ENVIRONMENT

CATCHMENT MANAGEMENT IN THE WATER INDUSTRY

Institution of MECHANICAL ENGINEERS

The water industry provides a vital ecosystem service to the population of the UK. Water is a vital life resource that supports individuals, food production and industry.

In recent years the UK has seen incidents of both flooding and drought that have exposed water companies to the difficulties of managing continuous supply of clean water and discharge of sewage for a growing population in changing climatic conditions. In December 2015 the United Nations Framework Convention on Climate Change will meet in Paris, where for the first time in over 20 years of UN negotiations, it will aim to achieve a legally binding and universal agreement on climate, with the objective of keeping global warming below 2°C.[1]

The impacts of climate change on the water industry are clear, with both flooding and droughts becoming more common-place. The water industry has to manage these changes, ensuring that the growing population in the UK can continue to have access to clean water, manage sewage and ensure that the water environment is protected, maintaining biodiversity in a healthy ecosystem.

A key element of the regulation is the EU Water Framework Directive, which requires water companies to foster an approach that not only delivers increased water quality in natural and artificial water-courses, but also improves the water environment. Moreover they are expected to achieve this with reducing income as efficiencies are realised. This process is called the catchment management approach.

Catchment management is the concept of managing the water environment as a whole in a particular catchment region, taking into account the needs of all stakeholders that access that water resource.

Recommendations

1. The Effective Catchment Management called for by Ofwat will not happen without structural reform. The water industry is too complex to achieve these goals. Catchment Management Teams must be given powers to make binding decisions, including the management of finance to implement those decisions. This should be recognised and treated as a key aspect of Ofwat's strategy.
2. The current Water Framework Directive has created a number of unintended consequences. An example is the way it is causing greater environmental impact through unreasonable waste water quality demands, driving up energy and chemical use. The Directive needs to be urgently reviewed to enable a more holistic approach to water management across the whole water network.

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THE WATER FRAMEWORK DIRECTIVE (WFD)

The purpose of the 2000 Water Framework Directive is to establish a framework for the protection of inland surface waters, estuaries, coastal waters and groundwater.

The WFD provides a classification scheme for surface water contaminants. It covers 53 chemical pollutants and is backed up by emissions permits in the UK. In the UK, water and sewerage companies have to meet these tight regulations and are monitored by the Environment Agency in England, Natural Resources Wales, the Scottish Environmental Protection Agency and the Northern Ireland Environment Agency. All of these regulatory bodies have different permitting and monitoring systems.

The water industry is made up of private companies which have to meet all these competing priorities for governments and consumers.

In order for the UK to achieve the requirements of the Water Framework Directive, a number of objectives for water quality have to be met. The environmental objectives are focused around the Ecological Status; this is classified in terms of five classes (high, good, moderate, poor and bad). These classes are established on the basis of specific criteria and boundaries defined against biological, physico-chemical and hydromorphological elements. Biological assessment uses numeric measures of communities of plants and animals (for example, fish and rooted plants). Physico-chemical assessment looks at elements such as temperature and the level of nutrients, which support the biology. Hydromorphological quality looks at water flow, sediment: a supporting element of the biological and in some cases physico-chemical status composition and movement, continuity (in rivers) and the structure of physical habitat.[2] The Directive requires that surface waters must be of at least Good Ecological Status and Good Chemical Status. Further details of the Water Framework Directive and the UK's implementation plan can be found at the Environment Agency website[3] and the European Environment Agency website[4].

The results of these environmental objectives are reported via the competent bodies to the River Basin Management Plan team and reported to the European Union every six years. The Catchment Management Approach is the framework being implemented to deliver the results of the environmental objectives of the Water Framework Directive.

THE CONCEPT OF SUSTAINABLE PRODUCTION

We do not make water; we capture and use it, then return it (consciously or unconsciously) to the environment. So 'sustainable production' requires meeting water demand (volumes and quality) and the needs of the environment (direct water requirements and the wider conservation of energy and resources used in treatment and transport) year round and into the future in an economically viable manner within the boundaries of what nature provides.

WATER DEMAND

About 34,500Ml/d of fresh water is abstracted in England and Wales, roughly two thirds as surface water, from rivers and reservoirs, and the rest as groundwater from aquifers. Groundwater is particularly important in the south of England, accounting for ~75% of supply in the southern region, and 35–40% of the water supplies in surrounding areas.[5] Even when not directly abstracted, groundwater supports, surface water sources particularly in providing baseflow river bed seepage in dry weather.

The existing water demand is unsustainable in some areas of southern England, and the predicted increases exacerbate the situation.

The Value of Water

Everyone needs water – and not just for drinking. Water is used to generate and sustain economic growth and prosperity, through activities such as farming, commercial fishing, energy production, manufacturing, transport and tourism. Water is at the core of natural ecosystems, and climate regulation. But the pattern of supply is particularly vulnerable to climate change. Demand for water is growing, putting a strain on available supplies.[1]

The main water users are:

People

The public water supply accounts for over half the annual abstraction. As the population grows so does the demand for water – directly and in agriculture, industry and services to support them. The UK population is projected to increase from 64.1 million (mid 2013 figure) to 73.3 million by mid-2037.[6] In the Thames and south-east region, which is already suffering water stress, the growth is expected to be over 40%.[7] At the current average consumption of 150l/h/d, population growth would result in additional demand of 1,380ml/d, although there are efforts to reduce household consumption through use of metering, amended building regulation requirements for water-efficiency, increased availability of water efficient products and raised public awareness such as water foot-printing, and through leakage reduction in the public water supply system. Current activities to raise awareness of water usage and ensure proper maintenance do not go far enough and are not effective. Continued development of the south-eastern regions will create significant problems in delivering public water supply.

Over 70% of the abstracted public water supply is returned to the environment (mostly to watercourse) within a few hours as treated effluent which supports river flows, and may be re-abstracted downstream. The cessation of treated discharges from small local sewage treatment works, as effluent is transferred to larger, energy-intensive works which can meet tightened discharge consents, may result in damagingly low stream flows during summer drought conditions and reduced capability to supply downstream abstraction.

Industry

Water abstraction to support electricity generation is mainly used in hydropower and cooling. A significant proportion of this is rapidly returned to the watercourse with little (if any) treatment or environmental cost.

Other industrial demand has declined since 2000 as industries change and businesses reduce their water demand (and associated supply, heating and disposal costs) through more efficient processes, use of the embedded water in the raw product, effluent recycling and rainwater capture.[8,9] The food and laundry industries have committed to reducing water consumption by 20% by 2020.[10] Several companies such as Dairy Crest and Nestlé expect to achieve this reduction by 2015[11,12].

New water-intensive industries, such as fracking, could increase industrial water demand by about 5%, requiring up to 5.4 million m^3/year water for ~1,000 billion cubic feet/year shale gas production, and produce 1.8 million m^3 of wastewater with high salinity, the injected chemicals and natural contaminants for treatment[13,14].

Furthermore sustainable efficiencies will be realised only through closer integration, earlier engagement and collaboration with the tier one and tier two+ supply chains. Approaches such as integrated procurement, product standardisation, ‘plug and play’ or off-site manufacturing and ’best person for the job‘ role allocation have contributed to performance improvements of over 30% in Asset Management five-year Plan.

Agriculture

In contrast to these year-round abstractions, agricultural demand and particularly spray irrigation are concentrated in the dry, summer months. Spray irrigation in East Anglia can already exceed the daily public water supply demand during dry weather. Water demand for agricultural irrigation, particularly in the east and south-east of England, is predicted to increase, rising by about a fifth by 2020. This could be exacerbated if climate change results in a shift from food crops in other countries to UK, or significant increase in energy crops, which generally requires more water than food crops – although there is ongoing crop water optimisation development.[15] Agriculture has a direct impact on water quality, and this will be exacerbated if increased rainfall causes more run-off of fertilisers, pesticides etc… or of dried-out soil and debris, and co-operation with farmers to prevent this (including no-spray areas) is an essential part of the water companies’ water catchment plans.

Water Management and Water Quality

There has been considerable effort to understand and improve water management in the UK, a number of wider-reaching strategies are being introduced to link the management of surface water, urban and rural land, flood risk and diffuse pollution with the allocation of the available water between potentially conflicting human, industrial, agricultural and environmental demands. These include the Environment Agency (EA), the Scottish Environmental Protection Agency (SEPA) and the Northern Ireland Department of the Environment (DOE) regional strategies, river basin and catchment management plans[16,17,18] and water company water resources management and drought plans.[19] These are linked to European Union legislation, including the Water Framework Directive which introduces the need for risk based assessment of hydro geomorphical, chemical and ecological factors in achieving ‘good ecological status’ and catchment management, to protect raw water sources from pollution, rather than removing it at a water treatment works. This ecological catchment work extends to research into the impact of acid rain on peat bog and upland water retention, improved modelling and bio-diversity management to understand the whole water cycle ‘catchment to coast’.

SUSTAINABLE TREATMENT – UNINTENDED CONSEQUENCES

Public pressure and the actions of environmental organisations have driven the need for legislation to improve the cleanliness of rivers, lakes, groundwaters and coastal beaches for a number of decades.

The Water Framework Directive provided an overarching framework for water management and committed European Union member states to achieve good qualitative and quantitative status of all water bodies by 2015. It is looking increasingly uncertain that any member states, including the UK, will be able to comply with those requirements and a review of the implementation of the Directive is planned for which a potential outcome could be a further tightening of the standards.

The impact of this legislation in the UK has been a significant improvement in natural water quality, particularly our rivers. However, those achievements have only been possible through the construction of high energy intensive treatment processes at our sewage treatment works necessary to meet the tightened effluent consent levels. Typically this is achieved through the addition of activated sludge processes requiring the generation of pressurised air which is mixed with the sewage. This is costing UK water companies up to £9 million a year on electricity to run 300 blowers for activated sludge plants. Industry estimates suggest that 1% of all of the UK's electricity is consumed by compressors used for the aeration of wastewater at the nation's sewage treatment works. Ofwat data from 2010 stated that Greenhouse Gas (GHG) emissions from the operational side of the water industry are approximately 0.7% of the total UK emissions.

Another area of waste water treatment that has increased in importance, is the requirement to control levels of nitrogen and phosphorus. Levels of both have increased in raw sewage due to the increasing use of detergents and fertilisers. Although natural processes do remove both nitrate and phosphate in most cases, the levels of reduction required cannot be achieved through natural processes alone and it is necessary to use chemicals, typically ferric chloride, ferrous sulphate or aluminium salts. The GHG emissions associated with the use of these chemicals is significant and continuity of supply is becoming a major concern.

CATCHMENT MANAGEMENT APPROACH

In 2013 the UK Government committed to following a Catchment-Based Approach. The aim of this approach is to improve the quality of catchment water, hence improving the environment of the catchment area. Each river catchment area will be unique and the challenge is to work with all stakeholders to ensure that the correct priorities and actions are taken, leading to an integrated approach to water management.

RECOMMENDATIONS

The Institution of Mechanical Engineers recommends the following to ensure Catchment Management is effective:

1. The Effective Catchment Management called for by Ofwat will not happen without structural reform. The water industry is too complex to achieve these goals. Catchment Management Teams must be given powers to make binding decisions, including the management of finance to implement those decisions. This should be recognised and treated as a key aspect of Ofwat's strategy. To take this forward it is suggested that Ofwat liaise with the Environment Agency, the Scottish Environmental Protection Agency, the Northern Ireland Department of the Environment and Natural Resources Wales over catchment management plan innovations to explore scope for home building and a wide range of infrastructure modification investment.
2. The current Water Framework Directive has a number of unintended consequences. An example is the way it is causing greater environmental impact through unreasonable waste water quality demands, driving up energy and chemical use. The Directive needs to be urgently reviewed to enable a more holistic approach to water management across the whole water network. Enforcement by the Environment Agency, the Scottish Environmental Protection Agency, the Northern Ireland Department of the Environment and Natural Resources Wales must represent individual solutions for each catchment. In an era of climate change and increasingly extreme weather events, this is no time for a 'one size fits all' single European vision that may not be appropriate in many cases.

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