CSOs and Storm Water

THE PROBLEM and THE SOLUTION

Combined Sewer Overflows (CSOs) and storm flows are becoming an increasing area of concern across the UK in terms of their discharge of untreated sewage into the sea, rivers, streams, lochs and lakes across the UK. ARM Ltd has over 35 years of experience in constructed wetland wastewater treatment systems applications across both the municipal and industrial sectors and have developed, designed and constructed a nature based CSO treatment solution, ARMStorm™ based on the unique benefits of wetland technology, which make them the most cost effective and sustainable way of managing and treating these high volume, event driven flows.

The problem

Over the past few years there has been increasing interest and concern about water company discharges via CSOs and storm overflows into UK water courses, and the sea. In 2021 we have seen the UK government forced to make a U-turn on a vote to allow these discharges to continue following pressure exerted via social media. The regulator is becoming more sensitive to this issue and a £90 million fine was issued to a water company in 2021.

The challenges associated with the CSO flow discharge treatment are:

- Intermittent flow (long periods of no flow)
- High volume variation
- Varying contaminant loads (first flush)
- Soluble and solid contaminants
- Treatment to consent or Environment Quality Standard (EQS)

The solution

ARMStorm™

The development and use of reed bed treatment systems has increased dramatically over the past 30 years as the benefits associated with them, of low maintenance, low operating costs, increased biodiversity, simplicity and consequently robustness are qualities which have gained greater currency in the municipal and industrial wastewater treatment markets adding significant **Natural Capital Value** to water treatment schemes. Reed bed practitioners around the world have, through innovation, developed the technology to match the increasingly wide ranging demands of industrial and municipal clients and local regulators governing water discharge quality requirements.

This has led to the generation of specialist reed bed technologies such as sludge treatment systems, aerated reed bed technology and reactive media systems. Further options including horizontal flow, vertical flow, tidal flow operation and the capacity to operate saturated or unsaturated allow reed beds to treat a broad range of municipal and industrial effluents to very high and consistent standards.

Included in this list is the treatment of **CSO** and **storm water** discharges for which reed beds have unique qualities to address the specific issues associated with management and treatment of flows.

ARMStorm™ addresses the issues associated with CSO and storm flows in the following ways:

- **Intermittent flow**
  Vertical flow Reed bed systems remain saturated and can maintain a viable biomass over longer periods of time. During periods of no flow to the system, intermittent aeration supports ongoing microbial degradation.

Collection pipework and airline installation

- **High volume variation**
  Reed bed systems have a larger working volume compared to the mechanical alternatives and as such can handle much larger daily flows. The freeboard of these systems can be increased to store and treat the higher design flows based on dilution and mass balance. The larger working volumes also mean these systems are more resistant to shock loads. The larger working volume of reed bed systems also increases the hydraulic residence time within the treatment system relative to smaller mechanical based treatment systems.
- **Varying contaminant loads (first flush)**
  The first flush of storm water contains the highest contaminant loads but, as outlined above, the large working volume buffers this first load and the associated longer residence time – compared to smaller treatment alternatives ensures discharges within consent are achieved. Aeration is turned on with the detection of new incoming flows and continues for 24 hours after incoming flows have stopped.
- **Soluble and solid contaminants**
  The large working volume of reed beds also allows solids storage within the system both in terms of biomass growth and the filtering of incoming solids. During periods of no flow the degradation of the organic solids continues with intermittent aeration, usually for 1 to 2 hours per day
- **Treatment to consent or Environment Quality Standard (EQS)**
  The sizing of the system and air flow rate is designed to match the load reduction requirement, based on the indicated inflow rates and load specification, down to comfortably below consent.

Media installation

Other benefits

The application of reed bed treatment systems offer other general benefits, including:

- **Protect environment** – through water treatment
- **Create environment** – through simulating a natural wetland
- **Sustainable alternative** – Principally natural materials and ecosystem based processes
- **Few or no moving parts** - can operate by gravity
- **Low power requirements** – no pumping within reed bed
- **Low maintenance** – as a result of the above
- **Low lifetime costs (TOTEX)** – due to low maintenance and low or no power requirement
- **Robust** – because there are few or no moving parts
- **Sludge and shock load management** – due to high working volume
- **Amenity** – very good aesthetic and attracts indigenous wildlife
- **Biodiversity** – reeds, plants and media support natural wetland ecosystems
- **High Natural Capital Value** – significantly higher than mechanical treatment alternatives

The CSO treatment system installed at Cowdenbeath highlights the benefits above and the suitability of wetland treatment systems to tackle the issues and problems associated with CSO and stormwater flows.

CASE STUDY: Cowdenbeath CSO Treatment

Need

A major Scottish Water infrastructure development was undertaken in Cowdenbeath including the construction of two new Combined Sewer Overflows (CSOs) which collected additional surface water from within the town. Historically, waste water from Cowdenbeath had been treated at a Waste Water Treatment Works (WWTW) on the south-east edge of the town discharging into the Lochgelly Burn. As the town expanded this WWTW became undersized and was converted to a pumping station passing flows forward to a larger works at Glenrothes. A holding tank of 1200m^3 was retained for this purpose. The increased flows generated by the new CSOs, totalling 229,700 m^3/annum, could not be managed by the pumping station or holding tank so a new treatment facility was required at the site to attenuate and treat the intermittent CSO flows prior to discharge into the Lochgelly Burn.

Scottish Water did not want to re-establish a full WWTW on the site and were therefore looking for a low maintenance treatment solution which could handle intermittent flows and discharge, within consent, into the Lochgelly Burn. Modelled CSO flow and load data was provided for a nine year period and provided a basis from which to generate design parameters. These are summarised below.

Solution

The proposed site for the treatment solution was to the east of the pumping station on an old landfill site which covered mine workings. This meant that significant project costs would be linked to ground remediation thus minimising the size of the treatment solution would be critical. Consequently an aerated vertical flow reed bed was the selected solution as this provides a high treatment capacity per unit area thus minimising the total land take. This was enhanced by making the bed much deeper than standard systems reducing the required treatment area further.

The data set was converted into cumulative summaries which determined that achieving complete treatment would not be cost effective as taking into account the highest flow outliers would greatly increase the size of the treatment area. The optimum treatment capability was concluded to be 79% of the annual BOD load, providing 95% overall compliance, and 100% of the ammonia load. The design solution was a two metre deep bed with a 4,000 m^2 process area which could treat 4000 m^3/d.

Flows are fed forward to the bed at a maximum rate of 46 l/s from a 3000 m^3 holding tank. On the occasions where flow rates exceed the storage capacity flows will spill to the Lochgelly burn on the basis that these will be rare events and the CSO will be significantly diluted.

	Flows	BOD	Total NH4	Unionised NH4
Loads	4000 m^3/day	16,429 Kg/yr	625 Kg/yr	–
Consents	–	9.0 mg/l	1.5 mg N/l	0.04 mg N/l

Benefits

The aerated reed bed system has provided Scottish Water with an effective low maintenance treatment solution at Cowdenbeath avoiding the need to construct a new WWTW to handle the significantly increased flow of waste water generated by the new CSOs in Cowdenbeath. Compared to the alternatives the system has a lower TOTEX and aesthetically and ecologically enhances the landfill site.