RIVER WATER QUALITY

IMPLEMENTING THE MONITORING REQUIREMENTS OF THE ENVIRONMENT ACT 2021

WHITEPAPER

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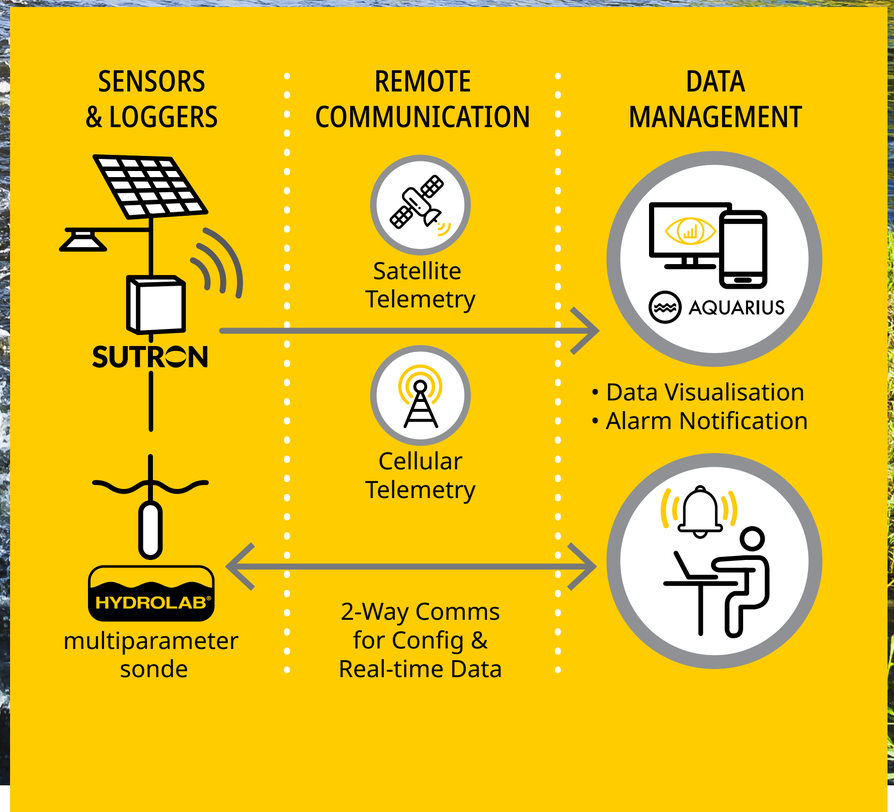
SUMMARY

The purpose of this document is to outline the water quality monitoring requirements of the Environment Act 2021, and to discuss some of the issues that need to be addressed in the development of monitoring networks.

OTT HydroMet (including the trusted brands HYDROLAB, SUTRON and AQUARIUS) and Hach are sister companies with complementary technologies and expertise in water quality monitoring. The solutions offered by these companies will therefore be featured alongside relevant sections of the text.



BACKGROUND

In its 25 Year Environment Plan, issued in 2018, the Government pledged to deliver cleaner air and water, to protect threatened species and to provide richer wildlife habitats. It promised to secure clean and plentiful water by 'improving at least three quarters of our waters to be close to their natural state as soon as is practicable'.

This paper will discuss river water quality, and whilst this can be affected by a variety of factors including agricultural and industrial pollution, the primary focus will be pollution caused by storm overflows.

Many wastewater treatment plants are unable to cope with the volumes generated during periods of high rainfall, so wastewater is allowed to 'spill' into watercourses. Whilst recent regulatory initiatives are designed to address the pollution resulting from such spills, it is important to remember that the volume of water entering the drainage system can be reduced by measures such as sustainable urban drainage systems (SUDS) and natural flood management (NFM). So, this is not just an issue for the water and wastewater sector; it is vitally important that other sectors also play their part – these include government, highways, local authorities, drainage boards, agriculture, developers, industry etc.

The Environment Act 2021 was the first major piece of environmental legislation to be enacted following the UK's departure from the EU. The Act aims to improve air and water quality, tackle waste, increase recycling, halt the decline of species, and improve our natural environment. It provides the Government with powers to set new binding targets for water quality, air quality, biodiversity, and waste reduction. The Act also established the Office for Environmental Protection (OEP), which will hold the Government and other public bodies to account.

At the same time as the Environment Bill was progressing through parliament, the cross-party Environmental Audit Committee (EAC) was conducting its own investigation which culminated in the publication of a report titled: 'Water quality in rivers'. This report made a number of recommendations that related to monitoring, and some of these were included in the Environment Act 2021. Philip Dunne MP, Chair of the EAC, said: "You can't improve the quality of our waterways unless you know how bad they are to start with, and unless you can measure progress against a baseline."

Water and sewerage companies (WaSC) are already required to install Event Duration Monitors (EDM) at storm overflows, but the Act imposes a requirement to continuously monitor water quality upstream and downstream of discharges, so that, for example, pollution alerts could be provided to regulators and the public.

The EDM data for 2022 storm overflows was published in March 2023. It showed that the ten WaSCs in England have 14,580 storm overflows, and that 91% of these were fitted with EDMs. On average, each overflow spilled 23 times for an average of 5.8 hours.

Around 89% of storm overflows discharge to rivers; 10% to coastal and estuarine waters, and 1% to groundwater.

REQUIREMENTS

Environment Act 2021 monitoring requirements

In section 81 of Part 5 (Water) of the Environment Act 2021, sewerage undertakers wholly or mainly in England are required to report on discharges from storm overflows in near-real time (within one hour). This EDM data will show where the discharge to the environment happened, when it started and when it ended.

Data from EDM improves visibility of sewage discharges into rivers and watercourses and helps sewerage companies to better understand where improvements can be made. EDM also helps the Environment Agency to monitor the performance of water companies. However, EDM does not provide any information on the volume of the flow, or the effects on the receiving waters. One of the main purposes, therefore, of Section 82 is to determine whether storm overflows have affected water quality, and to make this information available in real-time.

Section 82 of the Environment Act 2021 reads as follows:
(1) A sewerage undertaker whose area is wholly or mainly in England must continuously monitor the quality of water upstream and downstream of an asset within subsection (2) for the purpose of obtaining the information referred to in subsection (3).

(2) The assets referred to in subsection (1) are:

(a) a storm overflow of the sewerage undertaker, and
(b) sewage disposal works comprised in the sewerage system of the sewerage undertaker, where the storm overflow or works discharge into a watercourse.

(3) The information referred to in subsection (1) is information as to the quality of the water by reference to:

(a) levels of dissolved oxygen,
(b) temperature and pH values,
(c) turbidity,
(d) levels of ammonia, and
(e) anything else specified in regulations made by the Secretary of State.

HL7-Sensor Array

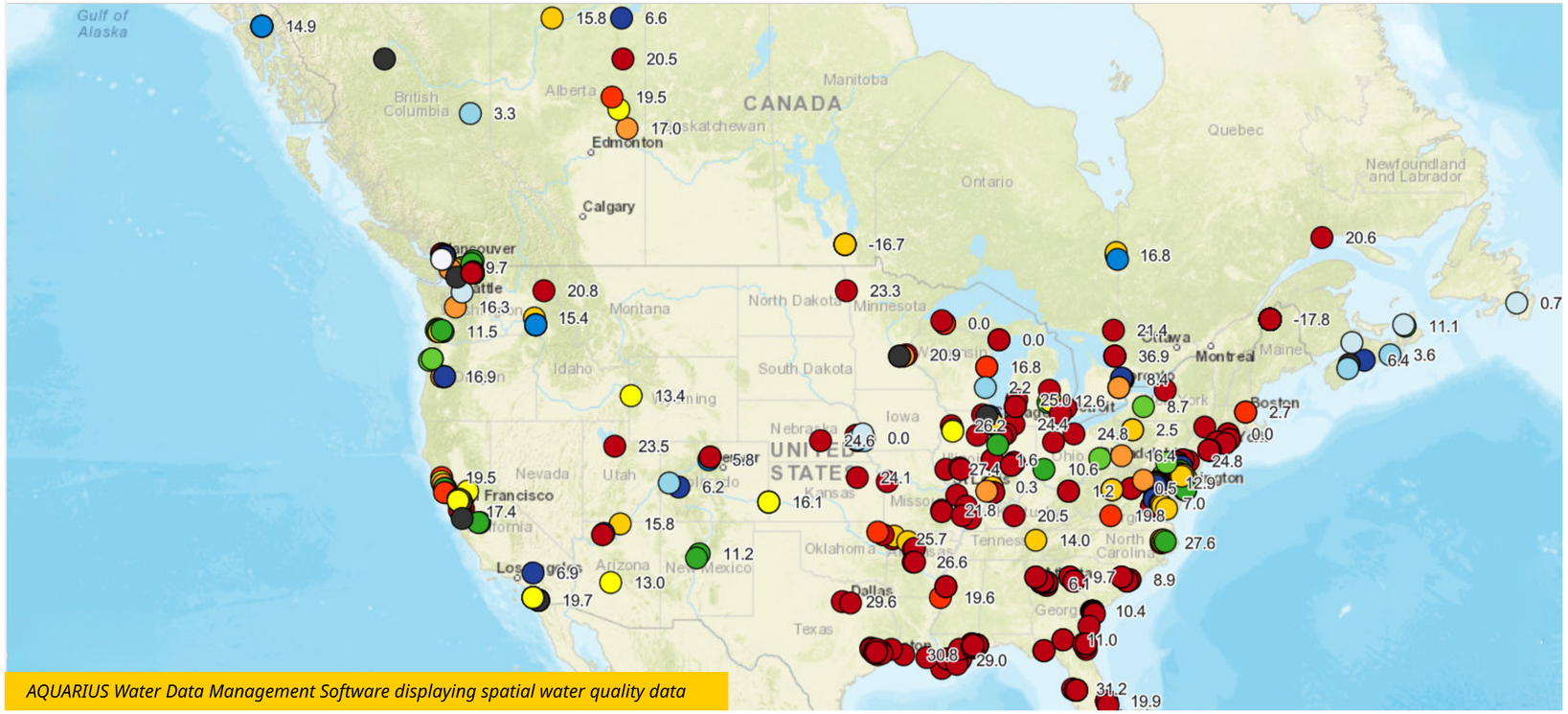
DEFRA CONSULTATION

Implementing Sections 81 and 82

The implementation of the Act's monitoring requirements has prompted a number of important questions, and it is anticipated that Defra will respond to these issues by publishing appropriate technical guidance.

The consultation ran from 12 to 23 May 2023, and sought the views of invited consultees on a number of key issues relating to both EDM and water quality monitoring. The questions addressed issues such as measurement parameters – whether it would be possible to monitor phosphates and nitrates, and whether ammonia or dissolved oxygen should be used to determine the maximum point of harm.

Consultees were also invited to submit comments and suggestions relating to the location of downstream monitors, exemptions and the definition of a cluster – a group of discharges that are sufficiently close for just one pair of monitors to be necessary. Importantly, the consultation also sought views on the ways in which data could be managed and displayed. It said that sewerage undertakers will need to provide near-real-time data to a third party to publish on an England-wide data visualisation platform. This will take the form of an interactive map (see USA example opposite) overlaid with easy-to-understand information about water quality and EDM data, but with access to the underlying data. It should show the impact of discharges and be overlaid with contextual information.



AQUARIUS Water Data Management Software displaying spatial water quality data

NETWORKS

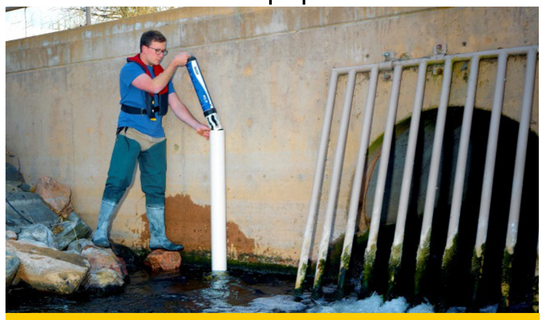
Water quality monitoring networks – issues to consider…

1. Timing

Clearly, there are a number of issues to be addressed, but most WaSCs already have experience with the operation of small river water quality monitoring networks. The Environment Agency has also operated such systems for over 30 years, so there is a great deal of knowledge and expertise available. When asked about the anticipated timing of monitor installations, Philip Dunne MP said: “During the next pricing review period, which begins in January 2025, we will start to see these monitors being installed, and I would hope by the end of that five-year period we should have close to full coverage of the outfalls which need to be monitored.”

In the short-term it is likely that WaSCs will wish to conduct pilot monitoring projects in the locations of greatest priority. These locations will be those that are already used for bathing purposes or for other water-based recreational activities such as fishing, canoeing, kayaking, sailing etc.

2. Measurement Equipment



Stilling well deployment for HYDROLAB sonde

Mains power and communications may not be available at many measurement sites, so the monitors will need to be low power; to run from solar panels and offer flexible communication options. These challenges have faced the Environment Agency for decades and have resulted in the development of portable and kiosk-based monitors that rely on multiparameter water quality sondes.

There are two main options for sonde deployment. (1) directly in the river, attached to a structure and protected by a stilling well. (2) inside a flow-through chamber, testing pumped water samples.

Ideally, it should be possible to install the monitors without the requirement for capital works. This lowers costs and speeds up installation times. It also allows flexibility in the choice of monitoring location because it would be simple to move the monitor if necessary.

Left: Hach walk-in analyser shelter. Right: Hach analysers

In most lowland situations, the multiparameter sonde will be appropriate for ammonia measurements. The ammonia sensor on the HYDROLAB HL4 and HL7 sondes, for example, has a range of 0 to 250 mg/L-N with accuracy the greater of ± 10% of reading or ± 2 mg/L-N. However, in some situations, such as upland rivers, greater sensitivity will be required. Here, the Hach Amtax SC Ammonium Analyser offers a number of range options allowing analysis between 0.02 and 1000 mg/L NH_4-N with accuracy of 3 % + 0.02 mg/L, but importantly, with a lower detection limit of just 0.02 mg/L NH_4-N. The Amtax requires mains power, but depending on the option chosen, is able to accept two sample streams; in these circumstances, a single Amtax could be deployed for both upstream and downstream monitoring.

Hach’s Amtax SC digital on-site analyser offers a high degree of accuracy and needs only minimal supervision thanks to automatic cleaning, calibration and self-diagnosis. Amtax SC instruments are ideal for installation outside or mounted in a kiosk, and offer easy access for reagents and servicing. Amtax could be used in conjunction with the Solitax SC for turbidity, using the infrared duo scattered light method. Solitax SC provides a unique colour independent measurement of solids and is ideal for monitoring river water. In addition, Hach’s pH probes could be utilized, offering exceptional pH sensor performance using the differential electrode measurement technique. Hach’s LDO2 probes offer highly accurate, reliable dissolved oxygen measurement with breakthrough luminescent technology. This optical probe dispenses with the requirement to replace membranes and electrolyte solution, making it virtually maintenance free. The LDO probe also requires no calibration between cap changes, usually every 2 years.

Hach instruments are deployed in hundreds of locations across the UK and offer reliable and highly accurate analysis of water quality. For river monitoring applications, these instruments, and the prefilter for the Amtax, could be installed in a sampling trough with all instrument mounted in a kiosk, complete with a suction pump to supply river water from the desired sampling location.

All of the Hach instruments and associated controllers utilize Prognosys, a predictive diagnostic system that alerts users to any upcoming instrument issues.

The monitoring parameters required by the Section 82 will detect most pollution incidents, but if further investigation and laboratory analysis is likely to be necessary, it would also be possible to install a water sampler that could be triggered in the event of a pollution incident.

3. Datalogging and Communications Equipment

Most multiparameter water quality sondes also feature internal dataloggers so that data can be stored locally. However, in order to leverage the value of the data, it should be possible to transfer raw data and processed data (averages, maxima, minima, calculated values etc.) to a central server in almost real-time. These sondes should also be able to issue alerts when pre-set conditions arise.

SUTRON's xLink product family includes a cost-effective Wi-Fi enabled datalogger with data transmission via IRIDIUM® or Cellular to cater for any monitoring environment. The modem is field exchangeable, enabling users to easily move from one telemetry type or service carrier to another.

The method by which routine data and alarms are transmitted is likely to vary from site to site. In most locations cellular communications will suffice, however, coverage in remote locations can be poor so it should also be possible to utilise alternative methods such as radio or satellite.

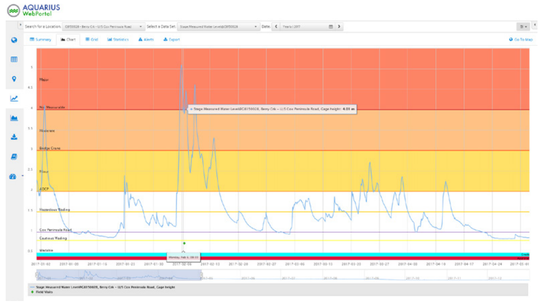
4. Data Management and Display

AQUARIUS Water Data Management Software is being used to gather, manage, and display data from thousands of measurement points in other countries, so it would be a good candidate for becoming Water UK's 'National Environment Data Hub'.
By centralizing environmental data within AQUARIUS, users can organize, analyse, and compare specific parameters for water quality and share those contextual insights in a more digestible way to non-technical stakeholders. For example, the modern dashboard approach improves team accessibility and understanding of continuous water quality data, and more specifically, how things change over time and when there are concerning deviations that require emergency response. AQUARIUS improves water quality monitoring and reporting by enabling more informed decision making with purpose-built QA/QC tools, data visualization, and customizable alerting without any tedious management and administration.

The challenge for data management and display will be (1) the volume of data from such large numbers of continuous monitors, (2) extracting useful insights from the data, and (3) being able to present the data to stakeholders with different needs.

WaSCs will be able to extract a wide variety of useful insights from the data, such as:

- baseline water quality over different seasons
- the level of harm (if any) of different outfalls
- influence of other pollution sources
- pollution alerts
- data to inform investment at wastewater treatment sites (especially smaller sites)
- protection for drinking water treatment plants



AQUARIUS WebPortal displays time-series data with thresholds for immediate alerting.

The data should also provide visibility of water quality for the public. Here, a traffic light display is likely to be more useful; helping river users to determine, for example, if it is safe to swim. However, the public should also be provided with an opportunity to drill down to measurement values in almost real-time.

In May 2023, Water UK said:
"Water and sewage companies will collaborate on creating, by this time next year, a new independently overseen National Environment Data Hub to provide the public with up-to-date information on the operation of all 15,000 sewage overflows in England. For the first time in the world, any member of the public will be able to get national 'near real time' (within the hour) information what is happening, building on the requirement on individual companies set out in the Government's world-leading Environmental Act. This will strengthen accountability, help the public to track progress in empower swimmers and others with the information they need. In addition, as thousands of new river quality monitors come online (planned to be installed from 2025 onwards), this additional data will also be added to the Hub to let people see the real-world impact on rivers.

5. Service and Calibration

Many storm overflows are located at remote sites, so monitoring equipment should be able to operate unattended for extended periods of time. However, it will be necessary for sondes to be recalibrated regularly in order to maintain data quality. The sensor with the shortest calibration period is usually the ammonium ISE sensor, from which total ammoniacal nitrogen can be automatically calculated using values from the pH and temperature sensors. Typically, this sensor requires recalibration every 4 to 8 weeks. This work could be undertaken in the field, but most practitioners simply swap sondes in the field with pre-calibrated sondes and return the field sonde for re-calibration in the laboratory. This provides an ideal opportunity for sondes to be checked and cleaned and for all sensors to be recalibrated.

HYDROLAB sonde calibration support completed in factory.

The calibration and service requirements of large numbers of monitors will necessitate investment in calibration laboratories and sufficient service engineers to conduct site visits at the required frequency.

6. Site location

Practical considerations will vary from site to site. For example, landowner permission may be necessary at some sites, and at others there may be vandalism or theft concerns, dictating that the sonde will need to be submerged out of sight. The optimal monitoring location should be chosen to ensure that the difference between upstream and downstream water quality is accurately measured. However, flexibility will be necessary to accommodate site variability.

Naturally, the location of the downstream monitor is of particular importance; it should be located at the first suitable point downstream. To ensure data validity, the downstream monitor must not be more than 500 m downstream from the point of cross-sectional mixing of the target discharge outlet.
Of the four statutory parameters, the maximum point of harm arising from ammonia is to be used as the key determinant for siting decisions. Ammonia was selected as the determining metric as it should be easier to identify the point of maximum harm, which is the first point of full cross-sectional mixing. However, as stated above, this was an issue addressed by the Defra consultation.

Hach and OTT HydroMet teams of service engineers can provide field maintenance and swap-in calibrated sondes.

The Defra consultation also listed the local factors that should be considered:

- river features or geography, including catchment type, variable annual flow,
- sources of dilution, and sources of diffuse pollution;
- the influence of other pollutant sources or significant sources of dilution on the end data; and,
- health and safety considerations for access for maintenance or repair.

7. Leveraging the value of the data

Naturally, the availability of real-time continuous data will provide all stakeholders with a clear understanding of river water quality at any moment in time. It will also enable the water companies to target and schedule improvement measures, and to subsequently check the success of improvement measures.

According to Water UK, improvement measures will include:

- Install the equivalent of thousands of new Olympics swimming pools to hold surges in rainwater that would otherwise overload the system;
- Increase the capacity of sewage treatment works, allowing them to treat higher volumes of rainfall and sewage;
- Replace concrete with grass and ponds to reduce rainfall run-off entering sewers, protecting them against the overloading that causes spills;
- Treat overflows spills so they have much less impact on the river, including through reed beds, wetlands and other nature-friendly projects; and
- Improve the sewer network by enlarging and improving pipes, allowing them to safely carry more sewage during peak times, and fixing misconnected pipes from properties.

CONCLUSION

The recent publicity surrounding storm overflows has created high levels of concern that greater effort and funding needs to be applied to prevent the harm that is being inflicted on our rivers. However, while many members of the public may not have been aware that storm overflows form a significant part of our existing wastewater management infrastructure, the recent publicity has helped to raise awareness of key issues such as:

- Reducing peak flows during storm events
- Natural flood management
- Sustainable urban drainage
- Limiting toilet waste to the 3 Ps
- Identifying the root causes of river pollution

Responding to widespread concerns, Water UK announced in May 2023 a "readiness to invest what is needed to deliver the ambition set out in the Storm Overflows Discharge Reduction Plan. This could involve additional funding of £10 billion this decade." Speaking on the BBC, Chair of Water UK Ruth Kelly said: "We have listened and have an unprecedented plan to start to put it right. This problem cannot be fixed overnight, but we are determined to do everything we can to transform our rivers and seas in the way we all want to see." She also said that the water companies want to be held to account, so the widespread availability of near real-time water quality data will make that possible.

Clearly, at £10 billion, the measures to improve water quality will be costly, so it is essential that decisions are underpinned by accurate reliable data, and that monitoring is undertaken to measure the effectiveness of different initiatives.

The monitoring requirements stipulated in Sections 81 and 82 will provide a comprehensive picture of not just the impact of storm overflows, but of river water quality generally. This will provide a dramatically improved understanding of the factors affecting water quality so that improvement measures can be targeted and effective.

Insights for Experts

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