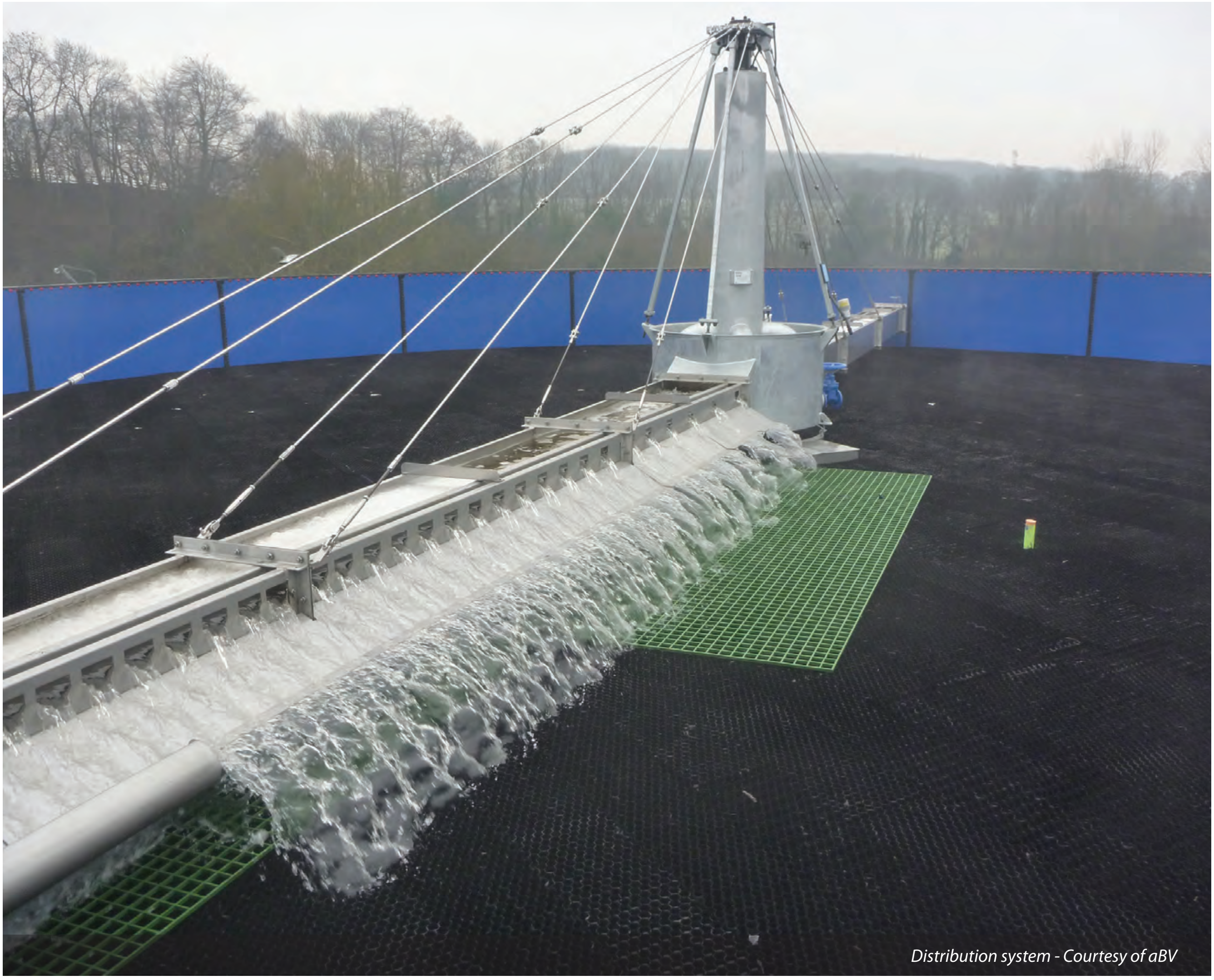
Wetherby STW

tertiary nitrifying trickling filter (TNTF) full scale trial

by Andy Gustard

Wetherby STW is the waste water treatment facility for the market town of Wetherby and its surrounding area. It has a population of approximately 23,000 people and is mainly unaffected by seasonal variations other than the local Wetherby Race Course. As there is no direct connection from the racecourse to the sewage treatment works, all racecourse wastewater is transported locally by tankers. The plant has been developed over many years and its present operation is a combination of the existing works and its subsequent refurbishment/ enlargement in order to meet the growing community.



Distribution system - Courtesy of aBV

Current operation of the sewage treatment works

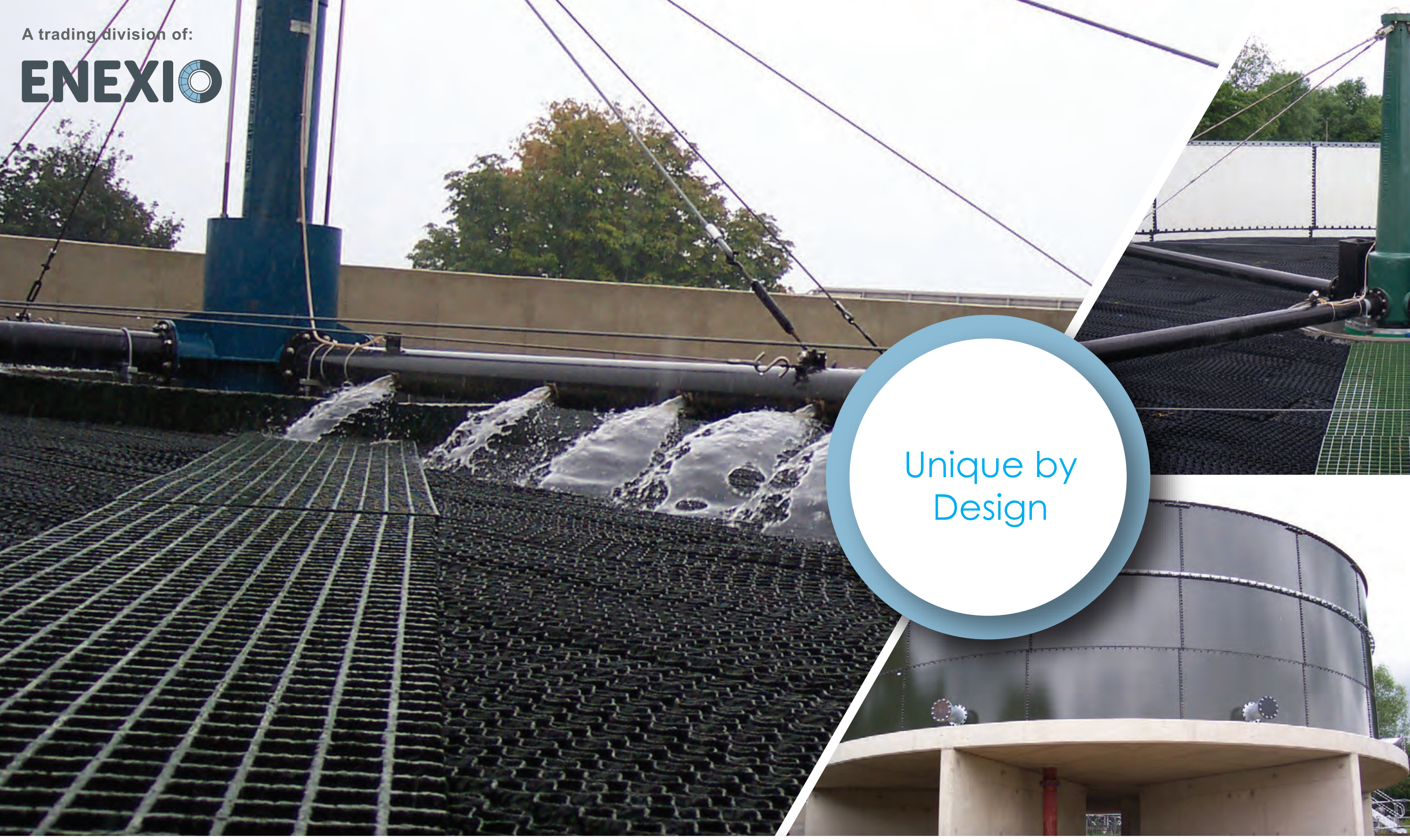
The inlet flow enters a screw pump chamber where all of the plant flow is lifted by the inlet screws and passed forward through the inlet screens and grit removal system. The inlet flow is monitored at this point via a channel flowmeter.

Flows enters a primary tank splitter chamber where it is split equally through 2 (No.) primary settlement tanks (PSTs). The outlet flow of the PSTs then combines back together and enters the carbonaceous only activated sludge plant (ASP) splitter chamber. It is then equally split and enters the 2 (No.) lanes/4 (No.) pockets of the ASP (surface aeration system). The outlet channels of the ASP combine together and enter the final settlement tank (FST) splitter chamber.

The plant flow is then split equally through the 2 (No.) FSTs and is then passed forward onto the tertiary nitrifying mineral filters splitter chamber which splits the flow into 4 (No.) mineral filters prior to combining again. The flow is again split and passes through 2 (No.) humus tanks. The effluent then finally enters the River Wharfe at the bottom of the site.

Outline brief of requirement

amey-Black & Veatch (aBV) was engaged by Yorkshire Water (YW) to investigate, design, construct and commission a tertiary nitrifying trickling filter (TNTF) system which was to be utilised by YW as part of the national trial for the chemical investigation programme (CIP2).



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Initially the design brief was to work with the full site flows which gave a flow to full treatment (FFT) of 128l/s. The design parameters were validated by a period of flow and load sampling which was undertaken by 24 hour composite samples. The loading was agreed with YW and comprises of:

- ***Suspended Solids***: 165kg/day
- ***BOD5***: 100kg/day
- ***COD***: 480kg/d
- ***Ammoniacal-N***: 280kg/d
- ***Alkalinity (minimum)***: 1435kg/day

The outlet treated effluent quality from the new TNTF had a design restriction of Ammoniacal-N 15mg.

The project was further challenged as its main intention is that it would only be required to operate for the life cycle of the trial programme of 12 months, this gave the project team opportunity to revise the required scope in order reduce the target value further. This was successfully undertaken jointly by aBV, sub-contractors and client.

Design decisions

Following high level costing of the solution it was identified that the proposal was unaffordable by Yorkshire Water. As a result of this affordability challenge, Yorkshire Water instructed aBV to develop alternative solutions to that identified in the Early Contractor Involvement (ECI) report submission. Three alternative options were identified:

- A 2-tank option to treat 100% of the works flow to full treatment (FFT).
- A 2-tank option to treat 50% of the works FFT.
- A 1-tank option to treat 50% of the works FFT.

A scope and cost assessment of the 3 options showed that the only option that could be provided within the Yorkshire Water budget for the scheme was the single tank option to treat 50% (64l/s) of the works flow to full treatment.

Final design progressed

The new plastic media tertiary nitrifying trickling filter (TNTF) plant was installed between the final settlement tank outlet and the tertiary mineral filter inlet. 50% of the plant flow was diverted into a new TNTF wet well via a low level splitter chamber. Treated effluent from the TNTF re-joins with the remaining 50% of the plant flow and directed to the existing mineral filters.

A duty/standby pumping system pumps a constant flow up into the TNTF at a rate of 83l/s, the minimum wetting rates for this system. 50% FFT is 64l/s; however the hydraulically controlled recirculation system ensures the TNTF outlet flows compensate the shortfall in flow to ensure a constant flow of 83l/s is conveyed onto the TNTF. The flow to the TNTF can be manually adjusted within the pump range but this was outside of the requirement of the scheme.

Ammonia concentrations in the feed and discharge to the TNTF are continuously measured by permanently installed in-line fixed instruments.

Process design parameters

The incoming flow design parameters are stipulated in the table below and formed the basis of the process guarantee. Feed BOD, COD and suspended solids loads to the TNTF are the 95%ile values obtained from a 9 day sampling programme undertaken in November 2014.

Concentrations were calculated at average daily flow (ADF). Design based on treated ammonia effluent (discharge from TNTF process) requirement of 15mg/l (95%ile).

Wetherby STW - Courtesy of aBV


Pre-start - Courtesy of aBV


Ongoing civils works - Courtesy of aBV


TNTF pumping station - Courtesy of aBV

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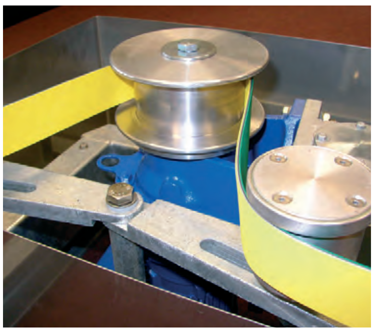

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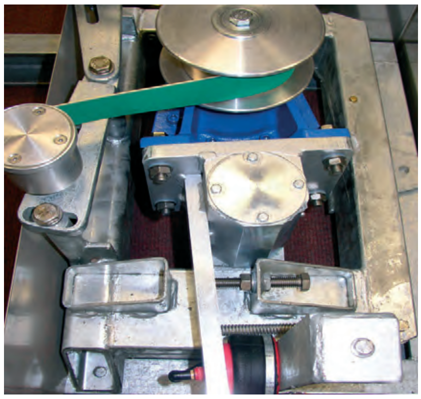

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Flow conditions		
Parameter	Unit	Value
DWF (50%)	m^3/d (l/s)	2,038 (24)
Average daily flow (50%)	m^3/d (l/s)	3,079 (36)
Max flow to TNTF (50%FFT)	m^3/d (l/s)	5,530 (64)
Design parameters		
Parameter	Unit	Value
Design temperature	ºC	7
COD (95%ile)	kg/d (mg/l @ ADF)	302 (98)
BOD soluble (95%ile)	kg/d (mg/l @ ADF)	52.5 (17)
SS (95%ile)	kg/d (mg/l @ ADF)	98.5 (32)
Ammonia load (design)	kg/d (mg/l @ ADF)	140 (45.5)
Ammonia consent (95%ile)	mg/l	15
Minimum depth	m	3.0
Preferred depth	m	4.8
Actual installed depth	m	5.1
Minimum number of filters	Number	1
Maximum filter diameter	m	25
Minimum wetting rate	$m^3/m^2/hr$	1.3
Plastic media specific surface area	m^2/m^3	>190
Maximum ammonia loading rate	$gAmm/m^2/d$	0.7

Design conditions also included sufficient alkalinity in the feed to drive nitrification and the absence of any biological inhibitors present in the influent. The TNTF was designed to tolerate a 50% variation in load from day to day (within the maximum design load) providing that the plant has seen the higher loading on 3 consecutive days in the previous 7 days.

Building the design - pre-construction works

Due to the proximity of the works to the local river extensive ecological surveys were undertaken. They identified the presence of otters, badgers, newts and ground nesting birds. As such, the works were programmed to be sympathetic to the environment and anyone working on the site was given the relevant ecological tool box talks.

The contract award date was 8 June 2015 with detail design commencing immediately. The design was agreed on 25 August 2015; however due to time constraints it was agreed that construction works commenced prior to this as the collaborative service team (CST) had already agreed the initial phase of works. Site works commenced therefore on 13 July 2015 with all sub-contractors having been informed of the required delivery dates and timescales associated for the site works. All the works were delivered to a high standard and with minimal delay. Below is an indication of the activities and performance of the works:

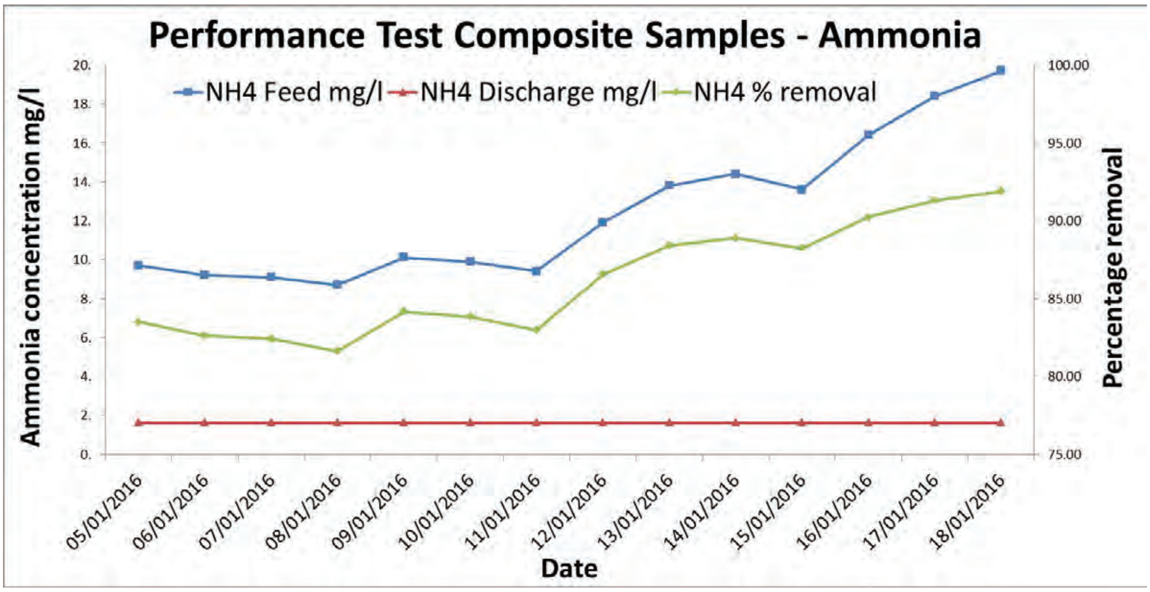
08/06/2015	Contract award
25/08/2015	Completion of detailed design
13/07/2015	Site set up commence:
30/07/2015	Commence civil construction
04/11/2015	TNTF S/C completion
13/10/2015	Mechanical installation complete
04/11/2015	MCC installation
30/10/2015	Electrical installation
17/12/2015	Commissioning completion
18/01/2016	Reliability completion

It should also be noted that there was no lost time incidents on site.

Testing conditions

The design is based on treated ammonia requirement of 15mg/l (95%ile). The performance test period was based on a 24 hour

TNTF internal view - Courtesy of aBV



(Note: due to limitations in analysis to 1.6mg/l at the external laboratory, the actual value for the effluent was lower than shown.)

composite sample over a 14 day consecutive day period. The 95%ile was measured by the allowance of 0 failures from the 14 samples. Subject to the design basis and 50% variation in load criteria being met, if the TNTF effluent fails to meet the target ammonia concentration due to the influent load exceeding the design criteria, that day's sample was discounted and an additional day in lieu would be added to the testing period.

The main target date for the contract was set as the TNTF to have been commissioned and in service for early November to allow sufficient time for the biological seeding of the system. This was achieved by turning flows onto the TNTF on the 6 November and an allowance of 63 days included so that it would achieve the design parameters when the external sampling commenced in March 2016. This was achieved and proved in January by completion of the 14 day process reliability. Above is a graph indicating the removal of ammonia across the Wetherby STW tertiary nitrifying trickling filter.

The editor and publishers would like to thank Andy Gustard, Batch Manager with amey-Black & Veatch, for providing the above article for publication.

Suppliers and Sub-Contractors			
Designer	amey-Black & Veatch (aBV)	Trace heating & insulation	Tees Insulation
Designer	LEADA	Access metal works	Jardonich
Designer	GHD Livigunn	FRC contractor	BBC Formwork
Civils contractor	amey-Black & Veatch (aBV)	Lifting equipment	Peter Cassidy
Mechanical installation	amey-Black & Veatch (aBV)	Kiosk	MCL Group Industries
TNTF plant	2H Water Technologies (ENEXIO)	Steel Tank	Kirk Environmental
Electrical installation	Circle Control & Design Systems	Valves	Industrial Valves
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TNTF plant - Courtesy of aBV

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