£95m project for "English Riviera"

new STW & full treatment for Torbay, Paignton & Brixham

by Peter Brookes

A £95m project covering the towns of Torbay, Paignton and Brixham will provide the "English Riviera" on the South Devon coast with its first ever comprehensive sewage collection and state of the art treatment works. Key element in the scheme is a £44m sewage treatment works providing preliminary, primary, secondary and UV disinfection of final treated wastewater, designed for a population of 210,000. Included in the project are a 9.6km transfer pipeline, pumping station, storm storage tanks and an extension to an existing short sea outfall. Torbay is the largest project in South West Water's 15 year 'Clean Sweep' project–- Europe's largest coastal sewage clean-up programme – which will result in the removal of some 200 crude sewage discharges close to some of the most famous and beautiful beaches in Britain.

Torbay: Location of new £44M STW works for 'English Riviera'

The resort of Torbay covers 15 European Union (EU) designated bathing waters. Various improvements have been carried out to the sewerage system over recent years, aimed mainly at controlling intermittent discharges affecting bathing waters. The current scheme is concerned with two continuous discharges; one at the north end of the bay will become an intermittent storm discharge under the scheme; the other at the south end will be utilised for the treated final effluent.

Environmental considerations were of high priority when siting the works, with noise, odour and visual impact of prime importance. Considerable local objection to the siting of a sewage treatment works at any of the viable alternative sites caused extensive delays and some 21 months elapsed before final approval was given to start work on the treatment works within the confines of disused Brokenbury Quarry. The quarry was excavated to a greater depth where necessary to ensure that the works structures are entirely below the level of the surrounding ground.

Tunnel

Flows are transferred to the treatment works through a new 4.25m diameter, 475m long, tunnel driven from the quarry to intercept the existing crude sewage outfall tunnel. This new tunnel will provide both stormwater storage and conveyance of crude sewage to the new wastewater treatment works. A separate 1200mm diameter pipeline within the new tunnel will convey the final effluent back to the existing tunnel for discharge to sea via an extended marine outfall.

The tunnel was driven from the bottom of a 50m deep shaft, which tapered from 7m dia at the surface to 10m diameter at the base. The shaft was lined with shotcrete with a waterproof membrane in the lower section below ground water table. The tunnel was driven with a *Dosco Roadheader TBM*. Some of the drive went through fissured limestone with water inflows up to 70 l/s Latter sections of the drive were through massive limestone where it was necessary to use explosives to excavate the rock. The new tunnel met the existing tunnel at a point some 60m below ground exactly to line and level.

Inlet pumping station

Incoming sewage arriving by the new tunnel is pumped up to the head of the new treatment works, a height of approximately 55metres.

At the base of the shaft four dry well pumps (3 duty/one standby) with a maximum flow capacity of 1134 l/s (+149 l/s from Brixham). The pumps are controlled in order that the pumped flow rate to the plant remains as close as possible to the incoming flow in the tunnel. Any greater flows from the combined sewerage system are stored temporarily within the inlet tunnel which has a storage capacity of some 6,000 cubic metres.

From the head of the works flow through the treatment process is by gravity throughout including connection to the outfall tunnel.

Torbay: Between a rock and a hard place - work on 475m long interceptor tunnel *(courtesy South West Water)*

Treatment processes

Preliminary treatment – fine screening consists of 3 6mm perforated, escalating band screens, and four grit and grease removal tanks. each 7.5m diameter constructed in concrete. Grit is transferred to sealed containers and removed from site to landfill. Grease is removed from site by tanker.

Primary treatment - preliminary treated effluent flows by gravity to four chemically assisted Densadeg® primary settlement tanks constructed in concrete with each having a lamella area of 82m^2. The Densadeg is a high rate lamella clarifier with internal sludge recirculation and integrated flocculation chamber. The standard maximum hydraulic load for sewage primary treatment is 25m/h over lamella area.

Effluent enters first into a flash mixing chamber where a coagulant PAC (Poly Aluminium Chloride) is dosed. Coagulated effluent then flows into the bottom of a slowly stirred flocculation chamber where polyelectrolyte is dosed to increase the size of the flocs. Immediately prior to entering this chamber the effluent is mixed in line with recirculated primary sludge, which encourages flocculation. The flocculated effluent goes into a plug-flow zone where laminar flow conditions encourage a slow flocculation producing dense and homogeneous flocculants of considerable size.

Finally, effluent enters the settlement zone which is equipped with lamella modules for accelerated clarification and with a picket fence/bottom scraper for integrated sludge thickening. A highly concentrated sludge is produced that can be sent directly to the dewatering stage. Part of this sludge is recirculated internally to enhance flocculation. Dirty backwash water from the downstream BAFF units is sent back to the Densadeg tanks for simultaneous co-settlement and thickening.

Secondary treatment

Clarified effluent flows by gravity to the adjacent eight Biofor® tanks. Each of which have a dedicated inlet well fitted with an inclined 1.2mm wedgewire screen. The Biofor® is a biological, aerated, flooded filter BAFF with both process air and effluent flowing in an upward direction. This process allows two simultaneous functions:

a) Biological oxidation/assimilation of soluble organic pollutant by fixed active biomass.

b) retention of suspended solids and associated insoluble organic pollutant by filtration.

***Biofor*® has the following specific features:**

- Biolite® is an expanded clay with high specific area, appropriate density and good resistance to attrition used as filtration media for the Biofor®. Its porosity ensures optimum biomass fixation.

Oxazure® - is a medium bubble air diffuser with elastic membrane. Optimum aeration is ensured by a dense grid of Oxazure at the bottom of the filtration bed.

Water distribution system

Distribution of settled sewage to filter bed is ensured by nozzles embedded in a monolithic floor. The up-flow process ensures distribution of water and air through the media, enabling a homogeneous suspended solids retention without any risk of short cuts or gas bubble entrapment. Homogeneous backwash water/air distribution is also ensured by the nozzles.

UV disinfection

Treated wastewater from the Biofor tanks goes to the UV disinfection units which consist of three channels, after which the flow rejoins the existing sewer via the new shaft and tunnel. There are two sets of 72 lamps in each channel (432 lamps) tubes in each channel. The UV plant has been designed on the basis of the following parameters – UV transmissivity of 45% with a minimum received dose of 24mWs/cm

Torbay: Construction work at Torbay *(courtesy South West Water)*

Odour control

Foul air extracted from different parts of the treatment works building is cleaned through a two stream, three phase, Azuair C treatment process. This process removes all odorous products found in the polluted air of the building by passing it through three scrubbing gas washing towers.

The first tower in each stream provides an oxidising environment with sodium hypochlorite intended to remove hydrogen sulphide and to a lesser degree amine compounds. The second tower provides a caustic environment with sodium hydroxide to remove the remaining hydrogen sulphide and other malodorous compounds. The third tower provides a reducing environment with sodium thiosulphate to work as a polishing stage and to remove any residual odour such as chlorine compounds

Each chemical scrubber consists of a tower packed with an inert material through which percolates the chemical solution. The base of the tower contains a sump for the recirculation of the liquid. Contaminated air is introduced at the base of the tower, above the sump, and passes up through the media. The liquid is sprayed over the top of the media and flows downward by gravity.

Duty/standby recirculation pumps are installed on each of the scrubbing towers. Each scrubbing tower has its dedicated chemical dosing pump for each type of chemical used. A common standby dosing pump is installed for each chemical dosed.

A continuous overflow at the base of the tower enables by products of the odour treatment process to be removed. Overflows from the towers are then returned to the head of the works for full treatment.

Sludge dewatering

Sludge originating from the primary and secondary processes are co-settled in the *Densadeg*® tanks. Excess sludge from Biofor® shows a good settleability and improves the flocculation of crude sewage when sent back to the clarifiers.

The co-settled sludge is thickened to a solids content of 4.5% in the *Densadeg,* thus eliminating the need for separate sludge thickening facilities. The sludge is then sent directly to the centrifuges for dewatering. Two centrifuges operate on a duty/duty basis and the target DS content after dewatering is 25%. Sludge is removed in sealed containers to a regional sludge treatment centre.

Teamwork

The design team of *Ondeo Degremont (Process) and Hyder Consulting (Civil)* worked closely together in a single office throughout the scheme to accelerate the provision and issue of drawings for construction. Civil engineering contractor, *Morgan Est* and all the major sub-contractors were brought into discussions on construction and installation methods so as to optimise the construction and maximise the opportunities for cost and time savings. The use of innovative construction methods and proprietary techniques contributed to significant time and hence, cost savings. The close partnership with all partners working to a common target cost, resulted in a good working relationship with shared resources and plant. There were several instances where additional expenditure by one partner gave an overall project cost and/or time saving benefit.

Project challenges

One of the biggest challenges to the construction works at Brokenbury was obtaining planning approval. Environmental considerations were of the highest priority for the project with noise, odour and visual impact being of prime importance. Odour emissions are believed to be the most onerous imposed on any such treatment works. The planting of more than 4500 trees and shrubs will further enhance the visual and landscaping aspects. An area of land to the side of the quarry has been set aside for informal public access, whilst an area on the other side of the quarry will be established to recreate a limestone environment for the attraction of butterflies.■

Note: *The author of this article, Peter Brookes, is Capital Investment Programme Leader with South West Water.*

Torbay: Work on 475m long interceptor tunnel *(courtesy South West Water)*