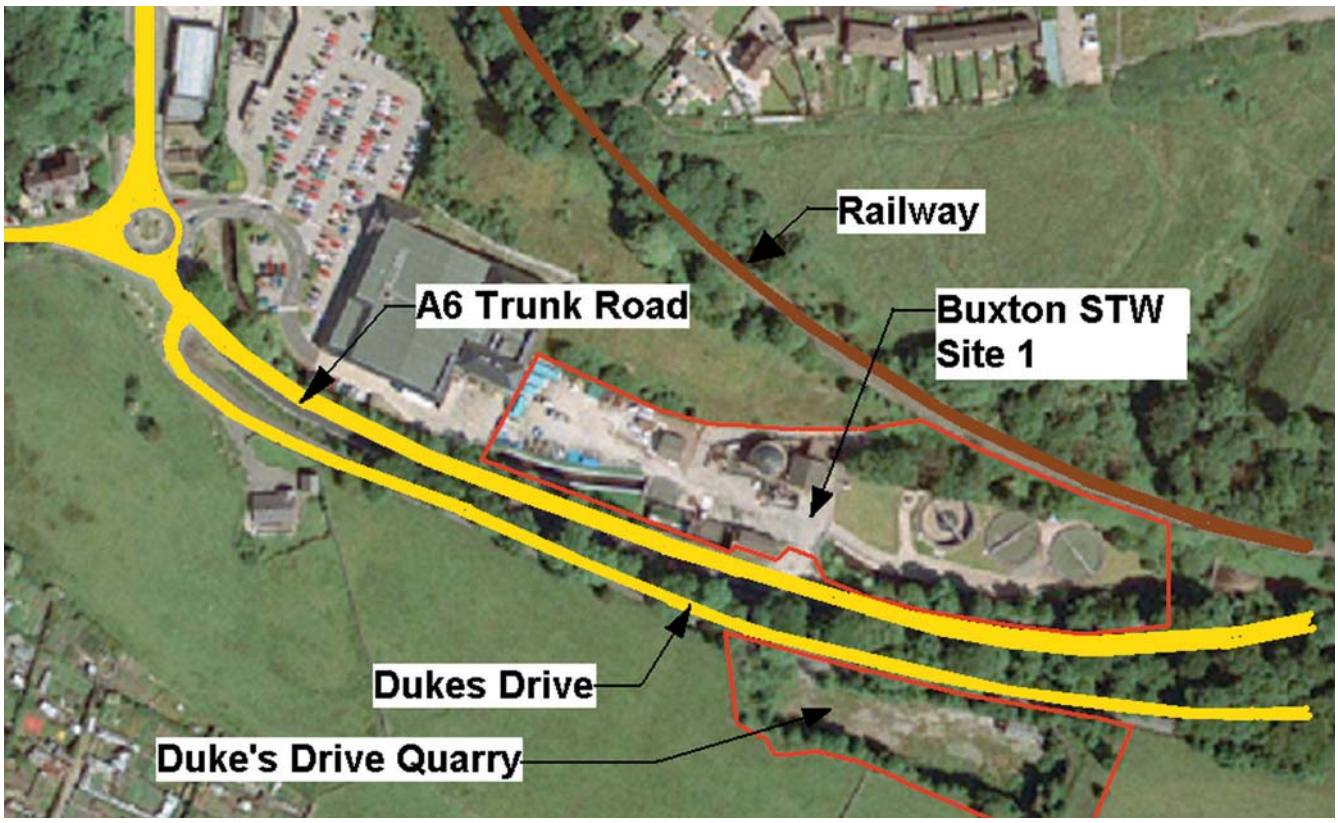
Buxton Sewage Treatment Works

new £12.5m Membrane Bio-reactor to meet Fisheries consent

by
Brian Morris CEng, MICE

The existing sewage treatment facility at Buxton has been developed over the years on two separate sites. Both sites lie within a section of the River Wye valley known as Ashwood Dale. The Dale also provides the main eastern corridor into Buxton for the busy A6 trunk road and the Buxton to Bakewell railway. The lack of space for further development on either of the operational sites was a key factor in the decision by Severn Trent to seek a small footprint solution. The treatment works is sized for a projected 2011/12 domestic population of 28,600.



Buxton STW: Aerial view of site courtesy: Severn Trent Water

Key driver for further investment at Buxton is the Urban Waste Water Treatment Fisheries Directive requiring the works to meet a new final effluent consent of 15mg/l BOD: 25mg/l SS and a seasonally variable ammonia consent of 5mg/l (summer) and 10mg/l (winter). Compliance with the quality driver is required by the end of March 2005.

Existing works

The existing works occupies two sites approximately 500 metres apart along the Wye valley. Site 1 accommodates the inlet works, storm tanks, primary settlement tanks, sludge digesting facility and sludge holding tanks. Site 2 contains rectangular filter beds and humus tanks and is operated on a double filtration basis. The sites are linked by two pipelines, a gravity main to transfer settled sewage and a smaller humus sludge return pipe.

Feasibility studies

Severn Trent Water's process selection matrix solution for the Buxton population and future consent standard would normally be an activated sludge plant.

Due to lack of space, early feasibility studies focussed on the possibility of relocating the entire works. Thirteen possible brown field sites in the Buxton area were assessed. Three of these sites were given detailed consideration. The favoured sites were disused quarries where the environmental impact of the plant could be minimised. However, the additional cost of transferring flows from the existing Site 1 either by sewer or rising main combined with the cost of providing other infrastructures such as access roads proved to be prohibitive. Feasibility concluded with the recommendation for a membrane plant to be constructed in Dukes Drive Quarry, which is a small disused limestone quarry located approximately 50 metres south of Site 1. The membrane plant has a footprint of approximately one third that of a conventional ASP.

Site investigation

Site investigation boreholes established that the quarry had been in-filled with inert waste and ash material to depths of up to 7 metres. This necessitated piled foundations for all structures. The ash material was also found to contain elevated levels of lead, copper, nickel and zinc with isolated hot spots of hydrocarbon contamination. Remediation involved localised removal of the 'hot spots' and the placing of a 300mm capping layer of compacted stone across the whole site.

Procurement
The project was procured on a design and build basis under the General Conditions of Contract for Water Industry Plant Form G/90. Contractor selection was by competitive tender. Three tenderers were chosen from Severn Trent's select list of AMP3 process contractors. The project specific information provided to tenderers was supplemented by Severn Trent's standard AMP3 civil mechanical and electrical standard specifications.

A tender process identified *Biwater Treatment Ltd* as the preferred contractor. *Biwater's* proposals included two particular initiatives that were to give them a clear advantage over the other tenders:

* development of an open cut proposal for crossing the River Wye, A6 trunk road and Dukes Drive. The result was a considerable saving in direct costs and the removal of considerable contingency monies from the commercial risk register for tunnelling related items;
* Biwater proposed the reuse of the R.C. basement structure of the digester plant heater house to accommodate the new inlet works.

Contract strategy
After reaching 'preferred contractor' status there followed an extended period of design development which involved the *Biwater* design team, Severn Trent engineers, technology and development and operational liaison staff. The construction contract was awarded on a target price, cost reimbursement basis with a pain/gain incentive scheme. Particular attention was given to developing the risk register during the design development period and valuing any changes from the original tender.

Inlet works
It is essential to protect the membranes at all times from damage from sewage debris. The design of the inlet works is crucial to the successful operation of the plant and ensuring that the projected asset life of the membranes is fully realised.

The new inlet works has been constructed largely in the basement of the digester heater house which was demolished as part of the enabling works on Site 1. The new inlet works comprises:

* rotating bar interceptor;
* two 6mm Three Star belt screens operating on a duty-assist basis with hand raked bypass;
* *Pista* grit trap with air lift pump discharging to a *Grit King* classifier;
* separation of flow to full treatment (195 l/s);
* two x 3mm *Three Star* belt screens operating in a duty-stand by basis with no bypass. Each screen sized to accept 195 l/s;
* screenings transfer for both 6mm and 3mm screens is by launder channel and macerator pumps which lift the screenings to a *Haith* washer compactor;
* inlet works channels are covered and ducted to an *OCS Peacemaker* odour control unit;
* screenings processing is undertaken within a building which is also connected to the *Peacemaker* unit. Dewatered screenings and grit are discharged into separate skips inside the building.

Flow to full treatment pumping station
Dukes Drive Quarry is approximately 15 metres higher than Site 1. Flows to receive full treatment are lifted via a pumping station containing duty/assist and standby *Flygt* variable speed submersible pumps.

Membrane plant
The new plant in the quarry consists of the following:

* anoxic zone and flow split to aeration lanes;
* three reinforced concrete aeration lanes. Unusually for an aeration plant the lanes are covered by a steel framed canopy structure. The purpose of the canopy is to prevent ingress of windblown debris such as leaves and twigs from the many trees which line Dukes Drive. Any such ingress at this stage of the process would pass forward to the membrane lanes;
* flow split to six membrane trains. Each lane contains 11 membrane cassettes. Space for a further two cassettes per lane has been allowed;

At the end of the aeration lanes duty and standby aeration recycle *Flygt* pumps return a constant 115 l/s (1x DWF) via a 0.75mm *Longwood brushed* 'D' screen to the anoxic zone. The purpose of the fine screen is to control the build up of hair and fibrous material which could become entangled around the membrane fibres.

Permeate is withdrawn from the membranes utilising the head differential between Dukes Drive Quarry and Site 1.

Process air is delivered by duty and assist variable speed ABS centrifugal blowers.

Scour air is provided by duty and assist fixed speed ABS centrifugal blowers. A common standby blower is available to cover process and scour air.

Three duty and one standby variable speed Grundfoss membrane recycle pumps capable of returning up to 4 x DWF to the head of the aeration lanes.

Cleaning of the membranes is carried out in various ways:

* regular back-pulsing of the membranes using permeate. Each train of membranes will be back-pulsed for approximately 30 seconds every five minutes;
* scour blowers provide coarse bubble aeration to gently agitate the cassette fibres to dislodge particulate matter;
* at approximately weekly intervals each membrane train is subject to a chemical cleaning cycle. A solution of hypochlorite is introduced into the backwash to clear any biological fouling of the membrane pores. Chemical cleaning is initiated by increases in trans-membrane pressure;
* at monthly intervals the backwash chemical clean will be undertaken with a solution of citric acid;
* at six monthly intervals each membrane train is taken out of service for about 24 hour to undertake a full immersion clean in a solution of hypochlorite.

Project status
Installation of the membrane cassettes was completed by mid May 2004. Commissioning of the new inlet works was to be completed by June 2004. Imported thickened activated sludge from the company's ASP at Derby will be used to seed the aeration process. This was scheduled for July 2004.

It is proposed that six membrane trains will be commissioned in pairs.

The contract includes an extended proving trial of 12 weeks. During this period the plant will be jointly operated by *Biwater* and Severn Trent Water. Completion of the 12 week trial is anticipated by October 2004. However, process maturation is expected to be fairly rapid with consent compliance being achieved within three weeks of seeding. ■

Note: *The author of this article, Brian Morris, is Senior Engineer, Severn Trent Water*