Family Iridaceae

*Patersonia glabrata* leafy Purple Flag

### Family Myrtaceae

*Angophora costata* Sydney Red Gum  
*Callistemon citrinus* Crimson Bottle Brush  
*Eucalyptus piperita* Sydney Peppermint  
*Eucalyptus punctata* Grey Gum  
*Eucalyptus robusta* Swamp Mahogany  
*Corymbia gummifera* Red Bloodwood  
*Kunzea ambigua* Tick Bush

*Leptospermum leavigatum* Coast tee Tree

*Melaleuca quinquenervia* Broad leaved paperbark

*Melaleuca linarifolia* Snow in Summer

*Syncarpia glomulifera* Turpentine

*Tristaniopsis laurina* Water Gum

### Family Onagraceae

*Ludwigia peruviana*\*

### Family Oxalidaceae

*Oxalis* sp. \*

### Family Pittosporaceae

*Bursaria spinosa*

*Pittosporum undulatum* Pittosporum

### Family Polygonaceae

*Persicaria decipiens* Slender Knotweed

### Family Proteaceae

*Banksia ericifolia*

*Grevillea sericea*

### Family Lomandraceae

*Lomandra longifolia* Spiny-headed Mat-rush

### Family Poaceae

*Imperata cylindrica* Blady Grass  
*Entolasia stricta*

### Family Polygonaceae

*Rumex crispus* Curled dock\*

### Family Rosaceae

*Rubus fruticosus*\* Blackberry

### Family Rhamnaceae

*Pomaderris lanigera*

### Family Sapindaceae

*Dodonaea triquetra* Common Hop Bush

### Family Sapindaceae

*Dodonaea triquetra* Hop Bush

### Family Solanaceae

*Solanum chenopodioides* Blackberry nightshade\*

### Family Verbenaceae

*Lantana camara* Lantana \*

*Verbena bonariensis* Purpletop \*

## MONOCOTYLEDONS

**Family Cyperaceae**

*Baumea articulata*

**Family Commelinaceae**

*Commelina cyanea*

**Family Liliaceae**

*Dianella caerulea* var *producta* Blue  
Flax Lily

**Family Poaceae**

*Penisetum clandestinum* Kikyu  
*Phragmites australis*

**Family Typhaceae**

*Typha orientali*

## **APPENDIX B - RIPARIAN CORRIDOR MONITORING**

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# Rapid Appraisal of Riparian Condition

Site: \_\_\_\_\_ te Number: \_\_\_\_\_ GPS Start: \_\_\_\_\_  
 Date: \_\_\_\_\_ Observer: \_\_\_\_\_ GPS End: \_\_\_\_\_

## Longitudinal continuity of riparian canopy vegetation (> 5 m wide)

Map	Score

0 = < 50%, 1 = 50-64%, 2 = 65-79%, 3 = 80-94%, 4 = > 95% vegetation bank, with 1/2 point

## Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1			
2			
3			
4			
Average			

## Proximity

Score

Nearest path of native

vegetation > 10 ha:

0 = > 1 km, 1 = 200 m - 1 km,

2 = contiguous, 3 =

Channel < 10m wide: 0 = VW < 5 m, 1 = VW 5-9 m, 2 = VW 10-19 m, 3 = VW 20-39m, 4 = VW >

Channel > 10m wide: 0 = VW/CW < 0.5, 1 = VW/CW 0.5-0.9, 2 = VW/CW 1-1.9, 3 = VW/CW 2-3.!

## Vegetation cover: Canopy > 5m, Understorey 1-5 m, Ground cover < 1 m

Transect	Canopy	Native Canopy	Understorey	Native Understorey	Ground Cover	Native Ground Cover	Number of Layers
1							
2							
3							
4							
Average							

Canopy and ground cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = > 60%

Understorey cover: 0 = none, 1 = 1-5%, 2 = 6-30%, 3 = > 30%

## Debris

Transect	Leaf Litter	Native Leaf Litter	Standing Dead Trees	Hollow-bearing Trees	Fallen Logs
1					
2					
3					
4					
Average					

Leaf litter and native leaf litter cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = > 60%

Standing dead trees (>20 cm dbh) and hollow-bearing trees: 0 = absent, 1 = present

Fallen logs (>10cm diameter): 0 = none, 1 = small quantities, 2 = abundant

## Features

Transect	Native Canopy Species Regeneration	Native Understorey Regeneration	Large Native Tussock Grasses	Reeds
1				
2				
3				
4				
Average				

Regeneration < 1 m tall: 0 = none, 1 = scattered, and 2 = abundant with 1/2 point subtracted for

Reeds and large tussock grasses: 0 = none, 1 = scattered, and 2 = abundant



Source: Jansen et al (2007) Rapid Appraisal of Riparian Condition Technical Guideline for the southern tablelands of New South Wales Land Water and Wool Canberra ACT  
<http://www.act.waterwatch.org.au/Files/Library/RARC.pdf>

## Calculation of Scores

Site Number: \_\_\_\_\_

### Longitudinal continuity of riparian canopy vegetation

Score	A

### Width of riparian canopy vegetation

Average	B

### Proximity

Score	C

### Vegetation Cover

Average	Canopy	Native Canopy	Understorey	Native Understorey	Ground Cover
	D	H	E	I	F

Native Ground Cover	Number of Layers
J	G

### Debris

Average	Leaf Litter	Native	Standing	Hollow-	Fallen Logs
	K	L	M	N	O

### Features

Average	Native Canopy	Native	Large Native	Reeds
	K	L	M	N

### Totals

Site Number	Habitat	Cover	Natives	Debris	Features
(out of)	11	12	9	10	8
	A+B+C	D+E+F+G	H+I+J	K+L+M+N+O	P+Q+R+S

Total
50

## **APPENDIX F - RIPARIAN MONITORING RECORD**

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Source: Jansen et al (2007) Rapid Appraisal of Riparian Condition Technical Guideline for the southern tablelands of New South Wales Land Water and Wool Canberra ACT  
<http://www.act.waterwatch.org.au/Files/Library/RARC.pdf>

## Rapid Appraisal of Riparian Condition

Site: \_\_\_\_\_ te Number: \_\_\_\_\_ GPS Start: \_\_\_\_\_  
 Date: \_\_\_\_\_ Observer: \_\_\_\_\_ GPS End: \_\_\_\_\_

### Longitudinal continuity of riparian canopy vegetation (> 5 m wide)

Map	Score

0 = < 50%, 1 = 50-64%, 2 = 65-79%, 3 = 80-94%, 4 = > 95% vegetation bank, with 1/2 point

### Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1			
2			
3			
4			
Average			

### Proximity

Score

Nearest path of native vegetation > 10 ha:

0 = > 1 km, 1 = 200 m - 1 km, 2 = contiguous, 3 =

Channel < 10m wide: 0 = VW < 5 m, 1 = VW 5-9 m, 2 = VW 10-19 m, 3 = VW 20-39m, 4 = VW >

Channel > 10m wide: 0 = VW/CW < 0.5, 1 = VW/CW 0.5-0.9, 2 = VW/CW 1-1.9, 3 = VW/CW 2-3.!

### Vegetation cover: Canopy > 5m, Understorey 1-5 m, Ground cover < 1 m

Transect	Canopy	Native Canopy	Understorey	Native Understorey	Ground Cover	Native Ground Cover	Number of Layers
1							
2							
3							
4							
Average							

Canopy and ground cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = > 60%

Understorey cover: 0 = none, 1 = 1-5%, 2 = 6-30%, 3 = > 30%

### Debris

Transect	Leaf Litter	Native Leaf Litter	Standing Dead Trees	Hollow-bearing Trees	Fallen Logs
1					
2					
3					
4					
Average					

Leaf litter and native leaf litter cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = > 60%

Standing dead trees (>20 cm dbh) and hollow-bearing trees: 0 = absent, 1 = present

Fallen logs (>10cm diameter): 0 = none, 1 = small quantities, 2 = abundant

### Features

Transect	Native Canopy Species Regeneration	Native Understorey Regeneration	Large Native Tussock Grasses	Reeds
1				
2				
3				
4				
Average				

Regeneration < 1 m tall: 0 = none, 1 = scattered, and 2 = abundant with 1/2 point subtracted for

Reeds and large tussock grasses: 0 = none, 1 = scattered, and 2 = abundant

## Calculation of Scores

Site Number: \_\_\_\_\_

### Longitudinal continuity of riparian canopy vegetation

Score	A

### Width of riparian canopy vegetation

Average	B

### Proximity

Score	C

### Vegetation Cover

Average	Canopy	Native Canopy	Understorey	Native Understorey	Ground Cover
	D	H	E	I	F

Native Ground Cover	Number of Layers
J	G

### Debris

Average	Leaf Litter	Native	Standing	Hollow-	Fallen Logs
	K	L	M	N	O

### Features

Average	Native Canopy	Native	Large Native	Reeds
	K	L	M	N

### Totals

Site Number	Habitat	Cover	Natives	Debris	Features
(out of)	11	12	9	10	8
	A+B+C	D+E+F+G	H+I+J	K+L+M+N+O	P+Q+R+S

Total
50



## APPENDIX G - COSTING AND PRIORITIES

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Priorities have been allocated as follows:

- \* Very High priority – urgent works
  - \* High priority- to be completed within two years
  - \* Moderate priority- to be completed within the next five years
  - \* Low priority- to be completed
-



<b>Management Strategy</b>	<b>Action</b>	<b>Responsibility</b>	<b>Cost</b>	<b>Priority</b>
Retrofitting infrastructure (GPT)	Prepare concept design to modify GPT	SSC – Stormwater Management	\$5,000	high
	Replace the existing GPT with a Baramy Vane Trap (preferred action)	SSC – Stormwater Management	\$65,000	high
	Increase the cleaning frequency of the existing structure (least preferred)	SSC – Civil Operations Unit	At Council's cost	
	Regularly clean new structure	SSC – Civil Operations Unit	At Council's cost	high
Repair low flow outlet pipe	Dewater wetland	SSC – Stormwater Management and SSC – Civil Operations Unit	Provisional cost estimate \$50,000	Very High
	Expose the last 15 m of existing Aluminium pipeline	SSC – Stormwater Management and SSC – Civil Operations Unit		Very High
	Remove and replace with Reinforced Concrete Pipe	SSC – Stormwater Management and SSC – Civil Operations Unit		Very High
	Backfill with 42 Megapascal (MPa) concrete	SSC – Stormwater Management and SSC – Civil Operations Unit		Very High

Dredging	Drain wetland	SSC – Civil Operations Unit	At Council's cost	
	Access the wetland and use excavator to dredge the existing sediment island from the centre of the wetland that is colonised by the common weed Arrowhead;	SSC – Civil Operations Unit	At Council's cost	high
	Dispose of this dredged sediment in an appropriate manner that will not result in the further distribution of weeds.	SSC – Civil Operations Unit	Up to \$250 per tonne (200 tonne expected) depending on waste disposal facility. Cost can be reduced if sediment is allowed to dry out prior to disposal	high
Design and Install floating reed bed	Have a floating reed bed designed and installed for Still Creek Wetland that would absorb some of the nutrients from the water entering the wetland;	SSC – Stormwater Management	\$35, 000	high
	Have the reed bed densely planted with native <i>Baumea sp.</i> , <i>Schoenoplectus sp.</i> , <i>Phragmites</i> or other suitable species;	SSC – Stormwater Management	See above	high
	Monitor the reed bed for invasion by <i>Ludwigia peruviana</i> (a noxious weed already present on the site) and remove before, during and after installation of the reed bed	SSC – Parks Operations Unit	At Council's cost	high
Replace fencing adjacent to wetland inlet	Remove the cable ties and wire used to secure the pool fencing located adjacent to the wetland inlet.	SSC – Civil Operations Unit	At Council's cost Fencing \$5000	moderate

	Properly secure the panels and control all access points with additional panels or appropriate barriers			
	Design and erect signage so it is prominently displayed warning of the dangers of entering the area around the GPT.	SSC – Stormwater Management	\$3,000	moderate
Research for flood mitigation in light of climate change	Basin profiles and volumes confirmed by Works As Executed survey.	SSC – Stormwater Management	At Council's cost	moderate
	The hydrology and hydraulics of the wetland confirmed using more contemporary modelling techniques. (The rainfall intensities used should be increased by at least 15% in consideration of projected Climate Change impacts).	SSC – Stormwater Management	At Council's cost	moderate
	Based on above studies prediction of any risk to public safety as a consequence of the Mina Road embankment overtopping should be considered and addressed.	SSC – Stormwater Management	At Council's cost	moderate
Vegetation and Weed Management	Identify the appropriate person within Council to oversee weed removal and bush regeneration in the wetland and upstream riparian corridor	SSC - Natural Areas Manager	At Council's cost	high
	Prepare a vegetation management plan for the wetland and riparian corridor that sets out basic principles and makes specific recommendations that could be implemented by a bushland manager	SSC - Natural Areas Manager	\$3,900	high
	Secure funding for the implementation of the vegetation management plan	SSC - Natural Areas Manager	At Council's cost	high



	Commission a qualified bush regeneration contractor to implement the vegetation management plan for Still Creek Wetland	SSC - Natural Areas Manager	\$45, 000 over 5 years	high
	Explore the opportunity to plant additional canopy trees and shrubs between trees around Abraham Close.	SSC - Natural Areas Manager	At Council's cost	moderate
	Promote Still Creek Wetland into SSC's Bushcare program to provide opportunities for local residents to join existing programs in weeding and bush regeneration activities	SSC - Natural Areas Manager / Bushcare Officers	At Council's cost	moderate
	Encourage and provide some incentives to promote local residents of the Mina Road subdivision's involvement in vegetation management and bush regeneration activities in Still Creek Wetland	SSC - Natural Areas Manager / Bushcare officers	At Council's cost	moderate
	Implement monitoring of vegetation management in the wetland and report in Council's State of the Environment Report	SSC - Natural Areas Manager / Bushcare Officers	\$5,000 per annum \$25,000 over 5 years	high
Riffle Zone	Remove existing sediment, light litter and weed build up from the inlet zone of the wetland;	SSC – Civil Operations Unit	At Council's cost	high
	Reshape this area with the aid of a small excavator to replicate a riffle zone using strategically placed sandstone boulders which would reduce inflow velocities	SSC – Civil Operations Unit	At Council's cost \$5000	moderate
Outlet structure screening	Use the floating reed bed to screen the vertical riser within the wetland;	SSC – Civil & Parks Operations Unit	Included in floating reed bed cost	moderate

	Use screen planting to reduce the visual impact of the high flow outlet located at the north western edge of the wetland	SSC – Civil & Parks Operations Unit	\$1000	moderate
Community education	Develop a community education program alerting the residents to their impact on water quality in Still Creek Wetland, issues associated with feeding the ducks bread as well as the impact that a large flock of ducks has on water quality and wetland vegetation.	SSC - Natural Areas Manager / Bushcare officers/ Stormwater Management	\$30 000 over 5 years	moderate
	Provide advice on actions residents can take at home to improve water quality and feed ducks vegetable scraps	SSC - Natural Areas Manager / Bushcare officers/ Stormwater Management	At Council's cost	moderate
Community consultation and engagement	Engage with Beaumaris Drive Reserve Bushcare Group as part of the vegetation management plan with the goal of linking Still Creek Wetland with Menai Park and the downstream Still Creek core Greenweb habitat areas.	SSC - Natural Areas Manager / Bushcare officers	At Council's cost	moderate
	Engage with the Parc Menai Bushcare group as part of the vegetation management plan and highlight the potential for the Still Creek Wetland and adjoining riparian corridor to provide a link between Menai Park, Still Creek and ultimately the Woronora River	SSC - Natural Areas Manager / Bushcare officers	At Council's cost	moderate
	Provide ongoing support and incentives for existing Bushcare groups to include Still Creek Wetland in their activities.	SSC - Natural Areas Manager / Bushcare officers	At Council's cost	moderate
	Undertake Still Creek Wetland days at the wetland and at Menai Town Centre celebrating World	SSC - Natural Areas Manager / Bushcare	\$7000 per annum	high

	Wetland Day and Clean Up Australia. Consider a macro invertebrate monitoring day at Still Creek Wetland	officers		
Wetland Infrastructure monitoring	Collect records over time of the volumes of sediment and litter removed from the inlet to Still Creek Wetland.	SSC – Civil Operations Unit & Stormwater Management	At Council's cost	high
	Measure the volume of sediment and litter removed from the Still Creek Wetland inlet following changes to the GPT	SSC – Civil Operations Unit	Council maintenance team weigh and record sediment and litter volumes at Council's cost	high
Water Quality monitoring	Undertake water quality monitoring based on SSC Strategic Water Quality Monitoring Program	SSC – Environmental Science Unit	5k per annum over 5 years (\$25000)	high
	Undertake macro invertebrate monitoring based on Georges River Combined Councils Committee Community River Health Monitoring Program	SSC – Environmental Science Unit	5k per annum over 5 years (\$25000)	high
	Distribute the results of water quality and macro invertebrate monitoring	SSC – Environmental Science Unit	At Council's cost	high
Monitor freshwater wetland vegetation and riparian EEC	Undertake monitoring of the following using the monitoring template developed by Jansen et al (2007) contained as Appendix F to this document. Longitudinal continuity of vegetation; Width of riparian vegetation; Proximity; Vegetation cover; Debris; Features;	SSC - Natural Areas Manager/ Bushcare Officers	7k per annum over 5 years (\$35000)	high

	Analyse and distribute data	SSC - Natural Areas Manager/ Bushcare Officers	At Council's cost	high
Monitor Fauna	Undertake fauna surveys annually for five years	SSC - Natural Areas Manager	\$20 000 per annum over five years	moderate
	Analyse and distribute data	SSC - Natural Areas Manager	At Council's cost	moderate
Monitor Environmental Education	Monitor and report on number of wetland environmental days; number of participants at wetland environmental days; requests for further information from residents/neighbours about the wetland or land management activities.	SSC - Natural Areas Manager/ Stormwater Management	At Council's cost	moderate
Total implementation estimate of costs over 5 years \$				
	NB All cost estimates exclude GST, are approximate and are indicative and subject to detail design and more comprehensive bill of quantities			