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Appendix 6.2

BIORESOURCES STRATEGY

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Contents

Key points of our strategy:

- Two centralised advanced anaerobic digestion (AAD) sludge treatment centres for all NWG sludge and for trading in the bioresources market;
- Upgrade of biogas to biomethane and injection into the natural gas grid at Howdon with plans for an installation at Bran Sands;
- Use of combined heat and power (CHP) at Bran Sands (and optional at Howdon) to harness the energy in biogas to generate renewable electricity and recover heat for the process;
- Transport strategy based on a network of local dewatering sites at six strategic sludge handling centres and onward transport of sludge cake by truck into AAD;
- Thickened raw sludge transported by road tankers 24/7 into SHCs or direct into AAD;
- Cake import and blending facilities at Bran Sands and Howdon;
- Fertiliser biosolids products recycled safely and beneficially to agriculture under the Biosolids Assurance Scheme (BAS).

Our robust long term strategy is founded on solutions that are safe (compliant with regulations and BAS), secure (low risk of failing), flexible (adaptable to changes and opportunities), economic (lowest whole-life cost) and sustainable (objectives of sustainable development).

Introduction

Our strategy for treating and recycling sewage sludge has evolved over the past 20 years. It is now considered to be industry leading, being an example of dynamic efficiency from innovation. In fact, our relative unit operating costs per tonne of dry solids are the lowest out of the 10 Water and Sewerage Companies (WaSCs) operating in England and Wales (Ofwat, May 2016).

We changed our strategy in 2007 from thermal drying and lime stabilisation to advanced anaerobic digestion (AAD). This change was driven by a number of factors, including:

- The cost of thermally drying our sludge increased significantly due to an unprecedented rise in the cost of energy, in particular natural gas;
- Maintenance costs at our regional sludge drying centre (RSTC) increased as the product was more abrasive than anticipated;
- Advances in digestion technology with the application of thermal hydrolysis transformed the economics of anaerobic digestion (AD).

A great many alternative options for treatment, transport and product re-use or disposal were considered in the development and evolution of our long-term sludge strategy. These options were all economically evaluated based on whole-life NPV models along with environmental and social aspects. A detailed matrix was used to compare and score these options against the following strategic objectives:

- safe - compliant with regulations;
- secure - low risk of failing;
- flexible - adaptable to changes and opportunities;
- economic - lowest whole-life cost;
- sustainable - meets the objectives of sustainable development.

We constantly consider technical and operational choices for managing our sewage sludge including new emerging technologies, optimisation of existing assets, trading in the bioresources market and opportunities for further efficiencies. We review our sludge strategy in light of any significant changes, such as in technical capabilities, regulatory aspects, risk and economics.

Sludge treatment centres

We operate and carefully manage the life cycle of sludge that is continuously produced from over 400 sewage treatment works (STWs) in the north east of England across an area of 9,422 square kilometres. Our region includes large sparsely populated areas that are served by a very large number of small or very small STWs. To the west of the region we have the Pennines, to the south the North York Moors, and to the north the Scottish Borders.

The majority of our 2.7 million customers live within twenty miles of the coast, around the main rivers of the Tyne, Wear and Tees. As a result, the greatest sludge volumes produced are from the main conurbations of Tyneside and Teesside.

We have taken advantage of this geographical population profile in developing our sludge treatment centre (STC) strategy, where all sludge is effectively treated, and renewable energy recovered, at one of two large AAD facilities. Our Tyneside site, co-located at Howdon STW, covers the northern half of our operating area, while our Teesside site is co-located at Bran Sands STW, covering the southern half of our operating area. This strategy provides economies of scale in AAD processing, minimises transportation costs and maximises energy recovery, by co-locating facilities with large STWs that produce high volumes of fresh energy rich sludge.

Our Bran Sands AAD facility was successfully commissioned and handed over operationally early in 2010. Howdon AAD was subsequently commissioned and operational in January 2013.

Sludge handling centres

Our transport operation was previously based on liquid sludge transfer by road tankers and sludge ships. As part of our strategy, we changed to cake transport where this was practical and cost effective. This is ideal for the AAD process as the sludge entering the thermal hydrolysis process prior to AD needs to be at around 16.5% dry solids.

We have a network of 6 strategic sludge handling centres (SHCs), co-located on STWs at key locations, which act as local 'hubs' that receive liquid sludge from satellite STWs by road tanker. This is based on proximity, availability and cost minimisation principles (e.g. considering transport, sludge treatment, energy recovery and end product recycling).

These centres support each other, providing flexibility and operational resilience. Each site consists of centrifuges, cake silos and cake loading conveyors. They produce raw sludge cake that is transported by road truck/trailer to Bran Sands and Howdon STCs.

The strategic SHC dewatering sites are co-located at the following STWs: Birtley, Hendon, Morpeth, Stressholme, Tudhoe Mill and Willington.

We have realised a significant and sustainable reduction in transport costs and carbon footprint by transporting sludge cake as opposed to liquid. To illustrate this, previously transferring 2,000,000m^3 of liquid sludge meant 90,000 road tanker journeys per year. By dewatering, this has resulted in far fewer journeys, with 320,000m^3 of sludge cake transferred through just 10,000 trailer loads per year.

Sludge transportation

Our sludge transportation and recycling operations are managed by a small dedicated sludge management operations team (5 employees). They direct our fleet of sludge haulage vehicles around the clock using state of the art equipment, such as Global Positioning Systems (GPS), vehicle telematics and logistics planning systems.

The fleet, owned and maintained through a joint venture company, currently consists of the following:

- 9 articulated tankers working between 144 and 168 hours a week via 24 agency drivers;
- 8 rigid bodied tankers operated on 5 day coverage with weekend standby by 11 agency drivers;
- 1 operational 30 tonne tipper truck with 2 spare trailers operated between 144 and 168 hours per week by 3 agency drivers across our 6 strategic SHC sites.

Our major STWs, STCs and SHCs are equipped with monitoring devices that provide just-in-time information, such as storage levels and sludge quality, for input into our integrated sludge movement planning and scheduling system.

Biosolids recycling

The end product from AAD, in addition to from biogas, is digestate (biosolids). Our normal operational option is to sustainably recycle this material as a fertiliser to agricultural land in accordance with all applicable regulations. This is recognised as the Best Practicable Environmental Option (BPEO) for biosolids, adding plant nutrients and humus-forming material to enrich the soil, and is supported by the UK Government. We also maintain flexible contingency options for our sludges through our supply chain to cater for planned and unplanned events. Our contingency options include composting and lime stabilisation followed by recycling to agriculture.

Energy generation

Our strategy is based on optimising our sludge production in favour of thickened fresh sludge to take full advantage of its renewable energy recovery potential through our AAD process. We consider many factors, such as transport, treatment, availability, reliability, regulatory compliance and energy recovery, when deciding on the optimal route for our sludges.

Using high quality biogas in combined heat and power (CHP) engines to generate renewable electrical energy was a part of our 2007 AAD and energy recovery strategy. We claim Renewable Obligation Certificates (ROCs) under the Government's RO scheme, administered by Ofgem for eligible electrical energy, with 1 ROC equivalent at Bran Sands and 0.5 ROC at Howdon.

Gas engines running on AAD biogas operate at average conversion efficiencies of around 40% and can require significant amounts of maintenance, depending upon the quality of biogas.

Since 2014, we now directly inject energy rich biomethane into the natural gas grid at Howdon after it has been upgraded from AAD biogas to remove carbon dioxide and impurities. The energy conversion efficiency for gas to grid (G2G) is over 95%, considerably more than from CHP gas engines. This also means a greater proportion of renewable energy (GWh), and has led to further operational efficiencies from gaining valuable renewable energy incentives (Renewable Heat Incentive) which support the Government's renewable energy policy.

We are also planning to deliver G2G at our Bran Sands AAD site, which will generate further revenues and protect customer bills. This will also mean that we would be the only water and sewerage company to have 100% of our energy-rich biogas used through this valuable route, further strengthening our status as the leading bioresources market business in England and Wales. This position will also allow us to explore other sustainable uses for our biogas products, such as in road fuel under the UK Government's Renewable Transport Fuel Obligation.

Recovered energy can be utilised at Bran Sands and Howdon to power the sewage treatment processes, thus these works are now moving closer to being 'self-sufficient'. State-of-the-art intelligent operation of our sludge treatment processes minimises resource use and maximises energy generation.

Maintenance

We carefully plan outages for operational and regulatory reasons. These are necessary to maintain our ability to process sludge and generate renewable energy. The coordination for these outages is part of our business-as-usual processes, having been refined over a number of years of operating AAD plants. We coordinate activities for outages between the two AAD centres, our sludge transportation team, and our strategic sludge handling and storage locations.

Outages are managed with minimal downtime and disruption. We currently do not have any third party suppliers to take into consideration, but we believe our planning and implementation of outages is world class and capable of taking into account the requirements of any third parties in the future.

As an industry, we actively share best practice and lessons learned in the efficient operation of AAD facilities, such as through a Cambi User Group and specific knowledge-sharing sessions.

Bioresources market

There are currently no sludge treatment facilities operated by third parties in our area of supply capable of dealing with our sludge volumes or offering a more efficient treatment option. No adjacent water companies operate facilities within an economic transport distance. Our own strategic sludge handling and treatment centres are ideally placed to take all of our sludge arisings efficiently, now and into the future.

We have previously been able to accommodate sludge inputs from third parties, including other WaSCs. This has typically been for a short timescale of a matter of a few months. Depending upon the volumes, type and quality of the sludge involved, we have some ability to adjust the balance of sludge transported into our AAD centres by taking into account the efficient use of capacity in our sludge assets, including for SHCs and strategic storage.

The quality of traded sludge must not impact unduly on our treatment process and our ability to safely recycle biosolids under the Biosolids Assurance Scheme (BAS).

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We are continuing to investigate the potential for long-term treatment contracts for bioresources arising from neighbouring WaSCs, particularly those located relatively close to one of our AAD centres. For example, we have been actively engaging with Yorkshire Water in their 2018 Bioresources Market Testing of the collection, treatment and recycling of bioresources to offer them resilient, innovative and efficient solutions. This activity has been led by our Commercial team, who together with our Bioresources Management team have vast experience and expertise in the development, installation and operation of innovative, resilient and specialised solutions.

As part of our commercial operations, we operate seven wastewater and sludge treatment facilities in Scotland (Ayrshire and Fife) and in Ireland (Cork) that consist of anaerobic digestion and thermal technologies. We have also commissioned a farm-waste AD facility in Leeds, including energy recovery through CHP and G2G biomethane injection.

We will also continue to explore other opportunities, such as in fleet management services, expanding our organic waste facilities, continuing to optimise our current bioresources service, and looking for additional options to recover energy. We are applying for a Standard National Open Operators Licence (O licence) to enable trading using our bioresources fleet.

Our customers will share in any benefits that the appointed business gains from importing, treating and recycling bioresources or organic material using appointed business assets. This will be done through the transfer price taking into account incremental costs and an appropriate share of the margin that reflects the risks incurred by both the appointed and non-appointed businesses.

In the past we have also provided ‘seed sludge’ to other WaSCs for commissioning of new sludge treatment facilities.

Measurement of sludge

We currently measure sludge production at a number of points in the sludge chain as part of our integrated sludge movement planning and scheduling system. Our major STWs, along with our STCs and SHCs, are equipped with level, flow, weight and dry solids measurement devices to provide just-in-time information. We also carry out extensive operational measurements using bench dry solids analysers, backed up with regular laboratory sampling and analysis (internally and externally).

The points in the sludge chain that we measure are as follows:

- Tanker volume (weekly tanker sheets) and deemed % dry solids (i.e. according to type of sludge) for small STWs only;
- Tanker volume and measured % dry solids;
- In-line sludge flow meter and dry solids meter (e.g. WaSP Units) at main tanker import points (SHCs and STCs), including commercial tankers;
- In-line sludge flow meter and dry solids meter in STCs both pre-AD and post AD (centrifuge for biosolids);
- Actual weight (weighbridge) of raw sludge cake and measured % dry solids (SHCs trucked into AAD);
- Actual weight (weighbridge) of all biosolids and measured % dry solids (all treated sludge from AAD).

All data is captured in our corporate systems, including site measurements undertaken by our operational teams.

Our methodology is focused towards more direct measurement further up the sludge chain. The approximate proportion of sludge directly measured, either by in-line sludge flow/dry solids metering and weighbridges with dry solids measurement, is about 95% of our sludge production. The remaining sludge volume is mainly from many small rural STWs.

Direct measurement requires calibration to maintain the level of accuracy. We undertake regular calibration of our monitoring equipment, taking into consideration manufacturer's recommendations, best practice, and performance.

This approach offers robust measurement of the vast majority of our sludge producing sites, and allows for continuous improvement towards further minimisation of transportation costs and maximising energy generation. It follows Pareto's principle in that 20% of our largest works produce over 80% of our sludge.

Conclusion

The change to AAD has resulted in significant, reliable and sustainable cost savings, as well as environmental benefits. For example, we now produce 50% less biosolids for recycling to agricultural land, and during 2013 there was only one odour complaint for our entire recycling service.

Our sludge strategy provides a robust framework for the way in which we manage sludge in the business. This allows for both long-term and short-term operational management and capital investment decisions to be planned and justified in the wider context. We believe that our sludge strategy is sustainable and industry leading.

Our six strategic STCs and two treatment centres are ideally placed to efficiently take all of our sludge production now and into the future, whilst also trading in the bioresources market.