

Core considerations and issues regarding the construction and use of Integrated Constructed Wetlands (ICWs)

"It is not so much the site and materials used to make a wetland, it is how it is designed and arranged within a specific landscape to create a system that will provide the required biogeochemical processing environment that will sustainably treat a polluted water source."

Initial considerations, before designing and constructing an ICW, are understanding their potential setting and optimal placement within a landscape, along with all necessary scaling to meet long-term future water management/treatment needs and their ancillary services and benefits.

As ICWs are essentially a co-joined land and water use undertaking, all essential connectivity with their location is critical: addressing their setting (landscape-fit), all water-contaminant flows (existing and potential hydraulic aspects) and biodiversity (ecological coherency).

The implementation of optimal land and water use are greatly aided by addressing all land and water aspects of the site. This is best undertaken by applying the UNEP – CBD Ecosystem Approach in which its 12 principles and supporting rationale can be applied i.e. applying social, economic and environmental coherency, and their inextricable linkage.

The ICW concept has been honed over the past 20 years of endeavour to which an 'adaptive management approach' has been applied to the treatment and management of a wide range of polluted water sources, including amongst others: agricultural and forest drainage, farmyard drainage, combined and non-combined sewage, landfill leachate, mine drainage and road drainage.

The following highlights some of the issues that continue to arise in applying the ICW concept:

1. The tendency for ICW systems to be seen mainly, sometimes solely, as wastewater treatment systems. While treatment may be the primary focus, the many other benefits and ecosystem services that ICWs can deliver should be recognised and optimised, otherwise it is not, an application of the ICW concept.
2. ICWs have an 'ecologically engineered' focus – an emphasis on formulaic 'civil engineering' alone is inadequate: the multi-celled, shallow configuration and design of helophyte-vegetated ICWs is thoroughly tested over a wide range of effluent types and site conditions (there are more than 100 operating and 80 peer-reviewed papers). Furthermore, as 'open systems' they are subject to a wide range of stochastic environmental influences e.g. heavy rainfall events and temperature extremes – these are addressed when applying the ICW concept by having an appropriate bespoke design addressing its setting and influents.
3. The overarching focus for ICWs is on their ecosystem services, one of which is water quality improvement (treatment), another is water flow moderation (flood abatement) - there are many more, which are of social, economic and environmental importance.
4. As the focus of ICWs is on ecological reanimation and the benefits derived from each specific site and the residual values of through-flowing 'waste' water, understanding the wider associated biogeochemical processes and potential ecology are essential. This is clearly not possible without their inclusion in their design and understanding the fate of vectored constituents including faecal viruses, bacteria and protozoans, and emerging contaminants, heavy metals, carbon sequestration and the capacity of self-management.
5. As land is a limited resource all aspects of a potential site should be addressed, most particularly its existing and possible linkages to water, even if it's solely for a single purpose: noting that there is inextricable linkage between social, economic and environmental interests.

Eight (essential) considerations in applying the 'Integrated constructed Wetland' (ICW) concept

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- 1. Consider any project within the context of delivering a functional ecosystem**
Providing the boundaries of engagement, whereby all known site-specific inputs and outputs can be readily measured.
- 2. Know 'Why'**
Clearly define goals and benefits, only then start designing for their achievement.
- 3. Engage in understanding the site**
Map and label the immediate environment, defining all boundaries and associations without prejudice – most particularly all water sources and receiving waters, soils and topography.
- 4. Collaborate**
There are fewer better motivations than engaging with others with a similar or connected goal (including those requesting the service). Whether motivated by competition or a sense of mutual responsibility, the mere presence of a learning partner, is likely to exert additional incentive/s to maintain awareness. Nonetheless, be thoroughly mindful of the real capabilities and the motivations of potential collaborators - and the problems associated with 'project ownership'.

5. **Prepare for stepwise motivations**

There is a need to be aware that there are distinct stages in completing a project. These should consist all conceivable challenges – ‘real interactions’ in understanding the site and how it will be used (including the loss and gain of its wider benefits). The satisfaction that comes from understanding each step also encourages - it will even promote further/newer innovation.

6. **Be aware of the wider context/ setting – its economy, social and environmental aspects**

Find a way of joining-up everything – one understood aspect (or even the awareness of its possibilities) triggers others, and furthers additional areas of interest and motivation – further emphasising the benefits of ‘integration’.

7. **Use what you already know**

The greater the depth of understanding, the more likely that site-specific information can be used, and be considered in the light of that experience and understanding, whilst also recognising that each site has specific attributes and requires making parallels and comparisons with earlier experiences. The old and new can stand together.

8. **Variation is the spice of life**

Having designed and completed one ICW project, using the experiences gained, ask if it could be done better (reflecting on the site’s attributes/opportunities and methods of construction). Could new ideas have been tried, knowing that each ICW project is a bespoke engagement with a site’s setting and its objectives/challenges?