

Integrating Constructed Wetlands into the Urban Fabric

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Synopsis

Constructed wetlands for the treatment of stormwater and wastewater form an important part in Water Sensitive Urban Design (WSUD). With careful planning and implementation, a wetland will achieve the desired outcomes for water quality improvement, as well as socio-economic and biodiversity goals.

Intelligent WSUD incorporating wetlands can deliver rehabilitation solutions as well as contribute to development that is notionally constrained by water, latent environmental conditions, environmental sensitivity and access to infrastructure. With the increasing sensitivity of waterways and government policies, it is essential to reduce the quantity of nutrients, sediments and other pollutants leaving a site.

Wetlands contribute to the maximisation of onsite retention and treatment of stormwater and wastewater at an economic cost favourable to traditional water management solutions. Developments in wetland design and construction technology provide sustainable and lower cost solutions with enhanced environmental and social amenity as well as strong consumer appeal. As a consequence, wetlands are a key element in the new urban and peri-urban context.

Problems resulting from poor or late-stage planning of water quality and biodiversity needs within a development can include: inadequate available area for a wetland and/or other treatment designs; a lack of slope from the inlet through to the outlet of the treatment area; or excessive gradients from inlet to outlet.

It is important to incorporate wetland needs and aspects (such as available area and slope) from the start of the planning process, thereby ensuring that the system will function effectively.

Introduction

The long-established traditional approaches to providing development infrastructure for water conveyance, treatment, and subsequent re-entry to the environment have been largely based on centralised systems employing pipes, pumps, aeration devices and to an extent, ponds and lagoons.

Whilst sometimes superficially highly efficient, these methods have often been shown to result in loss of the water resource, environmental degradation, and increasing infrastructure and maintenance costs. In contemporary Australia, this approach is not sustainable.

In contrast, the emerging practice of Water Sensitive Urban Design (WSUD) emphasises a more decentralised approach, the restoration of the natural water cycle in terms of surface runoff, groundwater, and evapotranspiration, and water management that is more in tune with natural environmental processes. Many WSUD design principles are now well established, but implementation on greenfield sites is proceeding only gradually, and is rare in established residential areas.

The impact of unmanaged stormwater runoff on waterways has become a major environmental issue in all developed countries and is now widely viewed as an urgent problem requiring a coordinated management approach by government, technical specialists and the community. The task is twofold: to reduce the present impacts, and formulate long-term runoff management strategies that will satisfy the needs of economic development while ensuring environmental sustainability.

Stormwater contains pollutants such as phosphorus, nitrogen, sediment and pathogens that are carried to waterways at rates and in volumes of runoff water determined by catchment topography, vegetation and rainfall (Queensland EPA, 2001; Land Systems EBC, 1993)

The most influential factor is usually the degree of urbanisation of the catchment, because the development process clears vegetation, modifies drainage ways from the curves of natural streams to straight lines, and introduces large areas of hard surfaces such as roofs and roadways - leading to increased peak runoff rates (Queensland EPA, 2001; Land Systems EBC, 1995)

Intelligent WSUD incorporating wetlands can deliver rehabilitation solutions as well as contribute to development that may be notionally constrained by water, latent environmental conditions, environmental sensitivity and access to infrastructure.

The Victorian Stormwater Committee (1999) noted that the key planning and design objectives of WSUD are to:

- Protect and enhance natural water systems
- Integrate stormwater treatment into the landscape
- Protect natural water quality
- Reduce runoff and peak flows from urban developments by employing local detention measures and by minimising impervious areas
- Disconnect pollutants from waterways
- Add value while minimising drainage infrastructure development costs

Development intensity in large cities usually means excessive areas of impermeable surfaces – stormwater treatment is almost always applied as hard engineering such as infiltration trenches or similar. Conversely, regional city and town drainage systems are generally suitable for greenfield and brownfield WSUD approaches.

The key issue for WSUD is the fitting of the treatment train to each site. This requires careful consideration of site characteristics such as slope, depth to water table, rainfall, soil type, and the type of development (Victorian Stormwater Committee, 1999). Important considerations such as capital and on-going maintenance costs also need to be assessed in order to ensure adequate budgetary resources are provided. The design process is also driven by the frequent need to find creative solutions to water management problems, even though WSUD design guidelines are now commonly available. The requirement for design creativity applies particularly to wetlands.

In contrast, wastewater treated through sewage treatment plants (STPs) generally end up in the river or ocean, with only some reuse occurring through irrigation of agricultural lands. Agricultural reuse in high rainfall areas is limited, as irrigation does not occur during rainfall, leaving questions being raised regarding what to do with the excess wastewater.

Wetland rehabilitation is one example of reusing treated effluent in a wet climate. By constructing a suitable wetland to ‘polish’ the tertiary treated effluent, outflows can be used to rehabilitate existing or degraded wetland areas before release into adjacent waterways (Queensland EPA, 2003; DLWC, 1998)

Constructed Wetlands

Constructed wetlands for the treatment of stormwater form an important part in WSUD. With careful planning and implementation, a wetland will achieve the desired outcomes for water quality improvement, as well as socio-economic and biodiversity goals (Melbourne Water, 2002; Boulton and Brock, 1999).

Wetlands contribute to the maximisation of onsite retention and treatment of stormwater and wastewater at an economic cost favourable to traditional water management solutions. Developments in wetland design and construction technology can provide sustainable and lower cost solutions with enhanced environmental and social amenity as well as strong consumer appeal.

Constructing stormwater wetlands in urban areas has become an effective means of stormwater quality improvement, as well as providing other landscape, environmental and passive recreational values (Melbourne Water, 2002).

Design Considerations

Water sensitive development involves simple design and management practices that take advantage of natural site features and minimise impacts on the water cycle. It is important to incorporate wetland needs and aspects (such as available area and slope) from the start of the planning process (DLWC, 1998). Consider the catchment – where does the water come from, how frequent are storm flushes, how much development is there now and in future, what quality is the water pre and post development including the receiving waterway, are there any groundwater issues? What is the size, slope, soils and vegetation of the site?

By assessing the catchment conditions at the start of the planning process of the development, the best site-sensitive development incorporating WSUD and constructed wetlands can be achieved (Melbourne Water, 2002; Victorian Stormwater Committee, 1999; Land Systems EBC, 1993). Problems resulting from poor or late-stage planning of water quality and biodiversity needs within a development can include inadequate available area for a wetland and/or other treatment designs, a lack of slope from the inlet through to the outlet of the treatment area, or excessive gradients from inlet to outlet. It can be a very difficult task to achieve a suitable wetland or other WSUD approach for a development site once the plans have been laid with little area available for stormwater management.

The types of stormwater treatment systems available for the site must also be taken into consideration when planning the development (Boulton and Brock, 1999; Victorian Stormwater Committee, 1999). Allowing enough room at the bottom of the development for a deep pond as the only means of stormwater treatment does not qualify the site to be a water sensitive development.

One important point to note is the difference between stormwater wetlands and stormwater ponds. Wetlands are not "ponds with a green fringe", as is the case in some urban developments, but rather contain densely planted, diverse vegetation. Ponds do provide some treatment benefits, however issues such as nutrient saturation and associated algae, sediment accumulation, and public safety risks from deeper water require a more complex approach.

Treatment designs should be spread throughout the development to increase water quality improvement, with the added benefit of increasing open areas for recreational uses when designed correctly (Land Systems EBC, 1993), slowing down runoff velocities, and increasing wildlife habitat throughout the development (Melbourne Water, 2002; DLWC, 1998).

Constructed wetlands for wastewater treatment were first developed in Australia in the early 1990's. Several 'first generation' wetlands began to fail over time due to constant inundation, consistently high depths, and little or no drying periods (Pont, 2004). Much has been learnt from the designs of the first generation wetlands, with shallower wetlands incorporating drying-out periods to allow rehabilitation and growth of the plants being designed. These management actions attempt to mimic a natural wetland cycle, thereby extending the life and performance of the constructed wetland.

Wastewater wetlands associated with STPs require suitable areas of land to perform efficiently (DLWC, 1998). A paper by Pont (2004) details the performances of undersized rehabilitated wastewater wetlands at two northern NSW STPs. Both wetlands displayed poor quality improvement of effluent prior to the rehabilitation, with increases in performance occurring once the wetlands were functional again (Pont, 2004). However, with adequate sizing these wetlands could produce even higher quality outflows.

Regularly, new developments occur adjacent to existing communities, and the design of the stormwater treatment systems should take into account any potential impacts on areas outside the development site. A case example of community involvement is detailed below.

Case Study: Corindi Beach Stormwater Wetland

Background

Corindi is a small village situated on the North Coast of New South Wales. The village is set in a beautiful environment close to an open ocean beach popular with swimmers, recreational fishers and walkers from the local community, Coffs Harbour City (30km south) and travelling tourists. Extensive areas of natural bushland and wetlands also surround the community. Community life includes a strong Dunecare Group, and the Corindi Beach Residents Group, who take a strong interest in the amenity of the village and the health of the local natural environment.

In 2002, Corindi Beach Developments purchased a development site on a cleared hillside on the southern edge of the village for a 50-lot subdivision. The original plan included a stormwater pond - a "hole in the ground at the bottom of the hill". Runoff from the development would flow to a protected (NSW SEPP 14) floodplain wetland of melaleuca forest.

The developers discussed with Council the need for something better. The subdivision design had already been completed, so the design team of Dr. Keith Bolton and David Pont were commissioned to create a site-sympathetic Concept Design for a constructed stormwater wetland to treat subdivision runoff to a standard suitable for on-flow to the floodplain wetland.

The lack of fall across the area available for a wetland imposed a serious constraint on the normal design approach of terraced steps, with drainable individual wetland components sized for specific treatment tasks, linked by gravity driven water flow. A one hectare wetland (about 6% of the 15ha catchment area) was designed as two facing systems draining each of the two subcatchments based on the sequence of sediment basin - macrophyte zone - gravel bed with melaleuca trees, and a common outlet cell connecting the two systems with an open water zone and an outlet to the floodplain wetland.

This lack of fall meant an inability to drain the wetland for appropriate management. Therefore a general depth of 33cm was designed into the wetland (except for the one metre deep open water zone), to ensure plant health over the long term. The Concept Design was completed, then the wetland constructed with little further input from the designers. The Corindi community was not consulted, on the basis that the subdivision community had not yet arrived.

About a year later, the Corindi village passed to the local government area of Coffs Harbour City Council. Council then received many complaints from the Residents Group about the scale and method of clearing, a mosquito plague, lack of erosion control on the site, and interference by the constructed wetland in natural water flows to the floodplain wetland.

David Pont was engaged by Ecotech Group to address the issues. In mid-2004 a meeting was held on site with Council staff. A plan was agreed to consult with the existing residents, then attempt to redress some of the problems of the site. A group of about fifteen residents attended a first meeting at the wetland, where an apology was offered for the impacts on residents, and the issues of water quality, hydrology, mosquitoes, and biodiversity were discussed during an extensive walk around all sections of the wetland. The residents offered cautious support for the remedial actions.

Residents were asked to consider the drowning risk to children posed by the open water section. The conclusion was that the wetland should not be fenced because the risk was very low. Children would need to fight their way through dense tough sedges to reach the deeper water, and toddlers would not be at risk. This issue can also be addressed by installing gradual slopes and batters with no steep sides, and if considered necessary, fencing of the open water itself inside a larger unfenced wetland.

A Plan of Works was written, and submitted to residents and Council for review. Following sign-off, the Plan has been implemented over the last six months, along with remediation of several design issues. The process has included: regular contact with residents; planting of several hundred native trees and sedges, many of which were germinated from seeds gathered on site; weed removal and turf transplanting; hydro-mulching on bare ground outside the wetland; installation of nesting boxes for bats and birds; raising of wetland berms to the design height; and widening of sediment/inlet zones; resetting of wetland bypass channel invert and main spillway floor.

Future

Ecotech Group is working with the Residents Group on a longer-term plan for two Osprey nesting poles near the wetland.

Other plans for the future include working with builders and new residents on effective control of sediments from the building sites, and pollutants from garden and lawn fertiliser, and pet droppings. This will reduce the pollutant load on the wetland that has developed into a valuable bird and frog habitat, and an aesthetic asset to the community.

Lessons learned

Planning means foresight -

- involve the community at an early stage
- WSUD and wetlands must be integrated into the whole site design at an early stage
- constructed wetlands can solve many water management problems, but the water management problems involved in development must be well defined in the design process and resolved iteratively.

Conclusions

The integration of requirements for WSUD techniques, including wetlands, must occur at the outset of site planning for a development in order to achieve the maximum water quality improvement, biodiversity habitats and passive recreational needs of the local community.

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