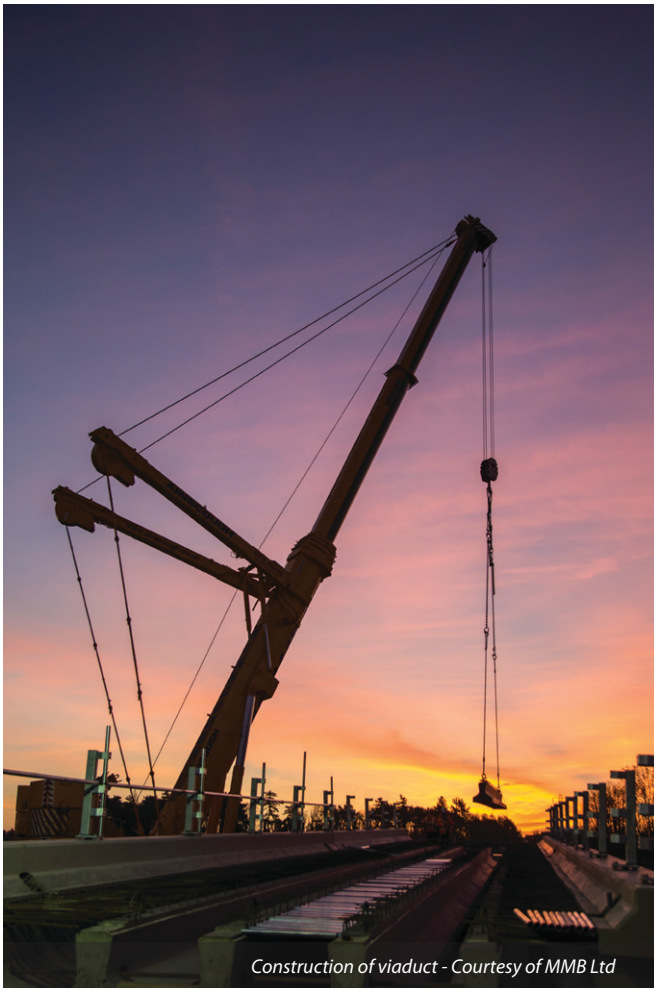
Worksop STW - Northern Area Sludge

new acid phase digestion plant constructed to treat imported sewage sludge arising from the largely rural catchment of Severn Trent Water's northern area

by Peter Moon CEng MICE & Dave Clark CEng MICE

Worksop Sludge Treatment Facility (STF) has been constructed to cater for a lack of sludge treatment capacity within Severn Trent Water's (STW) Northern Area. The Worksop STW site was selected as central to the area and a new access road was constructed as part of the scheme to better connect the facility to the surrounding road network. The STF is designed to process a peak load of 10,209 tonnes dry solids (TDS) a year of sewage sludge with approximately 80% of this coming from tankered imports. The plant was designed around acid phase digestion (APD) to maximise gas yield and solids destruction. Due to the high strength liquors produced and high proportion of imports, an Amtreat® liquor treatment plant was also included.

Placing of PCC arched bridge - Courtesy of MMB Ltd



Construction of viaduct - Courtesy of MMB Ltd

Background

The new STF has been constructed within the confines of the existing Worksop STW on an area that was formerly used as a pellet store for dried sludge. This area was being utilised for skip and resources storage which was relocated as part of the site clearance works. The new part of the development borders the existing treatment works on the north, west and south. A new access road was also constructed to the south, incorporating the construction of a viaduct over the River Ryton and an arched bridge over the Chesterfield Canal.

Worksop Sludge Treatment Facility is being delivered as part of STW's e5 Alliance, a joint venture formed between four framework contractors and STW, that was established to deliver major waste water non-infrastructure projects with efficiency, innovation and collaboration at its core. The project has been designed and constructed by specialist Mott MacDonald Bentley (MMB) and is the final project of three that MMB have delivered across the alliance, with major projects completed at Rushmoor and Strongford STWs.

Access works

A previous access study had identified the preferred route into the existing site; this connected the site with the Retford Road and included crossings of the Chesterfield Canal and River Ryton. The route was challenged to try and make use of existing crossing points however, alternative routes were either technically unfeasible or not acceptable to the many stakeholders. The route of the new access road runs through land acquired from the Osberton Estate. The development of this site was conditional upon maintaining the landscape and heritage of the neighbouring estate. A detailed

MAX RECOVERY
MAX SAFETY
MAX EFFICIENCY
MAX UPTIME

S:MAX

S:MAX SLUDGE SCREENING

Minimum operator intervention
Minimum civils requirement
Industry-leading screenings removal technology
No requirement for holding tanks or buffering

S:MAX

PRO:DEC

D:MAX

CDEnviro

cdenviro.com

hard and soft landscaping proposal was developed to minimise the impact the new sludge treatment facility and access road would have on the local landscape. This included extensive planting to screen the sludge treatment facility, the selected plants being both native to the local area and acceptable to the Estate.

The new access involved upgrading an existing farm access as the existing horizontal and vertical alignment of the road did not provide acceptable sight lines for the national speed limit. Whilst average speeds at the location were measured to be acceptable for the proposed junction design, a formal Traffic Regulation Order to reduce the speed limit to 50mph was required before Nottinghamshire County Council would enter into a Section 278 agreement and permit the development to go ahead. The existing highway alignments also posed a challenge for the drainage design, ultimately this was resolved using traditional highway gullies to capture runoff which was discharged into drainage ditches on the adopted highway and swales along the private access road.

The hard landscaping included construction of a masonry clad arch spanning the Chesterfield Canal. This was a specific requirement of British Waterways. The canal at this point was a known water vole habitat and as such the arch was specified both to maintain sight lines along the canal but also to preserve the habitat along the southern edge of the canal.

The arch itself is a proprietary three section precast concrete arch. It was installed in nine segments using temporary stoppages on the canal. Once the precast arch was installed, the approach ramp earthworks were undertaken using recycled fill sourced locally. The arch abutments, originally envisaged as brick wing walls, were redesigned utilising Tensar reinforced earth grids to enable a grassed slope to develop. This solution was both more cost effective and aesthetically appealing.

The viaduct over the River Ryton and its flood plain was designed by MMB to reflect the requirements of the flood risk assessment accepted by the Environment Agency. Unlike the Chesterfield Canal arch, this structure had to have minimal piers restricting flow and a narrow deck with hollow parapets to enable flow in excess of the one in one hundred year flood design event to pass over the deck. A precast solution was developed comprising four spans with six 18m long beams per span. The beams were again cast locally and lifted into place, then an in situ deck slab was cast.

Sludge facility

The layout of the sludge facility was developed to reflect the flow sheet. Sludge is imported into a central location (this being the noisiest and most odorous part of the process, the central location provides the most shelter and screening for this activity). The sludge then flows clockwise around the site from screening to thickening to digestion, dewatering then export and liquor treatment.

Aside from the noise and odour considerations, landscaping also played a part. The landscaping visual impact assessment concluded that dark colours, particularly grey would mitigate the visual impact. Consequently charcoal grey and anthracite were selected as the primary tank colours. Where unwanted heat gain was a consideration - primarily for the kiosks containing the motor control centres; goosewing grey was selected.

For ease of construction the plant was separated into five distinct areas based around the construction sequence:

Area A: Dewatering

The dewatering area comprises 2 (No.) dewatering buffer tanks of 750m^3 active volume, a package polyelectrolyte dosing system, centrifuge feed pumps, 2 (No.) Alfa Laval centrifuges, 2 (No.) CTM Systems cake conveyors, a six-bay 4,500m^2 concrete cake pad and a wheelwash.

Worksop Sludge Treatment Facility viewed from new access road Courtesy of MMB Ltd

New access provision at Worksop STW - Courtesy of MMB Ltd

Completed masonry arch over canal - Courtesy of MMB Ltd

Poly dosing plant - Courtesy of MMB Ltd

Amtreat® plant - Courtesy of MMB Ltd

Early construction of the cake pad enabled its use as a compound and storage area. Its permanent segregation into six bays created ideal storage areas for the multiple sub-contractors working on site during the construction phase.

Area B: Liquor Treatment

As 80% of the sludge being treated at Worksop is imported, a liquor treatment plant was required to treat the centrate and filtrate generated by the sludge treatment facility prior to it being returned to the head of the existing sewage treatment works. A performance specification was written for a package plant requiring 90% removal of ammonia and BOD. Following a whole life cost assessment, an Amtreat® plant was selected.

This plant required a 630m^3 liquor blend tank upstream and no downstream balancing. Effluent from this plant is discharged into a site drainage system intercepting any areas at risk of sludge spillage. This drainage system is then returned to the head of the existing sewage treatment works.

Area C: Reception and Thickening

The import facility was designed to accept two tankers discharging sludge at any one time and to provide 6mm screening to avoid rag and other detritus blocking the downstream processes. CDEnviro SMax SRU15 screens were selected following trials by STW, these screens provided two-dimensional screening and were connected via a JR Pridham sludge logger to a Bauer coupling for the incoming tankered sludge.

Downstream of the screens sludge was pumped either to a pre-thickening buffer tank (thin route) or pre-digestion blend tank (thick route) depending on the thickness of the sludge. Washwater arising from the washdown cycle was separated and directed to site drainage. The SCADA system is programmable to select whether sludge should follow the thin or thick route depending on site of origin or measured sludge thickness.

Thin sludges are mixed in the pre-thickening buffer tank with Hidrostal externally mounted pump mixers to maintain a homogenous feed to the gravity belt thickeners. Solids Technology supplied the belt thickeners which are mounted outside to reduce the potential for hydrogen sulphide build up had they been contained within a building. The belts are sized to process 60m^3 of sludge an hour and thicken to 7% dried solids.

The belt thickeners and the raw sludge tanks are connected to an odour control system supplied by Air Water Treatment to minimise odour originating from the site.

Thickened sludge is pumped into the pre-digestion blending tank where it is blended with imported thick sludge and mixed with Hidrostal externally mounted pump mixers.

Area D: Digestion

The digestion area contains the 2 (No.) gas phase digesters (GPDs) and the acid phase digester (APD). APD has been installed at STW sites at Derby, Clay Mills, and Wanlip; it pre-treats the sludge to enable greater solids destruction within the downstream GPDs.

The Worksop plant is the smallest to be constructed having a capacity of 450m^3/day sludge throughput. The 'bagel' design was developed within e5 to minimise the footprint of the plant.

The conventional GPDs are of similar design to the APD utilising an epoxy coated steel tank with a stainless steel roof and top rings (gas space). Unconfined gas mixing was selected on a whole life cost basis. The digesters are inspected on an annual

GPDs with feed pumps and heating system in foreground - Courtesy of MMB Ltd

DESIGN, MANUFACTURE, INSTALLATION AND COMMISSIONING OF MATERIALS HANDLING EQUIPMENT.

CTM SYSTEMS

CTM Systems Limited
Atherstone House
The Sidings
Merrylees Industrial Estate
Merrylees, Leicester LE9 9FE
Phone: 08450 775512
Fax: 08450 775513
Email: sales@ctm-systems.co.uk
Web: www.ctm-systems.co.uk

SUPPLIERS OF:

- Sludge cake reception bunkers
- Sludge cake storage silos
- Shafted and shaftless screw conveyors
- Fixed and radial conveyors
- Live bottom bins
- Dried sludge cooling screws
- Screenings handling conveyors
- Troughed belt conveyors
- Continuous mixers/blenders

WORKSOP STW: CTM are proud to have designed, manufactured and installed the centrifuge cake transfer conveyor system for the Sludge Treatment Plant at Severn Trent Waters Worksop STW. The scheme has been commissioned in 2015.

Circle

Specialist Electrical Contractors to the Water Industry.

Control & Design Systems

Tel: 01423 323900
Fax: 01423 323304
Email: postmaster@circle-control.co.uk

Electrical Contractors

COMP'Ex'

NICEIC APPROVED CONTRACTOR

Unit 8, The Poplars Industrial Estate, Wetherby Road, Boroughbridge, North Yorkshire YO51 9HS


Sludge import facility - Courtesy of MMB Ltd


Sludge thickening - gravity belt thickeners - Courtesy of MMB Ltd

external and 10 yearly internal inspection cycle, and efficiencies have been gained by designing utilising a steel tank with removable panels and shallower floor slope to enable access by cherry-picker for internal inspections.

Area E: Gas island

This area contains the gas storage and consumption elements and is adjoined to the digestion area. It contains the gas holder, boiler house (supplied as part of a package heating system), CHP Engine, waste gas burner and vent stack. Locating all this plant in one area eliminated the need for any pipe bridges and enabled a lot of the DSEAR zones associated with the installation to be located in one discreet area.

Integration

The project has utilised some 80 subcontractors, coordination and management of the interfaces of design, construction, installation and commissioning has been key to the success of the project. Each of areas A, B C and D/E has its own motor control centre housed in one of two kiosks on the site. Control of each item of plant is automated through the site SCADA system.

Conclusion

The plant has been a challenge to design and build, the successful outcome has been testament to the relations forged between MMB, their subcontractors, e5 and Severn Trent Water. The plant was successfully commissioned over the winter of 2014/5 and has now been processing sludge and generating biogas and electricity for six months.

The editor and publishers would like to thank Peter Moon, Design Lead with Mott MacDonald Bentley Ltd, and Dave Clark, Senior Programme Engineer with Severn Trent Water, for providing the above article for publication.


APD in foreground with GPDs and gas mixing compounds - Courtesy of MMB Ltd

Delivering fully integrated design and construction services to the UK water industry

MMB
Mott MacDonald Bentley

W www.jnbentley-mmb.co.uk
@ info@mm-b.co.uk
T 01756 799425