

The Drax Power (Generating Stations) Order

Land at, and in the vicinity of, Drax Power Station, near Selby, North Yorkshire

Flood Risk Assessment

(Submitted for Deadline 2)



The Planning Act 2008
The Infrastructure Planning (Applications: Prescribed Forms and Procedure)
Regulations 2009 – Regulation 5(2)(q)

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Table of Contents

EXECUTIVE SUMMARY		6
1	INTRODUCTION	1-1
1.1	Project Background	1-1
1.2	Development Proposal	1-1
1.3	Consultation	1-2
2	METHODOLOGY	2-10
2.1	Overview	2-10
2.2	Overarching National Planning Policy Statement for Energy (EN-1)	2-10
2.3	National Planning Policy Framework	2-11
2.4	Potential Sources of Flooding	2-13
2.5	Potential Effects of Climate Change	2-13
2.6	The Flood Water Management Act 2010	2-14
2.7	Sustainable Drainage	2-15
2.8	Review of Relevant Local Planning Policy	2-15
2.9	Other Local Guidance	2-16
2.10	Methodology	2-17
3	SITE DESCRIPTION	3-19
3.1	Site Location	3-19
3.2	Site Description	3-20
4	EXISTING FLOOD RISK	4-24
4.1	Historical Flooding	4-24
4.2	Risk of Fluvial and Tidal Flooding	4-24
4.3	Risk of Flooding from Surface Water	4-29
4.4	Risk of Flooding from Groundwater	4-30
4.5	Risk of Flooding from Reservoirs	4-30
4.6	Risk of Flooding from Sewers	4-31
5	FLOOD RISK DURING CONSTRUCTION AND OPERATIONAL PHASE	5-32
5.1	Flood Risk during Construction Phase	5-32
5.2	Post-Development Flood Risk	5-32
5.3	Proposed Mitigation	5-36
6	PROPOSED SURFACE WATER DRAINAGE STRATEGY	6-42
6.1	Above Ground Installation	6-42
6.2	Gas Pipeline Route	6-42
6.3	Gas Receiving Facility and Compressor Station	6-42

6.4	Construction of Single Unit Option (Unit X Only)	6-43
6.5	Construction of Twin Unit Option (Unit X and Unit Y)	6-44
7	SEQUENTIAL TEST	7-45
7.1	Sequential Test	7-45
7.2	Exception Test	7-46
8	CONCLUSIONS	8-47
8.1	Existing Flood Risk	8-47
8.2	Flood Risk during Construction	8-47
8.3	Post-Development Flood Risk Management	8-48
8.4	The Sequential Test and the Exception Test	8-49

Table of Tables

<i>Table 1 – Summary of Scoping Opinion Comments Related to Flood Risk and Drainage</i>	1-3
<i>Table 2 – Summary of Consultation</i>	1-4
<i>Table 3 – Flood Probability Conversion Table</i>	2-12
<i>Table 4 – Flood Zones</i>	2-12
<i>Table 5 – Flood Risk Vulnerability and Flood Zone Compatibility</i>	2-12
<i>Table 6 – Anticipated Changes in Extreme Rainfall Intensity (EA Climate Change Guidance, 2016)</i>	2-13
<i>Table 7 – Peak River Flow Allowances by River Basin District - Humber Area (EA Climate Change Guidance, 2016)</i>	2-14
<i>Table 8 – Envisaged Sea Level Rise Allowance in Millimetres per Year using 1990 Base Sea Level (EA Climate Change Guidance, 2016)</i>	2-14
<i>Table 10 – Flood Levels during 'Defended Scenario' (EA's River Ouse Hydraulic Model, 2009)</i>	4-26
<i>Table 11 – Maximum Flood Levels and Proposed Finished Floor Levels</i>	5-37

Table of Figures

<i>Figure 1 – Drax Power Station Location (Contains OS data © Crown copyright and database right (2018))</i>	3-19
<i>Figure 2 – Approximate Location of the Proposed Works and Surface Water Features (Contains OS data © Crown copyright and database right (2018))</i>	3-20
<i>Figure 3 – Model Nodes Location (EA's River Ouse Hydraulic Model 2009)</i>	4-27
<i>Figure 4 – Future Baseline Floodplain Extent and Flood Depth during Breach Scenario</i>	4-29
<i>Figure 5 – Post-Development Floodplain Extent</i>	5-34
<i>Figure 6 – Post-Development Flood Depth Change</i>	5-35

<i>Figure 7 – Maximum Flood Levels in the Vicinity of The Above Ground Structures Predicted for the 1 in 200 year with Climate Change Breach Scenario</i>	5-37
<i>Figure 8 – Location of the Proposed Flood Relief Channel</i>	5-38
<i>Figure 9 – Post–Development with Mitigation Floodplain Extent</i>	5-39
<i>Figure 10 – Post–Development Scenario with Mitigation - Flood Depth Change</i>	5-40

EXECUTIVE SUMMARY

WSP was appointed by Drax Power Ltd to prepare a Flood Risk Assessment to support a Development Consent Order (DCO) application for the proposed re-powering project at the Drax Power Station, North Yorkshire. The assessment was undertaken in accordance with the National Planning Policy Framework (NPPF) and Overarching National Policy Statement for Energy (EN-1). The assessment provides a quantitative analysis of pre- and post-development flood risk.

The Environment Agency (EA) Flood Map for Planning shows that the area of the Proposed Scheme is located partially in Flood Zone 2 and partially in Flood Zone 3. During consultation the EA confirmed that the area of the Proposed Scheme and its surroundings are protected up to the 1 in 200 year event by the flood defences located along the banks of the River Ouse. There is however residual risk associated with a breach of the flood defences. A breach of the existing flood defences is unlikely to happen as they are regularly inspected and maintained by the EA to ensure an appropriate level of protection.

The River Ouse at the location of the Proposed Scheme is tidally influenced. The risk of flooding in this area is therefore a combination of fluvial and tidal flooding, with tidal being the dominant source. A 2D TUFLOW hydraulic model of a breach in the flood defences was developed to support this FRA. The results of the hydraulic modelling show that the area of the pipeline route and the northern part of the Power Station Site could be flooded during the unlikely breach scenario.

A flood relief channel is proposed to be built in the northern part of the Power Station Site as part of the Proposed Scheme to mitigate potential increase in flood depth in the area. The results of the post-development hydraulic modelling show that the construction of the Proposed Scheme with the proposed flood relief channel would provide sufficient and satisfactory level of mitigation.

The finished floor levels of the proposed structures will be 600 mm above the flood levels predicted for the 1 in 200 year event with climate change allowance during the post-development with mitigation breach scenario. The proposed approach to finished floor levels is considered to provide satisfactory mitigation to ensure that the Proposed Scheme will remain operational during the flood event.

The localised areas along the pipeline route and within the boundary of the Power Station Site are indicated to be susceptible to flooding from surface water.

Surface water runoff from all new development within the Power Station Site will be collected, stored, treated (as necessary) and managed via the existing surface water drainage regimes and discharged from the site via the existing consented outfalls. The existing discharge rates will remain unchanged.

Surface water runoff generated in the area of the AGI will be discharged to the nearby watercourse with discharge rate limited to the rate agreed with the Selby Area Internal Drainage Board (IDB). Appropriate pollution prevention measure will be incorporated in the surface water drainage system proposed for this area.

The new pipeline crossings with watercourses will be constructed a minimum of 1 m below the bed of the watercourses. The new crossings will not interfere with the flow of the watercourse

and will not impact the current capacity of the channels, therefore they will not increase the risk of flooding.

The North Perimeter Ditch will be diverted to allow for construction of the battery storage building. The diversion channel will be designed as a two-stage channel, with the lower section designed to match the capacity of the existing North Perimeter Ditch to ensure no change to the existing drainage system, and the upper section designed to provide the required mitigation flood relief channel. The proposed diversion of the North Perimeter Ditch will not increase the risk of flooding in the area.

The area of the Proposed Scheme is considered to be at low risk of flooding from groundwater, sewers and reservoirs.

1 INTRODUCTION

1.1 Project Background

- 1.1.1. WSP has been appointed by Drax Power Ltd to prepare a site specific Flood Risk Assessment (FRA) to support a Development Consent Order (DCO) application for the proposed re-powering project at the Drax Power Station, North Yorkshire.
- 1.1.2. The FRA is conducted in accordance with the National Planning Policy Framework (NPPF) and Overarching National Policy Statement for Energy (EN-1), providing a quantitative analysis of flood risk to support the DCO application. The assessment includes the following:
- Review of the relevant policy, legislation and guidance.
 - Review of the availability and adequacy of the existing information related to risk of flooding.
 - Confirmation of the sources of flooding that may affect the proposal.
 - A quantitative assessment of the risk of flooding to the proposal and to the adjacent sites as a result of the proposal.
 - Provision of appropriate flood mitigation measures, including an outline surface water drainage strategy.

1.2 Development Proposal

- 1.2.1. The Proposed Scheme is to repower up to two existing coal-powered generating units (Units 5 and 6) at the Existing Drax Power Station Complex with new gas turbines that can operate in both combined cycle and open cycle modes. The repowered units (which each constitute a new gas fired generating station) would have a new combined capacity of up to 3,600 MW in combined cycle mode (1,800 MW each), replacing existing units with a combined capacity to generate up to 1,320 MW (660 MW each). The new gas turbine generating units have been designated the terms "Unit X" and "Unit Y".
- 1.2.2. Each unit would have (subject to technology and commercial considerations) a battery energy storage facility. All battery units may be protected by the same structure.
- 1.2.3. At present there are two potential options under consideration:
- Repowering of either Unit 5 or 6 and construction of Unit X as a gas fired generating station; or
 - Repowering of both Units 5 and 6 and construction of Unit X and Unit Y as two gas fired generating stations.
- 1.2.4. Construction of the proposed Unit X and Unit Y would require demolition of the existing structures that are currently located in this area.
- 1.2.5. The location of the Proposed Scheme is shown in Appendix A. The proposed site layout for the repowering of one unit and the construction of one gas fired generating station is shown in Appendix B and the layout for the repowering of two units and the construction of two gas fired generating stations is shown in Appendix C.
- 1.2.6. For the construction of Unit X, one existing but disused sludge lagoon would be brought back into operation to serve the existing coal fired units, while the southern sludge lagoon

would be decommissioned and filled in, allowing the area to be used for construction laydown. If a second unit was repowered, all existing sludge lagoons to the east of the northern cooling towers would be decommissioned and filled in to allow gas turbine Unit Y to be built. New lagoons would be built to the north of the existing northern cooling towers.

- 1.2.7. In order to repower to gas, a new Gas Pipeline would be constructed from the existing Drax Power Station Complex to the National Transmission System (NTS) operated by National Grid. The new Gas Pipeline will be buried and approximately 3 km long and will be located in the area to the east of the Power Plant Site. The Gas Pipeline will begin at the existing NTS located in the vicinity of Rusholme Grange, south of the River Ouse. This connection will run into new above ground installations (AGIs) south of Rusholme Lane. A permanent access road to the AGIs will be constructed off Rusholme Lane. The pipeline will then head in a north-west direction and connect to a new Gas Receiving Facility (GRF) east of New Road.
- 1.2.8. Construction works would include the following activities:
- Earthworks.
 - Deep excavations, drilling and piling.
 - Demolition of the existing structures.
 - Construction of temporary and permanent access roads.
 - Construction of the proposed above ground structures.
- 1.2.9. The gas turbine generating units will be constructed in stages, which are referred to as Stage 1 and 2 in the assessment. During Stage 1, Unit X will be constructed and one existing coal-firing unit will remain in operation. During Stage 2, Unit Y will be constructed while Unit X is operational as a gas-fired unit.
- 1.2.10. Each construction stage will take approximately 34 months followed by commissioning. It is anticipated that the two construction stages will be separated by up to a year, but it could be longer depending on commercial considerations. The overall construction programme will last at least 83 months including commissioning of the second unit. The battery storage unit and the gas pipeline will be constructed during Stage 1.
- 1.2.11. It is envisaged that construction of the first unit will commence in 2019/2020. If two units are built, the construction of the second unit would likely commence in 2024 and be completed in 2027.
- 1.2.12. The design life of the proposal is considered to be 25 years after which the continued operation of infrastructure will be reviewed. If it is not appropriate to continue operation, the plant will be decommissioned. It is expected that all the above ground plant structures will be removed, while the pipeline would remain in situ.

1.3 Consultation

- 1.3.1. The Scoping Opinion on the Proposed Scheme was received in October 2017. The summary of the comments related to flood risk and drainage only is shown in Table 1. The complete scoping opinion on the impacts to the water environment is detailed in the Chapter

12 (Water Resources, Water Quality and Hydrology) of the Environmental Statement (ES) (Examination Library ref APP-080) prepared for the Proposed Scheme.

Table 1 – Summary of Scoping Opinion Comments Related to Flood Risk and Drainage

Section of Scoping Report	Applicant's Proposed Matter	Planning Inspectorate's Comments	Summary of Response
7.8.2	Surface water runoff associated with operation of the pipeline	The Scoping Report (section 4.12) explains that areas of the site are at risk from surface water flooding, predominantly those areas along field boundaries and in local depressions. However, the Applicant explains that as the pipeline will be buried (and ground surface reinstated to current levels), its operation will not change the rate, volume or quality of surface water runoff. The Inspectorate is in agreement that this matter can be scoped out for the operational phase. However, the effects on surface water runoff from above ground structures associated with the gas pipeline should be considered.	The potential impacts associated with surface water runoff from above ground structures associated with the pipeline are assessed within this FRA.
7.8.2	Changes to fluvial and tidal flood risk during the operation of the pipeline	The Applicant explains that following construction, the existing ground surface associated with the buried pipeline will be reinstated to current levels. The Inspectorate agrees that the potential for significant effects is therefore unlikely and that effects from the pipeline itself can therefore be scoped out. However, the Inspectorate considers that the effects on flood risk from above ground structures associated with the gas pipeline should be considered.	The potential impacts associated with fluvial and tidal flooding associated with above ground structures associated with the pipeline are assessed within this FRA
4.11	Consultation	The Inspectorate notes section 4.11 of the Scoping Report, where Selby Area Internal Drainage Board (IDB) is described as the Lead Local Flood Authority (LLFA) for the area. The Inspectorate advises that North Yorkshire County Council is the LLFA for the area covering the application site.	NYCC were consulted as LLFA. Other relevant authorities were also consulted.

Section of Scoping Report	Applicant's Proposed Matter	Planning Inspectorate's Comments	Summary of Response
7.8.4	FRA	The Inspectorate welcomes that a Flood Risk Assessment (FRA) will be prepared to support the EIA and stresses the need for early discussions with the EA. The Applicant should agree the scope of the FRA with the EA and ensure that up to date and appropriate climate change allowances are utilised in any modelling. Large parts of the site fall within Flood Zones 2 and 3 on the EA Flood Maps (as illustrated on Figure 2 of the Scoping Report). The FRA should therefore demonstrate that the requirements of the sequential and exception tests are satisfied. The approach and conclusions of the FRA should be agreed with the EA prior to submission of the DCO application, with evidence of such agreement provided (for example in a draft SoCG).	Early and extensive engagement has been held with the EA throughout the preparation of the FRA.

- 1.3.2. The summary of consultation undertaken to the date and that relates to flood risk and drainage only is provided in Table 2. The consultation summary related to all aspects of the water environment is provided in Chapter 12 (Flood Risk, Water Quality and Hydrology) of the Environmental Statement. The important correspondence with the Authorities is shown in Appendix D.

Table 2 – Summary of Consultation

Body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
Environment Agency	Consultation email sent in November 2017, response letter received via email on 8 January 2018, letter reference RA/2017/137861/02	- The FRA will need to clearly demonstrate that flood risk to others will not be increased as a result of the development. Any increase in risk to others will have to be mitigated, including provision of floodplain compensation if required. - The Upper Humber hydraulic model is being currently developed, and the final

Body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
		report is envisaged to be issued in April 2018. If the Humber model data is available, it should be used to support the assessment. However, if the data is not available at the time of assessment, the best available data should be used. If best available data changes during the assessment period or during the planning process, the assessment may need to be updated using the latest data. • The current climate change policy and guidance should be used in the assessment. If new policy/guidance comes into force during the application process, the assessment should be updated accordingly. • No objections to the proposed study areas, but at this stage cannot determine whether they are appropriate. Study area to be properly defined and justified in line with relevant guidance. • If the 2009 River Ouse hydraulic model is used, it is appropriate to re-run the model in ISIS. If the Upper Humber hydraulic model is used, then the model should be re-run using the same software used to develop the model. • The EA advised that they do not determine the application of the Sequential Test. • A breach scenario should be included. The breach location can be the same as that used for the White Rose Scenario, unless the Upper Humber modelling is available, in which case the breach data from this model should be used. • The design scenario that should be used for the scheme is the 1 in 100 year event plus climate change allowance, or the 1 in 200 year event (tidal) level if greater.
Environment Agency	22 January 2018, Meeting	• EA advised that the early results from the new Upper Humber hydraulic

Body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
		modelling indicate a change in the fluvial and tidal interaction, with the tidal limit possibly shifting and fluvial flows having more of a dominant effect. It is likely to be caused by climate change. Considering this information, the EA will confirm which modelling scenario should be used instead of the 2009 River Ouse model. • EA confirmed that the hydrology of survey in the 2009 River Ouse model does not need to be updated but need to show no effect on local communities. • The sensitivity analysis will be undertaken as per usual modelling specification; • No need to consider the undefended scenario. • Historic flooding records will be requested.
Environment Agency	26 January 2018, Letter via email, letter reference RA/2017/137861/03	• The 2009 River Ouse model data, along with the same methodology used for the White Rose Carbon Capture model will provide a sufficiently robust approach, such that the assessment will not have to be updated using the new Upper Humber model when it becomes available. • The hydraulic model supporting the FRA will have to be reviewed by the EA to determine whether it is fit for purpose.
Environment Agency	26 January 2018, Letter via email, letter reference RA/2017/137861/03-L02	• The EA's Approach to Groundwater protection guidance should be followed. • Discharge of surface water or foul water is not allowed into land impacted by contamination; • No discharge to made ground or directly to the groundwater resources is allowed.

Body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
Environment Agency	27 February 2018, Letter via email (response to consultation on the PEIR), letter reference RA/2018/138164/01	- EA advised that the FRA should be undertaken in accordance with the EA comments received in January 2018. - Any work or structures, in, under, over or within 16m of the top of the bank of the tidal River Aire (Main River) will require an Environmental Permit. - An Environmental Permit will also be required for any temporary structures or stockpiles of materials within the floodplain.
Environment Agency	05 March 2018, Conference call	- The results of the hydraulic modelling and flood mitigation options were discussed. - The EA agreed to the proposed mitigation solutions in principle, however the EA would need further modelling and evidence before providing additional comments.
Environment Agency	14 March 2018, Email	The FRA should demonstrate no increase in risk pre- and post-development scenarios.
Environment Agency	27 April 2018, Email	Outcome of the model review by the EA indicates a few minor changes are required to the model before the EA will sign it off.
Environment Agency	4 May 2018, Email	Response to the comments on the hydraulic model issued to the EA
Environment Agency	10 May 2018, letter via email, letter reference RA-2018-138541-01	Confirmation that the FRA is considered acceptable – subject to the confirmation that the hydraulic model supporting the FRA is considered fit for purpose
Selby Area Internal Drainage Board	December 2017 – February 2018, Email and telephone conference	- Surface water runoff from additional new impermeable areas should be limited to the pre-development greenfield runoff rate or 1.4l/s/ha, whichever is the least; - Existing discharge points should be used wherever possible;

Body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
		• New outfalls should be set back from the bank and not protrude into the watercourse. Appropriate erosion prevention measures should be applied if required. A marker post should be provided near a new outfall to highlight the presence of the outfall for maintenance operatives; • The IDB does not have any historic flood records or water quality data.
Selby District Council	January – February 2018, Email	• In accordance with NPPF, the Sequential Test does not need to be carried out. However, it is likely that inspectors reviewing the application would expect that the sequential approach was applied in the design process.
North Yorkshire County Council	November 2017, Email	• The Council advised that the proposal is located within the area of the IDB and therefore, the IDB should be consulted in relation to works near the watercourses; • EA guidance on pollution prevention measures and the NYCC SuDS Design Guidance should be followed; • No consent from NYCC is required as the proposed works are located in the area under the jurisdiction of the IDB; • The FRA should clearly explain how the potential impacts on flood risk will be mitigated; • Surface water runoff should be contained within the site boundary for all events up to the 1 in 30 year event; • The design of the site must ensure that flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that avoid risk to people and property both on and off site.

Body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
Canal and River Trust	February 2018, Letter (response to consultation on the PEIR)	- Any changes to the abstraction (or any discharge) rates compared to existing rates have the potential to affect navigation on the river. As a result, the Trust recommend that full details of any potential changes to the abstraction and return volumes compared to as existing should be fully clarified as part of any full Environmental Statement; - Should a potential discharge to the River Ouse Navigation be required by Drax Power Ltd, the flow rate of the discharges should be agreed with the Trust and ensure that their location and means of construction do not impede navigation on the river or otherwise raise any navigational safety issues.

2 METHODOLOGY

2.1 Overview

- 2.1.1. This FRA report summarises baseline flood risk information and identifies flood risk to the Proposed Scheme and potential flood risk to other areas caused by the Proposed Scheme.
- 2.1.2. Flood risk is assessed in accordance with the NPPF, NPS and local planning policy relevant to the proposed location of the Proposed Scheme. A summary of these policies is provided in this section.

2.2 Overarching National Planning Policy Statement for Energy (EN-1)

- 2.2.1. The Overarching National Policy Statement for Energy (NPS EN-1) recognises that infrastructure can have adverse effects on the water environment. It states that the effects could lead to adverse impacts on health or on protected species and habitats and could result in surface waters, groundwaters or protected areas failing to meet environmental objectives established under the WFD.
- 2.2.2. It states that where projects are likely to have effects on the water environment, applicants should undertake an assessment of the existing status of, and impacts of the proposed project on, water quality, water resources and physical characteristics of the water environment as part of the ES. The Environmental Statement (ES) should particularly describe: existing quality of watercourses, existing water resources, existing physical characteristics of the water environment and impacts on protected waterbodies and areas.
- 2.2.3. Section 5.7 (Flood risk) of NPS EN-1 details that projects of 1 hectare or greater in Flood Zone 1 in England and all proposals for energy projects located in Flood Zones 2 and 3 in England should be accompanied by a Flood Risk Assessment (FRA). The requirements for FRAs are that they should (paragraph 5.7.5 of NPS EN-1):
- Be proportionate to the risk and appropriate to the scale, nature and location of the project.
 - Consider the risk of flooding arising from the project in addition to the risk of flooding to the project.
 - Take the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made.
 - Be undertaken by competent people, as early as possible in the process of preparing the proposal.
 - Consider both the potential adverse and beneficial effects of flood risk management infrastructure, including raised defences, flow channels, flood storage areas and other artificial features, together with the consequences of their failure.
 - Consider the vulnerability of those using the Site, including arrangements for safe access.
 - Consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and identify flood risk reduction measures, so that assessments are fit for the purpose of the decisions being made.
 - Consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes.

- Include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular project.
- Consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of the project may affect drainage systems.
- Consider if there is a need to be safe and remain operational during a worst case flood event over the development's lifetime.
- Be supported by appropriate data and information, including historical information on previous events.

2.2.4. In determining an application for development consent, the SoS should be satisfied that where relevant (paragraph 5.7.9 of NPS EN-1):

- The application is supported by an appropriate FRA; the Sequential Test has been applied as part of site selection.
- A sequential approach has been applied at the site level to minimise risk by directing the most vulnerable uses to areas of lowest flood risk.
- The proposal is in line with any relevant national and local flood risk management strategy.
- Priority has been given to the use of sustainable drainage systems (SuDS).
- In flood risk areas the project is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed over the lifetime of the development.

2.3 National Planning Policy Framework

2.3.1. The NPPF and Planning Practice Guidance 'Flood Risk and Coastal Change' documents provide guidance on how new developments must take into account flood risk, including allowance for the impacts of climate change.

2.3.2. In relation to flood risk, the NPPF encourages decision makers to:

- Steer new development to lower risk locations that are appropriate to the proposed use and ensure that development is safe.
- Prevent any increase in flood risk elsewhere and reduce flood risk through the layout and form of the development and the appropriate application of sustainable drainage systems.
- Reduce flood risk by making space for water by creating flood flow paths and by identifying, allocating and safeguarding space for flood storage.
- Use regeneration to help relocate development to lower risk locations when climate change is expected to mean that some existing development may not be sustainable in the long-term.

2.3.3. As discussed below, the NPPF defines flood risk as the product of the likelihood or chance of a flood occurring (flood frequency) and the consequence or impact of the flooding (flood consequence).

2.3.4. Flood frequency is identified in terms of the return period and annual probability. For example, a 1 in 100 year flood event has a 1% annual probability of occurrence. Table 3 provides a conversion between return periods and annual flood probabilities.

Table 3 – Flood Probability Conversion Table

Return Period (years)	2	5	10	20	50	100	200	1000
Annual Flood Probability (%)	50	20	10	5	2	1	0.5	0.1

- 2.3.5. The NPPF identifies Flood Zones in relation to flood frequency. The zones refer to the probability of river (fluvial) and sea (tidal) flooding, whilst ignoring the presence of defences. Table 4 summarises the relationship between the Flood Zone categories and the identified flood risk.

Table 4 – Flood Zones

Flood Risk Area	Identification	Annual Probability of Fluvial Flooding	Annual Probability of Tidal Flooding
Flood Zone 1	Low Probability	<0.1%	<0.1%
Flood Zone 2	Medium Probability	1% - 0.1%	0.5% - 0.1%
Flood Zone 3a	High Probability	>1%	>1%
Flood Zone 3b	Functional Floodplain	>5%	>5%

Flood Consequences

- 2.3.6. The consequence of a flood event describes the potential damage, danger and disruption caused by flooding. This is dependent on the mechanism and characteristics of the flood event and the vulnerability of the affected land and land use.
- 2.3.7. The EA have identified five classifications of flood risk vulnerability and provide recommendations on the compatibility of each vulnerability classification with the Flood Zones. This is outlined in Table 5.
- 2.3.8. Full details of EA Flood Zones and flood risk vulnerability classifications can be found in the Planning Practice Guidance 'Flood Risk and Coastal Change'.

Table 5 – Flood Risk Vulnerability and Flood Zone Compatibility

EA Flood Zone	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	ü	ü	ü	ü	ü
Zone 2	ü	ü	Exception test required	ü	ü
Zone 3a	Exception test required	ü	ü	Exception test required	ü

EA Flood Zone	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 3b	Exception test required	ü	û	û	û

ü Development considered acceptable

û Development considered unacceptable

- 2.3.9. In accordance with this guidance, the Proposed Scheme is considered as 'essential infrastructure' and should remain operational during flood events.

2.4 Potential Sources of Flooding

- 2.4.1. In accordance with the NPPF, the following sources of flooding have been considered in this assessment:

- Fluvial water from watercourses.
- Overland surface water runoff from adjacent sites.
- Site generated surface water runoff.
- Surcharging of sewers.
- Reservoirs.
- Groundwater.
- Tidal water.

2.5 Potential Effects of Climate Change

- 2.5.1. Scientific consensus is that the global climate is changing as a result of human activity. Whilst there remain uncertainties in how a changing climate will affect areas already vulnerable to flooding, it is expected to increase flood risk significantly over time. Projections of future climate change for the UK indicate that more frequent, short-duration, high-intensity rainfall events and more frequent periods of long-duration rainfall could be expected.
- 2.5.2. The EA has issued updated guidance on climate change allowances for flood risk assessments in their report, 'Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities' (March 2016). This guidance outlines anticipated changes in extreme rainfall intensity, peak river flows and sea level rise resulting from climate change for the next 100 years. These are outlined in Tables 6 to 8. The guidance recommends that new drainage systems should be assessed using both the 'central' and 'upper end' allowances in order to understand the possible range of the impact of climate change on flood risk.

Table 6 – Anticipated Changes in Extreme Rainfall Intensity (EA Climate Change Guidance, 2016)

Allowance Category	Total Potential Change Anticipated for 2010 to 2039	Total Potential Change Anticipated for 2040 to 2059	Total Potential Change Anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

Table 7 – Peak River Flow Allowances by River Basin District - Humber Area (EA Climate Change Guidance, 2016)

River Basin District	Allowance Category	Total Potential Change Anticipated for the '2020s' (2015 to 2039)	Total Potential Change Anticipated for the '2050s' (2040 to 2069)	Total Potential Change Anticipated for the '2080s' (2070 to 2115)
Humber	Upper end	20%	30%	50%
	Higher central	15%	20%	30%
	Central	10%	15%	20%

Table 8 – Envisaged Sea Level Rise Allowance in Millimetres per Year using 1990 Base Sea Level (EA Climate Change Guidance, 2016)

Area of England	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115
East, East Midlands, London, South East	4mm	8.5mm	12mm	15mm

- 2.5.3. The design life of the Proposed Scheme is considered to be a minimum of 25 years, with the end of the designed life of the Proposed Scheme envisaged to be in c.2052. For the purpose of this assessment a design life of 38 years was considered to allow for a potential extension period to the operation of the plant.
- 2.5.4. The hydraulic modelling undertaken as part of this FRA considers the sea level rise due to climate change predicted for the year 2065. The predicted sea level rise of 427mm was calculated in accordance with the EA Climate Change Guidance (2016).

2.6 The Flood Water Management Act 2010

- 2.6.1. The Flood and Water Management Act 2010 (FWMA) introduces new responsibilities for local authorities to manage flood risk and sets out new requirements for the management of sustainable drainage.

Lead Local Flood Authorities

- 2.6.2. Under the FWMA the unitary authority or County Council for an area is designated the 'Lead Local Flood Authority' (LLFA) with responsibility for managing flood risk from surface water, groundwater and ordinary watercourses within their area. The LLFA is also ordinarily the consenting authority for works near or within ordinary watercourses.
- 2.6.3. In areas where there are special drainage requirements such as the areas surrounding Drax Power Station, Selby Internal Drainage Board (IDB) has permissive powers to manage water levels within their drainage district. IDBs undertake works to reduce flood risk to people, property and infrastructure, and to also manage water levels for agricultural and

environmental needs. They are also the consenting authority for works near or within ordinary watercourses (unless the requirement for such consents is disapplied in the DCO). Consultation with NYCC (December 2017) confirmed that the IDB should be consulted on with respect to the following areas:

- Allowable discharge rates.
- Discharge points.
- Outfalls.
- Quality of process water (in joint consultation with the EA).
- Study area.
- Land Drainage Consent

2.7 Sustainable Drainage

- 2.7.1. The Non-Statutory Technical Standards for Sustainable Drainage Systems (DEFRA, 2015) provides general guidance for the design, maintenance and operation of sustainable drainage systems. Detailed design and guidance is provided in The SUDS Manual (CIRIA, 2015).
- 2.7.2. In addition, the NPPF promotes the SUDS hierarchy, which states that the following methods of surface water disposal from a site should be considered in descending order of preference:
- Discharge to the ground.
 - Discharge to a surface water body.
 - Discharge to a surface water sewer
 - Discharge to a combined sewer.

2.8 Review of Relevant Local Planning Policy

Selby District Core Strategy Plan (2013)

- 2.8.1. The following policies relate to drainage and flood risk:
- Policy SP15 (Sustainable Development and Climate Change) sets out to promote sustainable development, and determine scheme layouts which are resilient to climate change:
 - Section A Part D) Ensure that development in areas of flood risk is avoided wherever possible through the application of the sequential test and exception test; and ensure that where development must be located within areas of flood risk that it can be made safe without increasing flood risk elsewhere.
 - Section A Part E) Support sustainable flood management measures such as water storage areas and schemes promoted through local surface water management plans to provide protection from flooding; and biodiversity and amenity improvements.
 - Section B part C) Incorporate water-efficient design and sustainable drainage systems which promote groundwater recharge.
 - Policy SP18 (Protecting and Enhancing the Environment) sets out to protect the District's environment, in particular by:
 - Section 7. Ensuring that new development protects soil, air and water quality from all types of pollution.

- o Section 8. Ensuring developments minimise energy and water consumption, the use of non-renewable resources, and the amount of waste material.
- o Section 9. Steering development to areas of least environmental and agricultural quality.

2.8.2. The Local Plan identifies a number of primary issues which should be considered. Two of these issues are relevant to the Proposed Scheme in relation to the water environment:

- Protection of groundwater: The District is underlain by the Sherwood Sandstone and the Magnesian Limestone aquifers, both of which provide a significant groundwater supply. Where there are no superficial deposits over the aquifers, groundwater contamination is a serious concern so consideration must be given to the prevention of pollution and the protection of water quality within the groundwater. Water conservation measures are promoted across the District to adapt to the future pressures of climate change.
- Flood Risk management: Significant flood risks exist across large areas of Selby District, most developments therefore require the application of the Sequential Test.

2.8.3. The promotion of SuDS across the District encourages infiltration and groundwater discharge.

2.9 Other Local Guidance

2.9.1. North Yorkshire County Council (NYCC) SUDS Design Guidance provides principles for the design of SUDS measures. The following principles should be followed during the design of surface water drainage:

- Surface water runoff should be managed in accordance with the SUDS management train.
- The peak runoff rate from the developed site for the 1 in 1 year, 1 in 30 year and 1 in 100 year events must not exceed the peak greenfield runoff rate from the site for the same event.
- Greenfield runoff rates should be determined using the Institute of Hydrology Report 124 (IH124) or Flood Estimation Handbook (FEH).
- Discharge runoff rate/volume from a whole or part brownfield site should be limited to the 70% of existing positively drained runoff rate/volume for those rainfall events or to the current greenfield runoff rate/volume, however greenfield runoff rate/volume should be achieved where possible.
- Greenfield runoff rate is maximum 1.4 l/s/ha unless modelling conclusively demonstrates greenfield runoff to be greater than this.
- The runoff volume from the developed site for the 1 in 100 year 6 hour rainfall event must not exceed the greenfield runoff volume for the same event.
- Should infiltration methods not be suitable and it is not possible to achieve greenfield runoff volume then it must be demonstrated that the increased volume will not increase flood risk on or off site.
- SUDS design must ensure that the quality of any receiving water body is not adversely affected and preferably enhanced.
- Appropriate ground exceedance flow paths must be included in a site design so in case of SUDS failure or rainfall that exceeds the design capacity of the drainage system, any exceedance flows do not cause flooding of properties on or off site.

- Surface water runoff generated in a development must be contained within the drainage system for all events up to and including the 1 in 30 year event.
- Surface water runoff from rainfall in excess of a 1 in 100 year event must be managed to ensure no increased risk of flooding to people and properties both on and off site.
- SUDS features located in highway and that serve those highways can be adopted by NYCC Highway Authority and maintained as part of the wider highways maintenance subject to agreement with Highway Authority.
- An allowance of 30% increase in rainfall intensity must be considered in SUDS design to allow for climate change.
- An urban creep of 10% must be considered in the drainage design.
- Information on adoption and maintenance of SUDS must be submitted to the Council.

Selby Area Internal Drainage Board Bye-Laws

2.9.2. Selby Area Internal Drainage Board Bye-Laws provide a summary of the requirements related to any works planned to be undertaken within or in close proximity to the ordinary watercourses located in the area under the jurisdiction of the IDB. The bye-laws also provide information on the requirements related to drainage discharge rates to the watercourses under the jurisdiction of the IDB. A summary of the general requirements is given below:

- Any works that may impact the IDB's watercourses and any discharge into these watercourses requires appropriate consent from the IDB. The consent should be obtained prior to commencement of the proposed works.
- Any new surface water discharge to an IDB watercourse must be restricted to the pre-development greenfield runoff rate or 1.4 l/s/ha, whichever is the lesser rate.
- No person shall directly or indirectly obstruct, impede or interfere with the flow of water in, into or out of any watercourses, or cause damage to the bank of any watercourse.
- Where works to an existing bank are necessary, the bank shall be reinstated to the original alignment and slope, and re-seeded as soon as possible thereafter.
- New outfalls should be set back from the bank and should not protrude into the watercourse.
- No materials or rubbish should be stored or stacked on the banks of the watercourses.
- No temporary or permanent structure should be constructed within 7m of the edge of the watercourse.

2.10 Methodology

2.10.1. The methodology adopted in the preparation of this FRA comprises:

- Review of available flood risk data to identify existing flood risk from fluvial, tidal, groundwater, surface water and artificial sources.
- Review of existing ground conditions on-site to determine groundwater levels, soil permeability and contamination risks through examination of previous land uses and information available from the EA, the British Geological Survey (BGS) and the National Soil Resources Institute (NSRI) Soils Site Report.
- Review of the Proposed Scheme with respect to the flood risk vulnerability and flood zone compatibility of the Scheme, in accordance with the methodology outlined in the NPPF.
- Assessment of how the Proposed Scheme might affect flood risk to the site and elsewhere supported by a hydraulic modelling of the proposed works.

- Preparation and assessment of proposals for the appropriate management of flood risk to enable construction and operation of the development without increasing flood risk elsewhere.

2.10.2. Data regarding flood risk relevant to the Proposed Scheme and the surrounding area has been obtained from the following sources:

- EA Flood Map for Planning available online, accessed March 2018
· <https://flood-map-for-planning.service.gov.uk/>.
- EA Flood Risk from Surface Water and Flood Risk from Reservoirs mapping available online, accessed March 2018
· <https://flood-warning-information.service.gov.uk/long-term-flood-risk/>.
- EA Groundwater mapping available online, accessed March 2018
· <http://apps.environment-agency.gov.uk/wiyby/default.aspx>.
- Natural England's MAGIC online mapping
· <http://www.natureonthemap.naturalengland.org.uk/MagicMap.aspx>.
- British Geological Survey (BGS) Geology of Britain Viewer available online, accessed March 2018
· <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>.
- Cranfield Soil and Agrifood Institute Soilscales mapping available online, accessed March 2018
· <http://www.landis.org.uk/soilscales/index.cfm>.
- North Yorkshire County Council Local Flood Risk Strategy, downloaded from the Council's website in March 2018.
- Selby Level Strategic Flood Risk Assessment Update, October 2015.
- Selby Level 2 Strategic Flood Risk Assessment, Living Document, February 2010.
- EA River Ouse Catchment Flood Management Plan, 2010.
- EA Humber River Basin Management Plan, 2016.
- Existing Drainage Plans obtained from Drax Power Ltd.
- Selby Area Internal Drainage Board mapping obtained from Selby Internal Drainage Board.
- Drax Repowering Hydraulic Modelling Report, HR Walingford, March 2018.
- Draft Drax Power Station Stage 1 Flood Risk Assessment, by Peter Brett, February 2018.
- White Rose Carbon Capture and Storage Project Flood Risk Assessment, Volume 2 of Environmental Statement, Chapter C.1, November 2014.
- White Rose Carbon Capture and Storage Project Surface Water and Flood Risk Technical Report, Volume 2 of Environmental Statement, Chapter C, November 2014.

3 SITE DESCRIPTION

3.1 Site Location

- 3.1.1. The existing Drax Power Station is located approximately 7km to the south-east from the centre of Selby, North Yorkshire, approximate NGR 466444, 427458. The works are proposed to be undertaken partially within the northern and the southern part of the Existing Drax Power Station Complex, and the new gas pipeline with associated infrastructure is proposed to be constructed in the area immediately to the east of the Power Station. The approximate location of Drax Power Station Complex and approximate areas of the proposed works are shown in Figures 1 and 2 respectively. The site location and the exact extent of the Proposed Scheme are shown in Appendix A.

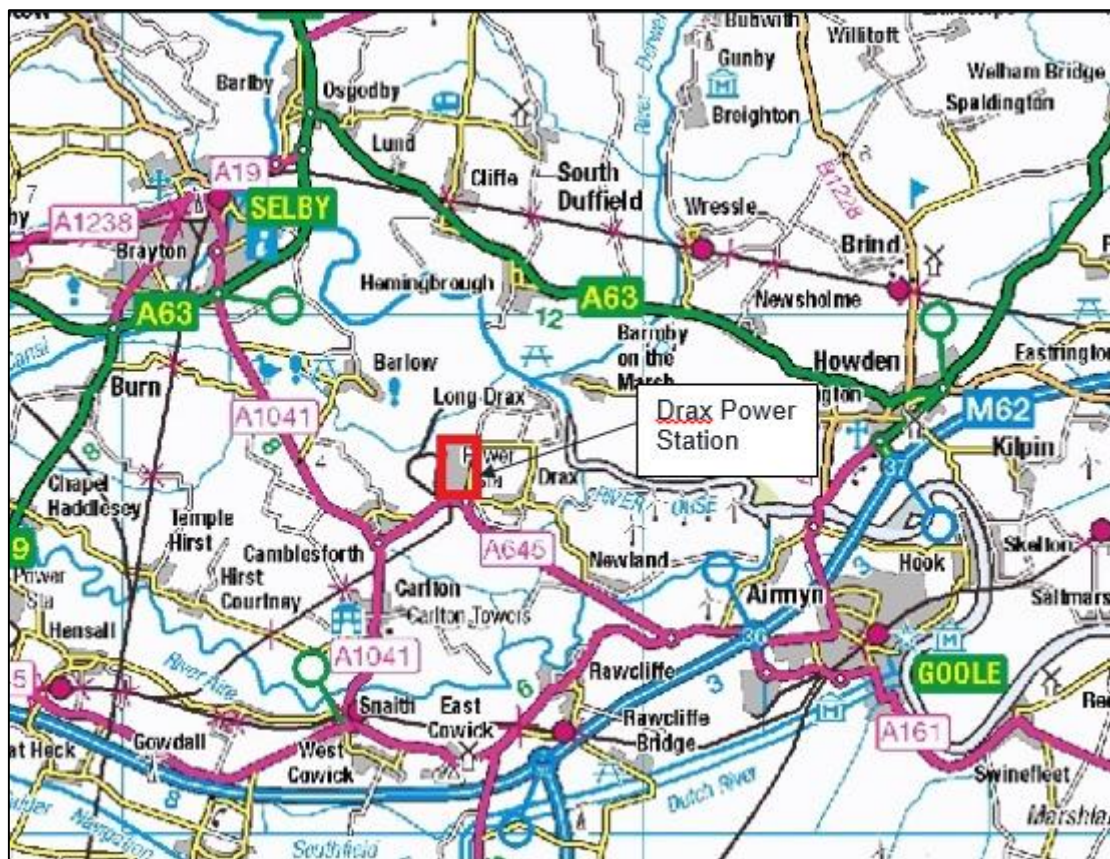


Figure 1 – Drax Power Station Location (Contains OS data © Crown copyright and database right (2018))



Power Station Site, and flows in an easterly direction to the Humber Estuary. The river is designated as a main river under the jurisdiction of the EA.

3.2.5. The proposed repowering works within the boundary of the Existing Drax Power Station Complex are located in close proximity to the following drains and watercourses:

- Carr Dyke – the dyke is culverted under the north-western part of the Existing Drax Power Station Complex and flows in a north-easterly direction towards the River Ouse. The dyke is under the jurisdiction of the Selby Area IDB, except for the length culverted under the Existing Drax Power Station Complex, which is under riparian ownership and is the responsibility of Drax Power Ltd. Carr Dyke becomes Lendall Drain just before its discharge to the River Ouse. Water levels in Lendall Drain and the discharge into the River Ouse are controlled by Lendall Pumping Station. The dike and pumping station is under the jurisdiction of the Selby IDB.
- Drain No 44 – the drain is located adjacent to a small wooded area in the north-eastern part of the Existing Drax Power Station Complex and is under the jurisdiction of Selby IDB.
- System of concrete channels – the channels are located in the areas of the north cooling towers and form part of the cooling water infrastructure. They are managed by Drax Power Ltd.
- North Perimeter Ditch – the ditch forms part of the existing surface water drainage system serving the Existing Drax Power Station Complex. Drax Power Ltd is responsible for this ditch.
- Sludge lagoons – The lagoons are located in the north-eastern part of the Existing Drax Power Station Complex and form part of the surface water management of runoff from the Coal Mound. Drax Power Ltd is responsible for the lagoons.

3.2.6. The new Gas Pipeline and AGI is proposed to cross or be constructed in close proximity to the following drains, all of which are under the jurisdiction of Selby IDB:

- Unnamed drains identified as 18/1, 18/2, 18/3, 18/4 on the Selby Area IDB plan.
- Carr Lane Drain.
- Back Lane Drain.
- Rusholme Lane Drain also known as Willow Row Drain.
- Clough Drain.
- Black Tom Drain also identified as '17' on the Selby IDB plan.
- Dickon Field Drain.

3.2.7. The main construction compound (Area A) is bounded to the west by an unnamed drain located adjacent to New Road, Drain No 44 to the north-west and Carr Lane Drain to the south. The unnamed drain identified along New Road is understood to be in riparian ownership and may form part of the New Road drainage system.

3.2.8. The construction compound (Area B) is bordered by an unnamed drain on the north-western boundary (understood to be in riparian ownership and maintained by Drax Power Ltd) and Drain No 44 along the north-eastern boundary. Drain No 44 extends into Area B along the northern edge of the wooded area. An unnamed drain, possibly an extension of the Drax North Perimeter Ditch, is located along the south-west edge of the wood.

- 3.2.9. Approximate locations of the above water features are shown in Figure 2 above. A detailed plan showing all water features in the vicinity of the Proposed Scheme is shown in Appendix E.

Geology and Hydrogeology

- 3.2.10. A review of British Geology Survey (BGS) mapping shows that the Existing Drax Power Station Complex and the area of the new Gas Pipeline are underlain by bedrock identified as Triassic Rocks (undifferentiated) – Sandstone and Conglomerate, interbedded, identified as Principal Aquifer. The BGS mapping also shows that the Power Station and the area of the new gas pipeline are underlain by superficial deposits in the form of Lacustrine Deposits – Clay identified as Unproductive Strata, and Alluvium – Clay, Silt and Sand identified as Secondary A Aquifer respectively.
- A Principal Aquifer is described as layers of rock or drift deposits that have high intergranular and/or fracture permeability – meaning they usually provide a high level of water storage. Principal Aquifers may support water supply and/or river base flow on a strategic scale.
 - A Secondary A Aquifer is described as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
 - Unproductive Strata is described as rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.
- 3.2.11. A review of the BGS borehole logs recorded within the boundary or in the vicinity of the Existing Drax Power Station Complex shows the Sandstone bedrock to be located at a depth of approximately 19 m below ground level (bgl). The borehole logs also indicate that groundwater was recorded at depths of between approximately 4.9 m bgl (borehole reference SE62NE29) and 2.20 m bgl (borehole reference SE62NE126) in the north-eastern and southern part of the area of the Power Station Site respectively.
- 3.2.12. The borehole logs recorded in the vicinity of the proposed gas pipeline show layers of sand logged at depths of approximately 17 m bgl, with Sandstone bedrock recorded at depths greater than 20 m bgl. Seepage of groundwater was recorded between depths of approximately 1.8 m bgl and 3.9 m bgl (borehole references SE62NE137 and SE62NE136).
- 3.2.13. The Selby Area IDB advised that high groundwater levels occur in the area of the Proposed Scheme.
- 3.2.14. The EA's Groundwater Source Protection Zone (SPZ) mapping shows that the Power Station Site and the area of the new Gas Pipeline are located in Zone 3 of the groundwater SPZ.

Soil Infiltration

- 3.2.15. A number of in-situ soil infiltration tests were undertaken as part of the site investigation undertaken to inform the Surface Water and Flood Risk Chapter of the Environmental Statement prepared for White Rose Carbon Capture and Storage Project. The results show a very low permeability ranging between 1.1×10^{-5} m/s and 6.97×10^{-8} m/s.

- 3.2.16. Considering this information and the recorded geology and hydrogeology of the site, the soil infiltration rates in this area are considered to be low and not suitable for infiltration techniques.

Existing Drainage

- 3.2.17. Information on the existing drainage system serving the Existing Drax Power Station Complex was received from Drax Power Ltd. Surface water runoff generated within the boundary of Power Station Site is managed by a complex drainage system that combines gravity and pumped systems with open ditches, culverts, land drainage and lagoons. These systems include the North Perimeter Ditch. They collect, manage and convey surface water runoff to a consented outfall into Carr Dyke in the north-western part of the site. From here, Carr Dyke conveys the surface water to Lendall Drain from where it outfalls to the River Ouse via the Lendall Pumping Station.
- 3.2.18. A series of ditches around the perimeter of the Existing Drax Power Station Complex are arranged to intercept and collect the on and off site surface water runoff and convey the water through the Existing Drax Power Station Complex into Carr Dyke.
- 3.2.19. The ash mound located to the north-west of the Existing Drax Power Station Complex has a self-contained surface water management system with a consented outfall to Carr Dyke.
- 3.2.20. Surface water runoff from the remaining coal and ash mounds is collected in land drains and conveyed to sludge lagoons where sediment is settled and filtered. The filtered water is then conveyed to the sedimentation tanks, from where it is either re-used in the cooling water make-up or pumped to the purge pump house and discharged to the River Ouse via the consented purge water discharge.
- 3.2.21. Surface water runoff generated in areas likely to pick up oily contaminants, such as oil tank storage areas and car parks, is passed through oil separators prior to discharge to Carr Dyke or the purge discharge to the River Ouse.
- 3.2.22. All foul effluent from toilets and welfare facilities is drained via a separate drainage system to an on-site sewage treatment plant. From here, the treated foul effluent is pumped to the primary surface water pumping station, from where it is pumped to the purge pump house and then to the River Ouse via the consented purge water discharge.
- 3.2.23. A drawing showing the existing drainage system serving the Existing Drax Power Station Complex is shown in Appendix F.

4 EXISTING FLOOD RISK

4.1 Historical Flooding

- 4.1.1. A review of the Selby District Council Level 1 SFRA indicates there are no records of historical flooding in the area of Drax Power Station or in the area of the proposed gas pipeline. Consultation was held with NYCC (December 2017) and they confirmed that they hold one record of surface water flooding in Barlow from 2011, north-west of the site. No further details were available about this event. Selby IDB (February 2018) were also consulted and they confirmed that they do not hold any historic flooding records.
- 4.1.2. The flood records received from the EA (February 2018) indicate that there is no known flood history in these areas. The EA Recorded Flood Outlines mapping is shown in Appendix G.

4.2 Risk of Fluvial and Tidal Flooding

- 4.2.1. The River Ouse is tidally influenced at the location of the Proposed Scheme. The risk of flooding in this area is therefore a combination of fluvial and tidal flooding, with domination of tidal influences.
- 4.2.2. A detailed Flood Map showing the area of the Proposed Scheme was received from the EA. The EA's Flood Map shows the extent of the floodplain during the 'undefended scenario', which means that the presence of the existing flood defences are not taken into account. The mapping does, however, indicate those areas of the floodplain that will benefit from flood defences during the 1 in 100 year fluvial event or the 1 in 200 year tidal event.
- 4.2.3. In summary the Flood Map received from the EA shows the following:
- The area where the new battery storage building, the new sludge lagoons, the collection point to the substation, and cable sealing ends and overhead conductors are proposed to be constructed is located in the medium risk Flood Zone 2.
 - The area where Unit X and Unit Y are proposed to be constructed is partially located in the medium risk Flood Zone 2.
 - The area of the new gas pipeline route and the associated GRF and AGI is located in the high risk Flood Zone 3.
 - The vast majority of the pipeline route with associated infrastructure is located in the area benefiting from flood defences during the 1 in 100 year fluvial event or the 1 in 200 year tidal event.
- 4.2.4. The EA's Flood Map is shown in Appendix H.
- Flood Defences**
- 4.2.5. The EA confirmed that flood defences in the form of walls and raised embankments are present along the western bank of the River Ouse. The information received from the EA shows that the flood defences present in the area of the Proposed Scheme provide fluvial and tidal protection and are maintained by the EA. Details of the flood defences received from the EA are summarised in Table 9. The exact location of the flood defences is shown in Appendix I.

Table 9 – Existing Flood Defence Details (EA, January 2018)

Asset ID	Description	Type	Downstream Crest Level (mAOD)	Upstream Crest Level (mAOD)	Existing Condition
29000	Floodbank with access steps. Sections of stone walling and piling present.	Embankment	6.16	5.86	3 (fair)
29003	Floodbank with sheet piling wall.	Wall	6.21	6.03	2 (good)
29004	Barrierbank. Public footpath along asset.	Embankment	5.94	6.05	2 (good)
29005	Floodbank wall. Public footpath along asset.	Wall	6.05	5.62	3 (fair)
29053	Barrierbank. Public footpath along asset.	Embankment	5.62	5.95	3 (fair)
77033	Barrierbank. Tidal river.	Embankment	6.06	6.31	3 (fair)
79662	Barrierbank. Public footpath along asset. Gas main runs under asset.	Embankment	5.71	6.13	3 (fair)

- 4.2.6. The EA advised that despite the fact that the risk of flooding in the area of the Proposed Scheme has been reduced by the presence of flood defences, there is still a residual risk of flooding in case of breach of the flood defences or their overtopping by a flood greater than that for which they were designed. The EA stated that asset inspections are undertaken on average every six months, although some critical assets are assessed on a more regular basis. The aim of the EA is to maintain all assets to at least 'fair' standard to ensure that the assets provide appropriate protection. Although a breach of the existing flood defences is

unlikely to happen, the EA requested a detailed breach modelling exercise to be carried out to support this FRA.

River Ouse Hydraulic Model 2009

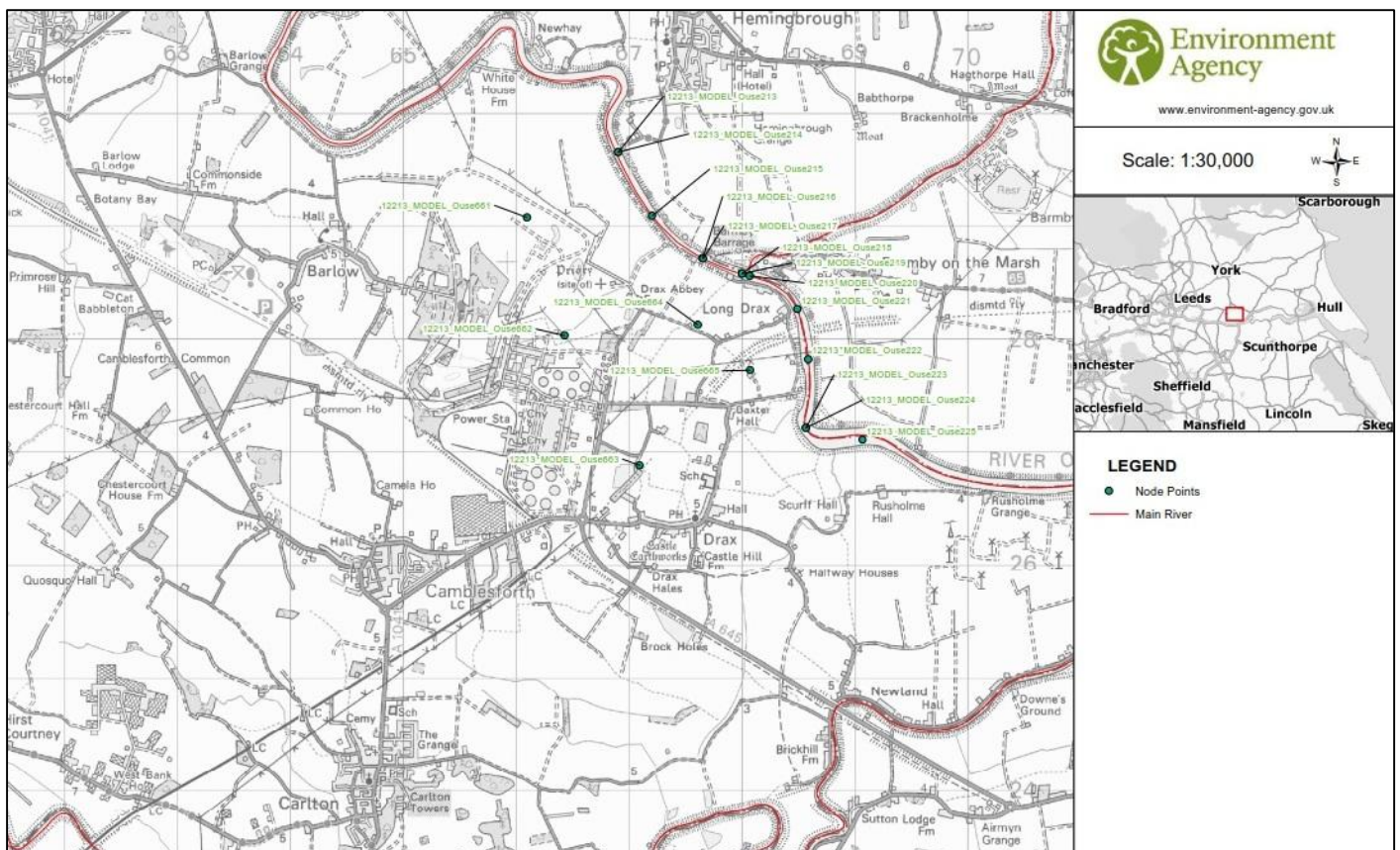
- 4.2.7. The EA advised that the hydraulic model of the River Ouse developed by Halcrow in 2009 is expected to be superseded at the location of the Proposed Scheme by the Upper Humber Flood Mapping Study which is likely to be published in April 2018. However, the EA confirmed in their letter dated 26th January 2018 (Appendix D) that the 2009 River Ouse Model is still the best available data to use at this time and provides a sufficiently robust approach to support this assessment.
- 4.2.8. The flood levels extracted from the 2009 River Ouse model were received from the EA and are summarised in Table 10. The table includes the flood levels predicted during the 'defended scenario' only, as the EA confirmed that the undefended flood scenario does not have to be considered in the assessment as the EA has no plans to remove the existing flood defences. The location of the model node points is shown in Figure 3.

Table 10 – Flood Levels during 'Defended Scenario' (EA's River Ouse Hydraulic Model, 2009)

Node Label	Maximum Water Level (mAOD)			
	1 in 25 year Return Period	1 in 100 year Return Period	1 in 200 year Return Period	1 in 1000 year Return Period
12213_Model_Ouse213	5.26	5.52	5.63	5.72
12213_Model_Ouse214	5.26	5.52	5.63	5.72
12213_Model_Ouse215	5.25	5.51	5.62	5.71
12213_Model_Ouse216	5.26	5.52	5.64	5.73
12213_Model_Ouse217	5.26	5.52	5.64	5.73
12213_Model_Ouse218	5.27	5.53	5.64	5.73
12213_Model_Ouse219	5.27	5.53	5.64	5.73
12213_Model_Ouse220	5.28	5.53	5.64	5.74
12213_Model_Ouse221	5.26	5.52	5.63	5.72
12213_Model_Ouse222	5.26	5.52	5.63	5.73
12213_Model_Ouse223	5.27	5.53	5.64	5.74
12213_Model_Ouse224	5.27	5.53	5.64	5.74
12213_Model_Ouse225	5.26	5.53	5.64	5.73
12213_Model_Ouse661	1.80	1.80	1.80	3.17
12213_Model_Ouse662	0.50	0.50	0.50	3.13

Node Label	Maximum Water Level (mAOD)			
	1 in 25 year Return Period	1 in 100 year Return Period	1 in 200 year Return Period	1 in 1000 year Return Period
12213_Model_Ouse663	2.30	2.30	2.30	3.05
12213_Model_Ouse664	0.80	0.80	0.80	3.12
12213_Model_Ouse665	2.30	2.30	2.30	2.30

Figure 3 – Model Nodes Location (EA's River Ouse Hydraulic Model 2009)



- 4.2.9. A review of the crest levels of the existing flood defences and the flood levels extracted from the 2009 River Ouse hydraulic model indicates that the vast majority of the flood defences provides a protection for up to and including the 1 in 200 year flood event. However it is noted that the crest level of 5.62 mAOD indicated for the flood defence in the area of Derwent View Farm (downstream and upstream section of the assets reference 29053 and 29005 respectively) is 0.02m lower than the flood level predicted for the 1 in 200 year event 'defended scenario'. This location is located approximately 1.2 km to the south-east from the Drax Power Station site. Considering the distance to the Proposed Scheme overtopping at this location is not predicted to pose flood risk to the Proposed Scheme.
- 4.2.10. A review of the crest levels of the existing flood defences and the flood levels extracted from the 2009 River Ouse hydraulic model indicates that the majority of the flood defences also provides a protection for up to and including the 1 in 1000 year flood event.
- 4.2.11. Considering the above information, the area of the Proposed Scheme is considered to be protected for up to and including the 1 in 200 year flood event by the existing flood defences.

Breach Scenario

- 4.2.12. The EA requested a breach modelling exercise to be undertaken to support this FRA.
- 4.2.13. Breach analysis of the White Rose Carbon Capture and Storage Project which is located immediately north of the Existing Drax Power Station Complex was undertaken by HR Wallingford in 2014. The breach location used in this model is approximately 1 km north of the Power Station Site. The breach model and approach was approved by the EA as part of the 2014 project and used a 2D hydrodynamic model (TUFLOW). The model was run for the 1 in 200 year tidal event with climate change occurring in conjunction with the 1 in 5 year fluvial event, as this was considered to represent the worst case scenario. The design life of White Rose Carbon Capture and Storage was considered to be 50 years, therefore the climate change allowance was calculated for the year 2065.
- 4.2.14. The EA confirmed that the existing White Rose Carbon Capture and Storage breach model could be used as a suitable future baseline scenario for the Proposed Scheme, without the need for further changes. The design life of the Proposed Scheme is considered to be 25 years (with the end of the design life being in the year approximately 2052), after which the continued operation of infrastructure will be reviewed and decommissioned if necessary. The climate change allowance considered in the existing White Rose Carbon Capture and Storage hydraulic model is therefore considered appropriate and was adopted for the purpose of this assessment providing a conservative approach.
- 4.2.15. The flood extent and depth during the future baseline are shown in Figure 4. This figure also indicates the boundary of the Proposed Scheme, including the area in the southern part of the Existing Drax Power Station Complex (where part of the Site Reconfiguration Works are being undertaken), which has been subsequently excluded from this DCO application.

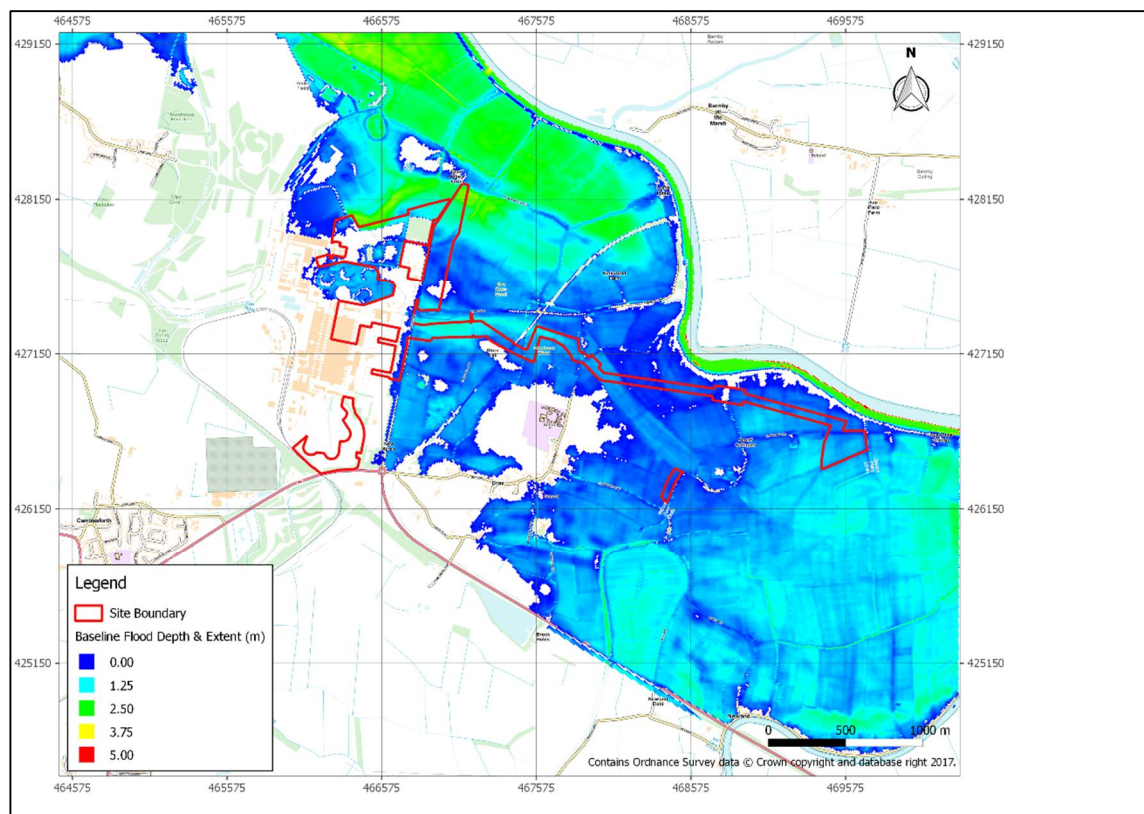


Figure 4 – Future Baseline Floodplain Extent and Flood Depth during Breach Scenario

- 4.2.16. The results show that the proposed pipeline route with the associated GRF and AGI, the area of the northern cooling towers and the area of the proposed battery storage building are potentially at risk of flooding during the modelled breach scenario. The results also indicate that the eastern edge of the Existing Drax Power Station Complex would be also prone to flooding, including the area of the proposed substation facility and partially the area of the proposed Unit Y. The results also show that the area proposed construction compounds (Area A and Area B) and the area of the proposed widening of Rusholme Lane are potentially at risk of flooding during the modelled breach scenario.
- 4.2.17. Details of the hydraulic modelling are provided in the ‘Drax Repowering – Hydraulic Modelling Report’ in Appendix J.

4.3 Risk of Flooding from Surface Water

- 4.3.1. A review of the EA’s Risk of Flooding from Surface Water mapping shows that the vast majority of the area of the Proposed Scheme is not susceptible to flooding from surface water. The EA’s Risk of Flooding from Surface Water mapping does, however, indicate that the following area are at risk:
- Isolated areas within the boundary of the proposed Unit X, and along the western edge of New Road indicated to be at low to medium susceptibility of flooding from surface water.
 - The area along the new pipeline between New Road and Wren Hall Lane is indicated to be at low susceptibility of flooding from surface water with small pockets indicated to be at medium to high susceptibility of flooding.

- The area of the pipeline route located to the north of Woodcock Wood is indicated to be at low to medium susceptibility of flooding from surface water with isolated pockets indicated to be at high susceptibility of flooding from surface water.
- The south-western and the north-eastern part of the main construction compound (Area A) and the area along the northern and eastern boundary of the smaller construction compound (Area B) are indicated to be mainly low risk of flooding from surface water, with small areas indicated to be at medium and high risk of flooding.

- 4.3.2. Low risk of flooding from surface water indicates those areas that could be at risk between the 100 year and 1000 year rainfall event. Medium risk of flooding from surface water indicates those areas that could be at risk between the 30 year and 100 year rainfall event, and high risk – those areas that could be at risk greater than 30 year rainfall event.
- 4.3.3. It is likely that the indicated risk of flooding is associated with localised areas of low ground where water would pond during or after severe or prolonged rainfall events.
- 4.3.4. Considering this information, the Proposed Scheme is generally considered to be at low susceptibility of flooding from surface water.

4.4 Risk of Flooding from Groundwater

- 4.4.1. Groundwater flooding occurs when water stored below ground reaches the surface. It is commonly associated with porous underlying geology, such as chalk, limestone and gravels.
- 4.4.2. Although the area of the Proposed Scheme is underlain by a few metres of clayey superficial deposits which are likely to limit groundwater emergence above ground level, the Selby Area IDB advised that high groundwater levels are likely to occur in the area of the Proposed Scheme.
- 4.4.3. The EA's Areas Susceptible to Groundwater Flooding (AStGWE) map is a strategic scale map illustrating areas susceptible to groundwater flooding on a 1 km² grid. It illustrates the proportion of each 1 km² grid square where geological and hydrogeological conditions indicate that groundwater emergence might occur. The Selby District Level 1 SFRA reproduces the relevant portion of AStGW map. The map indicates that the area of the Existing Drax Power Station Complex is located in a 1 km² grid square where less than 25% of the land is considered to be susceptible to groundwater flooding. The map also shows that the proposed route of the new gas pipeline is not located in the area susceptible to groundwater flooding.
- 4.4.4. Considering the above information, there is a potential risk of flooding from groundwater however it is considered to be low.

4.5 Risk of Flooding from Reservoirs

- 4.5.1. Reservoir flooding may occur as a result of the capacity of the facility being exceeded and/or as a result of dam or embankment failure.
- 4.5.2. A review of the EA's Risk of Flooding from Reservoirs mapping shows that the northern and southern part of the Existing Drax Power Station Complex is at risk of flooding from reservoirs. In accordance with Selby Level 1 SFRA the nearest reservoir is located approximately 4 km upstream of the Proposed Scheme. The EA is responsible for ensuring that reservoirs are inspected regularly and essential safety works are carried out. The EA therefore advised that

reservoir flooding is extremely unlikely to happen. Considering this information, the risk of flooding from reservoirs is considered to be low.

4.6 Risk of Flooding from Sewers

- 4.6.1. The Selby Level 1 SFRA includes information on the historical records of flooding from sewers in the area of the Proposed Scheme. The information provided in the Selby Level 1 SFRA shows the total number of properties at a 1 in 30 year risk of sewer flooding based on historic flooding over the previous 10 years. Due to data protection requirements the data has not been provided at individual property level; rather the register comprises the number of properties within 4 digit postcode areas that are at risk of sewer flooding either internally or externally. The map included in the Selby Level 1 SFRA shows that the Proposed Scheme is located in the area where up to three incidents of flooding from sewers were recorded in the last 10 years.
- 4.6.2. The Existing Drax Power Station Complex is surrounded by rural areas to the north, west and south-west, therefore there is no risk of flooding from sewers from these directions. The power station is bounded by the A645 and New Road to the south-east and east. A new gas receiving facility is also proposed to be located adjacent to New Road. It is likely that these roads are provided with an appropriate highway drainage system that is regularly inspected and maintained, therefore the risk of flooding from the highway drainage system is considered to be low.
- 4.6.3. The route of the new gas pipeline crosses rural areas with no drainage infrastructure and therefore there is no risk of flooding from sewers.

5 FLOOD RISK DURING CONSTRUCTION AND OPERATIONAL PHASE

5.1 Flood Risk during Construction Phase

Increased Risk of Flooding to the Power Station Site, Construction Workers, and People and Properties Elsewhere Caused by Temporary Works in the Existing Floodplain

- 5.1.1. The EA advised that the area of the Proposed Scheme and its surroundings are protected by the existing flood defences for up to the 1 in 200 year flood event. The potential risk of flooding during construction is therefore associated with a breach of the existing flood defences. The breach scenario is very unlikely to happen as the flood defences are regularly inspected and maintained by the EA to ensure that they provide an appropriate level of protection. The results of the hydraulic modelling undertaken as part of this FRA indicate that the proposed construction compounds (Areas A and B and potential compounds that may be required along the pipeline route) are located in the area indicated to be at risk of flooding during the unlikely breach of the existing flood defences. The breach of flood defences is considered to be an extreme and rare event. However, appropriate mitigation measures were investigated and are discussed in the 'Proposed Mitigation' further down this section.

Construction of Temporary Culvert(s)

- 5.1.2. Temporary culvert(s) may be required on the local drains to allow access along the proposed pipeline route. Any works near or within the watercourses would require appropriate consent from the Selby Area IDB. The consent should be obtained prior to the works commencing (unless the requirement to do so as been disapplied by the DCO). Construction of temporary culverts may impede the flow in the channels if not appropriately designed, which could result in an increased risk of flooding in the area. The proposed mitigation measures are discussed in the 'Proposed Mitigation' further down this section.

Works in the Areas Indicated to be at Risk of Flooding from Surface Water

- 5.1.3. A review of the EA's Risk of Flooding from Surface Water mapping shows that the vast majority of the area of the Proposed Scheme is not susceptible to flooding from surface water. The EA's Risk of Flooding from Surface Water mapping also shows isolated areas of the Proposed Scheme to be susceptible to flooding from surface water. The risk of flooding is associated with localised low ground level areas where water would pond during or after prolonged and heavy rainfall events. Water ponding in the low ground areas could delay construction works if not appropriately managed. The proposed mitigation measures are discussed in the 'Proposed Mitigation' further down this section.

5.2 Post-Development Flood Risk

- 5.2.1. The existing flood defences protect the area of the Proposed Scheme and its surroundings for up to the 1 in 200 year flood event, however there remains a residual risk of a breach in the defences. Hydraulic modelling of the post-development scenario was undertaken for the 1 in 200 year with climate change breach scenario with the 1 in 5 year fluvial event to establish the residual risk to the Proposed Scheme and whether the construction of the Proposed Scheme would increase the risk of flooding in the area. Details of the baseline and the post-

development hydraulic modelling are provided in the 'Drax Repower – Hydraulic Modelling Report' attached in Appendix J.

Risk of Flooding to the Proposed Scheme During Breach Event

- 5.2.2. The results of the hydraulic modelling indicate that the majority of the above ground structures of the Proposed Scheme (namely the proposed AGI, GRF, the battery storage building, the relocated sludge lagoons (if the two unit option is taken forward), partially Unit X and Unit Y, and the electrical connectors) will be constructed in areas indicated to be at risk of flooding during a breach of the existing flood defences.
- 5.2.3. In accordance with the Planning Policy Guidance 'Flood Risk and Coastal Change', the Proposed Scheme is considered to be 'essential infrastructure' that must remain operational during flood events. It is therefore proposed to raise these features above the predicted flood level to ensure that these areas will not be flooded during the breach scenario and will remain operational. The proposed mitigation measures are discussed in the 'Proposed Mitigation' further down this section.

Increased Risk of Flooding to People and Properties Caused by Construction of New Structures in the Floodplain

- 5.2.4. Construction of the proposed structures as discussed above within areas indicated to be at risk of flooding following a breach of the flood defences could reduce the floodplain storage capacity and increase the risk of flooding in the area.
- 5.2.5. The proposed structures were included in the hydraulic model to determine the potential effect elsewhere. In the model, the above ground structures were represented by simple rectangular shapes which provided a conservative approach as no flood water was allowed in these areas, while in reality flood water would flow around the structures.
- 5.2.6. The post-development results indicated a small increase of up to 3 mm in flood depth across the vast majority of the floodplain in comparison to the future baseline results.
- 5.2.7. The results indicated that the proposed battery storage and the relocated sludge lagoons could potentially block the existing overland flood flow path shown in the northern part of the Power Station Site in the future baseline scenario. A plan showing the extent of the floodplain during the post-development scenario is shown in Figure 5. The works would result in a very small and localised increase of 13 mm and 20 mm in flood depth at two locations in Drax village. The locations in Drax village where the increase in flood depth are predicted are shown in Figure 6. These areas are shown to be flooded in the future baseline scenario. Appropriate mitigation measures are discussed in the 'Proposed Mitigation' further down this section.

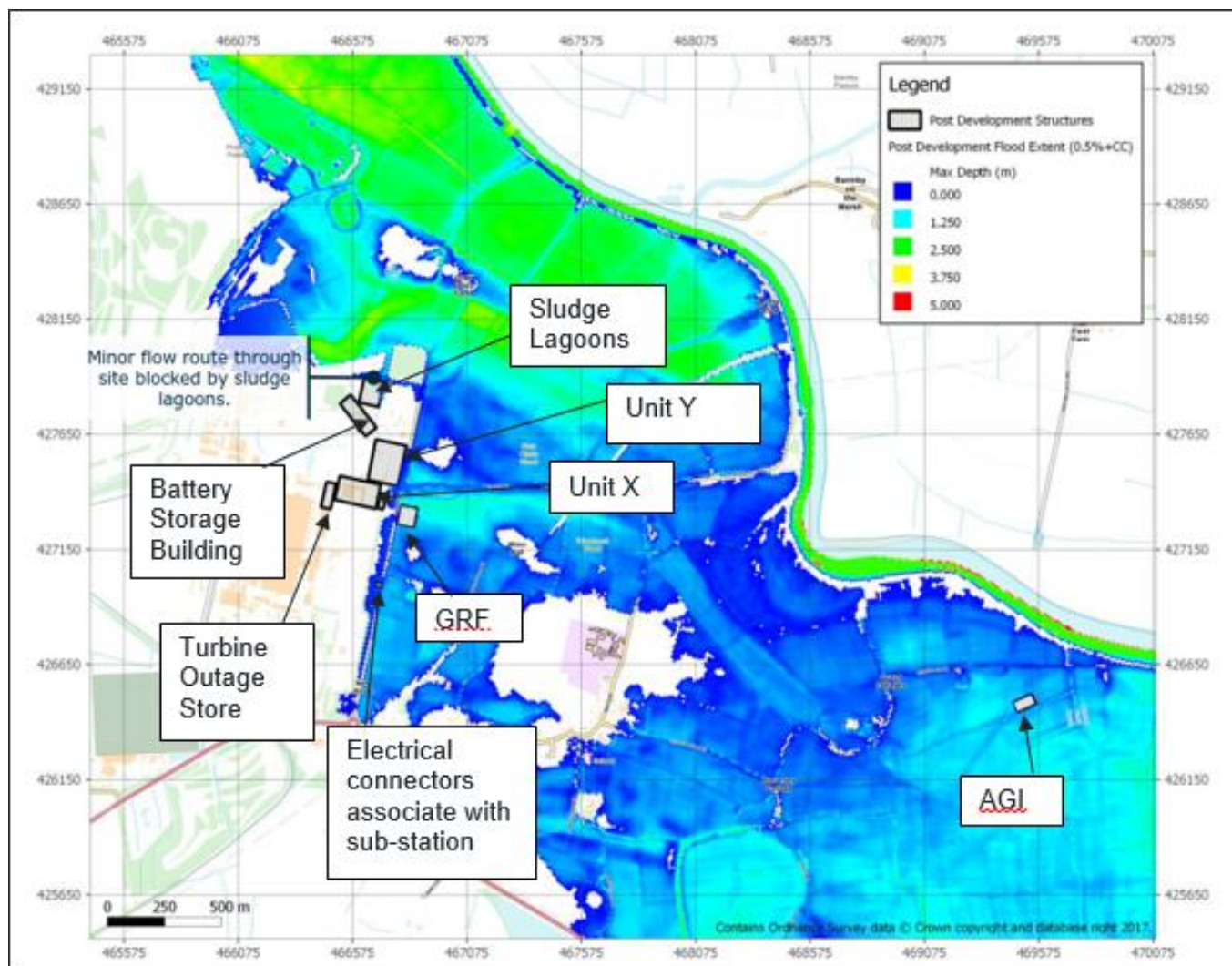


Figure 5 – Post-Development Floodplain Extent

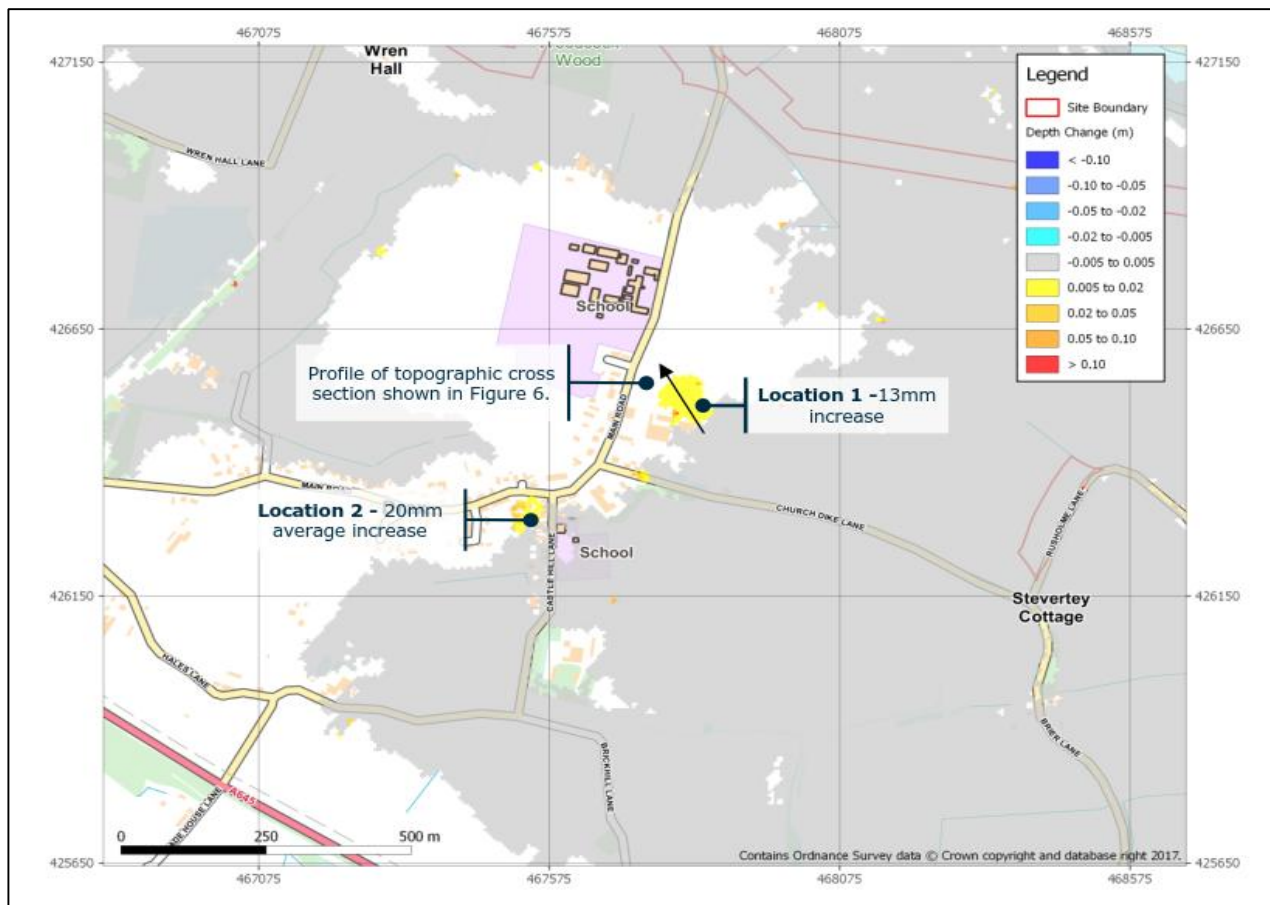


Figure 6 – Post-Development Flood Depth Change

Increased Risk of Flooding Caused by Increase of Impermeable Area

- 5.2.8. The majority of the proposed construction will take place on land that is already paved or occupied by buildings. Therefore, there will be no increased surface water runoff from these areas.
- 5.2.9. The proposed AGI with associated access road, GRF and the battery storage unit will be constructed on land that is largely unpaved, therefore there is the potential for an increase in the rate and volume of surface water runoff from these areas. The proposed mitigation is discussed in the 'Proposed Mitigation' further down this section and Chapter 6 of this FRA.

New Crossings with Watercourses

- 5.2.10. The proposed gas pipeline will cross Back Lane Drain, the unnamed IDB's drain reference 18/1 and Rusholme Lane Drain. The new crossings, if not appropriately designed, have the potential to reduce the current capacity of the channels and impact the flows within these watercourses which could result in an increased risk of flooding in the area. The proposed mitigation measures are discussed in the 'Proposed Mitigation' further down this section.

Increased Risk of Flooding to the Proposed Scheme from Surface Water

- 5.2.11. The EA's Risk of Flooding from Surface Water mappings shows localised areas along the pipeline route and within the boundary of Drax Power Station to be susceptible to flooding from surface water. It is likely that these areas are associated with localised low ground levels

where water would pond during prolonged and heavy rainfall events. The proposed mitigation measures are discussed in the 'Proposed Mitigation' further down this section.

Increased Risk of Flooding to the Proposed Scheme and the Existing Drax Power Station Complex caused by Diversion of North Perimeter Ditch

- 5.2.12. The battery storage building will be located in the area that is crossed by the North Perimeter Ditch, which is part of the existing drainage system serving Drax Power Station. The diversion of the ditch has the potential to reduce the existing capacity of the channel and therefore increase the risk of flooding to the Proposed Scheme and the Power Station if the diversion channel is not appropriately designed. The proposed mitigation measures are discussed in the 'Proposed Mitigation' further down this section.

5.3 Proposed Mitigation

Construction Phase Mitigation

- 5.3.1. Site specific flood evacuation procedures will be developed for the construction workers working on the construction of the Gas Pipeline and associated infrastructure. The construction workers undertaking works within the boundary of Power Station Site will follow the existing Drax Power Station Complex flood evacuation procedures in case of flooding. The construction workers will be made aware of potential flood risk and will be familiarised with the flood evacuation procedures.
- 5.3.2. Appropriate drainage systems and localised amendments to the existing ground levels will be required in the areas of construction works that are indicated to be at risk of surface water flooding, especially in the area of the proposed Unit X and the GRF, and the gas Pipeline route located between New Road and Wren Hall Lane and to the north of Woodcock Wood. It is also recommended that no material is stored and no offices are located in the area of construction compounds indicated to be at risk of flooding from surface water, namely the south-western and the north-eastern part of the main construction compound (Area A) and the area along the northern and eastern boundary of the smaller construction compound (Area B).
- 5.3.3. Where required, temporary culverts for plant crossings will be sized appropriate to the size of a watercourse to ensure no unacceptable obstruction to the flows and no reduction in the current capacity of the channel. The Selby Area IDB will be consulted to obtain appropriate consent from the IDB for construction of temporary culverts and agree the required sizing parameters (to the extent required in accordance with the DCO).

Post-Development Mitigation

Risk of Flooding to the Proposed Scheme during Breach Scenario

The finished floor levels of the proposed above ground structures will be established a minimum of 600 mm above the flood levels predicted for the 1 in 200 year with climate change breach scenario to ensure that they will remain operational during flood events. The maximum flood levels predicted in the vicinity of the above ground structures of the Proposed Scheme together with the proposed finished floor levels are summarised in Table 11. A plan showing the location of the above ground structures with the predicted flood levels is shown in Figure 7.

Table 11 – Maximum Flood Levels and Proposed Finished Floor Levels

Proposed Structure	Maximum Flood Level (mAOD) during 1 in 200 year with Climate Change Breach Scenario	Proposed Finished Floor Level (mAOD)
Sludge Lagoons	4.52	5.12
Battery Storage Building	4.44	5.04
Unit X and Unit Y with adjacent structures	4.46	5.06
Gas Receiving Facility	4.46	5.06
Above Ground Infrastructure	4.23	4.83
Infrastructure associated with Sub-station/Electrical connectors	4.46	5.06



Figure 7 – Maximum Flood Levels in the Vicinity of The Above Ground Structures Predicted for the 1 in 200 year with Climate Change Breach Scenario

Increased Risk of Flooding to People and Properties Caused by Construction of New Structures in the Floodplain

- 5.3.4. The results of the post-development hydraulic modelling shows that the construction of the Proposed Scheme could result in a localised small increase in flood depth of 13 mm and 20 mm at two locations in Drax village. Mitigation measures were investigated with the aim to

reduce the post-development increase in flood depth to less than 10mm, which is considered the margin of error for TUFLOW hydraulic modelling.

- 5.3.5. The hydraulic modelling identifies that the proposed sludge lagoons and the battery storage building block the potential flow path of flood water in the northern part of the Power Station Site. The increase in flood depth indicated in the post-development scenario could be mitigated by reinstatement of that flood flow path. The limited space within the Power Station Site does not facilitate relocation of the sludge lagoons and the battery storage building. Therefore, a flood relief channel is proposed to convey the flood flows in a similar way to that identified in the baseline scenario. The modelling has indicated that a channel of minimum 5 m width and depth of 0.75 m is required to convey the flood flows. The channel will be grassed to encourage infiltration and prevent stagnation of water when the flood waters recede. A typical cross section through the channel is shown on drawing reference 70037047-2.5A-C-005 attached in Appendix K. The channel will be designed during the detailed design stage of the Proposed Scheme. The location of the proposed flood relief channel is shown in Figure 8.

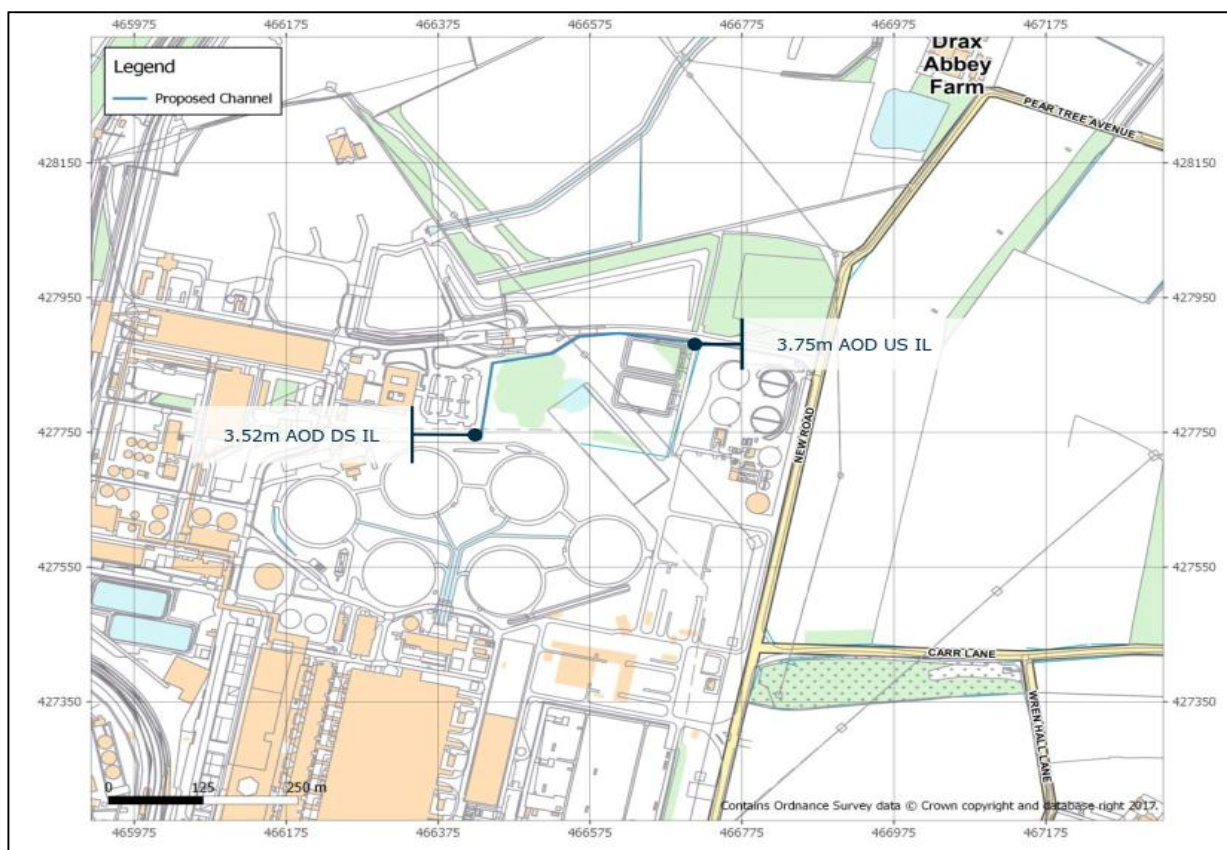


Figure 8 – Location of the Proposed Flood Relief Channel

- 5.3.6. The proposed flood relief channel was added to the post-development hydraulic model to ensure that the localised increase in flood depth indicated in Drax village for the post-development scenario is not greater than 10 mm. The results of the post-development scenario with the proposed flood relief channel show that the flood flow path in the northern part of the Power Station Site is reinstated and the levels of detriment in flood depth are

reduced to below 10 mm in Drax village. A plan showing the post-development scenario with the mitigated floodplain extent and a plan indicating the location of maximum increased flood depths in Drax village are shown in Figure 9 and Figure 10 respectively.

- 5.3.7. The results of the post-development scenario with the proposed flood relief channel show no increase in the extent of floodplain in comparison to the future baseline results.

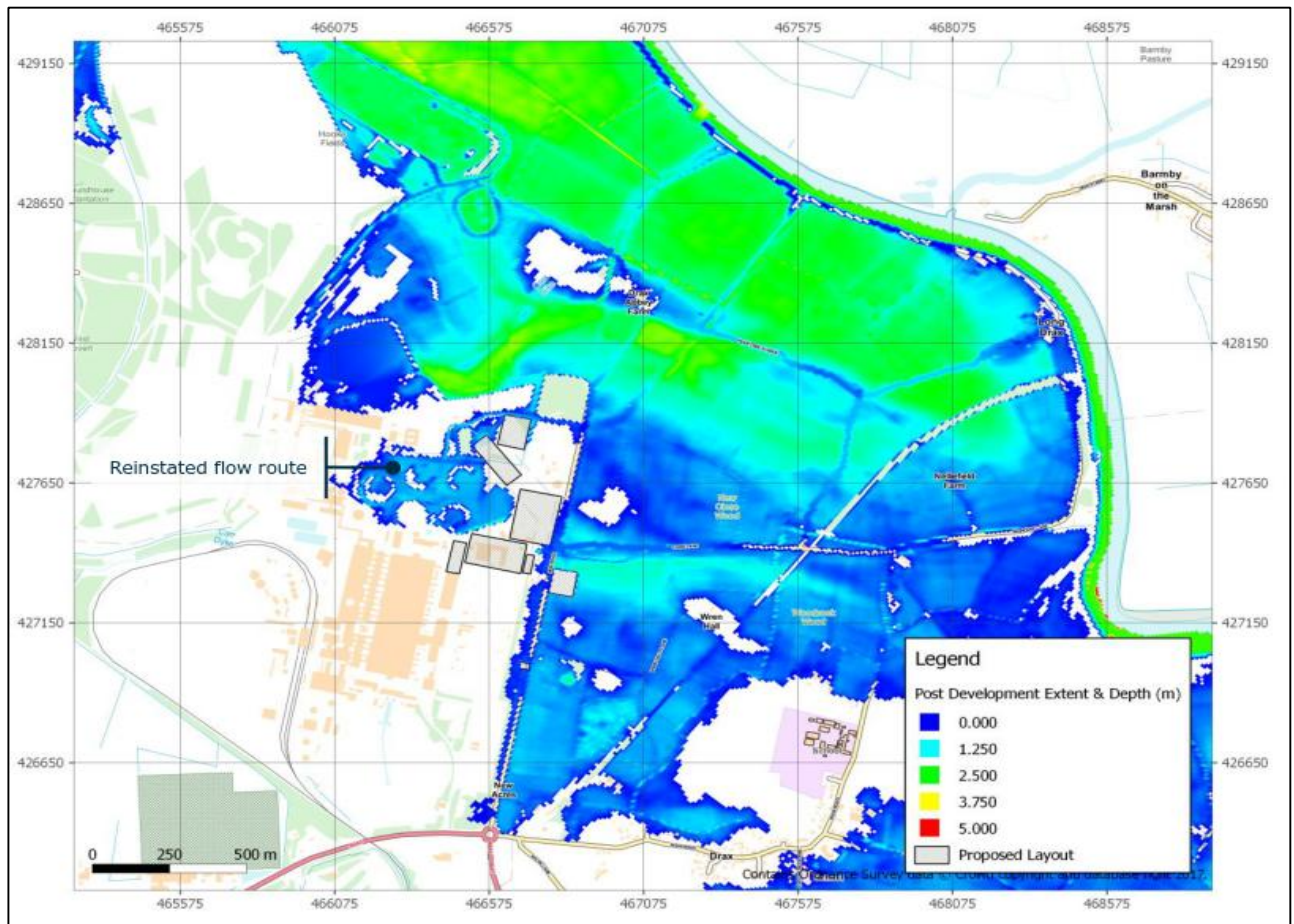


Figure 9 – Post-Development with Mitigation Floodplain Extent

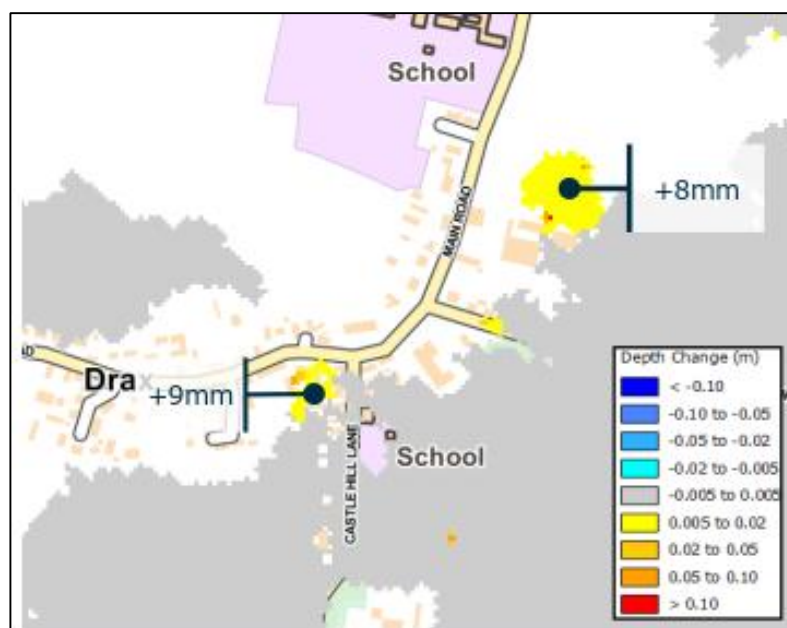


Figure 10 – Post-Development Scenario with Mitigation - Flood Depth Change

- 5.3.8. Details of the hydraulic modelling, including baseline, post-development and post-development with mitigation scenarios are shown in 'Drax Repower – Hydraulic Modelling Report' shown in Appendix J.

Increased Risk of Flooding Caused by Increase in Impermeable Area

- 5.3.9. Surface water runoff generated by the Proposed Scheme will be discharged to the existing drainage systems serving Drax Power Station, which discharge via consented outfalls to Carr Dyke or the River Ouse, with the exception of the remote new AGI facility which will discharge to the Dickon Field Drain. Details of the proposed outline surface water drainage strategy are provided in Chapter 6 of this FRA; a brief summary is provided below:

- The proposed outline surface water drainage strategy was prepared in accordance with the advice from the Selby Area IDB.
- Surface water runoff generated in the area of the AGI and the associated access road will be collected, attenuated and routed through an oil separator. The discharge rate for Dickon Field Drain will be limited to pre-development Greenfield runoff rates or 1.4 l/s/ha whichever is lesser.
- Surface water runoff generated in the remaining areas of the Proposed Scheme will be discharged to the existing drainage systems serving the Existing Drax Power Station Complex. The existing discharge rates to Carr Dyke and the River Ouse will remain unaltered.

New Crossings with Watercourses

- 5.3.10. The new Gas Pipeline will be buried and, in accordance with the requirement of the Selby Area IDB, the new crossings with watercourses will be constructed a minimum of 1 m below the bed of the watercourses. This will ensure the pipelines do not reduce the capacity of the existing watercourses and that the Gas Pipeline will not be damaged during maintenance of the watercourses. The new crossings will therefore not increase the risk of flooding in the area or elsewhere.

Increased Risk of Flooding to the Proposed Scheme from Surface Water

- 5.3.11. New buildings in the Proposed Scheme will be elevated 600 mm above the flood levels predicted for the 1 in 200 year event with climate change during breach scenario. In addition, the Proposed Scheme will be served by appropriately designed surface water drainage system. The proposed surface water drainage strategy and the finished floor levels proposed for the important elements of the Proposed Scheme will provide adequate mitigation against the increased risk of flooding to the Proposed Scheme from surface water, and no additional mitigation is required.

Increased Risk of Flooding to the Proposed Scheme and the Existing Drax Power Station Complex Caused by Diversion of North Perimeter Ditch

- 5.3.12. The North Perimeter Ditch will be diverted to the north of its current location to allow for construction of the battery storage building. The diversion channel will be designed to ensure no reduction of the existing capacity of the channel. The diverted ditch is likely to be about 50% longer than the existing North Perimeter Ditch and therefore provide additional capacity within the overall drainage system to ensure there is no increase to the risk of local surface water flooding. The diversion channel is proposed to be combined with the proposed flood relief channel, and to operate as a two-stage channel. The diversion channel is discussed in detail in Chapter 6 'Proposed Surface Water Drainage Strategy'. The location on the proposed diversion channel and a typical cross section through a two stage channel is shown on drawing reference 70037047-2.5A-C-005-shown in Appendix K.

6 PROPOSED SURFACE WATER DRAINAGE STRATEGY

6.1 Above Ground Installation

- 6.1.1. The Above Ground Installation (AGI) will be located adjacent to the National Transmission System (NTS) gas pipeline, as shown on Drawing No 70037047-2.5B-C-003 included in Appendix K. It will comprise two small compounds, one to be operated by National Grid and one to be operated by Drax Power Ltd.
- 6.1.2. The AGI compounds will contain a Minimum Offtake Connection (MOC) and Pipeline Inspection Gauge (PIG) PIG Trap Facility (PTF) and on-site Pressure Reduction and Metering Station (PRMS). No large buildings are proposed. A permanent paved access road will be required from Rusholme Lane, with a turning head and two parking spaces in each compound. The remainder of the compounds will be surfaced with gravel scalplings or a similar non-paved finish.
- 6.1.3. A surface water drainage scheme will be provided for the new AGI facility to ensure surface water runoff is controlled in accordance with Selby IDB requirements. Essentially, these are that surface water runoff is limited to existing pre-development greenfield runoff rates or 1.4 l/s/ha, whichever is the lesser, and should comply with general pollution prevention guidelines. Selby IDB has indicated that a new surface water discharge can be made into the nearest available IDB watercourse – in this instance Dickon Field Drain - subject to final approval and consent by Selby IDB.
- 6.1.4. Surface water drainage will be provided for the paved surfaces (access road, turning head and parking spaces), with runoff routed through an oil separator and attenuation storage to a new consented outfall into the adjacent Dickon Field Drain. At this stage, it is envisaged that attenuation storage would be provided in over-sized pipes or a buried tank. An indicative surface water drainage scheme is shown on Drawing No 70037047-2.5B-C-004 in Appendix K.
- 6.1.5. The surface water drainage system will be managed and maintained by Drax Power Ltd in accordance with scheme approved pursuant to requirement 12 of the draft DCO.

6.2 Gas Pipeline Route

- 6.2.1. The gas pipeline route is shown on Drawing No 70037047-2.5B-C-003 in Appendix K. The gas pipeline will be a buried pipeline. No permanent surface water drainage requirements are proposed.
- 6.2.2. Temporary pumping of groundwater from excavated trenches during construction will require a separate consent from Selby IDB, unless such requirement is otherwise disapplied by the DCO. A separate consent may also be required from the EA under new EA abstraction regulations, unless such requirement is otherwise disapplied by the DCO. These will be included as part of the Construction Environmental Management Plan (CEMP). No separate surface water drainage scheme is required for the gas pipeline route.

6.3 Gas Receiving Facility and Compressor Station

- 6.3.1. The Gas Receiving Facility (GRF) and compressor station will be located in a fenced compound to the east of New Road, as shown on Drawing No 70037047-2.5B-C-003 in Appendix K. The GRF will comprise a gas compressor building, associated gas compression apparatus and an access road.
- 6.3.2. A new surface water drainage scheme will be provided in the GRF compound for the building roof and access road, which will be connected to the Existing Drax Power Station Complex surface water drainage system. At this stage, it is proposed that a connection will be made to the existing surface water drainage culvert running the length of New Road. The New Road culvert drains through the Power Station Site via a network of culverts and open ditches to the main surface water discharge point for the site at the consented outfall to Carr Dike. An indicative surface water drainage scheme in the GRF compound is shown on Drawing No 70037047-2.5B-C-002 (single unit option) and 70037047-2.5A-C-006 (twin unit option).
- 6.3.3. The surface water drainage system for the GRF compound will be managed and maintained by Drax Power Ltd in accordance with the existing Selby IDB consent.

6.4 Construction of Single Unit Option (Unit X Only)

- 6.4.1. The proposed site layout for Unit X is shown on Drawing Nos 70037047-2.5B-C-001 and 002 in Appendix K.
- 6.4.2. Unit X will comprise two gas turbines and two Heat Recovery Steam Generators (HRSG) and a 100MW Battery Storage Facility (BSF). All permanent construction will be within the Drax Power Station site on land that is already paved or built upon and serviced by existing surface water drainage. Much of the existing surface water drainage within the areas will become redundant and removed to clear the site for the new construction. However, some existing surface water drainage in the areas will need to be retained and diverted locally to the north and south of the proposed Unit X construction area.
- 6.4.3. A new surface water drainage scheme will be provided, as required, to service the new Unit X buildings and associated paved access and service areas surrounding the facilities. The new drainage will connect locally into the existing surface water drainage network for the Drax Power Station Complex. No additional surface water runoff is envisaged from the gas turbine and HRSG areas, as these areas are already paved with impermeable surfaces, or covered by existing buildings, and drain via the existing surface water drainage system.
- 6.4.4. A new surface water drainage scheme will be provided for the BSF which could form part of the new surface water drainage scheme for Unit X. The BSF and service road will be constructed on land that is currently largely unpaved. In addition, the existing North Perimeter Ditch and main surface water carrier drains are routed through this area along with the existing Coal Store Drain to the sludge lagoons. It will be necessary to divert these outside the proposed construction area. A permanent flood relief channel is proposed to be routed around the north and west of this area. It is proposed that the North Perimeter Drain is diverted along the same route as the flood relief channel and that the two channels are combined to form a two-stage channel arrangement. This will increase the length of the North Perimeter Ditch and provide additional attenuation storage capacity. An indicative surface water drainage scheme is shown on Drawing Nos 70037047-2.5B-C-001 and 002. All new surface

water drainage for Unit X will be managed and maintained by Drax Power Ltd in accordance with the existing drainage consents.

- 6.4.5. Surface water runoff for temporary construction laydown areas will be managed locally via the CEMP, with runoff either piped by gravity, or pumped if necessary, back to the existing Drax surface water drainage network.
- 6.4.6. Overall, surface water runoff arising from the construction of Unit X can be managed within the existing surface water drainage regime so as not to increase the surface water discharge from the site

6.5 Construction of Twin Unit Option (Unit X and Unit Y)

- 6.5.1. The proposed site layout for Unit X and Unit Y is shown on Drawing Nos 70037047-2.5A-C-005 and 006 in Appendix K.
- 6.5.2. Unit Y will replicate the components of Unit X and will be constructed consecutively rather than concurrently. It is anticipated that there would be a gap of one year between construction periods but this could be longer depending on commercial considerations.
- 6.5.3. The surface water drainage scheme for Unit X will already be in place when Unit Y is constructed. Additional surface water drainage will be provided for Unit Y, which could form part of the Unit X surface water drainage or be provided separately. In either case, all new surface water drainage for Unit Y will connect locally into the existing surface water drainage network for the Drax Power Station Complex and be managed and maintained by Drax Power Ltd in accordance with the existing consented discharges.
- 6.5.4. The proposed location of Unit Y will require the existing sludge lagoons to be moved and the diversion of the existing pumping main from the Primary Surface Water Common Plant Pumping Station to the Purge Pump House. All other existing surface water drainage in this area will become redundant.
- 6.5.5. An indicative surface water drainage scheme for the twin unit option is shown on Drawing Nos 70037047-2.5A-C-005 and 006.
- 6.5.6. Surface water runoff for temporary construction laydown areas will be managed locally via the CEMP, with runoff either piped by gravity, or pumped if necessary, back to the existing Drax surface water drainage network.
- 6.5.7. Overall, surface water runoff arising from the construction of Units X and Y can be managed within the existing surface water drainage regime so as not to increase the surface water discharge from the site.

7 SEQUENTIAL TEST

7.1 Sequential Test

- 7.1.1. The NPPF recommends that the risk-based Sequential Test should be applied by the Local Planning Authority when considering applications for new development. Its aim is to steer new development to areas at the lowest risk of flooding (Flood Zone 1). Where this is not possible, higher risk flood zones can be considered, but in the context of flood risk vulnerability classification and the possible application of the Exception Test.
- 7.1.2. Selby District Council confirmed (February 2018) that as the proposed development is part of the existing Power Station, therefore the proposal could not be located somewhere else and the Sequential Test does not need to be carried out. However the sequential approach should be considered in the design process.
- 7.1.3. The EA advised that only the 'defended scenario' and the 'breach scenario' should be considered in this assessment as the EA do not plan to remove the existing flood defences. Considering the crest levels of the existing flood defences, the area of the Proposed Scheme is protected for up to the 1 in 200 year flood event.
- 7.1.4. The results of the 'breach scenario' show the area of the proposed battery building and sludge lagoons may be flooded during a 1 in 200 year breach event with climate change. The area of the existing Drax Power Station is heavily developed with very limited areas of not-developed land that can be used for further improvements. The proposed location of the new battery building and the new sludge lagoons was therefore chosen considering the space available within the boundary of the Power Station. In addition, the decision on the location of the new battery building and the sludge lagoons was also influenced by the requirement of where these features should be located in relation to the existing infrastructure that needs to be linked to the proposed features.
- 7.1.5. The results of the 'breach scenario' shows that the southern part of the Power Station area, where rearrangement of the existing infrastructure is proposed to be carried out, is located in the area that would not be flooded during the 1 in 200 year breach event with climate change.
- 7.1.6. Similarly to the Power Station, the new gas pipeline route and the associated infrastructure are located in the area that is protected by the existing flood defences for up to the 1 in 200 year flood event. The location of the AGI was chosen to suit the existing gas main infrastructure located in the vicinity of Rusholme Grange on the right bank of the River Ouse. The results of the hydraulic modelling of the breach scenario show that the vast majority of the area to the east of the Power Station Site may be flooded during the 1 in 200 year breach

event with climate change allowance. Considering this information, the new pipeline could not be located in the area with lower risk of flooding.

7.2 Exception Test

- 7.2.1. In accordance with Table 2 of the Planning Practice Guidance 'Flood Risk and Coastal Change', the proposed development is considered as 'essential infrastructure'. In accordance with Table 3 of the same guidance, essential infrastructure can be located in Flood Zone 3, but the Exceptional Test should be carried out.
- 7.2.2. In accordance with the NPPF for the Exception Test to be passed:
- It must demonstrate that the development provides wider sustainability benefits to the community that outweigh flood risk.
 - A site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.
- 7.2.3. The Proposed Scheme is an improvement to the existing Power Station, and therefore it cannot be located in a different area. The Proposed Scheme consists of conversion of the power plant units that are currently running on coal, into units that are running on gas. The proposal provides a sustainable approach to the production of energy, which is less harmful to the environment.
- 7.2.4. The Proposed Scheme will be constructed as part of the existing power plant, therefore appropriate flood emergency procedures are already in place. In addition, the finished floor levels of the proposed structures will be established 600 mm above the flood levels that may occur during the 1 in 200 year breach scenario with climate change allowance to ensure that these elements will remain operational. The results of the hydraulic modelling of the post-development scenario with the proposed mitigation in the form of a flood relief channel shows that construction of the proposed structures is unlikely to increase the risk of flooding elsewhere.
- 7.2.5. Considering the information provided in the paragraphs above, the Proposed Scheme fulfils the requirements of the Exception Test.

8 CONCLUSIONS

8.1 Existing Flood Risk

- 8.1.1. The EA's Flood Map for Planning shows that the area of the Proposed Scheme is located partially in Flood Zone 2 and partially in Flood Zone 3. During consultation the EA confirmed that the area of the Proposed Scheme and its surroundings are protected up to the 1 in 200 year event by the flood defences located along the banks of the River Ouse. There is however residual risk associated with a breach of the flood defences. A breach of the existing flood defences is unlikely to happen as they are regularly inspected and maintained by the EA to ensure an appropriate level of protection.
- 8.1.2. The River Ouse at the location of the Proposed Scheme is tidally influenced. The risk of flooding in this area is therefore a combination of fluvial and tidal flooding, with tidal being the dominant source. A 2D TUFLOW hydraulic model of a breach of the existing flood defences was undertaken for the future baseline scenario as part of this FRA. The model was run for the 1 in 200 year event with the 50 year climate change allowance along with a 1 in 5 year fluvial event. The design life of the Proposed Scheme is 25 years, therefore the 50 year climate change allowance provides a very conservative approach. The results of the future baseline hydraulic modelling shows that the area of the pipeline route and the northern part of the Power Station Site could be flooded during the unlikely breach scenario.
- 8.1.3. The EA Flood Risk from Surface Water mapping shows localised areas along the pipeline route and within the boundary of the Power Station Site to be susceptible to flooding from surface water. The indicated areas at risk of flooding are likely to be associated with the localised lower ground levels where water would pond during or after prolonged and heavy rainfall events.
- 8.1.4. The area of the Proposed Scheme is considered to be at low risk of flooding from groundwater, sewers and reservoirs.

8.2 Flood Risk during Construction

- 8.2.1. The most notable potential risk of flooding during construction is associated with a breach of the existing flood defences. The hydraulic modelling undertaken as part of this FRA indicated that the proposed construction compounds (Areas A and B and potential compounds that may be required along the pipeline route) are located in the area indicated to be at risk of flooding during the unlikely breach of the existing flood defences. Appropriate flood evacuation procedures will be developed for construction works along the pipeline route.

Construction workers working within the boundary of the Power Station Site will follow the existing Drax Emergency Plan.

- 8.2.2. The area of the proposed Unit X and along the proposed Gas Pipeline route, especially in the area between New Road and Wren Hall Lane and to the north of Woodcock Wood, are at risk of flooding from surface water. The south-western and the north-eastern part of the main construction compound (Area A) and the area along the northern and eastern boundary of the smaller construction compound (Area B) are also indicated to be susceptible to flooding from surface water. The potential risk to construction works will be mitigated by provision of appropriate drainage systems and potential localised amendments to the existing ground levels. It is also recommended that no materials and plant are stored and no offices are located in these areas of the construction compounds which are indicated to be at risk of flooding.
- 8.2.3. The ground levels will be reinstated once the works are completed to ensure no reduction of the floodplain storage during the unlikely breach scenario.

8.3 Post-Development Flood Risk Management

New Structures in Floodplain

- 8.3.1. Hydraulic modelling of the post-development breach scenario was undertaken to support this FRA. The results of the hydraulic modelling shows no increase in the extent of floodplain in comparison with the future baseline results. However the results show a small and localised increase in flood depth of 13 mm and 20 mm at two locations in Drax village. Although the breach scenario is considered unlikely, further mitigation was investigated.
- 8.3.2. To mitigate the potential increase in flood depth at Drax village, a flood relief channel will be constructed in the northern part of the Power Station Site. The flood relief channel was represented in the 2D breach model to ensure it would provide appropriate mitigation. The results show that the potential increase in flood depth indicated at the two locations in Drax village was reduced to less than 10 mm, which is considered as the margin of error for TUFLOW hydraulic modelling. The construction of the proposed flood relief channel is considered to provide sufficient and satisfactory level of mitigation.

Surface Water Runoff Management

- 8.3.3. Surface water runoff from all new development within the Power Station Site will be collected, stored, treated (as necessary) and managed via the existing surface water drainage regimes and discharged from the site via the existing consented outfalls.
- 8.3.4. The majority of the proposed construction will take place on land that is already paved or occupied by buildings. Therefore, there will be no increased surface water runoff from these areas. Where new construction is proposed on land that is currently unpaved, increased surface water runoff will be managed either within the existing surface water drainage system or the provision of additional new drainage ditches, over-sized pipes or buried storage tanks.
- 8.3.5. Where a new surface water discharge is required outside the Power Station Site for the AGI facility, on land that is currently farm land, additional surface water runoff from paved surfaces will be collected and routed through an oil separator and attenuation facility to a new outfall

into the Dickon Field Drain. A new consent application will be made to Selby IDB for this discharge.

- 8.3.6. The proposed surface water runoff management will ensure no increase in the flood risk in the area or elsewhere.

Risk of Flooding to the Proposed Scheme

- 8.3.7. The Proposed Scheme is considered as 'essential infrastructure' and should remain operational during flood events. The proposed finished floor level of the proposed structures will be established 600 mm above the flood levels predicted for the 1 in 200 year event with climate change allowance during the post-development with mitigation breach scenario. The proposed approach to finished floor levels is considered to provide satisfactory mitigation to ensure that the Proposed Scheme will remain operational during the flood event.

New Crossings with Watercourses

- 8.3.8. In accordance with the requirements of the Selby Area IDB, the new pipeline crossings with watercourses will be constructed a minimum of 1 m below the bed of the watercourses. The new crossings will not interfere with the flow of the watercourse and will not impact the current capacity of the channels, therefore they will not increase the risk of flooding in the area or elsewhere.

Diversion of North Perimeter Ditch

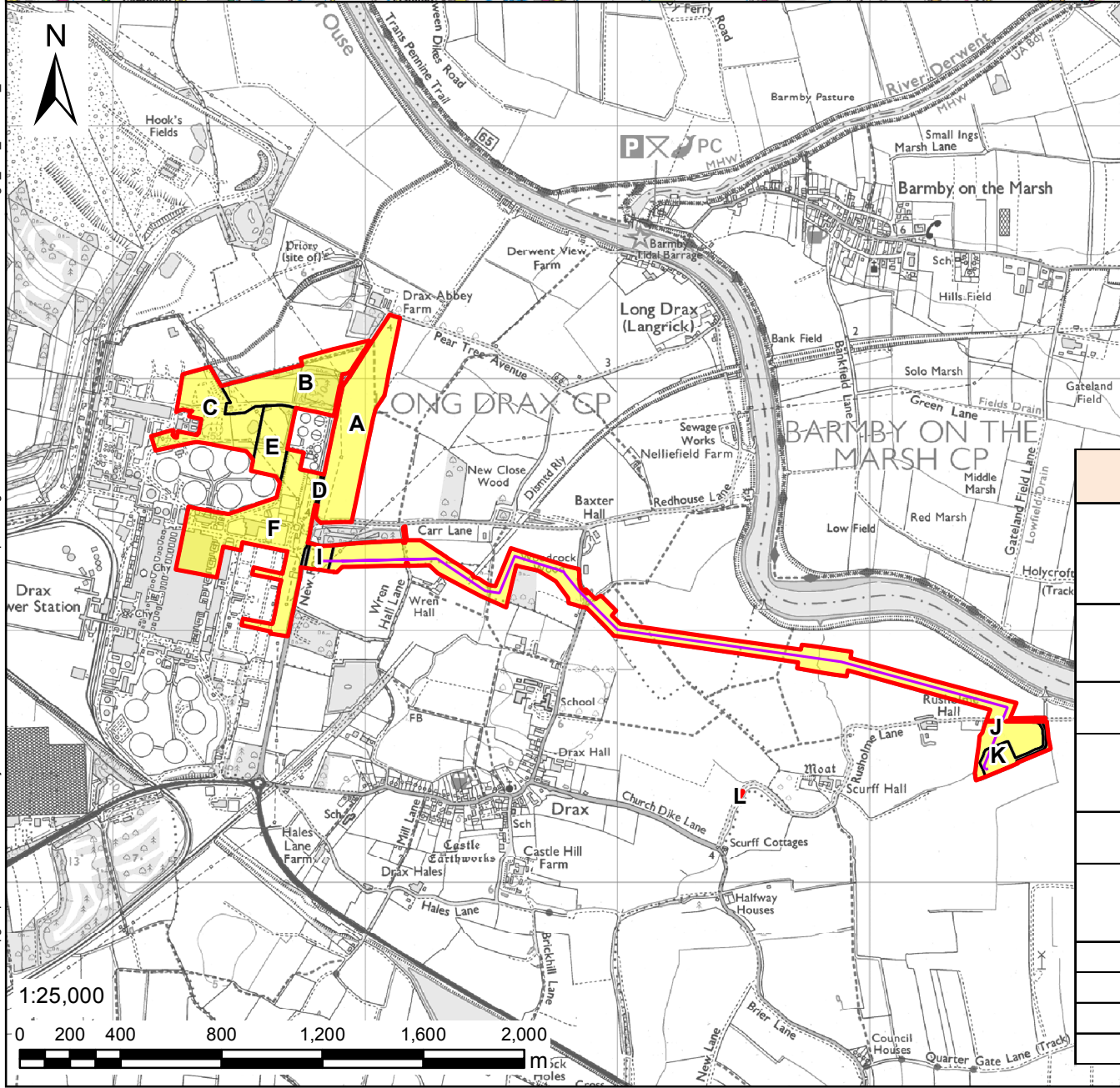
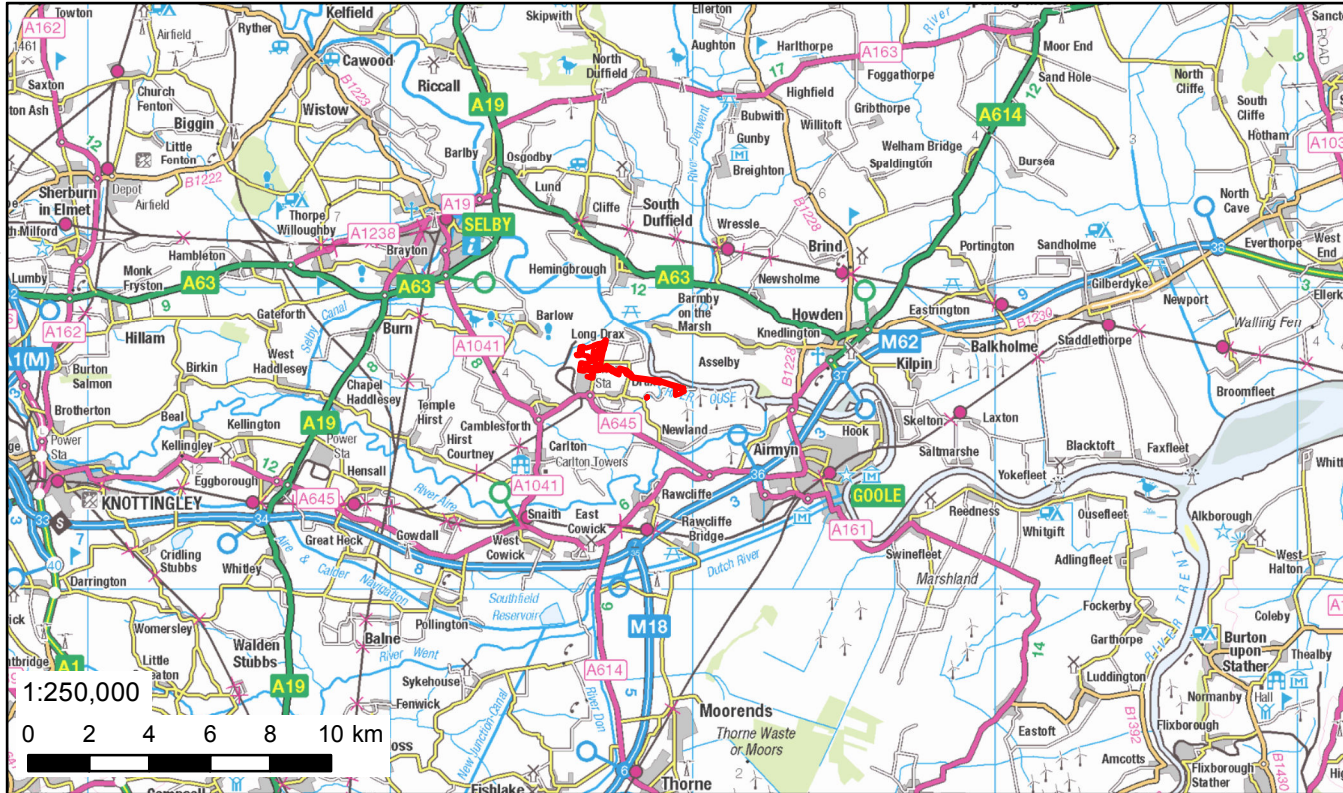
- 8.3.9. The diversion channel will be designed to match the capacity of the existing channel to ensure no change to the existing drainage system. The proposed diversion of the North Perimeter Ditch will not increase the risk of flooding in the area.

8.4 The Sequential Test and the Exception Test

- 8.4.1. The Proposed Scheme is part of the Existing Drax Power Station Complex and therefore cannot be located elsewhere. The sequential approach was considered during the design of the Proposed Scheme.
- 8.4.2. The Proposed Scheme consists of conversion of the power plant units that are currently running on coal, into units that are running on gas. The Proposed Scheme provides sustainable approach to production of energy, which is less harmful to the environment.
- 8.4.3. The Proposed Scheme will be constructed as part of the existing power plant, therefore appropriate flood emergency procedures are already in place. In addition, the finished floor levels of the proposed structures will be 600 mm above the flood levels that may occur during the 1 in 200 year breach scenario with climate change allowance to ensure that these elements will remain operational during the unlikely breach scenario. The results of the hydraulic modelling of the post-development scenario with the proposed flood relief channel shows that construction of the proposed structures is unlikely to increase the risk of flooding elsewhere.
- 8.4.4. Considering the information provided in the paragraphs above, the Proposed Scheme fulfils the requirements of the Exception Test.

APPENDIX A: SITE LOCATION

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Document Path: \\uk.wspgroup.com\central\data\Projects\70037047 - DRAX Re-powering DCO-Yorkshire\GIS\Mxd\Site Location and RLB\Fig1 - Site Location_v9.mxd



Key

Site Boundary

Development Parcels

Gas Pipeline

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B	12/10/2018	RMcC	STAGE 0 REMOVED FROM DCO	CT	CT
A	18/04/2018	RMcC	FIRST ISSUE	CT	LP
REV	DATE	BY	DESCRIPTION	CHK	APP

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CLIENT:

drax

PROJECT:

The Drax Power (Generating Stations) Order

TITLE:

Regulation 5(2)(o) Site Location Plan

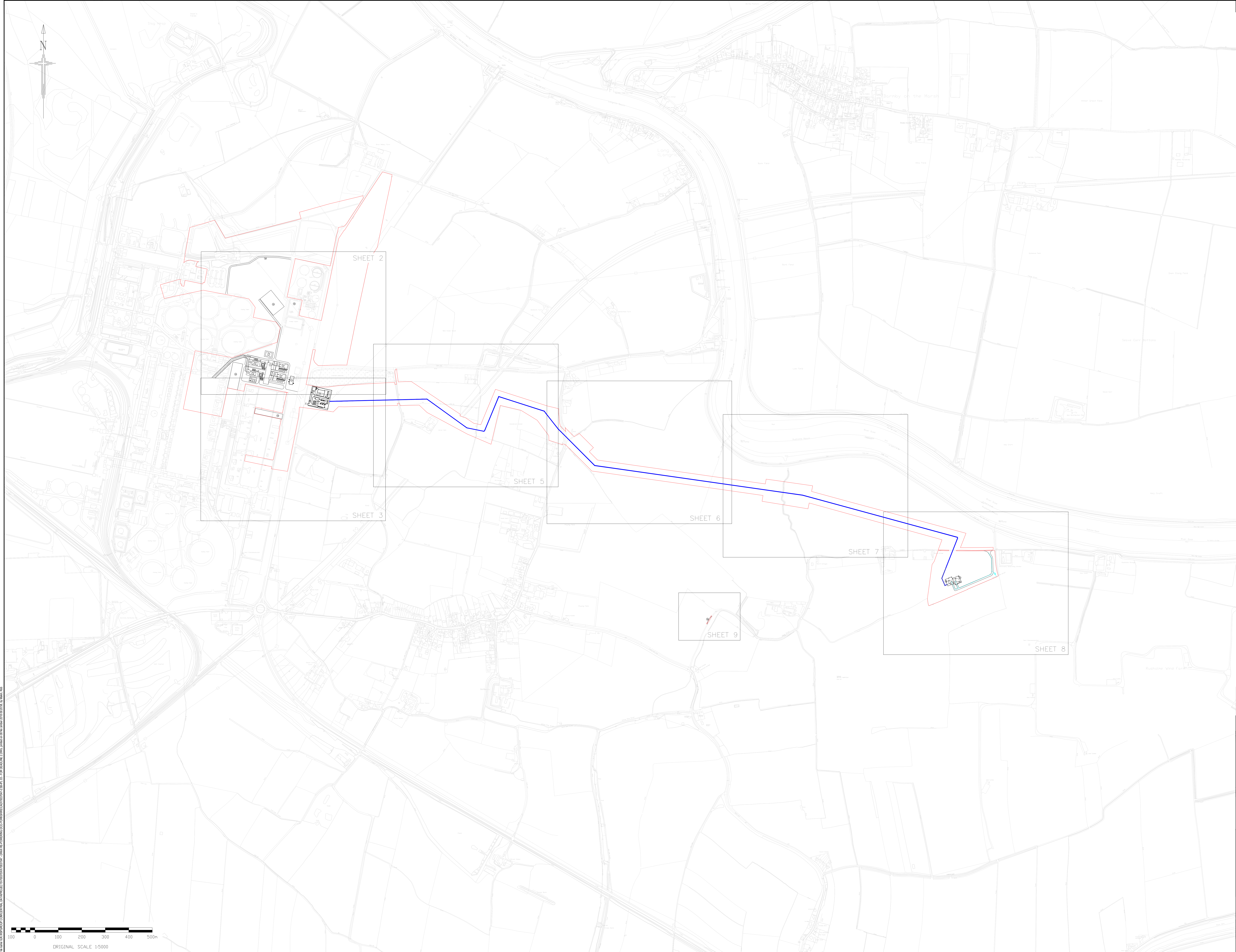
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PROJECT No: 70037047	DESIGNED: WSP	DRAWN: RMcC
DATE: 02/11/2018		REV: B

DRAWING No:

70037047-2.1

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APPENDIX B: PROPOSED SITE LAYOUT – ONE UNIT OPTION



DO NOT SCALE

LEGEND
— PROPOSED DCO ORDER LIMITS
— GAS PIPELINE ALIGNMENT
— GAS AGI SURFACE WATER DRAIN

POWER STATION SITE

ITEM	DESCRIPTION
1	GAS TURBINE BUILDING
2	BYPASS STACK
3	HRSG BUILDING AND MAIN STACK
4	TRANSFORMER AREA
5	POWER CONTROL CENTRES
6	FEEDWATER PUMPHOUSE
7	FUEL GAS STATION MAIN
8	MAIN PIPE RACK
9	GAS RECEIVING FACILITY
10	GAS COMPRESSOR BUILDING
11	GAS INSULATED SWITCH GEAR
12	REINSTATED SLUDGE LAGOONS
13	BATTERY ENERGY STORAGE FACILITY
14	TURBINE OUTAGE STORE (TOS) BUILDING
15	CONNECTION POINT TO 400KV SUBSTATION FOR NEW UNITS
16	FLOOD MITIGATION CHANNEL

GAS ABOVE GROUND INSTALLATION (AGI)

ITEM	DESCRIPTION
17	AGI (MINIMUM OFFTAKE CONNECTION) (NATIONAL GRID)
18	AGI (DRAX FACILITY)

TRAFFIC MANAGEMENT

ITEM	DESCRIPTION
19	TEMPORARY PASSING PLACE FOR GAS AGI CONSTRUCTION TRAFFIC

In/rastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2) (o)

REV	DATE	BY	DESCRIPTION	CHK	APP
03	25/10/2018	SP	Third issue submitted to E generation Deadline 2	RM	BS
02	20/06/2018	SPS	Second issue to include comments prior to e-annotation	RM	BS
01	27/04/2018	SPS	First issue	RM	BS

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CLIENT:

PROJECT:
The Drax Power
(Generating Stations) Order

TITLE:
Application Document Reference 2.5B
Single Unit Option
Indicative Plant Layout
Key Plan - Sheet 1 of 9

SCALE @ A3: 1:5000	CHECKED: R. MANN	APPROVED: B. SIBTHORP
PROJECT No: 70037047	DRAWN: B. SIBTHORP	DATE: 25/10/2018

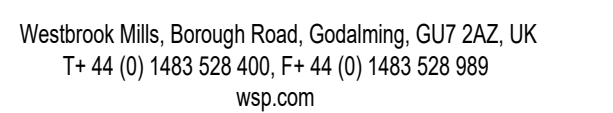
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ITEM	DESCRIPTION
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2	BYPASS STACK
3	HRSG BUILDING AND MAIN STACK
4	TRANSFORMER AREA
5	POWER CONTROL CENTRES
6	FEEDWATER PUMPHOUSE
7	FUEL GAS STATION MAIN
8	MAIN PIPE RACK
9	GAS RECEIVING FACILITY
10	GAS COMPRESSOR BUILDING
11	GAS INSULATED SWITCH GEAR
12	REINSTATED SLUDGE LAGOONS
13	BATTERY ENERGY STORAGE FACILITY
14	TURBINE OUTAGE STORE (TOS) BUILDING
15	CONNECTION POINT TO 400KV SUBSTATION FOR NEW UNITS
16	FLOOD MITIGATION CHANNEL

Q2	25/10/2018	MP	Second issue Submitted or Examination Deadline 2	RM	BS
01	23/04/2018	SPS	First issue	RM	BS
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The Draft Power (Generating Stations) Order

Application Document Reference 2.5B
Single Unit Option
Indicative Plant Layout
- North of Site - Sheet 2 of 9

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		25/10/2018

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SITE RECONFIGURATION
WORKS NO LONGER PART OF
PROPOSED SCHEME. DETAIL
REMOVED FROM SHEET

02

25/10/2018

SP

Second Issue Submitted to Examination/Deadline 2

RM

BS

01

27/04/2018

SPS

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PROJECT:

The Drax Power
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TITLE:

Application Document Reference 2.5B
Single Unit Option
Indicative Plant Layout
- South on Site - Sheet 4 of 9

SCALE @ A2

1:750

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B. SIBTHORP

PROJECT No

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DESIGNED

B. SIBTHORP

DRAWN

S. SPINKS

DATE

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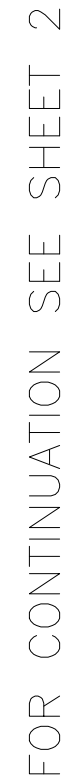
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FOR CONTINUATION SEE SHEET 3

EOP CONTINUATION SEE SHEET 3



FOR CONTINUATION SEE SHEET 6

LEGEND

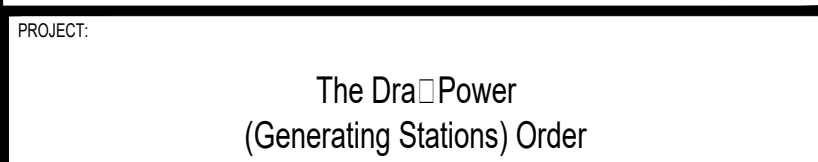
— PROPOSED DCO ORDER LIMITS

— GAS PIPELINE ALIGNMENT

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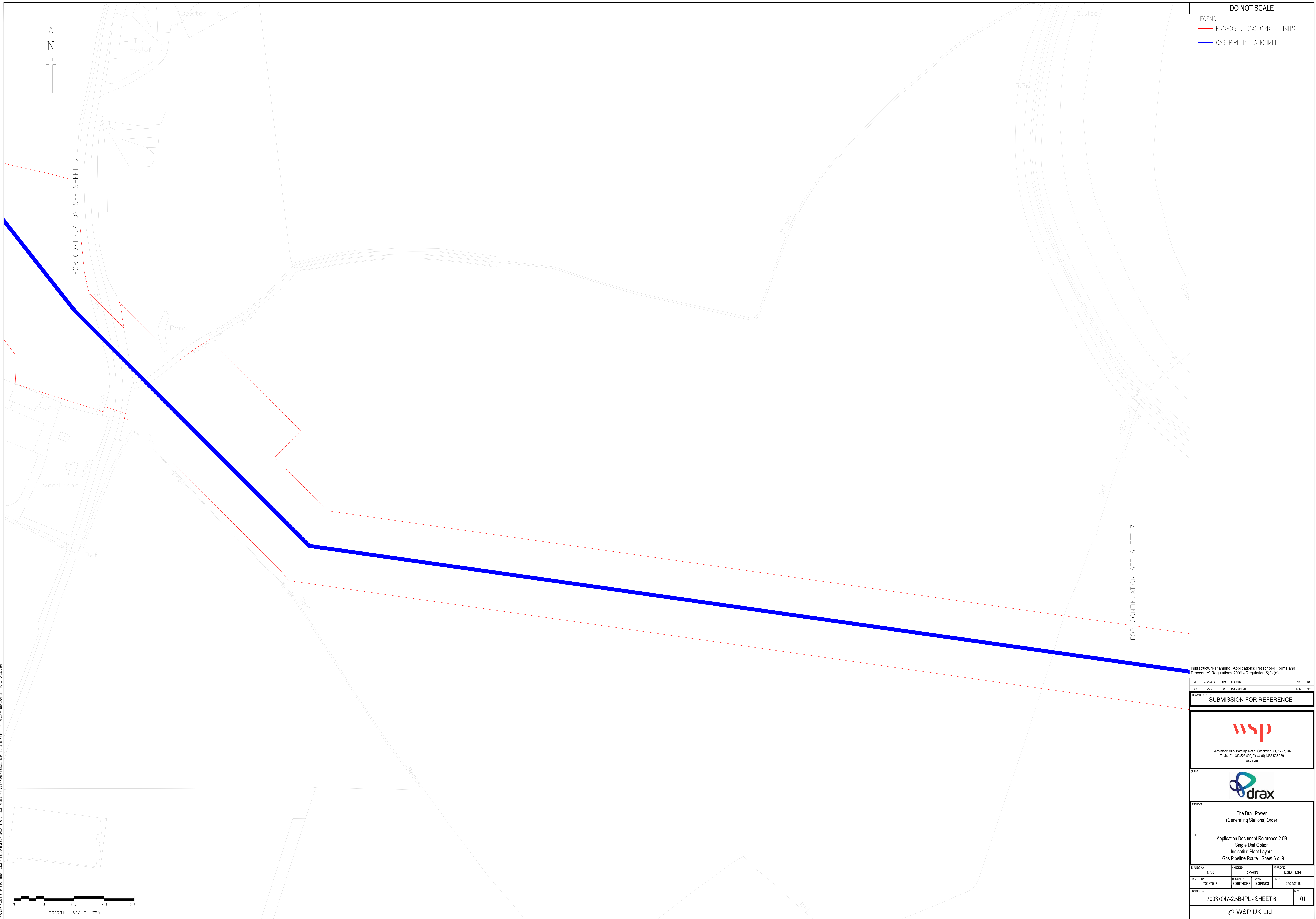
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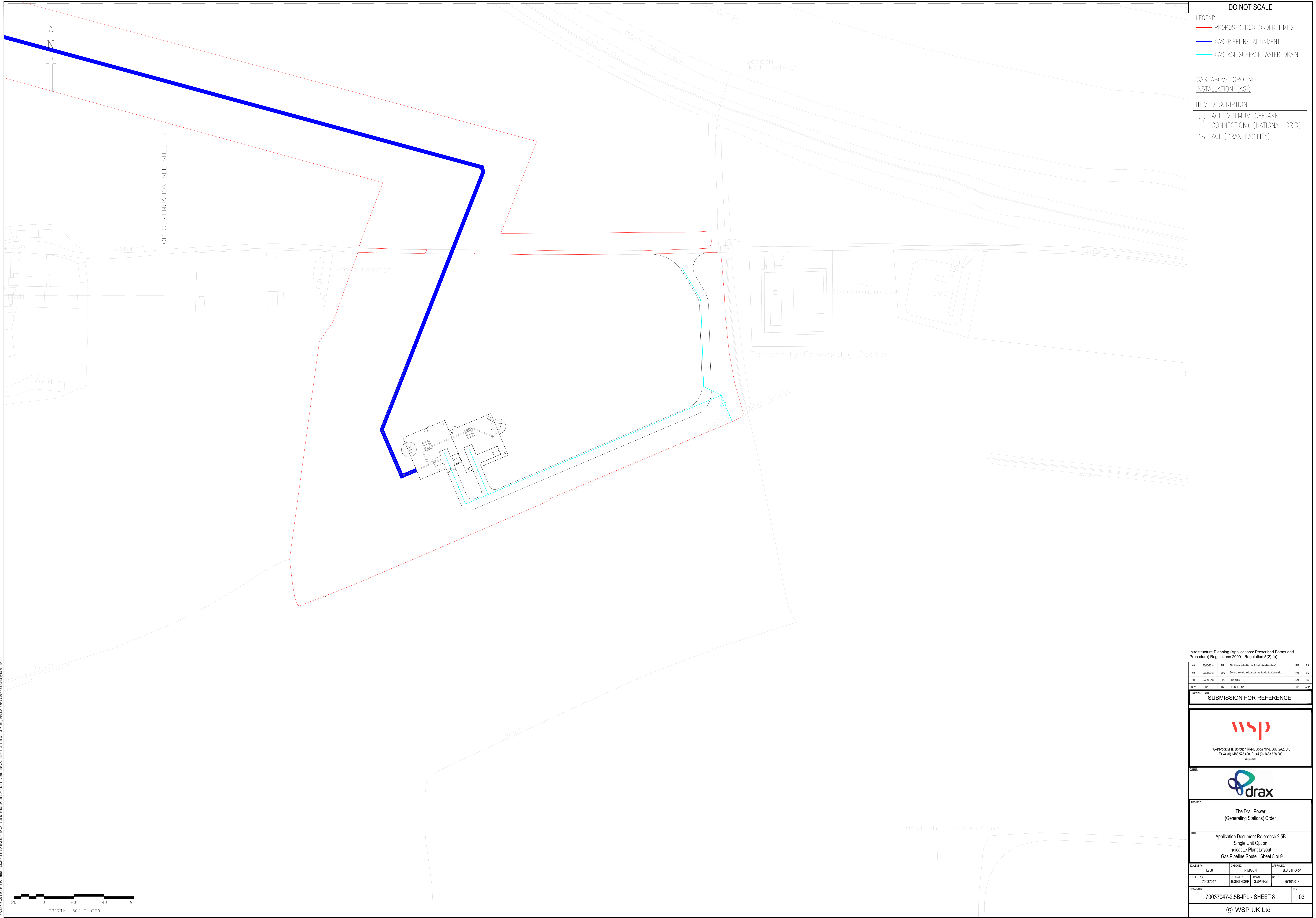


- Gas Pipeline Route - Sheet 5 of 9

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70037047 2 5B IPI SHEET 5	02

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LEGEND

PROPOSED DCO ORDER LIMITS

GAS PIPELINE ALIGNMENT

GAS AGI SURFACE WATER DRAIN

GAS ABOVE GROUND
INSTALLATION (AGI)

ITEM	DESCRIPTION
17	AGI (MINIMUM OFFTAKE CONNECTION) (NATIONAL GRID)
18	AGI (DRAX FACILITY)

In/rastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2) (o)

REV	DATE	BY	DESCRIPTION	CHK	APP
01	25/10/2018	SP	First issue		
02	25/10/2018	SPS	Second issue to include comments prior to e-annotation		
03	25/10/2018	SP	Third issue submitted in E-annotation Deadline 2		

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CLIENT:

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PROJECT:

The Drax Power
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TITLE:

Application Document Reference 2.5B
Single Unit Option
Indicative Plant Layout
- Gas Pipeline Route - Sheet 8 of 9

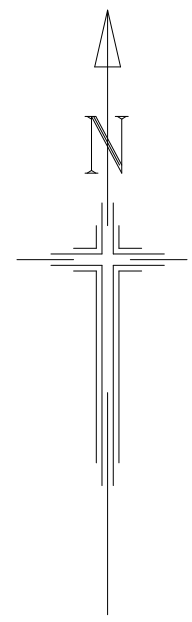
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PROJECT No.	DRAWN	DATE
70037047	B. SIBTHORP	25/10/2018

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70037047-2.5B-IPL - SHEET 8	03

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Path (unpaved) Mean High Water Beacon (Red Flashing) Pond RUSABENE Diamond Cottage Electricity Generating Station Mast (Telecommunication) GVD Drain Drain Drain Drain Drain



Drain

4.0m

1.22m RL1

19

Def

5 0 5 10 15 20m

ORIGINAL SCALE 1:250

DO NOT SCALE

LEGEND

PROPOSED DCO ORDER LIMITS

TRAFFIC MANAGEMENT

ITEM	DESCRIPTION
19	TEMPORARY PASSING PLACE FOR GAS AGI CONSTRUCTION TRAFFIC

In/rastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2) (a)

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TITLE:

Application Document Reference 2.5B
Single Unit Option
Indicative Plant Layout
- Passing Place - Sheet 9 of 9

SCALE @ A3 1:250	CHECKED R. MAKIN	APPROVED S. SIBTHORP
PROJECT No. 70037047	DRAWN S. SPINKS	DATE 27/04/2018

DRAWING No. 70037047-2.5B-IPL - SHEET 9	REV. 01
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APPENDIX C: PROPOSED SITE LAYOUT – TWO UNIT OPTION



DO NOT SCALE

LEGEND

PROPOSED DCO ORDER LIMITS

GAS PIPELINE ALIGNMENT

GAS AGI SURFACE WATER DRAIN

POWER STATION SITE

ITEM	DESCRIPTION
1	GAS TURBINE BUILDING
2	BYPASS STACK
3	HRSG BUILDING AND MAIN STACK
4	TRANSFORMER AREA
5	POWER CONTROL CENTRES
6	FEEDWATER PUMPHOUSE
7	FUEL GAS STATION
8	MAIN PIPE RACK
9	GAS RECEIVING FACILITY
10	GAS COMPRESSOR BUILDING
11	GAS INSULATED SWITCH GEAR
12	SLUDGE LAGOONS
13	BATTERY ENERGY STORAGE FACILITY
14	TURBINE OUTAGE STORE (TOS) BUILDING
15	CONNECTION POINT TO 400KV SUBSTATION FOR NEW UNITS
16	CABLE SEALING END
17	FLOOD MITIGATION CHANNEL

GAS ABOVE GROUND INSTALLATION (AGI)

ITEM	DESCRIPTION
18	AGI (MINIMUM OFFTAKE CONNECTION) (NATIONAL GRID)
19	AGI (DRAX FACILITY)

TRAFFIC MANAGEMENT

ITEM	DESCRIPTION
20	TEMPORARY PASSING PLACE FOR GAS AGI CONSTRUCTION TRAFFIC

In Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2) (a)

REV	DATE	BY	DESCRIPTION	CHK	APP
01	25/10/2018	SP	Third issue Submitted to Examination Deadline 2	RM	BS
02	26/05/2019	SPS	Second issue to include comments prior to examination	RM	BS
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CLIENT:

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PROJECT:

The Drax Power (Generating Stations) Order

TITLE:

Application Document Reference 2.5A
Two Unit Option
Indicative Plant Layout
Key Plan - Sheet 1 of 9

SCALE AS 1:5000

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PROJECT No. 70037047

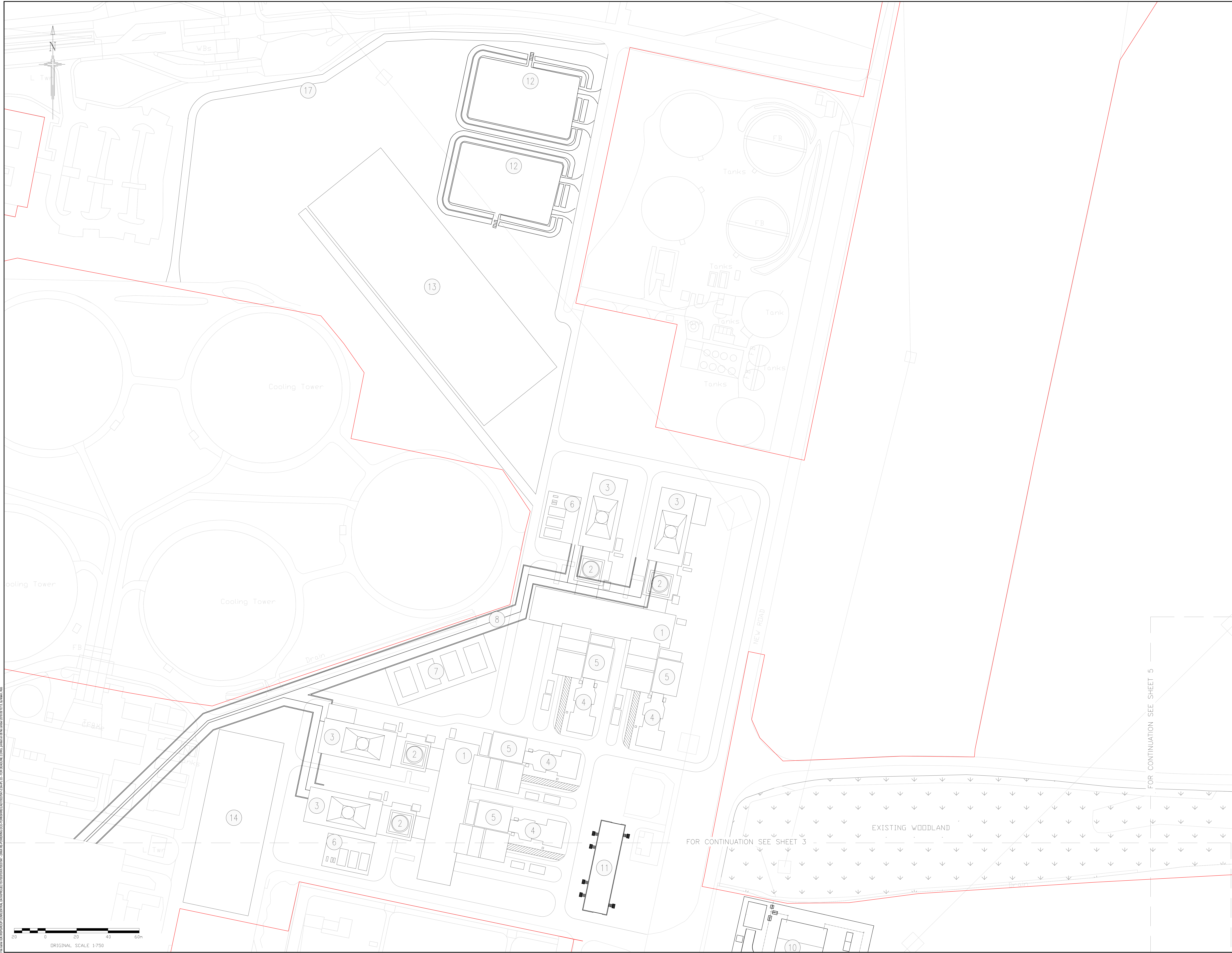
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DATE 25/10/2018

70037047-2.5A-IPL - SHEET 1

03

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LEGEND

PROPOSED DCO ORDER LIMITS

POWER STATION SITE

ITEM	DESCRIPTION
1	GAS TURBINE BUILDING
2	BYPASS STACK
3	HRSG BUILDING AND MAIN STACK
4	TRANSFORMER AREA
5	POWER CONTROL CENTRES
6	FEEDWATER PUMPHOUSE
7	FUEL GAS STATION
8	MAIN PIPE RACK
9	GAS RECEIVING FACILITY
10	GAS COMPRESSOR BUILDING
11	GAS INSULATED SWITCH GEAR
12	SLUDGE LAGOONS
13	BATTERY ENERGY STORAGE FACILITY
14	TURBINE OUTAGE STORE (TOS) BUILDING
15	CONNECTION POINT TO 400KV SUBSTATION FOR NEW UNITS CABLE SEALING END
16	COMPOUND AND OVERHEAD CONDUCTORS
17	FLOOD MITIGATION CHANNEL

In/rastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2) (a)

REV	DATE	BY	DESCRIPTION	CHK	APP
02	20/06/2018	SPS	Second issue to include comments prior to a submission	RM	BS
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Two Unit Option
Indicative Plant Layout
- North o. Site - Sheet 2 of 3

SCALE @ A3

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R. MANN

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B. SIBTHORP

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B. SIBTHORP

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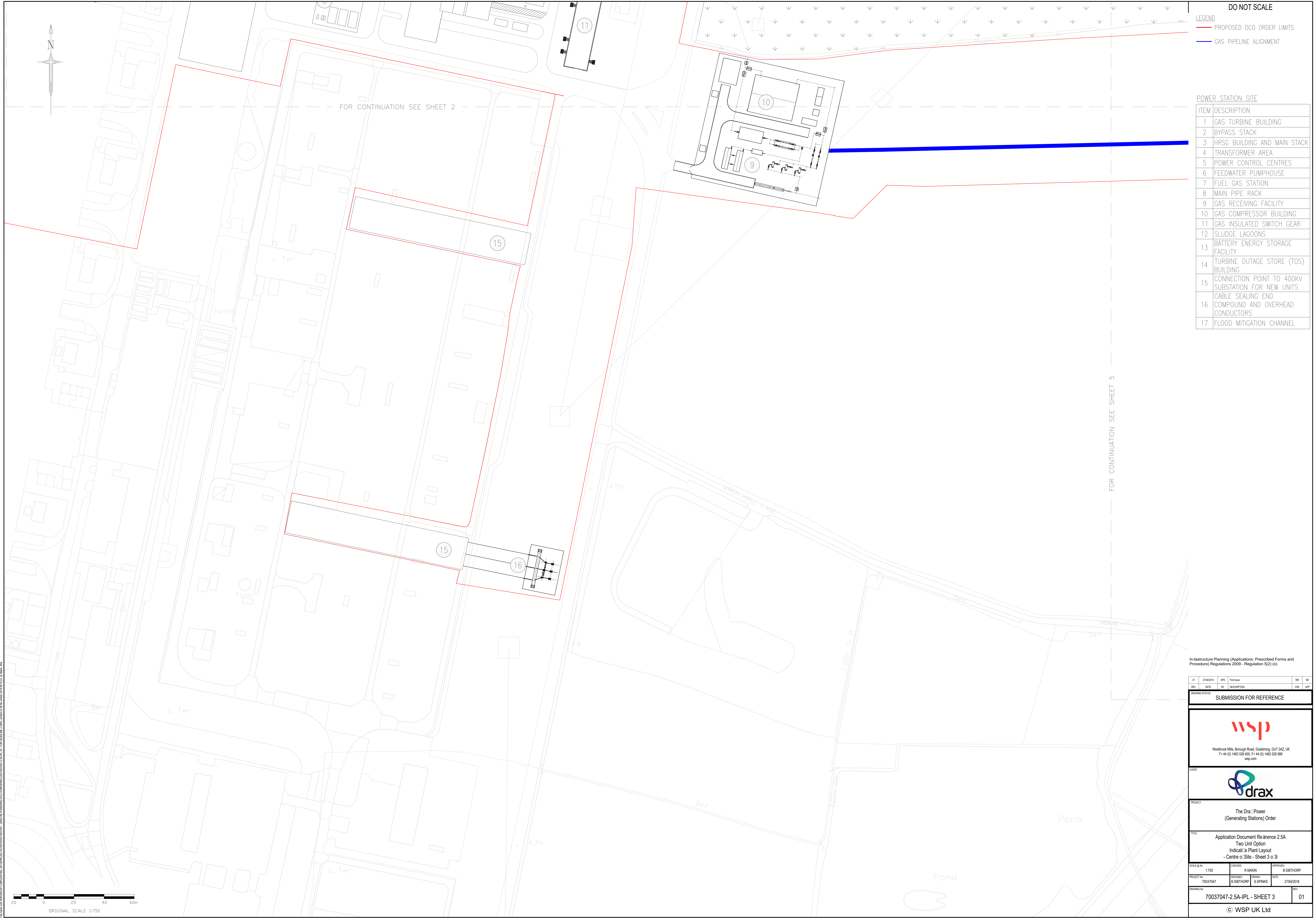
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REV

02

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LEGEND

PROPOSED DCO ORDER LIMITS

GAS PIPELINE ALIGNMENT

POWER STATION SITE

ITEM	DESCRIPTION
1	GAS TURBINE BUILDING
2	BYPASS STACK
3	HRSG BUILDING AND MAIN STACK
4	TRANSFORMER AREA
5	POWER CONTROL CENTRES
6	FEEDWATER PUMPHOUSE
7	FUEL GAS STATION
8	MAIN PIPE RACK
9	GAS RECEIVING FACILITY
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12	SLUDGE LAGOONS
13	BATTERY ENERGY STORAGE FACILITY
14	TURBINE OUTAGE STORE (TOS) BUILDING
15	CONNECTION POINT TO 400KV SUBSTATION FOR NEW UNITS CABLE SEALING END
16	COMPOUND AND OVERHEAD CONDUCTORS
17	FLOOD MITIGATION CHANNEL

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01	27/04/2018	SPS	Final Issue		RM	BS
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wsp.com

CLIENT:

drax

PROJECT:

The Drax Power (Generating Stations) Order

TITLE

Application Document Reference 2.5A
Two Unit Option
Indicative Plant Layout
- Centre of Site - Sheet 3 of 9

SCALE @ A3	CHECKED	APPROVED
1:750	R. MANN	B. SIBTHORP
PROJECT No	DESIGNED	DRAWN
70037047	B. SIBTHORP	S. SPINKS
DRAWING No:	DATE	REV
70037047-2.5A-IPL - SHEET 3	27/04/2018	01

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SITE RECONFIGURATION
WORKS NO LONGER PART OF
PROPOSED SCHEME. DETAIL
REMOVED FROM SHEET

02

25/10/2018

SP

Detail Plans and Plans to Erection

RM

BS

01

27/04/2018

SPS

Final Issue

RM

BS

REV

DATE

BY

DESCRIPTION

CHK

APP

DRAWING STATUS

SUBMISSION FOR REFERENCE

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The Drax Power
(Generating Stations) Order

TITLE

Application Document Reference 2.5A
Two Unit Option
Indicative Plant Layout
- South o. Site - Sheet 4 o. 9

SCALE @ A2

1:750

CHECKED

R. MAKIN

APPROVED

B. SIBTHORP

PROJECT No.

70037047

DESIGNED

B. SIBTHORP

DRAWN

S. SPINKS

DATE

25/10/2018

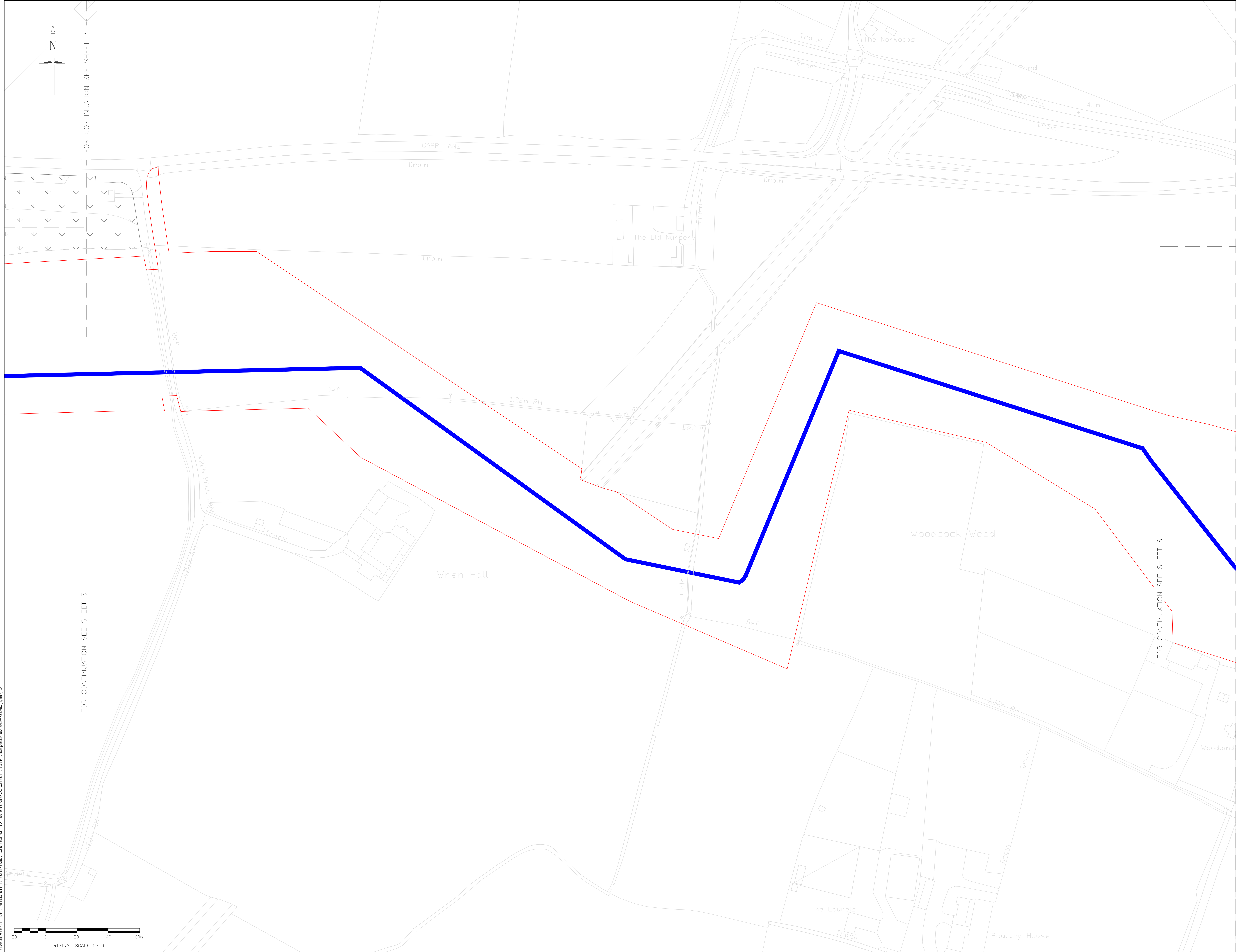
DRAWING No.

70037047-2.5A-IPL - SHEET 4

REV.

02

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DO NOT SCALE

LEGEND

PROPOSED DCO ORDER LIMITS

GAS PIPELINE ALIGNMENT

In /astructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2) (o)

02	25/10/2018	SP	Second issue Submitted in E-consultation Deadline 2	RM	BS
01	27/04/2018	SPS	First issue	RM	BS
REV	DATE	BY	DESCRIPTION	CHK	APP

DRAWING STATUS

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CLIENT:

drax

The Drax Power
(Generating Stations) Order

TITLE

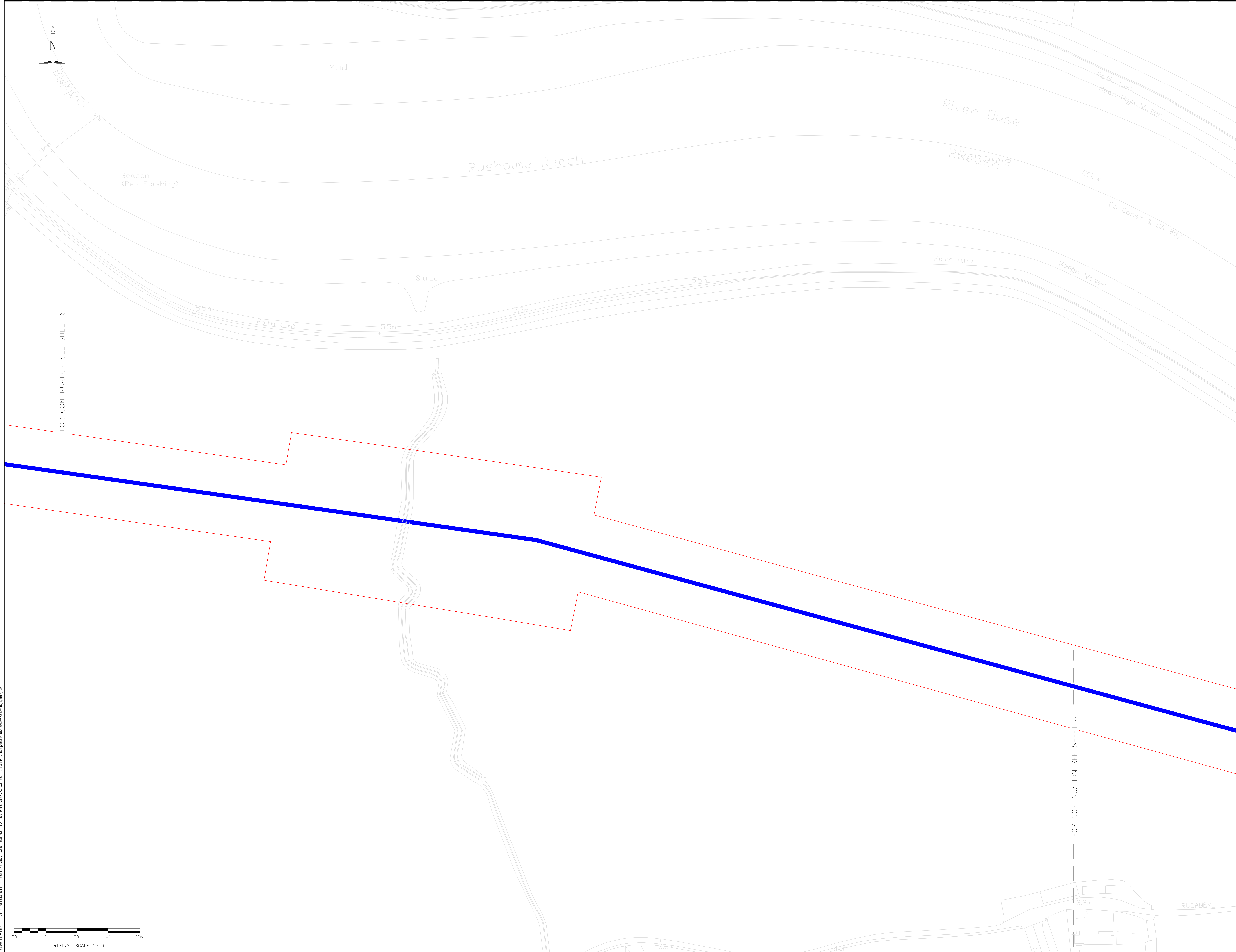
Application Document Reference 2.5A
Two Unit Option
Indicative Plant Layout
- Gas Pipeline Route - Sheet 5 of 9

SCALE @ A2	CHECKED	APPROVED
1:750	R. MAKIN	B. SIBTHORP

PROJECT No	DESIGNED	DRAWN	DATE
70037047	B. SIBTHORP	S. SPINKS	25/10/2018

DRAWING No:	REV
70037047-2.5A-IPL - SHEET 5	02

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LEGEND

PROPOSED DCO ORDER LIMITS

GAS PIPELINE ALIGNMENT

In/rastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2) (o)

REV	DATE	BY	DESCRIPTION	CHK	APP
01	27/04/2018	SPS	Final Issue	RM	BS

DRAWING STATUS

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CLIENT:

drax

The Drax Power
(Generating Stations) Order

TITLE

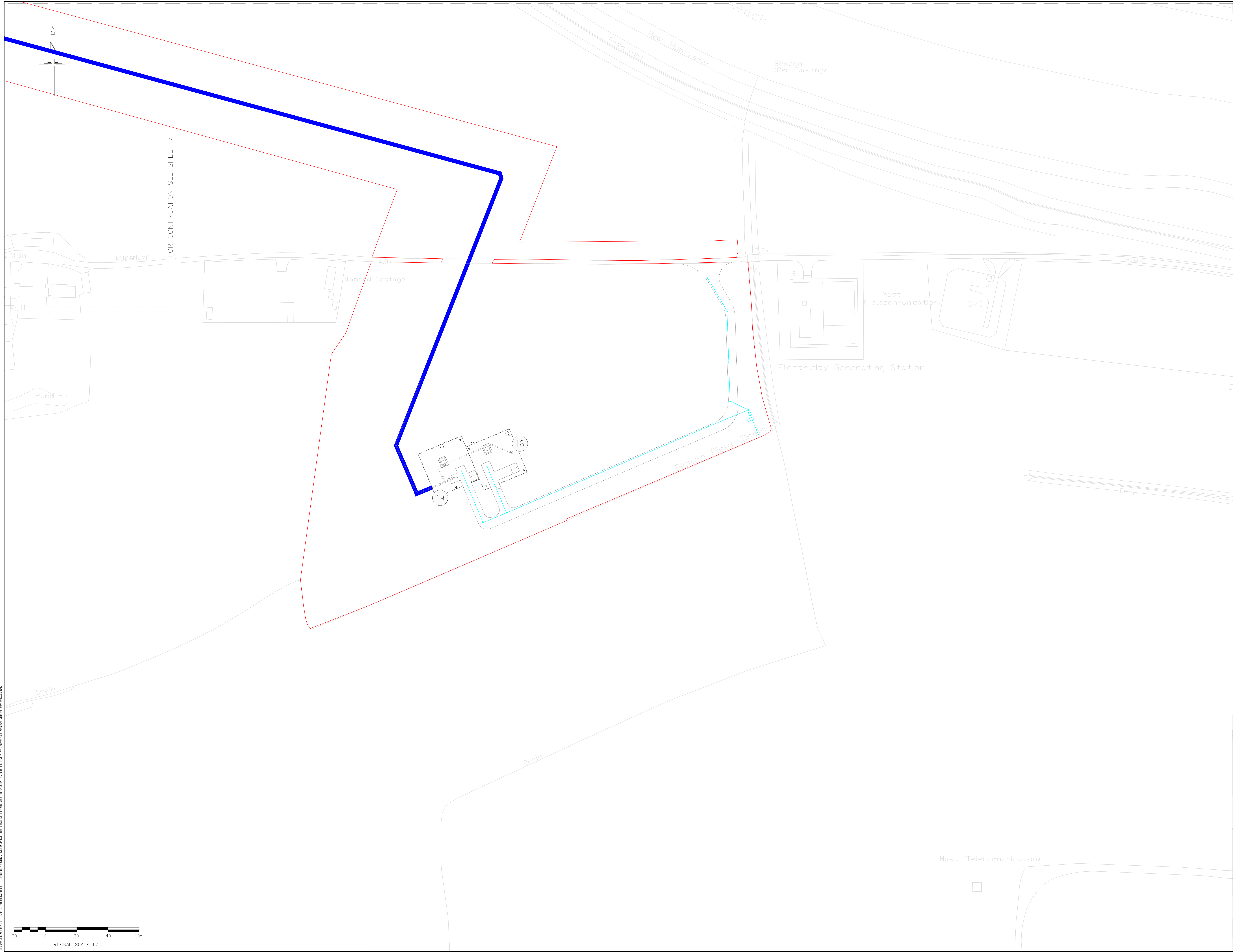
Application Document Reference 2.5A
Two Unit Option
Indicative Plant Layout
- Gas Pipeline Route - Sheet 7 of 9

SCALE @ A3	CHECKED	APPROVED
1:750	R. MAKIN	B. SIBTHORP

PROJECT No.	DESIGNED	DRAWN	DATE
70037047	B. SIBTHORP	S. SPINKS	27/04/2018

DRAWING No.	REV.
70037047-2.5A-IPL - SHEET 7	01

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LEGEND

PROPOSED DCO ORDER LIMITS

GAS PIPELINE ALIGNMENT

GAS AGI SURFACE WATER DRAIN

GAS ABOVE GROUND
INSTALLATION (AGI)

ITEM	DESCRIPTION
18	AGI (MINIMUM OFFTAKE CONNECTION) (NATIONAL GRID)
19	AGI (DRAX FACILITY)



In/rastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2) (a)

REV	DATE	BY	DESCRIPTION	CHK	APP
02	25/10/2018	SP	Second issue Submitted in E-consultation Deadline 2	RM	BS
01	27/04/2018	SPS	First issue	RM	BS

DRAWING STATUS

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CLIENT:

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The Drax Power
(Generating Stations) Order

PROJECT:

Application Document Reference 2.5A
Two Unit Option
Indicative Plant Layout
- Gas Pipeline Route - Sheet 8 of 9

SCALE @ A3	CHECKED	APPROVED
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PROJECT No.	DRAWN	DATE
70037047	B. SIBTHORP	S. SPINKS 25/10/2018

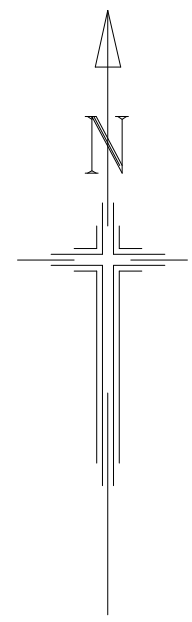
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70037047-2.5A-IPL - SHEET 8

REV.

02

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Drain

4.0m
+

1.22m RL

20

Def



ORIGINAL SCALE 1:250

DO NOT SCALE

LEGEND

PROPOSED DCO ORDER LIMITS

TRAFFIC MANAGEMENT

ITEM	DESCRIPTION
20	TEMPORARY PASSING PLACE FOR GAS AGI CONSTRUCTION TRAFFIC

In/rastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2) (o)

REV	DATE	BY	DESCRIPTION	CHK	APP
01	27/04/2018	SPS	Final Issue	RM	BS

DRAWING STATUS SUBMISSION FOR REFERENCE



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The Drax Power
(Generating Stations) Order

TITLE Application Document Reference 2.5A
Two Unit Option
Indicative Plant Layout
- Passing Place - Sheet 9 of 9

SCALE @ A3 1:250	CHECKED R. MAKIN	APPROVED B. SIBTHORP
PROJECT No. 70037047	DESIGNED B. SIBTHORP	DRAWN S. SPINKS

DRAWING No. 70037047-2.5A-IPL - SHEET 9	REV. 01
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APPENDIX D: CONSULTATIONS

Louise Markose
WSP

Our ref: RA/2017/137861/02
Alt ref: ENVPAC/YORKS/00239

Via email:
louise.markose@wsp.com

Date: 8 January 2018

Dear Louise

Drax Power Station, Selby, YO8 8PH

Drax Repower Project

Thank you for your recent enquiry regarding the above project. You have asked a number of questions, which I have provided responses to below, where appropriate.

1. Given the site is tidally dominated and is already extensively developed would floodplain compensation be required? If so please provide details.

Answer 1

It is possible that floodplain compensation will be required. As part of the flood risk assessment process you will need to clearly demonstrate that flood risk to others will not be increased as a result of the proposed development. If your proposals result in an increase in risk to others then this will need to be mitigated for.

2. We are still developing the scheme proposals and have not established if ground levels will change. However, we assume that any changes in ground levels and therefore water levels will be small in comparison to the total floodplain volume therefore would we need to explicitly model the impact of any changes in ground levels within the floodplain?

Answer 2

The answer to question 1 applies here as well. In addition, for any changes to ground levels in Flood Zone 3 (FZ3) you will need to demonstrate that there is no resultant increase in risk to others. If the changes in levels are small you could provide compensatory storage for the volume lost. Alternatively and for greater changes, you could model the effects of the changes and show appropriate compensation/mitigation for the resultant increase in risk.

3. We have assumed that the 2009 ISIS River Ouse Model (already received from the Environment Agency) is fit for purpose and will be used to inform the assessment. We do not propose to update the hydrology, undertake new surveys or upgrade the model. We will only be re-running the model with the required climate change scenarios. Can the EA confirm this approach is acceptable?

Answer 3

You should contact our Customers and Engagement Team:

neyorkshire@environment-agency.gov.uk to confirm what is the current best available data relevant to this site.

If available, the Upper Humber model would be the most appropriate to use. Currently, the final report is still in the process of being finalised (due in April), however the model data may be available - if it is then this should be used to inform the assessment as it will hold the most up to date information.

You should always use the best available data at the time of assessment. If the Upper Humber model data isn't available, when you start your assessment, then you should use the best data available from our customers and engagement team. If best available data changes during your assessment period or during the planning process for this development, then you may need to update your assessment based on the latest data. This will be dependent on the significance of the new data in respect to your assessment. We will take a pragmatic approach to determining whether you need to reassess, however, we are not likely to give any concession if the data changes could be significant to the assessment.

4. We have assumed that the Scheme is a Nationally Significant Infrastructure project and as such due regard to National Policy Statements needs be taken. With respect to climate change allowances the overarching National Policy Statement for Energy (EN1) states that applicants should use the "latest UK Climate Projections available at the time the ES was prepared". Those being UKCP09, we aware that UKCP18 is due out in a phased approach between May and November 2018, the application is due to be submitted in May 2018. We are also aware of the Flood Risk Assessment Climate Change allowances and the high allowances that also may be applicable. Therefore we would like to seek your advice on which set of climate change parameter we should use. If further information is required to determine which set of climate projections to use we would be happy to provide clarification on the Proposed Scheme. Please also provide guidance if the scheme or part of the scheme is critical infrastructure.

Answer 4

You should use the current policy and guidance at the time of making your application and update where necessary, if new policy/guidance comes into force during the application process. It is up to you to assess and decide on the most appropriate climate change levels/allowances to use relevant to your development, in line with the new policy/guidance. Once you have made this assessment and selected appropriate allowances, we would be happy to discuss this with you further.

Current guidance is:

<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

5. The proposed study areas for surface water and groundwater features is 0.5km and for features in hydraulic connectivity and groundwater abstractions is 1Km. The study area is considered appropriate based on professional judgement and current knowledge of the area. Please can the EA confirm they are happy with the study area?

Answer 5

We don't necessarily have any objections to the proposed study areas, but at this stage cannot determine whether they are appropriate. Study areas should be properly defined and justified in line with relevant guidance. You should use a source-pathway-

receptor model to assess risks to groundwater and define appropriate areas of study accordingly.

6. We are not proposing to undertake water quality sampling to inform the impact assessment. Therefore we would like to seek the EAs advice on the acceptable approach to establishing the baseline conditions for the assessment of water quality.

Answer 6

In establishing the groundwater quality and the impacts of the development on it, we you should follow the relevant guidance - <https://www.gov.uk/guidance/land-contamination-risk-management>. If your assessment, based on the guidance, indicates that sampling should be carried out, then we would expect this to occur. The EA adopts a site specific risk based approach. We could accept a tiered risk assessment approach, so with increasing complexity and site sensitivity we would expect more detailed information. The tiered approach, starts with qualitative, then generic quantitative risk assessment followed by detailed quantitative risk assessment. This approach means that the risk assessment is proportional to the risk. We acknowledge that contamination will be dealt with under the Ground Conditions and Contaminated Chapter.

If the risk based approach indicates that site specific quality data is required then there are several options for obtaining this. The site has an associated Environmental Permit and there may have been a requirement to produce a site condition report when the permit was issued or there may be a requirement for water quality monitoring at the site. If this data is available then it could be informative in helping to establish baseline conditions.

7. We are currently looking into how to construct the gas pipeline as shown on the attached plans there are two possible routes (A&B), we do not believe the routes cross main rivers (Aire, Derwent or Ouse) however it does cross some Ordinary Watercourse. Where the route crosses the Ordinary Watercourses there are two options a) to open cut the watercourse and disturb the ditch b) to auger underneath with no actual ditch disturbance. Would the EA be open to some discussions about option a? We will also consult with the LLFA and the IDB on this matter but would like to seek the EAs opinion on this too.

Answer 7

We are not able to provide any views on this question as we are not the regulating authority for ordinary watercourses in this context. As you have identified, you will need to contact the Lead Local Flood Authority (LLFA) and the Internal Drainage Board (IDB) for ordinary watercourse crossings in Selby. If the site is in the IDB District it will be the IDB who will be the consenting body for any works.

8. We are proposing to re-run the model in ISIS rather the latest Flood Modeller Pro (FMP). This is to reduce instability issues and to keep work to a minimum. Please can the EA confirm they are happy with this approach?

Answer 8

If using the 2009 Ouse model then it would be appropriate to re-run the model in ISIS as it was originally run in ISIS. If using the Upper Humber model data (if available) then you should use the appropriate software to run it - i.e. the same software used on that model or an appropriate later version of it.

9. We have assumed that there is no need to carry out the Sequential Test given the site is being redeveloped. Please can the EA confirm this assumption.

Answer 9

We do not determine application of the sequential test or whether it has been passed. This falls to the Planning Authority. Application of the test should be in line with the guidance found at the following:

<https://www.gov.uk/guidance/flood-risk-and-coastal-change>

The sequential approach should also be taken, when considering site design, with development being prioritised in areas of the lowest flood risk first.

10. We are currently investigating if we can use the White Rose Carbon Capture (2014) breach model for this study. However, please can the EA confirm if breach modelling will be required if so please outline the location of the breach (can this be the same as the White Rose location), methodology and design scenario.

Answer 10

A breach scenario should be included if there are works being undertaken in Flood Zone 3. The breach location can be the same as that used for the White Rose Scenario, unless, the Upper Humber modelling is available, in which case the breach data from this should be used.

11. Please can the EA confirm the design scenario we should use for the scheme as a whole?

Answer 11

From a flood risk perspective, the 1:100 plus climate change should be used, or the 1:200 (tidal) level if greater.

12. Please can the EA provide the Shapefiles /.TAB that go along with the reservoirs units from the 2009 ISIS model?

Answer 12

If available, this should be provided by our Customers and Engagement Team

13. Please can EA provide any studies of extreme water levels in the Humber Estuary?

Answer 13

If available, this should be provided by our Customers and Engagement Team

14. Please also the EA also provide details of mitigation the EA would expect to see in the FRA.

Answer 14

The mitigation required depends on the exact nature and scale of the works and the assessed impacts of the development. The applicant will be expected to provide appropriate mitigation to ensure that their proposals are both protected from flood risk, and also to ensure that flood risk to others is not increased or exacerbated. This may include, among other things, the provision of compensatory storage.

I hope that the above answers your questions sufficiently. As discussed, I will now compile additional information on constraints and requirements etc. and forward it to you in due course. I will also look to arrange a meeting, where we can discuss any issues further.

If you would like to discuss any of the above in the meantime, please don't hesitate to contact me.

Yours sincerely

Nick Beyer
Planning Specialist

Telephone: 0203 025 5581

E-mail: sp-yorkshire@environment-agency.gov.uk

Address: Lateral, 8 City Walk, Leeds, LS11 9AT



AGENDA & MEETING NOTES

PROJECT NUMBER	70007347	MEETING DATE	22 January 2018
PROJECT NAME	Drax Repower	VENUE	Foss House, York
CLIENT	Drax Power Ltd	RECORDED BY	CT
MEETING SUBJECT	Drax Repower briefing		

PRESENT	Drax - Oliver Baybut, Jim Doyle EA – John Bullers, Anne Netherway, Cynthia Neale, Jenny Lear, Dave Piercy, Martin Fuller Nick Beyer WSP – Chris Taylor, Louise Markose
APOLOGIES	None
DISTRIBUTION	As above
CONFIDENTIALITY	Confidential

ITEM	SUBJECT	ACTION	DUE
1	Project Overview JD gave an overview of the project (see attached slide pack) and the context of the project, with the possible closure of coal units in 2025. Statutory consultation is currently running until 27 February 2018. Public feedback has generally been positive with most responses supportive of the project. The project is fast paced in order to meet external deadlines. Drax aims to submit the DCO application in May 2018 to meet the timeframe for the energy market auction, which requires a DCO by September 2019. Plant would be operational plant by 2023/24.		

2	Air Emissions JD/CT - Drax proposes to use new generation high efficiency gas turbines, which result in lower CO₂ but higher NO_x than previous GTs because of higher combustion temperatures. The higher temperature is also needed to drive the existing steam turbines in CCGT mode. Selective Catalytic Reduction would be needed to reduce NO_x emissions. However, this would also result in emissions of ammonia (ammonia slip). JB – Confirmed that the high efficiency turbines are outside the scope of the BAT Reference Note and that the EA is still developing its position on this new technology. The EA position is that the decision over abatement is a permitting issue and advise that the permit application should be submitted so that the issue is resolved before the DCO hearing. OB - UK power production is changing and there is a need to fill the gaps in renewable production. The Repower project will allow a fast response using the battery storage, then a fast ramp rate for the OCGT. Higher efficiency CCGT mode would be preferred if producing power for longer. The mode change would depend on the duration of demand. JB – is efficiency affected by length of steam leg runs? OB – not significantly (<0.1% against efficiency of ~63% in CCGT mode) JB – will it be 2xGTs per unit? OB – yes, up to 2xGTs and 2xHRSG for each unit, therefore up to 8 new stacks JB – EA preference is to reduce number of stacks where possible. CT – other stack configurations have been explored but are not possible with the vertical HRSG design needed to accommodate the project within the site.		
3	Biodiversity CT – outlined programme of ecology surveys to take place up to and beyond DCO submission date in order to obtain all necessary data. Design will aim to minimise impacts: • avoid use of jetty to avoid dredging and impacts on otter • no change to cooling water • avoid/minimise habitat loss where possible. Martin – Assessment should consider cetaceans, sonic disturbance of fish and fish passage. Eels and lamprey are a concern in the area. Assessment on designated sites will be needed. CT – confirmed assessment on designated sites is underway. OB – confirmed no change to water intake or discharge CT – confirmed that the final pipeline route would be selected taking into account impacts on environment and heritage.		
4	Flood Risk LM – presented local situation for flood risk and confirmed WSP is engaging with EA to determine scope of the FRA and breach model. DP – The early results from new Humber modelling results indicate a change in		

	the fluvial and tidal interaction, with the tidal limit possibly shifting and fluvial flows having more of a dominant effect than currently thought. This is probably due to climate change. The EA will confirm which modelling scenario should be used in light of this and also if the Humber model should be used instead of the current 2009 River Ouse model. Noted that Upper Humber model report unlikely to be available before April and so too late to be included in this study. CT confirmed that WSP would be unable to include comments received after March in the Environmental Statement. Confirmation needed on breach location and if that needs to be changed (as per email sent after the meeting) Confirmation if we did need to use the outputs from the Humber model in the breach model, would this need to be reviewed and what would be the review period (~2 months)? Confirmation needed that review would not be required if using the Ouse model as this is already approved. <i>Note – Confirmation on the modelling approach needed by COB 26th January; if no further updates WSP will use the Ouse model.</i> Additional points discussed and confirmed: • Confirm WSP don't need to update the hydrology or survey in the 2009 River Ouse model (if used) but need to show no effect on local communities. • WSP will carry out the normal sensitivity analysis as per usual modelling specification. • No need to consider the undefended scenario as the EA has no plans to remove these defences. • It is unlikely that floodplain compensation will be required; however the results of any ground raising / mitigation (wall etc) will be discussed with the EA • Although it may be unlikely that compensation is required, it still might be, depending on the outcome of the assessment of flood risk. It is important that the FRA demonstrates that the proposals will not increase flood risk to others. Any increases will need to be mitigated, which may include compensation. • WSP will request historic flooding records in particular the 2013 tidal event and will look into the outline as part of the modelling / sensitivity analysis WSP requests that all outstanding data requests be sent out as soon as possible.	DP	26/1/18
5	Groundwater / Contaminated Land CT – outlined work to date on PRA (see slide pack); confirmed programme for relocating sludge lagoons: • One decommissioned and one recommissioned for Unit X • Three decommissioned and two constructed for Unit Y. JL – noted the need to include assessment of shallow perched water if drilling is used. Guidance has been issued.		

MEETING NOTES

6	Water pollution / Surface water LM – WSP is consulting with IDB. Construction issues including watercourse crossing will be addressed in draft CEMP to be submitted as part of the ES. DP – IDB consent required for any open cut crossing and that silt management procedures would be needed e.g. PPG5 NB – WFD assessment may not be required based on the use of the jetty most likely not going ahead and the red line boundary getting refined. This will be discussed with the EA over the next month or so and confirmation sought.		
7	OAB NB – confirmed that EA can review draft documents OB – confirmed that waste will be accommodated by existing site management procedures and that Drax will aim to reuse any soil on site. JL – noted that Drax should be aware of CLARE requirements.		

Louise Markose
WSP

Our ref: RA/2017/137861/03
Alt ref: ENVPAC/YORKS/00239

Via email:
louise.markose@wsp.com

Date: 26 January 2018

Dear Louise

Drax Repower – Flood Risk Modelling

Further to recent correspondence and following our meeting of 22 January 2018, we agreed to confirm some details with regard to the modelling approach for your assessment of the proposals at Drax. Specifically, we will confirm what we consider to be the best available model data for you to use and also the requirements for model review.

Best Available Data

Following some further consideration and comparison of data, we consider that using the 2009 Ouse model data, along with the same methodology used for the White Rose Carbon Capture model (as previously agreed), will provide a sufficiently robust approach, such that we won't require you to re-run/re-model when the Upper Humber model study data becomes available.

Model Review Requirements

When we review a flood risk assessment (FRA) supported by modelling, we need to review the model so that we can confirm that it is appropriately representative of the scenarios it is modelling. This is so that we can determine whether it is fit for purpose as a basis for the FRA and therefore we can be confident in the conclusions of the FRA.

In our recent meeting we discussed whether it would be necessary to review the model if it was run following an already established and agreed modelling methodology (White Rose Carbon Capture). I have discussed this with our modelling and forecasting (M&F) team, who manage our reviews, and they have told me that a review will still be necessary. Based on the flood risk and the type of development, a detailed review will be required.

Although a review is still necessary, as the baseline model has already been accepted in a previous application (White Rose Carbon Capture FRA), our reviewers can focus on the proposed development model (how you have represented your 'as built' scenario in the model) and also on the outputs of the model. They will also, however, carry out some outline checks on the baseline element of the model for good practice and to ensure that everything is the same as expected.

In order to carry out this full review the M&F team will carry out the following activities:

Model review activity table

Review activity		Review level		
		Basic	Basic (Enhanced)	Detailed
Model report	Read and review executive summary	ü	ü	ü
	Read and review conclusions	ü	ü	ü
	Read and review validation and/or calibration information	ü	ü	ü
	Read and review full report and appendices	û	ü	ü
Model files	Open model files to check key input parameters are as outlined in Model Report (where PSO teams are capable and have software)	û	ü	ü
	Open and interrogate the model	û	û	ü
	Re-run the model	û	û	ü
	Produce a summary of findings note for PSO teams, with suggested items for further amendment/ comments	û	û	ü

ü - What we will do

û - What we will not do

In order to facilitate our review you will need to provide us with the full model (including input and result files) and associated modelling, hydrology, calibration and sensitivity reports and results.

Based on current conditions, the above review is expected to take 15 working days to complete.

I hope that the above, together with previous correspondence, now gives you sufficiently clear direction to proceed with your modelling study.

If I can be of any further assistance, please don't hesitate to contact me.

Yours sincerely

Nick Beyer
Planning Specialist

Telephone: 0203 025 5581

E-mail: sp-yorkshire@environment-agency.gov.uk

Address: Lateral, 8 City Walk, Leeds, LS11 9AT

Louise Markose
WSP

Our ref: RA/2017/137861/03-L02
Alt ref: ENVPAC/YORKS/00239

Via email:
louise.markose@wsp.com

Date: 26 January 2018

Dear Louise

Drax Repower – Further Groundwater and Contaminated Land Advice

We recently agreed to provide you with further information, advice and guidance that to add to what we provided in our recent answers to your questions under our ref: RA/2017/137861/01.

Please see the following from a groundwater and contaminated land perspective.

The existing use of the site as a power station presents a high risk of contamination that could be mobilised during construction, to pollute controlled waters. Controlled waters are particularly sensitive in this location because the proposed development site located on a Principal Aquifer and within a Source Protection Zone 3.

We would anticipate that the following topics would normally be covered under the planning regime. Some of the topics would be controlled via the planning process whilst others would be provided as informatives which should be followed.

A document called the Environment Agency's Approach to Groundwater Protection, dated November 2017, contains information and advice about groundwater protection. The guidance should be followed.

The site has a permit and therefore any issues covered by the permitting regime are unlikely to be dealt with under the planning regime.

However, it may be beneficial to understand the permit requirements to ensure that work isn't duplicated under different regimes.

Land impacted by contamination

The developer should follow the relevant guidance for land impacted by contamination. Any remediation must be carried out in a strictly controlled manner to ensure that contaminants are not exposed and releases allowed to air, land or controlled waters, which could cause pollution, harm or nuisance. Clearing areas, particularly removing hardcover, must be done in a manner not likely to expose contaminants to flushing by incipient rainfall or surface water run-off on the site. Temporary surface water controls and management of any materials movement on site is critical to ensure protection of controlled waters near the site.

If, during development, contamination not previously identified is found to be present at the site then no further development (unless otherwise agreed in writing with the Local Planning Authority) shall be carried out until a remediation strategy detailing how this contamination will be dealt with has been submitted to and approved in writing by the Local Planning Authority. The remediation strategy shall be implemented as approved.

We recommend that developers should:

- Follow the risk management framework provided in CLR11, Model Procedures for the Management of Land Contamination, when dealing with land affected by contamination.
- Refer to the Environment Agency Guiding principles for land contamination for the type of information that we required in order to assess risks to controlled waters from the site. The Local Authority can advise on risk to other receptors, such as human health.
- Consider using the National Quality Mark Scheme for Land Contamination Management which involves the use of competent persons to ensure that land contamination risks are appropriately managed.
- Refer to the contaminated land pages on GOV.UK for more information.

Drainage

In the first instance foul drainage should be discharged to mains sewer. The surficial deposits on site consist of either low permeability clay or higher permeability sands and gravels. We have the following comments regarding the surface water drainage. Only clean uncontaminated water should drain to the surface water system. Roof drainage shall drain directly to the surface water system (entering after the pollution prevention measures). Appropriate pollution control methods should be used for drainage from access roads and car parking areas to prevent hydrocarbons from entering the surface water system.

There should be no discharge into land impacted by contamination or land previously identified as being contaminated. There should be no discharge to made ground. There must be no direct discharge to groundwater.

Foundations

At the current time the detailed design of any foundations are outstanding. If penetrating methods are required then a risk assessment may be required. We suggest that approval of piling methodology is further discussed with us when the guidance has been utilised to design appropriate piling regimes at the site. Advice and guidance can be found on the government website. Previous guidance included Piling and Penetrative Ground Improvement Methods on Land affected by contamination: Guidance on Pollution Prevention". NGWCL Centre Project NC/99/73.

INFORMATIVES

Storage of oils or chemicals

Any facilities for the storage of oils or chemicals shall be provided with secondary containment that is impermeable to both the oil/chemical and water, for example a bund, details of which shall be submitted to the local planning authority for approval. The minimum volume of the secondary containment should be at least equivalent to the capacity of the tank plus 10%. If there is more than one tank in the secondary containment the capacity of the containment should be at least the capacity of the largest tank plus 10% or 25% of the total tank capacity, whichever is greatest. All fill points, vents, gauges and sight gauge must be located within the secondary containment. The secondary containment shall have no opening used to drain the system. Associated above ground pipework should be protected from accidental damage. Below ground pipework should have no mechanical joints, except at inspection hatches and either leak detection equipment installed or regular leak checks. All fill points and tank vent pipe outlets should be detailed to discharge downwards into the bund.

Waste on site

The CLAIRE Definition of Waste: Development Industry Code of Practice (version 2) provides operators with a framework for determining whether or not excavated material arising from site during remediation and/or land development works are waste or have ceased to be waste. Under the Code of Practice:

Excavated materials that are recovered via a treatment operation can be re-used on-site providing they are treated to a standard such that they fit for purpose and unlikely to cause pollution. Treated materials can be transferred between sites as part of a hub and cluster project.

Some naturally occurring clean material can be transferred directly between sites. Developers should ensure that all contaminated materials are adequately characterised both chemically and physically, and that the permitting status of any proposed on site operations are clear. If in doubt, the Environment Agency should be contacted for advice at an early stage to avoid any delays.

The Environment Agency recommends that developers should refer to:
the Position statement on the Definition of Waste: Development Industry Code of Practice and;

The [Environmental regulations](#) page on GOV.UK.

Waste to be taken off site

Contaminated soil that is, or must be, disposed of is waste. Therefore, its handling, transport, treatment and disposal are subject to waste management legislation, which includes:

- Duty of Care Regulations 1991
- Hazardous Waste (England and Wales) Regulations 2005
- Environmental Permitting (England and Wales) Regulations 2010
- The Waste (England and Wales) Regulations 2011

Developers should ensure that all contaminated materials are adequately characterised both chemically and physically in line with British Standard BS EN 14899:2005 'Characterization of Waste - Sampling of Waste Materials - Framework for the Preparation and Application of a Sampling Plan' and that the permitting status of any proposed treatment or disposal activity is clear. If in doubt, the Environment Agency should be contacted for advice at an early stage to avoid any delays.

If the total quantity of waste material to be produced at or taken off site is hazardous waste and is 500kg or greater in any 12 month period the developer will need to register with us as a hazardous waste producer. Refer to the [Hazardous Waste](#) pages on GOV.UK for more information.

I hope that the above information is useful to you. If I can be of any further assistance, please don't hesitate to contact me.

Yours sincerely

Nick Beyer
Planning Specialist

Telephone: 0203 025 5581

E-mail: sp-yorkshire@environment-agency.gov.uk

Address: Lateral, 8 City Walk, Leeds, LS11 9AT

Jim Doyle
Drax Power Station

Our ref: RA/2018/138164/01
Your ref: 70037047

Via email:
jim.doyle@drax.com

Date: 27 February 2018

Dear Jim

Drax Power Station

Drax Power Limited: Proposed Repower of up to two coal fired units to gas together with battery storage at Drax Power Station

Statutory consultation under Section 42 of the Planning act 2008 (as amended)

Thank you for notifying us of the consultation period on the above proposal. We have reviewed the information submitted, including the Preliminary Environmental Information Report (PEIR), and have provided our comments below. Please note that our comments are not presented in any particular order of importance.

Flood Risk

Overall, we support your proposals and the assessment methodology described within the PEIR. The following comments relate to sections 12.4.10 – 12.4.15.

We have recently provided advice regarding the assessment of flood risk, outside of this formal consultation. Specifically relating to Section 12.4.12 of the PEIR, it is important that you account for and apply our advice provided in the letter, ref: RA/2017/137861/03, dated 26 January 2018, when carrying out your assessment of the flood risks associated with the proposed development. The wording of Section 12.4.12 may not be completely accurate in light of the advice within the above letter.

Please note that elements of this development may require a permit under the Environmental Permitting (England and Wales) Regulations 2016, for any proposed works or structures, in, under, over or within sixteen metres of the top of the bank of the tidal River Aire, which is designated a 'main river'. A permit will also be required for any temporary structures or stockpiles of materials within the floodplain. A permit is separate to and in addition to any planning permission/DCO granted. Further details and guidance are available on the GOV.UK website: <https://www.gov.uk/guidance/flood-risk-activities-environmental-permits>

To speak to someone within our Yorkshire area about flood risk activity permits, please email floodriskpermityorkshire@environment-agency.gov.uk

Groundwater and Contaminated Land

Overall, we remain satisfied with the characterisation of the site's geology and hydrogeology. Controlled waters are sensitive in this location, as the site is located on a principal aquifer within a Source Protection Zone 3. The site's use as a power station means that contamination could be easily mobilised during construction and operation, thereby polluting controlled waters. The PEIR has been reviewed and we have the following comments on the Ground Conditions Chapter:

Section 11.6.11 indicates that there is potentially significant effects to controlled waters from the transfer of contaminants and that additional assessment is required. The report indicates "A further assessment of risks to groundwater will be undertaken in the ES following the Phase 2 ground investigation." We accept this approach. If the further assessment identifies potential sources of contamination, these will need to be remediated unless it can be demonstrated that there will be no resultant unacceptable environmental deterioration to controlled waters.

Section 11.2.12 indicates that "Following the Phase 2 ground investigation, it may be possible, if it is considered necessary, to divide the study area into a number of 'averaging areas' in which risks will be independently assessed." We have no objections to the principle of dividing the site into smaller areas and assessing the risk independently. However, it will be important that any potential sources of contamination are assessed appropriately and not combined with a low risk area, which would result in a lower, and therefore not representative, average risk level.

The Next Steps section indicates that a CEMP will be submitted and intrusive ground investigation will take place. We look forward to receiving this information.

In addition to the above, it is important that you refer to and apply the advice and guidance provided in our letter, ref: RA/2017/137861/03/L02, dated 26 January 2018.

Biodiversity

The biodiversity section of the PEIR is, overall, very thorough, with all of the relevant legislation and local planning policy issues referenced where appropriate.

We understand that the transport option for delivery of construction materials that includes use of the river and jetty is not currently preferred, however we recognise that it is still presented as an option. The PEIR indicates that additional studies will be carried out for the Environmental Statement if this option is ultimately chosen.

If the jetty option is chosen, there are a number of ecological issues that would become relevant. The impacts of the development on fish, eel and lamprey passage and also cetaceans (whales, dolphins, porpoise) in the river (records of sightings are with the North & East Yorkshire Ecological Records Centre) would need to be assessed. All cetaceans are European Protected Species as is the Humber population of sea and river lamprey.

Water Resources – Abstraction

The PEIR confirms that all licensed abstraction volumes and conditions will remain unchanged. No further action is required unless proposals are altered to result in required changes to licensed abstractions.

Scoping Comments

Finally, please note the advice provided in our EIA scoping response to PINS – PINS ref: EN010091-000170 and our ref: RA/2017/137510/01. This advice still applies and should be accounted for during preparation of future assessments.

If you have any questions further to our response, or wish to discuss the specifics of any potential DCO conditions, please don't hesitate to contact me. Please note that any detailed advice, however, would incur a charge in line with our existing agreement.

Yours sincerely

Nick Beyer
Planning Specialist

Telephone: 0203 025 5581

E-mail: sp-yorkshire@environment-agency.gov.uk

Address: Lateral, 8 City Walk, Leeds, LS11 9AT

AGENDA & MEETING NOTES

PROJECT NUMBER	70007347	MEETING DATE	05 March 2018
PROJECT NAME	Drax Repower	VENUE	WSP Leeds
CLIENT	Drax Power Ltd	RECORDED BY	CT
MEETING SUBJECT	Drax Repower FRA, air quality and biodiversity		

PRESENT	Drax - Oliver Baybut, Jim Doyle, Jenny Blyth NE – James Walsh EA – John Bullers, Dave Piercy, Allan Roberts Jones, Emma Pemberton, Richard Chase, Nick Beyer WSP – Chris Taylor, Louise Markose, Bethan Tuckett Jones, Philip Davidson, Ioanna Gegisian
APOLOGIES	None
DISTRIBUTION	As above, Richard Griffiths and Alexis Coleman (Pinsent Masons)
CONFIDENTIALITY	Confidential

ITEM	SUBJECT	ACTION	DUE
1	Project overview Brief overview given by OB confirming submission late May 2018.	None	
2	Flood Risk LM reviewed the memo (WHS1583_Technical_Note_01_Modelling Summary v3.0) regarding flood modelling issues, model runs completed and mitigation options. DP – any solution proposed is acceptable if it can be demonstrated that it is effective. If flood storage it would ideally be outside flood zone 3. Artificial channel could also work but EA would need to see detail. Aim should be no meaningful increase or exacerbation of flood risk. NB – model would need review by EA technical team but DP can do an initial review of the approach. LM to prepare schedule for notes, model results and input required by EA in the form of review and teleconferences. NB to confirm achievable programme	LM NB	6 March 8 March

3	Overview of emission scenarios, including consideration of SCR and BAT. Approach to emissions scenarios for ES and Environmental Permit. OB gave overview of likely operation of plant. Each unit will have 2xGTs (600 MW each), 2xHRSGs linked to existing STs (600MW) and cooling infrastructure. Battery storage of 100 MW per unit. Total of 3,800 MW. No change to water system and little change to waste. OB confirmed it would be possible to achieve 50mg/m³ NO_x emissions for the high efficiency GTs without SCR but that this would require burner modifications and de-rating. Without this, emissions would be ~85mg/m³. SCR would provide a reduction to 30mg/m³ but result in ammonia slip. OEM has confirmed emissions of ~3.5mg/m³ are realistic. BAT justification is not yet complete. BTJ described contents of memo (MEMO AQ emissions 20180302). Modelling has considered both OCGT and CCGT. CCGT is the worst-case for emissions. OB confirmed that continuous emissions scenario is realistic. Electricity market in 2023 is unknown so plant could be peaking or base load. Need to assume constant operation to allow this mode of operation. Preference is for maximum load in CCGT mode to maximise efficiency. BTJ confirmed one unit operation results would be between baseline and two unit scenario so detailed calculations not required. PD described the impact of modelling results in terms of effects on designated sites. Impacts are significantly less on designated sites without SCR. Preference from ecology perspective would be not to install SCR in order to reduce nitrogen deposition. JW agreed that environmental impacts with SCR are greater than without. ARJ noted that the modelling assumptions are important. Realistic assumptions should be used for the rate of ammonia slip, NO_x emissions, plume depletion and other emissions. PD stated that it is important to consider the precautionary principle for the HRA. Sensitivity testing was discussed. RC stated that it could be helpful to look at the likely maximum OCGT operation (1,500 hours per year). OB confirmed that additional data on SCR would be provided through Energy UK. OB confirmed that the Permit application would be submitted on similar timeframe to the DCO. BTJ confirmed that it would be possible to include total annual NO_x emissions for each scenario in addition to ground level concentrations. This would be provided as a total and g/kWh. RC asked about the potential operation as a peaking plant. OB/CT confirmed this would have a very rapid ramp rate, supported by the battery facility. This would be in OCGT mode initially without SCR. During CCGT ramp up, SCR would be less effective, but total mass emissions of NO_x and NH₃ would be lower than normal operation. RC stated that the EA would be developing a generic approach to the new high efficiency GTs but that each project would be treated on the basis of site specific detail.		
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MEETING NOTES

4	Confirmation of designated Sites for assessment (focussing on statutory designations). JW confirmed that the basis of selecting sites for assessment (15km for European sites and 5km for SSSIs) was acceptable to NE.		
5	Critical loads to be used, including specific consideration of approach to nitrogen deposition and the River Derwent. PD stated that the assessment had so far considered the most sensitive feature in each site for selecting CLs. This will be refined on the basis of habitat mapping. This should improve the results for the Humber where sensitive habitats are relatively remote from Drax. CLs have been taken from APIS and knowledge of the sites. R. Derwent has no CLs as it is a riverine habitat. WSP will adopt a qualitative approach for this site, which will be influenced by agricultural emissions. JW agreed this approach. EP noted that EA would consult with water quality team. JW to provide any relevant habitat mapping held by the EA PD to issue short note on this issue for comment	JW PD	16 March 16 March
6	Approach to assessment for Project Process contributions >1%. PD stated that the project contribution would be <1% if SCR is not installed. JW confirmed that 1% threshold (value rounded to nearest whole number) remained valid.		
7	Approach to in-combination assessment. BTJ raised the issue that the effect of the Eggborough project is a net reduction in N deposition compared to baseline. The range of effect is therefore zero (net-neutral) to about -3%. Agreed that sensitivity testing should cover this envelope. BTJ to issue a memo to EA with summary of scenarios to be modelled and any other items of clarification. JB to confirm if any other relevant projects are being brought forward	BTJ JB	12 March 16 March
8	N-deposition rates in the context of predicted future trends in N-deposition / concentrations. PD stated that the assessment will consider trends in N deposition from national issues such as the increasing fleet of electric vehicles. This will be considered in a qualitative assessment. Agreed that this approach was reasonable.		

Szostak, Elzbieta

From: Taylor, Chris
Sent: 14 March 2018 12:34
To: Markose, Louise; Le Roy, Stefan; Szostak, Elzbieta
Subject: FW: Drax - flood modelling

Categories: Orange Category

Hi all

Please see below from the EA.

Chris

From: Beyer, Nick [mailto:nick.beyer@environment-agency.gov.uk]
Sent: 14 March 2018 12:15
To: Taylor, Chris <Chris.Taylor2@wsp.com>
Subject: RE: Drax - flood modelling

Hi Chris,

Thanks for your email. I've chased my Data and Evidence colleagues for an update on the model review timescales and I will report back to you when I hear.

One point regarding the artificial channel and the mitigation it affords, I note that the detriment to Drax village is shown as reduced to a 7mm depth increase, as was agreed for the carbon capture scheme.

In our meeting last week, we discussed possible differences between the current situation and the carbon capture scenario due to different modelling. At the time, 7mm increase was deemed acceptable because the area was already shown to flood and the increase was seen to be an insignificant change to risk.

It is important that you demonstrate no increase in risk between pre and post development scenarios.

If your baseline modelling shows no flooding in Drax Village, a 7mm increase could be very significant (difference between dry and wet). As discussed, we would look to see no increase in flood risk outside of the Drax Power Station site, otherwise any increases would need to be fully explained and justified. Any changes to risk to properties from no risk to some risk would be considered unacceptable.

Finally, regarding WFD, if there is no development within 8 metres of a fluvial main river or 16 metres of a tidal main river, then we wouldn't expect you to do a formal WFD assessment of the impacts on WFD requirements for fisheries, biodiversity and geomorphology related to the river.

You still have a responsibility to ensure that you are complying with the requirements of the WFD, though, so you should still assess the impacts on groundwater waterbodies as part of your Environmental Impact Assessment, as was recognised in your EIA Scoping report.

I hope this helps. Feel free to give me a call if you would like to discuss any of the above.

Kind regards

Nick

Nick Beyer

From: Taylor, Chris [<mailto:Chris.Taylor2@wsp.com>]
Sent: 13 March 2018 18:03
To: Beyer, Nick <nick.beyer@environment-agency.gov.uk>
Subject: Drax - flood modelling

Dear Nick

Following our recent discussions, we have completed preliminary modelling to demonstrate that the artificial channel option is viable to remove the impact of the project on flooding at Drax village in the breach model. I have attached a figure to demonstrate the change and the reduction in impact.

We anticipate that model files will be available for your team to review by Thursday or Friday this week. Could you please confirm the expected review period?

If your technical team have any queries we would be happy to talk them through the project and modelling issues so that issues can be resolved quickly.

Could you please also let me have feedback to confirm that a WFD assessment will not be required for this project?

Kind regards
Chris

Chris Taylor MChem PhD MEnvSc MIAQM
Associate Director



M [REDACTED]

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wsp.com

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Szostak, Elzbieta

From: Beyer, Nick <nick.beyer@environment-agency.gov.uk>
Sent: 27 April 2018 16:29
To: Markose, Louise
Cc: jim.doyle@drax.com
Subject: Model Review: Drax Power Station, Selby
Attachments: 2018s0387_03_Drax_Review_Document (v1 27 Apr 2018).xlsx

Hi Louise,

Please attached, the model review report from JBA, for the Drax model.

The reviewer has raised some minor issues, as you will see, but these are not considered likely to have impacted the results of the model, overall.

I am advised that sensitivity testing has been raised as an issue that needs to be addressed and that we will require evidence of sensitivity testing (and results) before we can accept the model as completely fit for purpose.

Please let me know if you would like to discuss this or need any further clarification on the work that is required to the model. I will put you in touch with the relevant people if need be.

Kind regards and have a good weekend.

Nick

Nick Beyer
Yorkshire Sustainable Places | Environment Agency
(0203 025 5581
Lateral, 8 City Walk, Leeds, LS11 9AT

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Technical Model Review Report		
Client	Environment Agency	
Single project or WEM package?	WEM Package	
Package name (if applicable)	2018-19 National Modelling and Forecasting Technical Support Contract	
Project name	Review No. 03 - Drax	
JBA Project Number (or overarching project)	2018s0387	
JBA Sub-Project Number (if applicable)	03	
Review requirements	A) Previous project - hydrology	N/A
	B) Previous project - hydraulic	N/A
	C) New project - hydrology	N/A
	D) New project - hydraulics	Included
	E) Survey data	N/A
	F) Reporting	Included

"RAG" key
1. Major issue – omission that could make the findings subject to challenge and which requires correction/further work.
2. Minor issue – non-standard method or method not following guidance but unlikely to have impacted on results
3. Clarification required – the approach used is unclear and requires further clarification before it can be reviewed
4. Recommendations – suggestion for improved / good practice but which is unlikely to change the project outcomes.
5. Acceptable (but does not meet best practice) – the approach is acceptable, however it is not in line with standard industry best practice
6. Acceptable – suggestion for improved / good practice but which is unlikely to change the project outcomes.

Summary of 1st review findings
This review has been carried out within the remit of the approach shown in the accompanying letter. The model is reasonably well set up and reported upon. There are several clarifications that should be added to bolster the reporting, however the model results appear robust.

B	Review of Drax Power Station Breach Model				
Date of model	March 2018				
Name of reviewer	David Kearney				
Date of review	27/04/2018				
Revision	v1				
Applicable standards or guidance	EA River Modelling Guidance - Chapter 7				
Nature of study watercourse(s)/constraints	Breach model				
Study objectives	To understand and potentially mitigate the residual risk of flooding				
Summary of 1st review	This review has been carried out within the remit of the approach shown in the accompanying letter. The model is reasonably well set up and reported upon. There are several clarifications that should be added to bolster the reporting, however the model results appear robust.				



Category	Detail	ID	Comment	Suitability	Suggested actions
Data to be reviewed					
Data to be reviewed	Software	B-1	TUFLOW 2017-09-AC-iSP-w64	Acceptable	
	AEPs provided / reviewed	B-3	Tidal 200yr	Acceptable	
	Scenarios provided / reviewed	B-5	Baseline, post development and mitigation	Acceptable	
	Reports	B-6	Drax hydraulic modelling report v1 March 2018	Acceptable	
Reporting					
Reporting	Reporting	B-8	Reporting covers the information required	Acceptable	
General comments					
General comments	File organisation / naming convention	B-14	File naming follows standard TUFLOW conventions and is well documented in accompanying information	Acceptable	
	Survey / topographic data	B-18	LIDAR data was purchased in December 2013, though no comment on when the LIDAR was flown is evident in the report. Spot checks against Open LIDAR show limited differences in elevation, however clarification should be added to the report.	Minor issue	Clarification on age of LIDAR
	Other	B-20		Acceptable	
General modelling approach					
	Model extents	B-22	Model boundaries seem appropriate, though flood water reaches the edge of the 2D domain in several locations. At the upstream limit this is minor, though downstream this crosses the extent of the floodplain. While the level is mainly controlled by overtopping of the Ouse defences in this location, has consideration been given to a boundary condition in this location?	Minor issue	Clarification on approach

General modelling approach	Modelling approach	B-26	The model is developed using 2D approaches, with some embedded 1D elements to ensure flow routes in the floodplain are suitably represented. The implementation of 1D structures in the floodplain is discussed further in section B-91	Acceptable	
	Application of hydrological estimates	B-28	Water is applied to the model using a level-time (HT) boundary applied directly to the 2D domain. The HT boundary is derived based on a 200-year tide level combined with a 5-year flow along the Ouse - this appears appropriate for estimating the residual flood risk from a breach in this location.	Acceptable	
ESTRY floodplain structures					
ESTRY floodplain structures	Representation of flow paths	B-90	Flow paths appear to be appropriately represented in the model	Acceptable	
	Hydraulic structure representation	B-91	Hydraulic structures in the floodplain have been represented using ESTRY culvert units linked to the 2D model using SX connections. Given dimensions are similar for each, it is assumed these are not based on survey, however appropriate parameters are implemented for the structure type defined.	Acceptable	
TUFLOW domain (1)					
TUFLOW domain (1)	General Schematisation	B-97	Grid is orientated SW-NE which is appropriate for the predominant flow path from the breach location	Acceptable	
		B-98	Grid resolution is 10m, which given the extent of the floodplain seems appropriate.	Acceptable	
		B-99	The extent of the grid and active domain are sufficient for understanding the flood risk to the site, noting that water does however reach the boundary of the active domain in several locations, however this is unlikely to materially affect model results.	Acceptable	
		B-101			
	Geometry	B-102	Topography modifications are generally applied in an appropriate manner. It is noted that there are some warnings in the messages file regarding dangling zlines where points are not snapped to the end of polylines. This does not appear to be overly impacting model results. The breach location is specified using a topography modification immediately to the east of Drax site, which it is assumed has been agreed with the EA, and appears appropriate given the location of the development.	Acceptable	
	Model parameterisation	B-106	Spatially varying roughness values are applied using materials layer files. Values of: - general surface: 0.035 - stubby building: 0.10 - general industrial type ground: 0.04 are implemented in the model. The stubby building value has been used to define areas of woodland, however the .tmf file defines woodland as a value of 0.1 also. 0.035 may be slightly low should a breach occur when crops are in full growth, has sensitivity testing been considered?	Clarification required	clarification on approach
	Representation of buildings	B-110	Buildings are represented with increased manning's n values and an increase in LIDAR levels of 0.3m. This appears appropriate.	Minor issue	
	Boundary conditions	B-112	HT boundary lines are applied along the Ouse defences, these are not digitised directly on top of the Code boundary in all places but this is unlikely to be materially affecting model results.	Minor issue	
		B-113	Internal sx boundaries appear to be appropriately positioned and flow through corresponding culverts is stable.	Acceptable	
	Initial conditions	B-117	Initial water levels are applied on the wet side of the Ouse defences, the polygon is not well digitised but this will not materially impact on model results.	Acceptable	
	Run parameters and output data	B-122	Model results are output at 15minute resolution which is appropriate.	Acceptable	
		B-123	No PO lines are present in the model	Acceptable	

Runs					
	Model simulations	B-154	Baseline Breach, Post Development Breach, mitigation and sensitivity at breach location	Acceptable	
		B-155		Minor issue	
Model results, interpretation, verification and stability					
Model results, interpretation, verification and stability	Model stability	B-157	Several warning messages are present about zines, however these are unlikely to materially affect results	Acceptable	
		B-158	Minor instabilities are noted at the start of the simulation,	Acceptable	
		B-159	Mass balance remains within +/-1% for the majority of the simulation (excepting the initial wetting of the domain)	Acceptable	
	Sensitivity testing	B-165	See B-106. A manning's n value of 0.035 may be slightly low should a breach occur when crops are in full growth, has sensitivity testing been considered?	Clarification required	Consider a sensitivity testing on Manning's 'n'
	Calibration / performance	B-166	No calibration has been undertaken - given the breach location	Acceptable	

Szostak, Elzbieta

From: Markose, Louise
Sent: 09 May 2018 16:41
To: Szostak, Elzbieta
Subject: FW: Drax model comments
Attachments: WHS1583_Technical_Note_01_Manning's Sensitivity Testingv1.0.pdf

From: Philip Hastings [mailto:philip.hastings@hydrosolutions.co.uk]
Sent: 04 May 2018 15:54
To: Beyer, Nick <nick.beyer@environment-agency.gov.uk>
Cc: Markose, Louise <louise.markose@wsp.com>
Subject: Drax model comments

Good afternoon Nick,

Please find attached the technical note addressing the Manning's sensitivity issues raised in the model review. Should you require anything further, please get in touch.

Kind Regards
Philip Weatherley-Hastings
Consultant

Wallingford HydroSolutions Ltd
Castle Court, 6 Cathedral Road, Cardiff, CF11 9LJ
Tel: +44 29 20647739
Email: philip.hastings@hydrosolutions.co.uk
Web: www.hydrosolutions.co.uk
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Project	Drax Power Station Modelling
Project Number	WHS1583
Title	Assessing Manning’s Value Sensitivity
Description	This technical note summarises the outcomes of Manning’s value sensitivity testing within the White Rose model.
Date	2 nd May 2018
Version	1.0

1 Summary of Work

Following model review by the EA, additional sensitivity on the Manning’s value was requested to ascertain model sensitivity to roughness across the floodplain for the 0.5% AEP plus climate change event. Manning’s values were universally changed by $\pm 20\%$ and compared to design post-development levels. 8 sample locations have been prepared and depths for each scenario are collected from these locations. The sample locations are shown in Figure 1.

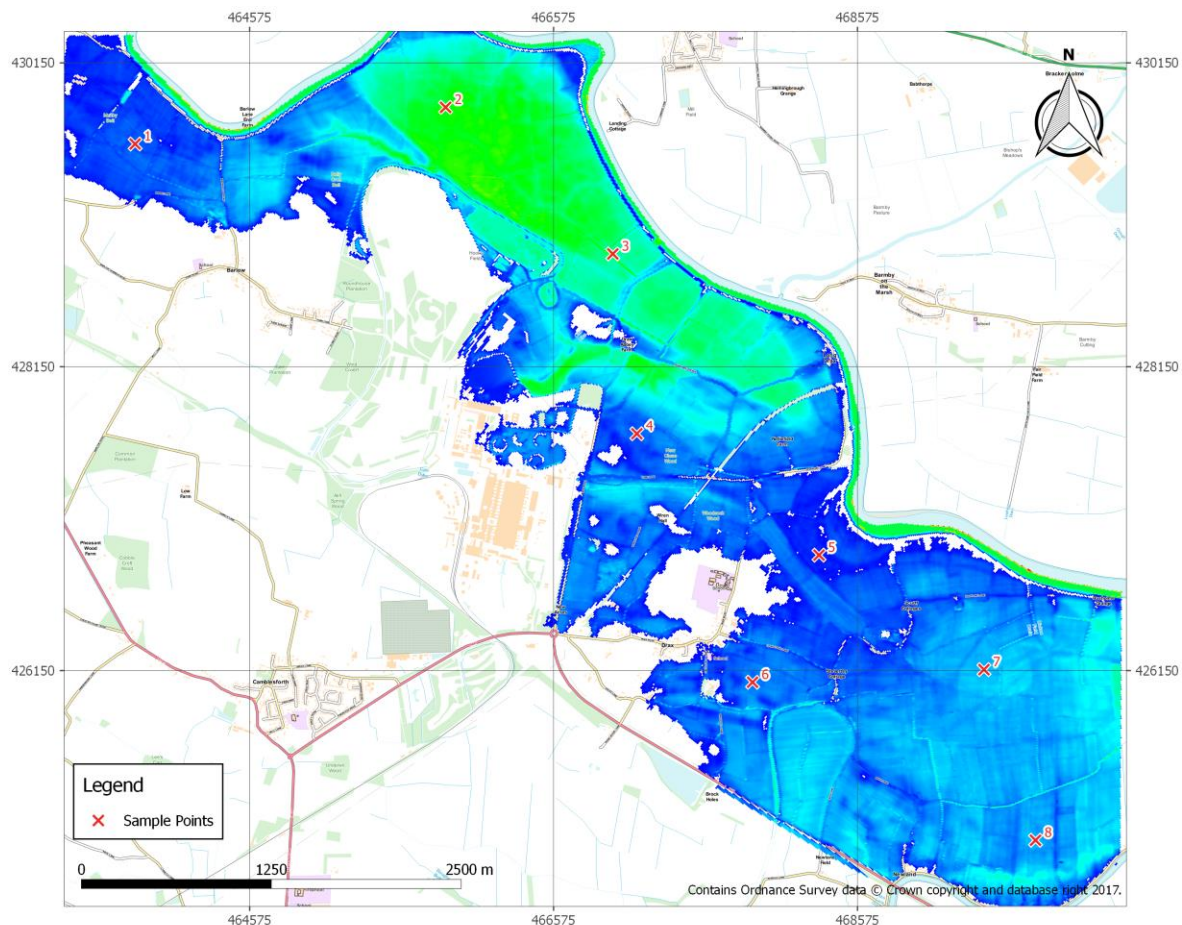


Figure 1 – Sample depth locations

2 Results

Results of the sensitivity testing is shown in Table 1 below. The results indicate that if a higher Manning’s were to be used (representing greater volume of crops on the floodplain), flood levels across the floodplain drop by up to 0.15m. This is not deemed to be a significant decrease in depth and it is concluded that the model is only minimally sensitive to increases in Manning’s.

When manning’s is decreased by 20% flood levels increase by up to 0.13m. Although flood levels slightly increase, the lower Manning’s values are not deemed to be representative of the floodplain and therefore represent an unrealistic representation of the floodplain.

Table 1 – Post Development Manning’s Sensitivity Results

Sample Pt	Post Dev Depth (m)	N+20% Depth (m)	Change compared to design run (m)	N-20% Depth (m)	Change compared to design run (m)
1	0.62	0.59	-0.03	0.66	+0.04
2	2.96	2.95	-0.01	2.99	+0.03
3	2.25	2.24	-0.01	2.28	+0.03
4	0.46	0.45	-0.01	0.49	+0.03
5	0.22	0.22	-0.00	0.34	+0.12
6	0.70	0.55	-0.15	0.79	+0.09
7	1.17	1.03	-0.14	1.30	+0.13
8	1.16	1.01	-0.15	1.26	+0.10

In addition to the above analysis, key areas of concern discussed in the modelling report located in Drax village are not shown to be flooded when Manning’s is increased by 20%. Changes in extent between sensitivity runs are shown below in Figure 2. This indicates that the Manning’s used in the baseline scenario represent a more conservative assessment of flood risk and should fields be heavily cropped, flood risk in Drax village would decrease. Therefore, the choices of Manning’s values in the existing baseline and post development model represent the most robust approach to modelling in this area.

When Manning’s is reduced by 20%, a small increase in extent is seen in key areas. However, this extent change is minimal and choosing to use Manning’s values 20% lower than what are currently used in the model would be inappropriate.

Overall, the roughness coefficients selected for the model are appropriate and no further consideration is required.

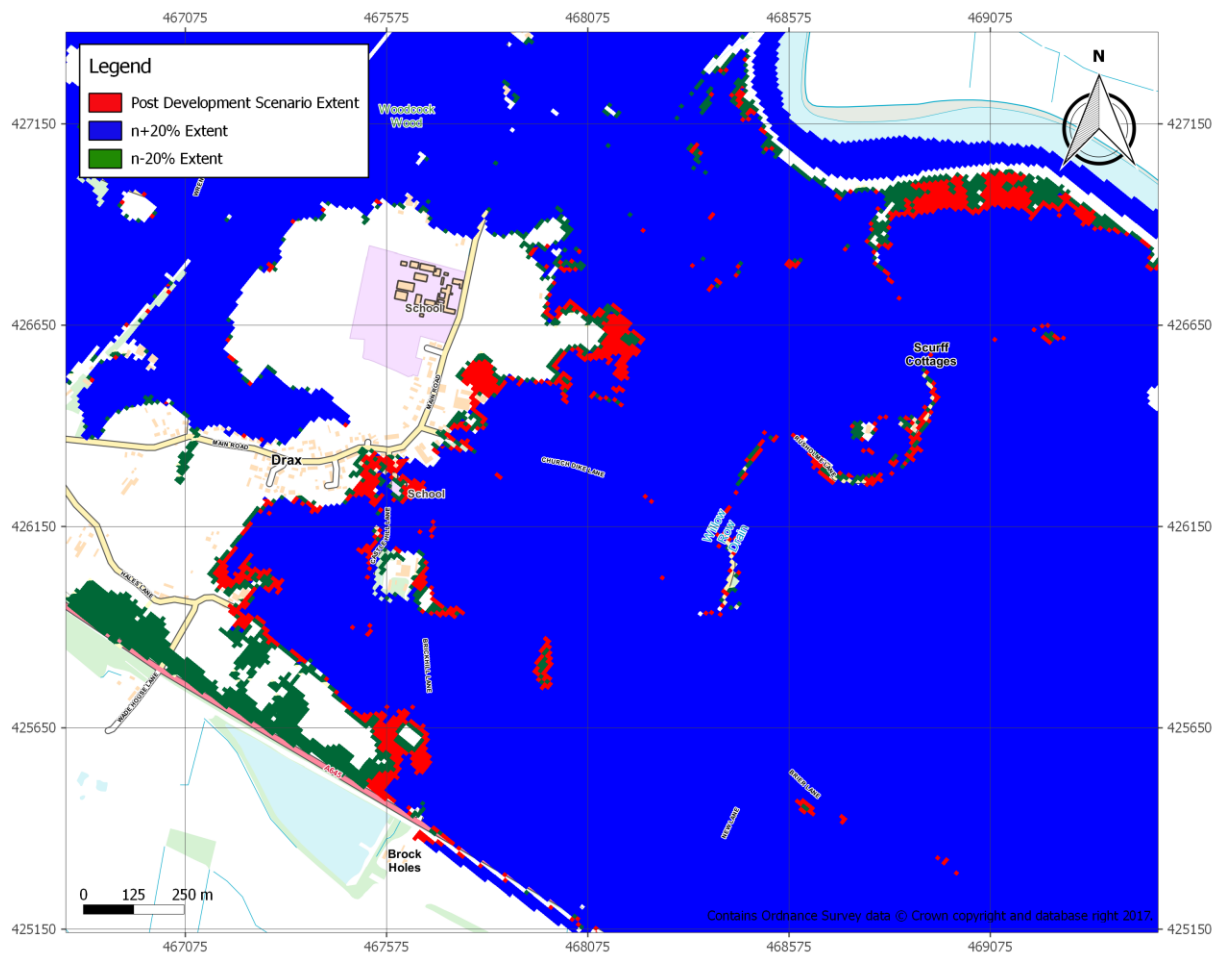


Figure 2 – Change in extent between sensitivity runs

3 Additional comments

Comments provided in the model review are addressed below.

Comment ID B-18 – Centremaps were contacted to ascertain the age of the LiDAR data. WHS were informed that a composite dataset using LiDAR from between 2001-2009 has been used.

Comment ID B-22 – Consideration of a boundary condition and glass walling at this location is provided in section 4.2 of the original White Rose study (Appendix 1 of the hydraulic modelling report). This model, which was approved by the EA, was recommended as suitable for use by the EA for this study.

Comment ID B106 – Roughness is addressed above.

Louise Markose
WSP

via email:
louise.markose@wsp.com

Our ref: RA/2018/138541/01
Alt ref: ENVPAC/1/YOR/00012
Your ref: 70037047

Date: 10 May 2018

Dear Louise

Drax Power Station, Selby, YO8 8PH.

Drax Repower Project - Flood Risk Assessment Review.

Thank you for submitting your Flood Risk Assessment (FRA) for our review and comment. We have reviewed:

- DRAX Re-Power Project, Land at, and in the vicinity of, Drax Power Station, near Selby, North Yorkshire, Environmental Statement – Flood Risk Assessment, Document Reference: 70037047, 24/04/2018.

Please note that the FRA and the mitigation measures detailed within it are reliant on the results of flood modelling that has not yet been found to be fit for purpose. We have provided comments on the model which need to be addressed. We are currently reviewing your response to our comments, which includes further modelling work. The contents of the FRA have been taken at face value and these comments are provided from the perspective that the model is considered fit for purpose. On the basis that it may not be found fit for purpose, these comments and the views represented are subject to change.

Assuming the model is found to be fit for purpose, we consider the FRA to be acceptable. If this FRA was submitted in support of the Development Consent Order (DCO) application we would not be likely to object to the DCO and would likely recommend that specific requirements be applied to the DCO with respect to the FRA.

I hope that these comments are useful to you. If I can be of any further assistance, please don't hesitate to contact me.

Yours sincerely

Nick Beyer
Planning Specialist

Telephone: 0203 025 5581
E-mail: sp-yorkshire@environment-agency.gov.uk
Address: Lateral, 8 City Walk, Leeds, LS11 9AT

Szostak, Elzbieta

From: Paul Jones <Paul.Jones@shiregroup-idbs.gov.uk>
Sent: 08 February 2018 10:42
To: Price, Jon
Cc: Markose, Louise; Szostak, Elzbieta; Farley, Isabelle; info@selbyareaidb.org.uk; lan.Chapman@selbyareaidb.org.uk
Subject: RE: Drax Repower Flood Risk Consultation

Jon,

Thank you very much; a very accurate summary.

Kind regards,

For and on behalf of the Shire Group of Internal Drainage Boards,

Paul Jones BSc (Hons) MSc (Eng) GMICE
Engineer to the Board
Lead Water Level Management Engineer

From: Price, Jon [mailto:Jon.Price@wsp.com]
Sent: 07 February 2018 14:19
To: Paul Jones <Paul.Jones@shiregroup-idbs.gov.uk>
Cc: Markose, Louise <louise.markose@wsp.com>; Szostak, Elzbieta <Elzbieta.Szostak@wsp.com>; Farley, Isabelle <Isabelle.Farley@wsp.com>; info@selbyareaidb.org.uk; lan.Chapman@selbyareaidb.org.uk
Subject: RE: Drax Repower Flood Risk Consultation

Paul

Thank you for taking the time to chat with me yesterday afternoon. It was a very useful discussion and I think we covered all of the points raised below. As a record of our discussion, I have set out below a summary of each of the points discussed. Please feel free to correct me if you believe I have misinterpreted any aspect or there is anything further you wish to add.

1. Installation of gas pipeline across watercourses. The IDB has no preference for the method of installation of the pipelines crossing beneath watercourses. The pipes should be installed with a minimum clearance below the bed of the watercourse of 1m. Where pipes are installed by open cut trenching, the banks of the watercourse are to be reinstated to the same line and slope, and grass seeded as soon as practicable after installation. The use of a bio-degradable mat (or similar) may be necessary in some installations to hold the grass seed and aid the re-growth of vegetation. The position of each crossing is to be marked by marker posts, one on each bank. The IDB noted groundwater levels are frequently high in this area and the applicant will need to consider buoyancy of the pipeline and associated buried apparatus.
2. Discharge rates. Surface water runoff from any additional new impermeable areas shall be limited to the pre-development greenfield runoff rate or 1.4 l/s/ha, whichever is the least.
3. New discharge points. Existing discharge points should be used wherever possible. The fewer discharge points the better. Bear in mind any new discharge will a consent.
4. New outfalls. Where required, new outfalls should be set back from the bank and not protrude into the watercourse. The velocity of the discharge should be considered and suitable protection provided to prevent erosion of the bank, where necessary. Low velocity discharges do not automatically need to be angled in the direction of flow in the watercourse. A marker post should be provided near a new outfall to highlight the presence of the outfall for maintenance operatives.
5. Pollution control measures. The applicant should comply with general pollution prevention guidelines.
6. Water quality monitoring. No permanent water quality monitoring is required. Temporary pumping of groundwater in excavations will require a separate consent. It will be necessary for the applicant to monitor

the quantity of temporary pumping as a payment is likely to be required per cubic metre of pumped water as part of the temporary consent. Note also the new EA abstraction regulations now consider the temporary pumping of groundwater to be an abstraction, and a separate abstraction consent will be required from the EA.

7. Discharge of surplus process water. No special restrictions if applicant is following general PPGs.
8. Sequential Test. The Sequential Test is not really a matter for the IDB. The proposed re-development is on an existing site and could not be located anywhere else.
9. Study area. The proposed study areas are acceptable. As indicated in 1 above, groundwater levels are an issue in the area and buoyancy of any buried structures or pipelines will need to be considered.
10. Future monitoring and sampling. There are no requirements for permanent monitoring and sampling. As indicated in 6 above, flow measurement will be required for any temporary pumping of groundwater.
11. Historic flood records. The IDB does not have any historic flood records. The best available flood record information is held by the EA. The Lendall Pumping Station is operated and maintained by the IDB. The pumping station has recently been fitted with water level telemetry but that will only provide an indication of water levels in the watercourse at the pumping station.
12. Water quality data. The IDB has no water quality data for ordinary watercourses.

Rusholme Lane. The Rusholme Lane Drain is also known as Willow Row Drain. Church Dike Lane is the approximate watershed for Rusholme Lane Drain, with land to north draining northwards to the River Ouse and land to the south draining southwards to the River Aire.

As a general comment, the IDB would wish to establish a general line of communication during construction and thereafter in order to be able to check on the progress of installed works and to ensure all parties are aware of each other's activities in the area.

I trust the above is correct.

Regards
Jon

Jonathan Price
Principal Civil Engineer, Water Engineering, Transport & Infrastructure



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From: Price, Jon
Sent: 05 February 2018 11:25
To: 'Paul Jones' <Paul.Jones@shiregroup-idbs.gov.uk>
Cc: Markose, Louise <louise.markose@wsp.com>; Szostak, Elzbieta <Elzbieta.Szostak@wsp.com>; Farley, Isabelle <Isabelle.Farley@wsp.com>; info@selbyareaidb.org.uk; Ian.Chapman@selbyareaidb.org.uk
Subject: RE: Drax Repower Flood Risk Consultation

Paul

Thank you for your responses to date.

There are a number of points that we would like to discuss with the IDB, as set out in my colleague Isabel Farley's email below. I will endeavour to ring you tomorrow morning to discuss these. If afternoon would be more convenient, please could you suggest a time. In short, the outstanding issues are:

1. Will installation of the gas pipeline beneath existing ordinary watercourses need to be by directional drilling / thrustbore or will open cut trenching across the watercourse and reinstatement of the invert and channel sides be acceptable?
2. What will be the allowable discharge rates to ordinary watercourses for surface water runoff from any additional new impermeable areas?
3. Can the discharge(s) be to the nearest local watercourse or will you require discharges to be collected and discharged at a single location to a specific watercourse?
4. If new outfalls are required, do you have specific requirements for their construction and position in relation to the bank?
5. Do you have specific requirements for pollution control measures for discharges to ordinary watercourses? Obviously, we will be providing a general level of pollution control measures, eg catch pits, silt control, oils, so this is whether you will require anything above that level of pollution control.
6. Will you require any water quality monitoring, either during construction or into the operational phase?
7. Will you have any specific requirements for the control and discharge of surplus process water, eg water quality, temperature, pH?
8. For the FRA, we have assumed that a Sequential Test is not required given that this is redevelopment on an existing site. Please could the IDB confirm this is acceptable?
9. Please could the IDB confirm the proposed study areas of 0.5km for surface water and groundwater, and 1km for features in hydraulic connectivity and groundwater abstractions, are acceptable?
10. Are there any specific mitigation measures that the IDB will require, eg monitoring and sampling points or flow measurement?
11. Does the IDB have historic flood records (from all sources) for this area?
12. Does the IDB have any water quality data for the ordinary watercourses?

I believe you have pointed us in the direction of your consent process and guidance notes, and provided us with a map of the watercourses and names.

Regards
Jon

Jonathan Price

Principal Civil Engineer, Water Engineering, Transport & Infrastructure



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From: Paul Jones [<mailto:Paul.Jones@shiregroup-idbs.gov.uk>]

Sent: 05 February 2018 09:54

To: Price, Jon <Jon.Price@wsp.com>

Cc: Markose, Louise <louise.markose@wsp.com>; Szostak, Elzbieta <Elzbieta.Szostak@wsp.com>; Farley, Isabelle <Isabelle.Farley@wsp.com>; info@selbyareaidb.org.uk; Ian.Chapman@selbyareaidb.org.uk

Subject: RE: Drax Repower Flood Risk Consultation

Jon,

Thank you for the email and apologies for the delay.

Please see attached plan covering the study area. The watercourse naming conventions are for those watercourses which the IDB currently choose to maintain under the Land Drainage Act 1991 (as amended). However, the planned Works and in particular, gas pipeline, will impact on all ordinary watercourses (both open channel and piped e.g. all watercourses other than Main River) which are not maintained by the IDB and will need to be determined by yourselves for a consent application.

A joint meeting with the EA would be beneficial but in the meantime, you are more than welcome to contact me on 01302 337798, option 3, option 2, and I should be available from 10am tomorrow, Thursday PM, or Friday.

Kind regards,

For and on behalf of the Shire Group of Internal Drainage Boards,

Paul Jones BSc (Hons) MSc (Eng) GMICE

Engineer to the Board

Lead Water Level Management Engineer

From: Price, Jon [<mailto:Jon.Price@wsp.com>]

Sent: 08 January 2018 17:46

To: Paul Jones <Paul.Jones@shiregroup-idbs.gov.uk>

Cc: Markose, Louise <louise.markose@wsp.com>; Szostak, Elzbieta <Elzbieta.Szostak@wsp.com>; Farley, Isabelle <Isabelle.Farley@wsp.com>; info@selbyareaidb.org.uk; Ian.Chapman@selbyareaidb.org.uk

Subject: RE: Drax Repower Flood Risk Consultation

Paul

Thank you for your response below.

Would it be possible for you to send a plan similar to the one you included below but covering the whole of our study area, ie covering the Drax site as below but also including the proposed gas pipeline routes? The attached plan shows our study area.

Also, what do the numbers on your plan represent, eg 20/8, UN010, etc? If these represent names of the watercourses in a database, would it be possible for you to provide the names of the watercourses impacted by our study area?

My colleagues are in the process of arranging a joint meeting with yourselves and Environment Agency. In the meantime, it would be useful to have a chat with you regarding some of the drainage aspects for the Drax Repower project. Do you have a contact telephone number?

Regards

Jon

Jonathan Price

Principal Civil Engineer, Water Engineering, Transport & Infrastructure



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From: Paul Jones [<mailto:Paul.Jones@shiregroup-idbs.gov.uk>]

Sent: 04 January 2018 15:08

To: Markose, Louise <louise.markose@wsp.com>; Farley, Isabelle <Isabelle.Farley@wsp.com>

Cc: info <info@selbyareaidb.org.uk>; Ian Chapman <Ian.Chapman@selbyareaidb.org.uk>

Subject: RE: Drax Repower Flood Risk Consultation

Dear Louise,

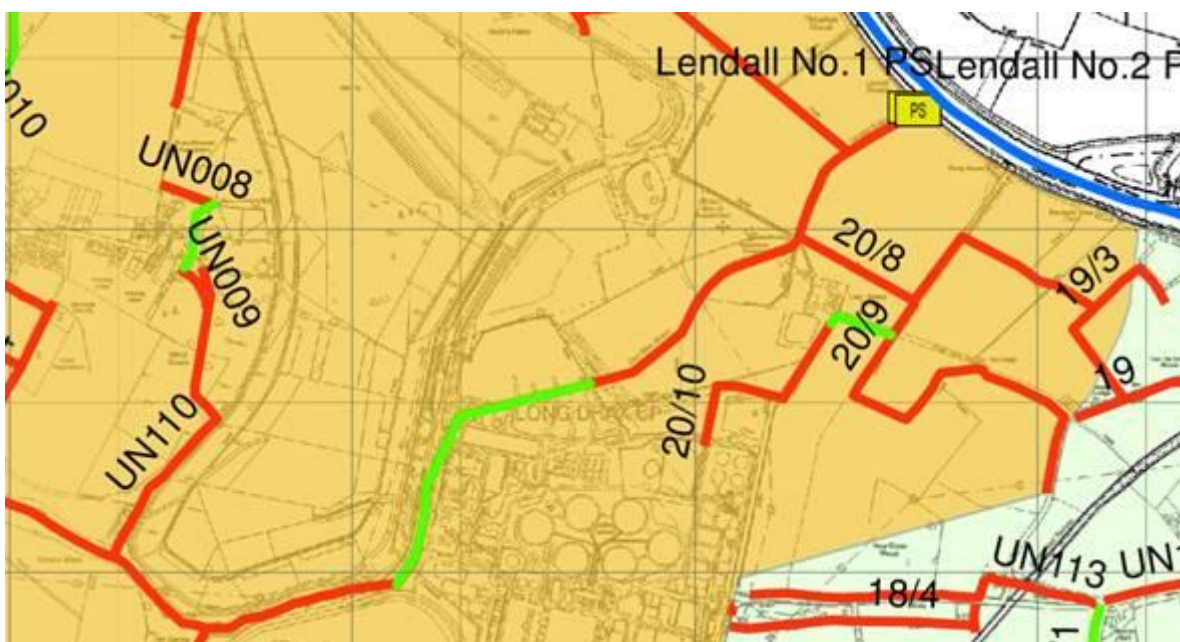
Please find extract from our OS mapping below.

Ordinary Watercourses (shown in red), Piped Ordinary Watercourses (Green), Main River (blue), hydraulic catchment (orange).

The pipeline beneath Area 'C' of the DRAX REPOWER PROJECT is the riparian owners responsibility. No obstruction should be placed within 7 metres either side of the pipelines or on top of the pipeline. This will enable access to repair/replace the pipeline should the riparian owner/occupiers be required to do so.

Consent, in addition to any planning or DCO, would be required from the IDB as described on the Boards website, <https://www.shiregroup-idbs.gov.uk/planning-consents/>

The proposed Gas Pipelines will also intersect IDB maintained watercourses and will require Consent from the IDB for each crossing point.



Kind regards,

For and on behalf of the Selby Area Internal Drainage Board,

Paul Jones BSc (Hons) MSc (Eng) GMICE
Engineer to the Board
Lead Water Level Management Engineer

From: Markose, Louise [<mailto:louise.markose@wsp.com>]
Sent: 03 January 2018 14:42
To: Farley, Isabelle <Isabelle.Farley@wsp.com>; Paul Jones <Paul.Jones@shiregroup-idbs.gov.uk>
Cc: info <info@selbyareaidb.org.uk>; Ian Chapman <Ian.Chapman@selbyareaidb.org.uk>
Subject: RE: Drax Repower Flood Risk Consultation

Hi Paul,

We would really appreciate a response by the end of this week / early next week.

Look forward to meeting you soon, we will be in touch.

Thanks
Louise

Louise Markose
MCIWEM, MA, MSc
Principal Consultant, Water Engineering, Transport & Infrastructure



M+ [REDACTED]

6 Devonshire Square
London
EC2M 4YE

wsp.com
Please note I work Monday to Thursday.

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From: Farley, Isabelle
Sent: 02 January 2018 17:34
To: Paul Jones <Paul.Jones@shiregroup-idbs.gov.uk>
Cc: info <info@selbyareaidb.org.uk>; Ian Chapman <Ian.Chapman@selbyareaidb.org.uk>; Markose, Louise <louise.markose@wsp.com>
Subject: RE: Drax Repower Flood Risk Consultation

Dear Paul,

Thank you for your reply.

We are currently waiting for a response from the EA as we are hoping to arrange a coordinated meeting with yourselves, the EA as we are based in Bristol/London.

Therefore we would greatly appreciate it if you could respond to our queries via email prior to the meeting, any issues you raise can be discussed in more detail in the meeting.

Kind regards,
Isabelle

Isabelle Farley

MSc BSc
Graduate Consultant, Water Engineering



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BS2 0HQ

From: Paul Jones [<mailto:Paul.Jones@shiregroup-idbs.gov.uk>]
Sent: 20 December 2017 14:54
To: Farley, Isabelle <Isabelle.Farley@wsp.com>
Cc: info <info@selbyareaidb.org.uk>; Ian Chapman <Ian.Chapman@selbyareaidb.org.uk>
Subject: RE: Drax Repower Flood Risk Consultation

Dear Isabelle,

Thank you for the consultation and I acknowledge receipt.

Would it be possible to meet at the Selby Area IDB office (12 Park Street, Selby, YO8 4PW) in the New Year for you to go through the proposals and raise any questions.

I will be available on Thursday 4th from 2pm or Thursday 11th from 2pm.

Kind regards,
For and on behalf of the Shire Group of Internal Drainage Boards,

Paul Jones BSc (Hons) MSc (Eng) GMICE
Engineer to the Board
Lead Water Level Management Engineer

From: info [<mailto:info@selbyareaidb.org.uk>]
Sent: 24 November 2017 07:56
To: Paul Jones <Paul.Jones@shiregroup-idbs.gov.uk>
Subject: FW: Drax Repower Flood Risk Consultation

Paul

Regards

Ian

From: Farley, Isabelle [<mailto:Isabelle.Farley@wsp.com>]

Sent: 23 November 2017 12:09

To: info <info@selbyareaidb.org.uk>

Cc: Markose, Louise <louise.markose@wsp.com>; Szostak, Elzbieta <Elzbieta.Szostak@wsp.com>

Subject: Drax Repower Flood Risk Consultation

Dear Selby IDB,

We have been commissioned by Drax Power Station to carry out the water environment chapter of the EIA and the Flood Risk Assessment. We have reviewed the Scoping Opinion and would now like to formally consult with Selby Internal Drainage Board about the scheme proposals. We are also consulting with North Yorkshire County Council on many of the questions below. It would be helpful to understand further how the responsibilities are split between the IDB and North Yorkshire as the LLFA.

It is likely we will need consult with the IDB throughout the project, therefore please could let me know if we have the correct contact details.

The Project

Drax Power Limited (the applicant) intends to undertake the repowering of two existing coal-fired units with gas at Drax Power Station in Selby, North Yorkshire. WSP has been commissioned to assist Drax to seek planning permission known as a Development Consent Order (DCO) which is required for all nationally significant infrastructure projects. The Site is located in an areas of complex flood risk comprising of Flood Zones 1, 2 and 3, with some areas understood to benefit from flood defences along the banks of the River Ouse. The source is the River Ouse and ordinary watercourses located within the study area such as the Carr Dyke. Flooding from surface water is typically associated with natural overland flow paths. Please refer to the accompanying plans (dated 9th November 2017) for further details on the Scheme Proposals. Also attached is an extract from the scoping report which provides further details on the scheme (dated September 2017).

We would like to seek your general comments on the scheme in relation to the water environment / flood risk. Therefore please provide comments on aspects you wish to be incorporated within the assessment. More specifically we would like to consult with you on the following key questions:

- We are currently looking into how to construct the gas pipeline as shown on the attached plans there are two possible routes (A&B), we do not believe the routes cross main rivers (Aire, Derwent or Ouse) however it does cross some Ordinary Watercourse. Where the route crosses the Ordinary Watercourses there are two options a) to open cut the watercourse and disturb the ditch b) to auger underneath with no actual ditch disturbance. Would the IDB be open to some discussions about option a?
- It is likely that the proposed development will increase the amount of impermeable area. The proposal is to utilise the existing drainage system wherever feasible or construct a new outfall(s) to the system of watercourses if required. What would be the allowable discharge rate from the new impermeable areas?
- What would be the preferable discharge points?
- If new outfalls are required to be constructed, does the IDB have their own guidance on the requirements for new outfalls to their systems?
- Does the IDB have specific requirements regarding pollution prevention measures?
- Are there any requirements for water quality monitoring during construction and operational phase?
- Should surplus process water need to be discharged, are there any specific requirements relating to the quality of process water that may need to be discharged to the local watercourses;
- We have assumed that there is no need to carry out the Sequential Test given the site is being redeveloped. Please can the IDB confirm this assumption;
- The proposed study areas for surface water and groundwater features is 0.5km and for features in hydraulic connectivity and groundwater abstractions is 1Km. The study area is considered appropriate based on professional judgement and current knowledge of the area. Please can the IDB confirm they are happy with the study area?
- Details of the consent process and application fee;
- Please include any details on mitigation the IDB would like to see included in the scheme / FRA.

Data request

- Historic flooding records (from all sources)
- Any water quality data
- A map showing the names and designation of the watercourse within the study area (Main River/Ordinary Watercourse), including any culverted watercourses

Thank you very much for your help, if you need any further information on the scheme or any aspect of the consultation please contact me directly.

It would assist the project if you could acknowledge receipt of this consultation and when we can expect to get a response back.

Kind regards,
Isabelle

Isabelle Farley

MSc BSc

Graduate Consultant, Water Engineering



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**JBA Consulting, Epsom House, Chase Park, Redhouse Interchange, Doncaster, South Yorkshire, DN6 7FE.
Telephone: +441302 337798**

WEM Framework Suppliers 2013-2019 and the Shire Group of IDBs is a member of the JBA group of companies.

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www.shiregroup-idbs.gov.uk

From: Farley, Isabelle
Sent: 18 December 2017 10:31
To: Markose, Louise
Subject: FW: Drax Repower Flood Risk Consultation Part 1
Attachments: image001.png; image002.png; m6 Living on the Edge 2012.pdf; m7 PPG05 09.08.pdf; FRA Enquiry - Drax - Watercourses.pdf; FRA Enquiry - Drax - Named Watercourses.pdf

From: Stephanie Bracegirdle [Stephanie.Bracegirdle@northyorks.gov.uk] on behalf of Ilfa [Ilfa@northyorks.gov.uk]
Sent: 18 December 2017 10:21
To: Farley, Isabelle
Subject: RE: Drax Repower Flood Risk Consultation Part 1

Good afternoon Isabelle,

Please see below our comments (in blue) to the information you requested (in black).

Our SuDS Design Guidance is referenced below within our comments and can be found at the following link:
https://www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf

With regards to your query about LLFA and IDB responsibilities; Internal Drainage Boards (IDBs) are a risk management authority, just like NYCC as LLFA and the roles are very similar. Unlike the County Council as Lead Local Flood Authority, IDBs cover areas of special drainage needs and manage flood risk and water levels on behalf of the communities that live there. If you plan to do works on or near a watercourse that is the responsibility of an IDB then it is important that you contact them to gain any permissions/consent as they are the risk management authority. IDBs also have different requirements to us (LLFA) with regards to discharge rates and storage requirements on site, so it is important to consult with them if you are working within an area where the responsibilities lie with the IDB. IDBs may also have additional regulations and bylaws, which will affect what you can and cannot do on an ordinary watercourse. The development site you are proposing is within the Shire Group of Internal Drainage Boards and so you should contact them with regards to the following points;

- Allowable discharge rates
- Discharge Points
- Outfalls
- Quality of process water (please also contact the EA)
- Study area for SW, GW features and Hydraulic Connectivity and GW abstractions.
- Land Drainage Consent

- We are currently looking into how to construct the gas pipeline as shown on the attached plans there are two possible routes (A&B), we do not believe the routes cross main rivers (Aire, Derwent or Ouse) however it does cross some Ordinary Watercourse. Where the route crosses the Ordinary Watercourses there are two options a) to open cut the watercourse and disturb the ditch b) to auger underneath with no actual ditch disturbance. Would the Council be open to some discussions about option a? – The council would be open to discussions re option a. It should be made clear within the proposals the two options considered with full details of how these measures will impact the watercourse, flood risk, ecology and future maintenance requirements. Once full details have been provided the council can make an informed comment to the LPA regarding the most appropriate method. You must also contact the IDB.

- It is likely that the proposed development will increase the amount of impermeable area. The proposal is to utilise the existing drainage system wherever feasible or construct a new outfall(s) to the system of watercourses if required. What would be the allowable discharge rate from the new impermeable areas? – Please contact the IDB. The IDB bylaws do specify 1.4l/s/ha. If you proposed to discharge into a Main River then you must contact the EA.

Please see North Yorkshire County Councils requirements in our SuDS Design Guidance for more information (link at the top).

- What would be the preferable discharge points? – We do not have a preferred location point for discharge. Please note you are proposing to discharge into an Ordinary Watercourse within an IDB, therefore you must contact the Shire Group of Internal Drainage Boards. If you are proposing to discharge within a Main River, please contact the EA.

- If new outfalls are required to be constructed, does the Council have their own guidance on the requirements for new outfalls to their systems? – We do not hold this information. Please contact the IDB

- Does the Council have specific requirements regarding pollution prevention measures? / Are there any requirements for water quality monitoring during construction and operational phase? – Construction and maintenance works in or near water have the potential to cause serious pollution or impact on the bed and banks of a watercourse and on the quality and quantity of the water. Please see the EA guidance on pollution prevention attached and our SuDS Design Guidance (link at the top).

- Should surplus process water need to be discharged, are there any specific requirements relating to the quality of process water that may need to be discharged to the local watercourses? – We do not have any specific requirements with regards to the quality of process water that can be discharged into local watercourses as the Environment Agency are the Risk Management Authority that regulate pollution control. Please contact them with regards to this requirement and also see their Pollution Prevention Guidance (PPG05) attached.

- We have assumed that there is no need to carry out the Sequential Test given the site is being redeveloped. Please can the Council confirm this assumption –

Please confirm with the Local Planning Authority – Selby District Council.

- The proposed study areas for surface water and groundwater features is 0.5km and for features in hydraulic connectivity and groundwater abstractions is 1km. The study area is considered appropriate based on professional judgement and current knowledge of the area. Please can the Council confirm they are happy with the study area? Please contact the IDB
- Details of the consent process and application fee – You will not require consent from NYCC as LLFA as the work proposed lies within an IDB. You must contact the IDB to gain any permissions/consents with regards to work on or near a watercourse.
- Please include any details on mitigation the council would like to see included in the scheme / FRA – It should be made clear within the FRA and scheme proposals how you wish to mitigate flood risk and compensate for any loss of floodplain as the site is located within Flood Zone 3, the functional floodplain. It should be made clear that the proposals do not increase flood risk on or off site. Runoff must be completely contained within the drainage system (including areas designed to hold or convey water) for all events up to a 1 in 30 year event. The design of the site must ensure that flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that avoid risk to people and property both on and off site. Please see our SuDS Design Guidance for more information (link at the top).

Data request

- Historic flooding records (from all sources) – North Yorkshire County Council in its capacity as Lead Local Flood Authority holds one record of surface water flooding in Barlow (2011), just NW of the site.
- Any water quality data – North Yorkshire County Council in its capacity as Lead Local Flood Authority does not hold this data.
- A map showing the names and designation of the watercourse within the study area (Main River/Ordinary Watercourse). Including any culverted watercourses – Please see attached. Light blue polyline indicates Ordinary Watercourses, and River Ouse and River Derwent (Main River) indicated by a dark blue polyline - Carr Dike, Unnamed and River Ouse are the watercourses within the study area.

I hope that this answers your questions. If you require any more information, please do not hesitate to contact me

Kind regards

Stephanie Bracegirdle
Flood Risk Management Project Engineer
North Yorkshire County Council
County Hall – Northallerton - DL7 8AH

Tel: 01609 535378

Mobile: 07974173678

Email: Stephanie.Bracegirdle@northyorks.gov.uk<<mailto:Stephanie.Bracegirdle@northyorks.gov.uk>>

[cid:image001.png@01D30471.AF05BA00]

From: Farley, Isabelle [<mailto:Isabelle.Farley@wsp.com>]

Sent: 30 November 2017 16:48

To: floodriskmanagement

Subject: Drax Repower Flood Risk Consultation Part 1

Dear North Yorkshire CC,

We have been commissioned by Drax Power Station to carry out the water environment chapter of the EIA and the Flood Risk Assessment. We have reviewed the Scoping Opinion and would now like to formally consult with North Yorkshire County Council about the scheme proposals. We are also consulting with Selby IDB on many of the questions below. It would be helpful to understand further how the responsibilities are split between North Yorkshire as the LLFA and the IDB.

It is likely we will need consult with the Council throughout the project, therefore please let me know if we have the correct contact details.

The Project

Drax Power Limited (the applicant) intends to undertake the repowering of two existing coal-fired units with gas at Drax Power Station in Selby, North Yorkshire. WSP has been commissioned to assist Drax to seek planning permission known as a Development Consent Order (DCO) which is required for all nationally significant infrastructure projects. The Site is located in an areas of complex flood risk comprising of Flood Zones 1, 2 and 3, with some areas understood to benefit from flood defences along the banks of the River Ouse. The source is the River Ouse and ordinary watercourses located within the study area such as the Carr Dyke. Flooding from surface water is typically associated with natural overland flow paths. Please refer to the accompanying plans (dated 9th November 2017) for further details on the Scheme Proposals. Also attached is an extract from the scoping report which provides further details on the scheme (dated September 2017).

We would like to seek your general comments on the scheme in relation to the water environment / flood risk. Therefore please provide comments on aspects you wish to be incorporated within the assessment. More specifically we would like to consult with you on the following key questions:-

- We are currently looking into how to construct the gas pipeline as shown on the attached plans there are two possible routes (A&B), we do not believe the routes cross main rivers (Aire, Derwent or Ouse) however it does cross some Ordinary Watercourse. Where the route crosses the Ordinary Watercourses there are two options a) to open cut the watercourse and disturb the ditch b) to auger underneath with no actual ditch disturbance. Would the Council be open to some discussions about option a?
- It is likely that the proposed development will increase the amount of impermeable area. The proposal is to utilise the existing drainage system wherever feasible or construct a new outfall(s) to the system of watercourses if required. What would be the allowable discharge rate from the new impermeable areas?
- What would be the preferable discharge points?
- If new outfalls are required to be constructed, does the Council have their own guidance on the requirements for new outfalls to their systems?

- Does the Council have specific requirements regarding pollution prevention measures?
- Are there any requirements for water quality monitoring during construction and operational phase?
- Should surplus process water need to be discharged, are there any specific requirements relating to the quality of process water that may need to be discharged to the local watercourses;
- We have assumed that there is no need to carry out the Sequential Test given the site is being redeveloped. Please can the Council confirm this assumption
- The proposed study areas for surface water and groundwater features is 0.5km and for features in hydraulic connectivity and groundwater abstractions is 1km. The study area is considered appropriate based on professional judgement and current knowledge of the area. Please can the Council confirm they are happy with the study area?
- Details of the consent process and application fee.
- Please include any details on mitigation the council would like to see included in the scheme / FRA.

Data request

- Historic flooding records (from all sources)
- Any water quality data
- A map showing the names and designation of the watercourse within the study area (Main River/Ordinary Watercourse). Including any culverted watercourses

Thank you very much for your help, if you need any further information on the scheme or any aspect of the consultation please contact me directly.

It would greatly assist the project if you could acknowledge receipt of this consultation and when we can expect to get a response back.

Kind regards,
Isabelle

Isabelle Farley
MSc BSc
Graduate Consultant, Water Engineering

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North Yorkshire County Council.

From: Paul Edwards <pedwards@selby.gov.uk>
Sent: 02 February 2018 11:09
To: Markose, Louise
Cc: Farley, Isabelle; Szostak, Elzbieta
Subject: RE: Drax Repower project

Dear Ms Markose,

I am sorry for the delay in replying to you.

The EA Flood Zone maps show, as you say, that the Station has a variety of flood risk zones of 3, through 2 to 1 and with some areas benefiting from flood defences. The Council's SFRA is not adopted and thus we have to defer to the EA flood zone maps.

The Technical Guidance to the NPPF confirms that electricity generating power stations and grid and primary substations are Essential Infrastructure. Whilst such Infrastructure in all Zones is acceptable in principle without a Sequential Test, those parts of the NSIP development in Zone 3 require the Exception Test to be passed (see Table 3 to the 2012 Technical Guidance) and of course essential infrastructure should be designed and constructed in order to remain operational and safe in times of flood.

Thus I would say that whilst the Sequential Test would not need to be carried out by the decision-maker according to the Technical guidance, I think that any Inspector(s) examining the NSIP application would rightly, given the extent of the wider site and the variety of flood zones, wish to be assured that the initial project planning had included the application of the Sequential Test such that parts of the site that were at lower risk were assessed to see if they could take development that is being planned in Zone 3. Although this is the application of the Sequential Test from another direction, I think the Inspector(s) would expect that this has been addressed.

The Exception Test would then fall to be addressed particularly in Zone 3.

On your final point about SDLP Policy EMP10, I can confirm that this Policy was saved in the 2008 saving Direction:
(http://www.selby.gov.uk/sites/default/files/Documents/Saved_Policies_Direction_and_Schedule.pdf)

The adoption of the Selby District Core Strategy Local Plan in 2013 did not replace this Policy so I can confirm that SDLP Policy EMP10 remains a part of the adopted development plan (http://www.selby.gov.uk/sites/default/files/Documents/Schedule_of_SDLP_Policies_replaced_by_CS_AMENDED_FEB_2014_LIST_ONLY.pdf).

You may take the view that EMP10 is directed towards additional / ancillary industrial development at or close to Drax...rather than the continuing development / repowering within Drax...I daresay that your colleagues will discuss relevant development plan policies with me at some point before the Preliminary Environmental Information is shared with the Council.

I trust that this is of assistance.

Kind regards

From: Farley, Isabelle [<mailto:Isabelle.Farley@wsp.com>]
Sent: 11 January 2018 16:34
To: Ruth Hardingham; Rebecca Leggott
Cc: Markose, Louise; Collins, Sophie
Subject: Drax Repower project

Dear Ruth and Rebecca,

As you are aware we have been commissioned by Drax Power Limited to carry out the water environment chapter of the EIA and Flood Risk Assessment. Drax Power Limited (the applicant) intends to undertake the repowering of two existing coal-fired units with gas at Drax Power Station in Selby, North Yorkshire. WSP has been commissioned to assist Drax to seek planning permission known as a Development Consent Order (DCO) which is required for all nationally significant infrastructure projects. The Site is located in an area of complex flood risk comprising of Flood Zones 1, 2 and 3, with some areas understood to benefit from flood defences along the banks of the River Ouse.

We have assumed that there is no need to carry out the Sequential test since the proposed works are within or in very close proximity to the existing Drax Power station. The land within these areas is predominantly brownfield, and the majority of the works are taking place within brownfield areas. The project is classified as 'Essential Infrastructure' and some structures may be in Flood Zone 3.

Could you please confirm whether, as the local planning authority, you require the Sequential Test to be undertaken for this development?

Can you additionally confirm if Policy EMP10 (Additional industrial/business development at or close to Drax and Eggborough Power Stations) from the Selby District Local Plan 2005 is still valid and can be applied to our assessment.

It would be greatly appreciated if you would be able to provide us with this information by 26/01/2018.

Kind regards,

Isabelle

Isabelle Farley
MSc BSc
Graduate Consultant, Water Engineering

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Paul Edwards
Principal Planning Officer

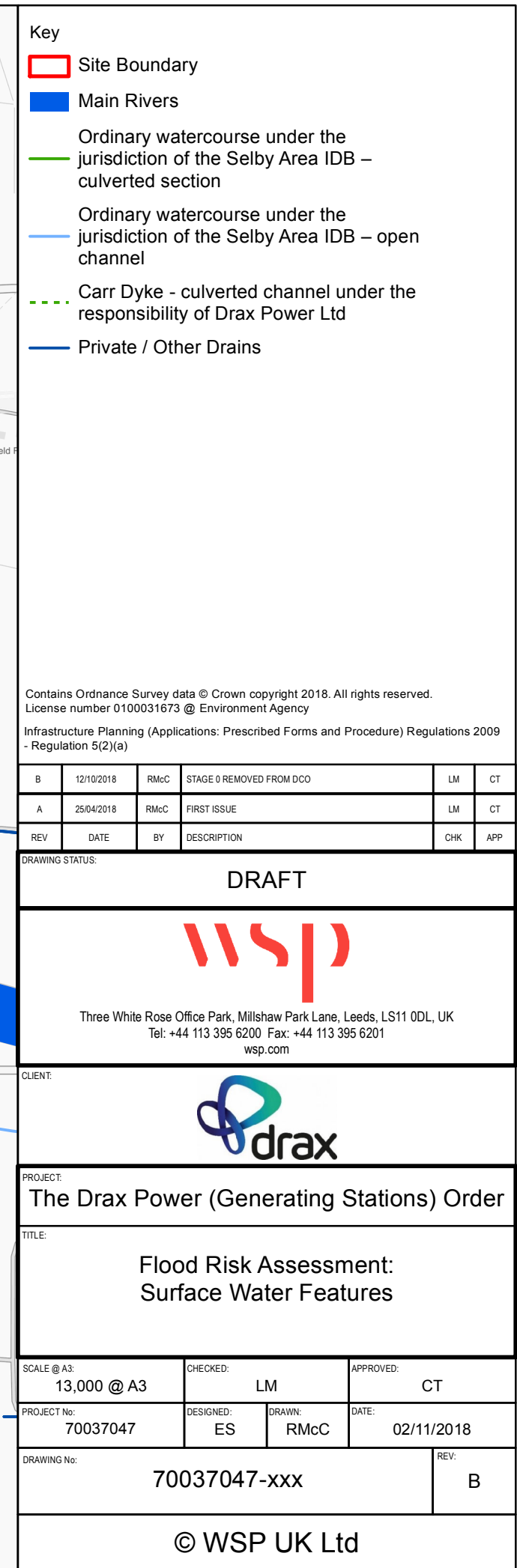
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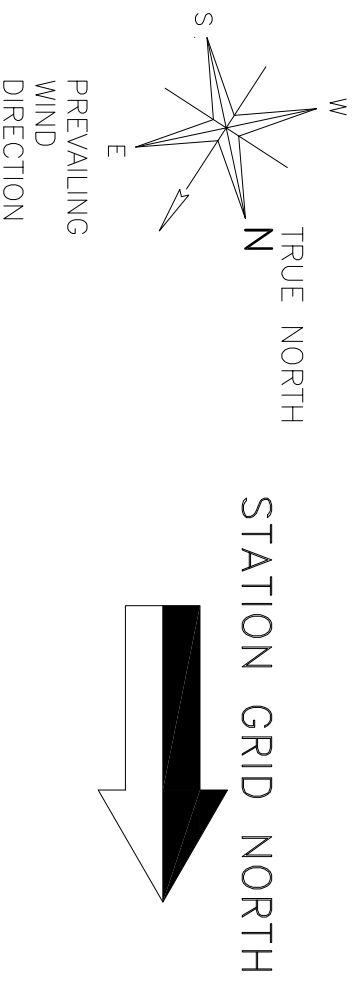
APPENDIX E: SURFACE WATER FEATURES



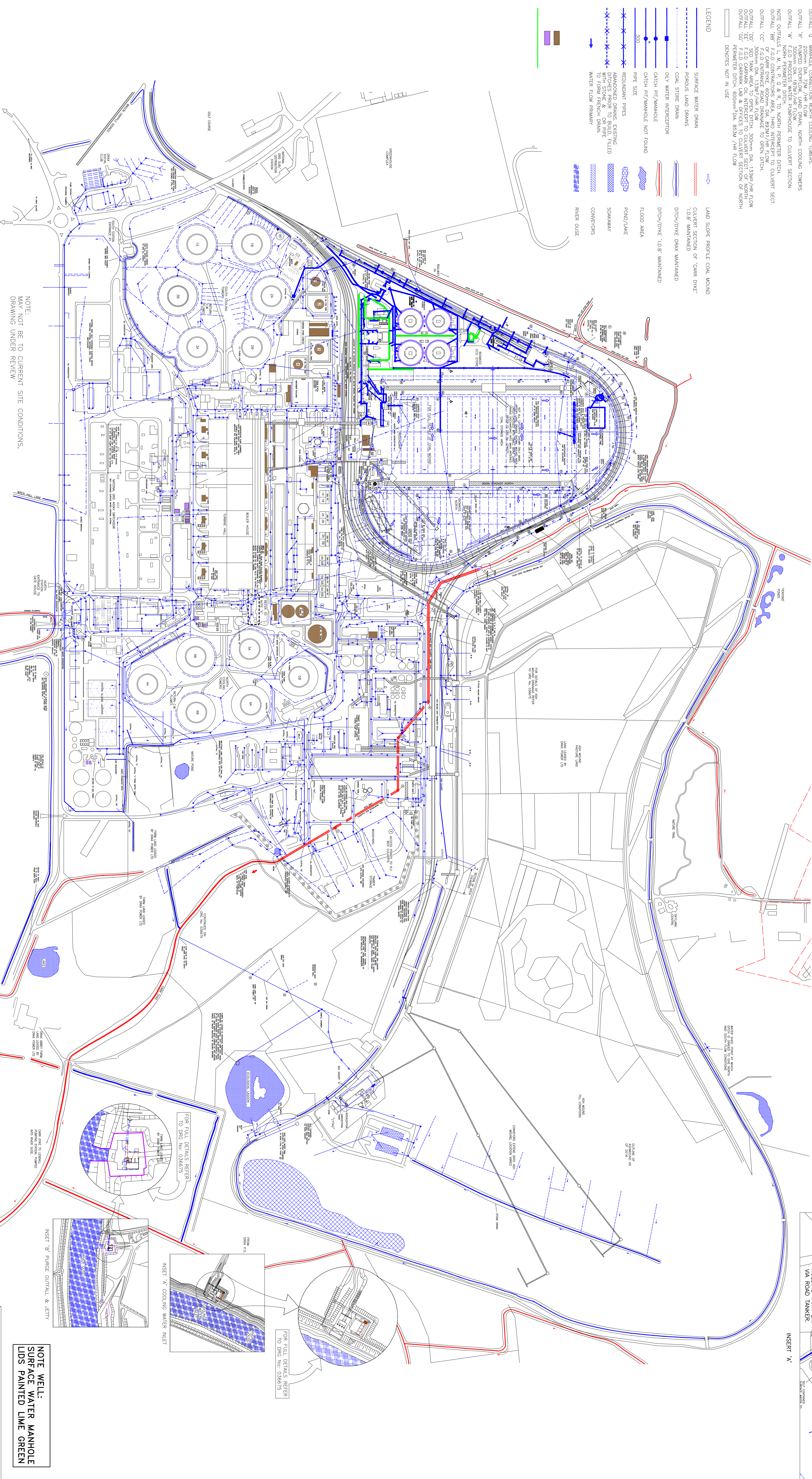
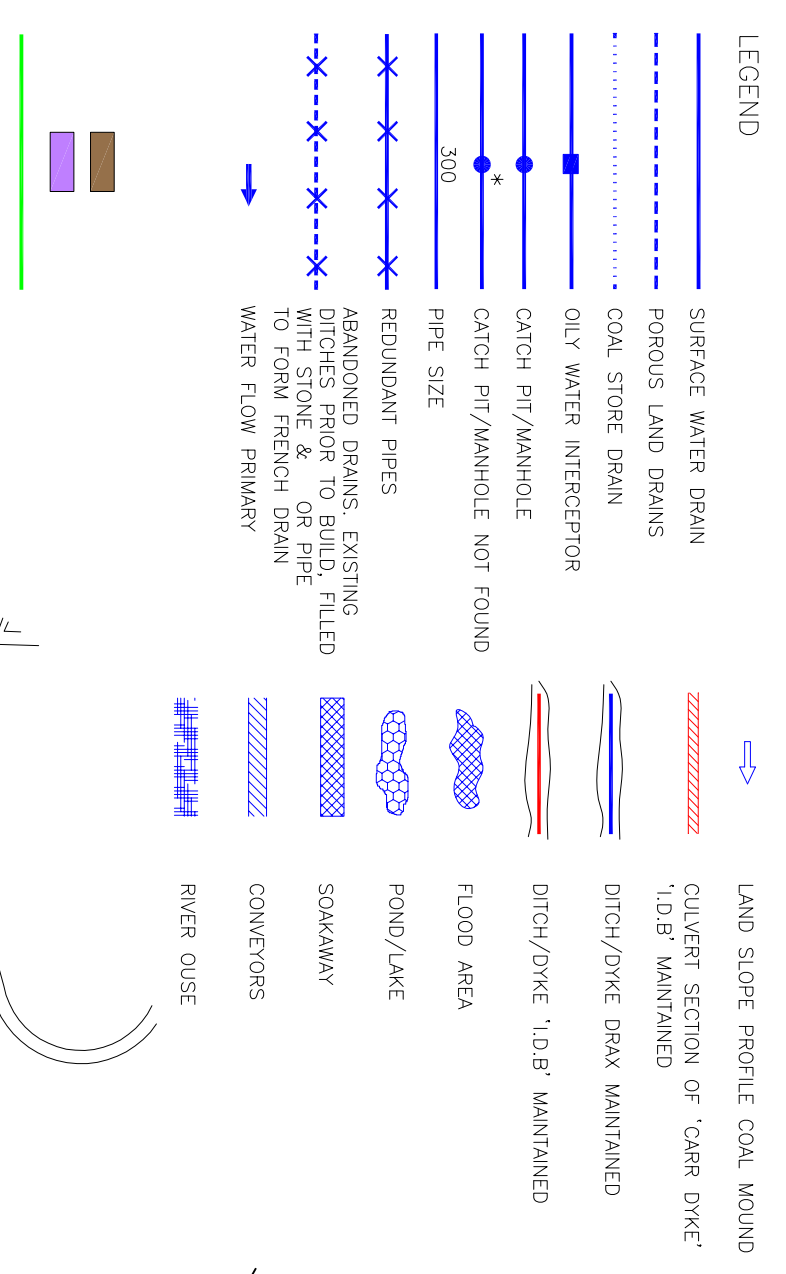
APPENDIX F: DRAX POWER STATION EXISTING DRAINAGE

FOR FURTHER DETAILS REFER TO THE FOLLOWING DRAINAGE:

034670: SURFACE WATER DRAINAGE COAL STOCK & SURROUNDING AREA
035411: BLOCK PLAN OVERVIEW OF SITE SURFACE WATER DRAINAGE DESIGNATED
038411: BLOCK PLAN OVERVIEW OF SITE SURFACE WATER DRAINAGE DESIGNATED
038412: OUTFALLS
038413: OUTFALLS
038414: OUTFALLS
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- LEGEND
- SURFACE WATER DRAIN
 - POROUS LAND DRAIN
 - COAL STORE DRAIN
 - OLY WATER INTERCEPTOR
 - CATCH PIT/MANHOLE
 - CATCH PIT/MANHOLE NOT FOUND
 - PIPE SIZE
 - REDUNDANT PIPES
 - ABANDONED DRAINS, EXISTING
 - DITCHES PRIOR TO BUILD, FILLED
 - TO FORM FRENCH DRAIN
 - WATER FLOW PRIMARY
 - LAND SLOPE PROFILE COAL MOUND
 - CULVERT SECTION OF 'COAL DYKE'
 - 1.0B MAINTAINED
 - DITCH/DYKE DRAIN MAINTAINED
 - DITCH/DYKE 1.0B MAINTAINED
 - FLOOD AREA
 - POND/LAKE
 - SOAKAWAY
 - CONVEYORS
 - RIVER GULSE



NOTE WELL:
SURFACE WATER MANHOLE
LIDS PAINTED LIME GREEN

DRAX POWER LTD

BLOCK PLAN OVERVIEW
OF SITE SURFACE
WATER DRAINAGE

DRAX UNIQUE No. 085317

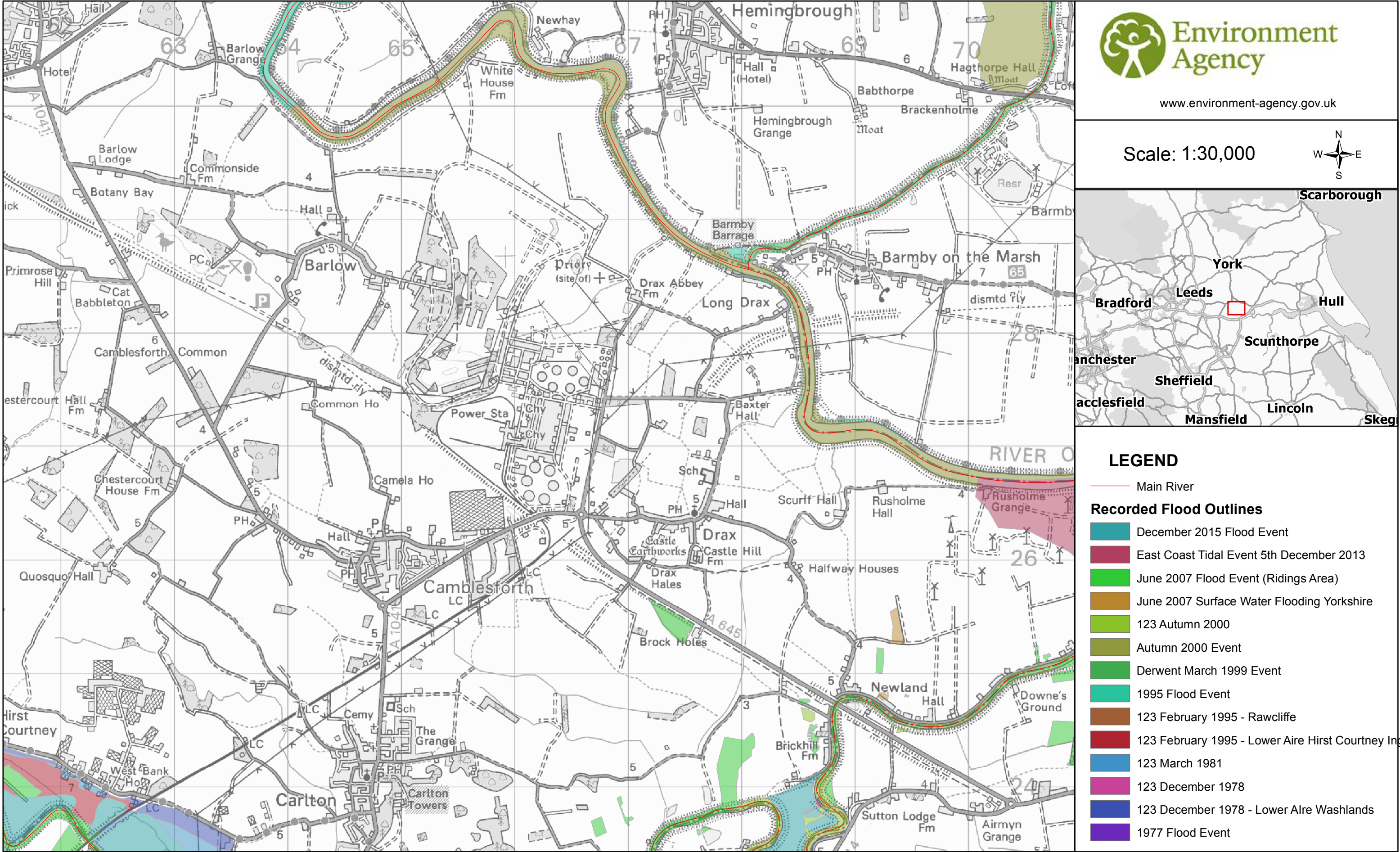
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NO.	DATE	REVISION	BY	CHKD	APP'D
Z10	2017/07/27	ISSUED FOR CONSTRUCTION	DRAX	DRAX	DRAX
Z9	2017/07/27	ISSUED FOR CONSTRUCTION	DRAX	DRAX	DRAX
Z8	2017/07/27	ISSUED FOR CONSTRUCTION	DRAX	DRAX	DRAX
Z7	2017/07/27	ISSUED FOR CONSTRUCTION	DRAX	DRAX	DRAX
Z6	2017/07/27	ISSUED FOR CONSTRUCTION	DRAX	DRAX	DRAX
Z5	2017/07/27	ISSUED FOR CONSTRUCTION	DRAX	DRAX	DRAX
Z4	2017/07/27	ISSUED FOR CONSTRUCTION	DRAX	DRAX	DRAX
Z3	2017/07/27	ISSUED FOR CONSTRUCTION	DRAX	DRAX	DRAX
Z2	2017/07/27	ISSUED FOR CONSTRUCTION	DRAX	DRAX	DRAX
Z1	2017/07/27	ISSUED FOR CONSTRUCTION	DRAX	DRAX	DRAX

APPENDIX G: HISTORICAL FLOODING

RFI/2018/71907 FEO Map centred on Drax Power Station, Drax

Date created: 30/01/2018



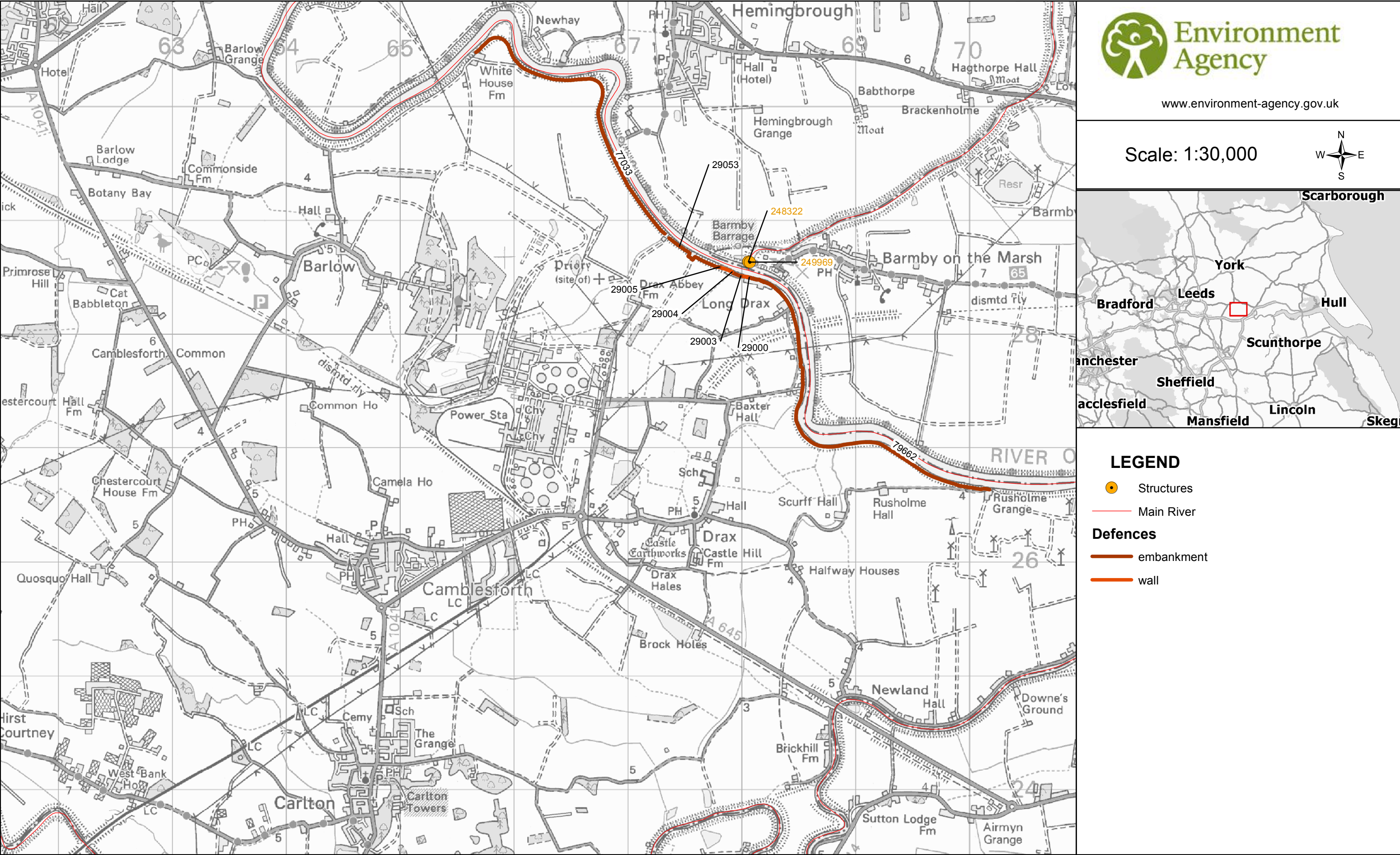
APPENDIX H: EA FLOOD MAP

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

APPENDIX I: EXISTING FLOOD DEFENCE

RFI/2018/71907 Assets Map centred on Drax Power Station, Drax

Date created: 30/01/2018

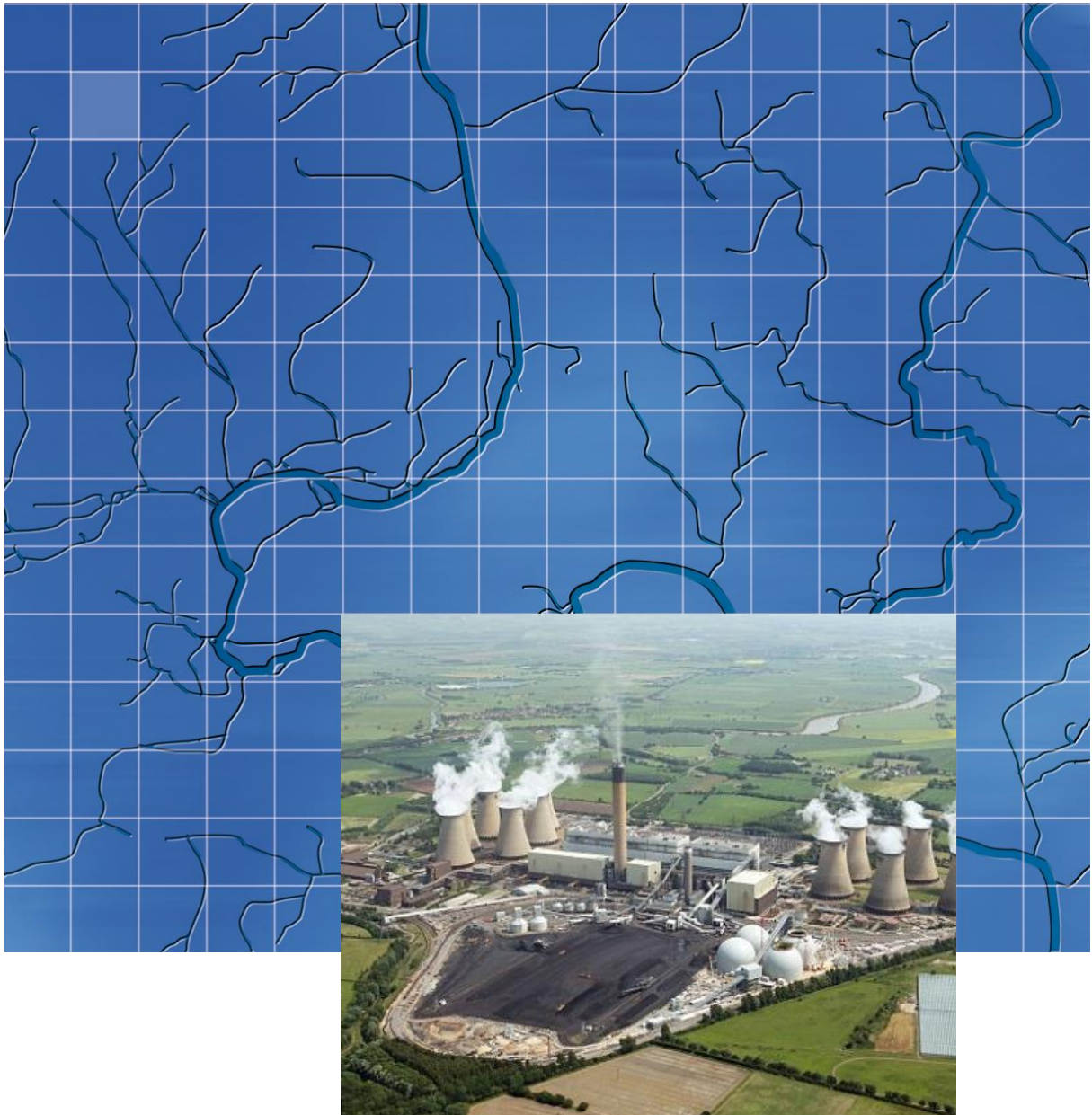


APPENDIX J: HYDRAULIC MODELLING REPORT

Drax

March 2018

Drax Repower – Hydraulic Modelling Report



WHS

Drax

Drax Repower – Hydraulic Modelling Report

Document issue details

WHS1583

Version	Issue date	Issue status	Prepared By	Approved By
1	22 nd March 2018	Draft	Philip Weatherley-Hastings (Consultant)	Paul Blackman (Technical Director)

For and on behalf of Wallingford HydroSolutions Ltd.

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www.hydrosolutions.co.uk

Contents

1	Introduction	1
1.1	Background	1
1.2	Sources of Data and Consultation	1
2	Site Description	2
2.1	Location	2
2.2	Proposed Development Layout	2
3	Hydraulic Modelling	4
3.1	Baseline Breach Modelling	4
3.2	Post Development Modelling	5
3.3	Mitigation Modelling	11
4	Sensitivity Analysis	15
5	Conclusions	15

Appendix 1 - 2014 White Rose Study Hydraulic Modelling Report

1 Introduction

1.1 Background

Wallingford HydroSolutions Ltd (WHS) was commissioned by Drax to undertake 2D hydraulic breach modelling analysis for proposed upgrades to the Drax Power Station, Drax, North Yorkshire. The analysis builds upon modelling undertaken by WHS for the White Rose Carbon Capture study undertaken in 2014. The Drax plant is sited approximately 700m from the River Ouse. Flood embankments exist along the banks of the Ouse.

The purpose of this commission is to provide a detailed assessment of changes to flood risk during a worst case breach scenario following the construction of new buildings and infrastructure at the Drax site and the associated loss of floodplain storage. To provide an accurate representation of breach flood behaviour, an existing 2D hydrodynamic model (TUFLOW) was used. It was agreed with the Environment Agency (EA)¹ that the existing White Rose breach model could be used as a suitable baseline scenario, without the need for further changes. The original study modelled the impacts of a large area of groundwork in the post development scenario. The proposed development footprint in the Drax Repower scheme is less extensive compared to the development modelled in the White Rose study.

This technical report presents the background to the breach modelling undertaken using TUFLOW modelling software, the model build methodology and subsequent output results.

1.2 Sources of Data and Consultation

The Environment Agency has been consulted to agree the model parameters and scope for the modelling work¹.

The main sources of data used within this study include;

- **White Rose Flood Study, WHS, 2014** – The White Rose study formed the baseline scenario. This was agreed with the EA prior to modelling.
- **Flood Information, Environment Agency, 2013** - The Environment Agencies flood defence asset locations and condition ratings for the defences in the area were also supplied.
- **LiDAR data** – Purchased December 2013 from CentreMaps Live.
- **Site layout plans, WSP, 2018²** – Site layout plans were provided by WSP during the project lifecycle.
- **10K OS Mapping**

¹ Environment Agency. 2018. Drax Repower – Flood Risk Modelling (RA-2017-137861-03.pdf).

² WSP. 2018. Site Plans vP6 – 70037047-G-001-B-P6.dwg

2 Site Description

2.1 Location

The site is located at NGR 466485, 427520 (Figure 1). The area surrounding the site is predominantly rural, with a number of small hamlets and villages such as Drax to the east, Camblesforth to the southwest and Barlow to the west. The main land use in the area is for agriculture, with around 85% of the surrounding land being categorised as this. The area is heavily drained, with a complex network of field drains in operation. The existing Drax power station takes up a considerable land take within the study area

2.2 Proposed Development Layout

The proposed development layout was reviewed to ascertain which structures required modelling. Development which was shown not to be in the baseline flood extent was excluded from the modelled layout for simplicity. The baseline flood extent with a breach of the defences is shown in Figure 1. It is clear that the flood extent does not propagate across the majority of the existing power station site, with north-eastern areas at the highest risk. Table 1 and Figure 2 below summarise the buildings modelled in the post development scenario following review of baseline flood extents and discussions with the WSP design team.

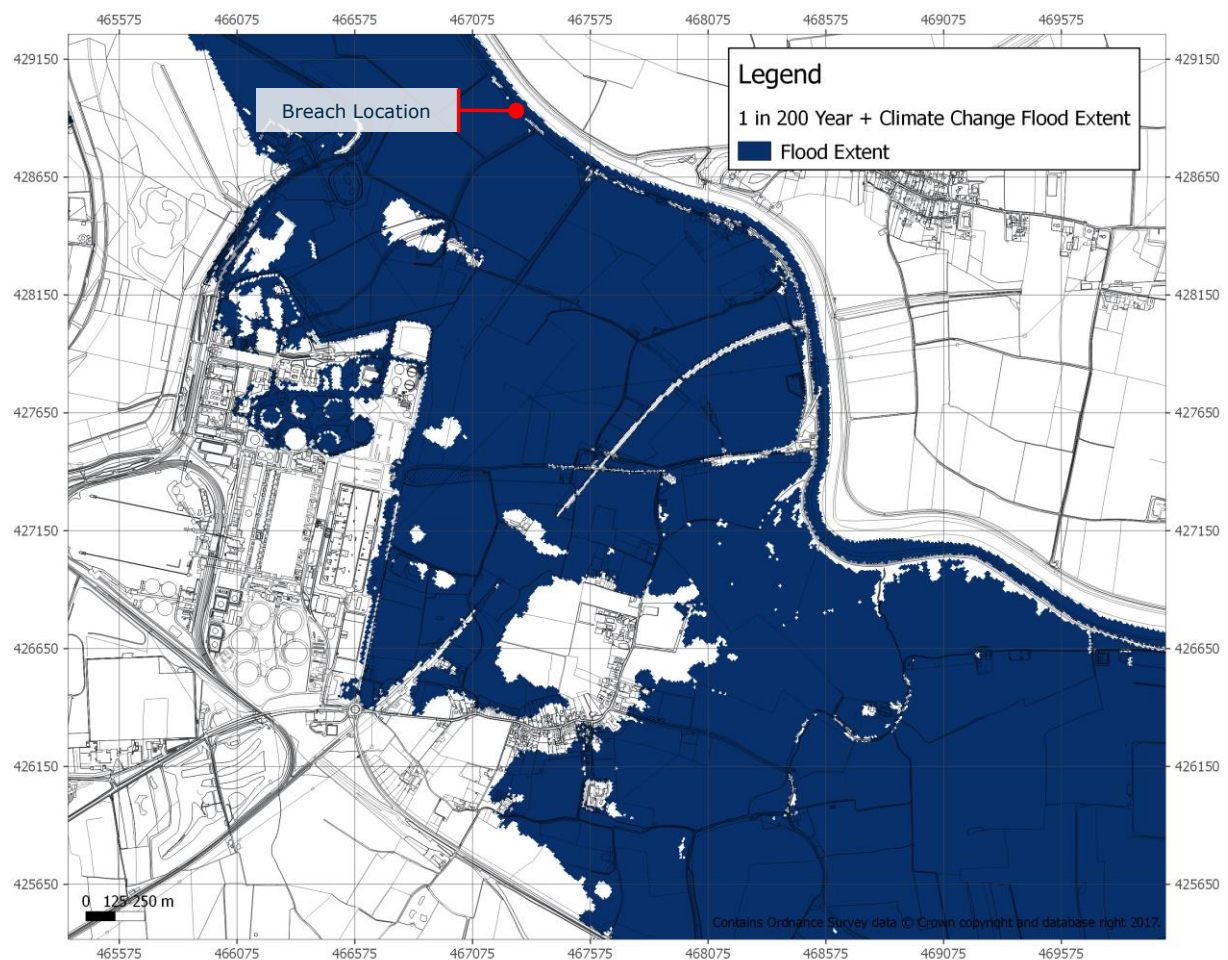


Figure 1 – Baseline Flood Extent with breach of flood defences

Table 1 – Structure ID

Structure ID	Description
1-7	Gas turbine buildings, transformation area and all associated infrastructure.
9-10	Gas receiving facility and compressor building
12	Sludge lagoons
13	Battery storage facility
14	Turbine outage store
17	AGI facility

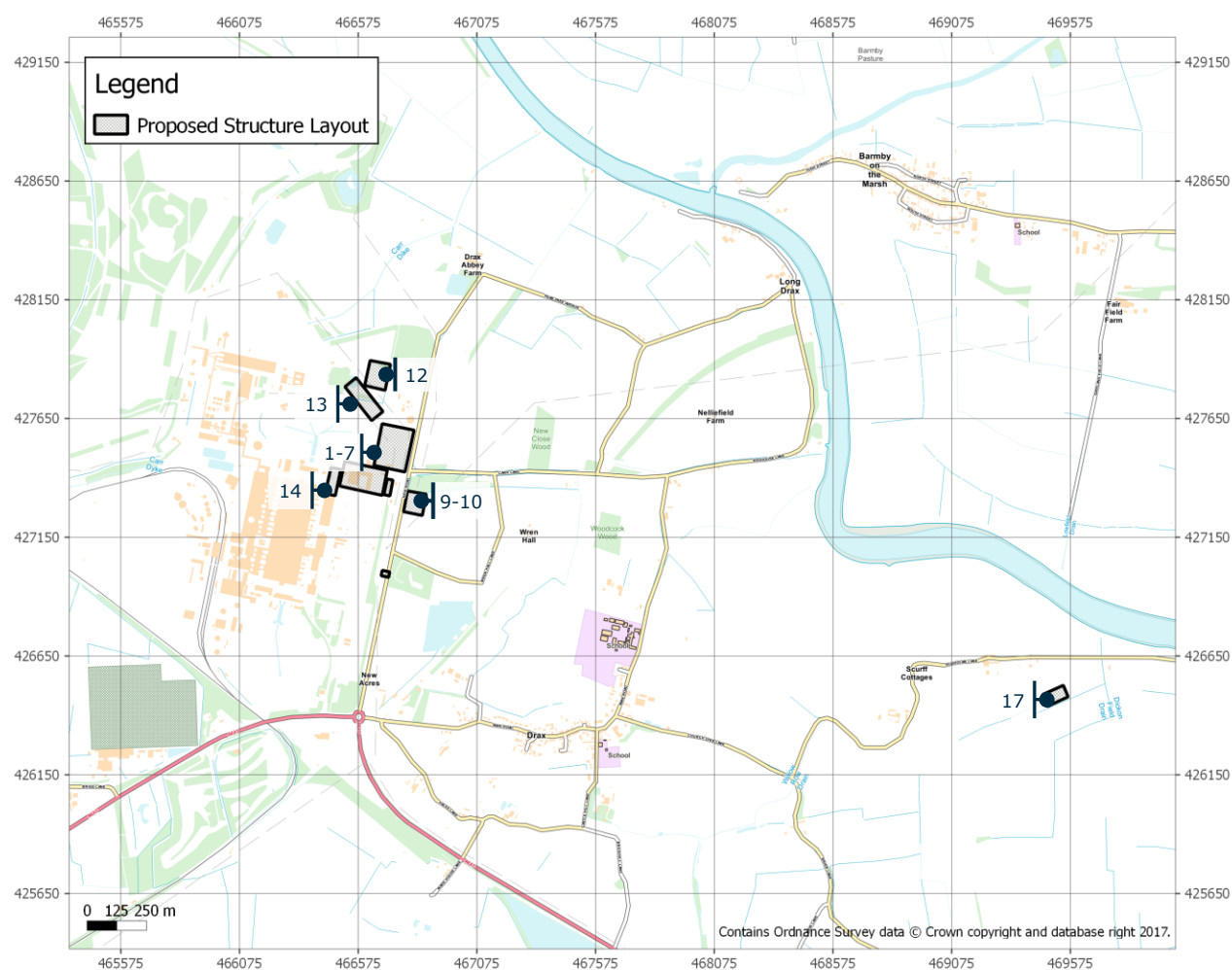


Figure 2 – Modelled Development Layout

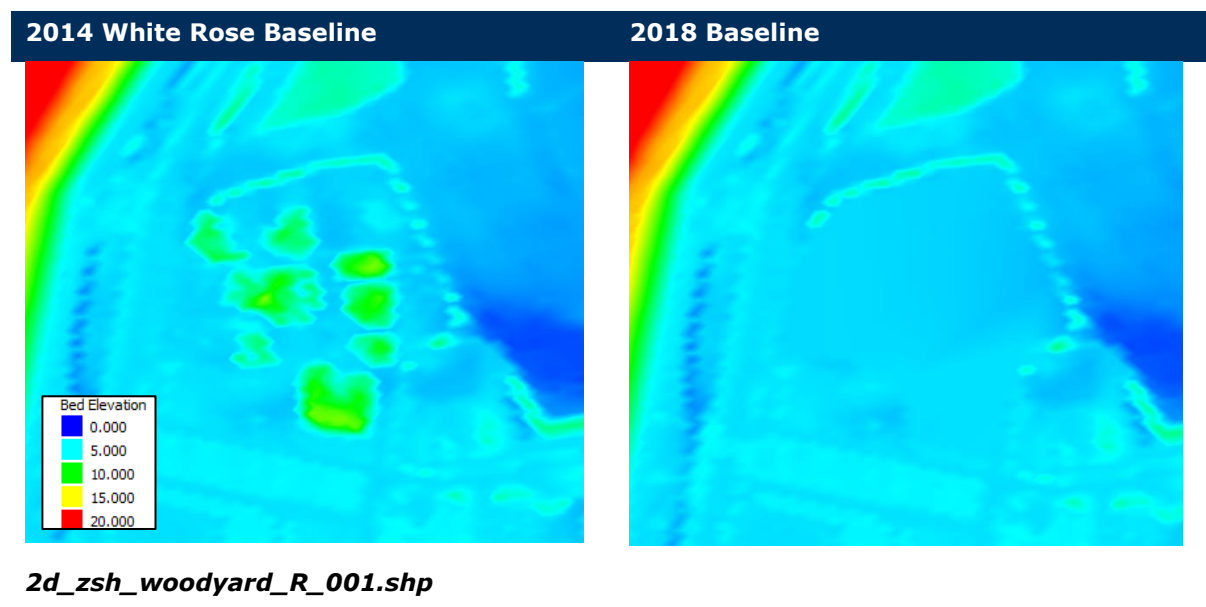
3 Hydraulic Modelling

3.1 Baseline Breach Modelling

The baseline breach model follows the methodology set out in the WHS1206_ERM – White Rose Report_Final.doc provided as Appendix 1 with this report. To ensure a like for like comparison between the baseline and post development runs, the baseline model was rerun using TUFLOW version TUFLOW.2017-09-AC-w64. This method allowed for a direct comparison of results without ambiguity caused by changes to model solutions across different versions.

Following discussion with Drax and WSP it became apparent that an area of topography in the north of the existing development was incorrectly represented. A number of wood piles, which were present in the LiDAR DTM, were removed using a z-shape to better reflect the DTM in this area. This change is shown in Table 2 below.

Table 2 – Baseline DTM Alteration



Beyond the two changes outline above, the baseline model remains as per the 2014 White Rose model. The breach location is in the same section of defence and the hydrology remains the same. A summary of TUFLOW files for the baseline runs is provided in Table 3.

Table 3 – Summary of files for baseline runs

Baseline Run File ID
<i>DRAX_BBR_OP3_0200T_2063_004.tcf</i>
<i>DRAX_BBR_OP3_0200T_2063_004.ecf</i>
<i>DRAX_BBR_OP3_004.tgc</i>
<i>DRAX_BBR_OP3_004.tbc</i>
<i>WHS1206_mat_001.tmf</i>

3.2 Post Development Modelling

3.2.1 Model Setup

The post development model incorporated an agreed building layout in the form of Z-shapes. These structures are shown in Figure 2. Discussion with WSP and Drax indicated that the buildings and infrastructure would be required to be flood free. Therefore, unlike the baseline model which utilised a 0.3m stubby-buildings approach, allowing some flow in and out of structures, the new structures were raised fully out of the flood extent, completely removing these areas from floodplain storage. The benefits of this approach are twofold:

1. The loss of floodplain storage is absolute, providing a conservative, 'worst-case' estimate of changes to flood risk in the post development scenario.
2. Finished floor levels could be determined from peak post development flood levels to ensure the structures remain flood free.

Table 4 below provides a summary of the key TUFLOW and shape files used in the post development scenario modelling.

Table 4 – Summary of key post development TUFLOW files

Key TUFLOW files for post development scenario	
<i>DRAX_PBR_OP3_0200T_2063_004.tcf</i>	
<i>DRAX_PBR_OP3_0200T_2063_004.ecf</i>	
<i>DRAX_PBR_OP3_004.tgc</i>	
<i>DRAX_PBR_OP3_004.tbc</i>	
<i>WHS1206_mat_001.tmf</i>	
Key shape files for post development scenario	Description
<i>2d_zsh_new_drax_layout_R_001.shp</i>	Proposed buildings.
<i>2d_zsh_woodyard_R_001.shp</i>	Removal of wood piles from DTM.

3.2.2 Model Results

The results of the post development modelling are shown in Figure 3 below.

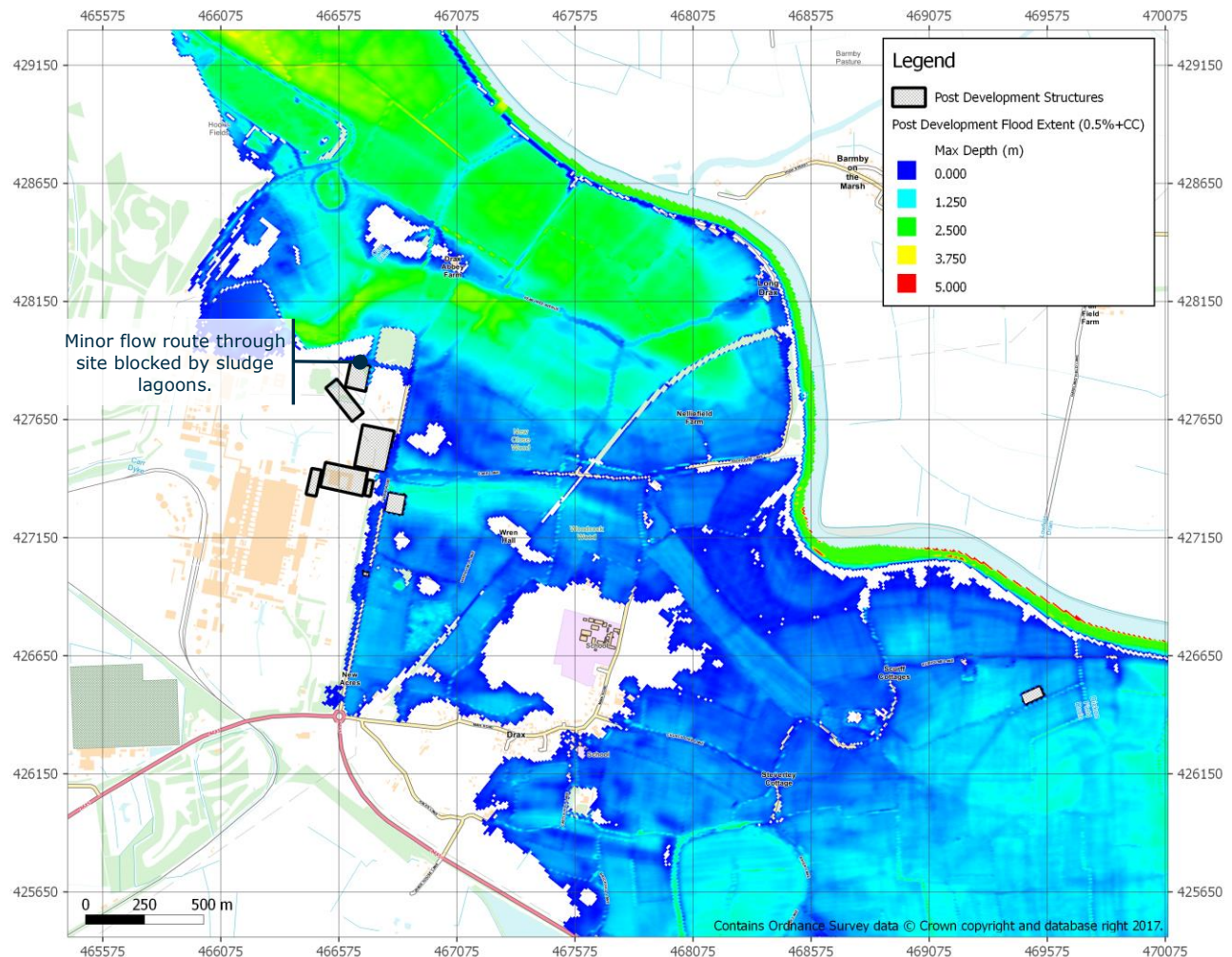


Figure 3 – Post Development Flood Depth and Extent

Figure 4 below shows the change in depth between the baseline and proposed scenario for the extreme breach scenario. This demonstrates that there is negligible change in flood depth across the vast majority of the floodplain of between 1mm and 3mm. This is less than the small predicted increase for the approved White Rose study of approximately 7mm.

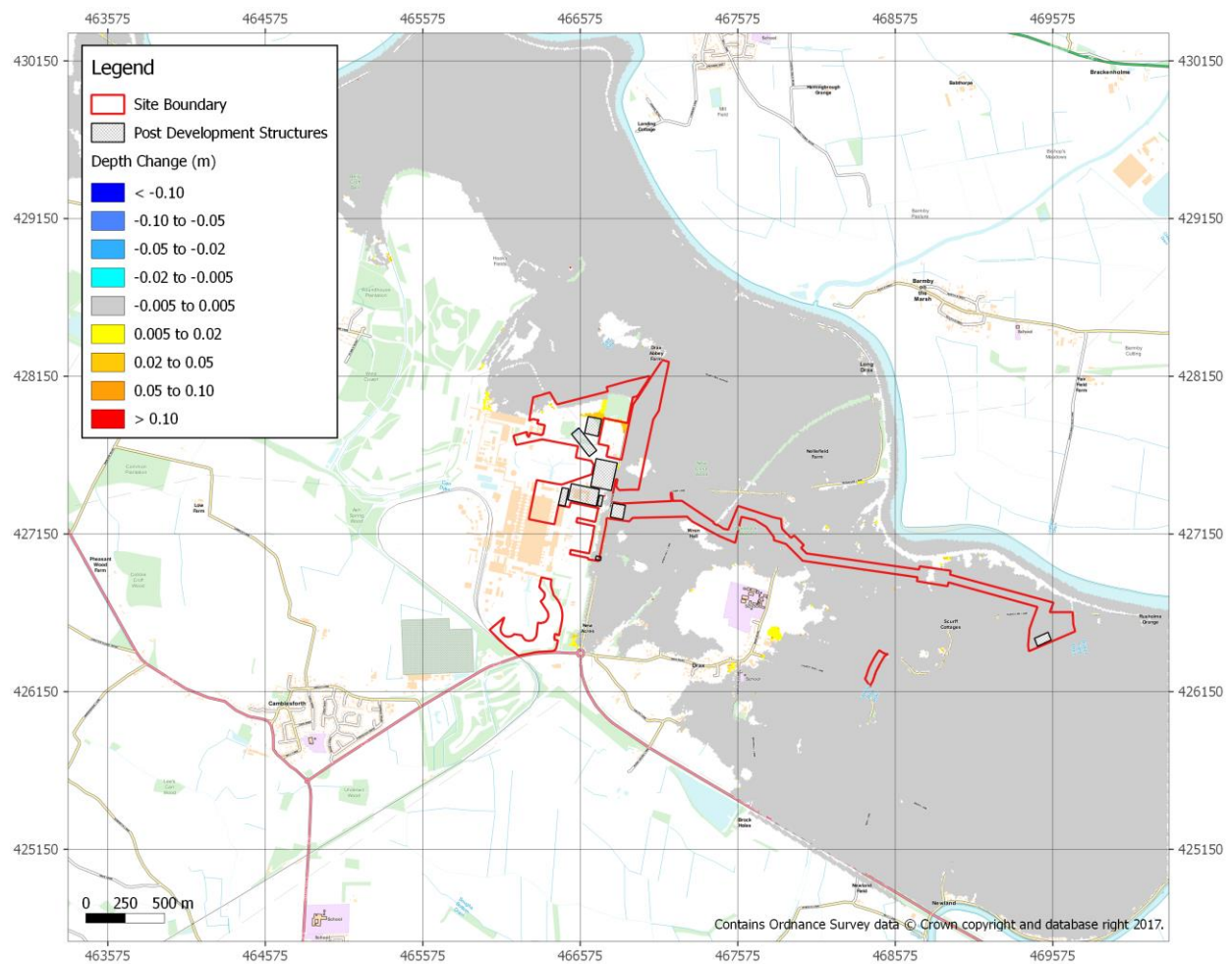


Figure 4 – Depth Change Plot

It is evident from the post development scenario model runs that a minor flow route through the site, present in the baseline scenario, is blocked by the proposed structures (Figure 5). The change in extent shown in Figure 5 does not show any significant increase in flood extent, however blocking the flood route does result in very small and localised increased flood depths at two locations in Drax village (Figure 6), where flood depths are increased by 13mm and 20mm. These areas of detriment are small and within the context of the modelled extreme breach event represent a minor increase in risk in the post development scenario. However, for completeness, the causes and potential solutions for this detriment have been explored.

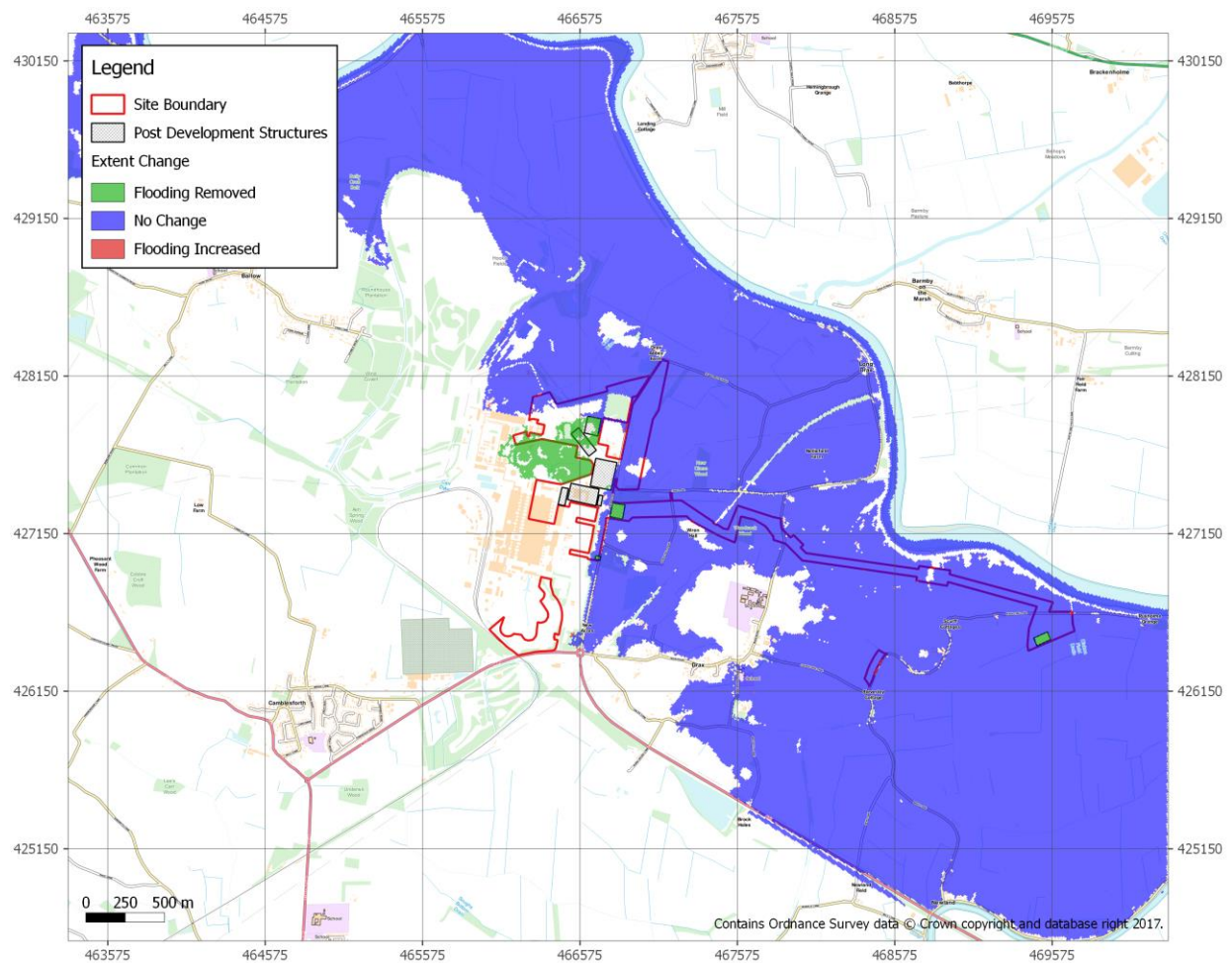


Figure 5 – Extent Change Baseline compared to Post Development

Although the extent of development is less significant in terms of floodplain storage loss for the current proposals compared to the previously proposed White Rose carbon capture scheme, the increase in predicted flood depth is slightly greater at the two isolated locations. The hydraulics of this phenomenon was assessed and the cause of this difference is due to topographic ridges in these locations in combination with lower baseline flood depths overall in the 2018 model runs using the latest version of TUFLOW. A slight increase in flood depths during the post development scenario across the entire floodplain (1-3mm) causes more water to spill into these areas, resulting in this difference in depth.

In comparison, for the 2014 model runs, the baseline flood depths were greater across the entire floodplain (approximately 7mm). As a result, the depth differences in two areas in Drax village were much less (7mm) and more consistent over the topography. Analysis of the hydraulic mechanisms in this location is shown in Figure 6 and Figure 7.

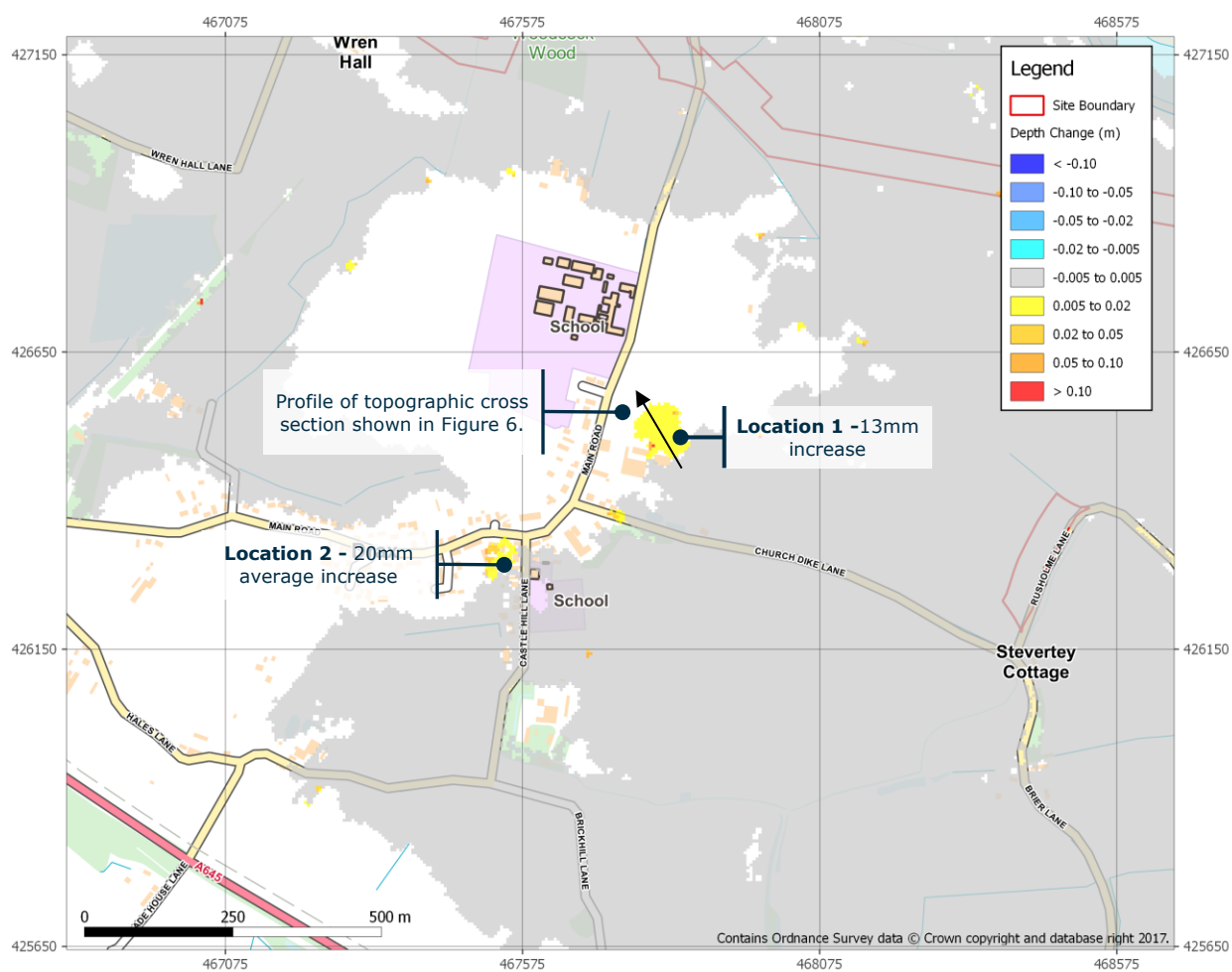


Figure 6 – Depth Change plot at Drax Village

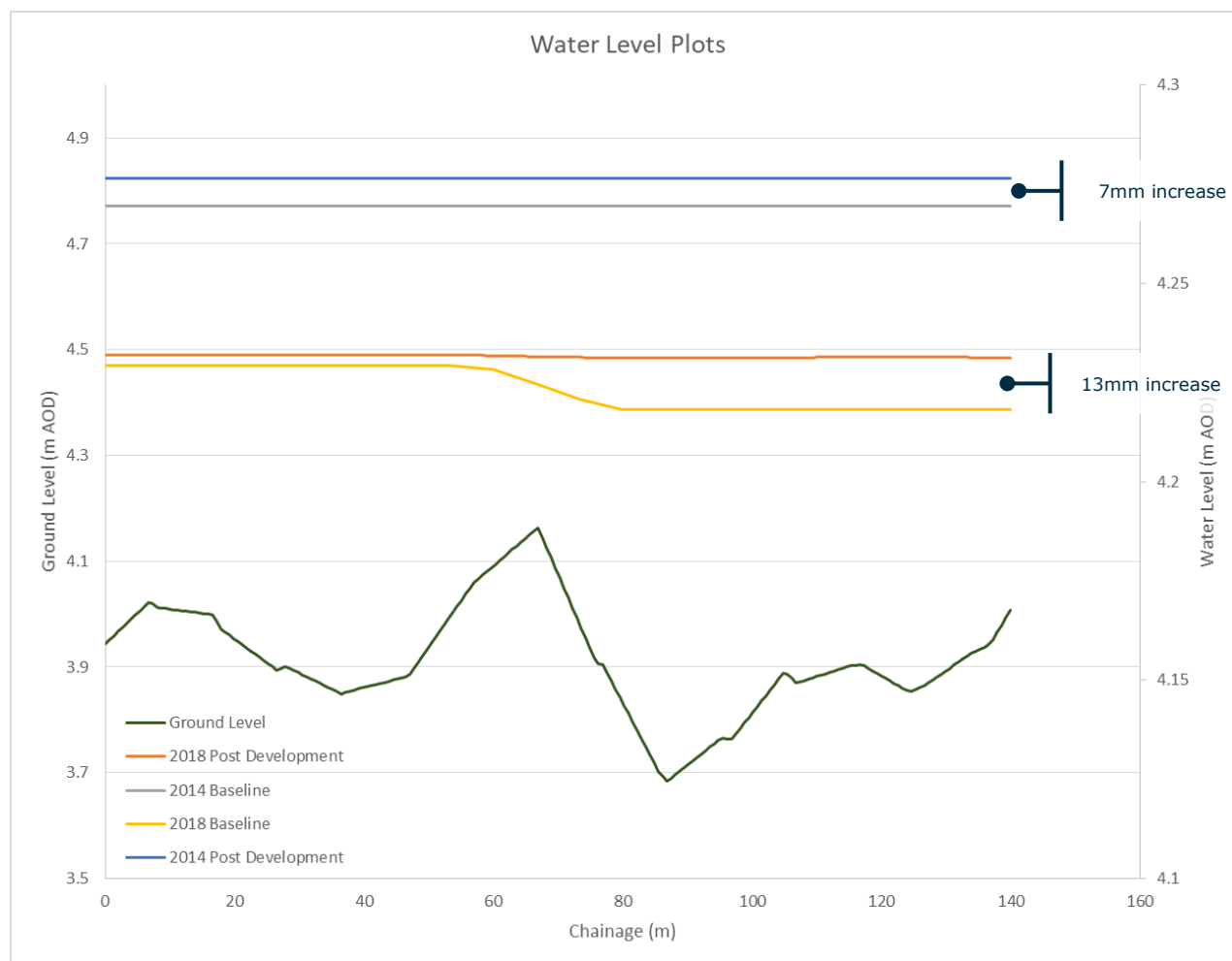


Figure 7 – Change in depth 2014 compared to 2018 in Drax Village (Arrow on Figure 5 shows the ground level profile shown above)

3.3 Mitigation Modelling

3.3.1 Model Setup

The increase in flood depths at two localised areas is shown in Figure 6. Although these areas of detriment are localised and only occur during a rare, extreme breach event, potential mitigation options have been explored to ameliorate this impact. As a target, it was considered that less than 10mm of increase in flood levels in these areas would be considered appropriate for three key reasons:

1. Detriment in these areas was 7mm in the original White Rose study. This was considered appropriate and approved by the EA;
2. Flooding occurs in these areas in the baseline event, and no change in extent is seen as part of the development proposals, and;
3. Detriment of less than 10mm is within the margin of error for TUFLOW modelling.

Based on Figure 5, the most suitable way to mitigate the impacts would be to restore the flood flow route blocked by the sludge lagoons. To achieve this, a channel shown in Figure 8 was modelled.

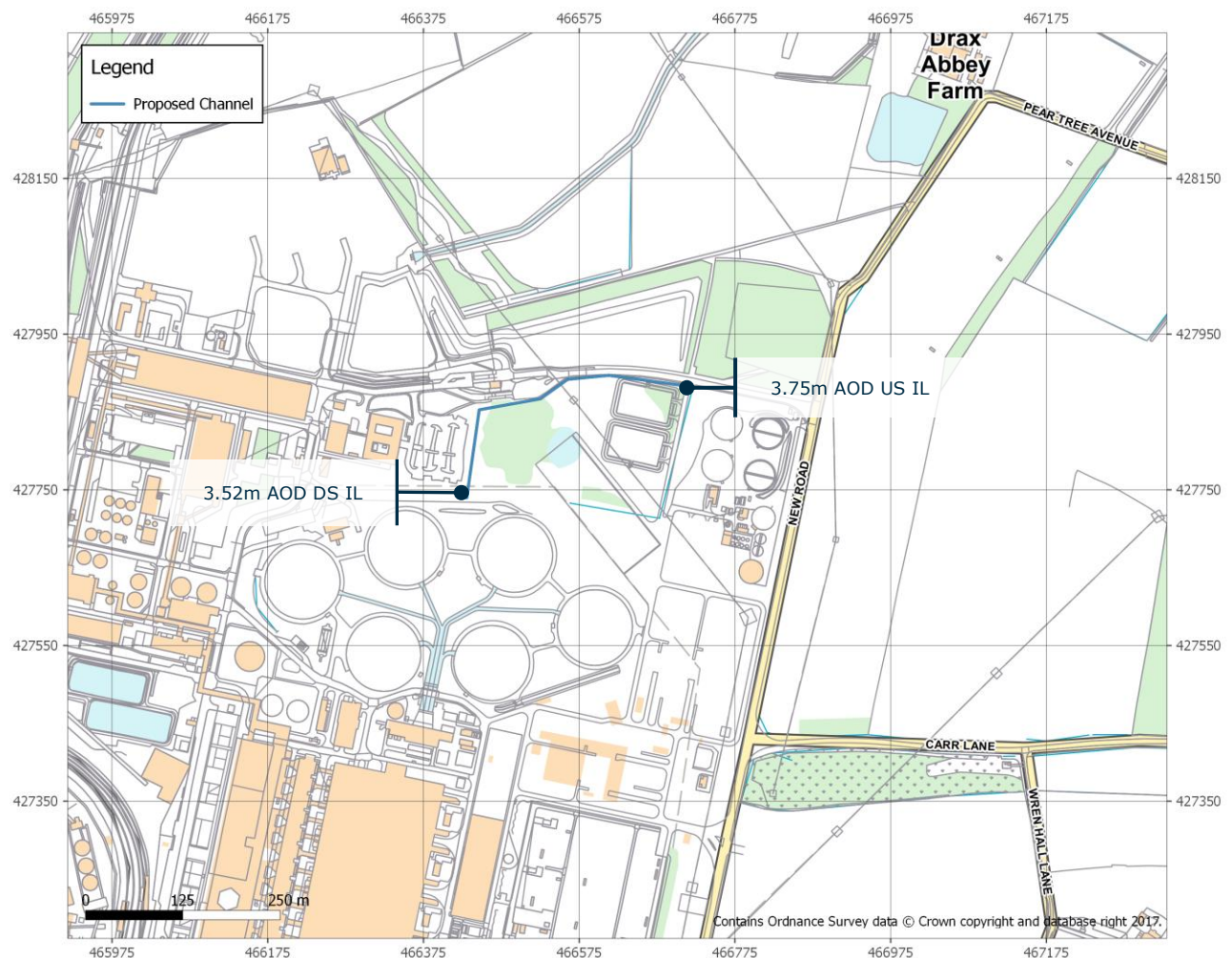


Figure 8 – Channel Layout

Table 5 – Mitigation channel dimensions

Width	Upstream IL (m AOD)	Downstream IL (m AOD)
5m (1 cell)	3.75	3.52

To model the channel appropriately on a 10m grid, a smaller 5m grid was embedded within the main mesh. The key files for the mitigation option modelling are shown in Table 6 below.

Table 6 – Mitigation modelling files

Key TUFLOW files for mitigation scenario

DRAX_PBR_OP1b_0200T_2063_004.tcf
DRAX_PBR_OP1b_0200T_2063_004.ecf
DRAX_PBR_OP1a_004.tgc
DRAX_PBR_OP1a_004.tbc
DRAX_PBR_OP1b_channel_004.tbc
DRAX_PBR_OP1b_channel_004.tbc
WHS1206_mat_001.tmf

Key shape files for mitigation scenario

Description

<i>2d_zsh_new_drax_layout_R_001.shp</i>	Proposed buildings.
<i>2d_zsh_woodyard_R_001.shp</i>	Removal of wood piles from DTM.
<i>2d_zsh_Drax_channel_L/P_001b.shp</i>	Lines and points for proposed channel.
<i>2d_bc_Drax_2d2dLink_001.shp</i>	2d to 2d link between 10m and 5m domain.

3.3.2 Mitigation Results

The results for the post development scenario with associated mitigation option are shown in Figure 9 below. The results of the model simulation clearly show the flow route through the site present in the baseline is reinstated with the mitigation option included within the modelling.

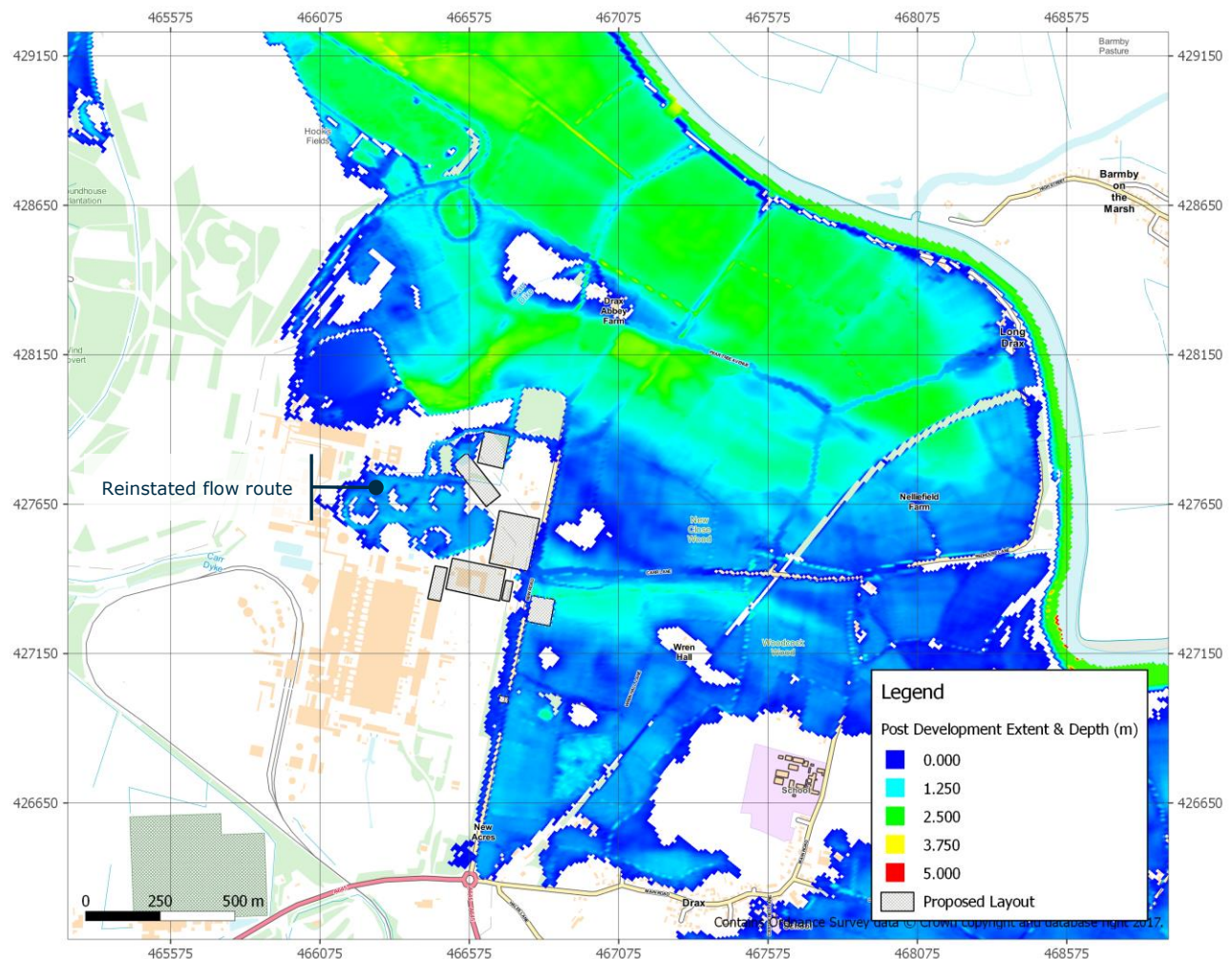


Figure 9 – Post Development with mitigation results

The results of the 2018 modelling were compared to the approved 2014 White Rose outputs. The depth change plots for the two different studies (Table 7) shows similar levels of detriment at the two locations. Levels of detriment are reduced to below 10mm in the 2018 Drax modelling when mitigation is provided. This is deemed to be a suitable level of increase given the previous results in 2014 and that no change in extent is shown (Figure 10).

Table 7 – Depth Change Plots White Rose (2014) Compared to Drax Repower (2018)

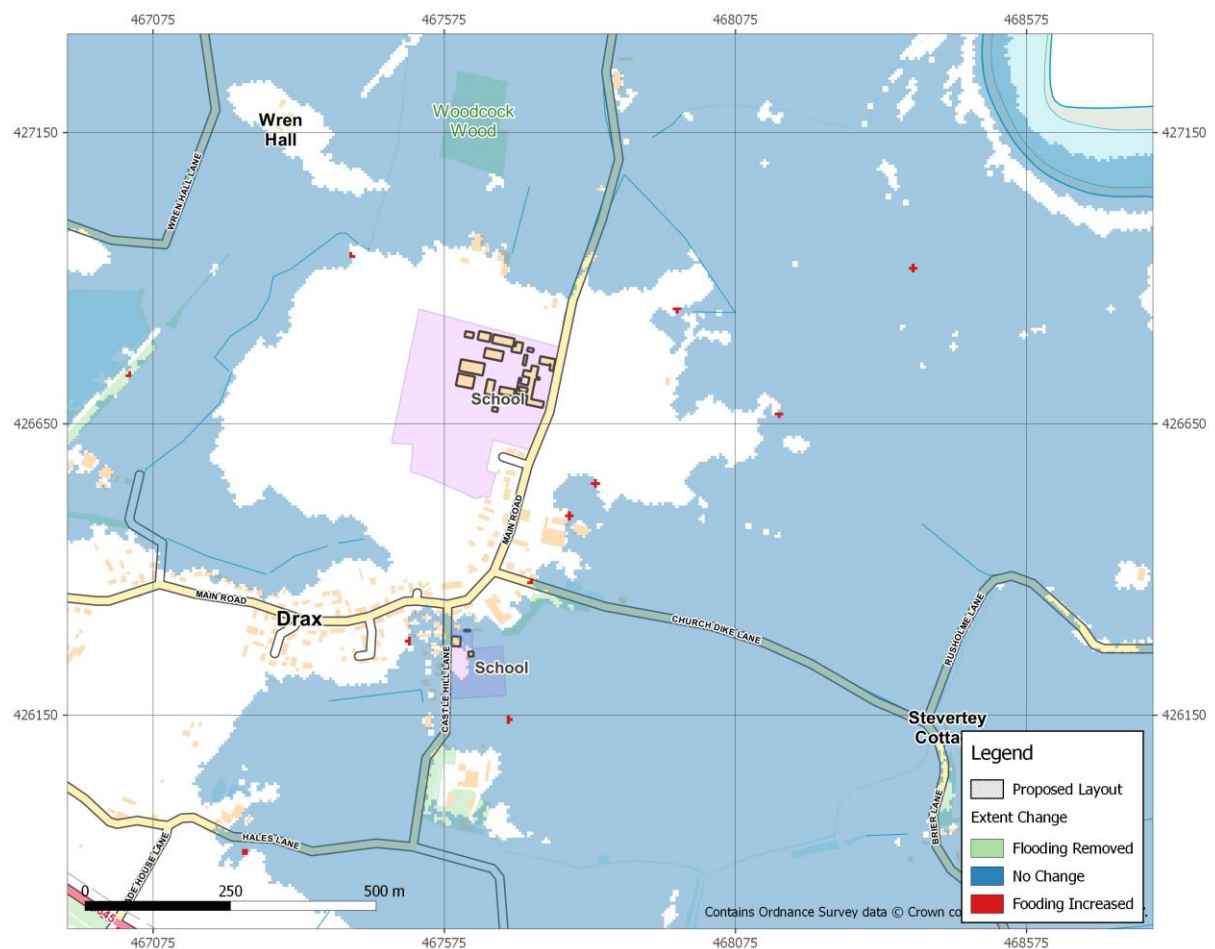
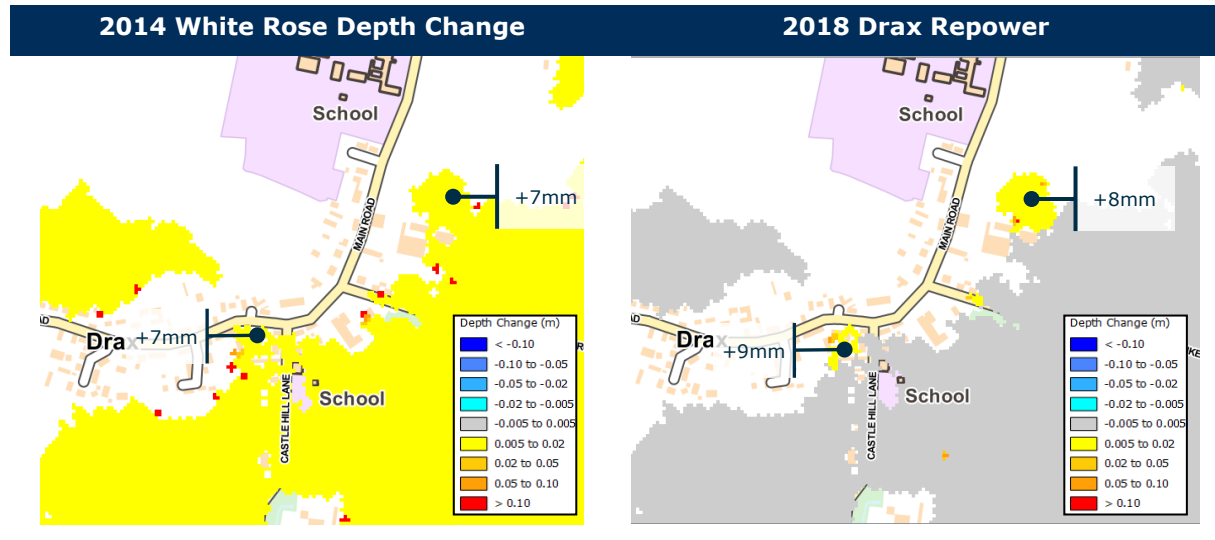


Figure 10 – Mitigation Compared to Baseline Extent Change Plot

4 Sensitivity Analysis

4.1.1 Floodplain Sensitivity

A comprehensive sensitivity analysis of the White Rose model is provided in Section 4.5 of the 2014 White Rose hydraulic modelling report (Appendix 1). In light of this and the fact that the EA have considered the White Rose model to form a suitable baseline, it is not deemed necessary to undertake additional sensitivity analysis on the current modelling.

4.1.2 Breach Sensitivity

To assess the model sensitivity to slight variations in breach geometry, the invert level of the breach was increased and decreased by 20mm. In reality, a breach scenario is likely to involve rapidly changing ground profiles at the breach location and is highly unlikely to have a fixed invert level in a real breach situation. Assessing the flood event to slight changes in breach geometry will allow for an assessment of the likelihood of any detriment caused by the development within the context of very specific conditions. It is particularly important in this instance owing to the hydraulic mechanisms resulting in minor detriment in the Drax village in the post development scenario. The results of this sensitivity analysis are shown in Table 8. Locations of key areas are shown in Figure 6.

Table 8 – Breach Geometry Sensitivity Analysis (Locations 1 and 2 shown in Figure 5)

Event	Change in Depth at Location 1	Change in Depth at Location 2
-20mm Breach Invert Level	+1mm	+15mm
Modelled Breach Invert Level	+13mm	+20mm
+20mm Breach Invert Level	+8mm	+11mm

The sensitivity analysis shows that the model is sensitive to small changes in breach geometry and that the hydraulic conditions which result in the minor detriment seen in Drax village occur under very specific conditions. With even slight changes to the breach geometry as seen in Table 8, depth changes between baseline and post development events are significantly reduced. This suggests that if a breach scenario were to occur, it is unlikely that flooding in Drax village would be significantly exacerbated if the Drax Repower scheme was constructed without mitigation.

5 Conclusions

Following modelling of the proposed Drax Repower scheme and the implementation of a mitigation option within the modelling, the results indicate an acceptable level of risk posed by the proposed additions at the Drax site. The key results and conclusions of the study are:

- Flood depth changes between the baseline and post development scenario are very low (1mm-3mm) across the vast majority of the floodplain.
- The post development scenario causes localised minor increases in flood depth in Drax village compared to the baseline event. These increases are generally between 13-20mm.
- The key mechanisms which result in this increase are a general reduction in baseline flood level across the entire floodplain in the 2018 modelling compared to the 2014 modelling. This is caused by slight changes to model solution calculations.

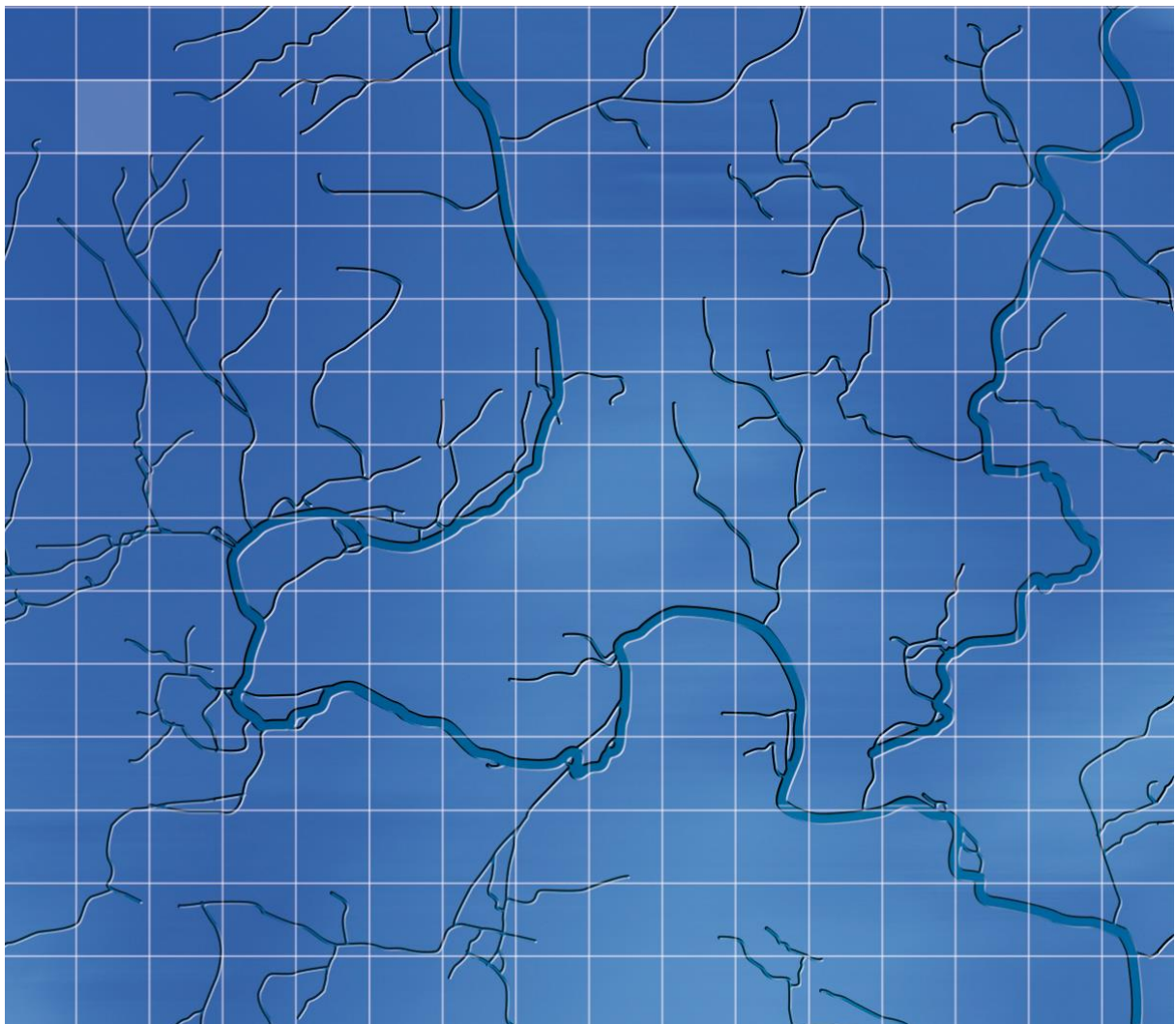
- This reduction caused topographic features in the areas highlighted to exacerbate differences in flood depth between baseline and post development scenarios.
- The localised small detriment seen in Drax is heavily dependent on the assumed breach conditions, and changes of only +/- 20mm in breach level significantly reduces the small change in flood depth between the post development and baseline.
- Owing to the fact that the predicted increases in flood depth are very small and localised and only occur in a specific extreme breach event, the proposed development is not considered to significantly increase flood risk elsewhere.
- Should the predicted minor detriment be unacceptable then the inclusion of a flood relief channel that reinstates a flow route through the Drax site may be considered. The inclusion of this feature reduces the detriment to below 10mm, similar to that which was accepted as part of the White Rose study in 2014. The requirement for any specific mitigation measures should be confirmed during detailed design.

Appendix 1 – 2014 White Rose Hydraulic Modelling Report

Environmental Resources Management

January 2014

White Rose CCS – Breach Analysis Study



Wallingford HydroSolutions Limited

Environmental Resources Management

White Rose CCS – Breach Analysis Study

Document issue details

WHS1206

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1	21 st January 2014	Draft	Cardiff
2	28 th January 2014	Final	Cardiff

For and on behalf of Wallingford HydroSolutions Ltd.

Prepared by Euan Hampton

Approved by Paul Blackman

Position *Technical Director*

Date **28th January 2014**

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This report has been produced in accordance with the WHS Quality Management system which is certified as meeting the requirements of ISO 9001:2008.

Contents

1	Introduction	1
1.1	Purpose	1
1.2	Sources of Data and Consultation	1
2	Site Description	2
2.1	Location	2
2.2	Existing Flood Risk	3
2.3	Tidal Flood Defences	4
3	Breach Modelling	5
3.1	2D Hydraulic Modelling	5
3.2	Breach Location	5
3.3	Breach Specifications	6
3.4	Hydrology	7
3.5	Model Build	10
3.6	Final Model Simulations	17
4	Modelling Results	17
4.1	Breach overview	17
4.2	Flood Level at the Site	20
4.3	Flood consequence	21
4.4	Flood Hazard	24
4.5	Sensitivity Analysis	27
5	Conclusion	35
Appendix 1	– Environment Agency Correspondence	i
Appendix 2	– Environment Agency provided data	ii

1 Introduction

1.1 Purpose

Wallingford HydroSolutions Ltd (WHS) was commissioned by Environmental Resources Management (ERM) to undertake a 2D hydraulic modelling breach analysis for the proposed White Rose carbon capture and storage facility (CCS) at the Drax Power Station, Drax, North Yorkshire. The analysis builds upon detailed consultation with the Environment Agency and an initial review of flood risk by ERM, as summarised within the White Rose Environmental Scoping Report (ERM, 2012)¹. The proposed CCS plant is sited approximately 700m from the River Ouse. Flood embankments exist along the banks of the Ouse.

The purpose of this commission is to provide a more detailed assessment of flood risk to the site posed by a flood defence breach, in order to confirm the suitability of proposed design levels for the site. The study will also assess the potential impacts of raising the site ground levels and associated loss of floodplain storage. To provide a more accurate representation of breach flood behaviour a 2D hydrodynamic model (TUFLOW) was required. This approach represents the current best practice in tidal breach modelling as recommended by the Environment Agency (EA)².

This technical report presents the background to the breach modelling undertaken using TuFLOW modelling software, the model build methodology and subsequent output results.

1.2 Sources of Data and Consultation

The Environment Agency has been consulted to agree the model parameters and scope for the modelling work (correspondence is provided in Appendix 1).

The main sources of data used within this study include;

- **River Ouse Model Update, Halcrow, September 2009** - The modelling report and appendices, prepared by Halcrow were supplied along with the extracts from the model results files and model files.
- **Flood Information, Environment Agency, 2013** - The Environment Agencies flood defence asset locations and condition ratings for the defences in the area were also supplied.
- **LiDAR data** – Purchased December 2013 from CentreMaps Live.
- **10K OS Mapping**

As part of the data request sent to the Environment Agency, water level hydrographs were requested at node locations adjacent to the proposed site. These hydrographs were not provided as part of the data package sent in response and therefore could not be used to inform the modelling undertaken. Alternative approaches were used to construct a water level hydrograph as described later in this report.

¹ ERM. 2012. White Rose Carbon Capture and Storage Project – Environmental Scoping Report on behalf of Capture Power Limited.

² Environment Agency Anglian Region. 2011. Requirements for Hazard Mapping (With guidance on breach analysis).

2 Site Description

2.1 Location

The site is located at NGR 466485, 427520 (Figure 1). The area surrounding the site is predominantly rural, with a number of small hamlets and villages such as Drax to the east, Camblesforth to the southwest and Barlow to the west. The main land use in the area is for agriculture, with around 85% of the surrounding land being categorised as this. The area is heavily drained, with a complex network of field drains in operation, as visible on OS mapping (Figure 1). The existing Drax power station takes up a considerable land area within the study area.

The proposed site is located immediately north of the existing Drax power station and the current ground levels range from approximately 1.8mAOD to 5.0mAOD. There is also a local spoil heap, which has a maximum level of 6mAOD.

The River Ouse is approximately 700m to the north east of the development site. The River Aire is also found to the south of the site, approximately 6km away. The River Ouse is a larger watercourse and due to the proximity this is considered to pose the dominant flood source, as confirmed by the Environment Agency. Flood defences are located along both watercourses; these are predominantly earth embankments. The existing defences are discussed in more detail within section 2.3.

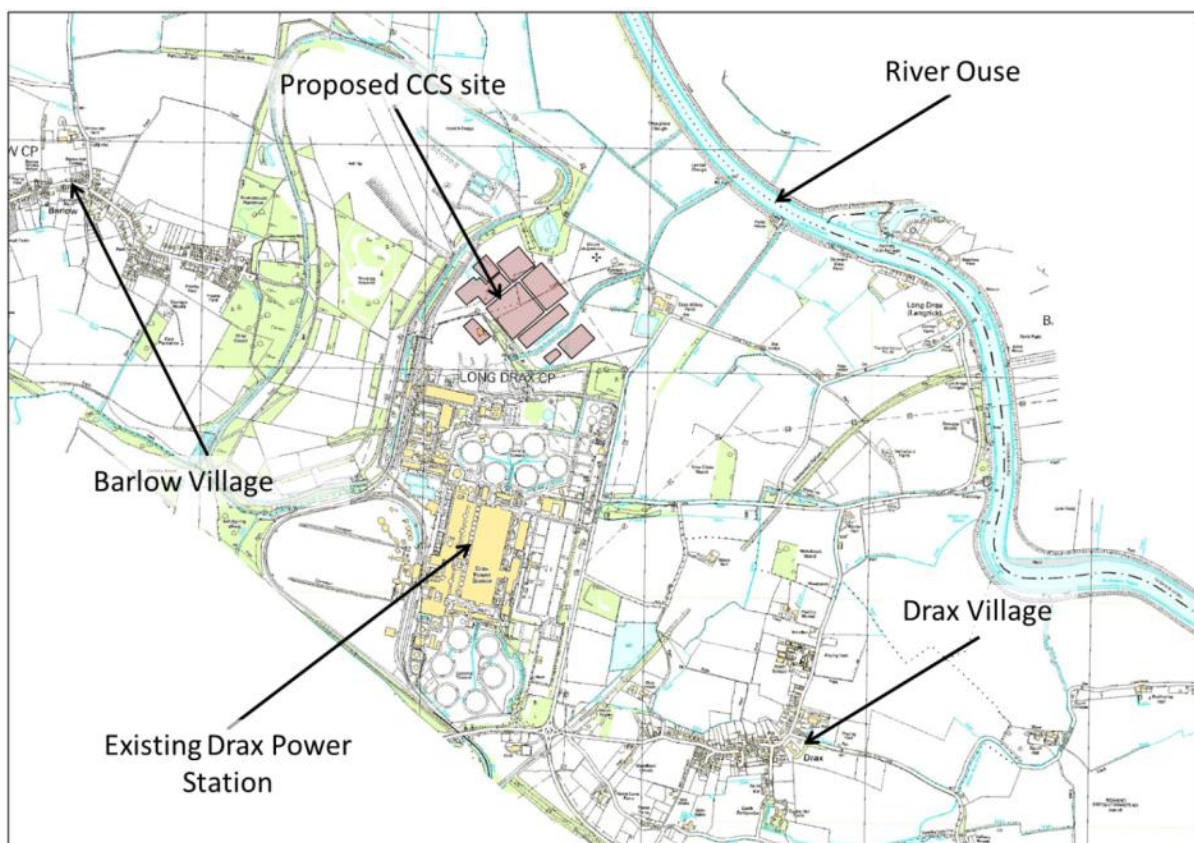


Figure 1: Site Location

2.2 Existing Flood Risk

Under natural conditions, including the absence of the River Ouse flood defences, the land around the proposed CCS site would form part of the Ouse estuary floodplain. Historically this land would have been prone to frequent flooding due to the low lying flat land profile and proximity to the watercourse.

The Environment Agencies flood map (see Figure 2) indicates that the site is at risk from flooding from a 1 in 200 year (0.5% Annual Exceedance Probability (AEP)) event from tidal sources or a 1 in 100 year (1% Annual Exceedance Probability (AEP)) event from fluvial sources, ignoring the benefit of existing flood defences. As the dominant mechanism for flooding at the site is considered to be tidal, this equates to a 0.5% AEP. The natural floodplain extent can be seen to extend for some considerable distance in all directions from the River Ouse.

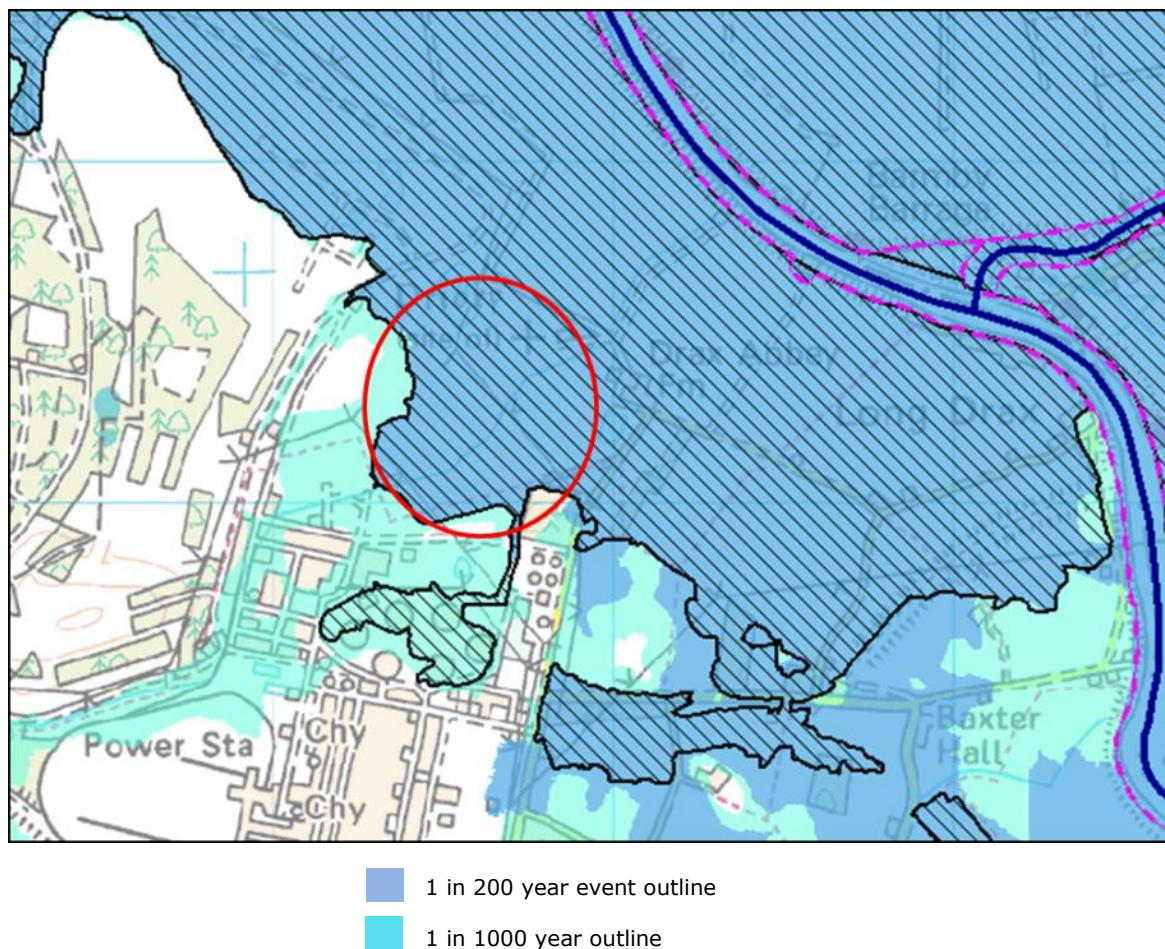


Figure 2: Environment Agency Flood Map showing approximate location of the site in relation to the River Ouse, and its predicted floodplain.

2.3 Tidal Flood Defences

The area around the White Rose site is protected from tidal flooding by defences that run along the banks of the River Ouse. These defences are in the form of earth embankments with localised sections of concrete walls and sheet-piling that provide a 1 in 200 year standard of protection (based on discussions with the Environment Agency in December 2013). Despite these defences, a residual tidal flood risk exists in the extreme possibility of defences overtopping or being breached. Of the two defence failures a tidal breach presents a greater threat to the site in comparison to that of overtopping, due to the volumes of water that would be associated with each.

The Environment Agency has confirmed the location of defences along this reach of the River Ouse, with details of its form, height (mAOD) and last surveyed condition (see Table 1 for guidance on condition rating). The map located in Appendix 1 highlights the location of the defences on the right bank of the River Ouse in this location.

Table 2 highlights the type, condition and heights of the defence.

Where condition is stated, the lowest condition rating for the defence is used, i.e. where the face has been given a rating of 4 “Poor”, but other elements still have a rating of 3 “Fair”, the Poor condition is stated.

Appendix 1 shows that the defence with reference 201R06 is located adjacent to the site. This defence is shown to have a condition rating of 4 for one of the elements. The Environment Agency has confirmed that although the landward face was classified with a rating of 4, this was not enough to lower the overall asset condition to the “poor” level, a copy of the email has been provided within Appendix 1.

Table 1– Environment Agency Asset Condition Grading (Source: Condition Assessment Manual, Environment Agency, 2006)

Grade	Description of Condition	Extent of Defects
1	Very Good	Cosmetic defects that will have no effect on performance.
2	Good	Minor defects that will not reduce overall performance of asset
3	Fair	Defects that could reduce performance of asset.
4	Poor	Defects that would significantly reduce performance of asset.
5	Very poor	Severe defects resulting in complete performance failure.

Table 2– Details of defence structures along this reach of the River Ouse, based on data provided by the Environment Agency a copy of which is contained within Appendix 1.

Asset Ref	Type	Defence height (US-DS)	Condition
201R08	Barrier flood bank	6.12 – 5.71	3
201R07	Barrier bank with sheet piling	6.15– 6.41	3
201R06	Barrier Bank	5.74 – 5.71	4
201R05	Barrier Bank with concrete walling	5.71 – 5.75	3
201R04	Raised Barrier bank	5.75 – 5.38	3
201R03	Flood bank	5.38 – 5.09	3
201R02	Barrier bank	5.09 – 4.71	3
201R01	Flood bank with sheet piling	4.71 – 4.84	3
101R04	Flood bank	4.94 – 5.89	3

3 Breach Modelling

3.1 2D Hydraulic Modelling

2D hydraulic modelling is particularly suited to tidal breach modelling allowing the propagation of flood water over a defined flood plain to be more accurately modelled, and more clearly analysed. This is achieved through the consideration of factors such as topographic divides, changes in slope and changes in surface roughness, all of which are modelled over the defined floodplain area. It is possible to estimate changes in depth, level and velocity of water over the defined floodplain. Furthermore, flood hazard mapping can also be derived for the site area enabling flood management decisions to be made.

A proposed breach methodology was proposed to the Environment Agency in November 2013 and this was agreed to during December 2013. A copy of the proposed methodology and the agreed acceptance are provided within Appendix 1.

3.2 Breach Location

The siting of the breach is critical in predicting the worst case flood scenario at any site. Given the nature of the catchment, which is relatively flat, it is considered most appropriate to site the breach location immediately adjacent to the proposed development. As such a length of defence was selected to the north east of the site. This section of defence was also considered suitable as it has the lowest asset condition rating score within the area, with one of the assets being rated as “poor”. Figure 3 below shows the selected breach location.

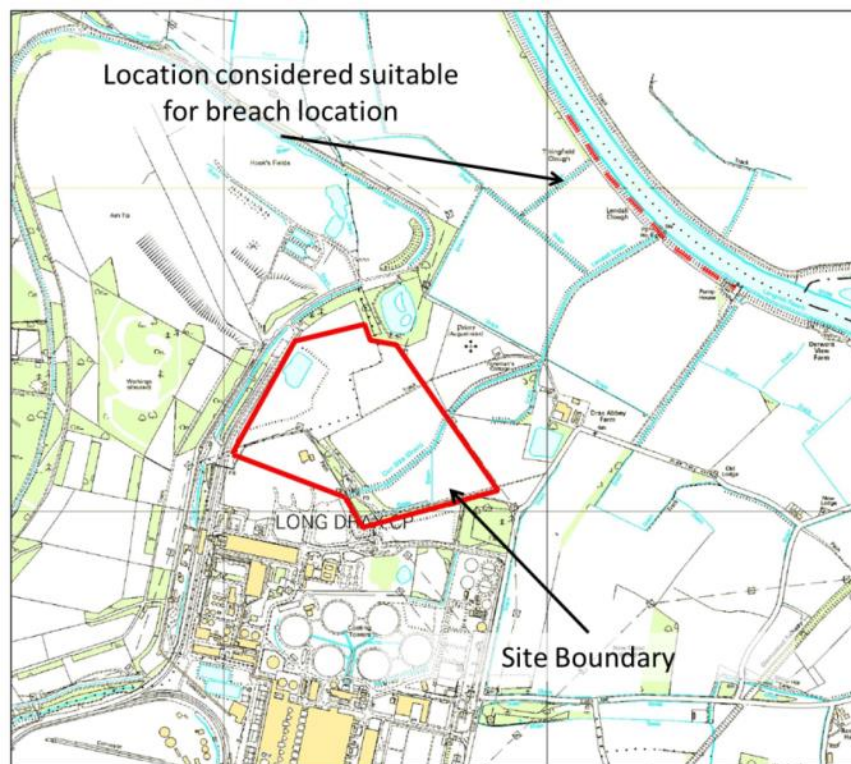


Figure 3: Selected breach location

3.3 Breach Specifications

The breach width and exposure duration are determined by the type of defence and the nature of the adjacent water body. According to Environment Agency guidance³, the breach width for earth embankments on a tidal river is 50m and should remain open for 72 hours.

The maximum breach level has been set to the ground level immediately behind the defence. The location of the breach was determined by considering the condition of the defences, proximity to the site and local floodplain topographic features.

The section of defence shown in Figure 3 is has the lowest asset rating and is located immediately adjacent to the site.

The level of the breach was based on an assessment of the levels immediately behind the defence, whilst confirming that this level was representative of ground levels along the defence in this location. The location shown on the plan in Figure 4 was considered to have ground levels that were representative of the floodplain behind the defences with a ground level of 2.48mAOD, as shown on Figure 5. This location is also considered appropriate being located upstream of the main drain running through the site, which has raised banks and would therefore tend to channel flood waters towards the site. This location was therefore considered to represent the worst case breach location.

³ Environment Agency, Anglian Region, Northern Area Requirements for Hazard Mapping.

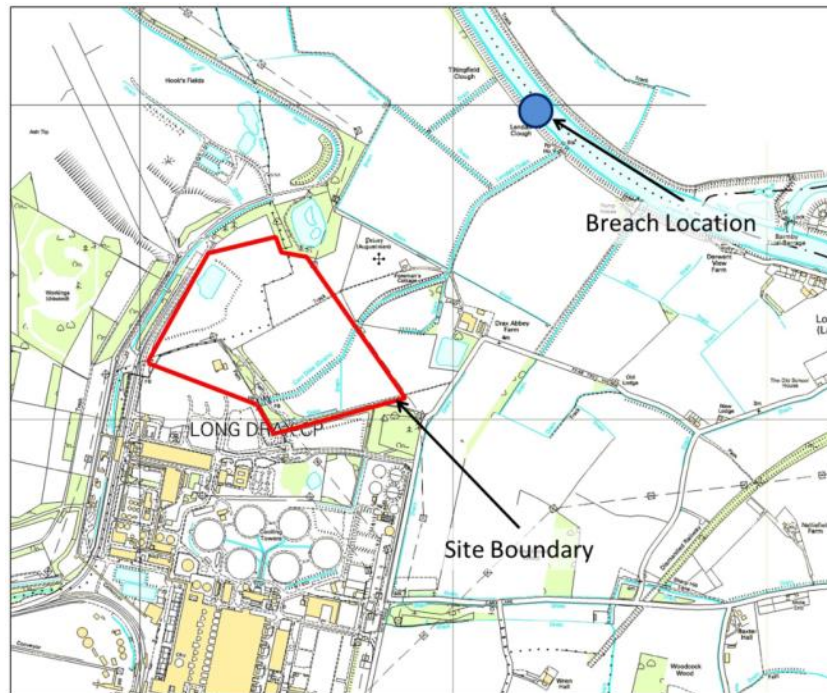


Figure 4: Location of breach in relation to the proposed development site.

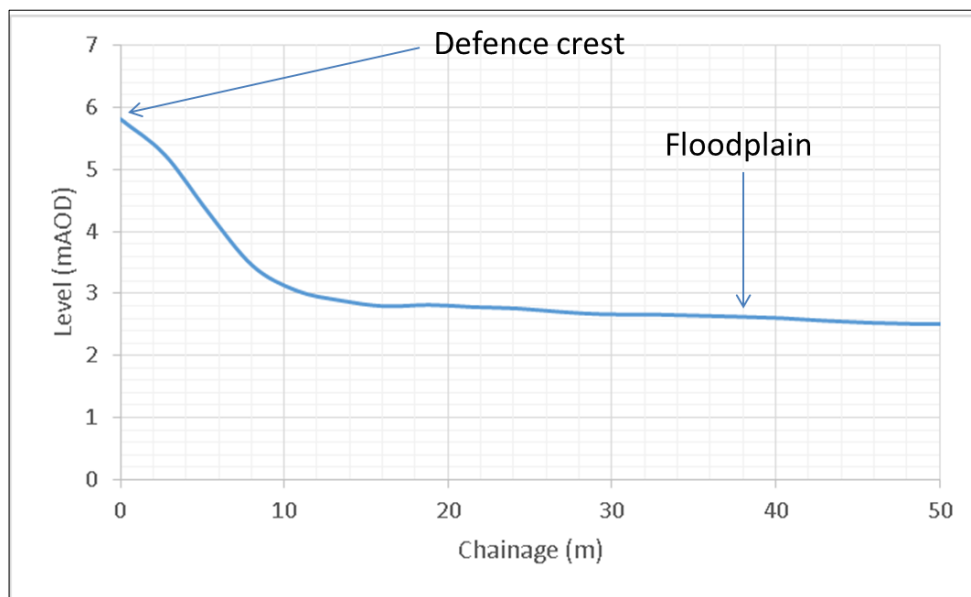


Figure 5: Profile of floodplain immediately behind the defence at the breach location.

3.4 Hydrology

The River Ouse adjacent to the proposed development is considered tidally dominant, with the Ouse tidal boundary approximately 15km upstream at Selby. In stream maximum flood levels have been taken from the Environment Agency hydraulic model of the River Ouse developed in 2009 by

Halcrow. Nodes CS45J, CS46, CS47 of the model have been considered, being found in the channel adjacent to the site. Table 3 below summarises the flood levels predicted at the aforementioned node locations.

Table 3 – Peak flood levels at model nodes adjacent to the site provided by the Environment Agency in 2013, extracted from the Halcrow model (2009).

Node	Peak Water Level, m AOD for Return Period (years) during a defended scenario							
	5	10	25	50	75	100	200	1000
CS45J	5.15	5.18	5.26	5.43	5.47	5.52	5.63	5.72
CS46	5.15	5.18	5.26	5.42	5.46	5.51	5.62	5.71
CS47	5.15	5.18	5.25	5.43	5.48	5.52	5.64	5.73
Average	5.15	5.18	5.26	5.43	5.47	5.52	5.63	5.72

Level hydrographs at the aforementioned nodes were requested from the Environment Agency to use as an inflow boundary to the 2D model. These have not been provided by the Environment agency, instead the downstream tidal boundary of the ISIS model was provided. The shape of this hydrograph will be used as the basis for the 2D hydrological input, scaled to the required flood levels.

As outlined to the Environment Agency (Appendix 1) this study will adopt the worst case event as the design standard for the proposed development site, whether this be the 1 in 200 year event (plus allowance for climate change) or the 1 in 1000 year event. Therefore to assess which of these two events is considered worst case an allowance for climate change, to be added to the 1 in 200 year event level was calculated. The design life of this development is considered to be 50 years and as agreed with the Environment Agency (Appendix 1) climate change will be calculated from present day to the year 2084.

It should be highlighted that the original study was carried out in 2009, as such an additional allowance must be calculated in order to bring the predicted 1 in 200 year tidal level up to present day (from which to start as a baseline).

Allowance for climate change was calculated from the National Planning and Policy framework technical guidance⁴. Based on this the predicted sea level rise between 2009 and 2084 equates to 427mm.

Assuming a sea level rise of 427 mm, the 1 in 200 year event design flood level would rise from 5.63mAOD (2009) to 6.06mAOD. Based on defence levels provided by the Environment Agency and provided in Appendix 2, this would result in the overtopping of defences at a number of locations along the Ouse in the vicinity of the Drax site.

The original hydrograph based on the study undertaken in 2009 and the scaled hydrograph to include an allowance for climate change up to 2084 are presented in Figure 6 below.

⁴ Department for Communities and Local Government. 2012. Technical Guidance to the National Planning Policy Framework.

As a result of the Environment Agency being unable to provide inflow hydrographs from the 1D nodes adjacent to the site, the downstream tidal curve used as the downstream boundary of the Environment Agency 1D model was scaled to the required peak flood level of 6.06m AOD adjacent to the site. When considering an extreme tidal event we also need to consider the minimum fluvial base flow in the river. We would normally opt to combine a QMED river flow with the extreme tidal event, however QMED fluvial level data were not provided with the Environment Agency data.

The minimum fluvial flood levels provided related to a 1 in 5 year fluvial event. Based on the Environment Agency data provided from the River Ouse model, the predicted 1 in 5 year maximum level is 4.38m AOD. As a result, this level was used as the minimum level that the water would reach during the simulation. Figure 6 highlights this level in relation to the 1 in 200 year tidal curve.

Using this method to form a model HT boundary within the model, the event modelled will equate to a 1 in 200 year tidal plus climate change (50 year) occurring in conjunction with a 1 in 5 year fluvial event and assumes that the peak level during the 1 in 5 year fluvial event is maintained over the 72hour simulation. This is therefore considered to be a conservative estimation of the level within the channel during the design event. Figure 7 represents the hydrograph used as the boundary within the model.

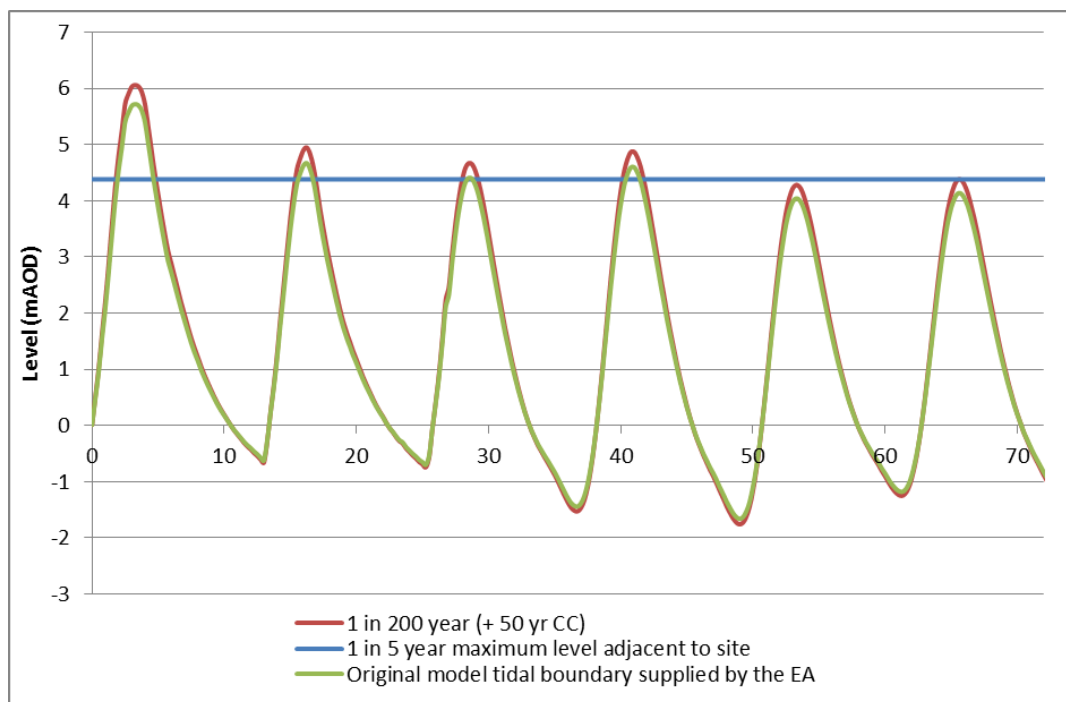


Figure 6: Inflow Hydrographs

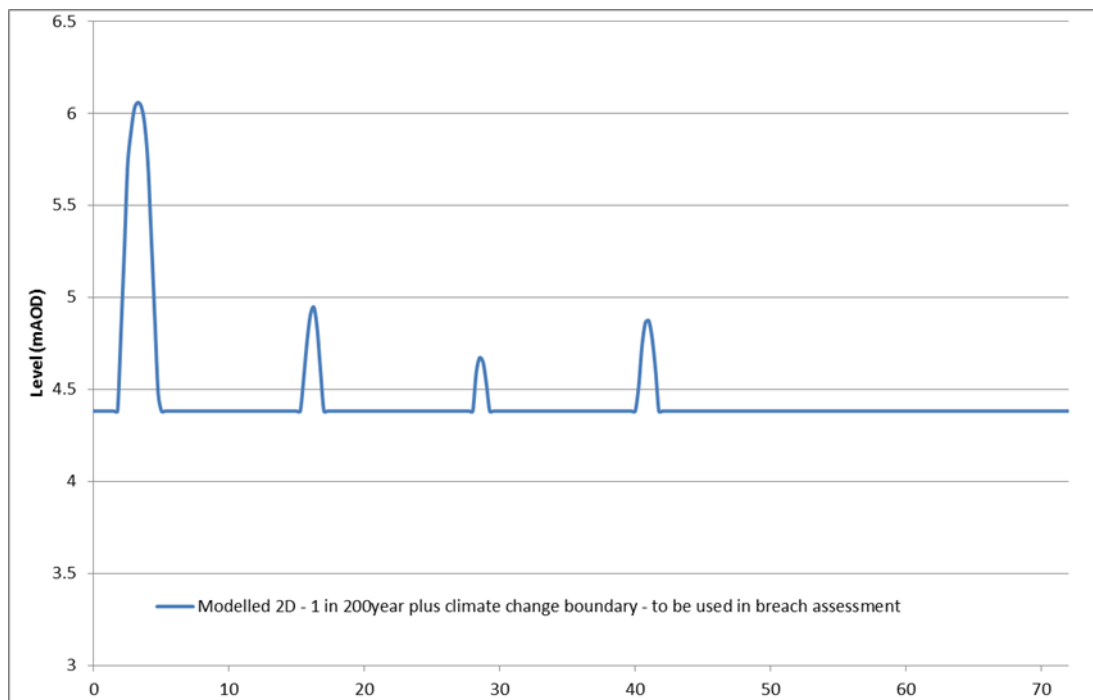


Figure 7: Inflow Hydrographs used within this model simulation – simulating a 1 in 200 year tidal event (plus 50 years climate change) occurring in conjunction with a 1 in 5 year fluvial event the peak of which is maintained throughout the entire model simulation.

3.5 Model Build

3.5.1 Model Data

The data used in the construction of the TUFLOW model includes;

- 2m resolution LiDAR data (filtered DTM);
- OS 1:10,000 Mapping, and;
- River Ouse Hydraulic model, maximum levels and tidal curve.

3.5.2 Modelling Assumptions

The following assumptions were made during the modelling.

The flood defence was assumed to be fully breached at the start of the simulation. In this instance water is allowed to gradually pour through the breach when the breach level is reached eventually increasing to the full tidal peak.

A bare earth DTM of the floodplain was used to reflect the base elevations of the area, while disregarding the influence of insignificant barriers to flow such as vegetation, fences and walls that are not designed to protect against flooding. Environment Agency guidance³ requires buildings within the flood plain to be modelled as barriers to flow through the increase of the Manning's n (ground roughness) value to 0.1 and raising of building footprints by 0.3m. This approach assumes

that buildings have an attenuation effect upon flood water levels. The Environment Agency guidance has been applied to the modelling conducted to reflect the fact that most buildings allow floodwater to enter through doors and air bricks and can be considered to be permeable. Further descriptions of the model runs conducted may be referred to within section 3.6.

3.5.3 Model Setup

The TuFLOW model has been developed using version 2012-05-AE-IDP-w64. The model has been simulated using a 2 second time step and a grid cell size of 10m which is considered acceptable because of the relatively flat topography of the flood plain. Flood plain topographic levels are based on LiDAR purchased from the Centre Maps Live in December 2013.

Figure 8 below shows the extent of the active TuFLOW area, which covers approximately 20km².

The TuFLOW model requires an inflow boundary condition to be defined. This is represented by a time dependent head boundary (HT) along the centre line of the channel, which replicates the extreme tide levels during the tidal flood event as outlined within the previous section. Figure 8 highlights the location of this inflow boundary in relation to the site, and the wider floodplain.

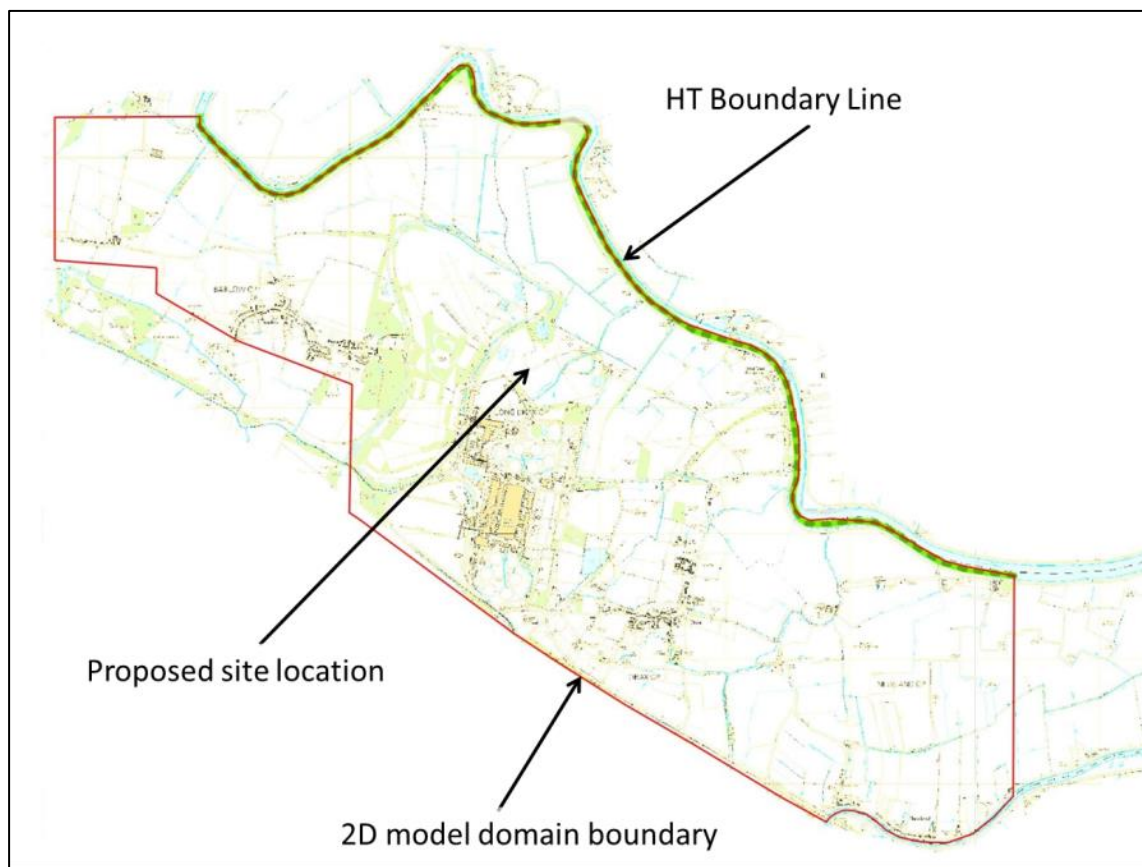


Figure 8: TuFLOW active model area

3.5.1 Floodplain Topography

Bare earth LiDAR data were supplied by ERM for use in the breach modelling. A filtered Digital Terrain Model (DTM) was used for this purpose. The LiDAR data were referenced to Ordnance Datum and has a horizontal resolution of 2m.

The DTM currently shows levels within the channel as approximately 4.5m AOD, likely reflecting water levels at the time of the survey. As such the levels must be lowered in order to allow free flow from and to the floodplain throughout the model simulation. The River Ouse bed levels as picked up by the LiDAR data were lowered in line with the minimum water levels that were to be modelled. As outlined in section 4.3 sensitivity analysis was undertaken on the lowest level to be read along the HT boundary, as such and in line with this the bed of the River Ouse channel were lowered using a za_shapefile to a level of 3.3mAOD.

3.5.2 Topographic features

The model grid size used within this study is 10m. As such defence level information was manually entered into the model to ensure that all high points and low points in the defences were taken into account. The lateral spill units used to represent the defences within the existing Environment Agency ISIS model were extracted, and converted to a shape file. Figure 9 outlines the location of the defences, and provides the average level along each of them as represented within the original model.

A number of road carriageways are raised above the floodplain. Given the grid cell size, these high points may be misrepresented, or completely missed through the model grid calculation process. As such these features that are considered to influence flood levels at the site have been manually re-entered into the DTM. As with the defences, lateral spills operating between reservoir units (which represent these roadways) were extracted from the original ISIS 1D model and converted to a shape file (points and lines), these were then entered into the model as Zshape files. Figure 9 below highlights the location of these road ways and provides an average level applied to them.

As mentioned within section 3.5.2, buildings within the floodplain were modelled as stubby buildings and raised above the floodplain by 0.3m. Figure 9 shows the location of these features.

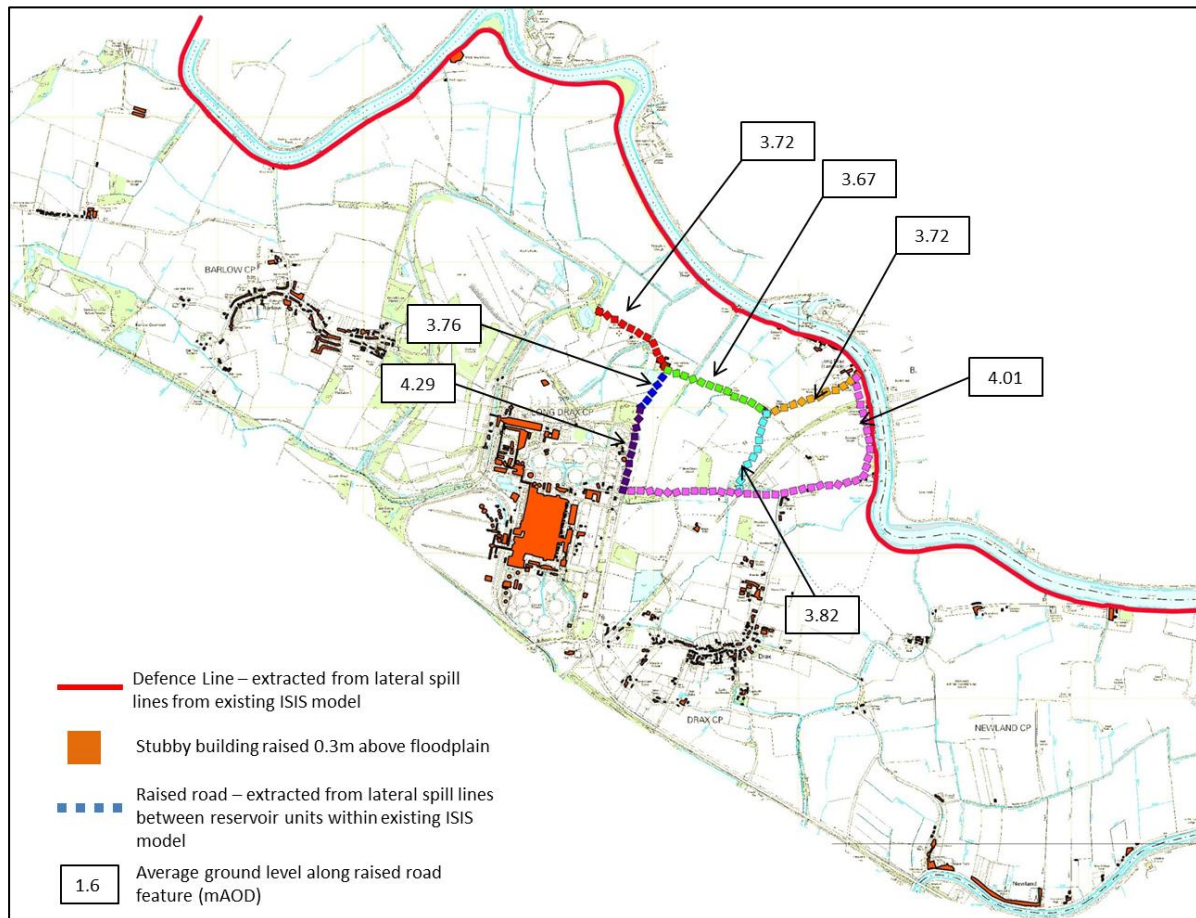


Figure 9: Topographic features added to the model

3.5.3 Manning's Roughness Values

The influence of hydraulic roughness represents the conveyance capacity of the land or riverbed where flows are occurring. Within the TuFLOW model, hydraulic roughness is defined by the dimensionless Manning's n coefficient.

A number of material roughness classifications have been identified based on engineering judgement and available literature (e.g Chow. 1959)⁵, with further guidance from the conveyance estimation software⁶. The distribution of these features has been defined using OS mapping in order to vary the conveyance rates throughout the model floodplain. Table 4 presents the key land use types identified along with their corresponding roughness values.

⁵ Chow, V T. 1959. Open-channel hydraulics. McGraw-Hill

⁶ Environment Agency. 2008. Conveyance Estimation Software

In order to improve the stability of the model and results through the breach, the breach shape file was assigned a higher Manning's value of 0.1. This will result in mass balance errors remaining below the 1% required by the Environment Agency, without impacting final model results.

Table 4 – Manning's n values used in TuFLOW model

Manning's n value	Description
0.035	Default – Open ground, Fields etc.
0.1	Buildings (stubby)
0.02	Roads
0.1	Woodland
0.01	Ponds
0.04	Industrial Workings
0.1	Breach

For more information with regard to the geographic location of each Manning's shapefile, please refer to the model files provided alongside this report.

3.5.4 Initial Water Levels (IWL)

To improve model stability the initial water level (IWL) within the River Ouse channel has been set to 3.3m AOD in line with level the bed has been lowered to.

3.5.5 Main Drain removal

As highlighted within Figure 10 below, the proposed development is located adjacent to a surface water drain. This drain has flood embankments on either side (non-formal), and therefore poses a significant block to conveyance. If water levels were to rise enough to allow water into the drain, the presence of the drain would result in storage of flood waters that may not exist, as during a flood event this ditch is likely to already be at capacity. As a result, the storage within the drain has been removed. This has been undertaken through the use of a Zshape, which will interpolate bank levels between the Zshape vertices along the embankments. This is the only drain within the area considered to provide potentially significant volumes of flood waters and therefore is the only one treated in this manner.

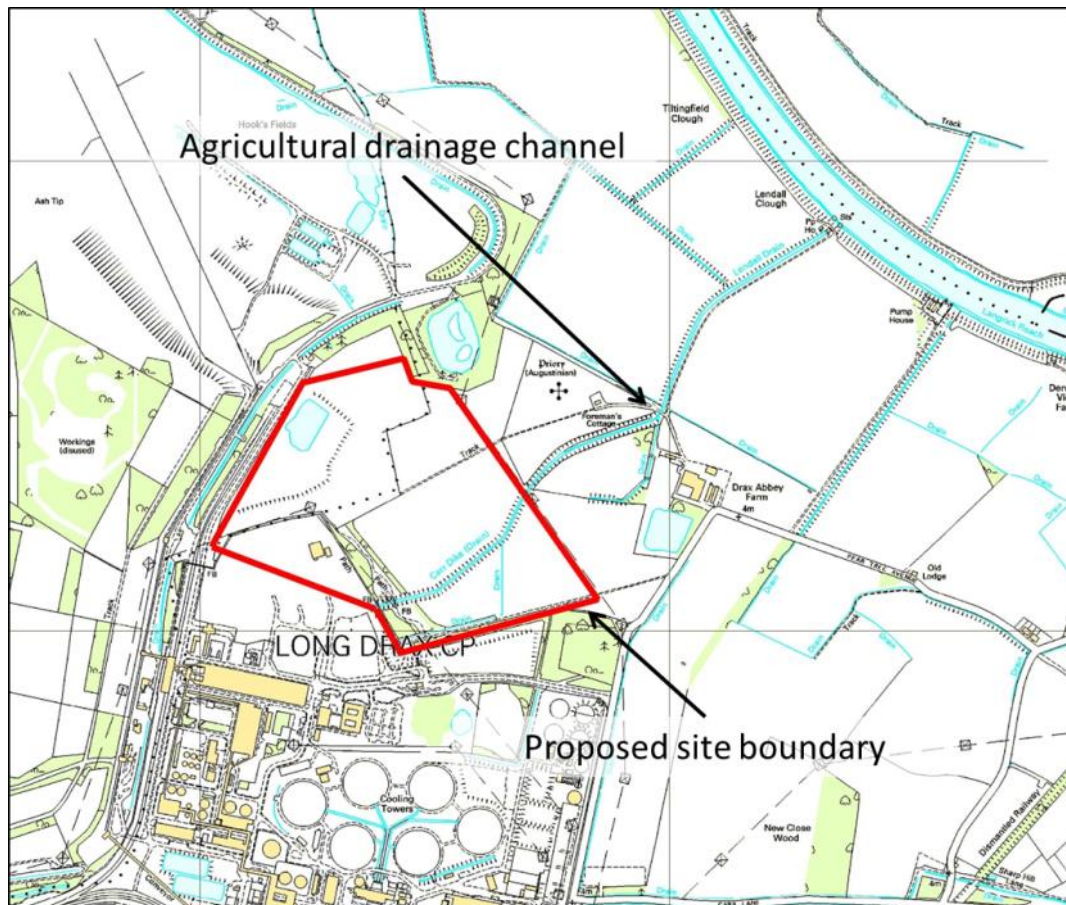


Figure 10: Location of main drain flow route to be removed from the model domain

3.5.6 Additional flow routes and culverts

A number of additional flow routes are present within the floodplain. A number of these are represented as orifice units between reservoir units within the existing Environment Agency model. In order to model these flow routes a number of 1D Estry units were modelled. Figure 11 below highlights the location of these culverts, the dimensions of which were taken from the original ISIS model (all found to be 1 x 2m).

As well as a number of culverts operating, 1 potentially significant “open” flow route was considered to require manual entry into the 2D domain. This flow route is highlighted on Figure 11 below; here the main carriageway of Redhouse Lane cuts through the disused rail embankment. The current model grid orientation caused this low point to be missed and so a zshape was manually entered to provide a flow route through the higher ground. Further detail is provided within the model files and log provided alongside this report.

Table 5 below highlights the dimensions of each of the Estry culvert units and the method for calculation.

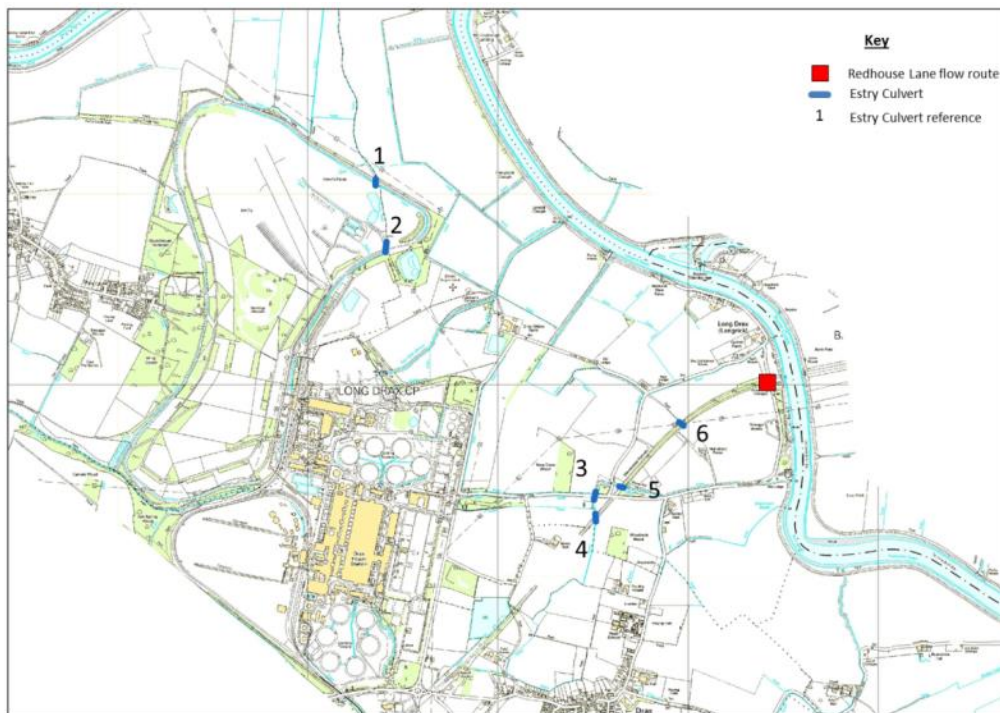


Figure 11: Location of additional flow routes within the floodplain

Table 5 – Dimensions of 1D estry culverts used within the breach model

Culvert Reference	Dimensions	Method of calculation
1	1m x 2m	Environment Agency Model
2	1m x 2m	Environment Agency Model
3	1m x 2m	Environment Agency Model
4	1m x 2m	Environment Agency Model
5	1m x 2m	Based on analysis of width of channel from LiDAR and based on representative culverts within the Environment Agency model.
6	3m x 3m	This is a footpath tunnel. Based on the raw LiDAR which identifies this route these dimensions are considered appropriate.

3.5.7 Post Development Topography

As this study will consider the flood consequence to the surrounding area as a result of the proposed development being raised out of the floodplain, a post development simulation was required. During this simulation the site was raised above the flood level (the level nominally set to 10m AOD), in order to consider and predict any likely impacts to the flood risk in the surrounding area. Figure 12 shows the modelled ground elevations, clearly showing the site boundary raised up above the surrounding floodplain during the post development simulation.

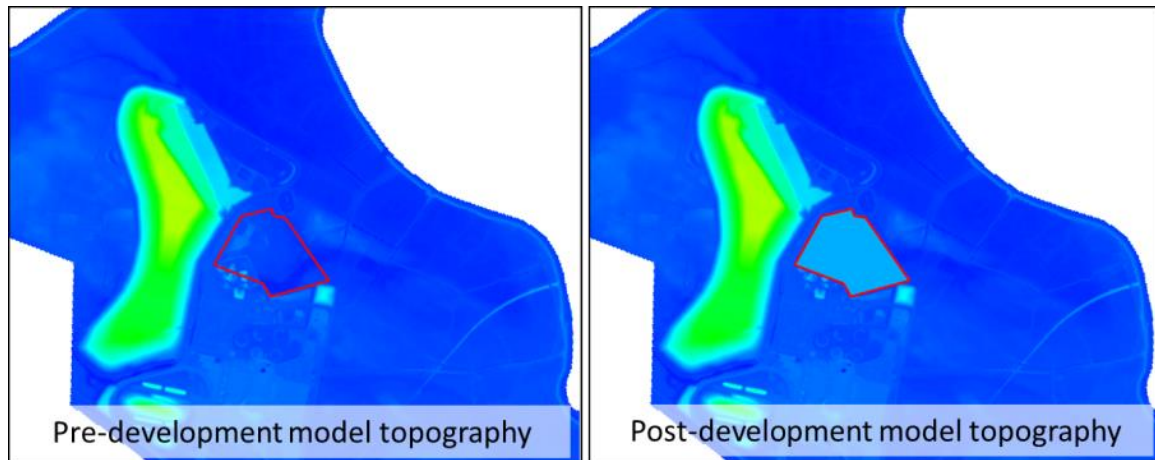


Figure 12: Raising the site above the flood level during the post development scenario through the use of a za_shape.

3.6 Final Model Simulations

The final model simulations that have been run in support of this breach analysis are;

1. **DRAX_BBR_0200T_2063_004** – This simulation represents a 0.5% AEP tidal event including a 50 year allowance for climate change occurring in conjunction with a 1 in 5 year fluvial event, with a breach of the defences occurring.
2. **DRAX_BBR_0200T_2063_004** – This simulation represents a 0.5% AEP tidal event including a 50 year allowance for climate change occurring in conjunction with a 1 in 5 year fluvial event, with a breach of the defences occurring. This simulation includes the raising of the proposed site out of the flood plain in order to allow consideration of flood impacts.

4 Modelling Results

4.1 Breach overview

As highlighted by Figure 13, which shows the proposed maximum flood extent during a baseline breach simulation, the site is considered to be at risk of flooding during a breach scenario. As required within the Environment Agency guidance documentation, a time series map of the tidal breach scenario showing the progression of flooding over the floodplain is presented within Figure 14 below. The simulation was run for a total of 72 hours which represents the approximate time required to repair a breach in this type of defence.

During the breach scenario, flood waters are first shown to breach through the embankment, and rapidly fill the low lying land directly to the north of the proposed site. This area is lower than the surrounding floodplain. As this area fills, the flood extent spreads to the south east, moving south towards a disused rail embankment, which presents a barrier to the conveyance through the floodplain. Flow routes through roads and culverts then begin to operate allowing floodwater through and around the embankment, resulting in flood waters following the natural gradient of the floodplain to the south east. As the simulation continues, flood water levels build up behind the railway embankment, causing the extent to increase to the north west of the study area (north of

the village of Drax), and to the south west. During this peak event, flood waters are also predicted to overtop the defences at a number of locations. As such the flood outline is the result of both a breach event and the predicted overtopping caused during a 1 in 200 year plus climate change event.

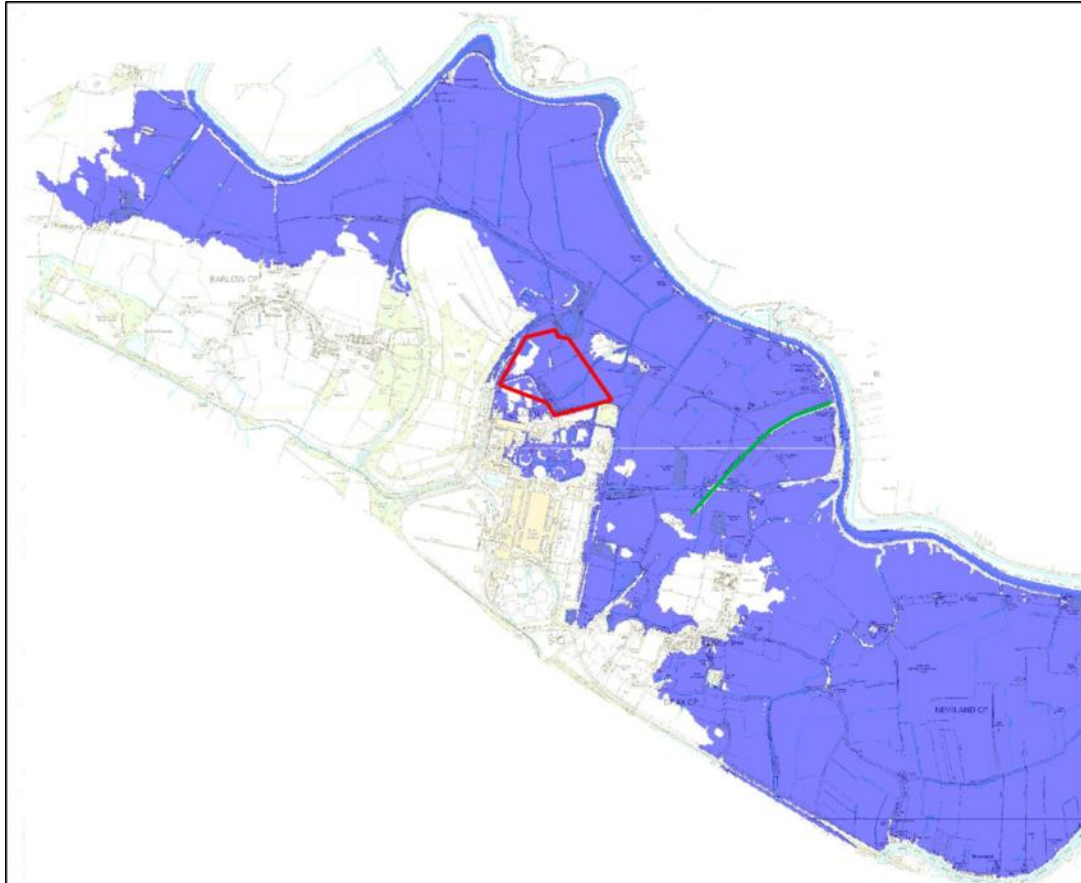


Figure 13: Maximum predicted flood extent during the modelled breach scenario, the location of the proposed development is highlighted in red, the location of the disused rail embankment is highlighted by the green line.

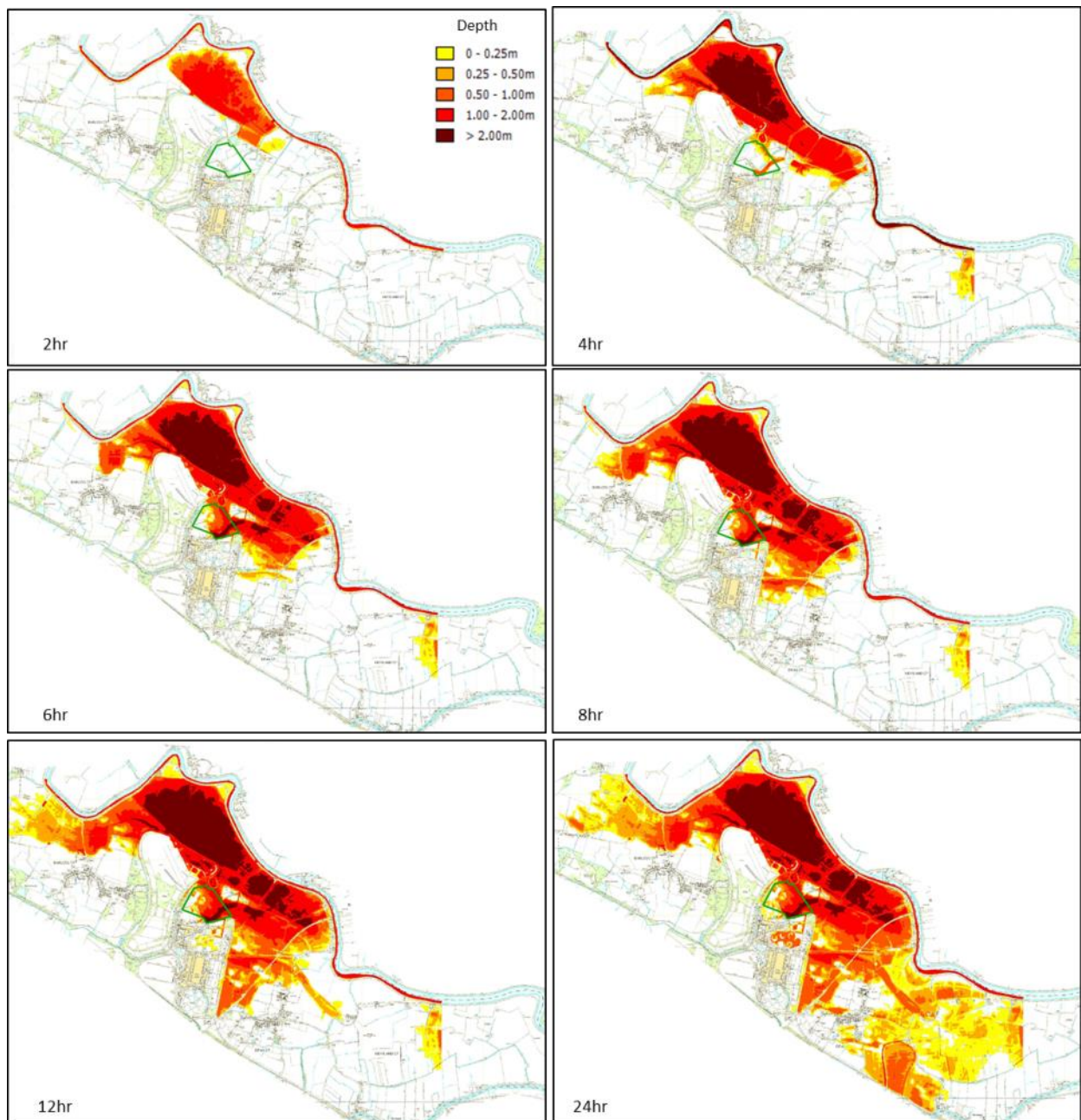


Figure 14: Time series map of the tidal breach simulation. The site is outlined with a green boundary.

4.2 Flood Level at the Site

Figure 13 highlights the maximum flood extent in relation to the site boundary. The maximum flood level at the site is predicted to be 4.53mAOD.

The maximum flood level at the site occurs at 17hrs hours into the simulation. This is approximately at the time of the second tidal peak in the simulation. This level reduces as tidal level decreases, to be reached again during the following tidal peaks.

It should be noted that glass walling does occur within the model. Figure 15 below highlights the location of the glass-walling. When glass walling occurs within a model, a number of checks and analyses need to be undertaken, as this can result in over estimation of flood levels within the 2D domain. With this study, the glass walling is not considered to cause significant over estimation of flood levels at the site as described below.

Firstly, when considering the water profile gradient through the catchment, it is clear that water levels are not flat, and that the glass walling is not causing a flat water profile back to the site location. Levels at the site are more dependent on the disused rail embankment, which creates a significant block to conveyance of the floodwaters. Often the model would be checked by adding a nominal outflow boundary along the line of which glass walling is occurring. However, in this case the glass walling is not considered significant to the site, nor is using an outflow boundary considered appropriate. When considering the topography of the ground to the east of the water profile (where the water would be expected to move, if glass walling was not occurring), there is a very limited volume of floodplain storage. The flood embankments along the lower River Ouse, and the River Aire will cause a natural barrier which will cause water to pool up behind in the same way as this glass walling effect.

The current proposed site level is 5.1mAOD, based on initial designs for ground raising. This level is 0.57m higher than the predicted flood levels that would be predicted as a result of combined breach and overtopping of the defences.

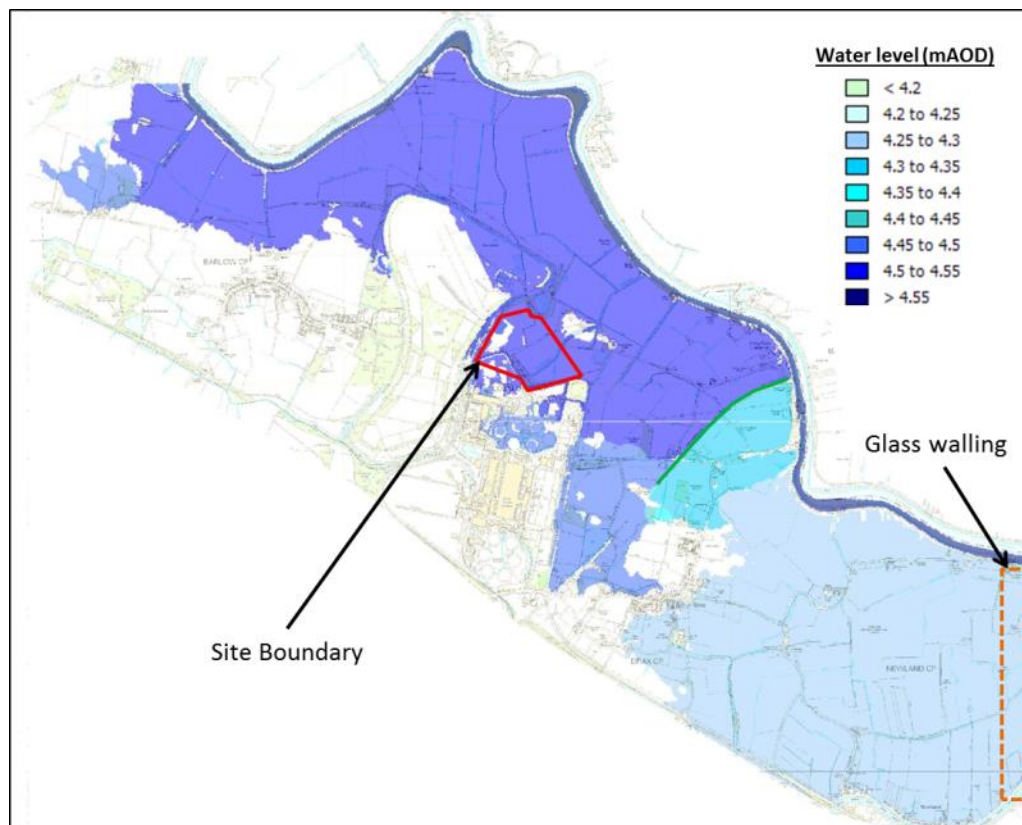


Figure 15: Water surface profile within the 2D domain shows a gradient down to the south east. The location of glass-walling is highlighted; however this is expected to have minimal impact due to the water level profile, the presence of the disused railway embankment (green line) and the relatively small area of flood plain storage to the east of this area.

4.3 Flood consequence

4.3.1 Overview

As the site is proposed to be raised above the predicted flood level, assessment of the consequence of this loss of floodplain storage has been undertaken to consider any change in flood risk in the surrounding area as a result of the proposals. In order to consider the flood consequence of the site, assessment of the change in extent, depth and flow velocity will be undertaken across the 2D domain.

4.3.1 Flood extent change

Minimal increase in flood extent is predicted as a result of the proposed development as these are shown to be restricted to a small number of model 10m cells and represent an insignificant increase in isolated patches around the edge of the flood extent. No additional properties or infrastructure lie within the predicted flood extent as a result of the development. As such, it is considered that there is no significant increase in flood extents as a result of the development. Model results files have been provided alongside this report. The proposed development reduces

the flood extent and reduces the predicted risk to the existing power station to the south west, as highlighted on Figure 17.

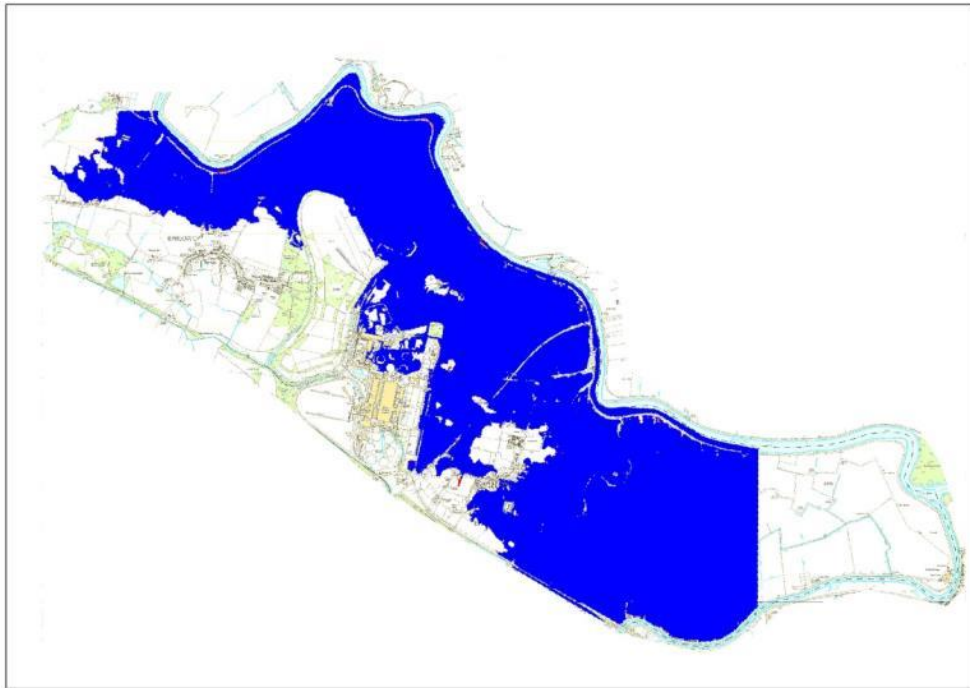


Figure 16: Change in flood extent as a result of the proposed development. Pre-development shown in blue, post development highlighted in red.

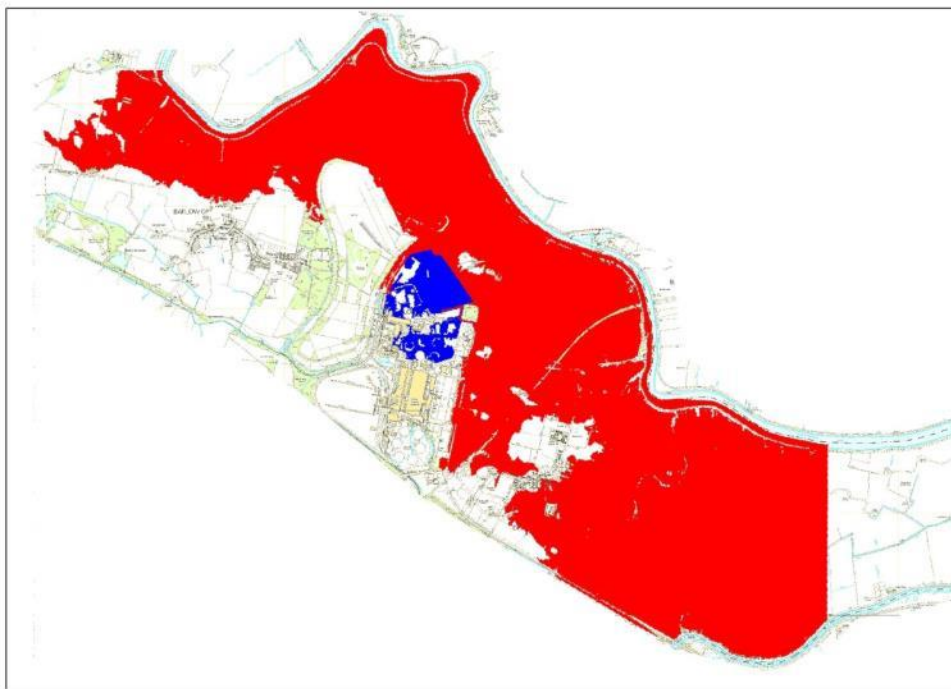


Figure 17: Reduction in flood extent as a result of the proposed development. Pre-development shown in blue, post development highlighted in red.

4.3.2 Flood depth change

During the baseline breach simulation (minimum water level in watercourse set to the 1 in 5 year fluvial peak) some minimal flood depth change as a result of the proposed site raising is found in relatively isolated patches as highlighted in Figure 18. Marginal increases are found in "Area A", with the maximum increase found to be 0.012m. Given that this area is already considered to flood during a pre-development simulation to an average depth of 1.4m and the land is currently the location of a pond and bordering fields, this increase is not considered to be significant.

Area B as highlighted within Figure 18 also shows a marginal increase in flood depth, with the flood level increasing by an average 0.03m. This area is predicted to flood to a depth of 0.08m during the pre-development scenario. Although this is a relatively large increase as a proportion of the pre-development predicted depth, as this is an isolated area within a wooded field on the power station site, this is again not considered significant.

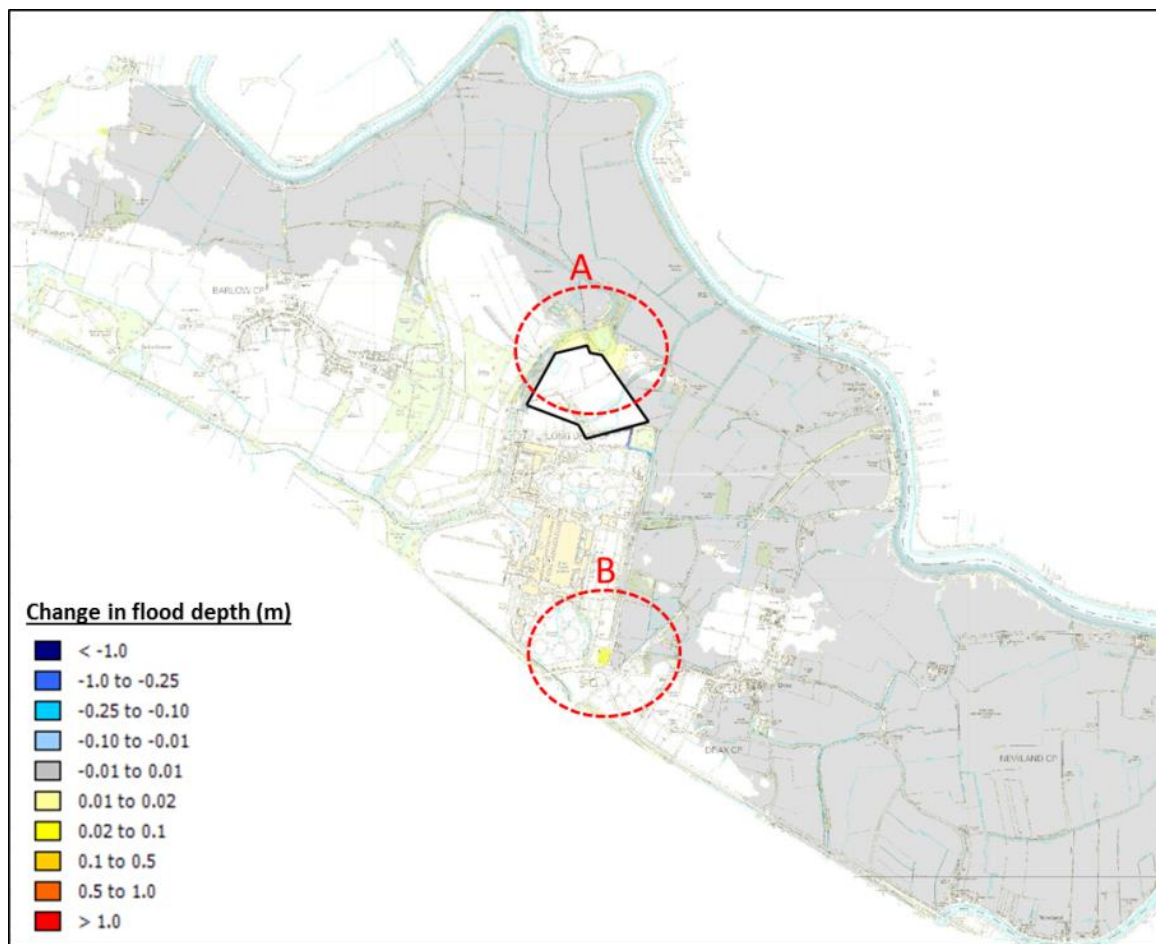


Figure 18: Change in predicted flood depths as a result of the proposed development (baseline breach analysis)

4.3.3 Flood velocity change

Flood velocity changes are predicted as a result of the development as highlighted in Figure 19. Velocities are shown to decrease generally adjacent to the site, with some peaks in increased velocity as flood waters are channelled along the boundary. Flow velocity increases identified are low, although there is an isolated number of cells showing a higher change. Average flow velocities during the pre-development scenario are 0.58m/s and 0.31m/s in locations A and B respectively. Maximum velocities reach 1.77m/s and 0.50m/s in areas A and B respectively. This highlights that these increases are not significant.

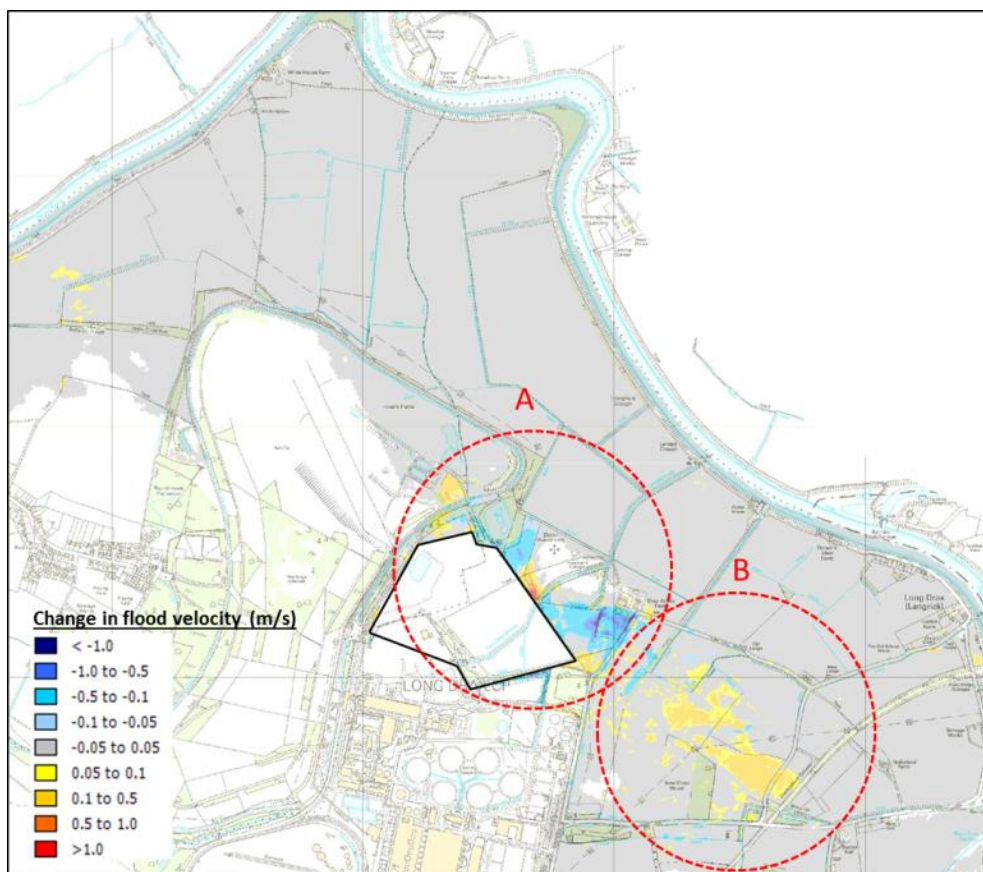


Figure 19: Change in predicted velocity as a result of the proposed development (primary assessment).

4.4 Flood Hazard

The proposed development site will sit above the flood level, as such no flood hazard will exist on the site. Flood hazard mapping has been undertaken to consider the flood hazard across the general area.

The hazard of flooding is a function of depth and velocity, combined with a debris factor and is used to classify the flood risk to people as a result of flooding.

In order to assess the maximum flood hazard during a flood event, the hazard level at each cell of the TuFLOW grid is assessed at every time step of the model simulation. Each element within the model is assigned one of four hazard categories 'Extreme Hazard', 'Significant Hazard', 'Moderate Hazard', and 'Very Low Hazard'. The derivation of these categories is based on the guidance set out in Flood Risks to People FD2320 (DEFRA & EA, 2005). Table 6 below shows the hazard rating for each category and a description of what this means.

Table 6 – Hazard to People Classification using Hazard Rating

Hazard Rating (HR)	Hazard Category	Description
Less than 0.75	Very Low Hazard	Caution
0.75 to 1.25	Moderate Hazard	Danger for some – includes children, elderly and infirm
1.25 to 2.0	Significant Hazard	Danger for most – includes the general public
More than 2.0	Extreme Hazard	Danger for all – includes emergency services

Figure 20 below presents the flood hazard ratings generated for the surrounding flood plain. As is clearly visible, the breach results in hazardous conditions, primarily associated with the very large flood depths experienced across this very flat topography. It should however be highlighted that there is safe access to and from the proposed site, via the existing power station complex. Although access routes have not been confirmed at this stage, it is suggested that these be directed towards the south, or south west of the site. Figure 21 shows the hazard rating to the surrounding area pre-development, as can be seen the wider catchment is shown to be in extreme hazard prior to the development and therefore there is no change overall.

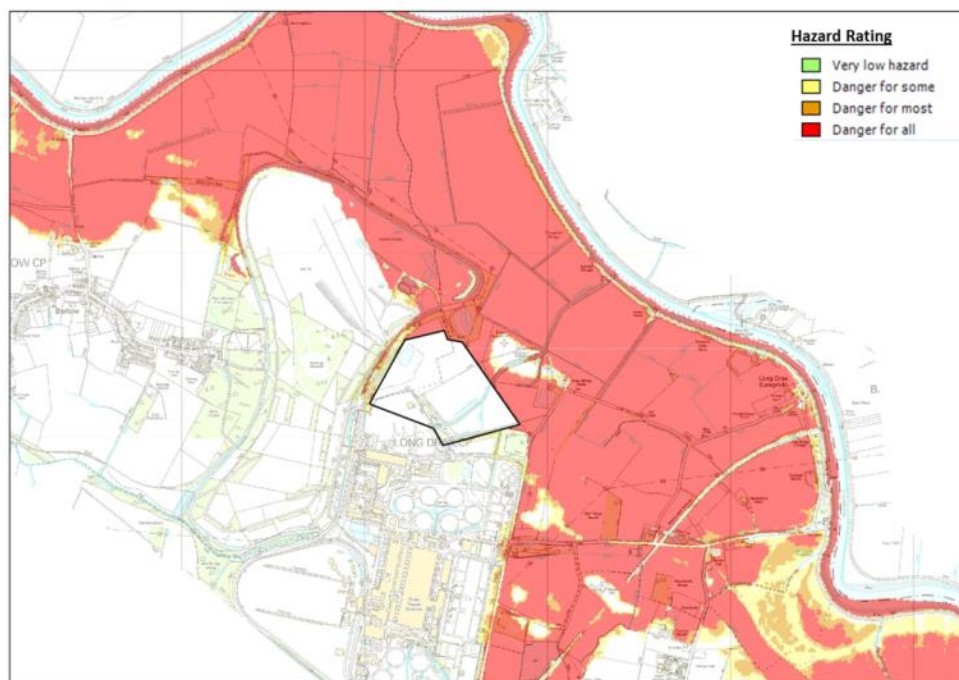


Figure 20: Hazard rating based on FD2320 – post development construction.

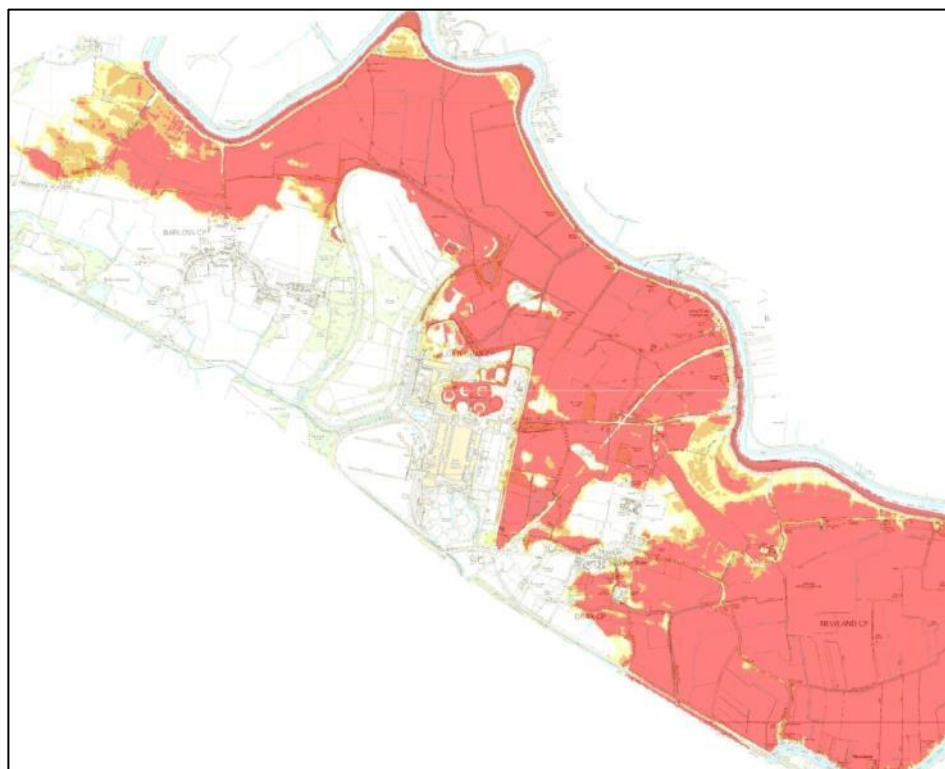


Figure 21: Hazard rating based on FD2320 – pre development construction.

4.5 Sensitivity Analysis

4.5.1 Overview

The use of 1 in 5 year flood fluvial flood levels as a minimum level in the inflow hydrograph provides a conservative estimation of the flood level at the site and sensitivity analysis has been undertaken on the minimum water level represented within the River Ouse. The baseline model uses a flood level within the channel set to the 1 in 5 year fluvial level. As a sensitivity test this has been reduced by 1m. The hydrograph associated with this sensitivity assessment is provided in Figure 22 below and shown alongside the baseline hydrograph in use.

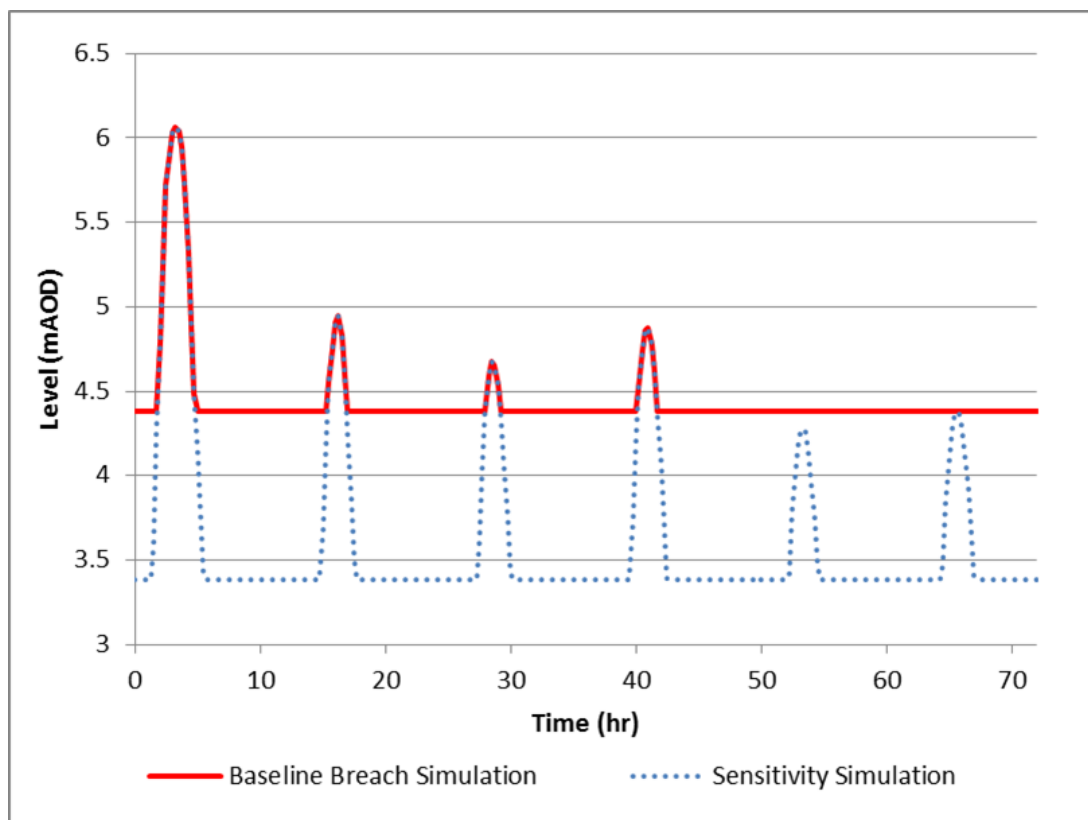


Figure 22: Sensitivity model inflow showing the minimum level reached during the tidal event being lowered by 1m compared to the baseline breach analysis simulation.

4.5.2 Design level and Flood extent

During the sensitivity analysis, the flood levels at the proposed development site are predicted as 3.94mAOD. This is 0.59m lower than that predicted during the baseline simulation.

As highlighted within Figure 23 during the sensitivity analysis, there is a greater increase in flood extent as a result of proposed development. This is found in the area highlighted within Figure 23 below. At this location, greater flow is found within the culvert units, allowing a greater conveyance of flood waters from upstream to downstream. These identified increases in extent are all found

within existing low points in the LiDAR. OS mapping shows these to be existing field drain systems. As such, the increased flood extent is not considered significant.

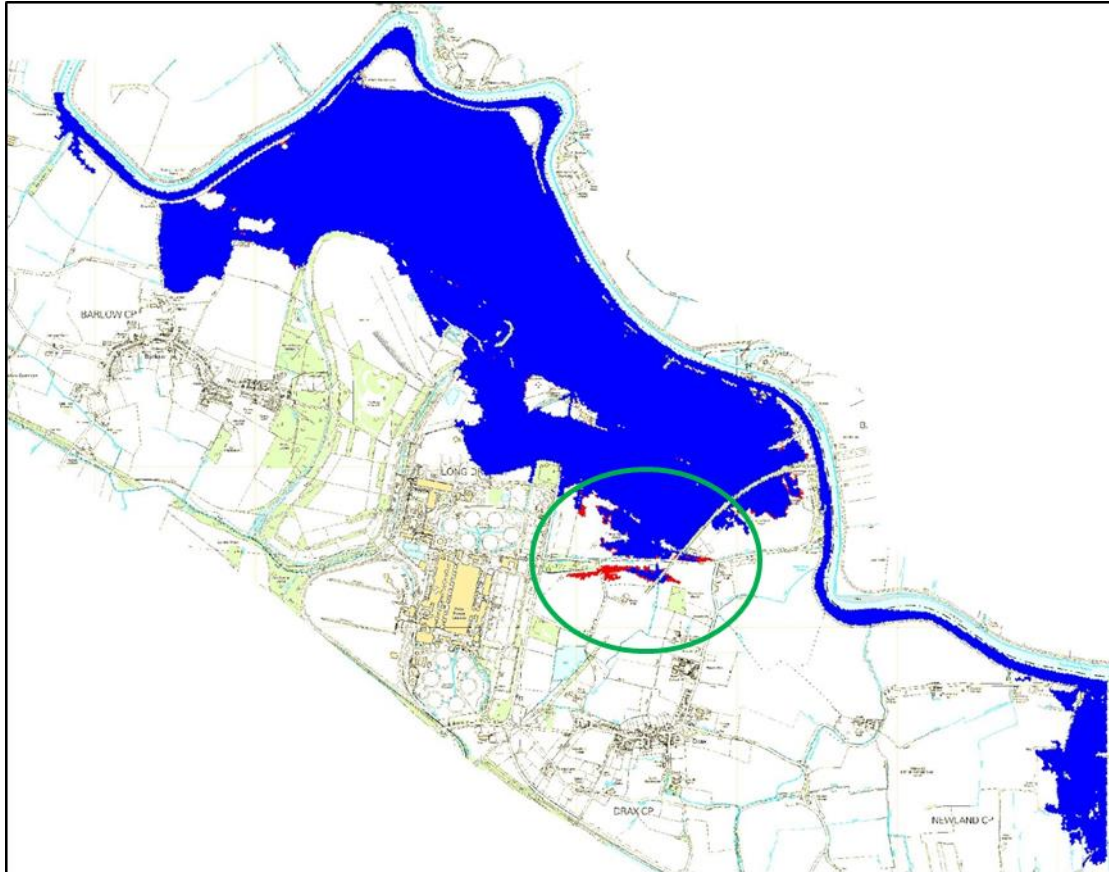


Figure 23: Change in predicted flood extent as a result of the proposed development (Sensitivity analysis)

4.5.3 Flood depth

During the sensitivity assessment the impacts on flood depth are slightly greater. Locations C and D in Figure 24, located close to the proposed development, suggest an increase in flood depth of up to 0.013 and 0.016m respectively. Given the rural location of these areas, and maximum depths in these areas reaching greater than 3m with averages of 1.6m and 1.9m respectively, this increase is not considered significant. Within the area marked E, the maximum increase predicted is 0.037m, given that flood depths are already considered high (0.9m), this increase is not considered significant.

Flood depths are also predicted to increase in area F. To the south of this area, these increases (up to 0.5m) are located within existing drainage ditches and are a product of increased flow through the culvert underneath the main road. Due to the location in an existing field drain this increase is again not considered significant. The increases to the north of the road are on average 0.03m, however increases of 0.09m are found as a result of an increased flood extent. Flood depths in this location are predicted to reach 0.35 during a pre-development simulation.

There are, however, a number of properties across the floodplain that show an increase of 0.01m or greater and therefore this must be considered in more detail. Figure 25 highlights 33 properties that are within or very close to the flood extent and point analysis has been carried out to assess the predicted flood depths pre and post development. The largest increase in flood depth is found at property 15, where flood depth increases from 0.12m to 0.14m (0.02m increase). This increase is relatively small and will not result in a significant increase in flood damage or flood hazard. Table 7 provides a summary of the impacts at the other properties identified.

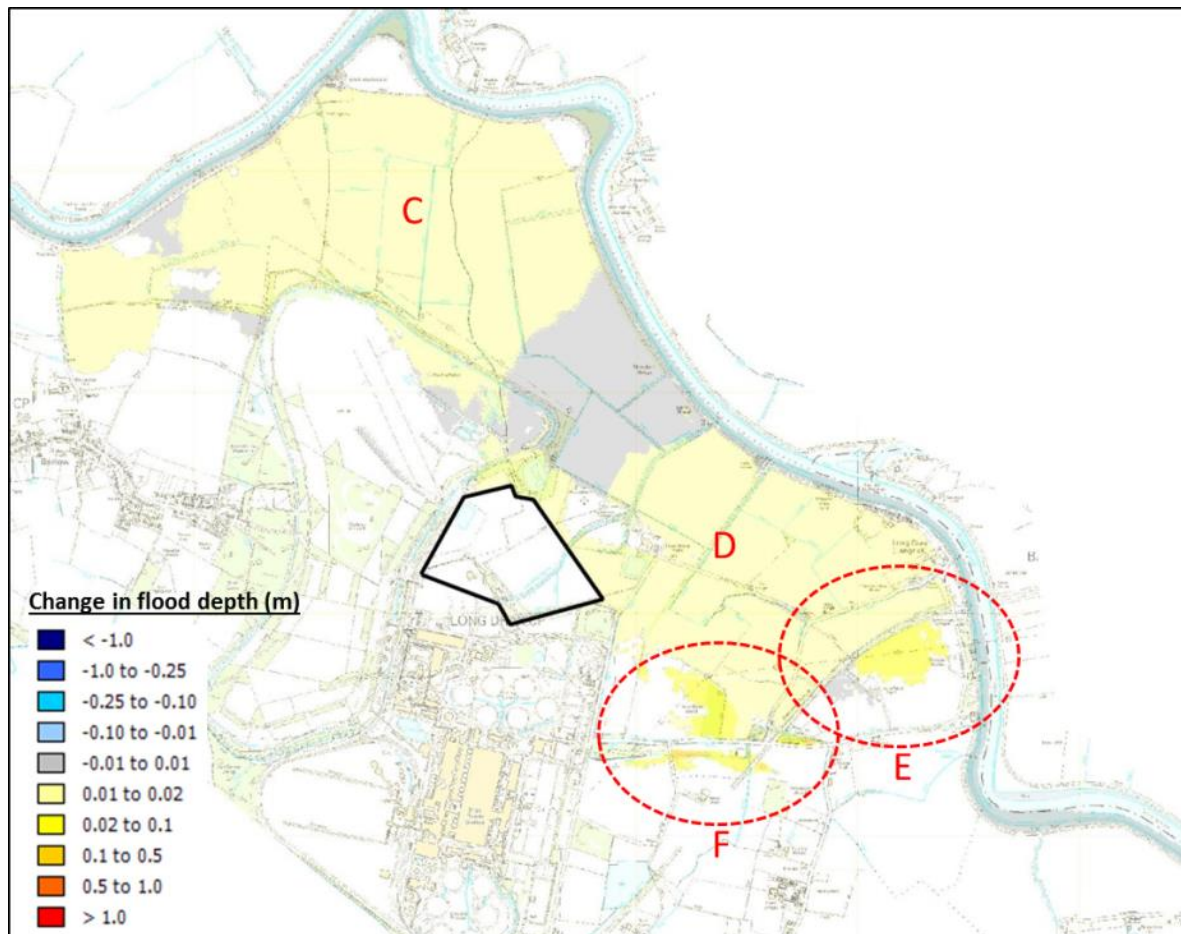


Figure 24: Change in predicted flood depths as a result of the proposed development (Sensitivity analysis)

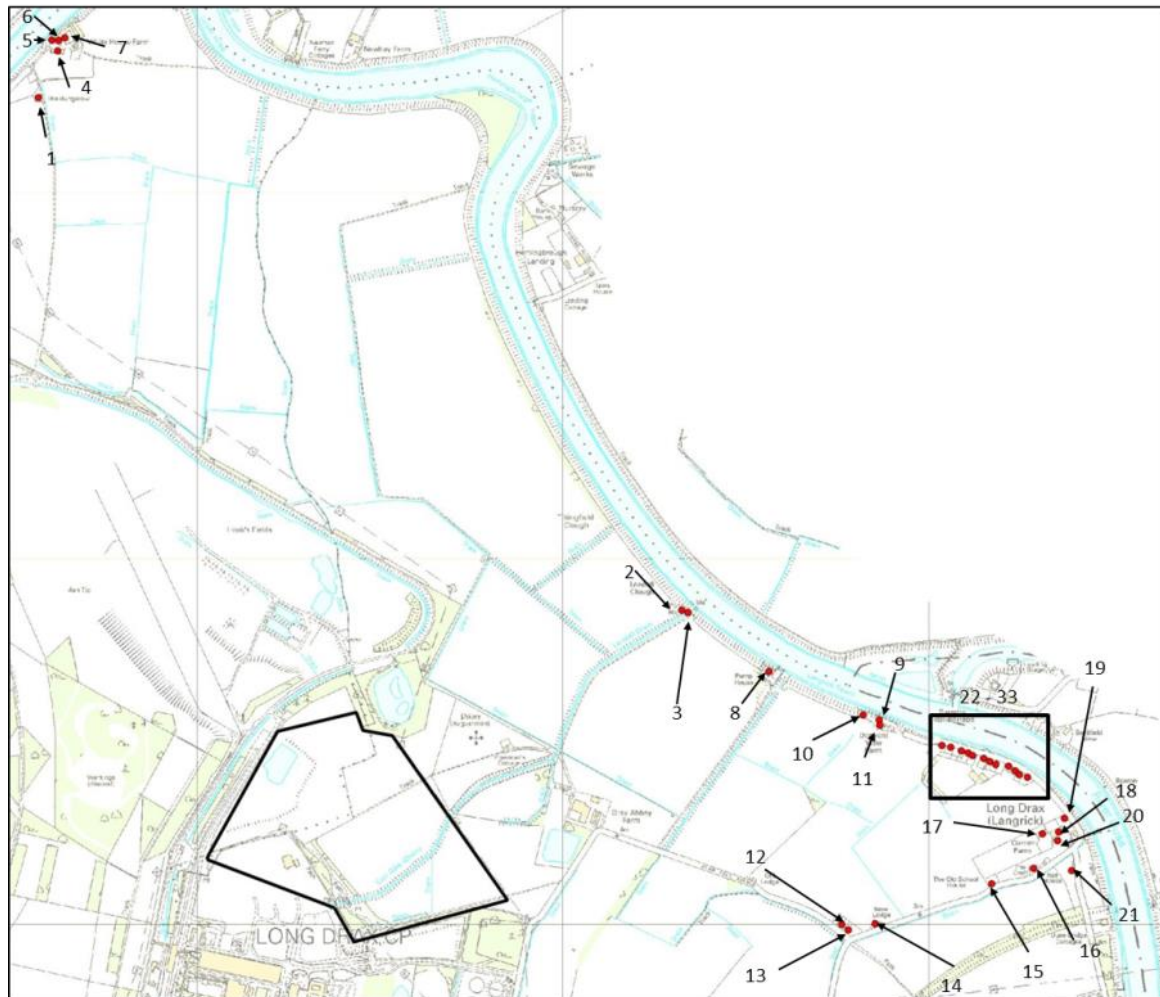


Figure 25: Properties located within or adjacent to the predicted flood extent

Table 7 – Change in flood depth at properties identified within or adjacent to the flood extent (sensitivity test).

ID	Pre-Development Depth (m)	Post Development Depth (m)	Difference (m)
1	0.67	0.68	0.01
2	0.58	0.58	0.00
3	0.05	0.05	0.00
4	0.04	0.04	0.00
5	0.01	0.01	0.00
6	0.10	0.10	0.00
7	0.18	0.18	0.00
8	-	-	-
9	0.03	0.04	0.01
10	0.08	0.08	0.00
11	0.59	0.61	0.01
12	0.26	0.28	0.02
13	0.33	0.34	0.02
14	0.97	0.99	0.02
15	0.12	0.14	0.02
16	-	-	-
17	-	-	-
18	-	-	-
19	-	-	-
20	-	-	-
21	-	-	-
22	0.05	0.05	0.00
23	0.05	0.05	0.00
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
29	-	-	-
30	0.02	0.02	0.00
31	0.06	0.06	0.00
32	0.00	0.00	0.00
33	-	-	-

4.5.4 Flood velocity

Flood velocity changes are predicted as a result of the development during the sensitivity analysis as highlighted in Figure 26. Velocities are shown to decrease generally adjacent to the site, with some peaks in increased velocity as flood waters are channelled along the boundary.

Table 8 highlights that there is no change in velocities at properties as a result of the proposal and as a result the relative changes in flow velocity across the floodplain are not considered to be significant.

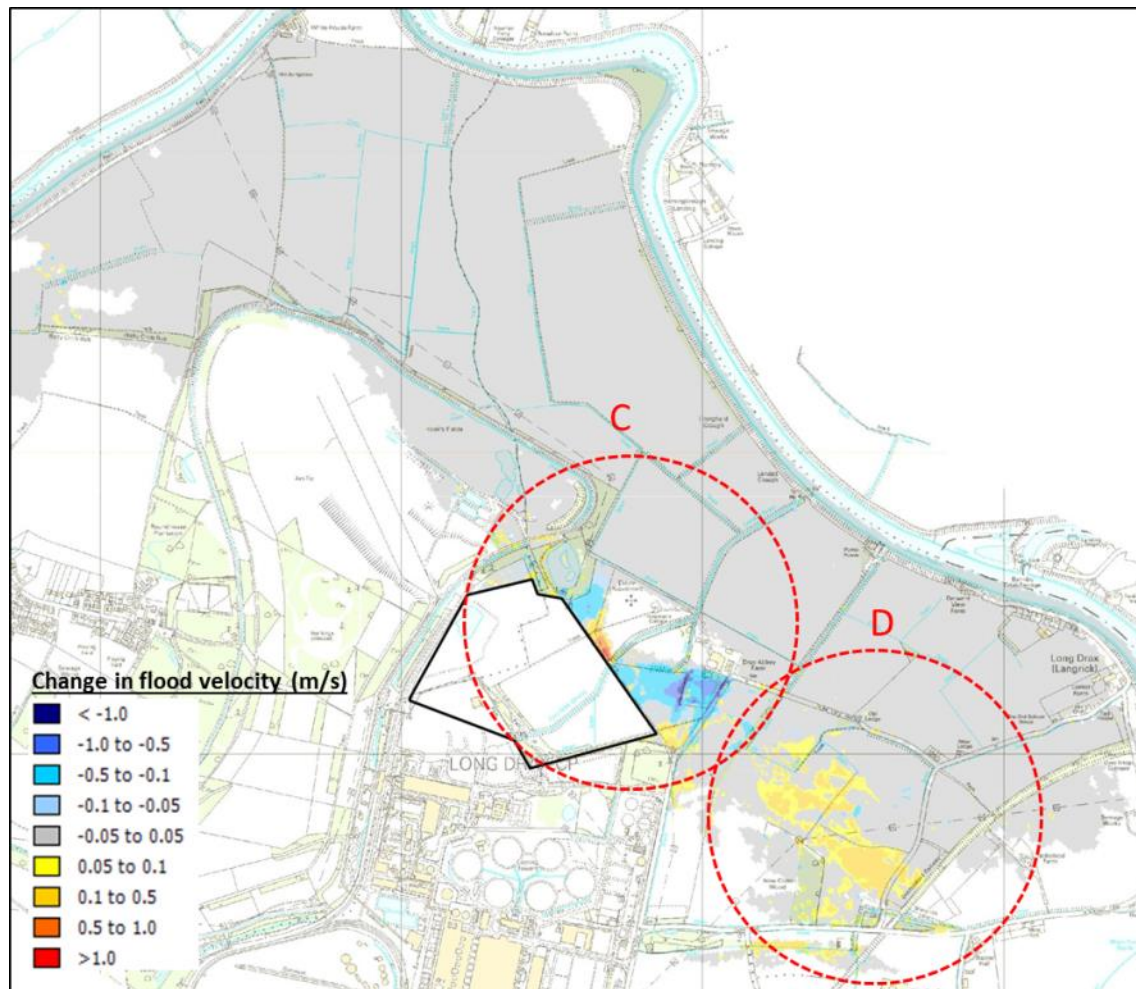


Figure 26: Change in predicted velocity as a result of the proposed development (sensitivity assessment).

Table 8 – Change in flood velocity at properties identified within or adjacent to the flood extent.

ID	Pre-Development Velocity (m/s)	Post Development Depth (m/s)	Difference (m/s)
1	0.04	0.04	0.00
2	0.20	0.20	0.00
3	0.05	0.05	0.00
4	0.00	0.00	0.00
5	0.01	0.01	0.00
6	0.18	0.18	0.00
7	0.05	0.05	0.00
8	-	-	-
9	0.01	0.01	0.00
10	0.14	0.14	0.00
11	0.20	0.20	0.00
12	0.12	0.12	0.00
13	0.16	0.15	0.00
14	0.40	0.40	0.00
15	0.02	0.02	0.00
16	-	-	-
17	-	-	-
18	-	-	-
19	-	-	-
20	-	-	-
21	-	-	-
22	0.05	0.05	0.00
23	0.11	0.11	0.00
24	-	-	-
25	-	-	-
26	-	-	-
27	-	-	-
28	-	-	-
29	-	-	-
30	0.06	0.06	0.00
31	0.01	0.01	0.00
32	0.00	0.00	0.00
33	-	-	-

5 Conclusion

The results of the breach modelling of residual tidal flood risk at the proposed White Rose site predicts the current predicted flood level for a 1 in 200 year plus 50 year climate change equates to 4.53mAOD. This takes account of the combined action of overtopping and breach and conservatively assumes the tidal event acting in combination with a 1 in 5 year fluvial event.

This predicted flood level is 0.57m below the proposed raised site level of 5.1mAOD. As such the current proposed level of the site is considered appropriate.

Flood risk impacts as a result of the proposed development and associated loss of floodplain storage are not considered significant.

Appendix 1 – Environment Agency Correspondence

White Rose Power Station Breach Analysis

The basic methodology for this breach assessment will be based on guidance provided by the Environment Agency Anglian Region, on requirements for Hazard Mapping. This document gives good guidance on what is expected from a breach analysis study for a site specific FRA. I have attached this document to the email for your reference.

- **Model Package**

I propose to use a TUFLOW 2D model (no 1D elements). This is considered appropriate due to the dominant source of flooding being thought of as Tidal. Therefore there is no requirement to undertake in channel modelling, but is more concerned with floodplain only flows.

- **Stage Hydrographs**

Hydrographs provided by the Environment Agency from their River Ouse model will be analysed. An allowance for climate change will be adopted on top of the 1 in 200 year maximum peak water level, and compared against the 1 in 1000 year level. It is initially considered that the 1 in 200 year + CC will exceed that of the 1 in 1000 year and therefore constitute a worst case event. As such it is most likely that only the 1 in 200 year plus climate change event will be used within the model. A sensitivity test may be undertaken using the 1 in 1000 year event depending on the nature of the hydrograph – this will be confirmed to the Environment Agency once the hydrographs have been provided. The climate change allowance considered will be for 50 years, as this is the expected operational period for the development.

- **Model Extent**

It is very difficult to estimate a maximum flood extent, until the model is first run. However based on initial assessment we would consider the 2D domain to be approximately 12km². The 2D domain levels will be based on LiDAR – purchased by ERM. The floodplain extent within the model will not be all of floodplain, but 2D boundaries will be sufficiently far from the site so that the boundaries applied in the model do not significantly affect the results. This will be verified through sensitivity testing. Considering the nature of the floodplain, very flat and rural a 10m grid cell size will be used.

- **Flood plain features**

Existing buildings will be represented as stubby buildings (elevated above ground level by 300mm and set with a higher manning's value).

Mannings values will be adopted representative of the land use, this will be based on 10K mapping.

Drainage ditches will be removed from the 2D domain – this will result in a conservative estimate being made, as storage within these ditches will not be considered. A reduced manning's will be applied however, in order to allow flow routing along these features to be considered.

- **Breach location**

At present the condition of the defences is unknown. As such the breach location will be set at the location along the defences closest to the proposed development site – see image attached. The breach will be set as 50m in length, and will have a level set to that of the ground adjacent to the defence location (as outlined within the EA guidance). Following receipt of defence conditions from the EA and prior to modelling, the breach location will be re-assessed. This will allow for any "weak areas" of defence to be considered as potential locations for the breach. It is proposed that WHS and ERM will confirm the breach location to the EA prior to modelling.

- **Sensitivity testing**

One sensitivity test will be undertaken. To be considered following receipt of EA data.

- **Model results and analysis**

Analysis will be undertaken on the post development model run. An assessment of flood impact will also be considered comparing the design event post development, to a pre-development simulation (removal of proposed buildings etc).

I trust the above approach is reasonable, and I would appreciate receipt of any comments asap. If you have any queries or questions, please do not hesitate to get in contact.

Thanks,

Euan Hampton

Flood Risk Consultant

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Email: euhan.hampton@hydrosolutions.co.uk

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If you require any further help, please do not hesitate to contact me.

Yours sincerely,

David Wannan
Customers and Engagement Team, Yorkshire Area

☎: 0113 819 6364 (Internal 728 6364)

✉: david.wannan@environment-agency.gov.uk

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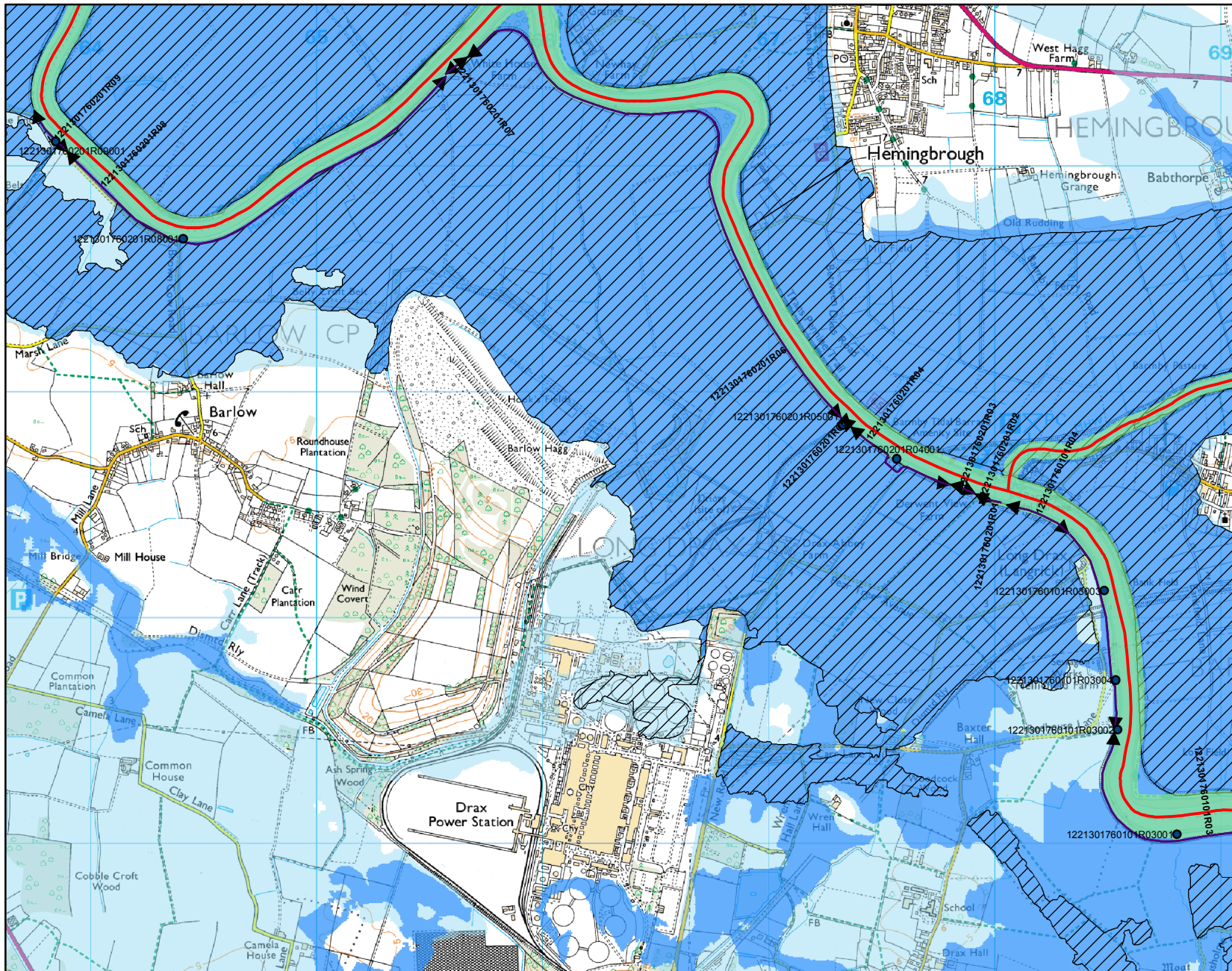
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Appendix 2 – Environment Agency provided data

Detailed FRA map centred on Drax Power Station. Completed on 18/11/2013



Scale 1:25,000

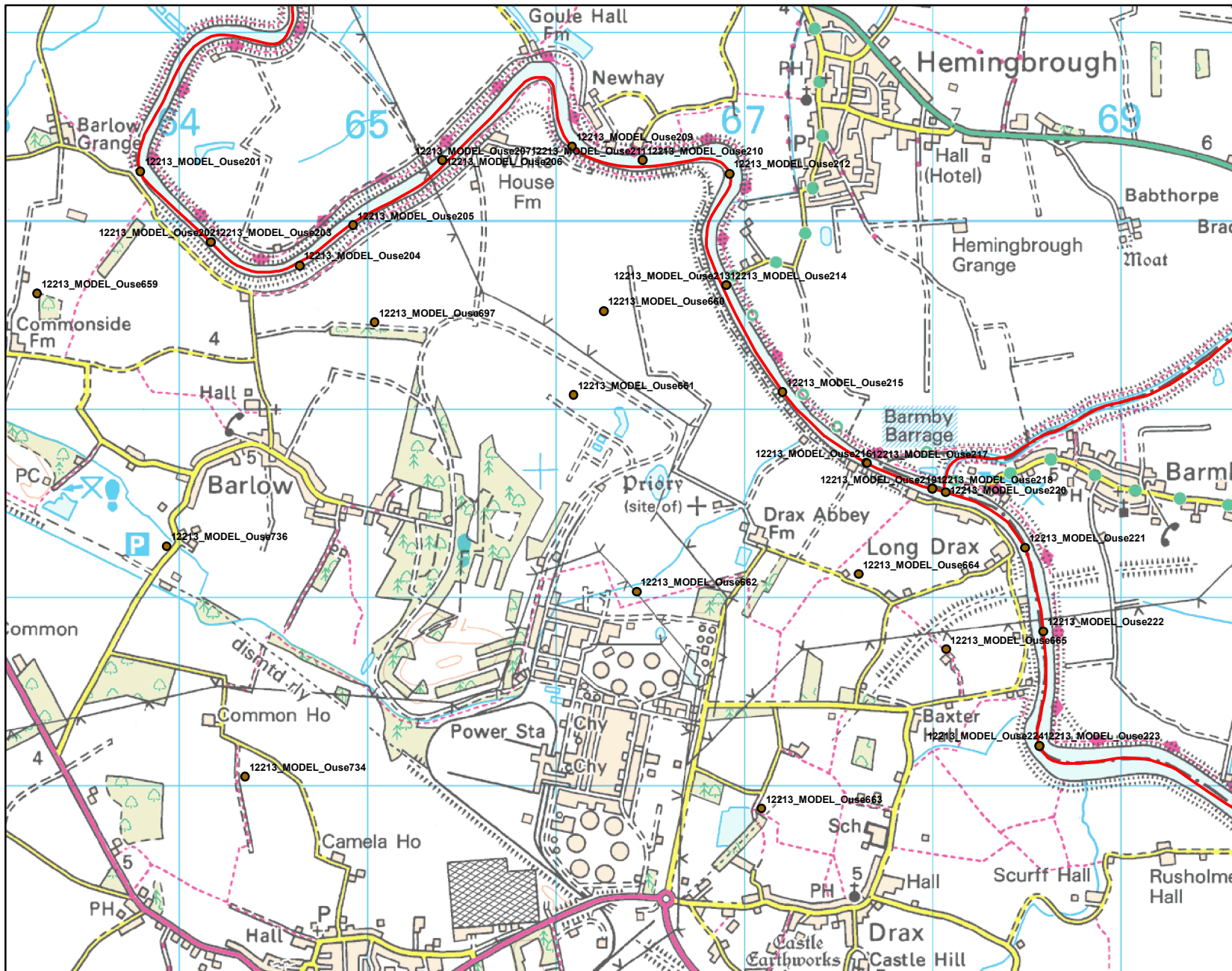


Please note that the supplied map is not considered by the Environment Agency to constitute a flood risk assessment on its own and may not be accepted by local planning authorities for that purpose. Using an inappropriate scale can in some instances result in a different indication of whether a particular point is within a flood zone.

Legend

- Structure
- ◀▶ Flood Defences
- Bank Top E-Planning Tool
- Areas Benefiting
- Flood Zone 3
- Flood Zone 2
- Main River

Detailed FRA map centred on Drax Power Station. Completed on 18/11/2013



Scale 1:30,000



Please note that the supplied map is not considered by the Environment Agency to constitute a flood risk assessment on its own and may not be accepted by local planning authorities for that purpose. Using an inappropriate scale can in some instances result in a different indication of whether a particular point is within a flood zone.

Legend

- Node Point
- Main River

AssetReference	InspectionDate	Condition	Weighting
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1221301760201R04	10/10/2012	2	9
1221301760201R04	10/10/2012	2	9
1221301760201R04	10/10/2012	2	9
1221301760201R04	10/10/2012	3	4
1221301760201R04	10/10/2012	2	2
1221301760201R04	07/06/2012	2	5
1221301760201R04	07/06/2012	2	9
1221301760201R04	07/06/2012	2	9
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[illegible]

[illegible]

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1221301760101R03001	20/12/2010	3	1
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AssetReference	AssetType	Maintainer	AssetDescription	AssetLocation	AssetLength	ActualDownstream	ActualUpstream	GridReference
						CrestLevel	CrestLevel	
1221301760201R04	raised defence (man-made)	Environment Agency	Barrierbank. Public footpath along top of asset.	Long Drax, langrick reach, Selby	569.8	5.38	5.75	SE6736828843
1221301760201R03	raised defence (man-made)	Environment Agency	Floodbank wall, Public footpath along asset.	Derwent View Farm.Long Drax, Selby	117.9	5.09	5.38	SE6780728587
1221301760201R02	raised defence (man-made)	Environment Agency	Barrierbank, Public footpath along asset	Derwent Farm, Long Drax, Selby	81.6	4.71	5.09	SE6791828546
1221301760201R01	raised defence (man-made)	Environment Agency	Floodbank with sheet piling	Long Drax, Langrick, Drax.	41.4	4.84	4.71	SE6799328515
1221301760101R04	raised defence (man-made)	Environment Agency	Floodbank with access steps. Sections of stone walling and piling present.	Ouse Bridge Cottages, Long Drax.	307.2	5.89	4.94	SE6805628496
1221301760201R06	raised defence (man-made)	Environment Agency	Barrier Bank, Tidal river.	Drax Abbey Farm, Long Drax, Selby	2797.7	5.71	5.74	SE6567130477
1221301760201R05	raised defence (man-made)	Environment Agency	Barrier Bank with concrete walling. I.D.B. Maintained.	Lendale Clough, Drax.	57.4	5.75	5.71	SE6732528882
1221301760101R03	raised defence (man-made)	Environment Agency	Barrierbank, Public footpath along asset. Gas main runs under asset.	Rusholme Hall, Long Drax, Selby	3098.6	4.96	5.89	SE6833528367
1221301760201R08	raised defence (man-made)	Environment Agency	Barrier floodbank.	Barlow Reach, Barlow, Selby.	2069.9	6.12	5.71	SE6389930061
1221301760201R09	raised defence (man-made)	Environment Agency	Retaining steelpile defence line	Thief Lane End, Barlow.	241.6	6	6.08	SE6375430244
1221301760201R07	raised defence (man-made)	Environment Agency	Barrierbank retaining steel piles.	White House Farm, Barlow, Selby.	123.6	6.41	6.15	SE6567130477

AssetReference	Type	Material	SubType	Revetment
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1221301760201R04	face (outward)	clay	embankment	none
1221301760201R04	crest	clay	embankment	none
1221301760201R04	face (inward)	clay	embankment	none
1221301760201R04	channel side	earth	natural	none
1221301760201R04	channel bed	earth	natural	none
1221301760201R03	face (outward)	clay	embankment	none
1221301760201R03	face (outward)	piling	wall	none
1221301760201R03	crest	piling	wall	none
1221301760201R03	face (inward)	piling	wall	none
1221301760201R03	berm	clay	embankment	none
1221301760201R03	face (inward)	clay	embankment	none
1221301760201R03	berm	earth	natural	none
1221301760201R03	channel side	earth	natural	none
1221301760201R03	channel bed	earth	natural	none
1221301760201R02	face (outward)	clay	embankment	none
1221301760201R02	crest	clay	embankment	none
1221301760201R02	face (inward)	clay	embankment	none
1221301760201R02	berm	earth	natural	none
1221301760201R02	channel bed	earth	natural	none
1221301760201R02	channel side	earth	natural	none
1221301760201R01	face (outward)	clay	embankment	none
1221301760201R01	berm	clay	embankment	none
1221301760201R01	face (outward)	clay	embankment	none
1221301760201R01	crest	clay	embankment	none
1221301760201R01	piling	piling	piling	
1221301760201R01	face (inward)	clay	embankment	none
1221301760201R01	berm	earth	natural	none
1221301760201R01	channel side	earth	natural	none
1221301760201R01	channel bed	earth	natural	none
1221301760101R04	face (outward)	clay	embankment	none
1221301760101R04	berm	earth	embankment	none
1221301760101R04	face (inward)	earth	embankment	none
1221301760101R04	crest	earth	embankment	none
1221301760101R04	face (inward)	piling	wall	none
1221301760101R04	berm	earth	natural	none
1221301760101R04	channel side	earth	natural	none
1221301760101R04	channel bed	earth	natural	none
1221301760201R06	face (outward)	clay	embankment	none
1221301760201R06	crest	clay	embankment	none
1221301760201R06	face (inward)	clay	embankment	none
1221301760201R06	channel side	earth	natural	none
1221301760201R06	channel bed	earth	natural	none
1221301760201R06	berm	earth	natural	none
1221301760201R05	face (outward)	concrete (precast)	wall	none
1221301760201R05	crest	concrete (precast)	wall	none
1221301760201R05	berm	clay	embankment	none
1221301760201R05	face (inward)	clay	embankment	none
1221301760201R05	berm	earth	natural	none
1221301760201R05	channel side	earth	natural	none
1221301760201R05	channel bed	earth	natural	none
1221301760101R03	face (outward)	clay	embankment	none
1221301760101R03	crest	clay	embankment	none
1221301760101R03	face (inward)	clay	embankment	none
1221301760101R03	berm	earth	natural	none
1221301760101R03	channel bed	earth	natural	none
1221301760101R03	channel side	earth	natural	none
1221301760201R08	face (outward)	clay	embankment	none
1221301760201R08	crest	clay	embankment	none
1221301760201R08	face (inward)	clay	embankment	none
1221301760201R08	berm	earth	natural	none
1221301760201R08	channel side	earth	natural	none
1221301760201R08	channel bed	earth	natural	none
1221301760201R09	face (outward)	piling	wall	none
1221301760201R09	crest	piling	wall	none
1221301760201R09	face (inward)	piling	wall	none
1221301760201R09	berm	clay	embankment	none
1221301760201R09	face (inward)	clay	embankment	none
1221301760201R09	berm	earth	natural	none
1221301760201R09	channel side	earth	natural	none
1221301760201R09	channel bed	earth	natural	none
1221301760201R07	piling	earth	embankment	none
1221301760201R07	face (outward)	piling	embankment	none
1221301760201R07	crest	piling	embankment	none
1221301760201R07	face (inward)	piling	embankment	none
1221301760201R07	berm	clay	embankment	none
1221301760201R07	face (inward)	clay	embankment	none
1221301760201R07	berm	earth	natural	none
1221301760201R07	channel side	earth	natural	none
1221301760201R07	channel bed	earth	natural	none

		MAX WATER LEVELS MAOD (WITHOUT DEFENCES) SCENARIO																MAX WATER LEVELS MAOD (WITH DEFENCES) SCENARIO																			
		level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow				
Node label	Reference	5	5	10	10	25	25	50	50	75	75	100	100	101	101	200	200	1000	1000	5	5	10	10	25	25	50	50	75	75	100	100	101	101	200	200	1000	1000
12213_MODEL_Ouse201	CS37	3.81	398.78	3.94	418.08	4.08	426.61	4.15	419.72	4.18	431.95	4.20	441.75	4.55	407.59	4.28	451.97	4.48	453.12	5.12	457.1	5.15	480.2	5.23	494.2	5.39	501.9	5.43	564.9	5.52	636.1	6.29	748.3	5.71	710.5	5.97	777.3
12213_MODEL_Ouse202	CS38	3.75	398.57	3.88	415.74	4.06	426.20	4.13	419.16	4.16	431.33	4.19	441.03	4.55	406.86	4.27	451.32	4.48	452.00	5.10	457.8	5.14	480.9	5.21	496.1	5.38	506.5	5.42	568.3	5.49	636.7	6.28	748.7	5.65	710.8	5.90	777.5
12213_MODEL_Ouse203	CS38J	3.75	398.57	3.88	415.74	4.06	426.20	4.13	419.16	4.16	431.33	4.19	441.03	4.55	406.86	4.27	451.32	4.48	452.00	5.10	457.8	5.14	480.9	5.21	496.1	5.38	506.5	5.42	568.3	5.49	636.7	6.28	748.7	5.65	710.8	5.90	777.5
12213_MODEL_Ouse204	CS38A	3.67	399.19	3.81	415.44	4.01	425.78	4.10	418.56	4.14	430.64	4.18	440.29	4.55	406.06	4.26	450.65	4.47	451.01	5.11	458.5	5.14	481.6	5.22	498.1	5.38	511.7	5.42	571.8	5.47	637.3	6.27	749.2	5.60	712.5	5.84	777.4
12213_MODEL_Ouse205	CS39	3.62	431.56	3.70	443.77	3.91	447.99	4.03	458.79	4.10	449.92	4.15	449.29	4.55	408.62	4.25	453.94	4.47	452.79	5.11	459.1	5.15	482.1	5.22	499.7	5.39	515.2	5.43	574.4	5.48	638.1	6.27	749.5	5.59	713.2	5.80	777.4
12213_MODEL_Ouse206	CS40	3.64	510.11	3.65	541.32	3.76	568.87	3.82	570.14	3.91	579.93	3.98	582.24	4.53	544.39	4.14	578.48	4.42	593.20	5.13	460.2	5.17	483.2	5.24	502.7	5.41	522.1	5.44	580.4	5.49	640.6	6.26	750.3	5.61	716.0	5.73	777.4
12213_MODEL_Ouse207	CS40J	3.64	512.22	3.65	543.33	3.76	570.79	3.82	572.18	3.91	581.88	3.98	584.15	4.53	546.03	4.14	580.30	4.42	595.05	5.13	460.2	5.17	483.2	5.24	502.7	5.41	522.1	5.44	580.4	5.49	640.6	6.26	750.3	5.61	716.0	5.73	777.4
12213_MODEL_Ouse209	CS42	3.68	513.77	3.69	551.98	3.75	605.03	3.79	628.56	3.86	635.86	3.91	640.45	4.52	624.79	4.09	649.05	4.37	689.75	5.16	464.0	5.19	486.9	5.27	512.5	5.44	548.6	5.48	607.5	5.53	656.4	6.24	766.8	5.64	732.8	5.73	790.6
12213_MODEL_Ouse210	CS43	3.71	514.03	3.71	548.63	3.75	589.11	3.79	586.64	3.86	604.10	3.92	611.74	4.52	536.12	4.10	606.51	4.38	632.53	5.15	465.2	5.19	488.0	5.27	515.4	5.44	557.4	5.48	616.6	5.52	663.0	6.23	771.3	5.63	738.2	5.73	797.9
12213_MODEL_Ouse211	CS43J	3.71	515.72	3.71	550.22	3.75	590.45	3.79	587.95	3.86	605.21	3.92	612.81	4.52	536.68	4.10	607.56	4.38	633.05	5.15	465.2	5.19	488.0	5.27	515.4	5.44	557.4	5.48	616.6	5.52	663.0	6.23	771.3	5.63	738.2	5.73	797.9
12213_MODEL_Ouse212	CS44	3.72	516.08	3.72	548.80	3.76	584.00	3.81	580.84	3.87	599.92	3.94	604.83	4.52	515.91	4.11	592.72	4.39	618.71	5.18	467.5	5.21	489.8	5.29	520.2	5.46	569.9	5.50	629.2	5.55	672.2	6.25	779.3	5.66	749.1	5.75	813.7
12213_MODEL_Ouse213	CS45	3.71	518.17	3.71	542.63	3.75	567.06	3.79	573.84	3.86	586.75	3.91	586.27	4.51	489.28	4.09	561.66	4.37	590.98	5.15	470.5	5.18	492.9	5.26	528.8	5.43	585.2	5.47	648.6	5.52	688.8	6.22	794.8	5.63	766.6	5.72	835.2
12213_MODEL_Ouse214	CS45J	3.71	518.88	3.71	542.63	3.75	567.06	3.79	573.84	3.86	586.75	3.91	586.27	4.51	489.28	4.09	561.66	4.37	590.98	5.15	470.5	5.18	492.9	5.26	528.8	5.43	585.2	5.47	648.6	5.52	688.8	6.22	794.8	5.63	766.6	5.72	835.2
12213_MODEL_Ouse215	CS46	3.71	539.30	3.71	574.52	3.74	617.18	3.79	626.56	3.86	628.74	3.91	626.43	4.51	562.75	4.09	632.34	4.37	646.31	5.14	473.1	5.18	495.9	5.25	535.6	5.42	595.8	5.46	659.0	5.51	698.9	6.21	803.2	5.62	775.7	5.71	847.2
12213_MODEL_Ouse216	CS47	3.72	540.12	3.72	575.83	3.76	640.30	3.80	681.70	3.84	701.20	3.88	713.84	4.50	665.16	4.05	732.71	4.33	759.16	5.15	475.8	5.19	499.4	5.26	545.0	5.43	606.5	5.48	669.5	5.52	708.9	6.22	812.2	5.64	784.6	5.73	859.1
12213_MODEL_Ouse217	OUSE02_27611	3.72	541.55	3.72	577.69	3.76	643.32	3.80	684.49	3.84	703.97	3.88	716.65	4.50	667.27	4.05	735.82	4.33	762.01	5.15	475.8	5.19	499.4	5.26	545.0	5.43	606.5	5.48	669.5	5.52	708.9	6.22	812.2	5.64	784.6	5.73	859.1
12213_MODEL_Ouse218	OUSE02_27241	3.72	542.31	3.72	578.33	3.75	647.98	3.80	698.60	3.83	741.62	3.87	773.92	4.48	920.10	4.02	837.02	4.26	986.23	5.16	478.3	5.20	502.4	5.27	556.1	5.44	616.5	5.48	678.5	5.53	717.6	6.23	820.0	5.64	792.5	5.73	868.9
12213_MODEL_Ouse219	OU	3.72	569.22	3.72	604.22	3.75	674.10	3.80	728.20	3.83	776.89	3.87	806.98	4.48	949.06	4.02	867.69	4.26	1008.18	5.16	513.4	5.20	535.2	5.27	563.0	5.44	616.5	5.48	678.5	5.53	717.6	6.23	825.8	5.64	792.5	5.73	868.9
12213_MODEL_Ouse220	OUSE02_27167	3.72	569.40	3.72	604.37	3.76	674.49	3.80	729.37	3.83	780.81	3.87	811.68	4.47	986.12	4.02	878.72	4.26	1042.14	5.16	513.8	5.20	535.6	5.28	563.6	5.45	618.8	5.49	680.3	5.53	719.5	6.23	826.5	5.64	794.2	5.74	871.0
12213_MODEL_Ouse221	OUSE02_26634	3.72	570.74	3.72	605.53	3.76	676.87	3.80	731.68	3.82	783.08	3.86	813.60	4.45	971.32	4.00	878.72	4.23	1030.78	5.15	516.9	5.19	539.1	5.26	575.5	5.43	634.7	5.47	693.8	5.52	732.6	6.22	834.0	5.63	806.3	5.72	885.9
12213_MODEL_Ouse222	OUSE02_26178	3.74	571.90	3.74	606.54	3.79	679.95	3.85	763.42	3.88	823.79	3.89	852.45	4.44	957.35	3.99	914.01	4.21	1018.48	5.15	519.5	5.19	542.0	5.26	589.8	5.43	648.1	5.47	705.8	5.52	743.4	6.21	844.4	5.63	816.5	5.73	898.3
12213_MODEL_Ouse223	OUSE02_25629	3.75	573.55	3.75	607.99	3.81	682.88	3.89	768.63	3.92	831.68	3.94	860.16	4.43	942.84	4.01	923.78	4.22	1018.78	5.16	523.3	5.19	546.1	5.27	608.5	5.44	666.1	5.49	723.9	5.53	758.1	6.24	858.7	5.64	830.4	5.74	915.1
12213_MODEL_Ouse224	OUS02_25629J	3.75	573.88	3.75	608.34	3.81	684.43	3.89	770.29	3.92	833.55	3.94	861.95	4.43	942.84	4.01	925.70	4.22	1018.78	5.16	523.3	5.19	546.1	5.27	608.5	5.44	666.1	5.49	723.9	5.53	758.1	6.24	858.7	5.64	830.4	5.74	915.1

SELBY SCENARIO																CAWOOD SCENARIO																			
level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow	level	flow				
5	5	10	10	25	25	50	50	75	75	100	100	101	101	200	200	1000	1000	5	5	10	10	25	25	50	50	75	75	100	100	101	101	200	200	1000	1000
5.09	452.85	5.13	470.00	5.18	480.05	5.31	484.99	5.34	517.94	5.37	564.03	6.09	750.69	5.52	676.27	6.00	868.08	5.12	450.15	5.16	469.84	5.23	481.40	5.40	494.83	5.44	518.04	5.48	553.56	6.28	719.11	5.63	665.03	5.95	772.16
5.09	453.26	5.13	470.34	5.18	480.32	5.31	488.20	5.34	518.20	5.37	564.44	6.09	751.30	5.49	676.43	5.93	868.21	5.10	450.86	5.15	470.47	5.22	483.26	5.38	498.21	5.42	523.02	5.47	557.78	6.27	720.03	5.59	665.89	5.88	772.47
5.09	453.26	5.13	470.34	5.18	480.32	5.31	488.20	5.34	518.78	5.37	564.44	6.09	751.30	5.49	676.43	5.93	868.21	5.10	450.86	5.15	470.47	5.22	483.26	5.38	498.21	5.42	523.02	5.47	557.78	6.27	720.03	5.59	665.89	5.88	772.47
5.09	453.73	5.14	470.76	5.20	480.65	5.34	485.05	5.37	518.77	5.40	564.87	6.09	751.93	5.47	676.58	5.87	868.34	5.11	451.61	5.15	471.13	5.22	485.13	5.39	501.44	5.43	527.54	5.47	562.30	6.26	720.91	5.59	666.73	5.82	772.77
5.10	454.11	5.15	471.08	5.21	480.92	5.36	487.25	5.39	518.98	5.43	566.44	6.09	752.40	5.51	676.70	5.84	868.43	5.11	452.19	5.16	471.66	5.22	486.55	5.40	503.78	5.44	530.92	5.48	565.79	6.26	722.15	5.60	667.34	5.78	772.98
5.12	455.02	5.17	471.76	5.23	483.16	5.40	494.08	5.43	519.43	5.47	569.50	6.10	753.46	5.55	677.61	5.76	868.65	5.13	453.37	5.17	472.72	5.24	489.29	5.41	509.91	5.45	539.48	5.50	573.03	6.25	725.25	5.62	668.63	5.71	773.50
5.12	455.02	5.17	471.76	5.23	483.16	5.40	494.08	5.43	519.43	5.47	569.50	6.10	753.46	5.55	677.61	5.76	868.65	5.13	453.37	5.17	472.72	5.24	489.29	5.41	509.91	5.45	539.48	5.50	573.03	6.25	725.25	5.62	668.63	5.71	773.50
5.15	458.16	5.20	474.48	5.27	490.96	5.44	504.80	5.48	537.74	5.52	579.47	6.14	761.56	5.61	689.45	5.74	869.75	5.15	457.21	5.20	476.34	5.27	498.79	5.44	535.72	5.48	576.84	5.53	609.53	6.23	741.96	5.64	689.60	5.73	789.29
5.15	459.18	5.20	475.43	5.27	493.15	5.44	508.91	5.48	544.70	5.52	583.16	6.15	764.60	5.62	693.24	5.71	870.02	5.15	458.37	5.20	477.41	5.27	501.65	5.44	544.17	5.48	586.59	5.53	618.57	6.22	746.81	5.64	696.17	5.73	796.46
5.15	459.18	5.20	475.43	5.27	493.15	5.44	508.91	5.48	544.70	5.52	583.16	6.15	764.60	5.62	693.24	5.71	870.02	5.15	458.37	5.20	477.41	5.27	501.65	5.44	544.17	5.48	586.59	5.53	618.57	6.22	746.81	5.64	696.17	5.73	796.46
5.18	460.90	5.22	477.01	5.29	496.99	5.46	517.64	5.51	555.88	5.55	589.76	6.20	769.66	5.66	699.49	5.75	870.58	5.18	460.27	5.22	479.18	5.29	506.36	5.46	556.85	5.51	599.58	5.55	631.15	6.25	754.77	5.67	707.49	5.76	810.99
5.15	463.03	5.19	479.01	5.26	501.89	5.43	528.40	5.47	569.28	5.52	600.89	6.16	776.67	5.63	707.30	5.72	871.51	5.15	463.45	5.19	481.39	5.26	517.54	5.43	572.54	5.47	618.37	5.52	650.48	6.22	770.64	5.64	725.98	5.73	830.24
5.15	463.03	5.19	479.01	5.26	501.89	5.43	528.40	5.47	569.28	5.52	600.89	6.16	776.67	5.63	707.30	5.72	871.51	5.15	463.45	5.19	481.39	5.26	517.54	5.43	572.54	5.47	618.37	5.52	650.48	6.22	770.64	5.64	725.98	5.73	830.24
5.14	464.85	5.18	481.50	5.25	505.57	5.42	536.61	5.47	578.70	5.51	610.47	6.17	782.15	5.63	713.57	5.72	874.77	5.14	465.13	5.18	483.26	5.25	530.89	5.42	586.87	5.47	630.08	5.51	660.55	6.21	779.14	5.63	735.37	5.72	839.97
5.16	466.92	5.20	484.95	5.27	509.81	5.44	545.24	5.48	588.40	5.53	620.28	6.20	788.12	5.64	720.41	5.74	878.78	5.15	467.90	5.19	485.67	5.27	544.15	5.44	600.50	5.48	641.99	5.53	671.50	6.22	787.86	5.64	744.68	5.74	850.12
5.16	466.92	5.20	484.95	5.27	509.81	5.44	545.24	5.48	588.40	5.53	620.28	6.20	788.12	5.64	720.41	5.74	878.78	5.15	467.90	5.19	485.67	5.27	544.15	5.44	600.50	5.48	641.99	5.53	671.50	6.22	787.86	5.64	744.68	5.74	850.12
5.16	468.98	5.20	487.94	5.27	514.03	5.45	553.60	5.49	596.57	5.53	628.59	6.22	793.36	5.65	726.35	5.75	882.34	5.16	470.34	5.20	488.23	5.27	555.20	5.45	611.49	5.49	652.40	5.53	681.70	6.23	795.82	5.65	752.64	5.74	858.60
5.16	506.34	5.20	523.96	5.27	546.37	5.45	557.58	5.49	596.57	5.53	636.22	6.22	824.29	5.65	742.80	5.75	919.99	5.16	506.90	5.20	524.59	5.27	555.20	5.45	611.49	5.49	652.40	5.53	681.70	6.23	800.45	5.65	752.64	5.74	858.60
5.16	506.73	5.21	524.42	5.28	546.90	5.45	558.23	5.49	598.28	5.54	636.83	6.22	824.88	5.65	743.37	5.75	920.44	5.16	507.31	5.20	524.98	5.27	557.51	5.45	613.76	5.49	654.57	5.54	683.83	6.23	801.08	5.65	754.32	5.74	860.38
5.15	509.69	5.19	527.89	5.26	550.82	5.44	568.67	5.48	610.80	5.52	643.73	6.21	829.38	5.64	747.65	5.74	923.89	5.15	510.34	5.19	527.89	5.26	574.62	5.43	629.77	5.48	669.96	5.52	699.88	6.22	809.92	5.64	769.70	5.73	874.76
5.15	512.18	5.19	530.79	5.27	554.14	5.44	579.31	5.48	620.92	5.52	654.83	6.21	833.18	5.64	751.23	5.74	926.83	5.15	512.88	5.19	530.32	5.26	588.81	5.43	643.07	5.48	682.76	5.52	713.30	6.21	820.59	5.64	782.34	5.73	886.87
5.16	515.76	5.20	534.81	5.27	558.76	5.45	593.77	5.49	634.82	5.54	669.59	6.24	838.61	5.65	759.25	5.75	930.92	5.16	516.41	5.20	533.71	5.27	607.45	5.45	661.09	5.49	700.61	5.53	731.09	6.24	835.41	5.65	799.66	5.75	903.31
5.16	515.76	5.20	534.81	5.27	558.76	5.45	593.77	5.49	634.82	5.54	669.59	6.24	838.61	5.65	759.25	5.75	930.92	5.16	516.41	5.20	533.71	5.27	607.45	5.45	661.09	5.49	700.61	5.53	731.09	6.24	835.41	5.65	799.66	5.75	903.31

AssetReference	AssetType	Maintainer	AssetDescription	AssetLocation	GridReference
1221301760201R05001	flood defence structure	private	Outfall from pumping station.	Lendale drain, Drax.	SE6733128847
1221301760201R04001	flood defence structure	internal drainage board	Outfall at Drax pumping station	Drax Abbey Farm, Drax.	SE6757328699
1221301760101R03003	flood defence structure	private	Outfall. High fall outlet from pumping station.	Corner Farm, Long Drax, Selby	SE6849128115
1221301760101R03004	flood defence structure	private	Outfall at Landing wharf for Drax power station.	Redhouse Lane, Long Drax, Selby	SE6854027720
1221301760101R03002	flood defence structure	internal drainage board	Outfall to drainage dyke.	Eastholme, Redhouse lane, Long Drax, Selby.	SE6854927500
1221301760201R08001	flood defence structure	internal drainage board	Outfall with 750mm flap	River View, Barlow, Selby.	SE6441329672
1221301760201R09001	flood defence structure	internal drainage board	Outfall	Mumby Belt, Barlow, Drax.	SE6385230105
1221301760101R03001	flood defence structure	internal drainage board	Outfall. 600mm Iron Flap. Drainage outlet	Willow Row Drain, Scurff Hall.Drax.	SE6881127038

Project	Drax Power Station Modelling
Project Number	WHS1583
Title	Assessing Manning’s Value Sensitivity
Description	This technical note summarises the outcomes of Manning’s value sensitivity testing within the White Rose model.
Date	2 nd May 2018
Version	1.0

1 Summary of Work

Following model review by the EA, additional sensitivity on the Manning’s value was requested to ascertain model sensitivity to roughness across the floodplain for the 0.5% AEP plus climate change event. Manning’s values were universally changed by $\pm 20\%$ and compared to design post-development levels. 8 sample locations have been prepared and depths for each scenario are collected from these locations. The sample locations are shown in Figure 1.

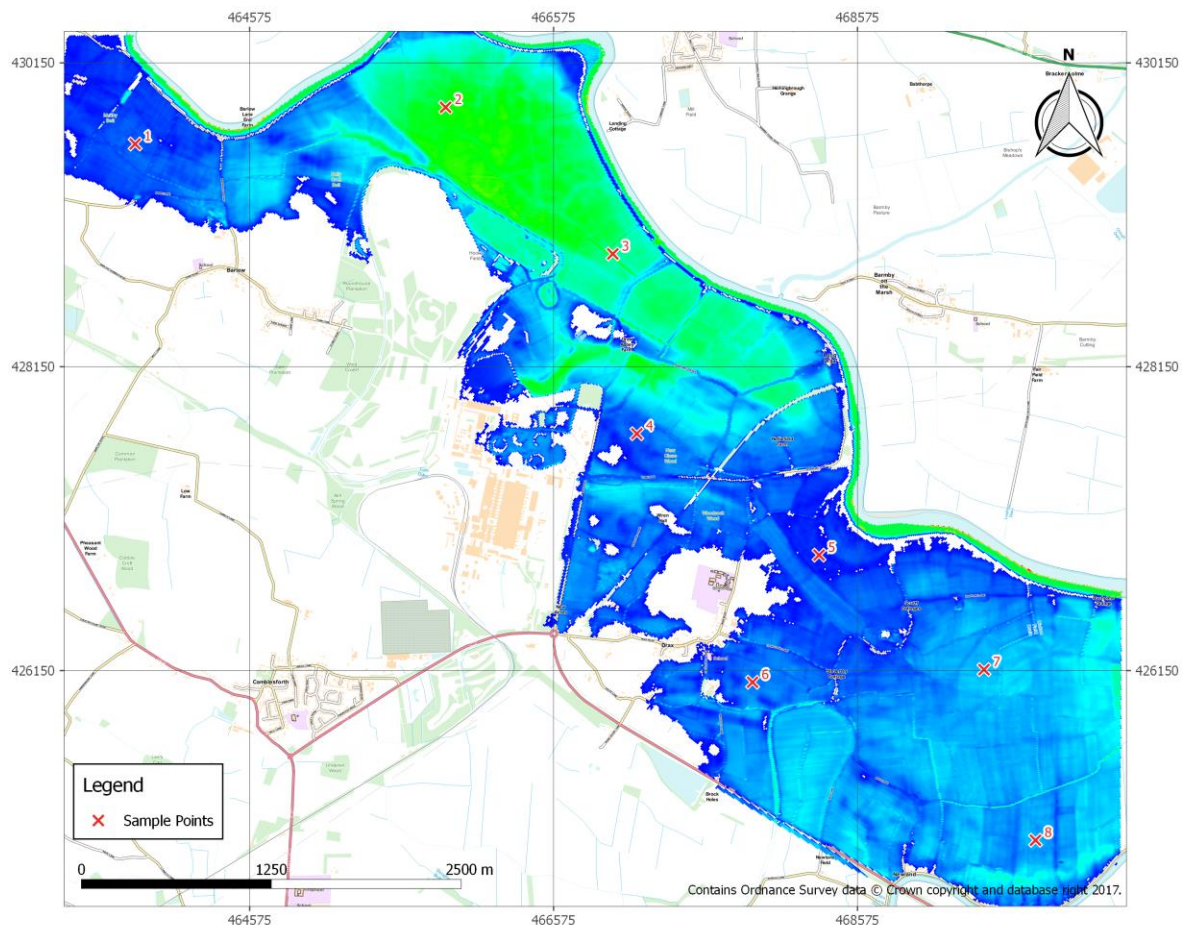


Figure 1 – Sample depth locations

2 Results

Results of the sensitivity testing is shown in Table 1 below. The results indicate that if a higher Manning’s were to be used (representing greater volume of crops on the floodplain), flood levels across the floodplain drop by up to 0.15m. This is not deemed to be a significant decrease in depth and it is concluded that the model is only minimally sensitive to increases in Manning’s.

When manning’s is decreased by 20% flood levels increase by up to 0.13m. Although flood levels slightly increase, the lower Manning’s values are not deemed to be representative of the floodplain and therefore represent an unrealistic representation of the floodplain.

Table 1 – Post Development Manning’s Sensitivity Results

Sample Pt	Post Dev Depth (m)	N+20% Depth (m)	Change compared to design run (m)	N-20% Depth (m)	Change compared to design run (m)
1	0.62	0.59	-0.03	0.66	+0.04
2	2.96	2.95	-0.01	2.99	+0.03
3	2.25	2.24	-0.01	2.28	+0.03
4	0.46	0.45	-0.01	0.49	+0.03
5	0.22	0.22	-0.00	0.34	+0.12
6	0.70	0.55	-0.15	0.79	+0.09
7	1.17	1.03	-0.14	1.30	+0.13
8	1.16	1.01	-0.15	1.26	+0.10

In addition to the above analysis, key areas of concern discussed in the modelling report located in Drax village are not shown to be flooded when Manning’s is increased by 20%. Changes in extent between sensitivity runs are shown below in Figure 2. This indicates that the Manning’s used in the baseline scenario represent a more conservative assessment of flood risk and should fields be heavily cropped, flood risk in Drax village would decrease. Therefore, the choices of Manning’s values in the existing baseline and post development model represent the most robust approach to modelling in this area.

When Manning’s is reduced by 20%, a small increase in extent is seen in key areas. However, this extent change is minimal and choosing to use Manning’s values 20% lower than what are currently used in the model would be inappropriate.

Overall, the roughness coefficients selected for the model are appropriate and no further consideration is required.

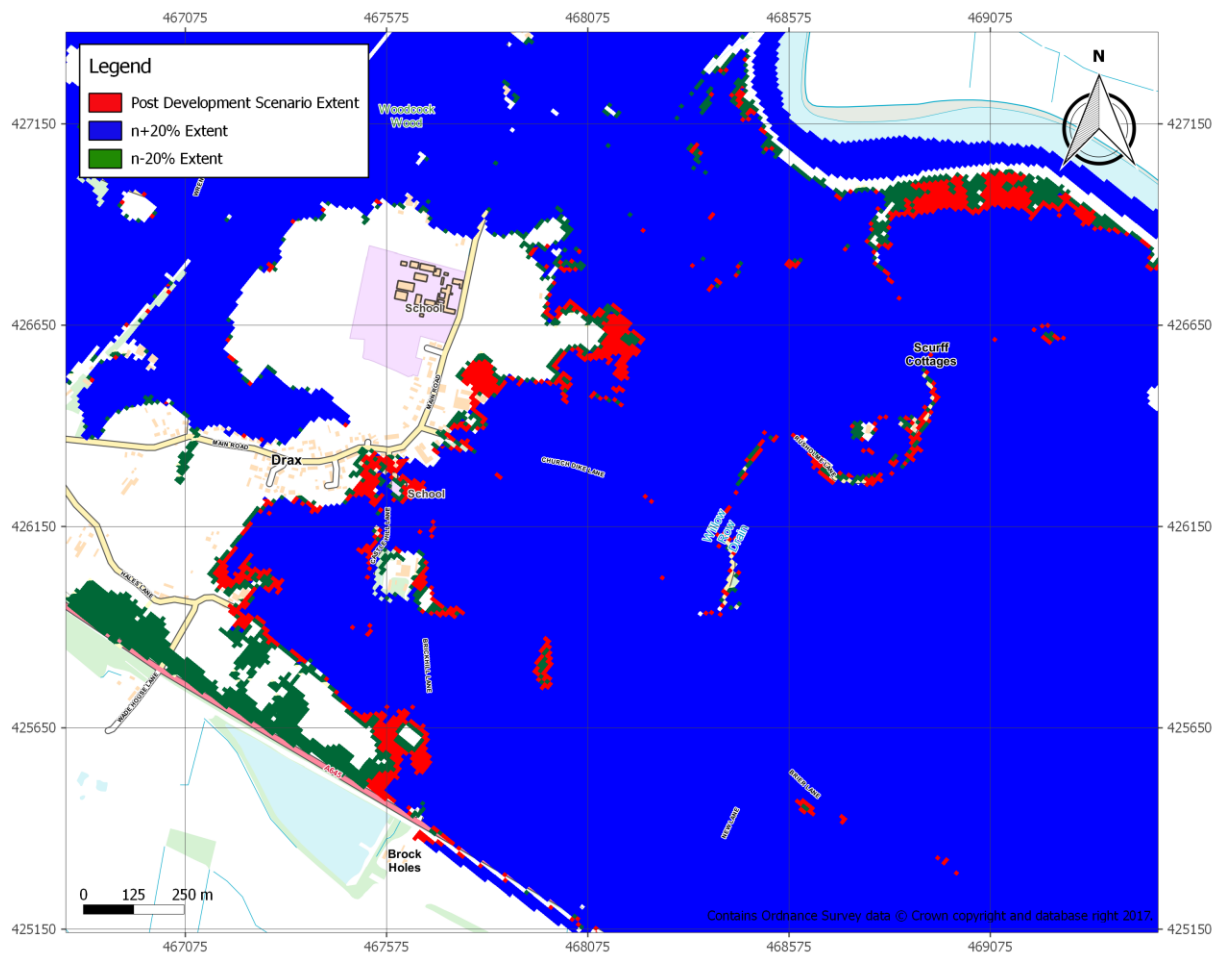


Figure 2 – Change in extent between sensitivity runs

3 Additional comments

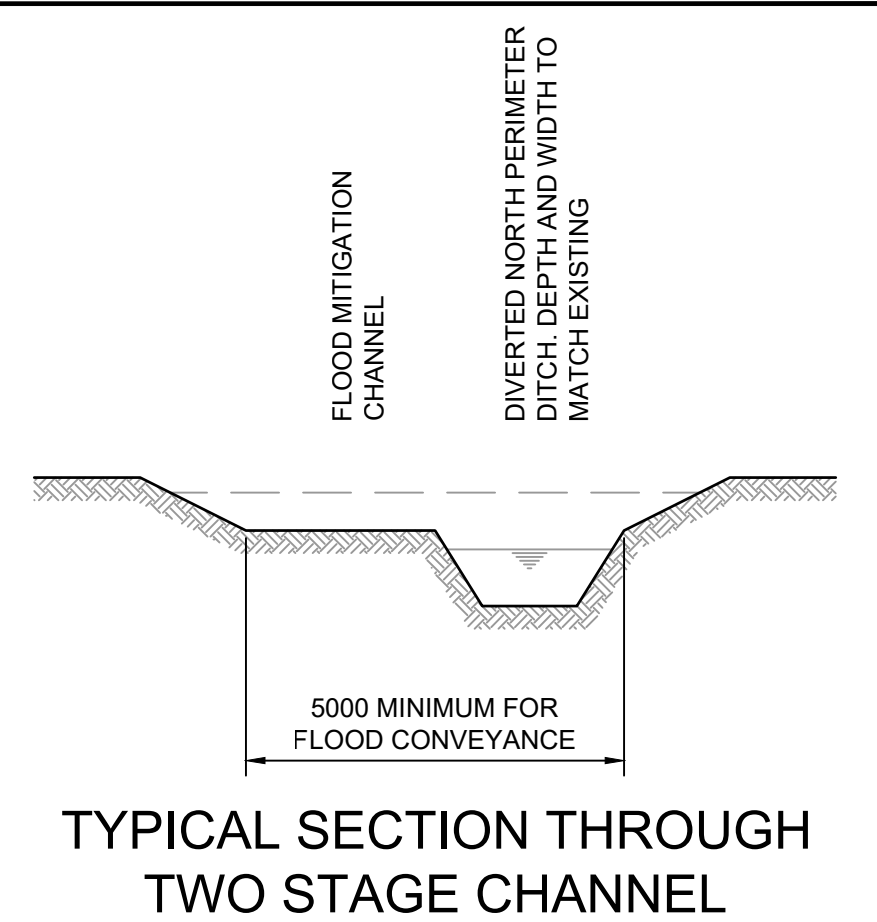
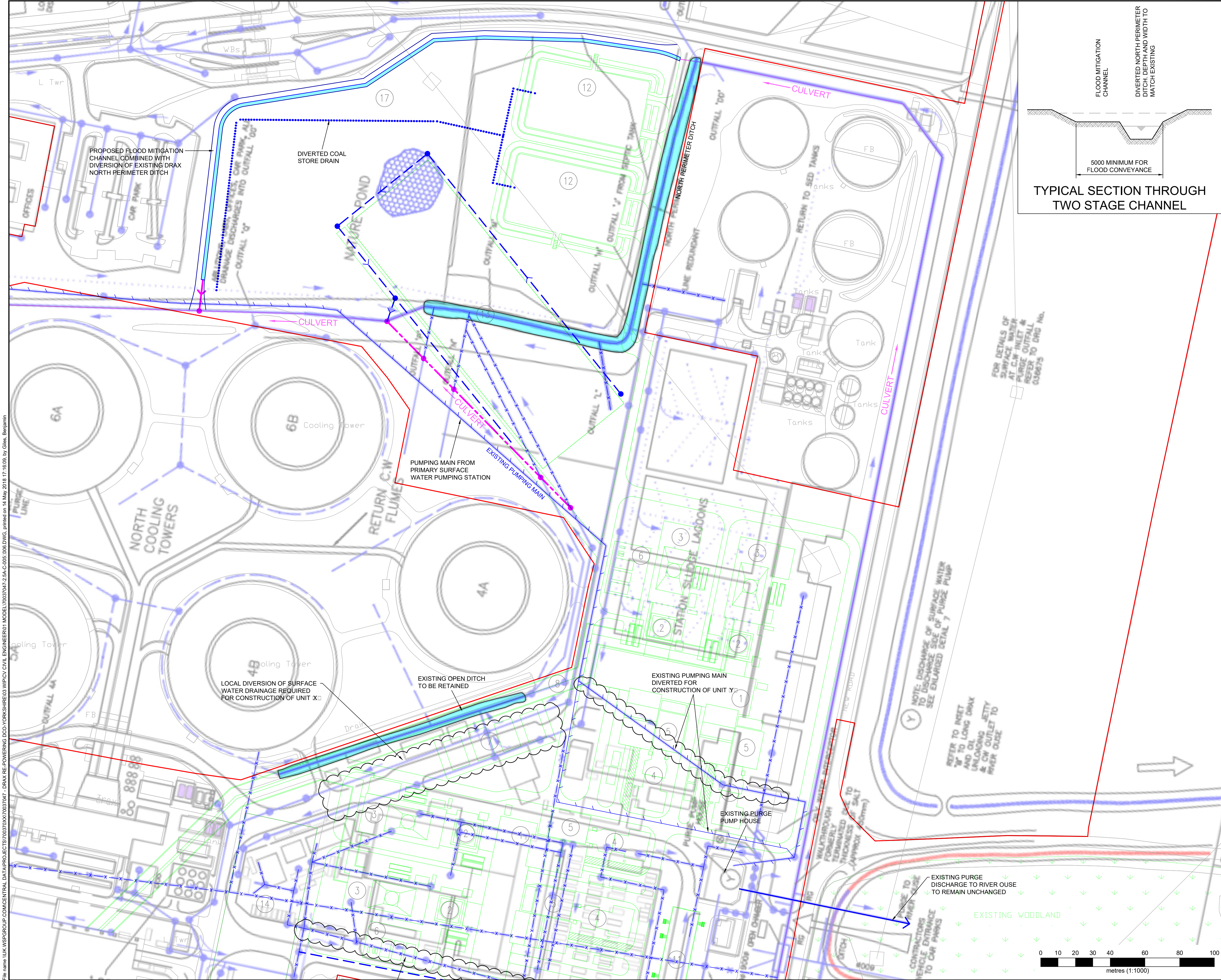
Comments provided in the model review are addressed below.

Comment ID B-18 – Centremaps were contacted to ascertain the age of the LiDAR data. WHS were informed that a composite dataset using LiDAR from between 2001-2009 has been used.

Comment ID B-22 – Consideration of a boundary condition and glass walling at this location is provided in section 4.2 of the original White Rose study (Appendix 1 of the hydraulic modelling report). This model, which was approved by the EA, was recommended as suitable for use by the EA for this study.

Comment ID B106 – Roughness is addressed above.

APPENDIX K: PROPOSED SURFACE WATER DRAINAGE STRATEGY



DO NOT SCALE

KEY

- PROPOSED DCO LIMITS
- NATIONAL GRID OWNERSHIP BOUNDARY
- INDICATIVE FUEL GAS PIPELINE ROUTE
- PROPOSED SURFACE WATER DRAINAGE
- DIVERTED COAL STORE DRAIN
- CULVERT (PROPOSED)
- EXISTING DRAINAGE TO BE BECOME REDUNDANT

70037047-2.5A-C-005 (SHEET 1)

70037047-2.5A-C-006 (SHEET 2)

KEY PLAN

INFRASTRUCTURE PLANNING (APPLICATIONS: PRESCRIBED FORMS AND PROCEDURE) REGULATIONS 2009 - REGULATION 5(2) (c)

B	30/04/2018	BRG	RED LINE BOUNDARY UPDATED.	JP	JP
A	22/03/2018	BRG	FIRST ISSUE.	JP	JP
REV	DATE	BY	DESCRIPTION	CHK	APP

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SITE/PROJECT:

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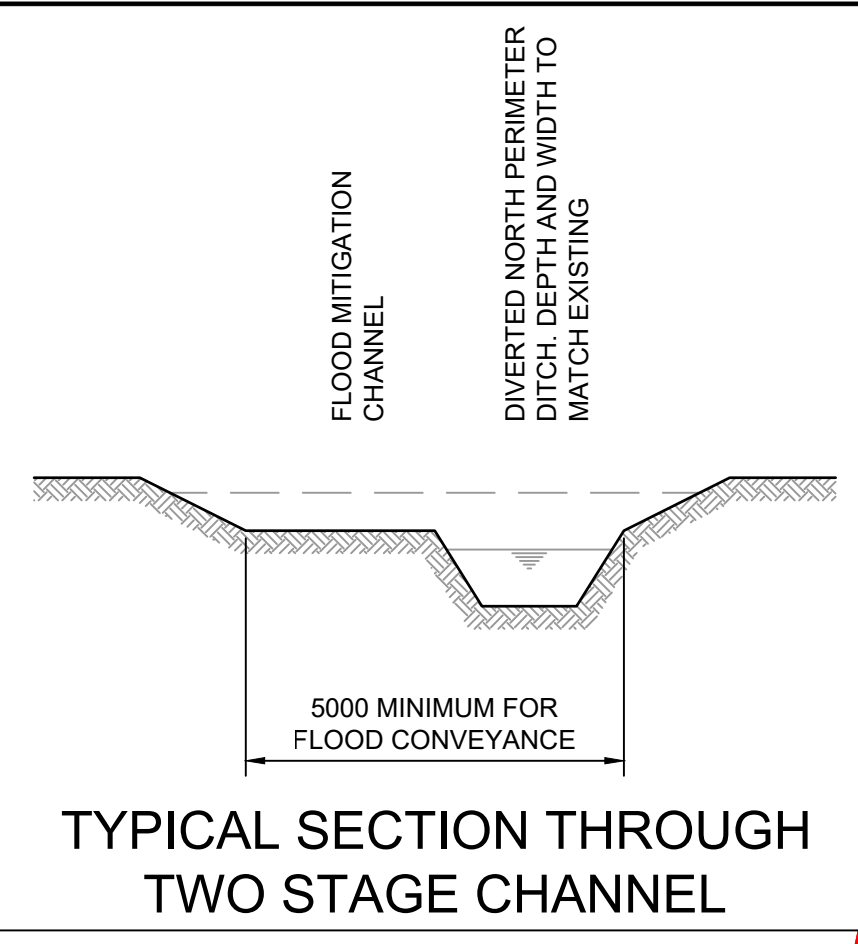
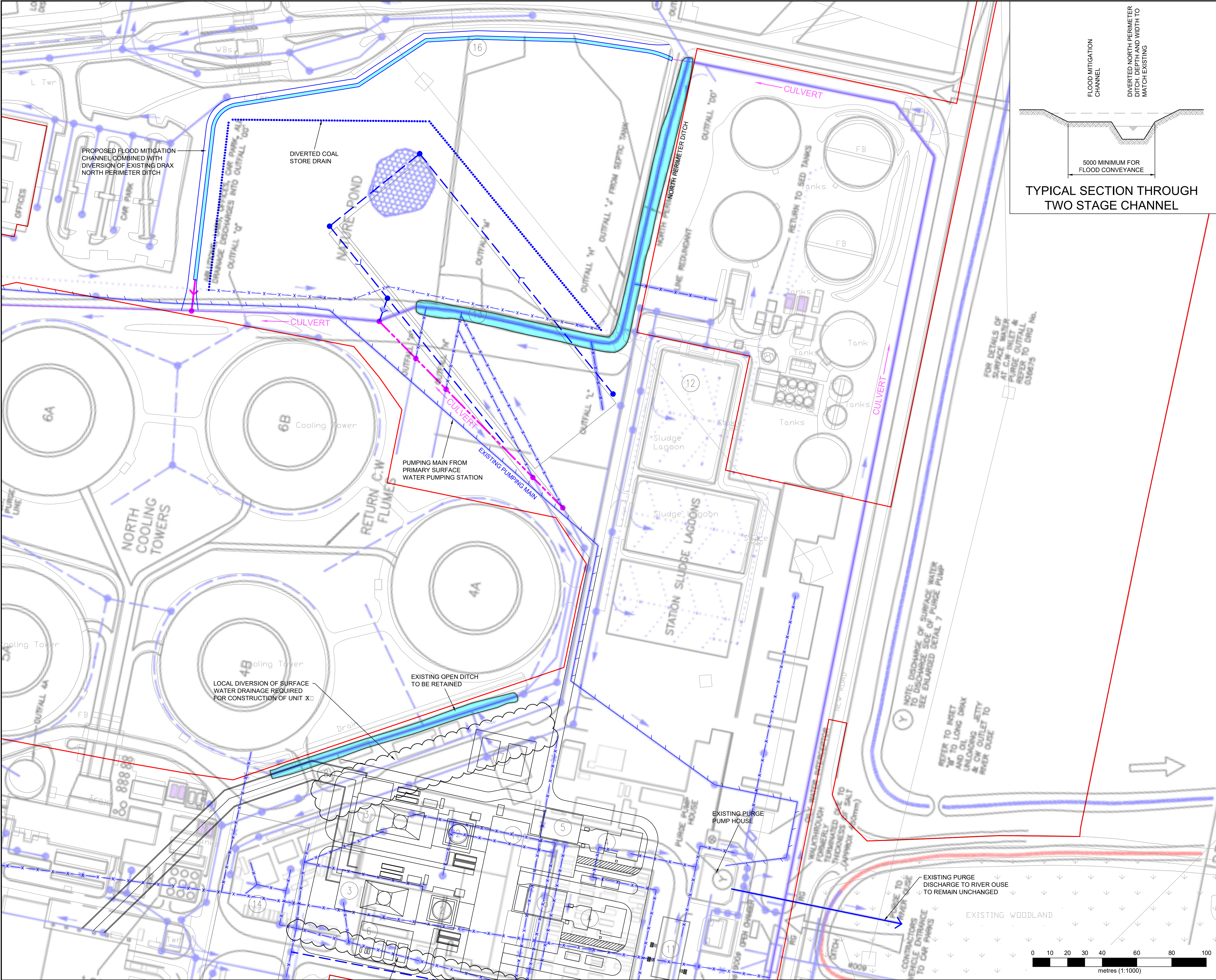
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TWO UNIT OPTION
SURFACE WATER DRAINAGE STRATEGY
SHEET 1

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PROJECT NO: 70037047	DESIGNED: JP	DRAWN: BRG
DRAWING NO: 70037047-2.5A-C-005	DATE: 22/03/18	REV: B

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DO NOT SCALE

KEY

PROPOSED DCO LIMITS

NATIONAL GRID OWNERSHIP BOUNDARY

INDICATIVE FUEL GAS PIPELINE ROUTE

PROPOSED SURFACE WATER DRAINAGE

DIVERTED COAL STORE DRAIN

CULVERT (PROPOSED)

EXISTING DRAINAGE TO BE BECOME REDUNDANT

EXISTING OPEN DITCH

70037047-2.5A-C-001 (SHEET 1)

70037047-2.5A-C-002 (SHEET 2)

70037047-2.5A-C-007 (SHEET 3)

KEY PLAN

INFRASTRUCTURE PLANNING (APPLICATIONS: PRESCRIBED FORMS AND PROCEDURE) REGULATIONS 2009 - REGULATION 5(2) (c)

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A	22/03/2018	BRG	FIRST ISSUE	JP	JP
REV	DATE	BY	DESCRIPTION	CHK	APP

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SINGLE UNIT OPTION
SURFACE WATER DRAINAGE STRATEGY
SHEET 1

SCALE @ A1: 1:1000

CHECKED: JP

APPROVED:

PROJECT NO: 70037047

DESIGNED: JP

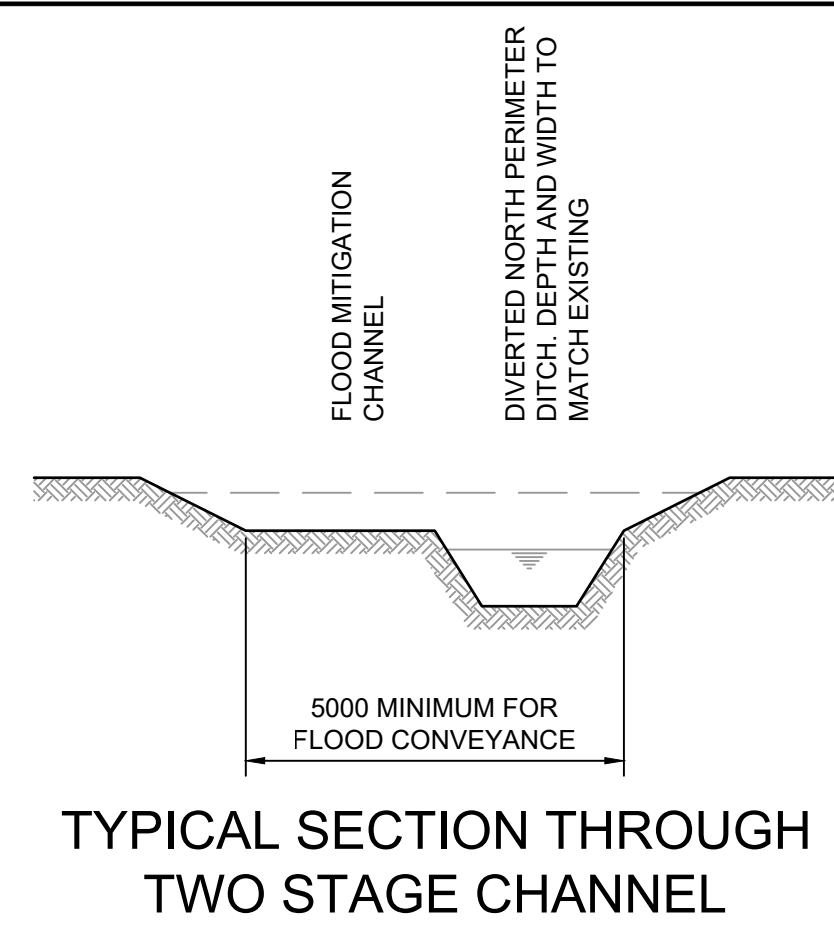
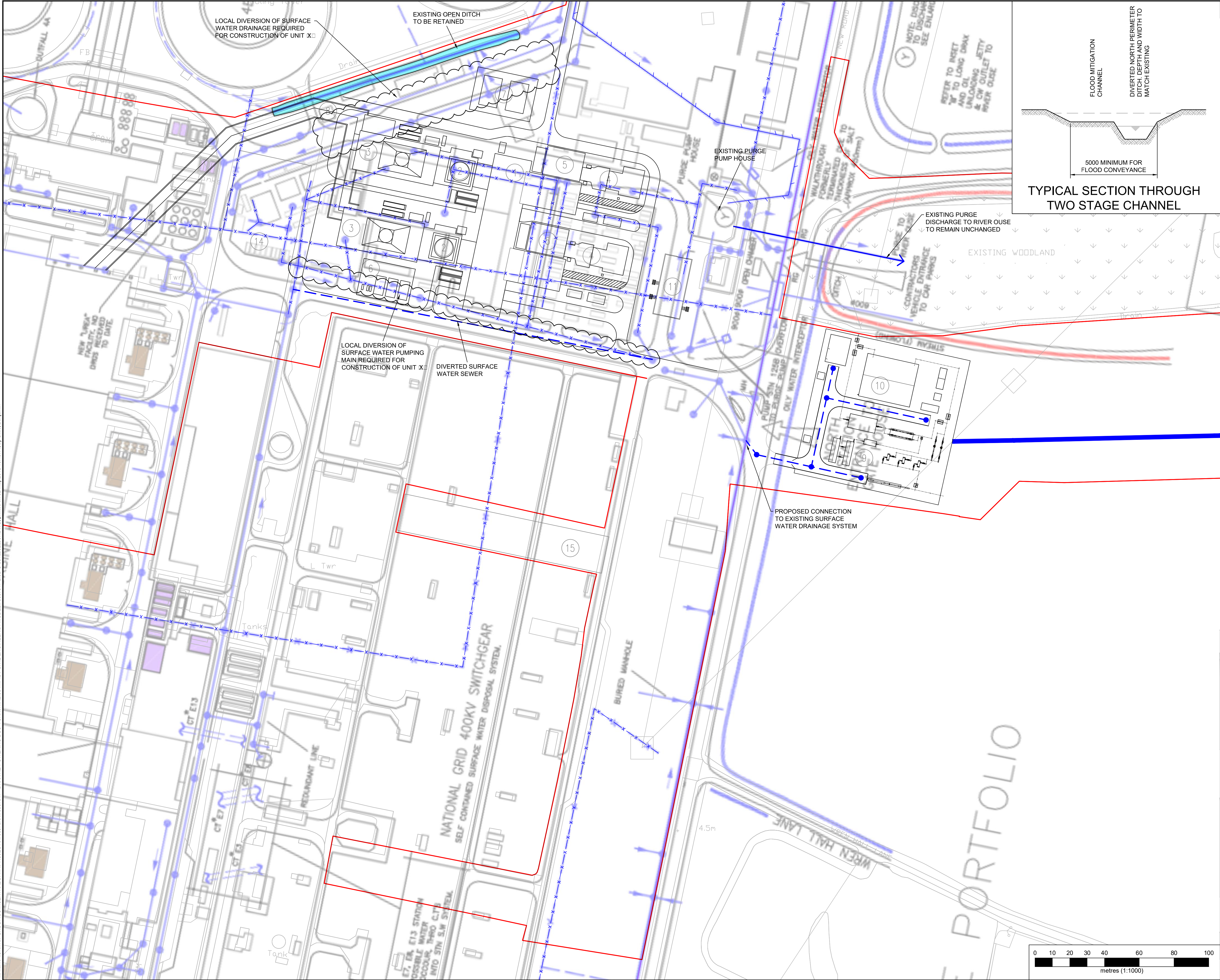
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DATE: 22/03/18

DRAWING NO: 70037047-2.5B-C-001

REV: B

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- KEY
- PROPOSED DCO LIMITS
 - NATIONAL GRID OWNERSHIP BOUNDARY
 - INDICATIVE FUEL GAS PIPELINE ROUTE
 - PROPOSED SURFACE WATER DRAINAGE
 - DIVERTED COAL STORE DRAIN
 - CULVERT (PROPOSED)
 - EXISTING DRAINAGE TO BE BECOME REDUNDANT
 - EXISTING OPEN DITCH

70037047-2.5A-C-001 (SHEET 1)

70037047-2.5A-C-002 (SHEET 2)

70037047-2.5A-C-007 (SHEET 3)

KEY PLAN

INFRASTRUCTURE PLANNING (APPLICATIONS: PRESCRIBED FORMS AND PROCEDURE) REGULATIONS 2009 - REGULATION 5(2) (o)

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A	22/03/2018	BRG	FIRST ISSUE	JP	JP
REV	DATE	BY	DESCRIPTION	CHK	APP

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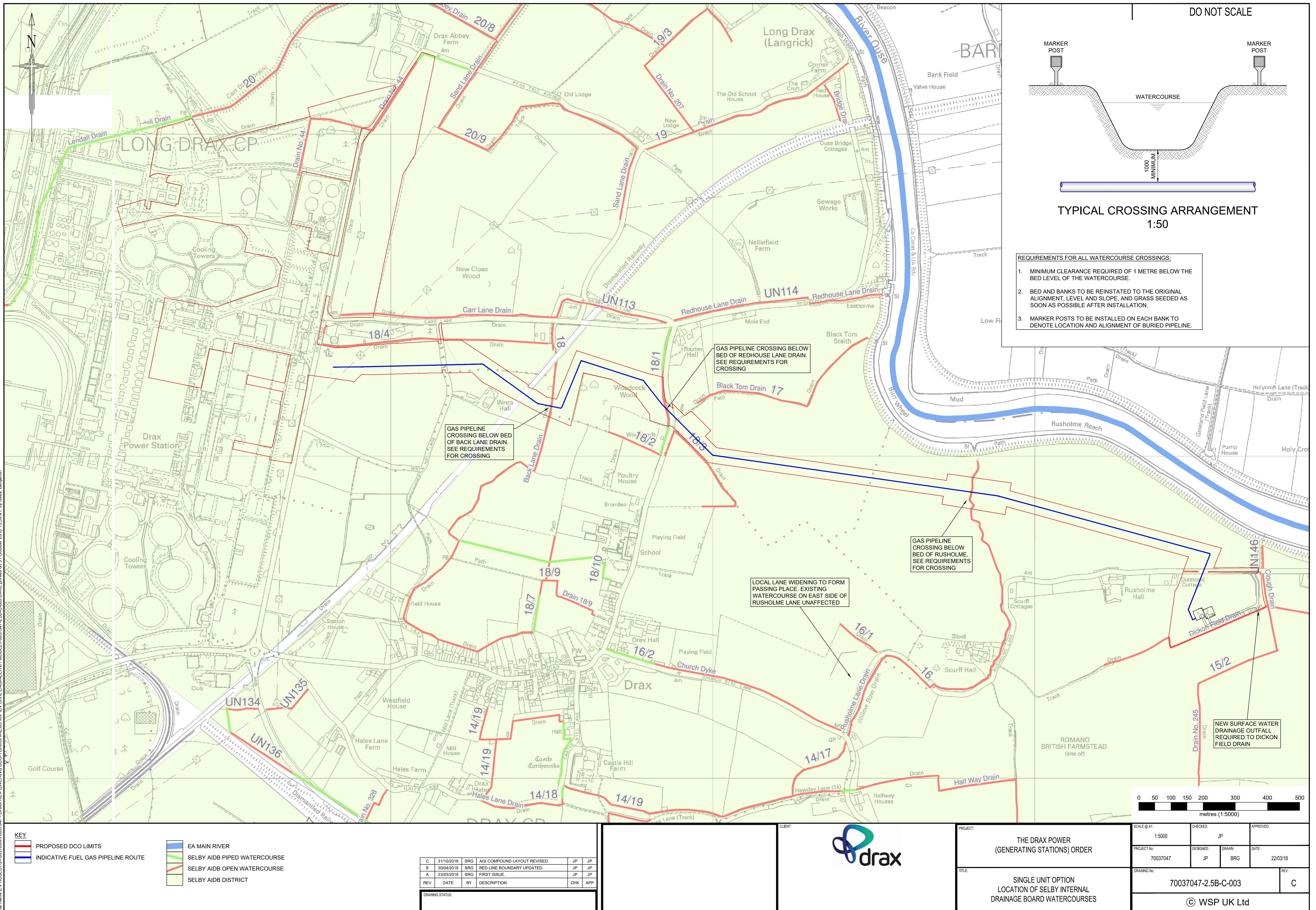
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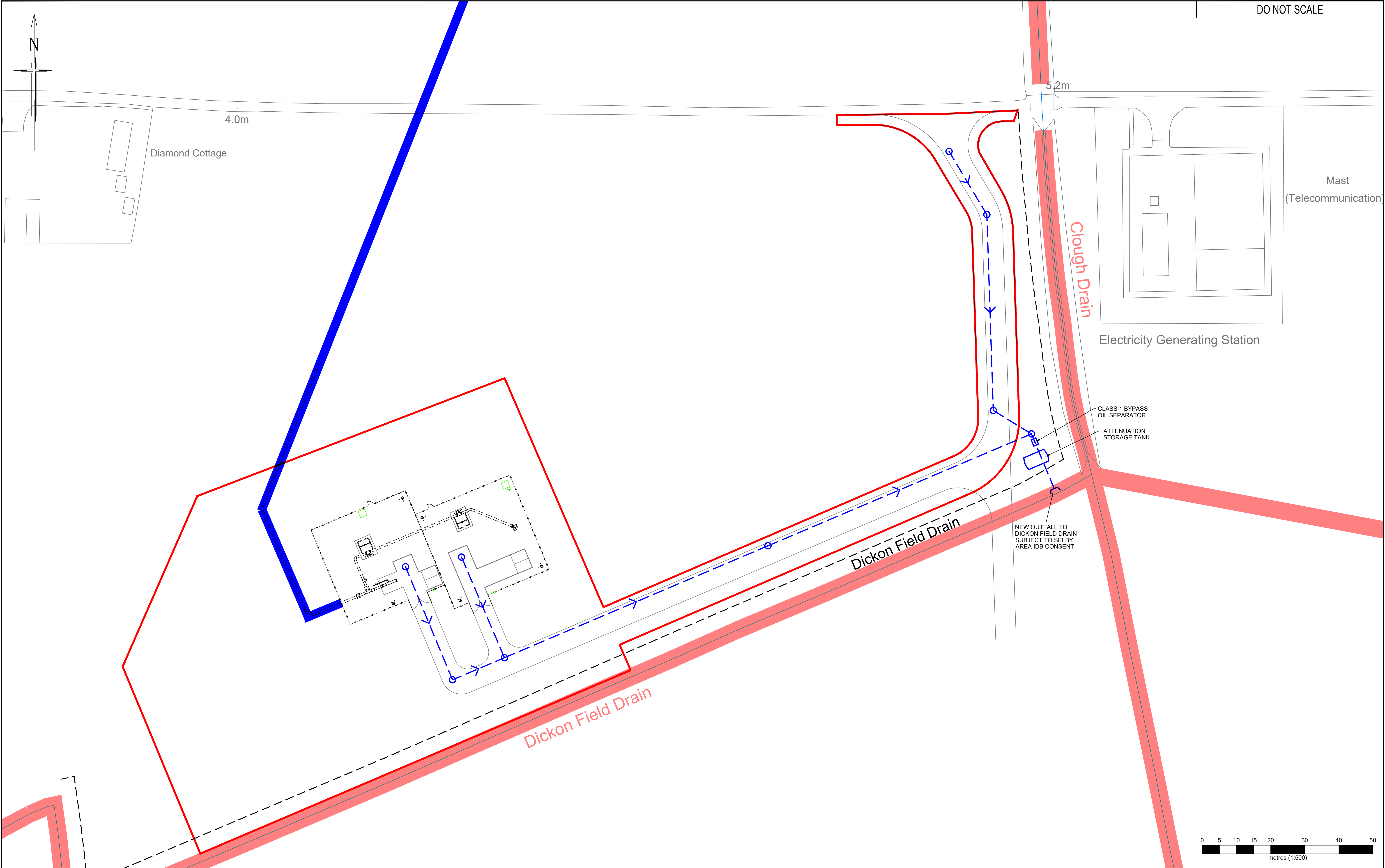
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DATE: 22/03/18		REV: B

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KEY

- INDICATIVE FUEL GAS PIPELINE ROUTE
- EXISTING DRAIN/WATERCOURSE
- PROPOSED SURFACE WATER DRAINAGE

INFRASTRUCTURE PLANNING (APPLICATIONS: PRESCRIBED FORMS AND PROCEDURE) REGULATIONS 2009 - REGULATION 5(2) (a)

C	31/10/2018	BRG	THIRD ISSUE.	JP	JP
B	06/09/2018	BRG	SECOND ISSUE.	ES	JP
A	22/03/2018	BRG	FIRST ISSUE.	JP	JP
REV	DATE	BY	DESCRIPTION	CHK	APP

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drax

PROJECT: THE DRAX POWER (GENERATING STATIONS) ORDER

TITLE: SINGLE UNIT OPTION ABOVE GROUND INSTALLATION PROPOSED SURFACE WATER DRAINAGE

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