# WQ1 APPENDIX 5 – AIR QUALITY TECHNICAL NOTE 2

## Drax Bioenergy with Carbon Capture and Storage

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

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# Air Quality Technical Note 2

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**SUBJECT**: Updated Model Results Following Changes to Emission Limit Values and Updated Mitigation

## FOREWORD

Following submission of the Environmental Statement to the Planning Inspectorate in May 2022, an update in relation to air quality was carried out in October 2022 to take account of updated emission limit values (ELVs) for the primary amine (termed 'Amine 1' in the ES). This was reported in **Air Quality Technical Note 1 (AS-019)** ("Technical Note 1"), **Appendix 6.4 (Operational Phase Air Quality Results Tables: Human Receptors)** (AS-014) and **Appendix 6.5 (Operation Phase Air Quality Results Tables: Ecological Receptors)** (AS-015) as an update to the operational phase air quality assessment reported in **ES Chapter 6 (Air Quality)** of the ES (APP-042).

This Technical Note ("Technical Note 2"), accompanied by **Appendix 6.4 (Operational Phase Air Quality Results Tables: Human Receptors)** (AS-014, Rev03 submitted at Deadline 2) and **Appendix 6.5 (Operation Phase Air Quality Results Tables: Ecological Receptors)** (AS-015, Rev03 submitted at Deadline 2) provides details of further relevant design updates and associated discussion of the changes to the air quality assessment as a result of changes to the annual and daily ELVs for Nitrogen Oxides (NOx) and, for the purpose of enhanced operational phase mitigation, Sulphur Dioxide ($SO_2$). The details and discussion presented below demonstrate that these changes do not affect the conclusions of the ES. The impacts of the changes in relation to ecological receptors are discussed in the Habitats Regulations Assessment Report (APP-185, Rev02 being submitted for Deadline 2).

## INTRODUCTION

Subsequent to additional analysis of the operation of the power station under the Proposed Scheme and the assessment of impacts since the preparation of the Environmental Statement (ES) for the Drax BECCS DCO application (May 2022) and the permit application to the Environment Agency in August 2022 (as reported in Technical Note 1), further information has been received from Drax that necessitated the updating of the air quality dispersion model input parameters for the purposes of the ES. Namely:

- The annual and daily emission limit values (ELVs) for NOx have been set to 160mg/Nm3 and 200mg/Nm3 (compliant with the requirements of the latest Best Available Techniques

(BAT) conclusions[1,2]) prior to the removal of $CO_2$ from the exhaust gases in the permit variation application. This implies that the emission concentrations for the purpose of air quality modelling at the stack exit will be 207mg/Nm$^3$ and 258mg/Nm$^3$ respectively (with the increase in emission limit purely due to the fact that the same mass of $NO_X$ is mixed within a smaller volume of gas following the carbon capture process). In effect, this means that the mass of NOx will be unaffected by the carbon capture process and the mass emission rate in g/s from the BECCS and non-BECCS units will be identical. Further details of these calculations are provided in Appendix A to the Technical Note; and

- To provide additional operational phase mitigation of acid deposition over sensitive ecological receptors, the annual ELV for $SO_2$ has been reduced to 45mg/Nm$^3$ for the BECCS units. This will be able to be secured via the environmental permit. The daily ELV remains unchanged.

## EMISSION LIMIT VALUES (ELV)

**Table 1** shows the emission concentrations and mass emission rates for NOx and $SO_2$ as modelled for the Air Quality ES and as updated in this Technical Note 2. For completeness, the changes to the primary amines updated in August 2022 for the permit application are also shown.

**Table 1 - Stack Emission Parameters for the With Proposed Scheme Scenario. Emission parameters that change are shown in green bold text**

| Parameter | | As Reported in the Air Quality ES | | As Updated in August 2022 Permit Application (1) | | As Updated in February 2023 (1) | |
|---|---|---|---|---|---|---|---|
| **Averaging Period** | | **Annual Limit** | **Daily Limit** | **Annual Limit** | **Daily Limit** | **Annual Limit** | **Daily Limit** |
| **Emission Concentrations (for each BECCS Unit) (mg/Nm$^3$)** | | | | | | | |
| Amine 1 | | 0.5 | 1.5 | **1** | **2** | | |
| Nitrogen Oxides | | 160 | 200 | | | **207** | **258** |
| Sulphur Dioxide | No Mit | 100 | 215 | | | 100 | 215 |
| | With Mit | 60 | 215 | | | **45** | 215 |
| **Mass Emission Rates (2 BECCS Units, combined stack) (g/s)** | | | | | | | |
| Amine 1 | | 0.444 | 1.333 | **0.889** | **1.778** | | |
| Nitrogen Oxides | | 142.2 | 177.8 | | | **183.3** | **229.1** |
| | No Mit | 88.9 | 191.1 | | | 88.9 | 191.1 |

[1] Thierry Lecomte, José Félix Ferrería de la Fuente, Frederik Neuwahl, Michele Canova, Antoine Pinasseau, Ivan Jankov, Thomas Brinkmann, Serge Roudier, Luis Delgado Sancho; Best Available Techniques (BAT) Reference Document for Large Combustion Plants; EUR 28836 EN; 2017.

[2] Following withdrawal from the EU, the UK is in the process of establishing a UK BAT system. The large combustion plant (LCP) sector is not scheduled for inclusion within the first tranche of sectors to which UK BATC will apply. At present, existing BAT Conclusions continue have effect in the UK through the EU Withdrawal Act and the LCP BAT Reference document for LCP was published in 2017.

| Parameter | | As Reported in the Air Quality ES | | As Updated in August 2022 Permit Application (1) | | As Updated in February 2023 (1) | |
|---|---|---|---|---|---|---|---|
| Sulphur Dioxide | With Mit | 53.3 | 191.1 | | | **40** | 191.1 |
| **Mass Emission Rates (2 BECCS Units + 2 non-BECCS Units, combined stack) (g/s)** | | | | | | | |
| Amine 1 | | 0.444 | 1.333 | **0.889** | **1.778** | | |
| Nitrogen Oxides | | 325.5 | 142.2 | | | **366.7** | **183.3** |
| Sulphur Dioxide | No Mit | 203.4 | 437.4 | | | 203.4 | 437.4 |
| | With Mit | 167.9 | 437.4 | | | **154.5** | 437.4 |

Notes:
(1) Changes from May 2022 ES are highlighted in bold and supersede the equivalent data presented in Tables 6.6, 6.7 and 6.17 of Chapter 6 (Air Quality) and Tables 1.1, 1.2 and 1.4 of Appendix 6.3 (APP-127) of the May 2022 ES.

## REVISED MODELLING: RESULTS (HUMAN HEALTH)

The tables below show the original (Air Quality ES) and revised (February 2023) model results for Nitrogen Dioxide at the point of maximum impact in the study area (based on 5 years of hourly meteorological data), both without and with the operational phase mitigation outlined in **paragraph 6.10.8** in ES **Chapter 6 (Air Quality)** [3]. The results are presented separately for the ES 'core model scenarios' (non-BECCS units operating on a 'mid-merit' basis, Table 2, updating data presented in **Table 6.15** in ES **Chapter 6 (Air Quality)**, and the ES 'worst case emissions profile' scenario (all units operating at full load for 8,760 hours per year, Table 3). Table 4 shows the maximum cumulative impacts (updating data presented in **Table 6.19** in ES **Chapter 6 (Air Quality)**.

The full set of $NO_2$ model results tables for the above scenarios have been updated and are presented in the updated version of **Appendix 6.4 (Operational Phase Air Quality Results Tables: Human Receptors)** (AS-014, Rev03 submitted at Deadline 2).

The impact of the update to the NOx ELV set out in this Technical Note 2 is a slight increase in $NO_2$ concentrations with the Proposed Scheme but no change in the assessment of the significance of effects. Based on the updated model results and taking into account changes made in **Technical Note 1**, **paragraph 6.9.23** in ES **Chapter 6 (Air Quality)** is superseded by the following changes specific to the $NO_2$ results both without and with the operational phase mitigation measures (changes from Technical Note 1 indicated by purple text, changes from this Technical note indicated by **bold green text,** with the original text shown with a double strike through):

[3] The only aspect of the operational phase mitigation that is relevant to emissions of pollutants other than SO2 is the increase in the temperature of the plume from 80C to 103C. This remains unchanged from the May 2022 ES by the updates set out in this Technical Note.

6.9.23 *The modelled impacts for all assessed pollutants, including amines as MEA, are below 1% of the relevant AQALs, with the exception of the hourly mean $NO_2$, hourly mean $SO_2$ and annual mean nitrosamine (as NDMA), where the maximum modelled impacts equate to* ~~*1.2%*~~ ***1.7% and 1.3% for $NO_2$ without and with mitigation respectively,*** *… and 10.2% of the NDMA EAL (without mitigation) and 9.6% (with mitigation). Given that the mitigation will be implemented as part of the Proposed Scheme, and to align with the August 2022 permit application, the maximum NDMA impact corresponds to a 'slight adverse' magnitude of change within the context of the significance criteria presented in Table 6.9 (ES Chapter 6 (Air Quality)). For all other assessed pollutants and averaging periods, the maximum modelled impacts are classified as 'negligible'.*

**Table 2 - Revised modelled maximum NOx impacts (Core Scenario) (updated numbers shown in green bold text)**

| Revision | Averaging Period | Maximum Concentration (µg/m³) | | | Impact as % of AQAL |
|---|---|---|---|---|---|
| | | Baseline | With Scheme | Max Impact | |
| **Without Mitigation** | | | | | |
| **Air Quality ES** | Annual | 0.06 | 0.13 | 0.09 | 0.22% |
| | Hourly | 4.05 | 4.31 | 2.44 | 1.22% |
| **Feb 2023 Update** | Annual | **0.06** | **0.16** | **0.12** | **0.29%** |
| | Hourly | **4.05** | **4.96** | **3.38** | **1.69%** |
| **With Mitigation** | | | | | |
| **Air Quality ES** | Annual | 0.06 | 0.12 | 0.07 | 0.18% |
| | Hourly | 4.05 | 4.06 | 1.80 | 0.90% |
| **Feb 2023 Update** | Annual | **0.06** | **0.15** | **0.10** | **0.24%** |
| | Hourly | **4.05** | **4.58** | **2.55** | **1.27%** |

**Table 3 - Revised modelled maximum NOx impacts (Worst Case Emissions Scenario) (updated numbers shown in green bold text)**

| Revision | Averaging Period | Maximum Concentration (µg/m$^3$) | | | Impact as % of AQAL |
|---|---|---|---|---|---|
| | | Baseline | With Scheme | Max Impact | |
| **Without Mitigation** | | | | | |
| **Air Quality ES** | Annual | 0.14 | 0.15 | 0.03 | 0.07% |
| | Hourly | 4.05 | 4.31 | 2.44 | 1.22% |
| **Feb 2023 Update** | Annual | **0.14** | **0.17** | **0.04** | **0.11%** |
| | Hourly | **4.05** | **4.96** | **3.38** | **1.69%** |
| **With Mitigation** | | | | | |
| **Air Quality ES** | Annual | 0.14 | 0.14 | 0.02 | 0.05% |
| | Hourly | 4.05 | 4.06 | 1.80 | 0.90% |
| **Feb 2023 Update** | Annual | **0.14** | **0.16** | **0.03** | **0.08%** |
| | Hourly | **4.05** | **4.58** | **2.55** | **1.27%** |

**Table 4 - Revised modelled maximum NOx impacts (Cumulative Scenario for Core Scenario) (updated numbers shown in green bold text)**

| Revision | Averaging Period | Maximum Concentration (µg/m$^3$) | | | Impact as % of AQAL |
|---|---|---|---|---|---|
| | | Baseline | Cumulative | Max Impact | |
| **Without Mitigation** | | | | | |
| **Air Quality ES** | Annual | 9.96 | 10.01 | 0.05 | 0.11% |
| **Feb 2023 Update** | Annual | **9.98** | **10.03** | **0.05** | **0.12%** |

In relation to the comparison of the Worst Case Emissions Scenario to the Core Scenario, **paragraphs 6.9.26 and 6.2.27** in **Chapter 6 (Air Quality)** are superseded by the following text (changes in bold green text)

6.9.26 *For instance, the maximum annual mean $NO_2$ Process Contribution in the Baseline scenario (0.14 µg/m³) notably increases under a worst-case operating profile relative to the core modelling Baseline scenario (0.06 µg/m³), with only a marginal increase in the With Scheme scenario (~~0.15 µg/m³~~ **0.17 µg/m³**) compared to the core modelling (~~0.13 µg/m³~~ **0.16 µg/m³**). This is a function of all four biomass units in the Baseline scenario switching from 'mid-merit' operation (full load for 4,000 hours per year) to continuous operation….*

6.9.27 *As a consequence, the maximum annual mean NO2 impact in the Proposed Scheme (~~0.03 µg/m³~~ **0.04 µg/m³**) scenario decreases slightly under the worst-case emissions profile scenario relative to the core modelling (~~0.09 µg/m³~~ **0.12 µg/m³**). This is evident for all modelled pollutants in the sensitivity test results, whereby the majority of modelled Baseline concentrations increase, whilst the With Proposed Scheme scenario concentrations remain largely unchanged or reduce slightly. Therefore, the maximum impacts are reported to decrease at the majority of receptors relative to the core modelling equivalents.*

The update to the modelled cumulative impact does not impact on any text in **ES Chapter 6 (Air Quality)** since the impacts remain insignificant.

The above updated text and associated revised model results do not change the conclusions of the operational phase air quality assessment reported in **ES Chapter 6 (Air Quality)** of the ES**.**

There are no annual average assessment levels for sulphur dioxide set for the protection of human health. Therefore the results of the submitted (May 2022) ES are unchanged by the additional mitigation set out in this note (which applies to the annual average $SO_2$ ELV only). Impacts on $SO_2$ concentrations were assessed to be negligible for human health in **ES Chapter 6 (Air Quality)** and they remain negligible following this update.

## REVISED MODELLING: RESULTS (ECOLOGICAL RECEPTORS)

The tables below, **Tables 5 – 8**, show the original (May 2022 ES) and revised (February 2023) maximum impacts of the Proposed Scheme on ecological receptors. **Tables 5 and 6** show the impacts on NOx and $SO_2$ concentrations for the core scenario, without and with operational phase mitigation respectively, **Tables 7 and 8** show the impacts on nitrogen and acid deposition.

The full set of modelled results tables for all scenarios have been updated and are presented in **Appendix 6.5 (Operational Phase Air Quality Results Tables: Ecological Receptors)** (AS-015, Rev03 being submitted at Deadline 2)**.**

In terms of NOx and $SO_2$ pollutant concentrations (and ammonia), the impacts of the operation of the Proposed Scheme alone on concentrations will not result in significant air quality effects at

assessed ecological receptors. As such, the text and conclusions of **ES Chapter 6 (Air Quality)** in this regard i.e. **paragraphs 6.9.34 – 6.9.37**, remain unchanged with the design changes set out in this Technical Note 2.

Similarly, the maximum impacts of the Proposed Scheme alone on nitrogen deposition are insignificant (<1% of the critical load) at all designated sites, even when taking into account the increased ELV for NOx i.e. **paragraphs 6.9.38 – 6.9.39** of **ES Chapter 6 (Air Quality)** remain unchanged.

The unmitigated impacts of the Proposed Scheme alone on acid deposition exceed 1% of the respective critical load at some sensitive habitats and the increase in the NOx ELV, prior to the application of mitigation results in a slight increase in acid deposition. The increase is largely imperceptible in the model results tables, with the exception being the maximum impact from the Proposed Scheme alone over Lower Derwent SAC and Breighton Meadows SSSI increasing from 2.0% of the critical load to 2.1% (Table 7). However no additional designated sites have maximum impacts over 1% of the critical load over and above those identified in the **ES Chapter 6 (Air Quality)**.

The additional mitigation of $SO_2$ emissions set out above more than offsets this increase such that the maximum mitigated impact of the Proposed Scheme are ≤1% over all designated sites (**Table 8**).

As a result, **paragraph 6.9.41** of **Chapter 6 (Air Quality)** is updated as follows:

> *6.9.41 The modelled PC from the With Proposed Scheme scenario operation is above 1% of the respective critical load at sensitive habitats within the Lower Derwent Valley SAC **(**~~2.0%~~ **2.1%)**, Thorne Moor SAC and Thorne, Crowle, and Goole Moors SSSI (1.3%), as well as at sensitive habitats within SSSI designations at Breighton Meadows **(**~~2.0%~~ **2.2.1%)**, Derwent Ings (1.6%), and Barn Hill Meadows (1.6%).*

and paragraph 6.10.14 is updated to:

> *6.10.14 The mitigation has also had the effect of reducing the modelled level of exceedance at Lower Derwent Valley SAC and the SSSIs at Breighton Meadows and Barn Hill Meadows, such that the impact of the With Proposed Scheme scenario alone is now ~~1.1%~~ **1.0%** (rounded to one decimal place) of the respective critical load at each of these sites, representing ~~marginal exceedance of~~ **compliance with** the 1% **insignificance** criterion.*

Impacts under the Worst Case Emissions scenario are lower than for the core scenario and are not considered further in this note. The results are however presented in **Appendix 6.5 (Operational Phase Air Quality Results Tables: Ecological Receptors)** (AS-015, Rev03 being submitted at Deadline 2**.**

**Table 5 - Revised modelled maximum PC Impact as % of critical levels for annual mean NOx, daily mean NOx and annual mean $SO_2$ at sensitive ecological receptors (Core scenario, without mitigation) (updated numbers shown in green bold text)**

| Receptor | Annual Mean NOx (Max Impact as % of CL) | | Daily Mean NOx (Max Impact as % of CL) | | Annual Mean $SO_2$ (Max Impact as % of CL) | |
|---|---|---|---|---|---|---|
| | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update |
| River Derwent SAC | 0.4% | **0.5%** | 1.6% | **2.4%** | 0.4% | 0.4% |
| Thorne Moor SAC/SPA/SSSI | 0.2% | **0.3%** | 0.7% | **1.2%** | 0.2% | 0.2% |
| Lower Derwent SAC | 0.4% | **0.6%** | 0.7% | **1.2%** | 0.4% | 0.4% |
| Lower Derwent SPA | 0.4% | **0.6%** | 0.7% | **1.2%** | 0.4% | 0.4% |
| Skipwith Common SAC | 0.1% | **0.2%** | 0.4% | **0.9%** | 0.1% | 0.1% |
| Skipwith Common SSSI | 0.1% | **0.2%** | 0.4% | **0.9%** | 0.1% | 0.1% |
| Humber Estuary SAC | 0.4% | **0.5%** | 1.0% | **1.6%** | 0.3% | 0.3% |
| Humber Estuary SPA/SSSI | 0.4% | **0.5%** | 1.0% | **1.6%** | 0.3% | 0.3% |
| Breighton Meadows SSSI | 0.4% | **0.6%** | 0.7% | **1.2%** | 0.4% | 0.4% |
| Eskamhorn Meadows SSSI | 0.1% | **0.2%** | 1.9% | **2.5%** | 0.1% | 0.1% |
| Derwent Ings SSSI | 0.3% | **0.4%** | 0.6% | **1.1%** | 0.3% | 0.3% |

| Receptor | Annual Mean NOx (Max Impact as % of CL) | | Daily Mean NOx (Max Impact as % of CL) | | Annual Mean $SO_2$ (Max Impact as % of CL) | |
|---|---|---|---|---|---|---|
| | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update |
| Went Ings SSSI | 0.1% | **0.2%** | 0.7% | **1.3%** | 0.1% | 0.1% |
| Barn Hill Meadows SSSI | 0.4% | **0.5%** | 0.8% | **1.3%** | 0.4% | 0.4% |
| Burr Closes SSSI | 0.2% | **0.2%** | 0.7% | **1.0%** | 0.1% | 0.1% |
| Common Plantation SINC | 0.0% | **0.1%** | 1.0% | **1.4%** | 0.0% | 0.0% |
| Disused Railway Embankment SINC | 0.1% | **0.1%** | 1.1% | **1.6%** | 0.1% | 0.1% |
| Barmby-on-the-Marsh LWS | 0.2% | **0.3%** | 1.4% | **2.2%** | 0.2% | 0.2% |
| Brockholes SINC | 0.0% | **0.1%** | 1.6% | **2.2%** | 0.0% | 0.0% |
| Meadow East of Orchard Farm SINC | 0.0% | **0.0%** | 0.5% | **0.7%** | 0.0% | 0.0% |
| Barmby Pond LWS | 0.3% | **0.4%** | 1.4% | **2.1%** | 0.3% | 0.3% |
| Cobble Croft Wood SINC | 0.1% | **0.1%** | 1.1% | **1.6%** | 0.1% | 0.1% |
| Hagg Green Lane SINC | 0.3% | **0.3%** | 0.7% | **1.7%** | 0.2% | 0.2% |
| Sand Pitt Wood & Barffs Close Plantation SINC | 0.1% | **0.1%** | 1.5% | **2.2%** | 0.1% | 0.1% |

| Receptor | Annual Mean NOx (Max Impact as % of CL) | | Daily Mean NOx (Max Impact as % of CL) | | Annual Mean $SO_2$ (Max Impact as % of CL) | |
|---|---|---|---|---|---|---|
| | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update |
| **Env. Agency Screening Criterion (as % of CL)** | **1%** | | **10%** | | **1%** | |

**Table 6 - Revised modelled maximum PC Impact as % of critical levels for annual mean NOx, daily mean NOx and annual mean $SO_2$ at sensitive ecological receptors (Core scenario, with mitigation)**

| Receptor | Annual Mean NOx (Max Impact as % of CL) | | Daily Mean NOx (Max Impact as % of CL) | | Annual Mean $SO_2$ (Max Impact as % of CL) | |
|---|---|---|---|---|---|---|
| | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update |
| River Derwent SAC | 0.3% | **0.4%** | 1.1% | **1.8%** | 0.2% | **0.1%** |
| Thorne Moor SAC/SPA/SSSI | 0.2% | **0.2%** | 0.6% | **0.9%** | 0.1% | **0.0%** |
| Lower Derwent SAC | 0.3% | **0.5%** | 0.4% | **0.9%** | 0.2% | **0.1%** |
| Lower Derwent SPA | 0.3% | **0.5%** | 0.4% | **0.9%** | 0.2% | **0.1%** |
| Skipwith Common SAC | 0.1% | **0.2%** | 0.3% | **0.6%** | 0.1% | **0.0%** |
| Skipwith Common SSSI | 0.1% | **0.2%** | 0.3% | **0.6%** | 0.1% | **0.0%** |

| Receptor | Annual Mean NOx (Max Impact as % of CL) | | Daily Mean NOx (Max Impact as % of CL) | | Annual Mean $SO_2$ (Max Impact as % of CL) | |
|---|---|---|---|---|---|---|
| | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update |
| Humber Estuary SAC | 0.3% | **0.4%** | 0.6% | **1.2%** | 0.1% | **0.1%** |
| Humber Estuary SPA/SSSI | 0.3% | **0.4%** | 0.6% | **1.2%** | 0.1% | **0.1%** |
| Breighton Meadows SSSI | 0.3% | **0.5%** | 0.4% | **0.9%** | 0.2% | **0.1%** |
| Eskamhorn Meadows SSSI | 0.1% | **0.1%** | 1.3% | **1.9%** | 0.0% | **0.0%** |
| Derwent Ings SSSI | 0.3% | **0.4%** | 0.4% | **0.9%** | 0.1% | **0.1%** |
| Went Ings SSSI | 0.1% | **0.1%** | 0.3% | **0.9%** | 0.0% | **0.0%** |
| Barn Hill Meadows SSSI | 0.3% | **0.4%** | 0.9% | **1.7%** | 0.1% | **0.1%** |
| Burr Closes SSSI | 0.1% | **0.2%** | 0.5% | **0.7%** | 0.1% | **0.0%** |
| Common Plantation SINC | 0.0% | **0.0%** | 0.6% | **0.9%** | 0.0% | **0.0%** |
| Disused Railway Embankment SINC | 0.1% | **0.1%** | 1.0% | **1.4%** | 0.0% | **0.0%** |
| Barmby-on-the-Marsh LWS | 0.1% | **0.2%** | 1.3% | **1.9%** | 0.1% | **0.1%** |
| Brockholes SINC | 0.0% | **0.0%** | 1.1% | **1.6%** | 0.0% | **0.0%** |

| Receptor | Annual Mean NOx (Max Impact as % of CL) | | Daily Mean NOx (Max Impact as % of CL) | | Annual Mean $SO_2$ (Max Impact as % of CL) | |
|---|---|---|---|---|---|---|
| | **Air Quality ES** | **Feb 2023 Update** | **Air Quality ES** | **Feb 2023 Update** | **Air Quality ES** | **Feb 2023 Update** |
| Meadow East of Orchard Farm SINC | 0.0% | **0.0%** | 0.4% | **0.5%** | 0.0% | **0.0%** |
| Barmby Pond LWS | 0.2% | **0.3%** | 0.9% | **1.5%** | 0.1% | **0.1%** |
| Cobble Croft Wood SINC | 0.1% | **0.1%** | 0.6% | **1.0%** | 0.0% | **0.0%** |
| Hagg Green Lane SINC | 0.2% | **0.3%** | 0.5% | **1.1%** | 0.1% | **0.1%** |
| Sand Pitt Wood & Barffs Close Plantation SINC | 0.1% | **0.1%** | 1.0% | **1.4%** | 0.0% | **0.0%** |
| **Env. Agency Screening Criterion (as % of CL)** | **1%** | | **10%** | | **1%** | |

**Table 7 - Revised modelled maximum PC Impact as % of critical loads for nitrogen deposition and acid deposition at sensitive ecological receptors (Core scenario, without mitigation) (updated numbers shown in green bold text; exceedances of screening criteria shown underlined)**

| Receptor | Annual Mean N-Dep (Max Impact as % of CL) | | Annual Mean Acid Dep (Max Impact as % of CL) | |
|---|---|---|---|---|
| | 2022 ES | Feb 2023 Update | 2022 ES | Feb 2023 Update |
| River Derwent SAC | Not assessed | **0.4%** | *Not Sensitive* | |
| Thorne Moor SAC | 0.5% | **0.5%** | 1.3% | **1.3%** |
| Thorne Moor SPA | 0.2% | **0.2%** | *Not Sensitive* | |
| Thorne Moor SSSI | 0.5% | **0.5%** | 1.3% | **1.3%** |
| Lower Derwent SAC | 0.3% | **0.3%** | 2.0% | **2.1%** |
| Lower Derwent SPA | 0.3% | **0.3%** | *Not Sensitive* | |
| Skipwith Common SAC | 0.2% | **0.2%** | 0.6% | **0.6%** |
| Skipwith Common SSSI | 0.2% | **0.2%** | 0.6% | **0.6%** |
| Humber Estuary SAC | 0.2% | **0.2%** | *Not Sensitive* | |
| Humber Estuary SPA/SSSI | 0.2% | **0.2%** | | |
| Breighton Meadows SSSI | 0.3% | **0.3%** | 2.0% | **2.1%** |
| Eskamhorn Meadows SSSI | 0.1% | **0.2%** | 0.2% | **0.2%** |
| Derwent Ings SSSI | 0.2% | **0.2%** | 1.6% | **1.6%** |
| Went Ings SSSI | 0.1% | **0.1%** | 0.2% | **0.2%** |
| Barn Hill Meadows SSSI | 0.2% | **0.2%** | 1.6% | **1.6%** |
| Burr Closes SSSI | 0.1% | **0.1%** | 0.4% | **0.4%** |
| Common Plantation SINC | 0.1% | **0.1%** | Assumed not sensitive | |

| Receptor | Annual Mean N-Dep (Max Impact as % of CL) | | Annual Mean Acid Dep (Max Impact as % of CL) | |
|---|---|---|---|---|
| | 2022 ES | Feb 2023 Update | 2022 ES | Feb 2023 Update |
| Disused Railway Embankment SINC | 0.2% | **0.2%** | | |
| Barmby-on-the-Marsh LWS | 0.4% | **0.4%** | | |
| Brockholes SINC | 0.1% | **0.1%** | | |
| Meadow East of Orchard Farm SINC | 0.0% | **0.0%** | | |
| Barmby Pond LWS | 0.4% | **0.4%** | | |
| Cobble Croft Wood SINC | 0.1% | **0.2%** | | |
| Hagg Green Lane SINC | 0.5% | **0.6%** | | |
| Sand Pitt Wood & Barffs Close Plantation SINC | 0.1% | **0.2%** | | |
| **Env. Agency Screening Criterion (as % of CL)** | **1%** | | **1%** | |

**Table 8 - Revised modelled maximum PC Impact as % of critical loads for nitrogen deposition and acid deposition at sensitive ecological receptors (Core scenario, with mitigation) (updated numbers shown in green bold text; exceedances of screening criteria shown underlined)**

| Receptor | Annual Mean N-Dep (Max Impact as % of CL) | | Annual Mean Acid Dep (Max Impact as % of CL) | |
|---|---|---|---|---|
| | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update |
| River Derwent SAC | Not assessed | **0.3%** | *Not Sensitive* | |

| Receptor | Annual Mean N-Dep (Max Impact as % of CL) | | Annual Mean Acid Dep (Max Impact as % of CL) | |
|---|---|---|---|---|
| | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update |
| Thorne Moor SAC | 0.4% | **0.4%** | 0.7% | **0.6%** |
| Thorne Moor SPA | 0.2% | **0.2%** | *Not Sensitive* | |
| Thorne Moor SSSI | 0.4% | **0.4%** | 0.7% | **0.6%** |
| Lower Derwent SAC | 0.2% | **0.2%** | 1.1% | **1.0%** |
| Lower Derwent SPA | 0.2% | **0.2%** | *Not Sensitive* | |
| Skipwith Common SAC | 0.1% | **0.2%** | 0.3% | **0.3%** |
| Skipwith Common SSSI | 0.1% | **0.2%** | 0.3% | **0.3%** |
| Humber Estuary SAC | 0.2% | **0.2%** | *Not Sensitive* | |
| Humber Estuary SPA/SSSI | 0.2% | **0.2%** | | |
| Breighton Meadows SSSI | 0.2% | **0.2%** | 1.1% | **1.0%** |
| Eskamhorn Meadows SSSI | 0.1% | **0.1%** | 0.1% | **0.1%** |
| Derwent Ings SSSI | 0.2% | **0.2%** | 0.9% | **0.8%** |
| Went Ings SSSI | 0.1% | **0.1%** | 0.1% | **0.1%** |
| Barn Hill Meadows SSSI | 0.2% | **0.2%** | 1.1% | **0.9%** |
| Burr Closes SSSI | 0.1% | **0.1%** | 0.2% | **0.2%** |
| Common Plantation SINC | 0.1% | **0.1%** | *Assumed not sensitive* | |
| Disused Railway Embankment SINC | 0.1% | **0.2%** | | |
| Barmby-on-the-Marsh LWS | 0.3% | **0.3%** | | |
| Brockholes SINC | 0.0% | **0.0%** | | |

| Receptor | Annual Mean N-Dep (Max Impact as % of CL) | | Annual Mean Acid Dep (Max Impact as % of CL) | |
|---|---|---|---|---|
| | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update |
| Meadow East of Orchard Farm SINC | 0.0% | **0.0%** | | |
| Barmby Pond LWS | 0.3% | **0.3%** | | |
| Cobble Croft Wood SINC | 0.1% | **0.1%** | | |
| Hagg Green Lane SINC | 0.4% | **0.5%** | | |
| Sand Pitt Wood & Barffs Close Plantation SINC | 0.1% | **0.1%** | | |
| **Env. Agency Screening Criterion (as % of CL)** | **1%** | | **10%** | |

For this Technical Note 2 and for the purposes of HRA, the Keadby 2 power plant emissions are considered within the background pollutant concentrations and deposition levels rather than aggregated within the in-combination impacts. This is consistent with the approach adopted by Keadby Generation Limited for their Keadby 3 Carbon Capture Power Station DCO (granted, December 2022). The results for the updated cumulative impact assessment are provided in full in **Appendix 6.5 (Operational Phase Air Quality Results Tables: Ecological Receptors)** (AS-015, Rev03 being submitted at Deadline 2) and a summary of the updated cumulative impacts for nitrogen and acid deposition is shown in Table 9, below (i.e. not including Keadby 3), for the core scenario with mitigation.

**Table 9 - Revised modelled maximum PC Impact as % of critical loads for nitrogen deposition and acid deposition at sensitive ecological receptors (Cumulative Core scenario, with mitigation) (updated numbers shown in green bold text; exceedances of screening criteria shown underlined)**

| Receptor | Annual Mean N-Dep (Max Cumulative Impact as % of CL) | | Annual Mean Acid Dep (Max Cumulative Impact as % of CL) | |
|---|---|---|---|---|
| | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update |
| River Derwent SAC | Not assessed | **0.7%** | *Not Sensitive* | |
| Thorne Moor SAC | 1.7% | **1.3%** | 1.9% | **1.5%** |
| Thorne Moor SPA | 0.9% | **0.6%** | *Not Sensitive* | |
| Thorne Moor SSSI | 1.7% | **1.3%** | 1.9% | **1.5%** |
| Lower Derwent SAC | 0.5% | **0.5%** | 1.8% | **1.6%** |
| Lower Derwent SPA | 0.5% | **0.5%** | *Not Sensitive* | |
| Skipwith Common SAC | 0.7% | **0.6%** | 0.8% | **0.7%** |
| Skipwith Common SSSI | 0.7% | **0.6%** | 0.8% | **0.7%** |
| Humber Estuary SAC | 0.5% | **0.4%** | *Not Sensitive* | |
| Humber Estuary SPA/SSSI | 0.5% | **0.4%** | | |
| Breighton Meadows SSSI | 0.5% | **0.5%** | 1.8% | **1.6%** |
| Eskamhorn Meadows SSSI | 0.8% | **0.6%** | 0.3% | **0.3%** |
| Derwent Ings SSSI | 0.5% | **0.5%** | 1.6% | **1.4%** |
| Went Ings SSSI | 0.4% | **0.3%** | 0.3% | **0.2%** |
| Barn Hill Meadows SSSI | 0.5% | **0.4%** | 1.9% | **1.5%** |
| Burr Closes SSSI | 0.2% | **0.2%** | 0.4% | **0.3%** |
| Common Plantation SINC | **1.7%** | **1.5%** | *Assumed not sensitive* | |

| Receptor | Annual Mean N-Dep (Max Cumulative Impact as % of CL) | | Annual Mean Acid Dep (Max Cumulative Impact as % of CL) | |
|---|---|---|---|---|
| | Air Quality ES | Feb 2023 Update | Air Quality ES | Feb 2023 Update |
| Disused Railway Embankment SINC | **1.5%** | **1.3%** | | |
| Barmby-on-the-Marsh LWS | **1.6%** | **1.4%** | | |
| Brockholes SINC | 0.7% | **0.6%** | | |
| Meadow East of Orchard Farm SINC | 0.4% | **0.4%** | | |
| Barmby Pond LWS | 1.0% | **0.9%** | | |
| Cobble Croft Wood SINC | **1.6%** | **1.5%** | | |
| Hagg Green Lane SINC | **1.9%** | **1.7%** | | |
| Sand Pitt Wood & Barffs Close Plantation SINC | **1.8%** | **1.7%** | | |
| **Env. Agency Screening Criterion (as % of CL)** | **1%** | | **10%** | |

As a result of the updates set out in this Technical Note, **paragraph 6.12.24 of Chapter 6 (Air Quality)** is updated as follows:

> *6.12.24 Using the significance screening criteria, the cumulative operational impacts on annual nitrogen deposition are classified as insignificant (≤1% of the critical level) at all designated sites except for Thorne Moor SAC and Thorne, Crowle, and Goole Moors SSSI. At these sites, the modelled maximum cumulative PC impact, which equates to ~~1.8%~~ **1.3%** of the respective critical **load**, exceeds the 1% significance screening criterion the maximum PEC exceeds the relevant critical load. This applies equally to the pre- and post-mitigation (see Section 6.10) cumulative air quality modelling results.*

Whilst the cumulative acid deposition impact decreases with the updates within this Technical Note 2, no change to the text of Chapter 6 is required. The impacts of the updates are considered in the **Habitats Regulations Assessment** (AS-185, Rev02 being submitted at Deadline 2).

# UPDATE TO ES APPENDIX 6.4 (OPERATIONAL PHASE AIR QUALITY RESULTS TABLES: HUMAN RECEPTORS) AND ES APPENDIX 6.5 (OPERATIONAL PHASE AIR QUALITY RESULTS TABLES: ECOLOGICAL RECEPTORS)

As referenced throughout this Technical Note 2, **Appendix 6.4 (Operation Phase Air Quality Assessment Results Tables: Human Receptors)** (AS-014, Rev03 being submitted at Deadline 2) and **Appendix 6.5 (Operational Phase Air Quality Results Tables: Ecological Receptors)** (AS-015, Rev03 being submitted at Deadline 2) include the revisions to capture all updates to the operational phase air quality model results (non-material in relation to human health, net beneficial in relation to ecological receptors). Specifically, these relate to:

- **Appendix 6.4:**
  - Revised data provided in Table 1.2 (Core Scenario – $NO_2$ annual average concentrations)
  - Revised data provided in Table 1.3 (Core Scenario – $NO_2$ hourly average concentrations)
  - Revised data provided in Table 1.11 (Core Scenario Cumulative Impacts - $NO_2$ annual average concentrations[4])
  - Revised data provided in Table 1.14 (Worst Case Emissions Profile – $NO_2$ annual average concentrations)
  - Revised data provided in Table 1.15 (Worst Case Emissions Profile – $NO_2$ hourly average concentrations)
  - Revised data provided in Table 1.25 (Core Scenario – $NO_2$ annual average concentrations – with mitigation concentrations)
  - Revised data provided in Table 1.26 (Core Scenario – $NO_2$ hourly average concentrations – with mitigation concentrations)
  - Revised data provided in Table 1.34 (Worst Case Emissions Profile – $NO_2$ annual average – with mitigation concentrations)
  - Revised data provided in Table 1.35 (Worst Case Emissions Profile – $NO_2$ hourly average – with mitigation concentrations)
  - Typographical correction in Table 1.33 (Core Scenario – Annual Mean Nitrosamine (as NDMA) concentrations – with mitigation) The percentage impact for receptors Eastrington, Fogathorpe, Cawood, Howden, Bring, Highfield, Willitoft and Receptor Grid Max have been corrected to Core Scenario – with mitigation percentage impacts. Previously the percentage impacts reflected the higher Core Scenario without mitigation impacts.
- **Appendix 6.5:**

[4] Table updated to include cumulative $NO_2$ impacts rather than cumulative NOx impacts.

- Revised data provided in Table 1.1 (Core Scenario – $NO_X$ annual average concentrations)
- Revised data provided in Table 1.2 (Core Scenario – $NO_X$ daily average concentrations)
- Revised data provided in Table 1.5 (Core Scenario – N-deposition annual average)
- Revised data provided in Table 1.6 (Core Scenario – Acid-deposition annual average)
- Revised data provided in Table 1.7 (Core Scenario – $NO_X$ annual average concentrations – with mitigation)
- Revised data provided in Table 1.8 (Core Scenario – $NO_X$ daily average concentrations – with mitigation)
- Revised data provided in Table 1.10 (Core Scenario – $SO_2$ annual average concentrations – with mitigation)
- Revised data provided in Table 1.11 (Core Scenario – N-deposition annual average – with mitigation)
- Revised data provided in Table 1.12 (Core Scenario – Acid-deposition annual average – with mitigation)
- Revised data provided in Table 1.14 (Core Scenario, Cumulative – $NO_X$ daily average concentrations)
- Revised data provided in Table 1.19 (Worst Case Emissions Scenario – $NO_X$ annual average concentrations)
- Revised data provided in Table 1.20 (Worst Case Emissions Scenario – $NO_X$ daily average concentrations)
- Revised data provided in Table 1.23 (Worst Case Emissions Scenario – N-deposition annual average)
- Revised data provided in Table 1.24 (Worst Case Emissions Scenario – Acid-deposition annual average)
- Revised cumulative data provided in Tables 1.13 – Tables 1.18 (Core Scenario, Cumulative – all metrics)

# CONCLUSIONS

The revised data presented in this Technical Note 2 and the associated updates to **Appendix 6.4 (Operation Phase Air Quality Assessment Results Tables: Human Receptors)** and **Appendix 6.5 (Operational Phase Air Quality Results Tables: Ecological Receptors)**, which capture the latest design information received since the August 2022 Permit Variation Application, represent no material change to the conclusions of the May 2022 **ES Chapter 6 (Air Quality)** in relation to human health. The impacts of the Proposed Scheme on annual mean and hourly mean NO2 concentrations remain within the

Environment Agency screening criteria for insignificance, namely 1% and 10% of the air quality assessment levels (40µg/$m^3$ and 200µg/$m^3$ respectively).

The conclusions with respect to ecological receptors, which reflect the beneficial impacts of the reduction in $SO_2$ emissions (and acid deposition), are set out in the **Habitats Regulations Assessment** (APP-185, Rev02 being submitted for Deadline 2)**.**

# APPENDIX A – $NO_X$ EMISSIONS MONITORING AND BATC COMPLIANCE ASSESSMENT

(Note: In this Appendix, numbers have been rounded to improve readability)

Under its current Environmental Permit, Drax must comply with the emission limits (ELVs) set out in the latest Best Available Techniques conclusions (BATc) for large combustion plant. Namely, for plant brought into operation prior to 2014 and using biomass as fuel, the concentration of NOx in the exhaust gases of the biomass units must not exceed:

- 160 mg/Nm$^3$ as an annual average
- 200 mg/Nm$^3$ as a daily average

The current arrangement for monitoring compliance with the BATc ELV is shown in Figure A1 below, and the impact of the February 2023 update will be illustrated with reference to the annual mean ELV (160mg/Nm$^3$).

The exhaust gases from each Biomass Unit amount to 573Nm$^3$/s (**Table 6.6, Chapter 6 (Air Quality)** (APP-042)). Emissions monitoring occurs immediately prior to the venting of the exhaust gases to atmosphere via the 259m main stack (illustrated as point A, in Figure A1). With emissions at the BATc limit, this gives an annual mean mass emission rate for NOx of 91.6g/s per biomass unit, calculated as:

$$160\,\frac{mg}{Nm^3} \times 573\,\frac{Nm^3}{s} = 91600\,\frac{mg}{s} = \mathbf{91.6}\,\frac{\boldsymbol{g}}{\boldsymbol{s}}$$

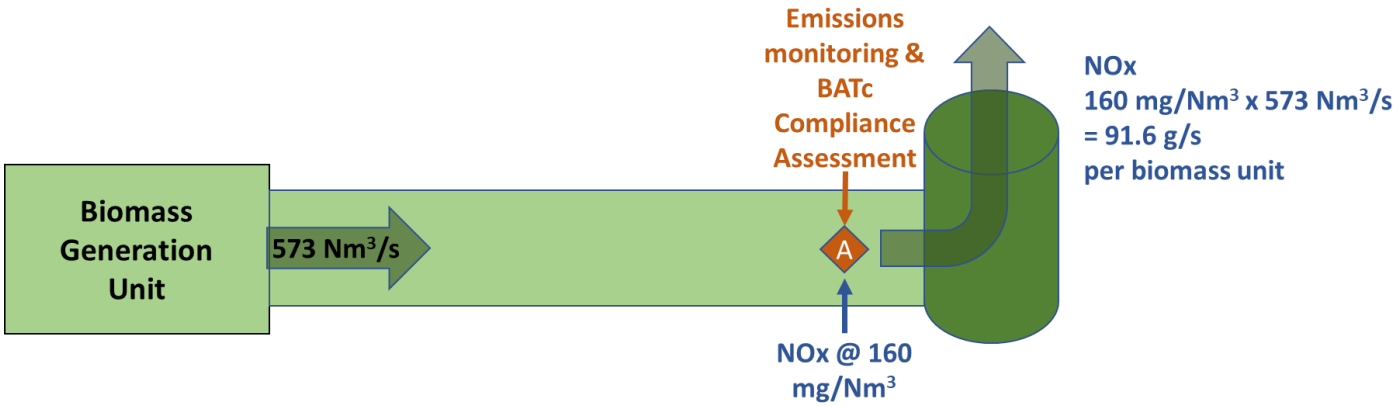


**Figure A1 – Current emissions monitoring arrangement**

In the May 2022 ES, it was assumed that following the installation of the carbon capture plant the emissions monitoring and BATc compliance assessment point would remain in its current location *i.e.* immediately prior to the venting of the exhaust gases to air. The assumed monitoring arrangement for the biomass units with carbon capture (BECCS) is shown in Figure A2 below,

with the emissions monitoring/BATc compliance point at Point A, installed **after** the carbon capture plant.

Since the exhaust gas volume post carbon capture is lower than for the existing biomass units *i.e*. 444Nm$^3$/s, following the removal of $CO_2$ (**Table 6.6, Chapter 6 (Air Quality)** (APP-042)), this resulted in a lower NOx mass emission rate per BECCS unit, 71.1g/s, than per non-CCS biomass unit. The BECCS unit NOx mass emission rate was calculated as:

$$160\,\frac{mg}{Nm^3} \times 444\,\frac{Nm^3}{s} = 71100\,\frac{mg}{s} = \mathbf{71.1}\,\frac{\boldsymbol{g}}{\boldsymbol{s}}$$

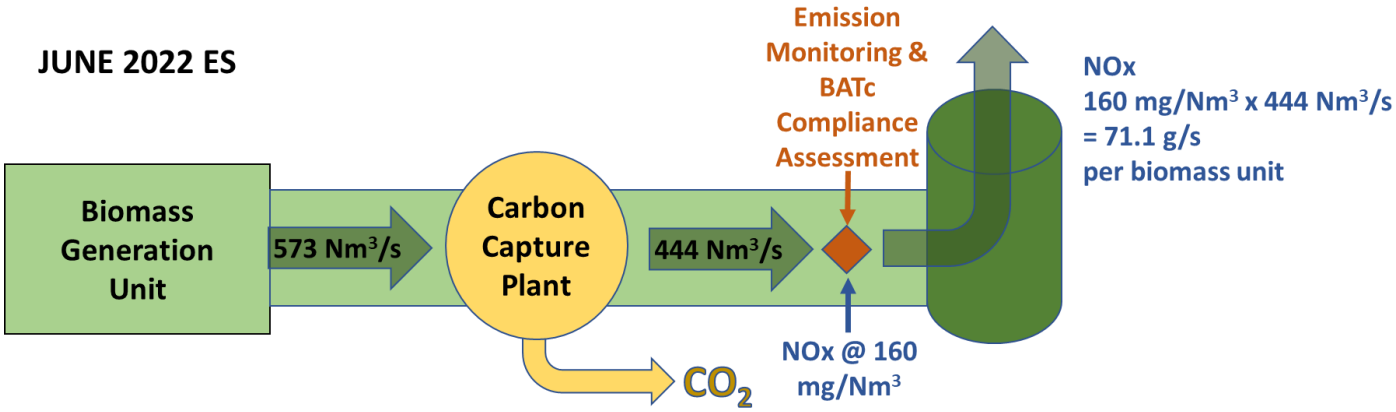


**Figure A2 - Emissions monitoring arrangement assumed in the May 2022 ES.**

Subsequent to additional analysis of the operation of the power station under the Proposed Scheme, it is now proposed (including in the permit application) that the BATc compliance assessment location for NOx is moved to the exhaust gas stream prior to the carbon capture plant (Point B, Figure A3). The emissions monitoring point will, however, be retained at its current location (A, Figure A3) immediately prior to the venting of the exhaust gases since the infrastructure for undertaking the monitoring is already installed at this location for existing operations.

The carbon capture plant will not change the mass of NOx in the exhaust gases but since the volume of the exhaust gases decreases, the concentration of NOx in the exhaust gases will increase i.e. 160mg/Nm$^3$ in an exhaust stream of 573Nm$^3$/s is equivalent to 207mg/Nm$^3$ in an exhaust stream of 444Nm$^3$/s where

$$207 = 160 \times \frac{573}{444}$$

and

$$160\,\frac{mg}{Nm^3} \times 573\,\frac{Nm^3}{s} = 207\,\frac{mg}{Nm^3} \times 444\,\frac{Nm^3}{s} = \mathbf{91.6}\,\frac{\boldsymbol{g}}{\boldsymbol{s}}$$

As a result, the mass emission rate of NOx from the BECCS units is returned to its value in the existing units, namely 91.6g/s per unit, and the emission limit value that will be set in the permit at the monitoring point, A, will be 207mg/Nm$^3$.

For the daily emission limit value, the post carbon capture emission limit value will be 258mg/Nm$^3$, where

$$258\frac{mg}{Nm^3} = 200\frac{mg}{Nm^3} \times \frac{573}{444}$$

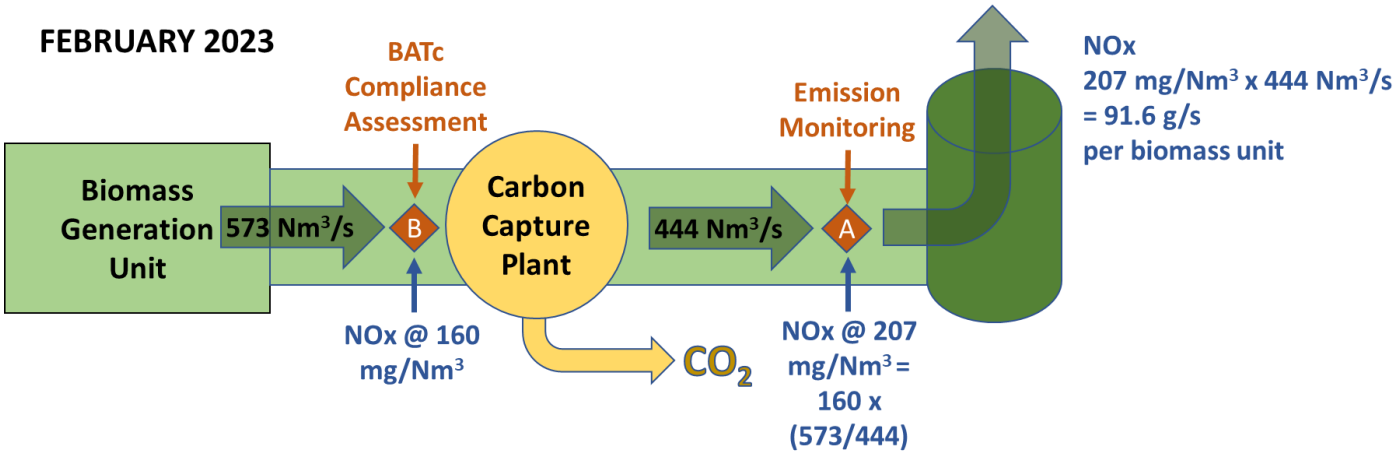


**Figure A3 – Updated, February 2023, Emissions monitoring arrangement.**

It is important to reiterate, that the change of compliance assessment location applies to NOx emissions only. All other pollutants will retain the BATc compliance assessment and Emissions Monitoring point at location A in Figure A3.