

Stoneyford Integrated Constructed Wetland

NI Water's innovative new pilot wetland solution

by Derek Crabbe BSc (Hons)

In 2014, NI Water began the construction of a new solution to municipal wastewater treatment in Northern Ireland. The Integrated Constructed Wetland (ICW) approach is still quite experimental within the water industry and design models are still under development. This process uses a natural ecosystem to break down and treat the pollutants in a design that requires no additional input energy, other than sunlight. This article details the construction of the 6 hectare integrated wetland at Stoneyford in County Antrim.



Side view of the pond, which is now in operation for wastewater treatment - Courtesy of NI Water

Site selection

Stoneyford, County Antrim, was selected to compare this process following a shortlist of suitable locations within Northern Ireland. The existing activated sludge treatment plant had reached the end of its useful life, particularly the mechanical and electrical equipment on the site. The site had also failed to meet its Water order consent at a number of its monthly sample visits; it was also hydraulically over-loaded beyond the original design and prone to premature storming direct to the water course.

A tender was raised and the ICW design compared favourably against a traditional activated sludge design and Stoneyford was selected as the first pilot site.

The sewerage catchment, entirely domestic, also featured predominately separate surface water drainage. For this reason the new ICW site was sized on treating all flows to Formula-A (16l/s for a population equivalent of approximately 1,000). The ICW process caters very well with intermittent flows and effectively balances out shock loading in the first pond. The exceptional buffering means even extreme storm events have almost negligible effect on outlet flow or quality. There is no need for any additional storm storage.

Location and footprint are probably the most significant issues for an ICW design, and at Stoneyford, NI Water were in a favourable position having ownership of a large catchment of land, which previously served a redundant water reservoir located at the village.



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Pic 2: Site layout drawing of the wetland, which shows the layout of the various ponds - Courtesy of NI Water



Pond 1 under Construction - Courtesy of NI Water



Pond 1 at the early stages of establishment - Courtesy of NI Water



Pond 5: Early stages of establishment, showing the island and moat
Courtesy of NI Water

Objectives

Having thoroughly assessed the appropriate location within the village, NI Water set about designing their first integrated constructed wetland.

NI Water derived three key objectives for this pilot:

- The ICW should preferably be unlined using only natural clay materials within the existing site.
- The design should integrate the wetland into the landscape and enhance its biological diversity through the containment and treatment of influent within emergent vegetated areas.
- The aesthetic placement of the constructed wetland into the local landscape should enhance the site's ancillary value and nature management.

Pond construction

The total area of the Stoneyford ICW site is approximately 6 hectares and made up of a series of very shallow, densely vegetated ponds as shown in the drawing on the left.

The pond area is 3.7 hectares and the remaining land provides road access around the ponds to allow the edges to be gently graded for safety. All embankments are safe for pedestrian access and the site in general would be suitable for the public or visitors. The total area of ponds is equivalent to five international football pitches.

The bottom and sides of the ponds were constructed utilising suitable on-site clays. There was no additional material imported other than construction stone for the roadways. The grading and landscaping required the re-shaping of approximately 30,000 tonnes of site material. The pond base was constructed using natural clay which was formed to the required level with a 'puddling' technique and rolled flat to provide the ideal natural liner to limit any infiltration from the base of the pond.

A 150mm layer of topsoil was then spread over the clay, which provides the muddy bedding for the pond planting. The ponds have been arranged to flow in series, and water depth in each is controlled via manually adjustable outlet weirs. This variable water depth is kept between 100-200mm. Waste management on this type of site is much less arduous and all soil material was re-used and landscaped within the site. Debris and redundant materials were kept to a minimum, resulting in site management and waste returns that were almost zero. Roadways have been kept minimal with geotextile underlay and stone base layer. The road finish has been purposely been finished in fine gravel to blend in with the natural aesthetics of the site and create a porous surface with no surface drainage required.

Establishing the plants

To speed up the establishment of the plants, over 60,000 wetland plants were planted in the ponds. Other landscaping outside the ponds included the 0.3 hectares of willow, approximately 100 young tree saplings, and re-seeding to the embankments and boundary. To encourage wildlife to the site, a small island was created in the final pond to provide a safe haven for birds and other wildlife.

Around the island is a small deep moat, which is only about 1,200mm deep, enough to stop the wetland plants spreading across the moat (see photograph on left). This small moat has already been a major attraction for ducks and geese, and will attract other birds too with the opportunity to use the lush surrounding plants as a new food source.

Site design

The site design was proposed by Vesi Environmental, designers for the project. The ponds are arranged in sequence to maximise the retention time of the influent (wastewater) and create long flow

paths to provide a retention time on site of approximately 90 days. This retention time is a lot longer than other traditional processes used. For example a new activated sludge plant will have a retention time of well under 12 hours, this substantial increase in time to 90 days impacts most on the footprint.

This low technology process uses anaerobic bacteria activity to carry out the breakdown of the pollutants. This is a much slower reaction process and the operating costs are much lower than a traditional process. Many of these future sites will not require any mains supply electricity for anything more than a flow meter and final effluent sampler.

Construction

To minimise the impact of other works in connection with the project, the contractor BSG Civil Engineering employed techniques such as directional drilling for the pumping mains, and use of locally sourced imported stone for the roadways. The site has also reused an existing pumping station building to house control panels and provided opportunity for an educational suite for site visits. There are further plans to possibly build a small shelter within the site for public use and possibly include a small solar PV system (3kW) to offset the site power completely.

Key advantages of the Stoneyford ICW

- Lower capital cost to construct than a conventional aeration WwTW, (ICW site £0.8m compared to £1.4m for a traditional design).
- Simple design, construction and maintenance skills requirement (no screening or blower equipment).
- Only technology is monitoring instruments, none of which are critical to the treatment process.
- Exceptionally low energy demands (<£50 per month electricity use on ICW site).

- Ease of commissioning/decommissioning.
- Ability to tolerate variable flows and influent quality.
- No sludge tankering required.
- Sustainable over a long lifetime (>50yrs).
- Increased biodiversity: Secure large scale wildlife habitats.
- Creation of an aesthetically-enhanced area with amenity potential for the local community.

Performance testing phase

The site is currently within a performance testing phase, which will involve NI Water monitoring the performance at each pond for 12 months. This period will also be used to help train the operating staff on how to recognise issues and get involved with the testing and commissioning regime. Maintenance on the site is not technical and typically involves grass cutting, clearing dead plant debris from inlet and outlets, general grounds maintenance and inspection. Observations will also include plant health, flow patterns, and sedimentation in the early ponds and inlets.

Other areas of development are in the area of biodiversity and monitoring any changes in the biodiversity at the site, the benefits to wildlife and the wider environment of the ICW. The data and information collected on the plants, birds and invertebrate fauna at the site may also be used for compiling informational brochures and signage and form part of raising awareness as well as a potential educational programme for the site in the future.

Another important aspect of biodiversity in the ICW solution is the variety of the vegetation. Different species of tall reeds, rushes, iris and sedges influence light levels, water temperatures, oxygen concentrations and water chemistry in their own way. The result is a mosaic of distinct patches of diverse species of vegetation across the wetland that increases the diversity of habitats to the benefit of biodiversity. This is good not only for nature, but is also good for the functioning capacity of the wetland.

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Successes and feedback

NI Water believes that this natural environmentally-friendly solution is particularly suited to rural areas and aims to introduce more of these sites, which promote sustainable solutions to wastewater treatment across Northern Ireland.

Since construction began, many of NI Water's stakeholders have followed this project with interest, as this is the first ICW for Northern Ireland. While the concept is simple, the 'soft' engineering can present many challenges. The most common feedback from site visits are; *'This isn't what I expected.'*

Visitors are surprised that the finished product has more in common with a lush green park land than any wastewater treatment site. The site has already been very popular within the industry with group visits from CIEEM, CIWEM, Irish Water, Institute of Water and the Institution of Civil Engineers. NI Water hopes to eventually open the site to the public and use this as an educational site for schools and groups.

Undertakings

BSG Civil Engineering Ltd was the main contractor for the scheme, with technical and project management support from White Young Green. Vesi Environmental Ltd was process designer for the project.

Construction time was a major challenge on this project, with construction commencing in April 2014. The £0.8m project became fully operational on target in November 2014.

Conclusion and future ICW plans

The Stoneyford Integrated Constructed Wetland truly provides a fully sustainable, low cost, low energy and low maintenance alternative to the modern, high technology-based wastewater treatment solutions normally adopted for a population of almost 1,000PE.

"We had visited the site expecting to see marshy bogs, swarming with flies and wreaking of a foul smell. What we actually experienced was completely different. There was no smell at all - even at the inlet ponds - and hardly a fly in sight. Groups of pony trekkers were enjoying the lush green amenity space and we even caught a glimpse of a Moorhen darting around the ponds. What surprised us the most however, was how clear the water leaving the final ICW pond was - it looked clean enough to drink!"

Stoneyford resident describing their experience of Glaslough Integrated Constructed Wetland during an NI Water organised informational site visit to a similar ICW constructed in the Republic of Ireland.

The Northern Ireland Environmental Agency (NIEA) has been very supportive of the project and like NI Water believes that this natural environmentally-friendly solution is particularly well suited to rural areas.

NI Water aims to introduce more of these sustainable solutions in the future with planning applications already submitted for ICWs at Castle Archdale and Ballykelly.

The editor and publishers would like to thank Derek Crabbe, Project Manager with NI Water, for providing the above article for publication.

NI Water would like to thank Monaghan County Council (managers of Glaslough ICW), BSG Civil Engineering, White Young Green and Vesi Environmental Ltd for all their support throughout this project.



(L-R) Bill Gowdy NI Water Director of Engineering Procurement, Regional Development Minister Danny Kennedy, and NI Water CEO Sara Venning - Courtesy of NI Water



April 2015: Aerial view of Stoneyford Wetland Courtesy of NI Water