5.2 Guidelines for preparing a Wetland Plan of Management

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Abstract

Preparation of wetlands Plan of Management (PoM) is a specialised task that requires a systematic process. This chapter offers a guideline and describes 11 key steps in the preparation of a PoM, foremost among which is consultation with key stakeholders at the early stage of planning. A PoM must also ensure that it clearly identifies the management objectives and issues, formulates sensible strategies and actions, and employs a monitoring protocol to gauge the effectiveness. Wetland management is an ongoing process, so too is its PoM preparation, which may be described as an adaptive management approach.

Introduction

The previous chapter (chapter 5.1) provided a description of a Wetland Plan of Management (PoM) and the need for its preparation. This chapter provides a generic framework for preparing such a plan, arranged in a series of systematic steps, with selected material from a number of existing PoMs that will assist with the preparation of site specific Wetland Plans of Management.

Under the *Local Government Act* 1993, NSW councils are required to prepare Plans of Management for community land, which includes parks and open space areas. The latter are the areas often identified as suitable for constructed wetlands and/or are used to protect existing wetlands from urban development. There are a number of key elements common to a PoM:

1. It must be a written document that is logically structured and easily read. Its circulation must be complete and timely so that all relevant stakeholders can be fully consulted on the planning process and contribute to the contents of the plan. Details regarding the consultation process are discussed in Step 6. The manner and results of all consultation must be fully documented within the plan;
2. It must describe the site and its management constraints and opportunities;
3. It must outline the management objectives and strategies for the wetland;
4. It must identify targets and the works necessary to achieve those targets;
5. It must contain an implementation and funding strategy as well as measurable performance criteria; and
6. It must be approved by the appropriate federal, state and/or local authority and identify the persons or organisation responsible for its implementation.

The Plan of Management Process

A Wetland Plan of Management must include all of the elements identified above if it is to be a practicable document. Consequently it is recommended that a step-by-step process, as set out below, be followed. To assist with this process the heads of consideration, in the form of a Table of Contents for three wetlands under the control of different Local Councils in New South Wales has been included in Appendix A. Although at first glance the content of the PoM for each of these wetlands looks dissimilar, there are key elements common to each, providing a framework around which the PoM can be fully articulated. These heads of consideration include:

- Identification of the wetland;
- Description;
- Functions, Uses, Values;
- Threats, Risks, Opportunities;
- Objectives;
- Management target/action/pathway;
- Monitoring/evaluation/responsibility; and
- Community involvement.

Consideration should also be given to the drivers, or "trigger", that initiated the preparation of the PoM. These may include:

- Legislative requirements;
- Timing – and existing PoM has finished its life and needs to be updated;
- Re-structuring of the existing manager or its replacement;
- Community concerns;
- Identification of another environmental issue;
- Availability of funding; and
- Political support for the PoM resulting in the setting of broad strategic goals that will be modified and updated during the preparation process.

Based on the above considerations and the history and the nature of the wetlands, the Sydney Olympic Park Authority has developed a flowchart

for the preparation of the PoM for the wetlands within Sydney Olympic Park (SOPA 2007). It has been structured around an adaptive management process that includes 11 Steps and addresses the heads of consideration listed above.

Step 1: Gather data/information

The first step in the preparation of a PoM is to gather all available data and information that exists on the wetland. At the completion of the information gathering exercise a comprehensive identification of any "data gaps" should be undertaken in a manner that facilitates the processing of the relevant data that is usable and accessible by the PoM preparation process.

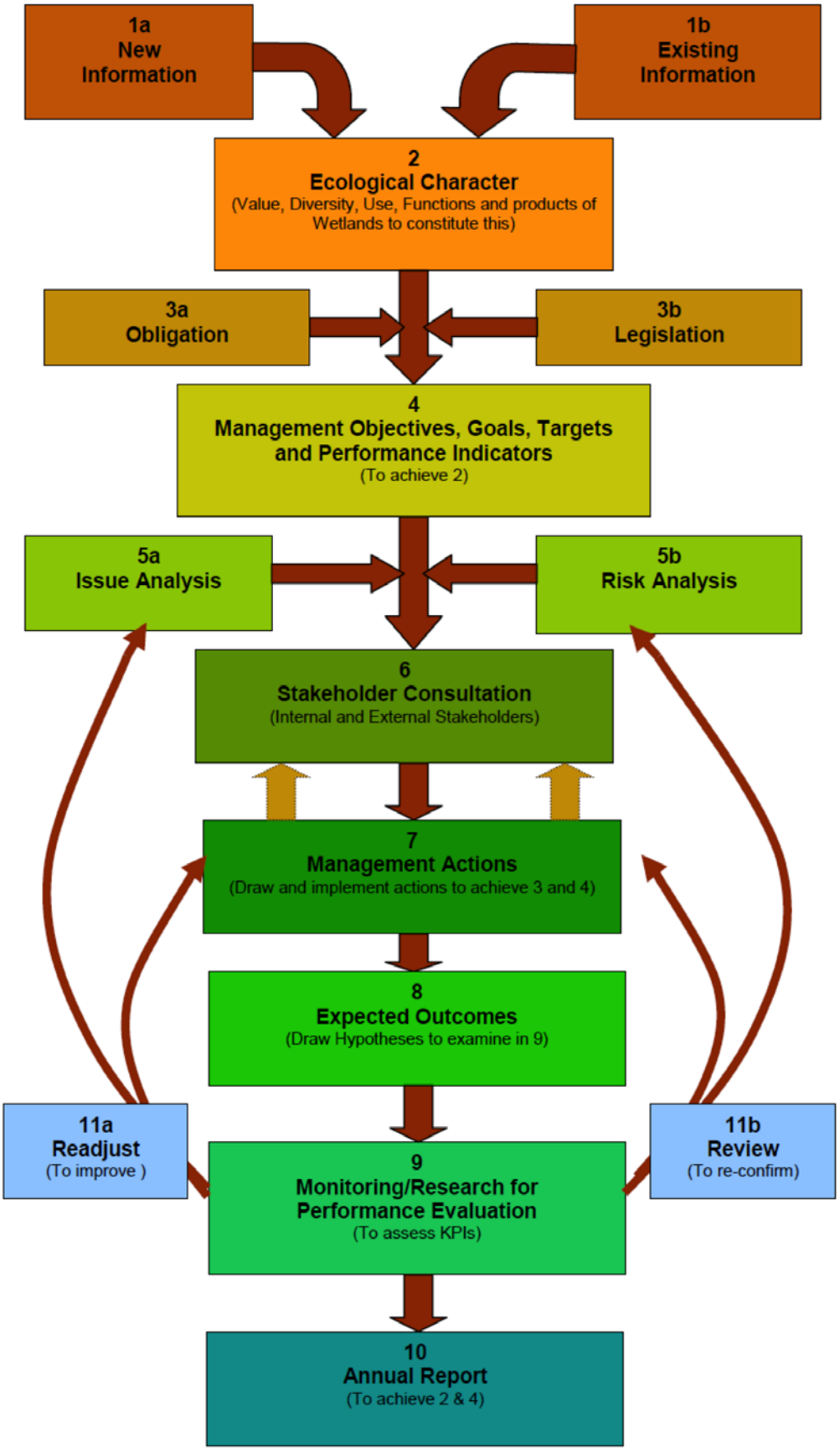

Figure 5.2.1. Framework for the PoM that was followed for all wetlands in Sydney Olympic Park in 2007.

The minimum background data and information required includes:

- Land ownership and details;
- Site description, hydrology, ecology and environmental features;
- Stakeholders; and
- Responsibilities and obligations for site managers.

Step 2: Describe the site (including Ecological Character and Risk Assessment)

The PoM must contain a complete description of the wetland site for which it is being written. The site description must include: site delineation and mapping; its ecological attributes; listing of the key flora, fauna, ecosystems and ecological communities; and identification of specific areas of special interest (e.g. Endangered Ecological Communities, migratory bird habitats, etc.).

Site description

Site description and delineation begins with the identification of a site as a wetland, including its buffer zone. Depending on the complexity of a site, a wetland delineation and description could be very straightforward and simple. However, for a site where wetlands are constructed, modified, realigned, and/or meant to serve other key purposes (e.g. water treatment, flood control, water reuse, recreation, conservation) the definition and characterisation of its objectives can become complex and convoluted. While it is easy to draw a boundary around most wetlands, it is sometimes very difficult to know exactly where that physical boundary is, especially when the extent of open water or water plants is not apparent.

Regardless, for reasons associated with ownership, management jurisdiction, responsibility and liability, a wetland's boundary must be defined, both on the ground as well as on a map.

Site description includes a clear definition of the type of wetland. However, defining and delineating a wetland requires categorising it as a specific type of wetland (refer to Table 5.2.1). This is not necessarily a straightforward task as there could be multiple types of wetlands: 42 types recommended by Ramsar (Ramsar 2013), 41 types that the NSW Government (DEC 2013); or 13 types that the Sydney Olympic Park Authority has categorised (SOPA 2007). Table 5.2.1 provides a description of the 13 different categories of wetlands identified by the Sydney Olympic Park Authority.

The PoM must be relevant to the specific management issues associated with the wetland and this can only be achieved through on site knowledge obtained by visiting the site.

The characteristics or attributes include, but should not be limited to, the following:

- Area, boundary, dimensions;
- Geomorphic settings;
- Climatic exposure;
- Habitat types, connectivity, diversity;
- Flora/fauna;
- Key, rare, endangered, threatened, priority species or ecosystems present;
- Surface water hydrology;
- Soil and water characteristics, including surface and ground water connectivity;
- Water quality features;
- Key ecological processes; and
- Any others.

Ecosystem Services

The formulation of a PoM depends on the quality and the level of detail gathered about the ecosystem services within the wetland. In our experience there can never be too much information gathered about the function and attributes of a particular wetland. Often, wetland description is considered as 'stock-take' of its key attributes including its climatic and geographical environments. The 'stock-take' approach assists in closely identifying various flora, fauna or ecological communities that the wetland hosts – whether any or many of these are already listed as rare, protected, priority, endangered, vulnerable or threatened. All written information gathered about a wetland should be 'ground truthed' to check its relevance and currency. In most cases existing reports and studies can be used to inform the 'ground truthing' and 'stock-taking' in identifying the Ecosystem Services. Table 5.2.2 provides some guidelines on the type, function, use and value of wetlands that may assist in the 'stock taking' process.

Ecological Character definition

Ecological Character is a simple expression of the ecological values that a wetland holds for now and in the near future. At the core of an Ecological Character assessment is the description of the components, processes, benefits and services of the

Table 5.2.1. Major Wetland Types in Sydney Olympic Park.

Ecosystem/Wetland Type	General Definition[#]
Freshwater Creek	Narrow, irregular, running freshwater channel. May contain macrophytes, isolated pools and runnels, often places of sediment accretion.
Freshwater Swamp	A wetland characterised by poorly drained soils and plant life dominated by trees. Swamps may or may not become dry during some parts of the year.
Freshwater Pond (Habitat Pond)	Relatively small and shallow water bodies with gentle slopes, which may or may not be connected to other water sources. They retain freshwater throughout most of the year. Generally moderate-to-dense macrophyte and algal coverage.
Freshwater Lake	Larger and deeper water bodies than ponds with sharp slopes that retain freshwater throughout the year. May have macrophytes along its edges, although plankton tends to be main component. Usually connected to other water sources.
Floodplain	A low plain, containing clusters of shallow to moderately deep water bodies, which when inundated becomes a floodway. When water recedes, the area may retain water from a few hours to months. They are generally formed of river sediment unless artificially constructed.
Stormwater Pond	Freshwater ponds constructed primarily for the treatment of stormwater runoff. These are characterised by low macrophytes. High sediment deposition, high turbidity and periodic algal blooms, primarily for stormwater treatment.
Leachate Pond	Ponds constructed to particularly treat leachate by solar evaporation or by bioremediation. These ponds have impermeable liner and contain little to no macrophytes. Access is strictly restricted and the waste (leachate) may have high TDS (Total Dissolved Solids).
Mangroves	Mangroves are trees (such as genus Avicennia) found in intertidal areas on sheltered shorelines and saline reaches of rivers and streams. They generally colonise areas of sediment deposition near low wave-energy pockets.
Mudflat	Shallow and gently sloped shores of creeks, rivers or estuarine ecosystems that are free from substantial vegetation and are subject to periodic flooding and minor wave action.
Saltmarsh	An intertidal habitat situated at high-tide elevation that is colonised by salt-adapted low-height plants, generally fringing the estuary exposed to low-energy wave action.
Saltwater Lagoon	Shallow water bodies partially cut off from main water body by reef or bund although it has tidal connection for most tides. Can have high algal growth, presence of seagrass and waterfowl.
Saltwater Creek	Narrow intertidal creek that ranges from saline at lower reaches to brackish at upper reaches where freshwater input occurs. They may be completely or partially drained on a daily basis. Generally fringed with mangrove or saltmarsh.

[#]The definitions are adapted from Ramsar Convention guidelines (Kingsford 2003) and the professional experience of the authors.

Table 5.2.2. Examples of wetland functions, uses and values, as ingredients for Ecosystem Services.

Wetland type	Functions	Uses	Values
An estuarine mangrove forest	Sediment trapping; nutrient capture; biodiversity shelter and corridor; fish spawning and nursery; role of a tree.	Education and awareness; recreation & leisure; tourism; etc.	Provide shelter to estuarine areas, including saltmarsh; contribute to fish production; nature reserve; aesthetics; biodiversity connectivity; etc.
A constructed freshwater wetland	Urban stormwater treatment; sedimentation basin; litter trap; biodiversity.	Stormwater detention and capture; education & awareness.	Pollution control; aesthetics; biodiversity connectivity; etc.
An urban creek	Flood mitigation and stormwater corridor; biodiversity corridor.	Leisure & recreation; etc.	Flood avoidance and assets protection; water connectivity.

wetland and how they are linked at the time they are being considered (Ramsar 2013). The components and processes of the wetland influence and determine the habitats, ecological communities and species that are found at a site. These in turn influence the benefits and services provided by the site. Together, these can constitute the Ecological Character of a wetland, as adopted by Ramsar. A full list of the recommended Ecological Character items is included in Ramsar Handbook No. 18.

Describing a wetland by following the Ecological Character pathway is particularly handy when setting management objectives and checking them against whether or not the Ecological Character goals were achieved by implementing the PoM. Regardless, an Ecological Character definition of a wetland is an essential requirement for Ramsar listing. Consequently undertaking Ecological Character definition in accordance with the Ramsar guidelines has merit in that even if Ramsar status is not sought for a local wetland it is useful to aim high and use Ramsar guidelines.

Step 3. The Drivers for the PoM

Legislation is one of the key drivers for preparing a wetland PoM. Legal requirements may vary locally between wetlands and these are generally identified within relevant local ordinances. For Sydney Olympic Park wetlands the key legal requirements are:

- *Sydney Olympic Park Authority Act* 2001;
- Sydney Regional Environmental Plan No 24 - Homebush Bay;
- *National Parks and Wildlife Act* 1974;
- *Threatened Species Conservation (TSC) Act* 1995;
- *Fisheries Management Act* 1994 and *Amendment Act* 2001;
- *Noxious Weeds Act* 1993;
- *Environment Protection & Biodiversity Conservation Act* 1999;
- *Protection of the Environment Operations Act* 1997; and
- *Environmental Planning & Assessment Act* 1979.

In addition to legislative requirements there may also be policy guidelines. The Guidelines that apply to Sydney Olympic Park wetlands include:

- Environmental Guidelines for Summer Olympic Games 1993;
- Plan of Management for the Parklands 2003 & 2010;
- Sydney Olympic Park Master Plan 2002 & 2030;
- Towards Sustainability: Sustainability Strategy 2002;
- Ramsar, JAMBA, CAMBA and ROKAMBA;
- SOPA Frog Management Plan 2002;
- Stormwater Operations and Reuse Protocols 2000;
- SOPA Biodiversity Management Plan 2008; and
- Landscape Presentation Standards 2002.

More details about legislation that are related to wetlands management are covered in Chapter 1.2.

Table 5.2.3. A list of Ecological Characters that were defined for three different types of wetlands at Sydney Olympic Park.

Measure	Preliminary Benchmark (Limit of Acceptable Change)
System drivers and ecological processes	
Grey Mangrove area	Retain the area of mangroves (40ha) @ 10% annual variation or 20% variation in 3 years
Water quality: pH (range: 5.5–6.5)	Keep within the Guideline
Biodiversity	
Mangrove diversity (two species)	No loss of the two species
Diversity of macroinvertebrate (13 taxa)	Enhance the current diversity
Diversity of aquatic fauna (unknown diversity)	Enhance the current diversity
Waterbird diversity and abundance	Enhance the current diversity and abundance
Major threats to ecological character:	
Measure	**Preliminary Benchmark (Limit of Acceptable Change)**
Tidal exchange (limited inundation and drainage)	Increase to daily occasions of tidal inundations
Water quality: Gross pollutants and road runoff	Filter before entry
Potential ASS	Incidents of PASS release do not exceed Guidelines
Pest mosquito population (<1 larva/dip of a net)	Pest mosquito populations maintained at <1 larva/dip

Political Support

In many instances, for a PoM to be prepared and then implemented, a high level of internal political support is required. Although many PoM are driven by legislative requirements, differing capacities, financial and human resources for implementation can mean that the draft of a POM can be "watered down" to more accurately reflect political will sometimes disguised as the lack of available resources. A key element of political success is the presence of a "champion" for the wetland who may be within or may be external to the organisation. If the former that individual will ultimately be tasked with implementing the PoM. The champion will often be the person who has secured the funds for the preparation of or the update to the PoM. He will have engaged with internal and external stakeholders so that key individuals in positions of power understand why the PoM is being developed and how the organisation will benefit from its implementation and will provide the necessary resources for its implementation. In the case where a champion is lacking or does not have the capacity to act as an advocate for the wetland the political support and subsequent resourcing for implementation of the PoM may not be guaranteed.

Step 4. Enabling Management Objectives and Strategies

A wetland PoM must have clearly defined management objectives as without these it is impossible to determine the corresponding management issues. Further, without clearly defined objectives there is no way of auditing the success of the implementation of the PoM. The objectives must be measurable but it should also be recognised that they may change over time.

A management objective should not be a generalised statement that may not be capable of attaining a practicable definitive goal. Table 5.2.4 provides hypothetical examples of clear objectives, as opposed to subjective statements.

Management objectives must be accompanied by a strategy that is quantifiable and capable of achieving the objectives. Strategies are a combination of efforts, tactics, tools and techniques that are employed in attaining the objectives. Once strategies are defined it becomes possible to articulate the corresponding management actions.

A Key Performance Indicator (KPI) is used to gauge if and when particular objectives are met. This is discussed in Step 9.

Table 5.2.4. Management objectives for three different types of wetlands.

Wetland Type	Problems	Issues	Objectives	Strategy
An estuarine mangrove forest	Due to mangrove die back from water pooling, pest mosquitoes breed heavily in the pools	Excessive mosquito biting due to mangrove degradation	Enhance mangrove habitat	Restore tidal exchange by excavating new channels
			Reduce mosquito population	Remove the tidal barriers through excavation
A constructed freshwater wetland	Blooms of toxic blue-green algae	Toxic algae may affect public and dogs	Reduce toxic algae	Introduce underwater propeller
				Install water fountain and oxygenation
			Enhance catchment water quality	Increase ground cover to reduce sediment movement
				Improve gardening practices to reduce nutrient load from gardening
				Improve wetland sediment health by removal and reduction and adopt a no-net-sediment gain policy
An urban creek	A 2.0km long freshwater creek has been filled with sediment, rubbish and weeds, thus obstructing stormwater flow and diminishing biodiversity	The poor health of the creek poses increasing flooding risk as well as biodiversity loss	Improve stormwater flow	Remove additional barriers to stormwater flow
				Develop stormwater detention provisions prior to entry to the creek
			Reduce sediment, nutrient and litter pollution	Increase ground cover to reduce sediment movement
				Intercept first flush through constructed wetlands
			Improve creek riparian health	

Step 5. Identification of Management Issues and Assessment of Risk & Vulnerability

Articulation of management issues is critical to the success of a PoM. These should be identified as part of Step 4 before developing the actual management strategies and actions needed to address them.

Identification of the management issues must include all the known and/or perceived constraints and limitations associated with the wetland. A PoM is a 'living' document and it is important that a futuristic view is reflected in its preparation. It is important to be brief in the description of constraints and limitations and if possible limit them to the top ten (10) priorities.

Issue Analysis

Management issues are a reflection of risks, problems and constraints. In many cases, the true driver for a PoM and the allocation of resources is dictated by the severity, urgency and the importance of the issues that are flagged. In a practical sense, issues and objectives are identified almost hand-in-hand.

Risk and vulnerability assessment

Assessment of risk and vulnerability is an important task in the preparation of a PoM. Although these are not difficult to assess, there are specific steps that need to be followed. Finlayson *et al.* (2011) and Gitay *et al.* (2011) provide tools respectively for

Table 5.2.5. List of potential risks that three different wetland types may offer.

Wetland Type	Problems	Constraints	Limitations	Risks
An estuarine mangrove forest	Due to mangrove die back from water pooling, pest mosquitoes breed heavily in the pools	Effective mosquito treatment measures are impractical	In-filling or draining the pools are expensive	1. Public may catch diseases from mosquito bites. 2. Mangrove health may further deteriorate.
A constructed freshwater wetland	Blooms of toxic blue-green algae	It has constant source of nutrients from the upper catchments and the lake water is used for lawn irrigation	Application of chemical treatment is not possible due to public concerns	1. Park users may come in contact with the algae-infested water and become sick. 2. Pet dogs may be affected if they drink the water.
An urban creek	A 2.0km long freshwater creek has been filled with sediment, rubbish and weeds, thus obstructing stormwater flow and biodiversity	The creek hosts sensitive freshwater fish species as well as the sediment contains pollutants that are locked in the sediment	Funding is limited for any restoration works to be undertaken	1. Flooding frequency and extent may increase 2. Biodiversity may suffer

assessing risk and vulnerability for wetlands. Risk and vulnerability assessment is also required to address and accommodate the need for adaptive management, especially in the context of changing environment such as Sea Level Rise and Climate Change (DECCW 2010). Table 5.2.5 contains a list of potential risks that could be identified for various wetland types.

Step 6. Stakeholder Consultation

Early consultation with stakeholders is essential to inform all parties that a wetland PoM is being prepared. By being articulated in an open forum an opportunity is presented for stakeholders to describe what they see as the issues of concern as well as possible management strategies and actions. It is also an important "first contact" such that stakeholders can identify the management team and management issues. Stakeholders will gain a sense of the purpose of the plan and are likely to be open about ideas for potential strategies to address management issues. It takes some effort and time for the relationship between the team and the stakeholders to develop but it is a critical element of the process and should be encouraged. A best case scenario is to be able to meet neighbours of the wetland and any other stakeholders on site in an informal setting that generates discussion.

Often it is not as clearly understood who should be consulted and this may be an outcome of the initial informal stakeholder meeting. The main purpose for the team preparing the PoM is to explain the proposed planning activity and any anticipated works and how the stakeholder may be involved (directly or indirectly). The number of stakeholders can vary from the immediate neighbours (that may be less than half a dozen) or in the case of the Parramatta River Estuary Management Plan in excess of 26 stakeholders (Cardno 2013).

Consultation is vital to ensuring that any actions proposed for the wetland are not a surprise to the stakeholders and an opportunity is provided for their cooperation in the development and implementation of the PoM. It is always good to be open, upfront, and transparent during any stakeholder consultation and be prepared to allow as much time as required to discuss individual issues. Proceedings must be documented and circulated to all attendees upon conclusion of the

consultation process and if possible team members with a technical background should be present to answer technical questions should they arise.

Step 7. Management actions through relevant work

The objectives and issues that were earlier listed need to be translated into works or actions so that the issues and objectives can be adequately described.

Actions have to be relevant and can be on-ground practical measures or a desktop exercise such as a description of how to operate the technical aspects of a water recirculation system, or how to respond to a maintenance requirement, or continued community engagement. Regardless, the action must be specific to resolving the identified issue.

Table 5.2.6 provides some hypothetical but relevant examples of actions emanating from objectives and strategies listed earlier in Table 5.2.4.

The introduction of a 'report card' will allow the success of the implementation strategy and PoM to be better determined. A coding system can be used to identify actions at particular sites within a wetland: it may take the following form: an action code such as NR11MN02 could be used to identify wetland NR, site number 11, which is a mangrove (MN) and the action is type number 02. In this manner, each and every action can be tracked and followed without confusion about a similar action implemented elsewhere.

Costing

In order to assess the resource requirements for the PoM, each action must be costed. In some instances costs can be estimated by wetland managers based on past experience, for example the continued maintenance of infrastructure. In other cases, costs will need to be generated from detailed designs of new infrastructure or vegetation planting, removal or other works. Cost items for one-off actions (say, capital works) and annual recurrent (maintenance) actions need to be identified separately.

Resources and Responsibilities

All management actions will require some form of resources for their implementation, with human resources being the primary requirement. It is important to break down the financial needs for each respective management action to assist in implementation. Table 5.2.7 provides an example of resource allocations in Sydney Olympic Park.

Timeline

Each action must be scheduled within a stated period of time. Further, it is essential to identify is the individual(s) responsible for implementing a particular action. An open-ended action with no time-line is unlikely to be implemented. A time schedule is important for at least two main reasons:

1. so that the implementation of the action does not affect wetland processes (e.g., seasonal functions); and
2. so that the action does not affect subsequent actions that are dependent on the completion of the previous action within a certain timeframe.

Step 8. Expected Outcomes

The expected outcomes of a particular management action must be articulated in the PoM, especially if more than one action is required to achieve the desired outcome.

Outcomes are also closely related to the Ecological Character definition. For example, each of the Ecological Characters described in Table 5.2.3 requires several strategies and management actions. Each action may result in one or more outcomes and each must be measured against achieving the overall objective.

Outcomes become meaningful only when performance evaluation is undertaken, and this is discussed further in Step 9 below. Performance evaluation can be accomplished through the use of Key Performance Indicators (KPIs). That is, the evaluation of a PoM may be gauged against the detail contained in the monitoring results. KPI's help senior management rapidly assess the status and implementation of the PoM. Table 5.2.8 demonstrates KPIs that have been used by Sydney Olympic Park, and have been informally designated the "quick-view traffic light" presentation.

Step 9. Performance Evaluation (through monitoring/research)

A PoM that is performance-based is an outcome oriented PoM and therefore needs a performance evaluation, with the latter directly related to Ecological Character definition, with measurable management objectives and a practicable implementation of actions. A monitoring program as part of the PoM is the mechanism that tracks the success of each action against the objective that the action is aimed at achieving.

Table 5.2.6. List of probable management actions in hypothetical scenarios.

Wetland Type	Problems	Issues	Objectives	Strategy	Actions
An estuarine mangrove forest	Due to mangrove die back from water pooling, pest mosquitoes breed heavily in the pools	Excessive mosquito biting due to mangrove degradation	Enhance mangrove habitat	Restore tidal exchange by excavating new channels	Survey
					Channel excavation
					Sediment disposal
					Before-after monitoring
			Reduce mosquito population	Remove the tidal barriers through excavation	Survey
					Excavation
					Sediment disposal
					Before-after monitoring
A constructed freshwater wetland	Blooms of toxic blue-green algae	Toxic algae may affect public and dogs	Reduce toxic algae	Introduce underwater propeller	Survey
					Introduce propeller
				Install water fountain and oxygenation	Survey
					Install water fountain
					Install oxygenation paddle wheel
			Enhance catchment water quality	Increase ground cover to reduce sediment movement	Planting and mulching
					Sediment control measures during excavation
					Sediment traps
				Improve gardening practices to reduce nutrient load from gardening	Less fertiliser and more manure
					Intercept garden seep before entering wetland
					Mulching
				Improve wetland sediment health by removal and reduction and adopt a no-net-sediment gain policy	Remove nutrient-rich sediment from the wetland bottom
					Remove excess sediment at certain interval, say every 5 years

Table 5.2.6. (cont.) List of probable management actions in hypothetical scenarios.

Wetland Type	Problems	Issues	Objectives	Strategy	Actions
An urban creek	A 2.0km long freshwater creek has been filled with sediment, rubbish and weeds, thus obstructing stormwater flow and diminishing biodiversity	The poor health of the creek poses increasing flooding risk as well as biodiversity loss	Improve stormwater flow	Remove additional barriers to stormwater flow	Survey
					Barrier removal
				Develop stormwater detention provisions prior to entry to the creek	Develop stormwater hydrograph
					Ensure landowners at the catchment adopt WSUD principles, including SW detention
			Reduce sediment, nutrient and litter pollution	Increase ground cover to reduce sediment movement	Planting and ground cover
					Sediment control measures during excavation
					Sediment traps upstream
				Intercept first flush through constructed wetlands	Build constructed wetlands to intercept low-flow for treating first flush

** Note that each Action must have three key things: when will the Action be implemented, who will implement it and at what tentative cost.*

The parameters, intervals and methods of monitoring, should be decided during the preparation of the PoM.

Wetland Monitoring Plan

A wetland monitoring plan will be required to accompany the PoM. The monitoring plan allows for a detailed approach to assess how management actions have met objectives. It allows for the collection and analysis of information in the longer term (5 to 10 years) on the success of the management actions. Monitoring is a very site specific process and will relate very closely to the objectives and actions set out in the plan. To be effective, monitoring must answer a question, such as "how does water quality in the wetland change over time with management?" A series of objectives can then be developed that will provide the answers to the questions and then site specific monitoring activities developed.

Monitoring activities should be clear, be achievable from physical, financial and political perspectives, have a set timeframe and provide the information to satisfy monitoring objectives. The monitoring plan and the information collected will allow the wetland manager to practice adaptive management and vary management actions if management objectives are not being met.

Employing GIS

Coding an action, either a task or a monitoring activity, in the manner described previously, lends itself to a Geographic Information System (GIS) which can assist in maintaining a database of the wetland itself and the implementation of specific management actions. By maintaining and updating the relational data-base files as background information to the GIS, it is possible to look at actions individually or collectively over an extended period of time. Figure 5.2.2 shows the process of

Table 5.2.7. Sample list of resources that were allocated for the PoM at SOP. [Management Card for MP14_MN; Badu Mangrove: Mangrove.]

Action Code	Possible Actions	Priority		Indicative Costs ($)		Possible Monitoring
		Frequency	*Significance*	*Oneoff*	*Annual*	
MP14_ MN01	Clear chokes and snags from channels and creeks to maintain suitable hydrology	Oneoff & Routine	Medium	400 000[C]	0	Hydrology
MP14_ MN02	Restore natural regime of tidal flushing and drainage by constructing runnels and channels	Oneoff & Routine	Medium	950 000[C]	0	Visual
MP14_ MN05	Stop and avoid excess sedimentation by planting/mulching nearby terrestrial areas	Oneoff & Routine	Medium	25 000	0	Visual/ sedimentation
MP14_ MN06	Provide filtration at the inlets to avoid hydrocarbon pollution from runoff	Oneoff & Routine	High	50 000[C]	0	WQ and records
MP14_ MN09	Periodically prune mangroves with prior permission from NSW Fisheries	Routine	High	0	1 000	Records
MP14_ MN10	Rotate use of education nodes every 2–3 months	Routine	High	Nil	Nil	Records
MP14_SM14	Control mosquito population	Routine	High	0	10 000	Mosquito
MP14_SM01	Transplant/encourage saltmarsh species on the walking tracks near Billabong	Routine	Medium	5 000	0	Visual

[C] - *Capital Works items*

documenting actions within the Badu Mangroves (a Wetland Management Unit), on the Sydney Olympic Park Wetlands GIS database.

Step 10. Reporting

Reporting is an important aspect of the PoM process. It involves summarising whether the objectives of the PoM were met through implementation of the agreed actions, and if the actions were implemented as per the timeframe and budget guideline. At the same time, the reporting can identify whether any actions need adjustment, as well as the reason(s) why certain actions have not been implemented.

The PoM must contain a guideline for reporting.

Reporting can be as simple as a one-page summary but must be readable and follow a logical format that can be easily repeated by subsequent monitoring reports. Irrespective of volume, a

Table 5.2.8. KPI on Newington Nature Reserve Wetland. **Wetland System:** Newington Nature Reserve Wetland; **Wetland Management Unit:** Newington Nature Reserve Wetland: MP16_SM

Parameter (Measure)	Benchmark (Limit of Acceptable Change)	Annual 'Traffic light' scores – see below			
		2007-08	2008-09	2009-10	
Ecological character management benchmarks					
Ecological processes					
Saltmarsh area (11.75ha)	Retain the area at no 'net loss' over three years				
Swamp Oak Floodplain forest (7.0ha)	Retain the area at no 'net loss' over three years				
Biodiversity					
Saltmarsh plant diversity (7 species)	Enhance the current diversity				
Migratory shorebirds (3 species)	Enhance the current diversity & abundance				
Pest mosquitoes	Control excess population				
Major threats to ecological character:					
Loss of *Wilsonia backhousei*	No 'net loss' of the existing coverage over three years				
Abrupt change in hydrology	Changes occur as per scientific outcomes				

'Traffic light' score options	
 Within 100% specified Limit of Acceptable Change	 Within > 75%, but < 100% specified Limit of Acceptable Change
 Within > 50%, but < 75% specified Limit of Acceptable Change	 Within < 50% specified Limit of Acceptable Change
 Limit of Acceptable Change is not assessable	

report will contain a list of the actions that were implemented, those that were not, cost updates, a list of new constraints, amendments required, etc. It can be somewhat subjective or objective. Figure 5.2.3 shows the graphical and tabular outputs that were generated as part of a summary report on the PoM that was prepared for Sydney Olympic Park, and provides a template for use elsewhere. Where a graphical reporting system is used, explanatory notes is required summarising what has been achieved but, most importantly, what needs be done to attain the Ecological Character objectives. Samples of these are shown in Appendix B.

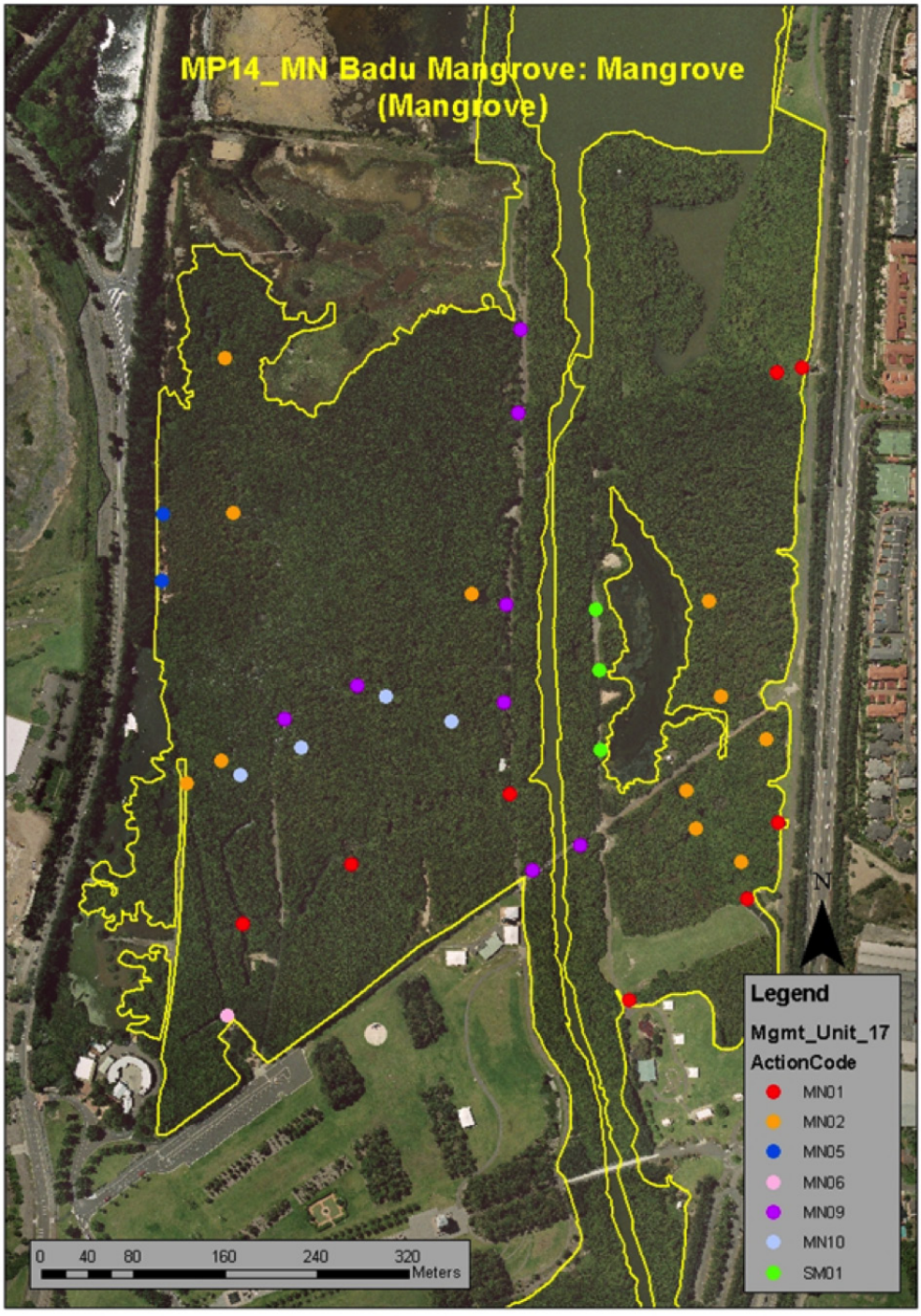

Figure 5.2.2 Snapshots on an initial plan for application of GIS in administering the PoM process at Sydney Olympic Park.

Step 11. Review and Re-adjust

As emphasised earlier, the PoM needs to undergo a routine review annually with a thorough review every three to five years.

The review is usually conducted by revisiting the issues that might have changed over time or changes to the legislative or other obligations. Any changes will have an impact on the issues and may require the formulation of new issues statements and re-prioritisation of the implementation strategy and actions. The review process may also include a revision of the timing of the proposed actions.

The re-adjustment of an adaptive PoM means that rather than re-writing the entire PoM, only minor adjustments to sections of the PoM will be required. An adaptive PoM allows for actions to be undertaken on an as needed basis without the need for a thorough review process. Consequently

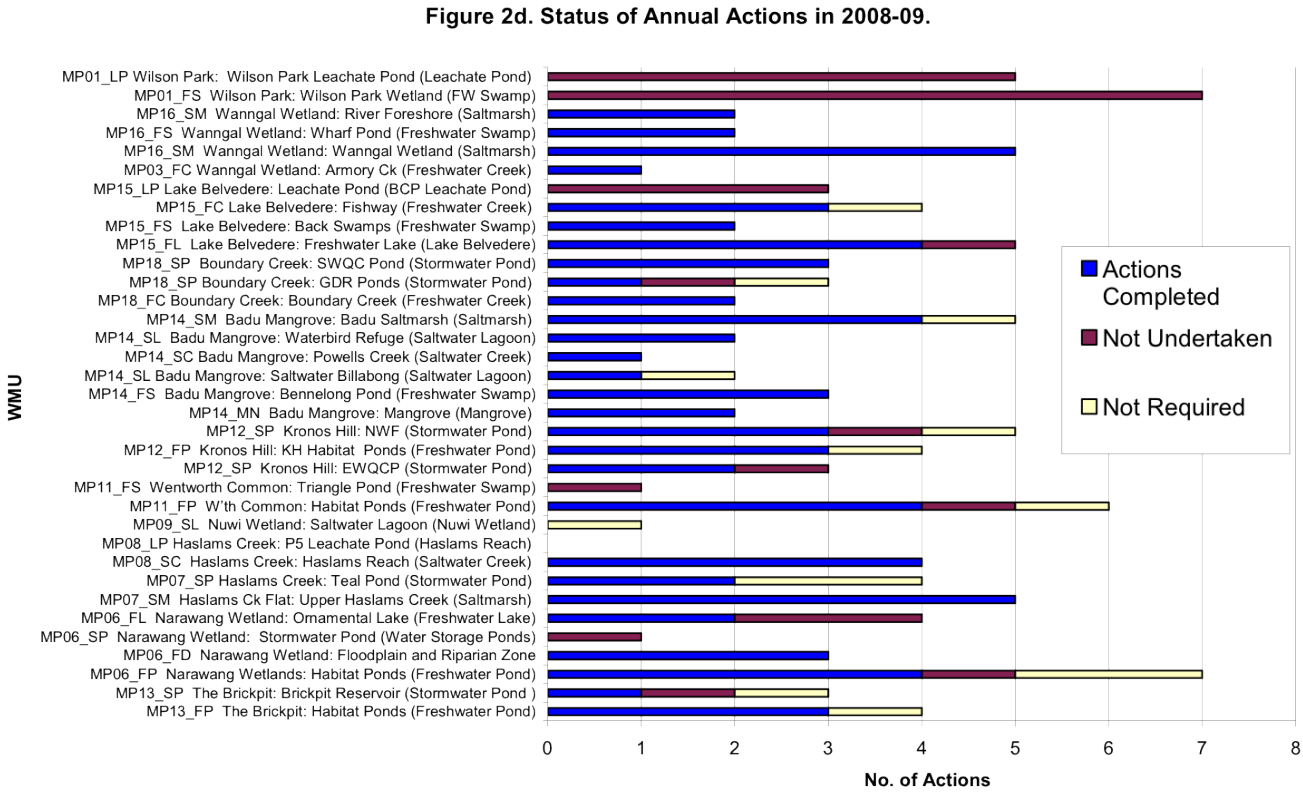

Figure 5.2.3a. Summary report card showing the status of recurrent annual actions undertaken for each of the 35 Wetland Management Units (WMU) within the Park during 2008-09 implementation period.

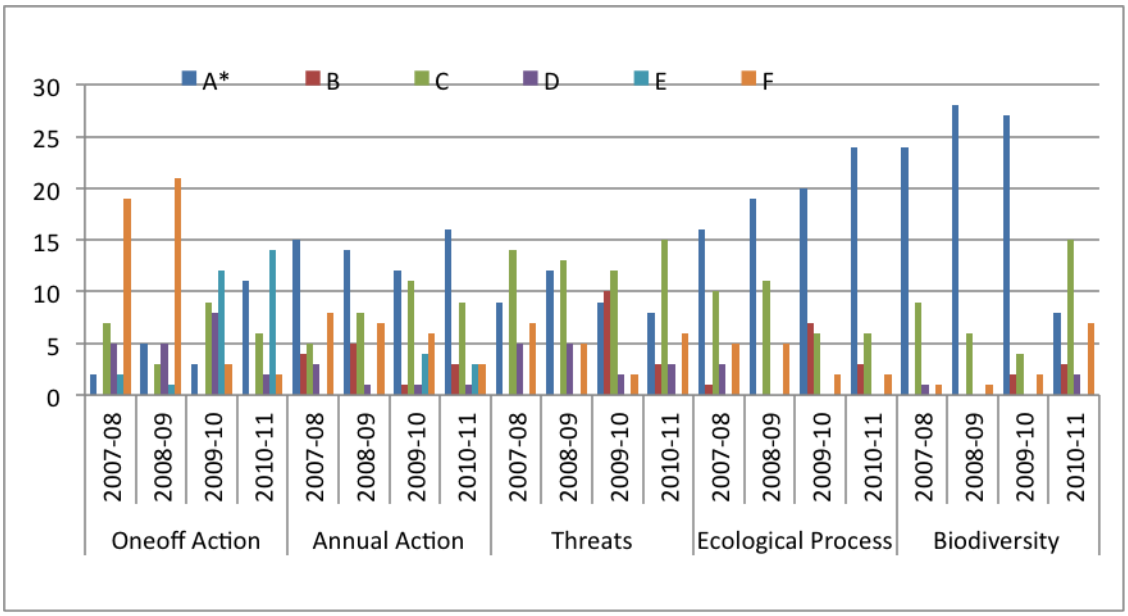

Figure 5.2.3b. KPI summary graph showing overall comparative status of implementation through simple scores (A-F) on One-off (capital works) actions, Annual (recurrent) actions, and Ecological Character assessment items (expressed in Threats to Biodiversity, Ecological Process and status of Biodiversity). This provides a rapid assessment of the PoM by the senior management.

an adaptive PoM allows for actions to occur in 'real time'. However, care must be exercised to ensure that 'real time' changes do not 'derail' the PoM.

Conclusions

Steps 1 through to 11 provide a framework which if followed will assist in the preparation of an adaptive PoM for most wetland systems. It will guide the process for a specific site to be defined and to have implementation strategy for a PoM adopted and funded.

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Further readings

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APPENDIX A

(Truncated) Table of Contents of three PoM.

One Tree Reach Wetland PoM; Hornsby 2013	Mason Park Wetlands PoM; Strathfield 2008	Careel Bay PoM; Pittwater 1998
Introduction	**1 INTRODUCTION**	**1.0 INTRODUCTION**
1.1 One Tree Reach Wetland 1.2 Plan of management 1.3 Objectives 1.4 Scope of the Plan 1.5 Local Government 1993 Act	1.1 WHAT IS A PLAN OF MANAGEMENT? 1.2 BACKGROUND TO THIS PLAN OF MANAGEMENT 1.3 LAND TO WHICH THIS PLAN OF MANAGEMENT APPLIES 1.4 OBJECTIVES OF THIS PLAN OF MANAGEMENT 1.5 PROCESS OF PREPARING THIS PLAN OF MANAGEMENT 1.5.1 CROWN LANDS ACT 1.5.2 LOCAL GOVERNMENT ACT 1.5.3 COMMUNITY CONSULTATION 1.6 WHAT IS INCLUDED IN THIS PLAN OF MANAGEMENT?	**2.0 SIGNIFICANCE AND GOALS** 2.1 Statement of Significance 2.2 Goals for Wetland Management
2 Site Setting and Context 2.1 Location and Setting 2.2 Site History 2.3 Land tenure, zoning and management 2.4 Climate 2.5 Physical Geography 2.6 Adjacent Landuse 2.7 Wetland Infrastructure	**2 DESCRIPTION OF MASON PARK** 2.1 LOCATION AND CONTEXT 2.2 SIGNIFICANCE OF MASON PARK 2.3 LAND OWNERSHIP AND MANAGEMENT 2.4 HISTORY AND CULTURAL HERITAGE 2.5 PHYSICAL CHARACTERISTICS 2.6 VISUAL ASSESSMENT 2.7 ACCESS AND CIRCULATION 2.8 BUILT FACILITIES AND PARK FURNITURE 2.9 USE OF THE PARK 2.10MAINTENANCE 2.11 FINANCIAL MANAGEMENT	**3.0 DESCRIPTION** 3.1 Location of Careel Bay 3.2 Land Tenure 3.3 Catchment Uses 3.4 History
3 Planning Context 3.1 Local Government ACT 1993	**3 PLANNING CONTEXT** 3.1 INTRODUCTION 3.2 LEGISLATION APPLYING TO MASON PARK 3.3 LOCAL PLANNING CONTEXT	**4.0 PLANNING CONTEXT**
4 Site Hydrology and Hydraulics 4.1 Catchment Description 4.2 Wetland Hydrology 4.3 Flow Regime 4.4 Climate Change 4.5 Water Quality 4.6 Conclusions		**5.0 PHYSICAL GEOGRAPHY** 5.1 Hydrodynamic processes 5.2 Sedimentary processes 5.3 Water quality and physico-chemical processes 5.4 Leachate 5.5 Gross pollutants
5 Environmental Values 5.1 Native Vegetation 5.2 Fauna Habitat Values 5.3 Aquatic Ecology 5.4 Introduced Species and Noxious Weeds 5.5 Key Threatening Processes		**6.0 VEGETATION MANAGEMENT** 6.1 Description and Significance 6.2 Background 6.3 Subtidal and Intertidal Vegetation 6.4 Terrestrial Vegetation 6.5 Vegetation in the Surrounding Catchment 6.6 Unvegetated Sediments 6.7 Management Issues
		7.0 FAUNA AND HABITAT MANAGEMENT 7.1 Background 7.2 Benthic Assemblage 7.3 Avifauna 7.4 Management Issues

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APPENDIX A

(Truncated) Table of Contents of three PoM.

One Tree Reach Wetland PoM; Hornsby 2013	Mason Park Wetlands PoM; Strathfield 2008	Careel Bay PoM; Pittwater 1998
6 Buffer Zone and Connectivity 6.1 Connectivity 6.2 Buffer Zone 6.3 Fish Passage Assessment **7 Social Values** 7.1 Existing and Potential User groups 7.2 Value of One Tree Reach Wetland to the Community 7.3 Community Consultation 7.4 Indigenous Heritage 7.5 European Heritage **8 Issue Analysis** 8.1 Acid Sulfate Soil Management 8.2 Weir Upgrade 8.3 Ecological Management 8.4 Open Space Maintenance 8.5 Recreational Facilities 8.6 Historical Context 8.7 Community engagement, education and capacity building 8.8 Funding and management **9 Management Strategies** 9.1 Acid Sulfate Soil Management 9.2 Weir Upgrade 9.3 Ecological Management 9.4 Open Space Maintenance 9.5 Recreational facilities 9.5.1 Objectives 9.6 Historical Context 9.7 Community Engagement, Education and Capacity Building **10 REFERENCES** **Appendices**	**4 VALUES, ROLES AND OBJECTIVES FOR MASON PARK** 4.1 INTRODUCTION 4.2 COMMUNITY VALUES 4.3 VISION AND OBJECTIVES FOR THE PARK 4.4 FUTURE ROLES OF MASON PARK 4.5 MANAGEMENT PRINCIPLES **5 ACTION PLANS** 5.1 INTRODUCTION 5.2 ACTION PLAN **6 IMPLEMENTATION AND REVIEW** 6.1 PERMITTED FUTURE USES AND DEVELOPMENTS INTRODUCTION 6.2 LEASES AND LICENCES 6.3 FUNDING SOURCES 6.4 REPORTING 6.5 IMPLEMENTATION OF THIS PLAN OF MANAGEMENT 6.6 REVIEW OF THIS PLAN OF MANAGEMENT **REFERENCES** **Appendices**	**8.0 HERITAGE AND COMMUNITY** 8.1 Aboriginal Heritage Values 8.2 Community Issues **APPENDICES**

APPENDIX B

Summary Report Card on the WMU during 2010-11 and suggested actions to be undertaken during 2011-12 and 2012-13.

WMU	Status of Ecological Character (EC) as at June 2010	Status of Actions undertaken during 2010-11	Actions recommended to maintain EC target during 2011-12 (and 2012-13)
MP13_FP The Brickpit: Habitat Ponds (Freshwater Pond)	All the EC targets were met by 100%.	Terrestrial weed control and water level for GGBF breeding; macrophyte control was not as extensive.	Aquatic weeds and control of excessive macrophytes. Transplanting aquatic macrophytes, biomanipulation and lime treatment may be deferred.
MP06_FP Narawang Wetlands: Habitat Ponds (Freshwater Pond)	All the EC targets were met by 100%, except Gambusia control; potential threat due to sediment built up.	Ponds 1, 3, 7, 8, 9, 10, 11, 14, 15, 16, 17, 19, 22 drained in August-September 2010, combined with University of Newcastle ARC grant research. Pump system upgrade also completed in these ponds; sediment removed from N14 but unsuccessful with N15.	Continue managing Gambusia and implement excessive sediment/slurry removals from Ponds N15. May defer Actions on algae harvesting, lime treatment, Eel capture, Carp electrofishing, shellfish introduction. Examine if Sea Level Rise may affect the ponds.
MP06_FL Narawang Wetland: Ornamental Lake (Freshwater Lake)	All the EC targets were met by 100%, except Alligator Weed and Carp controls.	Undertaken terrestrial and Alligator Weed control measures.	Continue to undertake Alligator Weed and terrestrial weed control measures as well as any bank erosion control measure. Defer Carp control; connection with WRAMS device ; provision of bird roosting structures; BGA control measures; and biomanipulation. Examine if Sea Level Rise may affect the wetlands.

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APPENDIX B

Summary Report Card on the WMU during 2010-11 and suggested actions to be undertaken during 2011-12 and 2012-13.

WMU	Status of Ecological Character (EC) as at June 2010	Status of Actions undertaken during 2010-11	Actions recommended to maintain EC target during 2011-12 (and 2012-13)
MP07_SM Haslams Ck Flat: Upper Haslams Creek (Saltmarsh)	One EC target was met by 100%; other two have not mainly because litter and faecal coliform bacteria controls were not met.	Saltmarsh regeneration; mangrove removal; litter control (partial); terrestrial weed control; boat control; gabion repair – all were completed.	Improve litter control device; continue saltmarsh regeneration and mangrove removal; improve water quality by controlling faecal coliform (Sydney Water).
MP07_SP Haslams Creek: Teal Pond (Stormwater Pond)	All the EC targets were met by 100%, except Gambusia control.	Terrestrial weed control; litter control were undertaken. Hydrology (outlet) management was not undertaken; exploring Gambusia control by a non-draining method was not tried.	Hydrology (outlet) management; explore Gambusia control by a non-draining method; Algal bloom; BGA control; biomanipulation and aquatic macrophytes coverage control may be deferred.
MP12_SP Kronos Hill: NWF (Stormwater Pond)	Major EC targets were improved over the past year in cases of aquatic macrophytes, algae, water pH and hydrology.	Water level for GGBF breeding, litter control, terrestrial weeds control and macrophytes planting were undertaken pH improvements was not undertaken.	Macrophytes harvesting and transplantation; suitable hydrology for macrophytes and GGBF; Azolla control; water pH (wash from the pool); sediment (slurry) removal to be undertaken; pickup litter at low level of water. Maintaining a device for WRAMS and placing structures for bird roosting may be deferred.
MP14_MN Badu Mangrove: Mangrove (Mangrove)	Major EC targets were met by 100% except for litter and tidal exchange.	Partial tidal exchange; mosquito control; mangrove seedling removal; partial litter control (bad in Black Ck); sediment control.	Full tidal exchange; progressive clearing of choke; litter control by installing baskets; sediment control; black creek litter control.

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APPENDIX B

Summary Report Card on the WMU during 2010-11 and suggested actions to be undertaken during 2011-12 and 2012-13.

WMU	Status of Ecological Character (EC) as at June 2010	Status of Actions undertaken during 2010-11	Actions recommended to maintain EC target during 2011-12 (and 2012-13)
MP14_FS Badu Mangrove: Bennelong Pond (Freshwater Swamp)	Major EC targets were not met in cases of hydrology (flooding and drying), weeds, aquatic macrophytes, algae and water quality.	Limited weed and litter controls and partial improvement in hydrology.	Improve litter control device; weed control; hydrology (flooding and drying) control and sediment (muddy water) control is required.
MP14_SL Badu Mangrove: Saltwater Billabong (Saltwater Lagoon)	Major EC targets were not met in cases of hydrology (tidal exchange), algae and odour emission.	Limited weed and litter controls; Wilsonia management Black Creek stormwater condition improved.	Improve litter control device; weed control; hydrology (tidal exchange). Black Creek stormwater condition further improved.
MP14_SL Badu Mangrove: Waterbird Refuge (Saltwater Lagoon)	All EC targets were met by 100%.	Tidal restoration (SlipGate); algal control; water quality control; shorebird habitat; saltmarsh regeneration; mangrove removal; litter control; signage – all undertaken.	Mangrove removal; signage; islands restoration and provision of Stilt habitat to continue.
MP14_SM Badu Mangrove: Badu Saltmarsh (Saltmarsh)	All EC targets were met by 100% except Juncus.	Mangrove control, Juncus control, mosquito control (*Bti*), terrestrial weed control undertaken; Inter-pond connectivity has not been achieved.	Connectivity by channels; weeds; sediment control to continue. Pond connectivity may be undertaken in stages.