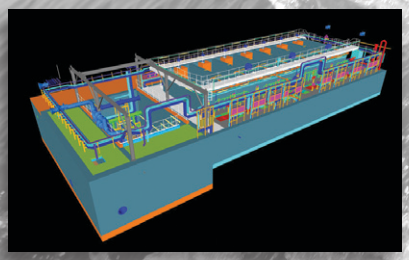
Forehill WTW
off site MEICA Construction
by Craig Wheatley

Forehill WTW is located in the Highlands of Scotland, to the west of Peterhead town centre. It originally opened in 1974 and supplies drinking water for a local population of around 29,000 people with an average demand of 19ML/day and a peak demand of 22ML/day. The design capacity of the works is 29.2ML/day with a maximum instantaneous flow of 1390m^3/hr at maximum works throughput. The original works at Forehill has in recent years suffered from rising pesticide levels in the raw water, therefore Scottish Water commissioned the design and construction of additional plant which would augment and upgrade the existing facility and provide new equipment to ensure the removal of pesticides from the final supply water.

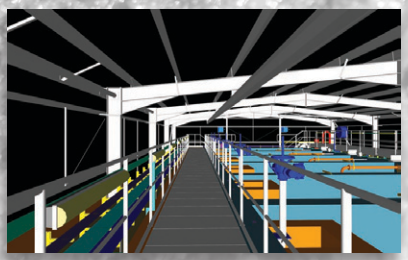
Aerial photo of Forehill WTW - Courtesy of Laing O'Rourke

DfMA pipe module successful installation - Courtesy of Laing O'Rourke



Digital Engineered model - Forehill WTW overview
Courtesy of Laing O'Rourke

Removal of all valves and flow meters from lower level considered with suitable removable sections of floor to provide access - Courtesy of LOR



Operational interface - access and maintenance
Courtesy of Laing O'Rourke

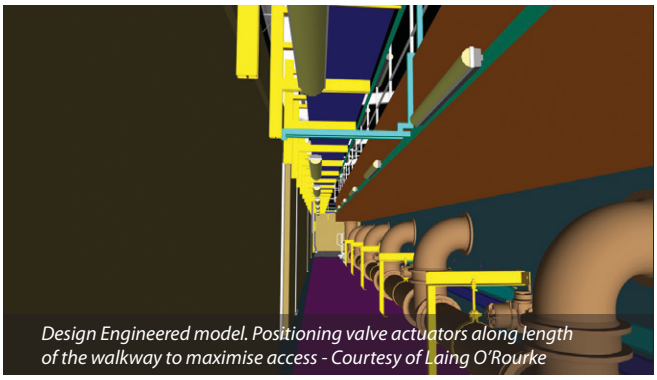
Project drivers and overview

Forehill WTW was identified as part of Scottish Water's SR10 Programme. Investment was needed to ensure that the works complied with the recognised quality drivers, DW3H. Compliance with the Drinking Water Directive 98/83/EC including standards specified in the Water Supply (Water Quality) (Scotland) Regulations 2001 for the specific, *Pesticides and/or Taste + Odour* parameters.

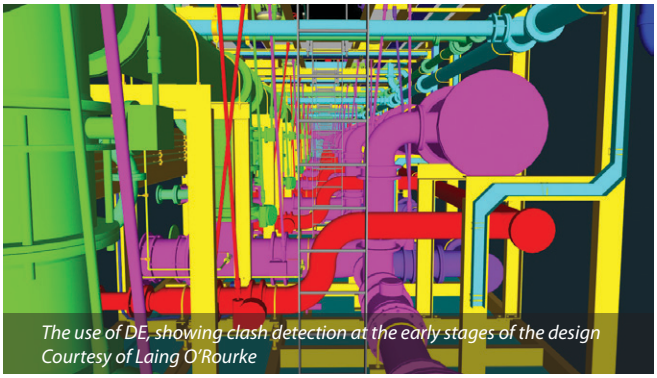
As part of a drive to improve quality of clean drinking water supplied to Peterhead and surrounding areas, Scottish Water awarded Laing O'Rourke the contract to upgrade the Forehill WTW. This includes a new granulated activated carbon (GAC) filter process working in tandem with the existing, downstream rapid gravity filters (RGF) system, to provide a final filtration process. These works were delivered using Laing O'Rourke's in-house capabilities of Expanded and Crown House technologies. At tender stage, Laing O'Rourke worked with Scottish Water to develop an accelerated Design for Manufacture and Assembly solution to the process pipe work.

Project objectives and delivery approach

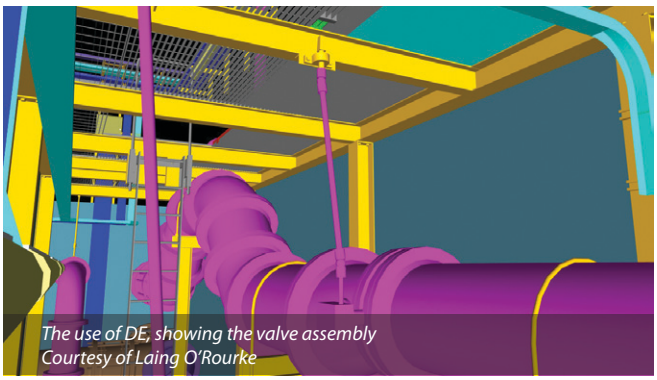
The new facility houses 7 (No.) GAC filter bays which captures a large proportion of pesticides that are present within the raw water source, before allowing the clean water to pass to the chloride treatment and on to the supply network.


Design Engineered model. Positioning valve actuators along length of the walkway to maximise access - Courtesy of Laing O'Rourke


Dirty backwash header Courtesy of Laing O'Rourke


The use of DE, showing clash detection at the early stages of the design Courtesy of Laing O'Rourke


North service trench module Courtesy of Laing O'Rourke


The use of DE, showing the valve assembly Courtesy of Laing O'Rourke

The carbon filtration media is designed to be removed, replaced and recycled once its filtration cycle of five years is complete. The new facility incorporates the latest technology to monitor and control water flows, demand levels, supply and filtration.

The innovative use of Digital Engineering (DE) by Laing O'Rourke was a first for Scottish Water on this type of project. The fully integrated model encompassed civil, mechanical and electrical components and equipment from the supply chain to ensure it accurately reflected the combined MEICA modules that were to be built and delivered to site.

The use of DE on the project enabled the whole site team and the client to visualise the operational design which proved to be a very effective collaborate tool, assisting in site design and construction meetings with the asset's operators and ensured a safe, quick and high quality installation.

Laing O'Rourke and Scottish Water worked together with an integrated design and construction approach adopted, enabling the designers to agree and lock down the design phase much earlier in order to allow the manufacturing, assembly, testing and commissioning phases to be compressed and run in parallel.

The use of Design Engineering and DfMA on the Forehill project meant that the programme and critical path could be reduced by nine weeks and on-site working-hours were greatly reduced saving on costs and making the construction inherently safer.

The site's carbon footprint was significantly reduced through the early involvement in design allowing raw material wastage to be driven out from the outset, while maximising recycling throughout the manufacturing process.

Design

Due to the extensive engineering work required to generate a fully integrated DE model, the design team's early engagement was crucial to the project success.

In the digital world Laing O'Rourke controlled the 'master coordinated' model with its structural designer developing and issuing the building and civil model to incorporate the requirements of the MEICA services. This hierarchy of model control ensures that all of the design team's disciplines are working with the latest information.

In doing so, discrepancies between the building construction and MEICA services were identified and reworked to give certainty that any DfMA modules delivered to site were integrated into the building structure first time with no on site modifications required.

The early engagement and selection of the supply chain was also a key factor in ensuring that the information contained within the DE model was relevant and accurate. The information incorporated into the model includes: weights, technical specification, part numbers, supplier's details and reference numbers resulting in it being available at any time in the future should Scottish Water require it.

The metal demountable walkway flooring was coordinated in the DE model, which allowed the design team to rationalise the supporting steel work by using the pipework supports for a dual purpose.

Access requirements for major control items such as flow meters as well as valve assemblies or major fittings were integrated into the flooring design to assist in future maintenance regimes. The floor loadings for removal of pipes, fittings or instrumentation were fully detailed individually to ensure that the lifting plan and the floor loadings were aligned.

Construction phase

Due to the extensive engineering input prior to the module build commencing, the physical off-site fabrication build of the 40m long trench assembly only took four weeks. The full module was fully assembled in the factory ensuring correct alignment prior to dispatch to site.

The precision engineering and pre-testing of the modules allowed for a quick and easy install.

Over 80 (No.) civil to mechanical pipework connections were required to connect the water tight structure to the delivery system. The GAC filter walls had cast in situ pipe couplings, requiring precise installation and continual monitoring for lateral and rotational movement that could adversely affect the connection points with the DfMA modules.

The tolerance for the pipe penetration cast in sections was required to be within 10mm to match the module design. Development of pipework arrangements maximised the connection tolerances available to plus or minus 10mm on structural connection pieces. This required a robust six stage survey and an 'as-built' procedure between site and manufacturing to ensure the delivered modules fit first time, with no on site modifications.

The building construction process required detailed planning to ensure the DfMA modules were installed at the appropriate point in the construction sequence. The main 40m trench assembly was installed within one day which then allowed the roof construction to continue.

The module connection task could then continue within a sealed building environment which again reduced the possibility of contamination within the systems.

The new interstage pumping station and backwash pumping system was constructed at the manufacturing facility and included electrical wiring which was then installed on site for integration into the site-wide control system.

The design solution comprises GAC treatment with the carbon media (adsorber) contained in reinforced concrete tanks, housed within a steel portal frame superstructure. Waste water generated from the process is transferred to a waste stream splitter chamber, before discharge to buffer tanks for onward pumping to the existing sewer network.

Conclusion

The Project gained CAPEX 3 approval on 27 March 2012 and construction started in early February 2013. Works were executed by Scottish Water Solutions (SWS) in-house delivery partners, Expanded, CHt and Atkins.

During a site visit prior to the commissioning period Geoff Aitkenhead, Executive Director Capital Investment and Chairman of Scottish Water Solutions commented:

> *"I think I have just seen the future."*

The Project was completed in July 2014 and was accepted and signed off by Scottish Water in September 2014. The total investment was in the region of £8.0m

The editor and publishers would like to thank Craig Wheatley, Project Manager with Crown House Technologies, for providing the above article for publication.

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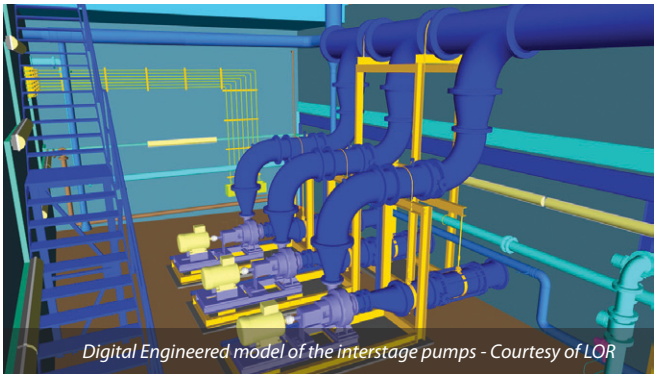
Modules being constructed off-site at LOR's dedicated manufacturing facility - Courtesy of Laing O'Rourke

40m main trench modules installed within one day Courtesy of Laing O'Rourke



Digital Engineered model of the interstage pumps - Courtesy of LOR

Interstage pumps consisting of four DfMA modules - Courtesy of LOR

Dry well with the interstage pumps, motive water pumps and backwash pumps - Courtesy of Laing O'Rourke