= Blackburn Meadows =

Blackburn Meadows is an area of land just inside the Sheffield city border at Tinsley . It became the location of the main sewage treatment works for the city in 1884 , and is now one of the largest treatment works in Britain . The treatment process was rudimentary , with sludge being removed to ponds and then to drying beds , after which it was used as manure or transferred by rail to a tip at Kilnhurst . The works progressively expanded to improve the quality of effluent discharged to the River Don and was a pioneer in the use of bio @-@ aeration , following experiments by the works manager during the First World War . This process became known as the " Sheffield System " , and was demonstrated to visitors from Great Britain and abroad . Despite these improvements , ammonia levels in the river below the works were high , and fish populations did not survive .

The works had its own internal standard gauge railway for over 100 years , which used three steam and three diesel locomotives over the course of its existence , until its replacement by road vehicles in the 1990s . During the 1926 general strike , the locomotives hauled trains over the main line , delivering wagons to Kilnhurst tip under a special dispensation . By the 1960s , the Sheffield sewer system was inadequate for the volume of effluent produced , and the Don Valley Interceptor Sewer was tunnelled beneath the city to the works , enabling 26 storm sewage overflows into the river to be shut down . Water quality was further improved by a new treatment process installed in 1992 to reduce ammonia levels , enabling fish stocks to be re @-@ established in the lower River Don . Subsequent improvements have been made so that the works complies with the Waste Incineration Directive and the Freshwater Fish Directive . The works was inundated by flood water on 25 June 2007 , when the Don burst its banks , but was recommissioned in just 18 days .

A power station was operational on the southern part of the site from 1921 , supplying electricity to the steel works of the Lower Don Valley . Although it closed in the 1970s , two of its cooling towers which were designed by L. G. Mouchel and Partners in 1937 , remained until 2008 , as demolition was difficult because of their proximity to Tinsley Viaduct , which carries the M1 motorway across the Don valley . Following extensive upgrading of the treatment works , to improve the quality of discharges to the river still further , the sludge beds became redundant , and have been turned into a nature reserve , providing habitat for migrating birds .

= = Sewage Treatment Works = =

Blackburn Meadows is the lowest point within Sheffield City Council area . The River Don flows out of the city under Templeborough railway bridge past a benchmark set at 96 feet (29 @.@ 27 m) above sea level . The meadows therefore formed a good site for a sewage treatment works , and Blackburn Meadows works was opened in 1886 . It is located on a site to the north of the Don , and to the east of Tinsley Viaduct . In 2006 it was claimed to be the second largest treatment works in the United Kingdom , processing 79 million gallons (360 @,@ 000 m3) of effluent each day , with only the works at Leeds processing more .

= = = History = = =

As the population of Sheffield increased , Sheffield Corporation bought 23 acres (9 @.@ 3 ha) of land at Blackburn Meadows , on which to build a sewage treatment works . In August 1884 , William Bissett and Son won the contract for its construction , which was overseen by Thomas West , who acted as Clerk of Works . 100 feet (30 m) of standard gauge railway track connected the limeshed to a junction with the Manchester , Sheffield and Lincolnshire Railway . Bissetts had completed their work by January 1886 , and although £ 2 @,@ 462 had been spent on extras , their final bill came to £ 23 @,@ 933 , which was £ 27 cheaper than the original contract value . Savings were made by using concrete for the foundations and bottoms of tanks , rather than brick and puddle clay .

By mid @-@ 1886 , the works was complete , and the Mayor , J. W. Pye @-@ Smith Esq , officially opened it on 2 June . The event was witnessed by members of the Council , and by invited guests , which included a representative from the London Metropolitan Board of Works . Reports at the time

indicated that the sewage passed through catch pits by gravity , allowing solids to settle , which were removed weekly . Milk of lime was then added as it flowed through mixing channels , after which it entered rectangular settling tanks . Next it passed on to a number of precipitating tanks , each holding 50 @,@ 000 imperial gallons (230 m3) , where after 30 minutes of settling , it passed over aerating weirs . Finally it ran through coke filters and was discharged into the river . Around 100 long tons (100 t) of sludge was removed from the precipitating tanks each day , to be pumped into ponds . Once the water had drained off , it was moved to drying beds , and was then used as manure by farmers , or was taken by rail to a tip at Kilnhurst , near Rotherham . Initially , there were 30 precipitating tanks and 60 aerating or filtering tanks .

The railway also developed , with the acquisition of 250 yards (230 m) of portable track and six tipping wagons in 1889 , a steam crane later the same year , and more wagons in 1891 and 1892 . The first locomotive arrived in 1898 , after its purchase from the Yorkshire Engine Company . It was an 0 @-@ 4 @-@ 0 saddle tank , which had been built in 1875 for use as a contractor 's engine , and had been refurbished by the manufacturer . A maintenance contract for the wagons lapsed in 1900 , as the men at the works had become proficient at repairs .

In parallel with the construction of the works , trunk sewers were built to convey sewage from the city to the works . These was a major programme of expansion to the sewer network in 1910 , to ensure that it could cope with the expected volumes of effluent produced . Because British sewers are also expected to handle rainwater , a series of storm sewage overflows were provided , which resulted in diluted sewage being discharged into the River Don in times of heavy rainfall .

= = = Expansion = = =

The quality of the effluent discharged into the Don was soon giving rise to concern , as the treatment process was unsatisfactory . An act of Parliament was obtained in 1900 , which allowed Sheffield Corporation to buy an additional 105 acres (42 ha) , on which contact beds would be built , so that the effluent could be better treated before discharge . The initial plan was costed at £ 367 @,@ 355 , which was reduced to £ 270 @,@ 369 when secondary contact beds were removed from the scheme . The Local Government Board approved the plans on 13 May 1905 , paving the way for the construction of a biological treatment system , instead of the system using lime . Logan and Hemmingway , who were contractors based at Nottingham , won the initial contract for excavations , and also the subsequent one for the construction of six settling tanks , 24 contact tanks , and Jordan bridge , which would carry the internal railway line over the River Don Navigation . The contract was worth £ 41 @,@ 046 , and further contracts followed , which included £ 36 @,@ 500 for 36 more contact beds and three settling tanks , £ 5 @,@ 000 for excavating 40 @,@ 000 cubic yards (31 @,@ 000 m3) of earth , and £ 36 @,@ 484 for storm beds and other work , which was subsequently raised to £ 39 @,@ 184 , so that they could pay their workers at the same rate as Sheffield Corporation paid their own workmen .

The Lord Mayor opened the first part of the new works on 28 October 1909 , and Sheffield Council increased the amount of land they owned for sewage treatment to 226 @.@ 5 acres (91 @.@ 7 ha) by buying another 81 acres (33 ha) , on which contact beds could be constructed if required at a later date . Discharges to the river were still of poor quality , and a secondary treatment process was designed , although its implementation was delayed by the onset of the First World War . However , John Haworth became works manager in 1914 , and began to experiment with ways to treat the effluent . A continuous narrow channel was constructed within a tank , and paddles were used to agitate the liquid . This allowed it to become oxygenated , which supported bacteria , allowing them to digest the sewage . The process was called bio @-@ aeration , but became known as the " Sheffield System " , and a steady stream of people came to inspect the works , both from local authorities in Great Britain and from overseas . Many of the contact beds were converted to use the new system between 1922 and 1927 . The treatment process significantly reduced the biochemical oxygen demand of the effluent discharged to the river , but was not good at removing ammonia , which was a major contributor to the poor water quality of the river below the works , and the destruction of the fish populations . The effluent regularly contained more than 20 mg / l of ammonia

, which resulted in levels of over 10 mg / l in the river . Few fish can survive in concentrations of over 2 mg / l .

In 1915 , the Corporation had made enquiries about purchasing a second @-@ hand steam engine , approaching six locomotive manufacturers , but eventually acquired a new 0 @-@ 4 @-@ 0 saddle tank from Peckett and Sons Ltd , which was built at their Bristol works in 1918 . The original engine became a spare , but was hired out to the Blackburn Meadows power station in March 1936 . A year later it was condemned by the insurance company , and was sold for scrap to Maden and McKee Ltd , who were based in Liverpool . A replacement was sought , and a third 0 @-@ 4 @-@ 0 saddle tank , made by Hudswell Clarke in 1914 , was bought from the Olympia Oil and Cake Company at Selby . It was coupled into a goods train , and arrived at the works in July 1937 . At the works , as at Selby , it carried the name Olympia , painted on the tanks . The Peckett was overhauled by the Yorkshire Engine Company at Meadow Hall Works between 1945 and 1946 . Because there was a statutory obligation to keep the treatment works operational , a special dispensation was obtained during the 1926 general strike , to allow this engine to run over the main line , delivering wagons to Kilnhurst tip . Kilnhurst tip eventually became full , and in January 1948 , regular tipping operations ceased , after a new tip at Thrybergh opened . Tipping continued at Kilnhurst sporadically , until it was closed in 1959 . During its operational life up to 1948 , 2 @,@ 917 @,@ 480 tons of sewage sludge was dumped at the site , and following closure , it was sold to the National Coal Board in 1961 .

= = = Modernisation = = =

The entire works was upgraded between 1956 and 1969 , in five distinct phases . The plan was announced in January 1956 , and was expected to cost £ 1 million . The first phase was the construction of a filter pressing plant , for which the main contractor was Norwest Construction Co Ltd , while the actual presses and other plant were supplied by S. H. Johnson and Co Ltd . This phase was completed in 1962 , and was officially opened by the Lord Mayor on 14 May 1963 . The second phase consisted of a preliminary treatment plant , a storm sewage separation plant , and metering of the flows within the plant . This was completed in 1965 . The third phase was split into two parts , which initially involved the building of new primary sedimentation tanks . Once these were operational in 1969 , the old sedimentation tanks were converted to become temporary storm sewage tanks . This fourth phase was called phase 3b , and was completed in 1970 . The final phase was the construction of a sludge incinerator , which was completed in 1969 and meant that the pressed sewage cake did not have to be taken to Thrybergh to be dumped .

The railway was also upgraded at this time . Thomas Ward Ltd supplied replacement track in 1955 , and a new 0 @-@ 4 @-@ 0 diesel electric shunter was ordered from Ruston and Hornsby Ltd in 1959 . It was delivered from Lincoln on a low @-@ loader in 1960 , and was so successful that a second engine of the same type was ordered the following year . The Hudswell Clarke steam engine was cut up on site in 1962 , but the Corporation wrote to Peckett 's to see if they would convert the Peckett engine to diesel hydraulic transmission . Peckett 's declined , and so the engine was converted at the works , by cutting off the boiler and saddle tank , and fitting a Perkins diesel engine removed from a crane . It was completed on 12 May 1962 , and worked well , although it spent most of its subsequent life working at Thrybergh tip . It returned to Blackburn Meadows in 1967 , and was cut up later that year . A prototype steel side @-@ tipping wagon was ordered from Robert Hudson Ltd of Leeds in 1955 , and a further 22 followed in 1957 , to replace the original wooden wagons . Charles Roberts and Co Ltd of Wakefield supplied 12 more in 1958 , and a further 35 in 1961 , with Hudsons supplying the final 6 in 1963 .

In 1976 , a new diesel shunting locomotive , made by Thomas Hill of Rotherham was purchased . It was built at Kilnhurst , and driven along the ex @-@ Great Central Railway line from there to the works . The first Ruston and Hornsby engine was partially dismantled , and eventually cut up in January 1978 . The connection between the works and the British Rail network was cut in 1984 , and the system became one of a very small number of isolated standard gauge railways . By 1986 , the track layout had been simplified , and the track across Jordan bridge had been lifted . When rail

operation ceased in the 1990s , one of the Hudson tipping wagons went to the National Railway Museum at Shildon , and the Thomas Hill engine , after several changes of ownership , is now located on the Peak Rail preserved railway at Matlock .

By the 1960s , the Sheffield sewers were inadequate for the volume of effluent , and overflowed into the river during periods of light rainfall and sometimes when there was no rainfall . Some of them had been in use for 80 years , and inspection revealed that major reconstruction was required . The solution adopted was to tunnel the Don Valley Interceptor Sewer through the Carboniferous rock beneath the existing sewers . Work began of the first phase in 1979 , when 1 @.@ 33 miles (2 @.@ 14 km) of 18 @-@ foot (5 @.@ 5 m) tunnel were built from the works to a drop shaft in Hawke Street . A new pumping station was required at Blackburn Meadows , and this phase was completed in July 1983 . Over the next decade , four further phases were completed , involving the tunnelling of 1 @.@ 39 miles (2 @.@ 24 km) of sewer with a diameter of 12 feet (3 @.@ 7 m) to a drop shaft near Furnival Road , a new sewer from Furnival Road to the Whitbread Brewery with another from the Sheaf Valley sewer to the central bus station , extension of the Don Valley sewer to Gilpin Street , and finally extension from Gilpin Street to Livesey Street in Hillsborough . As a result of this work , the capacity of the sewers was greatly increased , and 26 storm sewage overflows were closed , resulting in significant improvement to water quality in the river .

= = = Improvements = = =

In 1992 , the problem of ammonia levels in the final effluent was addressed by the construction of a system using anoxic zones and diffuse air activated sludge treatment . This dramatically reduced ammonia levels , and was the most significant factor in the re @-@ establishment of fish stocks in the lower River Don . In 1990 , the outdated filter presshouse and incineration plant were replaced by a new sludge @-@ dewatering plant and a fluidized @-@ bed incinerator . The new plant made the old sludge beds , situated to the east of the River Don and on the island formed by the Don and the Holmes Cut , redundant , and these have now become a nature reserve . Further improvements to the process were completed by 2005 . These included an upgrade to the wet scrubbing system , in order to remove heavy metals and acid gases such as sulphur dioxide , hydrogen chloride and hydrogen fluoride from the flue gases produced by the incinerator , and the addition of a tertiary adsorption filter , which removes mercury and dioxins . The improvements were designed to ensure that the plant met the standards set out in the Waste Incineration Directive .

The outflow from the works , which passes under the River Don Navigation and joins the river beside Jordans weir , has in the past been a major contributor to the pollution of the River Don , but some £ 70 million has been invested in upgrading the plant , to ensure that discharges to the river meet the requirements of the Freshwater Fish Directive . In dry weather , the outfall discharges 30 million gallons (136 @,@ 000 m3) of treated water each day , more than doubling the flow in the river at this point .

The works was shut down on 25 June 2007 , after the Don burst its banks , and the entire site was engulfed by several feet of water . It remained submerged for over a week , with much of the equipment suffering catastrophic damage . Once the water subsided , imaginative ways had to be found to return it to operation within a reasonable time . The analyser which measures emissions from the incinerator plant had been completely destroyed , and in order to mitigate a 16 @-@ week delivery time , the manufacturers removed one from a training centre at Telford , and it was hired by Yorkshire Water until a new unit could be supplied . The plant was recommissioned and operational just 18 days after its inundation .

In 2012 , a contract for the construction of a mesophilic anaerobic digestion facility was awarded , including the construction of buildings and various other pieces of equipment required for the treatment of sludge . Mesophilic anaerobic digestion enables the breaking down of biodegradable materials using micro @-@ organisms under moderate temperatures . The new sludge treatment facility enables the recycled sludge to be used on neighbouring farmlands as manure , and also enables Yorkshire Water to generate 1.9MW of renewable energy using combined heat and power units .

= = Power Station = =

In 1921 , Sheffield Corporation built a coal @-@ fired power station on spare land at the south west corner of Blackburn Meadows . At the time there was no national grid , and the steelworks which occupied much of the Lower Don Valley needed additional electrical power . The chosen site was close to the steel works , was near the river , which supplied cooling water , and was well @-@ served by railway lines , to deliver coal . The station was modified between 1937 and 1942 , when its capacity was increased to 72 Megawatts , and remained operational until the 1970s . When the rest of the power station was demolished in the 1980s , two of its seven cooling towers were left standing due to their close proximity to the M1 motorway , and the risk that their demolition might cause Tinsley Viaduct to be damaged . The 250 @-@ foot (76 m) towers were hyperbolic in shape , and were designed by L. G. Mouchel and Partners , who had also been responsible for the first such towers erected at Liverpool in 1925 . The Blackburn Meadows towers were built between 1937 and 1938 . English Heritage considered whether they should be designated as listed structures , but ruled against it because the internal cooling structures had been removed , and there was no context for them , as the rest of the station no longer existed . On 24 August 2008 , at 3 am , the two landmark towers were finally demolished with explosives , without damaging the motorway .

= = Nature Reserve = =

In 1993 Sheffield City Council negotiated with Yorkshire Water and leased an unused part of the former sewage works for 99 years , at an annual rent of one peppercorn , to enable it to be reclaimed and turned into a nature reserve . In order to manage the project , a consortium was formed , with representation from Sheffield City Council , Sheffield Wildlife Trust , South Yorkshire Forest and Yorkshire Water . It now provides habitat for migrating birds , for which it is an area of European significance . The Wildlife Trust run an active programme of school education visits . In 2005 the City Council exercised an option to increase the size of the reserve by taking over additional land from Yorkshire Water .