

Acklam Road Screening Structure

a multi-disciplinary wastewater project using BIM in the delivery of a small-to-medium scale project for Northumbrian Water

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The Acklam Road unsatisfactory combined sewer overflow (uCSO) was identified in 2003 as requiring improvement due to unsatisfactory sewage solids discharged into a watercourse. The Environment Agency (EA) placed an L1 (local priority) investment driver on the uCSO and the owner of the asset, Northumbrian Water Limited (NWL) was obligated to provide a solution. The problem related to the CSO's design and location. It is a 'pipe-end' type CSO on the end of a storm sewer which is fed by three hydraulic controls spaced approximately 1km apart in the area of Thornaby, Stockton-on-Tees. The storm sewer followed the course of the Mandale Beck which has been encapsulated by the sewerage system by urban creep over the last 60 years. The CSO discharged into a tide locked watercourse which runs along the course of the Old River Tees (diverted in the late 19th century). The Old River Tees watercourse is littered with sewage debris after every storm event because of the existing poor design and screening ability of the existing CSO.



Mezzanine level maintenance area showing top level of screens - Courtesy Mott MacDonald

Studies and design

Mott MacDonald was employed by NWL in 2005 as consultant engineers to identify feasible solutions. After two years of investigation and optioneering, sixteen potential solution options were identified. NWL determined that three of these options should be developed further at conceptual design stage.

During conceptual design stage further investigation brought to light other considerations including the presence of seasonal bat roosts around the existing CSO outfall and that the local stakeholders had differing expectations of what any proposed scheme should address.

The key considerations for Northumbrian Water in finalising the design were:

- *Hydraulic performance:* The current screening arrangement is poorly designed and creates turbulence, high hydraulic losses resulting in heavy aesthetic pollution of the watercourse and flooding of the adjacent golf club and cricket club.
- *Access and effective maintenance of the new asset:* The new structure is relocated to provide much improved hydraulic approach conditions and for NWL's operational staff to perform effective maintenance.



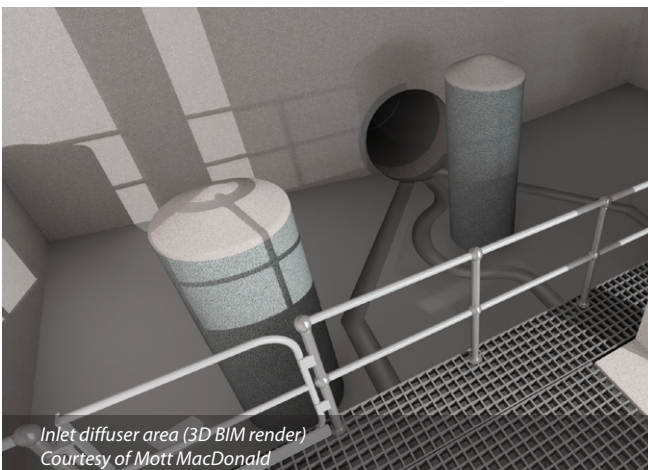
Aesthetic sewage pollution - Old River Tees watercourse
Courtesy of Mott MacDonald



Aesthetic sewage pollution - Acklam Road uCSO
Courtesy of Mott MacDonald



Mezzanine level maintenance area (3D BIM render) showing top level of screens - Courtesy Mott MacDonald



Inlet diffuser area (3D BIM render)
Courtesy of Mott MacDonald

The EA agreed a cost benefit derived budget figure for construction of the scheme, beyond which the project would not proceed. Only one of the options considered to meet the design requirements was within the cost benefit value. This entailed intercepting the storm overflow upstream of the existing CSO structure and diverted it through a new purpose built mechanical screening structure. NWL decided to progress with this option, however, the need for an above-ground structure and motor control centre (MCC) kiosk meant that planning permission had to be sought from the Local Authority.

Planning permission

Mott MacDonald applied for planning permission for the scheme in 2010 and was rejected on the basis of the intrusive nature of the above-ground building. Mott MacDonald and NWL approached the local authority to discuss making the scheme more amenable in its visual appearance and to add features to project which would provide benefit to the local community. Some elements included:

- Encapsulating the above-ground concrete structure within an extended embankment effectively making it completely subterranean.
- Removing an existing dead-end access road and footpath both of which were in a poor state of repair and replacing with a dual use footpath/cycleway to fit in with the local planning Master Plan.
- Epoxy coating with a 'safety green' compound to both footpath/cycleway and the main access covers to blend these into the landscaping.
- Tunnelling of a new outfall system to avoid open trenching through a main commuter road (the A1130) in Thornaby.
- By virtue of the new tunnel, 80m of redundant watercourse and contaminated land could be returned to grassland, providing new habitat for wildlife.
- New tree and shrub planting and improvement of the green space to create high value amenity land.

In 2011, Mott MacDonald and NWL reapplied for planning permission incorporating the additional features as well as rationalising the physical size of the design as far as possible. This resulted in gaining planning permission and the scheme progressed into detailed design stage.

Building Information Modelling (BIM)

Mott MacDonald decided to trial the use of Building Information Modelling (BIM) on this project given its combination of structural, civil, mechanical and electrical engineering elements. Mott MacDonald chose this to demonstrate the value of the emerging technology to NWL and it was readily accepted.

During the design process BIM was used in live design meetings with the client's management team, mechanical and electrical teams, and Operations and Maintenance (O&M) teams to rationalise the design and increase end user involvement. This enabled the best solutions for the end user to be delivered. Alongside this, Mott MacDonald has developed 4D programming links and 5D cost links. During the course of the project MM's in-house costing department produced a full bill of quantities from the model. Aside from the project, it has left Mott MacDonald with a range of BIM library content which can now be used repeatedly across other projects generating future efficiencies.

Construction

The works involved the diversion of an 1,800mm diameter storm overflow into a new bespoke screening structure containing a flow diffuser inlet, 3 (No.) escalator screens and associated launder pumps and equipment, a mezzanine servicing level, a tunnelled outfall system for screened flows and piled outfall structure.

The structure acted as a pipe end screening facility for storm overflows in Thornaby covering a population of 13,500. This meant

it needed to be designed to accommodate flows from as low as $0.1\text{m}^3/\text{s}$ to as high as $4.5\text{m}^3/\text{s}$ in a 40 year return period storm, whilst still screening up to a 5 year return period storm. To manage the differing flow volumes and velocities which could damage the mechanical screening plant, NWL, as part of their work to support local businesses, approached Newcastle University.

Computational Fluid Dynamics (CFD) model

NWL created a computational fluid dynamics (CFD) post-graduate project to design the inlet diffuser arrangement. Particular conditions of removing hydraulic dead spots so that suspended solids would not settle on the benching and so that flow velocity was less than 1m/s at the screen faces were incorporated. The CFD model results fed into the BIM software model with drawings produced for NWL's competitive tendering process.

Local contractor (Esh Construction Ltd) was appointed in 2012 to construct the scheme with the works completed in July 2013. Construction involved pipejacking for 70m of 1,800mm diameter outfall tunnel, staged construction of reinforced concrete inside a 21m by 13m sheet piled cofferdam, construction of a new embankment, open trench construction of 100m of new 1,800mm diameter sewers as well as 6 (No.) bespoke in situ manholes.

Conclusion

The project has been an excellent trial of BIM, highlighting the areas for significant future savings as well as establishing the value of the process. Mott MacDonald and NWL are now exploring facilities management elements of the scheme and how these can be incorporated into the wider business model.

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