Design, Construction and Establishment of Wetlands:
Questions and Answers

Wetlands are considered one option to improve stormwater quality within a suite of other treatment measures. Wetlands can help urban development achieve water quality treatment obligations. This questions and answers bulletin on wetlands aims to address common questions and queries arising from Melbourne Water's Wetland Design Manual.

The Wetland Design Manual

What is the Wetland Design Manual?

Feedback from the development industry indicated that they wanted prescriptive design criteria and also certain flexibility with designs and processes. The Wetland Design Manual was designed to clearly document and standardise Melbourne Water's requirements for the design and construction of wetlands. It aims to expedite Melbourne Water's approval process and ensure that minimum design criteria are met in regards to the design and construction of Melbourne Water wetlands regardless of whether it is constructed by Melbourne Water or a developer. Melbourne Water will still consider and allow new and innovative designs to be submitted, that differ from the prescriptive design criteria, but with these designs there is a longer acceptance process and no certainty that these designs will be accepted by Melbourne Water.

Who were the wetland specialist consultants that were engaged in the preparation of the new Wetlands Design Manual?

Melbourne Water has prepared this design manual with the assistance of a specially appointed wetland specialist consultant and a steering committee of experienced people who provided valuable comment and advice on the content of this design manual. Industry stakeholder interviews were also undertaken to identify issues of concern with the previous document and submissions were received in relation to a draft of the design manual which assisted in the formulation of the final document. The document was also peer reviewed by several other specially appointed wetland specialist consultants and reviewed against current science literature by an academic researcher.

How do I use the design manual?

The Wetland Design Manual has been structured as a series of parts and associated products to help maximise the flexibility of its use within the land development industry. The design manual will be used to inform the industry of best practice and standards to be followed when designing wetlands, and will be used by developers, designers and consultants. It will be solely for use online, rather than a printed document, and will be available via Melbourne Water's website. Hyperlinks and cross-references will be included throughout the document and will help with navigation and ease of use of the document. It is expected that the most heavily used parts of the design manual will be Parts A2 Deemed to Comply Design Criteria, Part A3 Design Considerations and Part B Design Acceptance Process.

What is the design acceptance process outlined in the design manual?

Melbourne Water has a design acceptance process for the delivery of our wetlands that developers, consultants and designers must follow. The design acceptance process, in the Wetland Design Manual, has a series of steps, milestones and hold points that clearly articulates the requirements of Melbourne Water's wetland design approach. It is expected that this design acceptance process will help to facilitate the consistent delivery of high quality wetlands and will improve the customer experience of working with Melbourne Water during the design, construction and establishment process.

Do I need to follow the various stages outlined in the design acceptance process?

Yes. A detailed description of the various stages (concept, functional and detailed design) is provided along with the associated requirements for each of these stages. The design manual has been prepared in this manner to provide the development industry with greater certainty and confidence that the designs that are submitted to Melbourne Water will be accepted, which will increase the efficiency of the design acceptance process, saving time and money for the industry.

What is the deemed to comply approach?

Melbourne Water has provided a prescriptive set of design criteria for a typical wetland. The deemed to comply approach requires designers to demonstrate compliance with this set of prescriptive design criteria. It is considered that this design criteria would be suitable for the majority of wetland sites across Melbourne. The review and acceptance process of the deemed to comply process will be quicker than alternate design reviews and if followed designers will have a high level of confidence that their designs will be accepted by Melbourne Water. A deemed to comply checklist has been provided to assist designers demonstrate how they have achieved the various design criteria for each stage of the design acceptance process.

What if I can't achieve all the deemed to comply requirements?

Melbourne Water acknowledges that not all sites and wetland designs can achieve all the design criteria associated with the deemed to comply requirements and that it would be far too difficult to define one set of design criteria that applies to all situations. Therefore we have provided a second review/acceptance approach known as the alternative approach. If certain design criteria cannot be achieved the designer must provide to Melbourne Water justification as to why the design criteria cannot be achieved and demonstrate how the wetland still achieves equivalent performance to the deemed to comply requirements and must still demonstrate compliance with the four core outcomes listed in part A1. The review acceptance process for the alternative approach will take longer than the deemed to comply approach and there is no certainty that the applications will be accepted by Melbourne Water.

Do I have to use the design tools, forms and templates provided in the Wetland Design Manual?

Yes. The design tools, forms and templates have been prepared to assist the consultant and designer through the design acceptance process. Design package templates have been provided for each stage of the design acceptance process. It is expected that all design submissions to Melbourne Water will adhere to the structure of the template and include the necessary information in the forms, as this will enable efficient processing of applications and quicker timeframes from Melbourne Water.

What was the consultation process for the Wetland Design Manual?

In June 2014, Melbourne Water wrote to 42 key members of the industry, emailed 800 registered users of the Land Development Manual, contacted every metropolitan council and conducted an online survey through our Planning and Building website to notify and to facilitate feedback on the Wetland Design Manual. Melbourne Water received a total of 16 written submissions plus numerous comments and feedback through the online questionnaire. Responses came in from civil engineers, land development consultants, wetland design experts, local councils, scientists and researchers, ecologists, landscape architects, nursery wholesalers and a variety of industry committees and institutes. In addition, we engaged an independent wetland specialist and a science researcher to undertake a peer review to assess the manual's suitability and comparison to current science and research. Melbourne Water also participated in several workshops with the technical advisory committee of the Association of Land Development Engineers to thoroughly discuss the design acceptance process and the new design standards.

Is there more emphasis on effective and safe maintenance throughout the Wetland Design Manual?

Wetlands must be designed to facilitate safe maintenance access to all areas of the wetland. Maintenance requirements should be considered through all phases of wetland design, as it is often too late to modify a wetland design to accommodate maintenance requirements during the detailed design phase. Melbourne Water maintenance staff have also experienced significant challenges with maintaining wetlands where maintenance provisions were not adequately considered during the design phase. These challenges include difficulties in accessing and cleaning out sediment ponds, inadequate space for drying material removed from the sediment ponds, high costs of disposing of contaminated material from sediment ponds plus insufficient land area surrounding a wetland to allow for appropriate renewal works. The learnings from these maintenance challenges will inform the new design standards in the Wetland Design Manual.

Design and construction of wetlands

Why does the design criteria specify a macrophyte zone extended detention depth requirement of less than or equal to 350mm?

The sensitivity of vegetation to inundation depth is well established in science literature. Plant growth is severely restricted in excessively deep water and plants will inevitably die, even if they persist for the first one to two years after establishment. The resulting relatively low plant cover will be detrimental to the overall wetland function and performance. Melbourne Water have developed the deemed to comply design criteria to achieve a good balance between protecting the macrophyte zone plants and maximising the volume of water that interacts with the plants. Previously, many wetlands have been designed and/or built to a depth unsuitable for plant establishment and growth and wetland performance has suffered accordingly. The extended detention depth of 350mm is the best balance between macrophyte vigour and hydraulic efficiency. If a designer proposes a greater extended detention depth as part of their design, Melbourne Water will require an inundation frequency analysis and wet spells analysis be completed to ensure the effective water depth (permanent pool plus engagement of extended detention) does not exceed half the design plant height for more than 20% of the time. A design tool has been provided in the design manual to assist designers.

Can a wetland be located within a retarding basin?

Yes, although not all can be located within a retarding basin. Wetlands can be located in the base of a retarding basin to reduce the total amount of land required for stormwater treatment and flood mitigation. Wetlands in retarding basins are prone to greater inundation depths when the retarding basin is engaged during intense rainfall events. It is important that the hydraulic and hydrological conditions within a retarding basin are checked during the design

process to ensure that the wetland vegetation is protected from high inflow volumes and velocities and that the expected inundation depth, frequency and duration will not be detrimental to the long term health of the wetland vegetation. Melbourne Water has initiated a program of hydrologic monitoring to identify wetlands failing to meet designed drawdown specification within retarding basins or stand alone.

Can a wetland be located within a waterway or drainage channel?

Although it is possible to design a wetland within a waterway it is not recommended and not our preference based on a number of factors. The primary objective when seeking to locate wetlands within waterways should be the protection of the connectivity of upstream and downstream ecosystems (including ephemeral waterways and constructed waterways). Connectivity is a vital component of stream ecology, maintaining baseflow conditions, provides passage for fish and invertebrates within the waterway, and facilitates the movement of water borne plant propogules within the waterway system. The location of wetlands within a waterway can significantly impact biodiversity processes within a waterway and can influence the natural sediment transport processes that may be required for downstream habitat formation and stability. Wetland systems that are within the waterway are also at risk of intercepting large volumes of water, debris and sediment that increases the need for and costs associated with maintenance. Maintenance is also more difficult and costly with a wetland located within a waterway and it is desirable for the hydrological regime of a wetland to be allowed to be taken offline, drawndown and dried out periodically, as this replicates the hydrological regime of a natural wetland through regular wetting and drying of wetland sediments (important to nutrient uptake) and the long term sustainability of the wetland vegetation (macrophyte regeneration and growth).

Why does the design criteria specify a maximum size limit for sediment ponds?

Sediment basins upstream of wetlands are sometimes over-sized without due consideration of appropriate sizing for sediment settling as per the WSUD Engineering Procedures: Stormwater. Over-sized sediment basins capture a greater proportion of finer sediments which can lead to accumulation of high concentrations of heavy metals, increasing disposal, operational and life cycle costs. In some instances, an over-sized system has the potential to reduce the frequency of low flows into the wetland compared to a correctly sized sediment basin.

Can a wetland have no liner to increase the exfiltration rate and improve treatment performance?

Most wetlands are designed and constructed with a compacted clay liner, in which there is little or no exfiltration rate. Although it is possible to construct a wetland with no liner, appropriate geotechnical testing (at the depth of the

wetland base) must be undertaken and used to justify the selected exfiltration rate used and represented in MUSIC modelling and associated water level spells analysis. Where the groundwater table is likely to interact with the wetland or where there are saline in-situ soils an impermeable liner must be used.

What is involved in the construction of a wetland?

The construction of a wetland primarily involves earthworks, levelling and compacting to form the wetland basin including the sediment pond, lining the basin (generally with a compacted clay liner), filling the basin with an appropriate topsoil, constructing an inlet and outlet structure and also a bypass and drawdown system, and planting with appropriate vegetation.

How much land area is required for wetlands?

The land area required for a wetland is generally determined by the following factors: the required performance objectives for the wetland; design and configuration of the wetland; maintenance provisions; flood conveyance; bypass type, size and location; edge treatments and safety batters; landscape considerations and structures; site topography and land development layout.

Can a bioretention system be incorporated into the wetland system to enhance treatment performance and achieve water quality objectives?

Bioretention systems are sometimes proposed downstream of a wetland to improve treatment performance outcomes predicted by MUSIC. It is our understanding that minimising the total footprint of a wetland treatment train has been the main driver behind this approach. Melbourne Water does not support this approach as there is a risk that these bioretention systems may remain wet for extended periods as the wetland slowly drains over a three day period. Bioretention systems are generally designed to function with regular wetting and drying cycles. While extended dry periods can result in a decline in the microbial population and adversely affect plant health, saturated conditions with excessive frequency or duration can result in excess algal growth. This can lead to biological clogging through the growth of a thick surface algae layer, which creates an inappropriate operation and maintenance requirement on the stormwater treatment system.

Why are low or controlled flows through a wetland important?

It is important that the wetland vegetation is protected from high flows so that the biofilms present upon the vegetation are not constantly stripped away and that fine sediments accumulated within the wetland and the macrophyte zone are not scoured from the wetland.

What are the benefits of a bypass route and a drawdown system with wetlands?

The bypass route allows flows to be diverted around the macrophyte zone of a wetland when the water level is at top of extended detention. The bypass route protects the macrophyte zone and wetland vegetation from scour during high flow events and enables the wetland to be temporarily taken offline for maintenance and for water level regulation. The drawdown system is a series of balancing pipes connecting open water pools to the twin chamber outfall pit which contains a gate valve that allows the wetland and various pools to be dried out assisting with maintenance. Both systems help to reduce maintenance and operational costs and are beneficial when the wetland is to be dried out to help stimulate plant revegetation and/or for maintenance works.

The role of vegetation in wetlands

What are the roles of vegetation in wetlands?

The treatment performance of a wetland is highly dependent upon flows passing through dense vegetation. The vegetation provides a high surface area substrate for the attachment of biofilms (algae and bacteria) which help break down pollutants. The physical structures of vegetation, like the stems and root system, stabilise the surface of the wetland and slow down the flow of water, resulting in clearer water. Wetland vegetation helps in the removal and retention of nutrients in the sediments and/or water. They do this by absorbing nutrients which they need to grow. The wetland vegetation also provides additional benefits with the creation of habitat, amenity and landscaping.

What types of vegetation are used in wetlands?

A wide variety of marshland plants are used depending on the design purpose, water depth and climate. The most common plant groups used within wetlands are emergent and submergent macrophytes. Emergent vegetation, stands proud of the water surface but remains rooted to the bottom of the wetland. Emergent macrophytes are planted at varying depths. Robust species that can tolerate significant changes in water level are selected such as: *Schenoplectis* sp.; *Baumea* sp.; *Eleocharis* sp.; *Bolboshenous* sp.; *Juncus* sp.; and *Carax* sp. Submerged plants are rooted to the wetland base and rarely emerge above the water. These species include: *Myrophyllum* sp. *Vallisneria* sp. and *Potamogeton* sp.

What percentages of wetlands are having vegetation issues?

Vegetation is an integral part of the wetland treatment process. In 2010, Alluvium Consulting undertook a study of 44 of Melbourne Water's wetlands and found that the median emergent macrophyte coverage was 30% in 2004 and 40% in 2009. This is considerably less than the 80% emergent macrophyte coverage required by existing guidelines. Therefore, a focus of the wetland

design manual is to ensure that appropriate vegetation is planted in the wetland and that the ongoing wetland water regime is suitable to support healthy emergent macrophyte vegetation. Melbourne Water has also just completed a substantial project assessing the proportion of vegetation cover across almost all of our constructed wetlands using Near Infra Red (NIR) spectral imagery analysis to generate a 'state of the asset' condition report. This project has provided data to assist with identification of wetland condition and will be used to identify wetlands that are likely candidates for rectification and renewal works.

What planting conditions are required for wetland vegetation?

The planting conditions required will be different for each plant species and can vary depending on: the area required; water level; soil type; temperature and climate; rainfall, maintenance and cost factor. The distribution of wetland vegetation is typically determined by inundation depth, frequency and duration. In wetlands these factors are determined by the permanent pool depth of the various macrophyte zones (submerged marsh, deep marsh, shallow marsh) and the amount of time that inflows engage the extended detention. Vegetation in the wetland has a direct relationship to the treatment performance. If the vegetation does not meet the design configuration it is unlikely that the wetland is performing the treatment required. Macrophyte vegetation must be planted in the wetland during summer months (November to March) to ensure a higher success rate of plant survival and establishment.

What are the types of wetland vegetation that should be avoided?

Generally wetland vegetation with high proliferation rate such as floaters should be avoided as these plants will produce a massive mat that will obstruct light penetration to the lower layer of the water column and this will affect the survival of living organisms thus decreasing the water quality in the long run. Invasive wetland vegetation that should be avoided in wetlands are: *Typha orientalis;* and some *Phragmites* which is a dominant species that can invade and take over the wetland area.

Why do the design criteria specify minimum plant formats for plant stock?

Many wetlands built in the past have experienced large scale failures of macrophyte plantings. One of the major drivers of macrophyte failure is the absence of a quality assurance framework that ensures the delivery of high quality plants in formats that are appropriate for their characteristics and the conditions they are to be planted into. The deemed to comply design criteria specifies the minimum plant formats for plant stock to attempt to rectify this issue.

What is the suitable water level for the growth of wetland vegetation?

The EDD of the wetland must be bypassed as quickly as possible for the 1st 12 months of the aquatic plantings establishment period. This is achieved by fully

opening the side winding penstock valve within the twin chamber outfall pit. The opening can then be adjusted (closed) over the remaining year of the defects period until the ultimate design width is achieved. This allows the vegetation to grow enough to generate a stem with leaves. If flows are not regulated the new vegetation can easily drown and die, which has significant ongoing establishment and operational costs.

Are there always open water areas and ponds in the design of wetlands?

Increasingly we have omitted open water and ponds from wetland system designs and generally if there is open water areas (comprising of submerged marsh) this should not exceed more than 20% of the wetland area. Open water areas should be provided as inlet, outlet and as intermediate pools in larger wetlands. Open water bodies are not counted as effective treatment areas. This is because submerged marsh plant communities can be seasonal in nature and intermittent in density and occurrence from year to year, depending on site conditions and water quality. In contrast, well established deep and shallow marsh vegetation is more stable over time. The onus is on the land developer if non-required community benefits and landscape features are proposed.

What are the operational requirements of wetlands?

A well designed, constructed and maintained wetland requires relatively minor operational requirements. The main activities are clearing pits, pipes, grates and grilles from debris and sediment build-up, water level management (like keeping outlets clear of debris), regular surveillance and monitoring, cycling from dry to wet conditions by adjusting outlets, inspections and clean-up after storm and flood events and early detection of weeds. This relatively low operational requirement is related to the self-organising capacity of the wetlands and robustness to buffer any ecosystem disturbance.

What opportunity do I have to provide feedback on the design manual?

Melbourne Water welcomes feedback on the design manual and the implementation success at all times and we will endeavour to involve all key stakeholders and customers in any future review process. Feedback can be provided via telephone (131 722) or in writing with comments addressed to:

Manager, Development Planning, Waterways & Land Group
Melbourne Water Corporation
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Melbourne VIC 3001

More information

More information on wetlands can be found at Melbourne Water's Planning and Building website.