

Cumbernauld SUDS

new SUDS detention ponds to treat surface water from an industrial park to improve water quality in the Red Burn, Cumbernauld

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Scottish Water owned six surface water outfalls which discharged to the Red Burn in Cumbernauld. These outfalls drained 37Ha surrounding Wardpark North and South Industrial Estates with three outfalls located in the southern section of the site and three located in the northern section. The development site was constrained to the west by the M80, to the east by the Red Burn and within a SINC (site of importance and nature conservation in semi-ancient woodland). Run-off from these areas was causing the Red Burn to fail its water quality standard therefore a SUDS detention scheme was proposed to treat the run-off prior to its discharge into the Red Burn.



Cumberland SUDS layout - Courtesy of Grontmij

Project background & scope

The development site was split into two distinct topographical sections - north and south.

- **To the north** is an undulating open grassland plateau of approximately 4Ha. To the east of the plateau the land falls sharply towards the Red Burn with an elevation change of 30m with a 1:2 to 1:3 gradient. There was evidence of landslips and shear rock faces.
- **To the south** is a densely wooded area (10Ha) with pockets of Scheduled Ancient Oak Woodland which slopes steeply from west to east towards the Red Burn.

The detention ponds were required to give four volumes of treatment. The scheme required the design and construction of:

- Transfer pipework and connections to existing outfalls.
- Detention ponds and control mechanisms.
- Discharge pipework and outfalls.
- New access road and maintenance access to all pond inlets and outlets.

The full system was to be designed for the predicted 1 in 200 year flows, which were in excess of 10m³/s. In total the scheme required over 20,000m³ of detention volume.

Undertakings

Balfour Beatty, engaged a multi-disciplinary team from Grontmij, under an NEC Option A contract, to provide design services and site support. The project was taken from CAPEX 2 to CAPEX 5, and was part of Scottish Water's investment programme.

Design process

The first stage of the design was to undertake catchment analysis to confirm the drainage areas for each of the six Scottish Water surface outfalls. This was carried out by examining the surface water drainage network and assessing the number of roofs, roads and land associated with each outfall.

A model of the drainage network was created in WINDES, a surface water software design tool, to calculate the predicted 1 in 30, 1 in 100 and 1 in 200 year flows for each outfall.

Based on the existing terrain and predicted flows the design was split into a north and south section. The larger, flatter north section took flows from 3 (No.) outfalls, while the steeper, more constrained south section took the flow from the remaining 3 (No.) outfalls.

The flows to the northern section were significantly larger. In total the northern outfalls required 18,000m³ of pond volume compared with 4,000m³ for the southern section.

Pond sizing

With the design split into two sections the next stage was to design the detention pond sizes and identify suitable locations to construct them. The ponds had to be large enough to handle the 1 in 200 year design flows, however, in order to avoid being classed as large reservoirs under the current revision of the Reservoirs Scotland Act (2011) each individual pond had to be less than 10,000m³ in volume. Furthermore, Scottish Water specified that each pond should be no more than 5,000m³. Multiple ponds would therefore be required for the northern section.

Taking into account the above constraints, WINDES was then used to help determine the number of ponds, initial pond footprints and required control levels. All pond iterations investigated had to comply with the Sewers for Scotland specifications for maximum depth, aquatic bench dimensions, freeboard, sediment forebays and side gradients.

Once the initial pond footprints had been identified a 3D CAD model of the site was created using detailed topographical information. This allowed the pond shapes to be developed and sculpted into the existing landform to create a natural and aesthetic SUDS scheme. Due to the nature of the design and the different constraints of the individual elements, the pond shapes, locations and access roads had to undergo several iterations until the final design was selected.

The final design consisted of four ponds in series connected by rock cascades in the northern section and a single pond in the southern section. As well as designing the ponds, 3D CAD was used to sculpt the surrounding land and access roads to achieve an overall cut and fill balance and eliminate the need for transporting soil to landfill. Material removed during the excavation of the ponds was reused for the pond embankments and to blend the cascade ponds into the existing topography.

Transfer pipe design

WINDES was also used to size the transfer pipes. In total there were 3 transfer pipes. One collected the flows from the three southern outfalls, one collected the flows from two of the northern outfalls and one for the remaining north outfall adjacent to the M80.

There were significant engineering and environmental challenges presented by the transfer pipe systems. As there was no vehicle access to the existing outfalls, and due to the topography of the land upvc pipe was selected instead of concrete due to its lighter weight and better manoeuvrability on a site with difficult access.

The southern transfer pipe was 800mm in diameter and crossed steep sloping land and semi-ancient scheduled woodland. From an early stage it was recognised that a balance would have to be found between the engineering requirements and the ecological and environmental requirements. Scottish Wildlife Trust was engaged throughout the project and walking parties undertaken to develop route corridors through which the transfer pipe could go. This resulted in a route that would be more accessible to construct and far more sustainable. This resulted in significantly reduced environmental impacts.

Due to the location and invert level (IL) of the northern outfalls compared to the proposed pond's IL, two transfer pipes were required. Transfer Pipe 1 had to collect flows from a 1,200mm dia. and a 750mm dia. pipe which shared the same outfall headwall.

Due to the proximity of the M80 to the outfall headwall there was no room to connect in upstream of the existing outfall therefore a new RC collection chamber had to be constructed at the existing outfall headwall. The transfer pipe exiting the new collection chamber was a 150m long, 1.4m diameter pipe which gravitated into the first pond in the series.



Pond 2A inlet - Courtesy of Grontmij



Pond 2A looking north - Courtesy of Grontmij



View from Pond 2B to Pond 2A - Courtesy of Grontmij



Pond 3A Transfer Pipe Route - Courtesy of Grontmij

Transfer Pipe 2 was a 600mm diameter pipe which gravitated into the fourth, and final, pond of the series. Due to the lack of cover between the available connection point and the fourth pond some localised raising of ground levels was required.

Access roads

The maintenance road route starting point runs from the Dunswood WwTW access road, and follows the line of the existing Castlecary sewer route through Scottish Wildlife Trust land, and provides access to the inlet and outlet of each pond within the cascade. A spur from the access road to the lower pond provides access to the inlet and outlet of this pond. The access roads were of Type 1, with suitable substrate and capping material. Finished road level of the access track sat flush with cover of sewer manholes, with a maximum vertical grade of 1 in 10 used. New road culverts were required at three gully crossings, and the existing concrete slabs covering the sewer line were avoided. The access roads were not required around the full perimeter of the pond, and were routed along one side of the pond to minimise the visual impact within the site.

Final design

North: The final design consisted of four detention ponds in series connected by 1.5m wide overland flow rock cascades. The total detention pond volume was 18,000m³. To convey the flows to the ponds a new RC chamber was constructed at the existing headwall for Outfalls 2 and 3, and a 150m long, 1.5m diameter transfer pipe was installed.

For Outfall 1, a new manhole connection was constructed adjacent to the M80. A new outfall conveyed the treated water down the 1:3 gradient to an outfall headwall and onto an arranged rock cascade area to dissipate momentum before flowing into the Red Burn. A pond bypass mechanism was also designed to allow the ponds to be drained for maintenance and vehicular access was provided to

all pond inlets, outlets and forebays. To ensure the area retained a natural aesthetic, an aquatic and terrestrial planting scheme was also created.

South: The final design consisted of a 1km long, 600mm diameter transfer pipe along the wooded slopes and a 4,000m³ detention pond situated in a clearing. The pond water level was controlled by a weir manhole. A pond bypass mechanism was also designed to allow the pond to be drained for maintenance and vehicular access was provided to the pond inlet, outlet and forebay. A new outfall with concrete headwall discharged the treated flows into the Red Burn. To ensure the area retained a natural aesthetic, an aquatic and terrestrial planting scheme was also created.

Construction & site support

During construction of the five SUDS ponds from June 2012 to February 2013, further support from Grontmij was given to Balfour Beatty on final design of the transfer pipelines and landscaping elements. In order to ensure public safety, without creating visually intrusive aspects such as fencing, the solution uses specific vegetation and planting within the aquatic bench of the ponds to discourage people from entering the ponds. Full operations and maintenance regimes were specified.

Completion

The construction was handed over to Scottish Water completed in March 2013 ahead of schedule. The site is now fully operational.

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Pond 3A from access road - Courtesy of Grontmij