Cromhall Wetland Investigation

Final Report

Wessex Water

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YTL GROUP

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Executive summary

Cromhall Water Recycling Centre (WRC) is a small rural works in South Gloucestershire. It has a population equivalent of 2,055, a mean daily discharge of 1.4 Ml/d and until recently treatment comprised mechanical screening, a single oxidation ditch and a humus/settlement tank, with effluent discharged to the Tortworth Brook.

Under the Water Framework Directive (WFD) Tortworth Brook is at moderate ecological status, with phosphate from diffuse (agricultural and rural land management) and point sources (water industry) the reasons for not achieving good status. Water quality modelling showed that a 3.0 mgP/l total phosphorus permit would be required for WFD compliance, requiring significant tertiary treatment investment (e.g. ferric dosing). Since 2010 Wessex Water have been in discussions with a local landowner (Tortworth Estate) and the Environment Agency (EA) to explore whether an Integrated Constructed Wetland (ICW) could be trialled as a more sustainable approach to reduce nutrient discharges from Cromhall WRC. The EA agreed to an Asset Management Plan 6 (AMP6) Water Industry National Environment Programme (WINEP) output to construct an ICW. They also acknowledged the performance uncertainties surrounding innovative nature-based solutions by not requiring a numeric permit standard; instead ICW performance and wider environmental benefits would be subject to this AMP7 investigation.

The ICW was completed in March 2020 and operational from April 2020. It is 0.8 ha in area and arranged in a modular design with a total of 12 cells combining open water, surface flow marsh and wet grassland habitat types, designed to perform ecological and bio-chemical functions. After the first four cells, flow is split into parallel, mirrored treatment streams (cells 5a-8a and 5b-8b) before combining prior to discharge to the brook. The ICW was designed to accept a maximum hydraulic loading rate of 32 l/s (2800 m^3/d) with hydraulic residence time of 0.4 to 3.2 days depending on flow rate. Modelled performance indicated a final effluent quality of <2 mgP/l total phosphorus and orthophosphate.

Environmental monitoring has taken place prior to, during and post operation of the ICW site and in the Tortworth Brook comprising water quality spot sampling, spot and continuous flow gauging, macroinvertebrates, diatoms and macrophytes. The aim of the monitoring is to understand the performance of the ICW and biodiversity benefits it delivers, and to identify any benefits in the receiving watercourse. Three PhD studies were commissioned to look at nutrient cycling within the wetland, the fate of antimicrobial resistant (AMR) bacteria, faecal contamination and microplastics and speciation of emerging contaminants within the wetland. The biodiversity natural capital gain was quantified using the Natural England Biodiversity Metric 3.0 (BM3.0).

The ICW became operational at the end of April 2020 and the findings, conclusions and recommendations presented here are based on monitoring for a limited period of operation to the end of November 2021. This period only covers two growing seasons one of which, summer 2020 was incomplete as the ICW was commissioned in spring of that year. The wetland was becoming established during this period and the findings need to be considered in this context. The performance of the wetland is expected to evolve over time and ongoing monitoring and assessment will be needed to develop a more complete understanding of operational performance and capabilities, ongoing maintenance and operational lifetime.

Wetland performance monitoring data have been collected since the wetland became operational however, intensive monitoring commenced in November 2020 to provide a full year of cell-by-cell water quality data for this report, and is the focus of this report. Performance for total phosphorus, suspended solids and ammonia is shown in Table ES-1.

Table ES-1 Mean concentrations of suspended solids, ammonia and total phosphorus (wetland inlet and outlet)

Site	Total phosphorus (mgP/l)	Suspended solids (mg/l)	Ammonia (mgN/l)
Wetland Inlet	2.15	7.07	0.72
Wetland Outlet	1.56	5.72	0.27
Removal	0.59	1.35	0.45
% Removal	27.50	19.09	62.49

For total phosphorus the wetland appears most effective in summer when receiving lower flows (longer residence time), warmer temperatures, more daylight and significant macrophyte growth. During summer months, concentrations into the wetland of ~3 mgP/l are common with discharges between ~2-2.5 mgP/l (16-30% reduction in concentration). Removal percentages over the winter months are minimal where concentrations both in and out of the wetland are broadly similar but low (~1 mgP/l). Ammonia and suspended solids are also effectively removed by the wetland with average reduction rates of 62% and 19% respectively.

Covid-19 pandemic caused delays with the PhD studies and the full results are not yet available. Emerging findings show that influent concentrations of pharmaceutical and personal care product (PPCP) vary seasonally and daily, with up to 90 compounds identified at a quantifiable level from 140 investigated. The ICW appears to remove some compounds from the aqueous phase (>70% removal), however others show negligible removal or an increase in concentration through the wetland system. Early findings show that the ICW can effectively limit the export of AMR bacteria into the environment (95-99.9%), with removal rates above 95% achieved even during winter conditions, and that Cromhall ICW can effectively remove microplastics (>95%). The PhD research so far shows reductions in both nitrogen and phosphorus. Nitrogen reduction is more sustained with rates of over 60%, whereas phosphorus removal is more variable. PhD data appears to show winter as more efficient, a conclusion that differs to that of Wessex Water analysis and appears to stem from a combination of factors such as sampling date and time as well as analysis technique.

The fate of these pollutants has not been investigated fully yet however, it is likely that they have settled out in the wetland or been taken up by plants. This may have important long-term maintenance and management implications for waste arisings from the ICW.

Assessment using the BM3.0 shows that Cromhall ICW has delivered a 111% and 42% increase in habitat and hedgerow biodiversity units, respectively. This is due to the limited biodiversity value of the preconstruction habitat (arable land) and the creation of the wetland and an area of surrounding neutral grassland (priority habitat). As the neutral and wetland grassland quality improves with maturity and management the number of biodiversity units delivered will increase further. This is in direct contrast to what would be expected if a 'traditional' approach to phosphorus removal (such as chemical dosing) had been adopted, which would typically involve the loss of a small area of undeveloped land within the footprint of the WRC. A Bioblitz identified that numerous species of plants, birds, bats insects and amphibians, have already colonised or are currently using the wetland system. The diversity and number of individuals using the wetland is expected to increase as the site establishes and the development of successional changes at different trophic levels.

Comparisons show that since construction, the WFD water quality status of the furthest downstream sampling point on the Tortworth Brook has improved from indicative Bad to Poor. Orthophosphate 90th percentile concentrations have approximately halved and

ammonia levels have also reduced from an indicative standard of Moderate to High. This indicates that the ICW may be improving the receiving waterbody however, the period of post construction monitoring data is limited and other catchment influences may be responsible for these changes.

Ofwat and Environment Agency guidance require water companies to consider nature-based solutions in their PR24 planning, whilst the PR24 WINEP options development process includes requirements to consider environmental net gain and natural capital. Consequently, nature-based solutions are being considered by water companies for engineering projects and this shift in regulatory emphasis should encourage their wider adoption. However, there are a relatively small number of nature-based solutions and a paucity of data on their performance and benefits to inform their uptake.

Monitoring of Cromhall ICW has helped in this regard however, the limited duration of monitoring data available and the relatively early stage of the operational life of the wetland introduce uncertainties into using these data for planning other such schemes. To allow nature-based solutions such as Cromhall ICW to become viable alternatives to 'traditional' treatment approaches, there needs to be acceptance that the performance will vary due to the natural processes involved. This needs to be recognised within the permitting of such schemes as this will give water companies the confidence and encouragement to adopt these solutions as alternatives to traditional approaches.

The monitoring under this investigation has demonstrated that had a 3 mgP/l total phosphorus permit for Cromhall ICW been in place it would have been breached in early autumn 2021, although would have been met as an annual average. The risk of non-compliance with a permit would deter the company from adopting these solutions in future. In the case of Cromhall ICW a descriptive permit is recommended, requiring monitoring to demonstrate wetland performance; it should not include a prescriptive total phosphorus limit. Such monitoring may allow adaptations to the wetland to enhance performance in future.

The delays experienced in the consenting for the development of Cromhall ICW demonstrate the need for greater knowledge sharing and guidance to all stakeholders involved in the delivery process so that issues can be identified and addressed early and their delivery streamlined. This will reduce overall costs, manage expectations and help all stakeholders in delivering environmental targets.

Monitoring of key parameters such ammonia, phosphorus, nitrate and suspended solids should continue to fully understand how the ICW performs as it becomes more established. This will give assurances of the ongoing capability to treat the effluent compared to design performance and allow comparison to other technologies such as chemical dosing. This may allow treatment performance to be optimised and any sustained reduction in treatment identified and where appropriate, remedial actions implemented.

The BioBlitz should be repeated to identify any change in the ecological value of the site as it becomes more established. This will confirm whether the expected further improvements in biodiversity are realised and strengthen the evidence base for the wider adoption of these approaches.

Existing data and that from the ongoing monitoring should inform a maintenance plan to ensure that treatment performance is sustained, and that operational resilience is maintained. The plan should include a schedule of works which may include operations such as cleaning pipework, additional planting or desilting. A project review should also be conducted under the Wessex Water "Make it Right" initiative which should include; optioneering, planning, design, construction, commissioning, handover and maintenance.

This approach will allow for lessons to be learnt ensuring that similar future works can be conducted in the most effect way.