Environmental Audit Committee: Nitrates Inquiry

Anglian Water Services Ltd.

1. What is the scale of nitrate pollution in the UK and what is the likelihood of the pollution getting worse?

The scale of nitrate pollution in the UK has been extensively researched over the last four decades and there are many academic, government and industry reports and papers describing the origins, pathways and impacts on drinking water and the environment.

Nitrate pollution can be assessed in both the temporal and spatial scale. The history of nitrate pollution is well documented. It has been identified that excess nitrate in the environment started occurring as a consequence of the modernisation and intensification of agriculture during and after World War II. Large areas of grassland were ploughed leading to oxidation of Nitrogen (N) in organic matter in the soil and the application of artificial nitrogenous fertilisers to crops began to increase significantly in the 1950s. These changes increased the amount of surplus NO3 in the environment which following rainfall was either washed off into ditches in rivers or leached from the soil into groundwater.

Due to differences in pathways and transport mechanisms, the response of surface water to nitrate pollution is more immediate than that with groundwater. The more rapid impact on surface water quality contrasts with the slow, lagged response seen in groundwater. This has particular relevance in terms of the reverse process of responding to measures to reduce surplus nitrate being lost to the environment.

A gradual increase in concentrations in groundwater in the affected areas became evident in the early 1970s. Across the UK's aquifers the impact of nitrate pollution is varied. The movement rate of water (and NO3) from soil zone to saturated zone is influenced by the depth of the water table and the properties of the aquifer and any formations above it.

For example, water passes quickly through fractured rocks but much more slowly through the matrix of chalk and sandstone. The typical velocity of groundwater through chalk matrix is only about 1 metre per annum (m/a). Therefore, where the unsaturated zone is thick, there can be a delay of many years before an increase in the amount of NO3 leached from the soil affects groundwater quality.

Therefore, nitrate pollution occurs in the groundwater of aquifers in agricultural areas where there is little or no natural cover, limited unsaturated zone and low rainfall. Within the Anglian Water region, this includes predominantly unconfined chalk sources, but also ones exploiting the Lincolnshire Limestone, Sherwood Sandstone and Lower Greensand. It is estimated that high nitrate sources in our region cover a combined catchment area of around 900km^2 across the counties of Norfolk, Suffolk, Cambridgeshire, Lincolnshire and Nottinghamshire.

Groundwater nitrate pollution is characterised by continuous baseline trends with annual/seasonal peaks. It is common to see impacted sources having had nitrate concentrations of more than 50 micrograms per litre (mg/l) for several decades. In a number of cases, the trends are still upward whereas in others they are flat. At a few sources the trend is downward but additional evidence is required to confirm the potential removal of treatment.

Long term monitoring, the annual analysis of data and trends, groundwater modelling and general research has indicated that the nitrate pollution problem has generally reduced in surface water over the last few decades, but is still an issue in groundwater. In some sources the nitrate concentrations are still on an upward trajectory with no sign of plateauing at all.

2. What are the consequences of nitrate pollution for the environment and for human life?

The accumulation of soluble forms of N particularly nitrate (NO3) in water can be detrimental as high concentrations in river water encourage eutrophication and in drinking water must be limited for health reasons.

Nitrate is not, in itself, of concern in drinking water, rather the possibility that it may be converted to the more toxic nitrite in the gut. Nitrite combines with haemoglobin to reduce the oxygen carrying capacity of the blood.

This does not occur in adults, as the adult gut will not change nitrate to nitrite, however, the infant gut prior to weaning has a different bacterial flora which will convert nitrate to nitrite. This conversion may be increased by gut infection, and the effect further increased if the water is of bad bacteriological quality. This illness produces a characteristic slate-grey skin colouration and is known as **'**blue-baby syndrome**'**. Its medical name is methaemoglobinaemia and occurs in bottle-fed infants, but is not a problem when infants are breast-fed.

It is theoretically possible for nitrite to combine with food materials in the stomach to produce compounds known as 'nitrosamines', and these have been shown to produce stomach cancer in animals. However, attempts to show that these theoretical reactions occur have proved negative and epidemiological studies in areas of high and low nitrate in drinking water have shown no increased incidence of stomach cancer in the high nitrate areas. There is, therefore, no confirmed link between nitrate and stomach cancer.

The nitrate pollution problem has a specific and costly impact on the water industry and the supply of wholesome water to the public. Without treatment, a significant proportion of the water abstracted by Anglian Water would be non-compliant with respect to the nitrate drinking water standard of 50 mg/l (as NO_3).

This issue has been identified and addressed with significant investment in treatment since privatisation of the water industry in 1989. The consequence of which now can be seen through the continued need for funding of the operation of treatment solutions and the need for refurbishment, replacement or, in some cases, new assets.

Since privatisation, we have invested around £100M in the construction of nitrate removal schemes. The consequences of relying on treatment to remove pollutants include increasing operational and operational costs, embedded carbon cost of plant construction, operational energy carbon cost, issues concerning disposal of process water by-product, and the environmental and social impacts of asset construction and operation

Currently, we have nearly 50 groundwater sources with elevated nitrate concentrations (roughly 25% of our groundwater sources). These supply Water Treatment Works (WTWs) that have either ion-exchange or blending as the treatment solution. By 2025, we will have 24 ion exchange plants with combined annual operating costs of £3M to £4M per annum.

3. How important are the different sources of nitrate pollution? Where should action be undertaken?

Nitrogen is found naturally in the environment and it is an essential plant nutrient. Some plants fix atmospheric N but modern farming practice involves its addition in the form of manure, sewage sludge and chemical fertilisers. This has led to an excess in the environment leading to a reduction in water quality and an increase pollution. Over 80% of the Anglian Water Supply area land is used for agriculture, and the majority of that is arable.

Nitrates originate principally from arable agriculture (growing crops) but generally not grasslands, unless the grass receives extremely heavy applications of fertiliser. Typically, the high levels of nitrate are not due to the use of nitrate fertilisers, as these fertilisers are taken up by crops during growth. Further nitrate becomes available to the growing crops through the action of soil bacteria which break-down organic matter from the previous years' crops and manures. The soil bacteria continues to produce nitrate after the crops are harvested and, therefore, levels build up in the soil through late summer/early autumn, until the soil temperatures are low enough to halt the bacteriological activity. This nitrate is then washed from the soil into surface water and groundwater through seasonal rainfall; typically beginning in late November/early December for the Anglian Water region. Land which is ploughed in the autumn and left fallow over winter has the highest nitrate leaching potential, but the trend away from spring-sown crops to autumn-sown over the last 20 years has reduced the nitrate entering waters as the autumn crops take up some of this nitrate before the winter rains.

Source apportionment work in the North Lincolnshire chalk has indicated that for a typical East Anglian nitrate-impacted source with an agricultural catchment, the largest source of nitrogen is the application of fertilisers to cereal crops (53%) and other arable crops, like oilseed rape (42%). Other contributions (5%) are from grassland, woodland, urban, septic tanks, sewer leakage and landfills. Individually, each of these contributes less than 1% of the total.

Similar work on one of our few sources in an urban setting with elevated and rising nitrate (but a distant agricultural catchment) has indicated that the largest source of nitrogen in the catchment is the application of fertilisers to cereal crops (wheat, barley and oats) (34%) and other arable crops such as oil seed rape (40%) Other contributions (26%) are from urban, grassland, woodland, septic tanks, sewer leakage and landfills.

On nitrates entering the environment from the sewage treatment process, it should be noted that anything other than a standstill limit, would involve significant investment for water recycling companies in order to meet changing requirements. For example, a filter works is not designed to remove Nitrogen, so it may need to be replaced with an activated sludge process. This would mean discarding the remaining asset life of the filter works which in itself is inefficient. Ultimately, the cost of new assets needs to be accounted for in our business planning and the cost will most likely be accounted for in bill payers' money. However, as with all other environmental drivers, we will work with the Environment Agency to promote appropriate schemes through the Water Industry National Environment Programme (WINEP).

4. How effectively does Government regulate nitrate usage so that nitrate pollution is reduced as quickly as possible?

In 1980, the Drinking Water Directive (DWD) set the prescribed concentration value for NO_3 at 50 mg/l, and many public supply sources were providing groundwater with concentrations exceeding or close to the limit. By 1989, about 1% of the UK population received non-compliant water and almost 200 public supply sources abstracted water above the 50 mg/l level.

The water industry responded by taking boreholes out of use, blending water supply with low NO3 sources or introduce treatment to remove nitrate. Additionally, various legislation has been introduced to improve farming practices to reduce NO3 too. This was effective in meeting the targets set out under DWD.

In 1991, the Nitrate Directive required EU states to identify waters that were or could be affected by Nitrogen pollution from agricultural sources and designate the land from which pollutants were deriving as 'nitrate vulnerable zones' (NVZs). Currently NVZs include about 58% of land in England. The Department for Environment, Food and Rural Affairs (Defra) reviews NVZs every four years to account for changes in water pollution and the system has not had the impact that was intended. Overall, we estimate that these measures brought about a 7% reduction of nitrates in drinking water.

Measures in these zones aim to significantly reduce the amount of NO3 leaching from soil. The basis for these measures was a series of large-scale experiments that began in 1990 when ten groundwater catchments, subsequently increased to 32, were selected as 'Nitrate Sensitive Areas'. Farmers in these areas were offered payments for complying with rules for the use of fertiliser and manure, the maintenance of a green ground cover in winter and the conversion of arable land to grassland. As a result of this government initiative NO3 leaching was reduced. However, significant long term improvements failed to materialise when the scheme closed in late 1990s.

Since the demise of the voluntary and financially incentivised NSA scheme, the compulsory and uncompensated NVZ Action Plan has been in place. This involves less radical land-use change mitigation measures and, although it has worked to reduce nitrate pollution, it is less effective. The NVZ rules are part of the requirements for cross compliance, known as Statutory Management Requirement 1. Farmers must meet all NVZ cross-compliance requirements to qualify for full payment under the Basic Payment Scheme and other direct payments

Article 7 of the Water Framework Directive (WFD) contains objectives of no additional treatment and the reduction and removal of existing treatment. It is against that aspiration that the Environment Agency has promoted the inclusion of groundwater catchment measures in the WINEP under No-Deterioration (DrWPA-ND) and Improvement (DrWPA-IMP) Drinking Water Protected Area Drivers. This has been successful in allowing water companies to work on catchment measures to achieve the objectives of nitrate reduction.

5. Are other nations taking more effective action on nitrates that the UK can learn from?

The European Environment Agency (2007) stated that nitrogen pollution was still a major European water issue:

- About 50-70 % of nitrogen input to water came from agriculture.
- During the last 15 years, there had been some reduction in nitrate concentration – but it was still high in many rivers, groundwater and coastal areas.
- Nitrate pollution may increase in future if the 'food crisis' and need for biofuels results in an increase in agricultural production.

Rivers with low pollution levels are found in the Nordic countries, Baltic States and in the Alps and western Balkans. The countries with a high proportion of rivers with high nitrate concentrations are western central European countries (UK, Denmark, Germany, The Netherlands, Belgium and France) with intensive agricultural areas.

The total area-specific load in the catchments/countries in northwestern Europe is more than double (triple) than in the Nordic countries and Baltic States. For all countries and catchments examined, agricultural or diffuse losses (agriculture plus background) accounted for more than 60 % of the total load.

6. What more could Government do to reduce nitrate pollution as quickly as possible?

Investigations, data analysis and catchment modelling in AMP5 and AMP6 have indicated that groundwater responds slowly to changes in land-use practice and catchment management measures to address nitrate pollution will not have an instant impact. However, the implementation of a variety of considered and targeted measures will lead to the eventual improvement in water quality and the gradual reduction in the reliance on expensive treatment.

To further reduce nitrate pollution the Government should consider:

- The reintroduction of the Nitrate Sensitive Area Scheme.
- Greater availability of information to farmers and agronomists regarding high risk land, best practices for application and consequences.
- Tighten NVZ Action Plan rules in the sensitive areas of impacted groundwater sources.
- Encourage and incentivise the use of autumn cover crops in agriculture. This could be part of the post-Brexit reform of farming subsidies, which the Environment Secretary has already said he wants to use to reward environmentally friendly farming practices.
- Explore other measures to mitigate nitrate impacts as part of CAP reform.
- Supporting longer strategic approaches to address the issue. This could include widening measures in policy, such as WINEP, to make requirements of agriculture and enable bigger timeframes for activity beyond the current five year Asset Management Period (AMP) periods that govern the water industry.
- Reviewing the implications of Brexit on any shift towards maximising UK arable productivity to ensure that we do not create future additional risks through any increase in fertiliser use.
- Providing additional support for research and development in areas such as improving the targeting of the application of chemical inputs, cover crops and crop types that require less chemical inputs.
- Greater responsibilities and accountability for chemical manufacturers. Particularly, an increased significance around how chemicals behave in water and their treatability in any future licencing activity around chemicals intended for use in agriculture.

Date	What happened?
1940s to 1970s	- Modernisation and intensification of farming with ploughing of grasslands after WWII, and increased use of artificial nitrogenous fertilisers from the 1950s. - Increased amount of nitrate washed from fields into rivers and groundwater becomes leached from the soil by infiltrating rain. Eventually, a gradual, but marked, increase in the concentration of nitrate in groundwater in the affected areas becomes evident in the early 1970s.
1980s	- Drinking Water Directive comes into force. - Awareness of elevated nitrate in groundwater and the risk of non-compliance with the drinking water standard.
1990s	- Construction and operation of first batch of nitrate treatment solutions between 1989 and 1999. - Nitrate Directive comes into force. - Development of Nitrate Sensitive Areas and then Nitrate Vulnerable Zones. - Increasing levels of academic research.
2000s	- More treatment solutions through AMP 3 and 4 business plans. - Water Framework Directive Article 7 and Drinking Water Safety Planning approach. - Regulators begin promoting catchment management as a long term sustainable alternative to treatment, encouraging prevention rather than ‘curing’ the issue.
2010s	- More treatment solutions introduced as part of AMP 5 and 6 business plans. - Widespread promotion of Catchment Based Approach by Defra. - We began our Groundwater Catchment Management project, which included stakeholder engagement and modelling work. - Modelling results and data analysis indicate continued rising trends in some sources, but some suggest a stabilising of trends or even a gradual decline. - Establishment of a dedicated Catchment Team in AMP6 which allows greater agronomic engagement and implementation of pilot studies with partners in Lincolnshire (with Environment Agency and ADAS) and Norfolk (with the Rivers Trust).