Peel Common Nitrogen Removal Scheme

one of six schemes have nitrogen removal as common objective

by

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Southern Water is carrying out £1.8 billion of capital schemes between 2005 and 2010. 4Delivery, a consortium comprising United Utilities, Costain and MWH has been contracted to deliver more than 250 of these schemes. This portfolio of work contains six schemes that have the common objective of nitrogen removal, of which Peel Common, a wastewater treatment works (WTW) located in Hampshire, on the south coast, near Fareham is one of the six. Peel Common works treats the wastewater from Fareham and Gosport catchments with a total population equivalent (PE) of approximately 250k with full flow to treatment limited to 1424 l/s.Peel Common had a very tight programme and achieved process conversion to 10 mg/l total nitrogen (TN) standard before the end of March 2008.

Aerial view of Peel Common Wastewater Treatment Works *photo courtesy of 4Delivery Ltd*

Nutrient Consents

Nutrient removal in wastewater treatment normally means the removal of phosphorus and or nitrogen to levels at which eutrophication is limited in the receiving waters. Eutrophication is defined as 'a process whereby water bodies receive excess nutrients that stimulate excessive plant growth'. This enhanced plant growth, often called an algal bloom, reduces dissolved oxygen in the water when dead plant material decomposes and can cause other organisms to die.

Where waters are defined as sensitive by the EA with respect to particular nutrients, the final effluent discharge needs to achieve 2mg/l total P and/or 15mg/l TN as annual averages for works between 10k and 100k pe and 1 mg/l total P and/or 10 mg/l TN as annual averages for works between 100k pe as defined by the UWWTD. Alternatively, percentage removal of 80% total phosphorus and 70-80% total nitrogen can also be applied.

The Environment Agency (EA) has recently designated the Solent, which is the area of sea between the UK mainland and the Isle of Wight, as well as harbours around the area as sensitive waters in regard to eutrophication. Peel Common serves a PE in excess of 100,000, and so due to the sensitive waters designation and the UWWTD, was required to achieve a 10 mg/l TN standard by the end of March 2008.

Existing process

The inlet flow from the Fareham and Gosport catchments undergo screening and primary treatment before they combine prior to the secondary treatment stage. The previous consent required carbonaceous treatment to achieve the consent of 60 mg/l SS and 25 mg/l BOD. The secondary treatment was achieved using the activated sludge process. This consisted of 4 No. lanes each with an anoxic zone and aeration zone, with a total capacity of 28,000 m^3. The flow from the lanes was combined before distribution to 4 No. 48m dia final settlement tanks as indicated in figure 1.1. The existing carbonaceous process was managed using only 3 of the 4 ASP lanes, and adequate settlement was achieved using only 3 of the 4 secondary clarifiers.

Process Modifications

To achieve TN reduction the existing activated sludge process was modified and a duplicate ASP was constructed doubling the capacity of the secondary treatment stage. This allows nitrification to be achieved in the aerobic zones and denitrification to take place in the anoxic zones.

The Peel Common Pong has Finally Gone

Bord na Mona's MONASHELL biofilter at Peel Common

Peel Common Wastewater Treatment Works at Fareham in Hampshire serves nearly a quarter of a million people. Since it opened in 1980 residents in Fareham and Gosport have been repeatedly complaining about the `eggy' smell emanating from the plant caused by high hydrogen sulphide concentrations. A number of measures have been put in place in the past to combat the smell including dosing the sewage beds with chemicals, covering certain wells and installing filter beds. None of these measures have been particularly successful to the extent that the smell became infamous and was nicknamed the "Peel Common Pong".

The problem became so acute that a local group of residents and councilors decided to kick up a stink. They formed an odour forum that began to work with Southern Water to investigate the problem and look for a solution. The solution came in the shape of a seashell. Bord na Mona's patented MONASHELL enhanced biofiltration system has a number of innovative features that can cope with the varying concentrations of hydrogen sulphide and other odorous molecules in the smelly gases emanating from the plant. A MONASORB activated carbon filter system is incorporated as a final polishing stage to ensure the Peel Common Pong is finally gone.

The success of Bord na Mona's approach and technology is not only apparent in it's ability to meet Southern Water's legal obligations, but can be measured by the approval of local councilors and residents. Leader of Fareham Council, Sean Woodward, said: "The smell used to be completely awful. When I first joined the council back in 1986 it was a problem and it has been a talking point ever since. However, there appears to have been a significant improvement." A rapid reduction in the number of complaints was noticeable overnight. Southern Water's Principal Process Scientist, Nigel Palmer, concurs: "By the time the gas passes through the layers of shells, the bacteria and carbon have removed most smells". The Odour Forum are also pleased with the success of the new technology. In a recent visit to Peel Common the Forum found the results of the new green solution "fantastic".

The success with the Peel Common Pong led Southern Water to look at further biofiltration systems. Unfortunately they recently installed an ineffective woodchip and seaweed system from another supplier to control odour from the inlet works. Bord na Mona were delighted to be invited back to Peel Common to help Southern Water make critical improvements to this system.

"Wood chip biofiltration has been heralded as a cheap alternative media for the treatment of odours and can be effective for treating odours that are clearly defined and vary little both in their nature and concentration. Unfortunately, in Bord na Mona's experience, few waste water treatment plants have such predictable loadings. Thus odour control systems require the flexibility and adaptability to handle unpredicted load changes to be sure that odour emissions continually meet legal obligations," explains Bob Maloney, Bord na Mona's Director.

After analysis of the failing biofilter's performance it was clear that the filter was experiencing loadings well beyond its treatment capability. The woodchip unit was both undersized and unable to adapt to high peak loadings, so Bord na Mona retrofitted a MONASORB unit to it.

"Experience is the key to successfully treating odours, particularly from waste water treatment plants. Often it is advisable to install a system that can cope with transient higher loadings than specified. Correct design and high build quality together with careful selection of the right media is essential to deliver a reliable and effective odour control system. Get this wrong and you may buy something that can be problematic and require retrofit technology to make it perform properly," reflects Bob Maloney. "Our confidence in our ability to deliver effective odour control systems is backed by our performance guarantees, bringing our customers peace of mind."

Southern Water Process Scientists are always looking to adopt appropriate technologies to benefit the environment and Bord na Mona now supplies more than 10 Southern Water Wastewater Treatment Works with MONASHELL systems.

Part of new equipment at Peel Common *photo Courtesy 4Delivery Ltd*

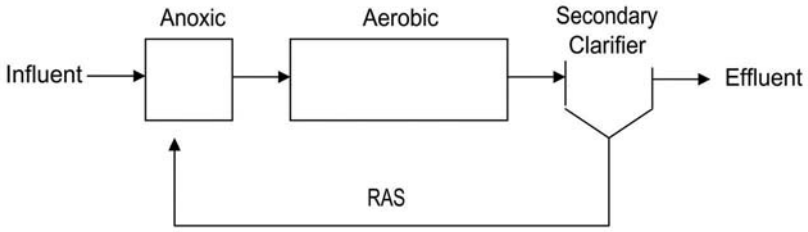


Figure 1.1 – Existing carbonaceous activated sludge process

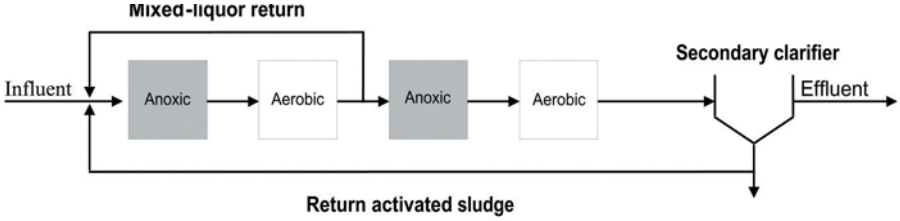
A full flow and load wastewater characterisation survey was conducted that identified that the incoming flow contained quantities of nitrogen higher than typical industry design parameter, and low levels of readily biodegradable COD (rbCOD). The rbCOD is necessary to achieve denitrification and without sufficient quantities an external carbon source is required. For Peel Common it was determined that methanol provided the most appropriate solution as this achieves the lowest whole life costs.

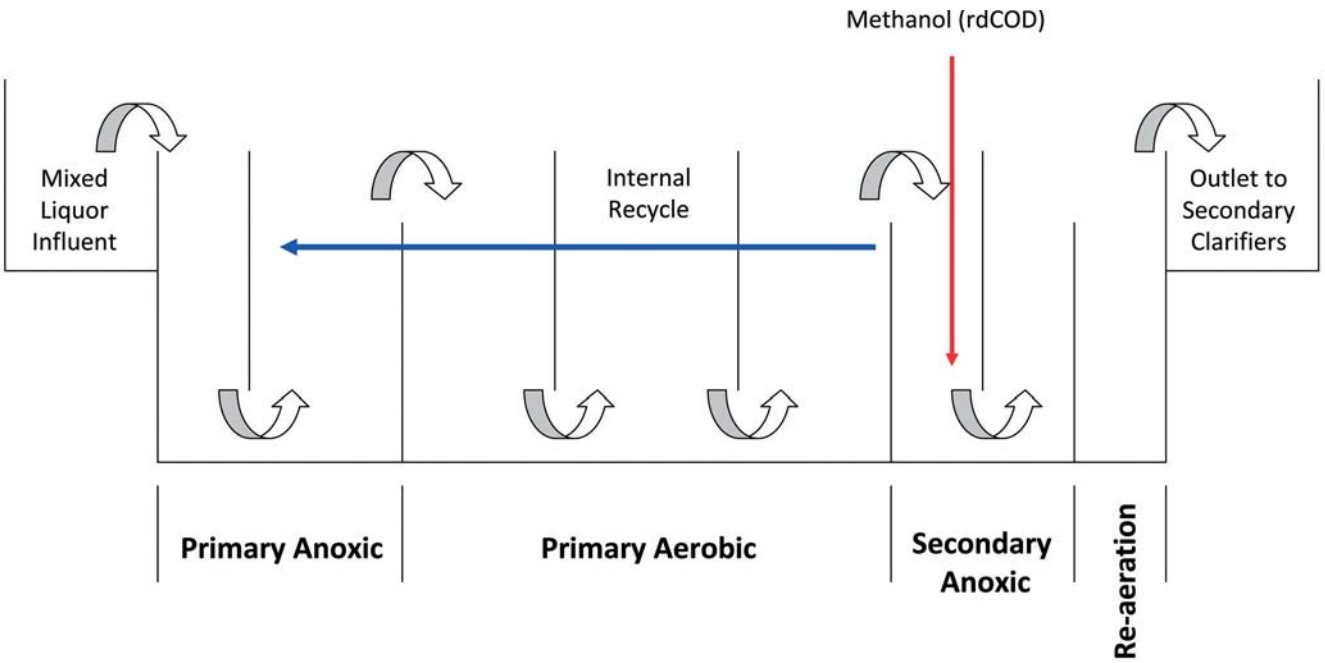
The process design approach was streamlined in order to meet programme dates, for Peel Common a minimum sludge age of 20d was targeted for nitrogen removal rather than the empirical approach of using food to microorganism ratio. This resulted in an additional ASP tank mirroring the existing refurbished ASP. This mirroring allowed the same aeration volume in each ASP, which suited flow distribution. Accurate hydraulic modelling allowed the flow split to be achieved using gravity head, eliminating additional pumping stations. A study into the secondary clarifiers showed that additional capacity was not required.

A number of different denitrifying configurations were considered before selecting a four stage Bardenpho configuration as indicated in figure 1.2 (below). This process configuration is proven at full scale to work successfully and has an efficient methanol utilisation.

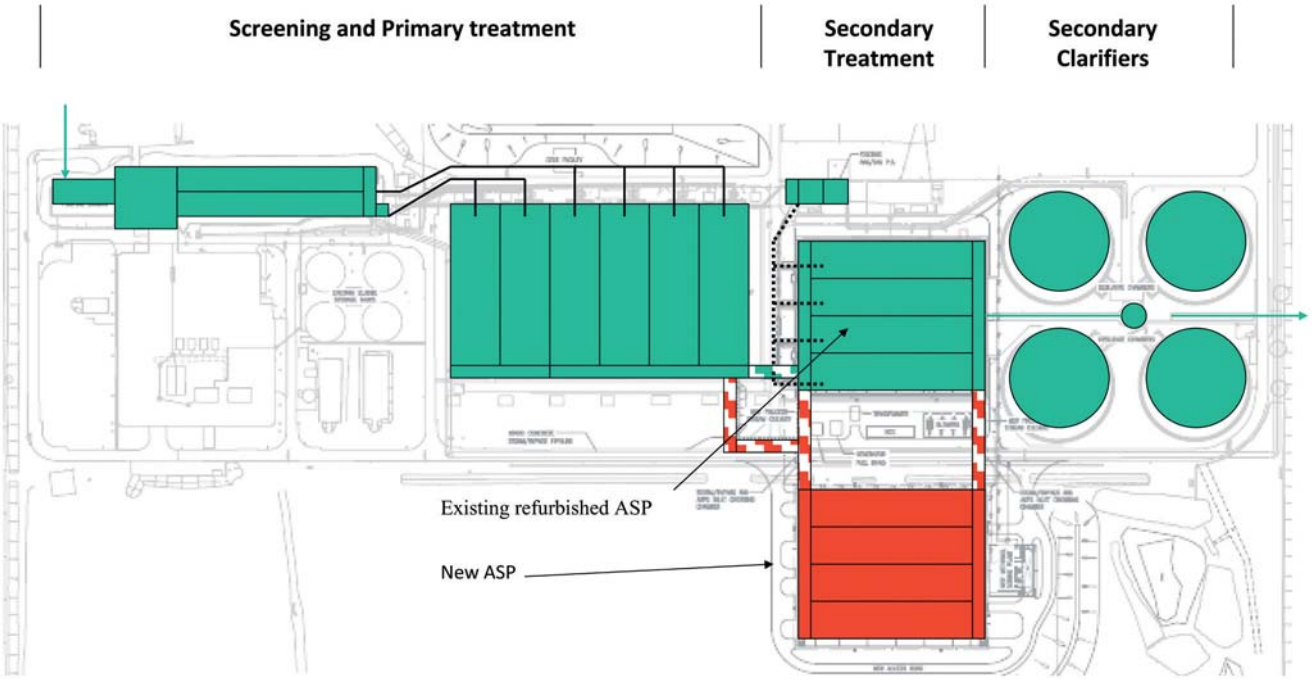
Application of the design

The incoming flow to the secondary process was split evenly between the new ASP and the refurbished ASP. The existing ASP consisted of a tank containing four parallel lanes fed by a common distribution channel delivering primary effluent and an individual Returned Activated Sludge (RAS) pipeline. To reconfigure the existing ASP to the four stage Bardenpho process the lanes needed modification. The refurbishment required the removal of all previous baffles and aeration equipment. This was achieved whilst ensuring the other





Cross-section of ASP configured to support 4 stage Bardenpho process



Schematic of Peel Common WwTW

lanes continued normal operation, ensuring compliance. The fit-out of all the lanes, both in the new ASP and the existing, followed the same format. The lane was split into 8 cells, these cells would support the 4 zones of the Bardenpho process. The lanes now have a larger primary anoxic zone and increased aeration capacity. An internal recycle system returns the mixed liquor from the end of the primary aerobic zone back to the primary anoxic zone. The methanol, which supplies the additional rdCOD for the de-nitrification process, is injected into the secondary anoxic zone. The plug flow then moves to the re-aeration zone before onward to the secondary clarifiers.

The modifications to the existing ASP were also designed to enable the lanes to be refitted, put back in service in the carbonaceous mode and to then switch over to operate in the denitrification mode when the whole plant modification was completed.

The flow distribution is achieved by combining the RAS and primary effluent before distribution to the lanes. This mixed liquor flows via submerged culverts into the distribution channel on each ASP tank. As the new ASP tank is a mirror of the refitted existing even flow distribution is accurately achieved. Modelling of the hydraulics allowed the design to make use of the gravity head on the site, therefore removing the need for pumping station at either inlet or outlet of the new ASP.

To achieve these modification to an existing works while maintaining compliance has provided lots of challenges. This has required the team to innovate, and apply techniques in new ways and to re-use and reconfigure existing structures. Under pressure coring to construct connections onto live process units has enabled process units to operate unaffected without the traditional need to take them

offline. The teamwork approach has enabled ideas to be quickly evaluated and enabled opportunities to be realised.

The nitrogen removal schemes of Peel Common and Budds farm have been the first to successfully apply this configuration at this scale within the UK, and achieve the 10mg/l TN consent. The team has liaised closely with MWH's nutrient removal experts across the globe to gain from their extensive design and commissioning experience. BIOWIN modelling was used to further optimise the configuration and this resulted in both operational and capital saving.

A number of design features were incorporated within the design to ensure commissioning could be achieved and the current consent could be met. These features included the use of sacrificial diffusers in future anoxic zones to provide aeration, configuration of new structures to act as temporary works and installation of pipeline connections to aid flow diversion.

Despite being a highly complex project with large inherent risks and tight deadlines, Peel Common achieved successful takeover two weeks ahead of schedule. Through the fast-track delivery of schemes such as these, Southern Water is working to reach their regulatory outputs. Peel Common is currently the location for an optimisation trial, which if successful will be rolled out to other schemes.

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