



# **HABITATS REGULATIONS ASSESSMENT – VOLUME 3 - APPENDIX 6**

## **Drax Nitrate / Phosphate Nutrient Limitation Note**

### **Drax Bioenergy with Carbon Capture and Storage**

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations, 2009 - Regulation 5(2)(g)

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# MEMO

<b>TO</b>	Natural England	<b>FROM</b>	WSP UK Ltd.
<b>DATE</b>	06 November 2018	<b>CONFIDENTIALITY</b>	Confidential
<b>SUBJECT</b>	<b>Briefing Note for Natural England about phosphate limitation in the River Derwent (DRAX Re-Power HRA Report) - revision 3</b>		

## 1. MOTIVATION

In May 2018, WSP UK Ltd. prepared a Habitats Regulations Assessment (HRA) Report of the Drax Repower Project for Drax Power Ltd. Section 6 of the HRA report discusses the air quality impacts arising from the proposed modification of part of Drax Power Station to run on natural gas. Section 6.3 describes, amongst other aspects, the potential impacts of nitrogen emissions – NO<sub>x</sub>, NO<sub>2</sub> and ammonia (NH<sub>3</sub>) – on the identified receptors. In paragraph 6.3.12 a statement is made that the “River Derwent (and the hydrologically connected downstream River Ouse) ... is strongly phosphate limited.”

The HRA was discussed at a meeting with Natural England (NE) on 26.6.2018, at which NE requested additional information about the above statement on phosphate limitation made in the HRA. This Briefing Note has been prepared by WSP UK Ltd. for NE to provide background information about the logic behind the statement made.

## 2. SCIENTIFIC BACKGROUND

The statement in paragraph 6.3.12 is made in the context of the assessment of nitrogen deposition onto designated sites arising from future power station emissions. For the majority of sites considered by the HRA, the potential impacts are assessed against site-specific critical loads – defined ranges of N deposition below which no adverse effects are expected to arise, based on best available scientific evidence. However, for the closest European Site, the River Derwent SAC, no information about a critical N load is available, because rivers do not typically have critical loads assigned.

The UK Air Pollution Information Service (APIS) provides the following information on its website<sup>1</sup> about nitrogen deposition onto Rivers and Streams:

*Impact Type: Deposition of pollutant*

*Key Concerns:*

*Deposition of ammonia, nitrate and other forms of nitrogen from the atmosphere could be an important source of nitrogen in some upland catchments where intensive agricultural activity is absent. Detailed nitrogen budgets, however, do not exist, so the relative inputs from atmospheric deposition are unknown. In such cases, increasing nitrogen inputs from atmospheric sources are likely to have ecological impacts. In most lowland rivers and burns, nitrogen inputs from catchment land-use, not deposition from the atmosphere, are likely to be much more significant (Strong et al. 1997, Smith & Stewart 1989, Foy et al. 1982).*

*Additional Comments:*

*A critical load cannot be given for nitrogen, as quantitative relationships between biology and nitrogen concentrations are poorly understood. The nitrogen to phosphorus ratio can be important, with a molar ratio of around 16:1 (7:1 by weight) being the threshold between N- and P-limitation (Wetzel 2001). Impacts could be assessed by deviation from*

<sup>1</sup> <http://www.apis.ac.uk/node/982>, last accessed 2/8/2018

a 'natural' ratio for an individual site. The nitrogen concentration and load in rivers, particularly those in agricultural catchments, have been rising for a few decades (Zhou et al 2000, Gibson et al. 1992). The main source of this nitrogen is inorganic fertilisers (Strong et al. 1997, Smith & Stewart 1989).

### 3. SITE-SPECIFIC ASSESSMENT

The assessment whether the River Derwent is P- or N-limited was made based on the N:P ratios calculated from available water quality monitoring data of the Environment Agency. Data from two EA monitoring sites was evaluated, one on the River Derwent and the other from the River Ouse:

- River Derwent at Loftsome Bridge
- River Ouse at Long Drax

For both sites, the complete available monitoring data recorded between January 2013 and July 2018 was obtained from the EA.

#### 3.1. Nitrogen speciation in the two rivers

N:P ratios in aquatic environments are usually calculated as the ratio between nitrate and orthophosphate. However, in the context of the DRAX Repower HRA, ammonia is the nitrogen species of primary concern, which readily transforms into other nitrogen species (i.e. nitrate, nitrite, ammonium [NH<sub>4</sub><sup>+</sup>], NO<sub>x</sub> gases, N<sub>2</sub> gas) in the environment. Therefore, all nitrogen species have to be taken into account in the assessment.

All aqueous nitrogen species (i.e. ammonia [NH<sub>3</sub>], nitrate, nitrite, ammonium [NH<sub>4</sub><sup>+</sup>]) and total calculated N (the sum of these four species, as N) over the period 2013 – 2018 in both rivers are plotted below in Figure 1 and Figure 2, respectively.

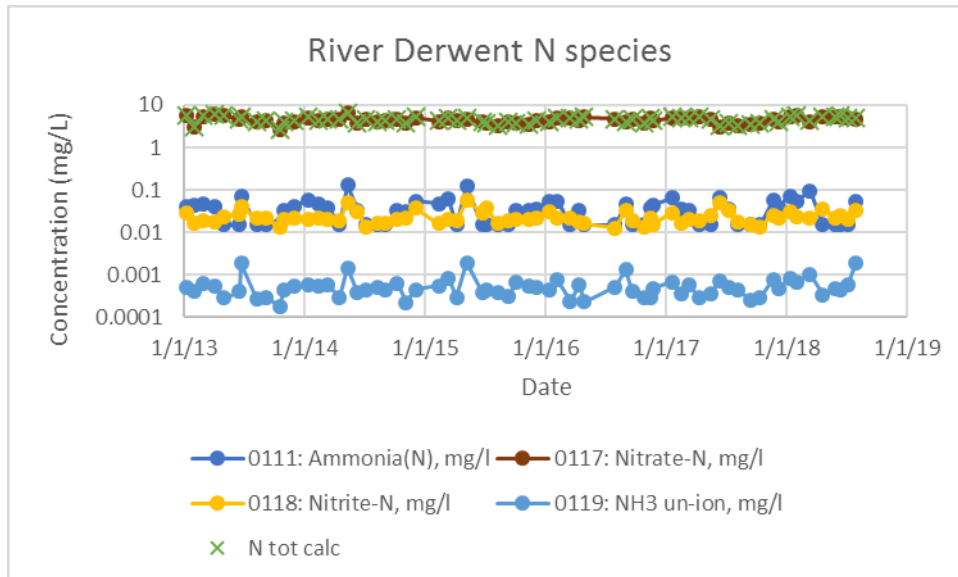


Figure 1: Measured aqueous nitrogen species and calculated total N in the River Derwent at Loftsome Bridge between 2013 and 2018

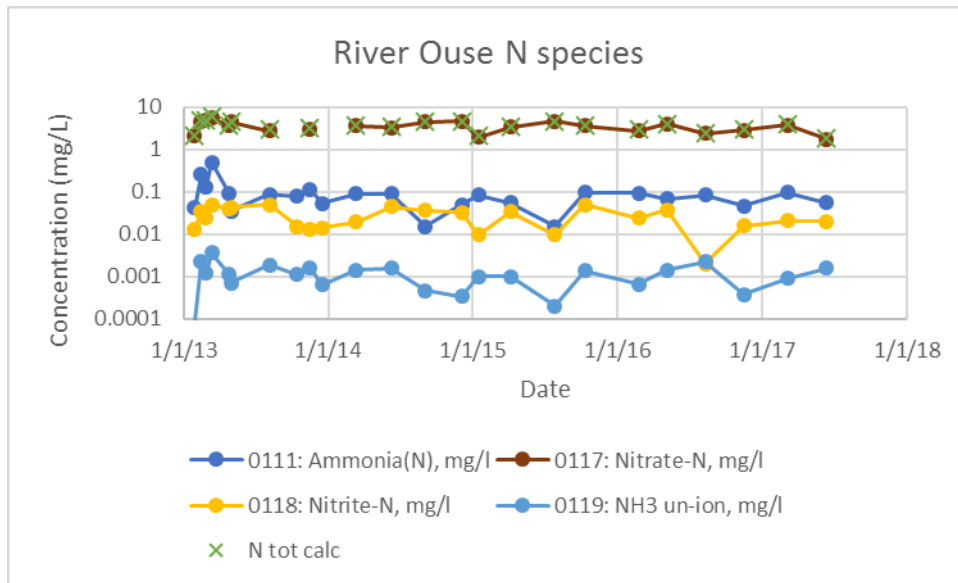


Figure 2: Measured aqueous nitrogen species and calculated total N in the River Ouse at Long Drax between 2013 and 2018

For both rivers, nitrate is the predominant N species by at least one order of magnitude. This is expected due to oxygenated conditions. The average concentrations of total calculated N and nitrate-N are shown in Table 1. In the River Derwent at Loftsome Bridge, nitrate-N constitutes 98.7% of total calculated N on average. In the River Ouse at Long Drax, nitrate-N constitutes 97.4% of total calculated N on average.

Table 1: Average concentrations of total calculated N and nitrate-N in the River Derwent and the River Ouse between 2013 and 2018

Parameter	Units	River Derwent at Loftsome Bridge	River Ouse at Long Drax
Total Nitrogen (calculated as N)	mg/L	4.54	3.41
Nitrate (as N)	mg/L	4.48	3.32
Nitrate-N/Total N	-	98.7%	97.4%

### 3.2. N:P ratios

For conservatism, N:P ratios were calculated both based on total N and nitrate-N. The concentrations of orthophosphate (reactive as P), nitrate-N and calculated total N in the River Derwent and the River Ouse are plotted in Figure 3 and Figure 4, respectively.

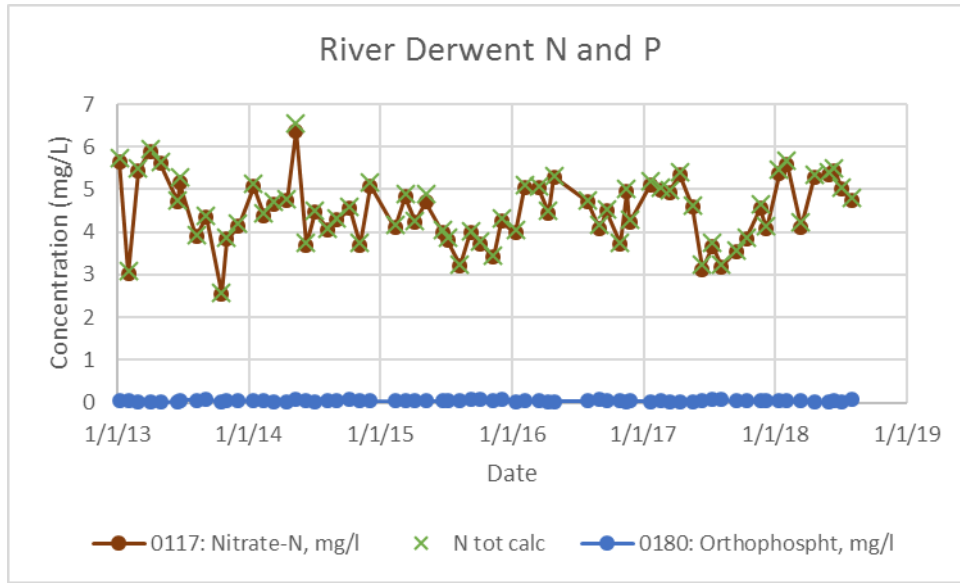


Figure 3: Concentrations of orthophosphate (reactive as P), nitrate-N and calculated total N in the River Derwent at Loftsome Bridge between 2013 and 2018

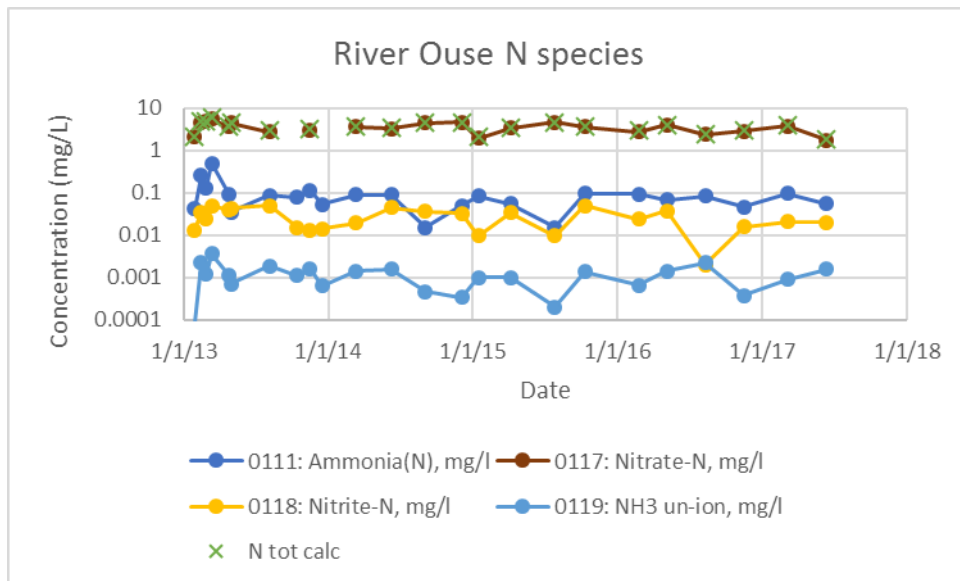


Figure 4: Concentrations of orthophosphate (reactive as P), nitrate-N and calculated total N in the River Ouse at Long Drax between 2013 and 2018

The average concentrations of calculated total N, nitrate-N and orthophosphate-P (reactive as P) during the assessed period and the N:P ratios at both stations are shown in Table 2.

*Table 2: Average concentrations of N and P measured in 2016 – 2018 and N:P ratios in the River Derwent and the River Ouse*

Parameter	Units	River Derwent at Loftsome Bridge	River Ouse at Long Drax
<b>Total Nitrogen (calculated as N)</b>	mg/L	4.54	3.41
<b>Nitrate (as N)</b>	mg/L	4.48	3.32
<b>Orthophosphate (reactive as P)</b>	mg/L	0.04	0.16
<b>N:P ratio by weight as Total N:P</b>	-	110.3	21.2
<b>N:P ratio by weight as Nitrate-N:P</b>	-	108.8	20.7

In the River Derwent at Loftsome Bridge, the N:P ratio by weight as Total N:P is 110.3:1, the N:P ratio by weight as Nitrate-N:P is to 108.8:1. Both N:P ratios are far in excess of the threshold of 7:1 by weight specified by Wetzel (2001).

In the River Ouse at Long Drax, orthophosphate concentrations are higher and nitrogen concentrations are lower than in the River Derwent. The N:P ratio by weight as Total N:P is 21.2:1, the N:P ratio by weight as Nitrate-N:P is to 20.7:1. Both N:P ratios are still significantly higher than the 7:1 threshold.

These data indicate that both rivers are phosphate limited at these monitoring stations. In phosphate limited systems, additional inputs of nitrogen have limited effects on plant productivity, as phosphate is the primary limiting nutrient. As such, additional N-inputs would be unlikely to lead to any perceptible eutrophication effects on SAC freshwater habitats.

#### 4. REFERENCES

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