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Catchment Monitoring Network Protects Thames River

Water quality in the River Thames has been linked to the activities of mankind for centuries. In 1858 Parliament had to be suspended because of the stench arising from pollution in the river, but today MPs' noses are no longer necessary for the detection of water pollution; a network of sixty highly sophisticated monitoring stations relay live water quality data to the UK Environment Agency (EA) and other stakeholders.

Rising in Gloucestershire and flowing through the Cotswolds, passing Oxford and Windsor, the River Thames meets the North Sea after passing through London. With a length of 215 miles, the Thames is the longest river entirely in England. However, the water quality of the river is constantly under threat and for this reason, the EA's Matt Loewenthal believes that the River Thames and its major tributaries are more closely monitored than any other rivers in the world.

The Thames is the longest river in England and the most closely monitored for pollution.

Thames history

In 1849 14,000 Londoners died of cholera and fish could no longer survive in the polluted Thames estuary.

The 'Great Stink' of 1858 was precipitated by the effects of the industrial revolution and by sewage from London's growing population. This was recognised at the time and resulted in the construction of massive sewers to the north and south of the river. Similar huge undertakings took place to ensure water supply, with the building of reservoirs and pumping stations on the river to the west of London. However, whilst these initiatives helped to limit pollution levels, water quality remained poor into the 1960s; the combined effects of inadequately treated sewage, industrial discharges, thermal pollution from power stations and the extensive use of non-biological detergents meant that parts of the estuary were considered 'biologically dead'.

Water quality improvements

During the 1960s and 70s, improvements were made at the two main sewage treatment plants at Crossness in southeast London and Beckton in east London, resulting in a dramatic improvement in water quality. As a result, many different animals, birds and fish have returned to live and breed in the estuary. Today there are 121 different species of fish and over 170,000 birds.

Matt Loewenthal manages the Environment Agency's automated water quality monitoring network in the Thames region. Commenting on water quality trends in recent years he says, "The decline of manufacturing industry in the region, coupled with investments and improvements in wastewater treatment systems have undoubtedly contributed to an overall improvement in Thames river water quality. However, we regularly record pollution incidents that arise from CSOs (Combined Sewer Overflows). These are detected by sudden sags in dissolved oxygen often in conjunction with a rise in ammonium."

Combined sewer overflows

CSO is the discharge, during rain storms, of untreated wastewater from a sewer system that carries both sewage and storm water (a combined sewerage system). The increased flow caused by the storm water runoff exceeds the sewerage system's capacity and the sewage is forced to overflow into streams and rivers in the area through CSO outfalls.

Changing rainfall patterns caused by climate change and urban development have meant that London's 140-year-old sewage system is often unable to cope with the combined flow from the city's sewage and storm water system. Of the 57 CSOs in London, 36 are considered unsatisfactory in terms of frequency of discharge and/or environmental impact. Even during periods of moderate rainfall, the overflows discharge storm water and sewage into the River Thames on average once a week. Around 20 million cubic metres of untreated sewage is discharged into the Thames every year.

Urban development including new housing, roads and even the creation of hard, non-porous parking areas in residential areas have made a significant contribution to increasing levels of precipitation rapidly entering the drainage system and thereby exacerbating the problem. However, sustainable urban drainage systems (SUDS) now feature in many new developments and these initiatives will help to prevent the sudden surges of influent at wastewater treatment plants.

Nevertheless, Matt Loewenthal believes that water quality in the Thames has reached a 'tipping point'. He explains, "The River Thames and its major tributaries are the primary water resources in a catchment with a population in excess of 12 million people. There are over 3,000 licensed abstractions of water, accounting for approximately 55% of effective precipitation. In addition there are over 10,000 consents to discharge sewage or trade effluent into the catchment. This means that, in terms of rainfall versus abstraction, the Thames is the most heavily used river in Britain."

"At the same time, climate change is creating more erratic weather conditions and London is located in one of the driest parts of Britain with annual rainfall of 750 mm, which is even lower than Dallas, Texas. This heightens the significance of CSOs and the decision to construct a £2 billion plus underground tunnel to deal with the discharge from 36 London CSOs has not come a moment too soon."

'Tideway Tunnel'

The UK Government gave permission for the Tideway Tunnel in March 2007. The storage-and-transfer tunnel will run beneath the Thames from Hammersmith in West London and convey the discharges for collection and treatment in east London.

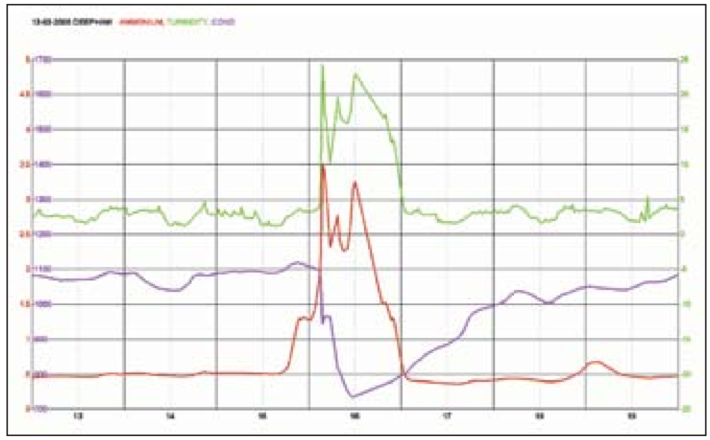
The new tunnel is not due for final completion until 2020, and Matt Loewenthal believes that water quality monitoring will play a vital role in the intervening period. "Even after the tunnel is finished," he says, "there will still be an important role for monitoring to play in the protection of the Thames from illegal discharges and failures to comply with discharge consents."

Monitoring network

As a consequence of the increasing environmental pressures on water resources the Thames Region of the EA has developed a network of fixed, transportable and fully mobile Automatic Water Quality Monitoring Stations (AWQMS), each of which has two common features.

First, each station collects water quality data from a YSI water quality sonde. These sondes cleverly incorporate a number of sensors into an instrument no larger than two feet of an average drainpipe. YSI sondes have been specifically designed to meet the requirements of users that need highly accurate, reliable data from unattended instruments.

Second, collected water quality data is transmitted to EA offices via telemetry. YSI normally provides this facility with the use of radio, mobile phone or satellite telemetry; however, the EA in the Thames Region already operates a real-time system based on Meteorburst.



Readings every 15 minutes from automatic water quality monitoring stations. Sudden spikes in data alert managers to the first signs of CSOs or other forms of pollution entering the Thames.

Environmental monitoring often takes place in remote locations where coverage from mobile phone networks is incomplete and the topography or distances involved preclude conventional radio. This is why, for example, the Agency is working with YSI on projects that use satellite telemetry. However, in the Thames region the infrastructure is in place for a Meteorburst data collection system, which means that the cost of adding further stations is minimal.

Data is transmitted via Meteorburst by bouncing signals off ionised particles high in the atmosphere that result from meteorite activity. Using this method it is possible to transmit data over distances of up to 600 km. Water quality data is collated centrally and can be accessed via the regional telemetry system or the internet (for selected stakeholders) via desktop computer or PDA.

There are four basic types of AWQMS, all of which employ the same YSI multiparameter water quality sonde:

1. Traditional brick buildings providing intake, surface and wastewater protection data to the EA, Thames Water and Vivendi.
2. The Green Box is a transportable, drop-down system featuring state-of-the-art instrumentation that affords significantly reduced maintenance in the field.
3. The Trailer system is a fully mobile AWQMS, providing the same data outputs as the above. It was developed in order to provide a flexible and cost-effective platform for short- to medium-term deployments on problem discharges, investigations and pollution incidents.
4. The Suitcase System is a portable solution for short-term deployments on pollution incidents and investigations.

Data from the AWQMS is described as real-time because sampling takes place every 15 minutes. The procedure is as follows:

First, a pump from within the AWQMS draws river water into the sample chamber that contains the YSI sonde, over a period of 4 minutes. This ensures that the sample is representative before a reading is taken from each of the sensors.

Once a reading has been taken, the pump stops and backflushes to prevent any build-up of solids.

The telemetry unit then transmits the data via Meteorburst technology. The master station at Newbury or Crystal Palace automatically sends a return message once it has received and checked the data. The data is then wiped from the telemetry unit until the next 15-minute data set.

The YSI sonde does not therefore require internal memory in this application. However, the Environment Agency has purchased large numbers of these sondes with internal batteries and data-loggers so that water quality data can be saved for subsequent manual download when used as stand-alone loggers.

2012 Olympics in London

Three real-time AWQMS have been installed by the EA at the Olympic site with a further four YSI 6600 long-term logging sondes deployed to support data from six existing stations on the River Lee above the Olympic site. These monitors are able to raise alarms should any part of the construction process cause unacceptable harm to water quality so that work can be halted and the source of the problem identified and remedied. The stations are also helping Thames Water to protect and improve water quality in the area.

A "green box" automatic water quality monitoring station quickly provides localized data at many points throughout the Thames River

Advantages of continuous monitoring

Each YSI sonde is loaded with sensors such as dissolved oxygen, temperature, pH, conductivity, turbidity, ammonium, blue-green algae and chlorophyll and as such it is able to detect pollution from almost any source. Real-time and historical data is also used by regulation, consenting and ecological appraisal teams as an additional risk management tool. In contrast to spot sampling, continuous monitoring is able to detect pollution at any time, 24 hours per day, 365 days per year.

Pollution incidents may result in a loss of dissolved oxygen (which causes fish kills); however; they will often also give rise to alterations in other parameters such as ammonium, turbidity and pH.

In addition to pollution from what are known as "point sources" AWQMS are being developed to monitor diffuse pollution. This is pollution that has many smaller sources occurring throughout a catchment. It is not easily detectable in the short-term but made more obvious following an analysis of long-term trends.

A further advantage to long-term monitoring lies in its ability to provide a picture of the background water quality, so that any subsequent patterns in water quality can be judged according to whether they are normal with respect to diurnal, seasonal or climate change.

Perhaps one of the most important benefits of an integrated system that monitors an entire catchment is the ability to track events such as algae blooms using YSI chlorophyll sensors and new blue-green algae sensors. This coupled with data from the turbidity and ammonium probes is very useful information for intake protection at water treatment plants – operators may shut down intakes if, for example, algae or ammonia levels are too high and a network such as that on the Thames is able to provide advance warning of pollution.

Such comprehensive information is also highly valuable from an environmental perspective because pollution events such as fish kills or poor water quality can be traced to a specific source.

Traditionally, one of the problems associated with long-term monitoring of natural water is biofouling. The EA has resolved this issue by employing YSI sondes, by pumping samples into a test chamber and by the inclusion of back-flushing in the monitoring routine.

In many other applications, particularly in those for which mains power for pumps is not available, it is necessary to deploy sondes that are capable of withstanding biofouling for extended periods. Under these circumstances YSI has developed an ingenious adaptation which incorporates small wipers that regularly clear the sensors of any fouling before readings are taken.

Trials have found that unattended YSI sondes are able to operate for up to three months in even high-fouling conditions when deployed with YSI's extended deployment wipers.

Whilst Thames river water quality has certainly improved, the river is still under pressure as a result of CSOs and high numbers of both abstractions for drinking water and consented discharges. However, Matt Loewenthal believes that through the EA's partnership with YSI they have been able to develop a highly effective monitoring network with the capability to monitor long-term trends and short-term pollution incidents.

As Matt says, "If you don't monitor it, you can't manage it!"

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