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Yorkshire Green Energy Enablement (GREEN) Project

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Contents

Version history

Date	Version	Status	Description/changes
01/11/2022	A	Final	First Issue
28/07/2023	B	Final	Second Issue, upon acceptance of Change Application. Changes include: an update to Section 2.3, Local Planning Policy, to reflect the local government reorganisation that has taken place since submission of the DCO application in November 2022; changes to Section 5.2, Risks During the Construction Phase, to reflect minor changes to construction access in flood zones associated with Design Change 2; and a change to Annex 9D.3 Watercourse Crossings to include one new crossing of Hurn’s Gutter.

Executive summary

Purpose of this report

This Flood Risk Assessment (FRA) is an appendix to **Chapter 9: Hydrology and Flood Risk, Volume 5, Document 5.2.9,** of the Yorkshire Green Energy Enablement (GREEN) Project (referred to as the Project or Yorkshire GREEN) in the Environmental Statement (ES). The FRA supports the Development Consent Order (DCO) application for the Yorkshire GREEN Project (hereinafter referred to as the Project or Yorkshire GREEN); a proposal by National Grid Electricity Transmission plc (National Grid) to provide a new link on the transmission system by upgrading and reinforcing the electricity transmission system in Yorkshire.

The Project comprises the construction of new infrastructure consisting of substations at Overton and Monk Fryston, 7km of overhead line, underground cables and four cable sealing end compounds (two at Shipton and two at Tadcaster); which would link up existing overhead lines and reinforce the system to increase the capacity of the wider network. The Project also includes works to existing infrastructure, including: reconductoring of 30km of existing overhead line; modification of 2.5km of existing overhead line; dismantling of 6km of existing overhead line; and installation of additional equipment at Osbaldwick Substation.

Flood risks associated with fluvial, and surface water sources have been identified during the construction and operation phase of the Project. Flood risk receptors include construction activities themselves, operational infrastructure, maintenance and repair activities, plus third-party receptors for which flood risk could be increased because of the works.

The flood risk management standards, including the appropriate climate change uplifts to be applied, for all elements of the Project, during both the construction and operational phases are set out in **Section 6** of this document. During both phases of the Project there will be an increase in impermeable area which will result in greater surface water runoff. To manage the increased runoff from these areas SuDS will be used with discharge of the runoff prioritised in the following order: infiltration to ground; discharge to watercourse following attenuation; and combined/surface water sewer following attenuation.

Further modelling was undertaken to establish the design requirements of the Overton Substation to achieve the National Grid 0.1% AEP + climate change (34%), design standard. The final design for the Overton Substation is for it to be built on a raised platform with a level of 13.71 mAOD which takes it out of the 0.1% AEP + climate change (34%) flood with the inclusion of a 300mm freeboard. The modelling approach and outputs are detailed in **Annex 9D.4** which support this FRA.

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1. Introduction

1.1 Context

1.1.1 This Flood Risk Assessment (FRA) accompanies an application by National Grid Electricity Transmission plc (National Grid) to seek powers to construct, operate and maintain the Project which comprises the construction of new infrastructure consisting of approximately 7km of new overhead lines, underground cables, two substations, cable sealing end compounds (CSECs), to link up two existing overhead lines, and to reinforce the system to increase the capacity of the network north of York. It would also include upgrading works to existing infrastructure, including reconductoring (the replacement of wires on an existing transmission line), steelwork strengthening and potential replacement of existing pylons along the 275kV Poppleton to Monk Fryston (XC) overhead line. It would also carry out the installation of additional equipment at Osbaldwick Substation.

1.1.2 The Order Limits cover the entire area within which the Project would take place, including temporary access roads, construction compounds and laydown areas, as well as the new overhead lines, substations and CSECs and the works to the existing infrastructure. These are anticipated as the maximum extent of land in which the Project may take place.

1.1.3 A more detailed description of the Project design and construction methodology can be found on **Chapter 3: Description of the Project, Volume 5, Document 5.2.3** of the Environmental Statement (ES) and **section 3.2** of this FRA. This document is an appendix to **Chapter 9, Hydrology and Flood Risk, Volume 5, Document 5.2.9.**

1.2 Overall scope and approach to the FRA

Scope

1.2.1 All potential elements of the Project to be put forward for the application for DCO are assessed in the FRA. This comprises all new infrastructure, plus all construction related activities including construction compounds, access tracks and watercourse crossings. This FRA considers flood risk associated with the construction, operation, and decommissioning phases of the Project. In accordance with the Scoping Opinion the operational phase assessment considers all new, permanent infrastructure, excluding pylons, as outlined in **Section 4.6**. Flood risk to the Project and to third parties arising from the Project are assessed. The FRA follows a source-pathway-receptor led approach to the assessment of flood risk.

1.2.2 The construction phase extends over a 4.5 year period from 2024 to 2028, with some elements of the Project being operational from 2027. The Project would have a design life span exceeding 80 years before a decommissioning phase would be reached. The decommissioning of the overhead lines and substations is expected to be subject to similar flood risks as the construction phase and would likely be adequately managed through embedded measures similar to those summarised in **Table 6-1**. However, decommissioning phase flood risks would need to be assessed in the context of the future baseline conditions and policy framework prevailing at the appropriate time.

Therefore, no detailed quantitative assessment will be carried out for the decommissioning phase of the Project as part of the FRA.

Approach to FRA

1.2.3 An approach to the FRA has been adopted which is proportionate to the scale and diverse nature of the Project and recognises that different elements of the Project infrastructure have different levels of sensitivity to flooding. This allows the assessment to focus on sensitive aspects of Project infrastructure or activities which need to take place in areas of higher flood risk.

1.2.4 A range of generally applicable design principles and environmental measures have been defined which should serve to reduce flood risk across the Project (**Section 6**). Flood risks to, and arising from, the Project are assessed in the FRA assuming that these generic measures will have been implemented, as secured by DCO requirements. In most areas and for most aspects of the Project, it is expected that these generic measures would be sufficient to manage any flood risk related to the Project. Detailed site-specific assessments within the FRA are therefore focussed on assessing risks to more sensitive aspects of Project infrastructure or activities which need to take place in areas of higher flood risk.

1.2.5 The linear nature of the overhead line infrastructure means that flood risk areas cannot be completely avoided along the route it traverses. Furthermore, although every effort has been made to sequentially locate sensitive aspects of infrastructure in areas of low flood risk, this has not always proved to be possible, due to the operational requirements of the Project, or due to the over-riding requirements of other environmental constraints. Conformance of different aspects of the Project infrastructure with the requirements of the Sequential and Exception Tests are considered in **Section 7**.

1.2.6 This FRA has primarily used the Environment Agency's openly available flood maps for fluvial and surface water flood risk. However, it was identified at the scoping stage of assessment that additional information and detail were available and were required to inform a more detailed assessment at certain locations. The Environment Agency has provided model outputs for the four following models:

- 2010 River Ure and Tributaries Modelling Study;
- 2016 York Detailed Model;
- 2018 Ouse and Wharfe Washlands Study; and
- 2002 Cock Beck Model.

1.2.7 The stakeholders consulted regarding the FRA comprised the Environment Agency, the Lead Local Flood Authorities (LLFAs) and Internal Drainage Boards (IDBs). Statutory Consultation took place between 28 October 2021 and 9 December 2021 in accordance with the Planning Act 2008 (the Act). In addition, non-statutory consultation meetings were held to present and agree the approach to the FRA. A preliminary technical meeting was held prior to Statutory Consultation to present the overall approach to the FRA and the need for and approach to flood modelling to support specific flood mitigation for the proposed Overton Substation[1]. A further technical meeting was held

[1] Held on 29 July 2021, attended by representatives from the Environment Agency, North Yorkshire County Council and the York Consortium of IBDs.

after Statutory Consultation but prior to completion of the FRA to: 1) Present the Overton Substation flood modelling; 2) present the draft drainage strategies for Overton and Monk Fryston Substations; and 3) discuss the Project element locations and the potential consenting requirements[2]. A summary of consultation carried out to support the development of the hydrology EIA and FRA can be found in **Table 9.6** of **Chapter 9: Hydrology and Flood Risk, Volume 5, Document 5.2.9.**

Study Area

1.2.8 The Zone of Influence (ZoI) applied within this assessment is based upon the ZoI used in **Chapter 9: Hydrology and Flood Risk, Volume 5, Document 5.2.9**; and therefore, comprises potential receptors for effects arising from the Project.

1.2.9 The ZoI extends 0.5km upstream and downstream of the Order Limits and is justified on the basis that any effects to receptors beyond these limits would likely be negligible (not significant) at such distances from the Project, particularly with the application of embedded flood management measures specified in this FRA (**Section 6**).

1.3 FRA definitions

Annual Exceedance Probability (AEP)

1.3.1 In this report, the probability of a flood occurring is expressed in terms of Annual Exceedance Probability (AEP), which is the inverse of the annual maximum return period. For example, the 1 in 100-year flood can be expressed as the 1% AEP flood, i.e., a flood that has a 1% chance of being exceeded in any year.

1.3.2 **Table 1-1** is provided to clarify the use of the AEP terminology as well a description of the Flood Zone definitions as set out in the National Planning Policy Framework (NPPF)[3] flood risk and coastal change guidance and used in the Environment Agency's Flood Map for Planning.

Table 1-1 - Flood Zone definitions and associated annual exceedance probability[4]

Flood Zones	Probability of Flooding	AEP	Definition
Flood Zone 1	Low Probability	<0.1% AEP of river or sea flooding	Land with less than 1 in 1,000 probability of flooding from rivers or the sea, in any given year.
Flood Zone 2	Medium Probability	1% - 0.1% AEP of river flooding 0.5% – 0.1% AEP of sea flooding	Land with between a 1 in 100 and 1 in 1,000 of river flooding; or land having between a 1 in 200 and 1 in 1,000 probability of sea flooding.
Flood Zone 3	High Probability	>1% AEP of river flooding	Land having a 1 in 100 or greater probability of river flooding in any year; or

[2] Meeting held on 16 June 2022, attended by representatives from the Environment Agency, North Yorkshire County Council and the York Consortium of IBDs.
[3] Ministry of Housing, Communities & Local Government (2021). National Planning Policy Framework (online). Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2 (Accessed October 2022).
[4] Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government. (2021). Flood risk and coastal change guidance. (online). Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change (Accessed 12 September 2022)

Flood Zones	Probability of Flooding	AEP	Definition
		>0.5% AEP of sea flooding	Land having a 1 in 200 probability or greater of sea flooding in any year.
Flood Zone 3b[4+]	Functional Floodplain	The 3.33% AEP (or 1 in 30 annual probability) event is used to define Flood Zone 3b, the ‘functional floodplain’.	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities (LPA) should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.

+ The Flood Zone 3b definition was updated within the NPPF on the 25/08/2022, prior to this, the 5% AEP (or 1 in 20 annual probability) event was often used to help define Flood Zone 3b, the ‘functional floodplain’, but was not part of the definition. This assessment uses this, older, definition as none of the EA modelling of LPA SFRAs have yet been updated to reflect the new definition.

1.3.3 Flood Zone 3b is defined by the Local Planning Authorities (LPA) in their Strategic Flood Risk Assessment (SFRA). The North Yorkshire County Council (NYCC)[5] area operates a two-tier system of local government with most LPA responsibilities held at the District level not at County Level. A summary of each of the LPA Flood Zone 3b definitions are provided in **Section 2.3**, though they are largely consistent in defining Flood Zone 3b using a 5% AEP modelled flood extent, or where this is unavailable the 4% AEP flood extent, and that is what is used in this study.

1.3.4 For this study, flood extent outputs from the following models, provided by the Environment Agency, have been used to identify Flood Zone 3b:

- York Detailed Model (5% AEP);
- River Ure and Tributaries Modelling Study (4% AEP); and
- Ouse and Upper Wharfe Washland Study (5% AEP).

1.3.5 **Table 1-2** presents an overview of the risk categories used in the Environment Agency’s Risk of Flooding from Surface Water (RoFSW) mapping, as these differ from the definitions of Flood Zones for fluvial and tidal flood risk described above.

[5] The local authorities' boundaries and titles are correct at the time of submission November 2022. North Yorkshire County Council, Hambleton District Council, Selby District Council, Ryedale District Council, Scarborough Borough Council, Harrogate Borough Council, Craven District Council and Richmondshire District Council are expected to form a new single council (North Yorkshire Council) on 1 April 2023 as a result of Local Government Reorganisation

Table 1-2 - Surface water flood risk category definitions and associated annual exceedance probability[6]

Probability of Flooding	AEP	Definition
Very low risk	<0.1% AEP of surface water flooding.	Land with less than 1 in 1,000 probability of flooding from surface water, in any given year.
Low risk	0.1 – 1% AEP of surface water flooding	Land with between 1 in 1,000 and 1 in 100 probability of flooding from surface water, in any given year.
Medium risk	1 – 3.3% AEP of surface water flooding.	Land with between 1 in 100 and 1 in 30 probability of flooding from surface water, in any given year.
High risk	>3.3% AEP of surface water flooding.	Land with more than 1 in 30 probability of flooding from surface water, in any given year.

1.4 Structure of this report

1.4.1 The rest of this report is structured as follows:

- **Section 2** establishes the planning policy context for the FRA;
- **Section 3** provides an overview of the relevant baseline characteristics of the Order Limits and a description of the Project;
- **Section 4** comprises a screening assessment to consider the potential risk from all sources of flooding prevailing across the Order Limits and the surrounding area and identifies those that require detailed assessment;
- **Section 5** presents a detailed assessment of flood risks associated with the Project. This includes the identification of flood risk receptors, consideration of risks to these receptors associated with all the significant hazards identified in Section 4, and specifies mitigation measures where appropriate;
- **Section 6** specifies flood risk management mitigation measures where appropriate, and considers residual risk**;**
- **Section 7 - Planning Policy Requirements:** applies the Sequential and Exception Tests as necessary to meet planning requirements.
- **Section 8 - Summary and Conclusions** summarises the main points arising from the FRA.

[6] Environment Agency. (2019). Risk of Flooding from Surface Water (RoFSW) mapping (online). Available at: https://check-long-term-flood-risk.service.gov.uk/map (Accessed 21 June 2022)

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2. Planning context and requirements

2.1 Introduction

2.1.1 The purpose of this section is to identify the relevant planning policies, regulatory requirements and best practice guidance that define the scope of this assessment.

2.2 National planning policy and supporting guidance

Adopted National Policy Statements (NPSs)

2.2.1 The Project is defined as a Nationally Significant Infrastructure Project (NSIP) under Section 14(1)(b) and Section 16 of the Act as it comprises the installation of an electric line above ground with a nominal voltage of more than 132kV and a length of more than 2km. Therefore, a DCO is required to authorise the Project.

2.2.2 Section 104 of the Act requires that DCO applications must be determined in line with the requirements of the relevant National Policy Statements (NPSs) which provide the overarching principles relevant to major energy infrastructure and the policies against which applications for NSIPs should be determined.

2.2.3 The FRA has been prepared in accordance with the Overarching National Policy Statement for Energy (NPS EN-1[7]), which sets out planning policy with regard to NSIPs in the energy sector, and the National Policy Statement for Electricity Networks Infrastructure (NPS EN-5[8]).

2.2.4 The 'minimum requirements for FRAs as set out in paragraph 5.7.5 of NPS EN-1[7] are that they should:

- *"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;*

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[7] Department of Energy and Climate Change (2011). Overarching National Policy Statement for Energy (EN-1). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf (Accessed 21 June 2022)
[8] Department of Energy and Climate Change (2011). National Policy Statement for Energy Networks (EN-5). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/37050/1942-national-policy-statement-electricity-networks.pdf (Accessed 21 June 2022)

- *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; and*
- *Be supported by appropriate data and information, including historical information on previous events."*

2.2.5 NPS-EN1[7] also requires that the Sequential Test and Exception Test are applied. Paragraph 5.7.12 of NPS EN-1[7] states that *"The IPC* [Infrastructure Planning Commission – now replaced by the Planning Inspectorate] *should not consent development in Flood Zone 2 in England or Zone B in Wales unless it is satisfied that the Sequential Test requirements have been met. It should not consent development in Flood Zone 3 or Zone C unless it is satisfied that the Sequential and Exception Test requirements have been met*."

The Sequential Test

2.2.6 The Sequential Test is set out in EN-1[7], Paragraph 5.7.13, as follows: "*Preference should be given to locating projects in Flood Zone 1 in England or Zone A in Wales. If there is no reasonably available site in Flood Zone 1 or Zone A, then projects can be located in Flood Zone 2 or Zone B. If there is no reasonably available site in Flood Zones 1 or 2 or Zones A & B, then nationally significant energy infrastructure projects can be located in Flood Zone 3 or Zone C subject to the Exception Test.*"

2.2.7 EN-1[7] also requires that a sequential approach should be applied to the layout and design when allocating land for development and land use types within development sites.

2.2.8 The sequential approach has been adopted throughout the Project planning and design process and is specifically considered in further detail in **Sections 5.3** and **7.1**.

The Exception Test

2.2.9 Paragraph 5.7.14 of NPS EN-1[7] states "*If, following application of the sequential test, it is not possible, consistent with wider sustainability objectives, for the project to be located in zones of lower probability of flooding than Flood Zone 3 or Zone C, the Exception Test can be applied. The test provides a method of managing flood risk while still allowing necessary development to occur.*"

2.2.10 In accordance with paragraph 5.7.16 of NPS EN-1[7], for the Exception Test to be passed:

i. "*it must be demonstrated that the project provides wider sustainability benefits to the community that outweigh flood risk [benefits to the community would include the benefits (including need), for the infrastructure];*

ii. *"the project should be on developable, previously developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously developed land subject to any exceptions set out in the technology-specific NPSs; and*

iii. *"a FRA must demonstrate that the project will be safe, without increasing flood risk elsewhere subject to the exception below and, where possible, will reduce flood risk overall."*

2.2.11 The 'exception below' mentioned in the third part of the Exception Test is set out in paragraph 5.7.17 of NPS EN-1[7]: *"Exceptionally, where an increase in flood risk elsewhere cannot be avoided or wholly mitigated, the IPC* [Infrastructure Planning Commission – now replaced by the Planning Inspectorate] *may grant consent if it is satisfied that the increase in present and future flood risk can be mitigated to an acceptable level and taking account of the benefits of, including the need for, nationally significant energy infrastructure as set out in Part 3 above. In any such case the IPC should make clear how, in reaching its decision, it has weighed up the increased flood risk against the benefits of the project, taking account of the nature and degree of the risk, the future impacts on climate change, and advice provided by the Environment Agency and other relevant bodies."*

2.2.12 The exception test is considered further within the assessment of flood risk in **Section 5**, the management of flood risk in **Section 6** with an overarching summary provided in **Section 7.2**.

Draft National Policy Statements (NPSs)

2.2.13 The Department for Business, Energy and Industrial Strategy undertook a review of the energy NPSs with the consultation taking place between September and November 2021. Draft revision of the NPSs were published by the Government in February 2022. The draft NPSs reflect the policies and broader strategic approach set out in the Energy white paper and ensure a planning framework is in place to support the infrastructure requirement for the transition to net zero.

2.2.14 **Table 2-1 - Changes of relevance to flood risk in the updated draft National Policy** Statements summarises those draft energy NPS policy revisions which are considered to be relevant to the Project.

Table 2-1 - Changes of relevance to flood risk in the updated draft National Policy Statements

Policy reference	Relevant implications	Section addressed in FRA
Draft Overarching National Policy Statement for Energy (EN-1)[9]	Draft section 4.9 which discusses climate change adaptation. The amended policy includes reference to the preparation of measures which support climate change adaptation; such as nature-based solutions, renewable energies and GHG emission avoidance. The draft section also discusses the assessment of impact of climate change on the project and emphasises that it must show climate resilience across a range of climate change scenarios.	✓ - Addressed under **Section 1.2: Overall scope and approach to the FRA**, **Section 5: Assessment of flood risk** and **Section 6: Flood risk management** of this FRA.
	Draft section 5.8 which discusses flood risk, setting out the minimum requirements of a flood risk assessment as well as information on the application of the Sequential and Exception tests. The draft amended policy states that projects should aim for climate resilient infrastructure and improve the sustainability of existing infrastructure where possible. The draft revision clarifies that the preferred areas are those with the lowest flood risk. It also clarifies that all projects should apply the sequential test when location assets within the development site. The draft EN-1 Section 5.8 exception is revised that the projects must provide wider sustainability benefits and reduce overall flood risk where possible.	✓ - Addressed under **Section 7: Planning policy requirements** of this FRA
Draft National Policy Statement for Electricity Networks Infrastructure (EN-5)[10]	Draft section 2.6 provides clarification on climate change adaptation. Specifically, paragraph 2.6.1 of the draft EN-5 sets out that the risks associated with climate change are likely to rise, impacting the resilience of energy infrastructure. Consequently, applicants are advised to set out the extent of vulnerability to flooding of the Proposed Development. Also, as appropriate, how resilient the project would be to flooding, particularly for substations that are vital for the electricity transmission and distribution network. The draft amended NPS EN-5 also add that Grid Connections should be resilient to coastal erosion where necessary.	✓ - Addressed under **Section 1.2: Overall scope and approach to the FRA**, **Section 5: Assessment of flood risk** and **Section 6: Flood risk management** of this FRA.

[9] Department for Business Energy and Industrial Strategy. (2021). Draft Overarching National Policy Statement for Energy (EN-1). (online). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1015233/en-1-draft-for-consultation.pdf (Accessed October 2022).
[10] Department of Energy and Climate Change. (2021). National Policy Statement for Electricity Networks Infrastructure (EN-5) (online). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1015238/en-5-draft-for-consultation.pdf (Accessed October 2022).

National Planning Policy Framework (NPPF)[3]

2.2.15 The NPPF (2021) acts as guidance for local planning authorities and decision makers, both in drawing up plans and making decisions about planning applications. This is supported by online Planning Practice Guidance[11].

2.2.16 Although the NPPF and the associated Planning Practice Guidance (PPG) are not directly applicable to NSIP developments, they do provide additional relevant guidance on a range of issues, including the definition of flood zones, development vulnerability classifications, compatibility of development types and flood zones, and appropriate allowances for the effects of climate change.

2.2.17 The NPPF sets out requirements for FRA for new developments and describes how the Sequential (Paragraph 161 and 162) and Exception Tests (Paragraph 163 and 164) should be applied, depending on the Flood Zone that the Project is located in, and its Flood Vulnerability classification. Paragraph 164 states that, '*To pass the exception test it should be demonstrated that:*

- *a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and*
- *b) 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.'*

2.2.18 Paragraph 167 of the NPPF[3] requires that new development should not increase flood risk elsewhere, and that opportunities should be sought to reduce flood risk, where possible. Paragraph 167 states '…*Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:*

- *a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;*
- *b) the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;*
- *c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
- *d) any residual risk can be safely managed; and*
- *e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.'*

2.2.19 Paragraph 169 of the NPPF[3] states "*Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:*

- *(a) take account of advice from the lead local flood authority;*

[11] Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government (2021). Planning practice guidance (online). Available at: https://www.gov.uk/government/collections/planning-practice-guidance (Accessed October 2022).

- *(b) have appropriate proposed minimum operational standards;*
- *(c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and*
- *(d) where possible, provide multifunctional benefits."*

2.2.20 There is a presumption for the use of Sustainable Drainage Systems (SuDS) within any development, except in rare instances where it can be demonstrated that SuDS principles cannot be feasibly incorporated within a development, as agreed with the planning authority.

Climate change guidance for FRA

2.2.21 NPS EN-1[7] and NPS EN-5[8] gives advice on accounting for climate change, to the effect that developments should be resilient and adaptive to the latest climate change projections.

2.2.22 Current Environment Agency guidance[12] have been used to determine appropriate climate change allowances to determine future flood hazard for the FRA (as updated on 27 May 2022). The Environment Agency guidance provides climate change allowances for river flow, set by individual operational management catchment, for the following epochs:

- '2020s', covering the period 2015 to 2039;
- '2050s', covering the period 2040 to 2069; and
- '2080s', covering the period 2070 to 2115.

2.2.23 The Project crosses three Environment Agency Management Catchments which are listed below (from north to south). The climate change peak river flow allowances relevant to each of the epoch's listed above and the Management catchments listed below are set out in **Table 2-2**. These catchments are presented in **Figure 9-3 A-F, Volume 5, Document 5.4.9** which accompany **ES Chapter 9: Hydrology and Flood Risk, Volume 5, Document 5.2.9**.

- Swale, Ure, Nidd and Upper Ouse;
- Wharfe and Lower Ouse; and
- Aire and Calder.

Table 2-2 - Climate change peak river flow allowances by management catchment[12]

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 2125)
Swale, Ure, Nidd and Upper Ouse Management Catchment			
Upper end	25%	33%	53%

[12] Environment Agency (2022). Flood risk assessments: climate change allowances (online). Available at https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances (Accessed 21 June 2022)

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 2125)
Higher central	15%	20%	34%
Central	11%	14%	25%
Wharfe and Lower Ouse Management Catchment			
Upper end	22%	29%	48%
Higher central	14%	18%	31%
Central	11%	13%	23%
Aire and Calder Management Catchment			
Upper end	24%	31%	51%
Higher central	15%	18%	31%
Central	11%	13%	23%

2.2.24 The Environment Agency guidance also provides climate change allowances for extreme rainfall set by individual operational management catchment, for the following epochs:

- '2050s', covering developments with a lifespan up to 2060; and
- '2070s', covering the period 2061 to 2125.

2.2.25 **Table 2-3** sets out these climate change peak rainfall allowances, relevant to the management catchments.

Table 2-3 - Climate change peak rainfall allowances[12]

	3.33% AEP		1% AEP	
Allowance Category	**Total Potential Change Anticipated for the '2050s' (up to 2060)**	**Total Potential Change Anticipated for the '2070s' (2061 to 2125)**	**Total Potential Change Anticipated for the '2050s' (up to 2060)**	**Total Potential Change Anticipated for the '2070s' (2061 to 2125)**
Swale, Ure, Nidd and Upper Ouse Management Catchment				
Upper end	35	40	40	45
Central	20	25	25	30
Wharfe and Lower Ouse Management Catchment				
Upper end	35	40	40	40
Central	20	25	25	30
Aire and Calder Management Catchment				

Upper end	35	40	40	45
Central	20	25	25	30

2.3 Local planning policy

2.3.1 The Project traverses the areas of three local planning authorities (LPAs), City of York Council (CYC), Leeds City Council (LCC), and North Yorkshire Council (NYC)[13]. Although, as an NSIP, the Project is not subject to LPA consent, LPAs are Statutory Consultees in the DCO process, and the Planning Inspectors may consider local planning guidance to be pertinent to the examination process. Local planning policies of relevance to flood risk and the Project are summarised below. Local planning policies should be aligned with the requirements of NPPF at national level, and this has generally been found to be the case. As noted in **Section 1.3**, the LPAs define Flood Zone 3b in their SFRAs. These definitions are provided below.

City of York Council

2.3.2 City of York Council Local Plan (2005) [14], Policy GP15a (Project and Flood Risk) requires an appropriate assessment to accompany a planning application where development is proposed in an area at risk of flooding or increased surface water runoff. The policy also states that proposals for new developments on previously undeveloped land (outside of defined settlements) must demonstrate that the development will not impact floodplain storage, affect water conveyance across the floodplain or increase flood risk elsewhere.

2.3.3 The CYC Strategic Flood Risk Assessment (SFRA)[15], published in 2013, maps Flood Zone 3b modelling output which identify areas with up to a 1 in 20 or greater annual probability of flooding in any year (5%).

Leeds City Council

2.3.4 The LCC Core Strategy (2019)[16], Policy EN5 (managing flood risk) has been developed in order to manage both fluvial and pluvial sources of flooding by avoiding development

[13] North Yorkshire Council was formed as a new unitary authority on 1 April 2023, at which date it assumed the local planning authority duties of the former North Yorkshire County Council, along with its constituent district councils, namely Hambleton District Council, Harrogate Borough Council, Selby District Council, Ryedale District Council, Scarborough Borough Council, Craven District Council and Richmondshire District Council. The Project Order Limits intersect the former Hambleton District, Harrogate Borough and Selby District Council areas. Local plans have not yet been updated to reflect this reorganisation, so this document makes reference to relevant policies from predecessor borough or district local plans.

[14] City of York Council. (2005). The Local Plan. (Online) Available at: https://www.york.gov.uk/CurrentLocalPlan (Accessed 21 June 2022)
[15] City of York Council. (2013). Strategic Flood Risk Assessment. (Online) Available at: https://www.york.gov.uk/downloads/file/2703/2013-strategic-flood-risk-assessment (Accessed 25 July 2022)
[16] Leeds City Council (2019). Core Strategy for Leeds. Available at: https://www.leeds.gov.uk/planning/planning-policy/adopted-local-plan/core-strategy-introduction (Accessed 21 June 2022)

in flood risk areas, where possible, by applying the sequential approach and where this is not possible by mitigating measures, in line with the NPPF.

2.3.5 The LCC SFRA (2007)[17] assesses the impact of flooding on development in Leeds. The LCC SFRA defines Flood Zone 3b *as 'land that is subject to flooding with a 1 in 20 year (5%) probability (or more frequently).'*

North Yorkshire Council (former Hambleton District Council area)

2.3.6 The HDC Local Plan (2022), Policy RM2 (flood risk) sets out the council's approach to managing and mitigating flood risk. It requires new developments to avoid areas of flood risk, conduct appropriate flood risk assessments and apply the sequential approach where necessary.

2.3.7 The HDC SFRA[18] provides part of the evidence base during development of the HDC Local Plan, by informing land-use allocations and sustainability appraisals. Within the HDC SFRA Flood Zone 3b has been defined '*on the basis of detailed river model outputs for 1 in 20-year (5% AEP) flood events accounting for any formal flood defences in place (or 1 in 25-year if 1 in 20-year not available*)'.

North Yorkshire Council (former Harrogate Borough Council area)

2.3.8 The HBC Local Plan[19] (2020) Policy CC1 (Flood Risk and Sustainable Drainage) specifies that a site-specific flood risk assessment should accompany a planning application where the development is proposed within Flood Zone 3a.

2.3.9 HBC is considered under the North West Yorkshire SFRA[20] to informs the consideration of flood risk in LPA Core Strategies and development frameworks. The SFRA does not provide a clear steer as to how they have defined Flood Zone 3b, however, there is some reference to Environment Agency guidance that states that this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood.

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[17] Leeds City Council (2007). Strategic Flood Risk Assessment. (Online) Available at: https://www.leeds.gov.uk/planning/planning-policy/evidence-and-monitoring/strategic-flood-risk (Accessed 26 July 2022)

[18] Hambleton District Council (2017). Level 1 Strategic Flood Risk Assessment (Online). Available at: https://www.hambleton.gov.uk/downloads/file/1015/sd45-level-1-strategic-flood-risk-assessment-final-report-march-2017 (Accessed 21 July 2022)

[19] Harrogate Borough Council (2020). Harrogate district Local Plan 2014-2035. (Online) Available at: https://www.harrogate.gov.uk/localplan (Accessed 21 June 2022)

[20] Harrogate Borough Council. (2010). North West Yorkshire Level 1 SFRA Update. (Online) Available at: https://www.richmondshire.gov.uk/media/8255/north-west-yorkshire-level-1-sfra-update.pdf#:~:text=Harrogate%20Borough%20Council%2C%20Richmondshire%20District%20Council%20and%20Craven,and%20in%20preparing%20their%20Local%20Development%20Documents%20%28LDDs%29. (Accessed 26 July 2022).

North Yorkshire Council (former Selby District Council area)

2.3.10 The HDC Local Plan[21] (2021) Preferred Approach SG11 (Flood Risk) sets out the councils' expectations when it comes to new developments and flood risk which broadly align with the NPPF in terms of flood resilience and risk management.

2.3.11 The SDC SFRA[22] has been prepared in order to collate and present recent flood risk information. '*For the purposes of the SFRA, identification of the functional floodplain for the Rivers Aire, Ouse and Wharfe has been undertaken using modelled data to define the land area which would naturally flood with an annual probability of 1 in 20 (5% AEP) or greater in any year and identifying land which is designed to flood (such as a flood attenuation scheme, washland or flood storage area)'*[22].

2.4 Other relevant local plans and consenting requirements

2.4.1 A number of other bodies with responsibility for management and regulation of the water environment have produced plans that are of relevance to this assessment. These bodies also have responsibilities for the regulation of activities in and around watercourses that could affect flood risk. These include the Environment Agency, Lead Local Flood Authorities (LLFAs) and Internal Drainage Boards (IDBs). Relevant plans produced by these bodies and their consenting powers are summarised below. A summary of consultation with these bodies during the process of preparing this FRA can be found in **Section 1.2** and **Table 9.6** of **Chapter 9: Hydrology and Flood Risk, Volume 5, Document 5.2.9.**

Environment Agency

2.4.2 The Environment Agency is the lead statutory body with responsibility for protection of the water environment. It is also responsible for flood defence and drainage for Main Rivers[23] (Main River is a statutory designation which is usually applied to larger watercourses) and estuarine and coastal areas. The Environment Agency has produced regional management plans and policies for the water environment; the key document of relevant to this FRA is the River Ouse Catchment Flood Management Plan[24]. The Order Limits span three policy areas, as defined within the plan, as follows:

- Sub-area 2 The Washland.
  The adopted policy is Policy 6 "*The risk of flooding is low and property affected is dispersed throughout the area.*"
- Sub-area 4 York.
  The adopted policy is Policy 5 "*Several areas have been identified through the Ouse Strategy Study where improvements could be justifiable"* and "… *We will promote the development of a surface water management plan which will identify the scale of the risk and recommend improvements*..."

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[21] Selby District Council. (2021). New Local Plan (online). Available at: https://www.selby.gov.uk/localplan (Accessed 21 June 2022)
[22] Selby District Council. (2021). Strategic Flood Risk Assessment. (Online). Available at: https://www.selby.gov.uk/strategic-flood-risk-assessment (Accessed 26 July 2022)
[23] Environment Agency. (2020). Main River Map. (Online) (Accessed 22 June 2022)
[24] Environment Agency (2009). River Ouse: Catchment flood management plan. (Online) Available at: https://www.gov.uk/government/publications/river-ouse-catchment-flood-management-plan (Accessed 12 September 2022)

- Sub-area 6 Tidal Ouse and Wharfe.
  The adopted policy is Policy 4 "*Recent defences have reduced risk in the area but climate change has the potential to increase risk as this area can be affected by both increased fluvial flows and increased sea levels and higher tidal flows*."

2.4.3 The Environment Agency is a statutory consultee in the DCO process and is also responsible for regulating engineering works liable to affect Main Rivers through the issuing of Flood Risk Activities Permits (FRAPs). Any works within 8m of a Main River banktop (or 8m of the landward side of a flood defence), increasing to 16m for a tidal Main River, will require Flood Risk Activity Permits (FRAP) to be applied for from the Environment Agency.

2.4.4 FRAPs are also required at different distances from the bank top/flood defence for Electrical cable service crossing over a Main River. The distances vary depending on the voltage of the electric cable[25].

Lead Local Flood Authorities

2.4.5 LLFAs were defined as risk management authorities under the Flood and Water Management Act 2010 (FWMA, 2010). They are responsible for the management of local flood risk (i.e. all other flood risk except that from Main Rivers and the sea). This is done though the process of developing Preliminary Flood Risk Assessments (PFRAs) and Local Flood Risk Management Strategies (LFRMS). LLFAs are statutory consultees to the DCO process. LLFAs are also responsible for regulating engineering works likely to affect Ordinary Watercourses through issuing Land Drainage Consents (LDCs) outside of IDB areas. Ordinary Watercourses include streams, drains, ditches and passages through which water flows that do not form part of the network of Main Rivers. The Order Limits traverse three LLFA areas: NYCC; CYC and LCC. A summary of each of the LLFAs is provided below. LDCs would need to be applied for any works within the stand-off distances specified by the individual LLFAs.

North Yorkshire County Council

2.4.6 NYCC functions only relate to Ordinary Watercourses that are outside of Internal Drainage Districts (as is the case with all LLFAs). The NYCC Local Flood Risk Management Strategy (LFRMS) (June 2013)[26] is of relevance to this assessment and sets out their position in relation to managing, regulating and coordinating the local flood risk, including flooding from other sources, including surface water, groundwater and the sewer network. It recognises and reinforces the findings of the Preliminary Flood Risk Assessment (PFRA; 2011).

2.4.7 NYCC have also produced a Culverting Works and Drainage Maintenance Protocol (2019), which is also relevant to this assessment, in regard to the proposed temporary watercourse crossings. NYCC specifies a stand-off distance of 5m, in their Guidance[37], for Project related works, including access tracks; however, this is not enforced.

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[25] Environment Agency (2020). Guidance: Exempt flood risk activities: environmental permits (online). Available at: https://www.gov.uk/government/publications/environmental-permitting-regulations-exempt-flood-risk-activities/exempt-flood-risk-activities-environmental-permits (Accessed 13 August 2021)
[26] North Yorkshire County Council (2013). Local Flood Risk Management Strategy (Online) Available at: https://www.northyorks.gov.uk/flood-and-water-management (Accessed 12 September 2022)

City of York Council

2.4.8 The CYC are responsible for local flood risk management within their region, which involves developing and maintaining a strategy for the management of local flood risk.

2.4.9 The LFRMS[27] (2022) identifies key flood risks from fluvial sources, including the Rivers Ouse and Foss, and from surface water runoff. It also notes that whilst flood defences effectively protect the area from flooding, it is vital to ensure their continued effectiveness following future climate change. The CYC LFRMS provides the principles for managing flood risk within the city of York.

Leeds City Council

2.4.10 The LCC LFRMS (2014)[28] notes that fluvial flooding is the primary risk within its region, with particular mention of flooding associated with the River Aire, River Nidd and River Wharfe. LCC LFRMS guides flood risk management activities within its region and is informed by the LCC SFRA (2007) [29].

Internal Drainage Boards (IDBs)

2.4.11 IDBs are not statutory consultees to the DCO process, but they are designated as risk management authorities under the FWMA 2010. They are responsible for manging water levels in low lying areas, with responsibilities that include managing land drainage and flood defence works on Ordinary Watercourses in their areas. It is IDBs, rather than LLFAs that are responsible for issuing LDCs in IDB areas.

2.4.12 The Order Limits traverse three IDB areas, as summarised below.

Ainsty IDB and Foss IDB

2.4.13 The Ainsty IDB (AIDB) and Foss IDB (FIDB) are responsible for sustaining land use (including inhabitation) within their 173km^2 and 125km^2 (respective) drainage district, through water level management, land drainage and flood risk management. The AIDB constitutes five districts to the west of York, which were amalgamated in 2011. The FIDB consists of two combined catchments to the northeast of York with an overall maintained watercourse length of 215.5km[30]. The AIDB and FIDB Policy Statements are of relevance to this assessment.

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[27] City of York Council. (2022). Local Flood Risk Management Strategy. (Online) Available at: https://www.york.gov.uk/downloads/file/281/local-flood-risk-management-strategy (Accessed 25 July 2022)

[28] Leeds City Council. (2014). Local Flood Risk Management Strategy. (Online) Available at: https://www.leeds.gov.uk/flooding/flood-risk-management-strategy (Accessed 21 July 2022)

[29] Leeds City Council. (2007). Strategic Flood Risk Assessment. (Online) Available at: https://www.leeds.gov.uk/docs/Strategic%20Flood%20Risk%20Assessment%20Oct%202007.pdf (Accessed 25 July 2022)

[30] The FIBD area is located within the catchment of the River Foss, a Main River which flows into the River Ouse in York. However, it should also be noted that the AIDB area contains a network of drainage channels and ordinary watercourses that also bear the name 'the Foss'. Part of this network drains northwards towards the River Ouse upstream of York, and another part drains southwards towards the River Wharfe downstream of Tadcaster. These are referred to as the Foss (tributary of Ouse) and the Foss (tributary of Wharfe) respectively.

2.4.14 The AIDB and FIDB are part of the York Consortium of Drainage Boards (YCDB). As such, the YCDB Policy Statement on Flood Protection and Water Level Management[31] is of relevance to this assessment, as are a number of their byelaws that relate to management of the drainage network. The Policy Statements of the IDBs are aligned and each include the following three objectives:

- to encourage the provision of adequate and cost effective flood warning systems;
- to encourage the provision of adequate economically, technically, and environmentally sound and sustainable flood and coastal defences; and
- to discourage inappropriate development in areas at risk from flooding.

2.4.15 The policy states that the IDBs monitor the condition of its assets and watercourses, in particular those identified as critical. No definition or identification of critical assets/watercourses is provided by the IDB; as a precautionary approach, it is therefore assumed any IDB adopted watercourse would be considered critical.

Kyle and Upper Ouse IDB

2.4.16 The Kyle and Upper Ouse IDB is responsible for managing a 118km^2 drainage district area, with approximately 253km of managed watercourses. A number of their byelaws that relate to management of the drainage network and are relevant to this assessment.

2.5 Other technical guidance

National Grid flood design guidance

2.5.1 National Grid have produced their own flood design criteria[32] which defines their target standards of protection (SoP) for flood defence/resilience that should be applied to all new build electricity transmission substations and at legacy substations subjected to an expansion or a major refurbishment programme. This document effectively sets out the minimum SoP as being a 0.1%AEP plus the applicable allowances for climate change as provided in the relevant national planning guidance. The National Grid Guidance also states that the default option shall be to include a 300mm freeboard in the flood resilience level.

SuDS guidance

CIRIA SuDS manual (C753)[33]

2.5.2 The CIRIA SuDS (C753) is the most up-to-date industry standard containing revised principles and technical advice for the planning, design, construction, management, and maintenance of effective SuDS. The drainage systems for new developments should be designed to align with the SuDS manual.

[31] York Consortium of Drainage Boards. (2008). Flood Protection and Water Level Management. (Online). Available at: http://www.yorkconsort.gov.uk/ainsty2008policystate.html (Accessed 25 July 2022)
[32] National Grid (2016). General electricity and substation design manual for civil, structural and building engineering, Section No:13; Flood defences for electricity for substations (TS 2.10.13, Issue 2). National Grid; London.
[33] CIRIA. (2015). SuDS Manual (C753). CIRIA; London.

DEFRA Non-statutory technical standards for sustainable drainage systems, 2015[34]

2.5.3 The Non-Statutory Technical Standards for Sustainable Drainage Systems is a national guidance document that provides a set of standards to be applied when designing SuDS systems for new developments. Standards include controls on peak flow and volume of run-off, and flood risk internal to the development and downstream. These are the flow standards to which the LLFAs generally adopt to judge any proposed surface water management system.

Lead Local Flood Authority surface water drainage advice

2.5.4 Each of the LLFAs produce guidance with regards to their requirements for drainage design and runoff estimation which are all principally based upon the non-statutory guidance set out above. They each set out and promote the same drainage hierarchy as follows:

- **Prevention** of runoff by good site design and reduction of impermeable areas.
- **Source Control:** Dealing with water where and when it falls (e.g. infiltration techniques).
- **Site Control:** Management of water in the local area (e.g. swales, detention basins).
- **Regional Control:** Management of runoff from sites (e.g. balancing ponds, wetlands).

2.5.5 The methods used to discharge surface water should be prioritised in the following order: infiltration to ground; watercourse; and combined/surface water sewer.

2.5.6 The West Yorkshire Combined Authority, which represents a number of different local planning authorities, including LCC, CYC and NYCC, produced the 'Leeds City Region Sustainable Drainage Systems Guidance[35]' in 2020. **Table 2-4** summarises the drainage/SUDS requirements for each of the LLFAs affected by the Project.

Table 2-4 - Local SuDS standards[35]

Issue	York CC	North Yorkshire CC	Leeds CC
Consider connections to Highway Drains	Yes	No	Yes, subject to commuted sum
Minimum Brownfield Discharge Rate reduction	30%	30%	Major development = 50% Minor development = 30%

[34] Department for Environment, Food and Rural Affairs. (2015). Non-statutory technical standards for sustainable drainage systems. (Online) Available at: https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards (Accessed 25 July 2022)

[35] West Yorkshire Combined Authority (2020). Leeds City Region Sustainable Drainage Systems Guidance (online). Available at: https://www.westyorks-ca.gov.uk/media/5397/lcr-suds-guidance-final-february-2020-1.pdf (Accessed October 2022).

Issue	York CC	North Yorkshire CC	Leeds CC
Greenfield Discharge Rate to be used	To be modelled using IH124 or FEH, 1.4l/s/ha	As calculated using IH124 or FEH methods. Alternatively, 1.4l/s/ha where not available.	For sites < 1ha a maximum discharge rate of 4 l/s can be used for all storms up to the 1% AEP event +CC. Alternatively IH124, ICP SUDS and FEH methods can be used.
Climate Change Allowance	30%	Link provided to the national guidance; further details provided below.	Link provided to the national guidance[12]
Urban Creep Allowance	0	10%	10%
Identified Special Areas of Drainage	No	No	No
Local SuDS Guidance	City of York Council Sustainable Drainage Systems Guidance for Developers[36] (2018)	North Yorkshire County Council SuDS Design Guidance[37] (2022 update)	Minimum Development Control Standards for Flood Risk[38] (2017)

2.5.7 The NYCC SuDS Design Guidance[37] (2022 update) refers to the national guidance in relation to the climate change (peak rainfall) allowance, however, it does advise on the relevant epochs depending on the lifetime of the development. Based upon the NYCC guidance, the relevant epochs for the lifetime of the Project are as follows:

- for the construction phase the central allowance uplifts for the 2050s epoch should be used; and
- for the operational phase, the upper end allowance uplifts for the 2070s epoch should be applied

2.5.8 The values for the peak rainfall uplift allowances are summarised in **Table 2-3**, by management catchment. On a precautionary basis the maximum allowance for 1% AEP events of all the management catchments was applied; which is 25% for the 2050s epoch (central) and 45% of the 2070s epoch (upper end).

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[36] City of York Council (2018) Sustainable Drainage Systems Guidance for Developers (online). Available at: https://www.york.gov.uk/downloads/file/2724/sustainable-drainage-systems-guidance-for-developers (Accessed October 2022).
[37] North Yorkshire County Council. (2022). SuDS Design Guidance (2022 update). North Yorkshire County Council; Yorkshire.
[38] Leeds City Council (2017) Minimum Development Control Standards for Flood Risk (online). Available at: https://www.leeds.gov.uk/docs/Minimum%20development%20control%20standards%20for%20flood%20risk.pdf (Accessed October 2022).

2.6 Summary of policy basis for FRA

2.6.1 Design standards for flood protection measures for flood vulnerable critical elements of Project infrastructure will be specified in **Section 3.1,** in accordance with the industry guidelines, with climate change allowances being taken from current Environment Agency climate change guidance, as summarised in the Section above. These design standards are broadly consistent with the requirements of planning policy. However, it is recognised that NPS EN-1 and EN-5 advise that further assessment should be made of residual risks to this type of infrastructure for events beyond the required design standard.

3. Site and Project description

3.1 Project description

Introduction

3.1.1 The information in this section includes only information deemed of relevance to this FRA. The Project is divided into six sections for ease of reference as indicated in **Figure 1.2, Volume 5, Document 5.4.1**. The Project will comprise both new infrastructure and works to existing transmission infrastructure and facilities as follows.

- Section A (Osbaldwick Substation): Minor works at the existing Osbaldwick Substation comprising the installation of a new circuit breaker and isolator along with associated cabling, removal and replacement of one gantry and works to one existing pylon. All substation works would be within existing operational land.
- Section B (North west of York Area): Works would comprise:
  - reconductoring of 2.4km of the 400kV Norton to Osbaldwick (2TW/YR) overhead line and replacement of one pylon on this overhead line;
  - the new 400kV YN overhead line (2.8km), north of the proposed Overton Substation;
  - the new Shipton North and South 400kV cable sealing end compounds (CSECs) and 230m of cabling to facilitate the connection of the new YN 400kV overhead line with the existing Norton to Osbaldwick YR overhead line;
  - a new substation (Overton 400kV/275kV Substation) approximately 1km south of Shipton by Beningbrough;
  - two new sections of 275kV overhead line which would connect into Overton Substation from the south (the 2.1km XC overhead line to the south-west and the 1.5km SP overhead line to the south-east);
  - works to 5km of the existing XCP Poppleton to Monk Fryston overhead line between Moor Monkton in the west and Skelton in the east comprising a mixture of decommissioning, replacement and realignment. To the south and south-east of Moor Monkton the existing overhead line would be realigned up to 230m south from the current overhead line and the closest pylon to Moor Monkton (340m south-east) would be permanently removed. A 2.35km section of this existing overhead line permanently removed between the East Coast Mainline (ECML) Railway and Woodhouse Farm to the north of Overton.
- Section C (Moor Monkton to Tadcaster): Works proposed to the existing 275kV Poppleton to Monk Fryston (XC) overhead line comprise replacing existing overhead line conductors, replacement of pylon fittings, strengthening of steelwork and works to pylon foundations.
- Section D (Tadcaster Area): Two new CSECs (Tadcaster East and West 275kV CSECs) and approximately 350m of cable would be installed approximately 3km south-west of Tadcaster and north-east of the A64/A659 junction where two existing

overhead lines meet. One pylon on the existing 275kV Tadcaster Tee to Knaresborough (XD) overhead line would be replaced.

- Section E (Tadcaster to Monk Fryston): Works proposed to the existing 275kV Poppleton to Monk Fryston (XC) overhead line would comprise replacing existing overhead line conductors, replacement of pylon fittings, strengthening of steelwork and works to pylon foundations.
- Section F (Monk Fryston Area): A new substation would be constructed to the east of the existing Monk Fryston Substation which is located approximately 2km south-west of the village of Monk Fryston and located off Rawfield Lane, south of the A63. A 1.45km section of the 275kV Poppleton to Monk Fryston (XC) overhead line to the west of the existing Monk Fryston Substation and south of Pollums House Farm would be realigned to connect to the proposed Monk Fryston Substation. East of the existing Monk Fryston Substation the existing 4YS 400kV Monk Fryston to Eggborough overhead line, which currently connects to the existing substation, would be reconfigured to connect to the proposed Monk Fryston Substation.

3.1.2 As set out in **Section 2.2**, the NPPF[3] and the associated PPG[11] provide guidance on vulnerability classifications for development types, based on their use/function and the compatibility of development with flood zones. A matrix is provided in **Table 3-1** that applies the NPPF flood risk vulnerability to the various elements of the Project and their compatibility with the Flood Zones.

Table 3-1 - Application of the flood risk vulnerability and Flood Zone 'compatibility' matrix to the Project

Project Type	Flood Risk Vulnerability Classification[1]	Flood Zone(s)[1]	Flood Risk Vulnerability and Flood Zone 'compatibility'
Construction			
Temporary construction compounds (TCCs) *(office and welfare facilities)*	Less Vulnerable	1, 2 and 3a	✓
Areas required for substation and overhead line construction activities *(access routes and working areas)*	Essential Infrastructure	1, 2, 3a, and 3b*	✓ Exception Test required[2]
Watercourse crossings	Water compatible	1, 2, 3a, and 3b*	✓
Operation			
Overhead line	Essential Infrastructure[2]	1, 2, 3a, and 3b*	✓ Exception Test required[2]
Cable Sealing End compounds (CSECs)	Essential Infrastructure	1, 2, 3a and 3b*	✓

Project Type	Flood Risk Vulnerability Classification[1]	Flood Zone(s)[1]	Flood Risk Vulnerability and Flood Zone 'compatibility'
Substations	Essential Infrastructure	1, 2, 3a and 3b*	✓ Exception Test required[2]

Notes:
1) Definition of flood zones is provided in **Table 1-1**
2) In Flood Zone 3a Essential Infrastructure should be designed and constructed to remain operational and safe in times of flood.
*In Flood Zone 3b (functional floodplain) Essential Infrastructure that has to be there and has passed the Exception Test, and Water Compatible uses, should be designed and constructed to a) remain operational and safe for users in times of flood; b) result in no net loss of floodplain storage; and c) not impede water flows and not increase flood risk elsewhere

3.1.3 The TCCs, watercourse crossings, substations and CSECs are all appropriate for Flood Zones 1, 2 and 3a. However, 'Essential Infrastructure' located within Flood Zones 3a and 3b is required to pass Part 2 of the Exception Test to be considered as appropriate for development. This means ensuring that the development will be safe for its lifetime, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall. Less Vulnerable land uses are not permitted in Flood Zone 3b, however, where construction activity areas, including access routes and working areas, are required to facilitate the construction of Essential Infrastructure then it will be necessary for these activities to be classed as essential infrastructure in these areas. It is noted that in flood Zone 3b '*essential infrastructure that has passed the Exception Test, and water-compatible uses, should be designed and constructed to:*

- *remain operational and safe for users in times of flood;*
- *result in no net loss of floodplain storage;*
- *not impede water flows and not increase flood risk elsewhere.'*

3.1.4 NPS EN-1[7] and NPS EN-5[8] provides advice on accounting for climate change, to the effect that developments should be resilient and adaptive to the latest climate change projections. Based on the proposed timescales for the Project, the following rainfall and fluvial allowances will be applied to the assessments undertaken:

- Peak rainfall allowance for the '2050s' epoch has been applied to the assessment undertaken for the construction phase of the Project; and allowances for the '2070s' epoch are used for the operational phase assessment.
- Peak fluvial allowances for the '2020s' epoch has been applied to assessments carried out for the construction phase, and allowances for the '2080s' epoch are used for the operational phase assessment.

3.1.5 These allowances cover assets with a design lifetime of up to 80 years, given a construction start date of 2024, with the operational phase beginning in 2028, with some elements of the Project becoming operational in 2027. No detailed quantitative assessment will be carried out for the decommissioning phase of the Project as part of the FRA, for the reasons outlined in **Section 1.2**.

3.1.6 The guidance on climate change for Essential Infrastructure[39], which includes grid substations, is that they should be assessed against the Higher Central allowance,

[39] Environment Agency (2016). Flood Risk Assessments: climate change allowances. (Online) Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances (Accessed 25 July 2022)

where situated in Flood Zone 2, 3a or 3b. No permanent Essential Infrastructure for this Project, other than pylons, are currently located within either of these flood zones.

3.1.7 In the scoping opinion (**Appendix 5.3.4A, Volume 5, Document 5.4.4A**), it was noted by the Environment Agency that the H++ climate change allowance should be "*treated as a 'sensitivity test'. It will help you assess how sensitive your proposal is to changes in the climate for different future scenarios. This will ensure your Project can be adapted to large-scale climate change over its lifetime*." A H++ scenario has not been undertaken, as the National Grid design criteria for flood resilience of a 0.1% AEP flood event with an allowance for climate change (+34% to flood peaks) and the inclusion of a freeboard, is considered to be a sufficiently credible maximum flood scenario.

3.2 Site characteristics

3.2.1 A detailed description of the baseline conditions for each Section (A-F) of the Project is given within **Section 9.5 of Chapter 9: Hydrology and Flood Risk, Volume 5, Document 5.2.9** and is summarised below.

Climate

3.2.2 The average annual total rainfall is 626mm, based on the Linton on Ouse station[40] record. The highest average monthly rainfall occurs in August, determined as 62.4mm; whilst the lowest average monthly rainfall occurs in February, determined as 39.9mm. The national annual average figures suggest the average rainfall values are similar along the length of the Project.

Topography

3.2.3 The Order Limits traverse the area from the north-west to the west of York, covering a linear distance of approximately 42km, north to south.

3.2.4 Ordnance Survey (OS) mapping indicates the area to the north-west of York is relatively low-lying and flat, with the highest point located near to Moor Lane (NGR SE580583) at 20m AOD. The topography surrounding this point is relatively flat at around 14-16m AOD, only falling to 10m AOD on the banks of the River Ouse and Hurns Gutter.

3.2.5 As the Order Limits continue southwards, past Hutton Wandesley (NGR SE506504) the topography steeply rises and there is increased variation elevation. The highest point within the Order Limits is at 59m AOD, located to the south-west of Stutton (NGR SE457406). However, the general elevation ranges between 20m AOD to 50m AOD. The lowest elevations are associated with the banks of the River Wharfe (10m AOD).

Geology, hydrology, and soils

3.2.6 The geology, hydrogeology and soils are described in detail in **Chapter 10 Geology and Hydrogeology, Volume 5, Document 5.2.10** and **Chapter 11 Agriculture and Soils, Volume 5, Document 5.2.11.** However, a brief summary is provided below.

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[40] Met Office (2021). UK Climate Averages. Topcliffe (North Yorkshire). (online) Available at: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcx57w9fb (Accessed 09 July 2021)

3.2.7 The northern portion of the land within the Order Limits lies upon predominantly Triassic geology consisting of sandstone and conglomerates[41]. These are overlain by superficial deposits of glacial till, sand, gravel, and moraines[41]. Sandstone clay soils can be found across much of the northern portion of the site[42].

3.2.8 South of the River Wharfe the geology and underlying soils change. This area is underlain by Permian Magnesian Limestone, which forms a low but distinct ridge of land running roughly north to south[41]. Generally, the underlying soils are loamy and free draining soils which are well suited to arable agriculture[42]. However, along the Main Rivers the soils are loamy and clayey, with impeded drainage and/or naturally high groundwater[42].

Land use

3.2.9 The land use within the Order Limits is predominantly agricultural; a combination of arable and pasture, with an irregular network of hedgerows and isolated areas of woodland. The Order Limits cross several significant transport infrastructure features including major roads and railway lines, in addition to minor roads and access routes.

Hydrology and drainage

3.2.10 The Order Limits cross a number of designated Main Rivers, including the River Ouse, River Nidd, River Wharfe and Cock Beck. There is also potential that the Project will interact with numerous Ordinary Watercourses, tributaries and IDB adopted drains, which largely fall within the Main River catchments.

3.2.11 The Project crosses areas served by extensive networks of artificial drainage channels, under the control and management of IDBs (see **Figures 9-3 A-F, Volume 5, Document 5.4.9** which accompany **Chapter 9**: **Hydrology and Flood Risk, Volume 5, Document 5.2.9** of the ES). Section A, including Osbaldwick Substation, is located within the FIDB district boundary, which extends out to the north-east of York. Section B, north of the River Ouse, is situated within the KUOIDB area, which covers the area to the north-west of York. The AIDB area covers much of the land area between the River Ouse and the River Wharfe.

3.2.12 Based on OS mapping and ecology survey data approximately 198 ponds/lakes have been identified which have potential for hydrological connectivity with the Project; with around 34 ponds/lakes located directly within the Order Limits.

3.2.13 Available OS mapping indicates that there are five springs located within close proximity to the Project, with two being located within the Order Limits.

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[41] BGS (2021) Geology of Britain Viewer (online). (Accessed 19 August 2021).
[42] Cranfield University (2021) Soilscapes. (online) (Accessed 19/08/2021)

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4. Flood risk screening

4.1 Introduction

4.1.1 The assessment uses the source-pathway-receptor approach, whereby all three of those elements must exist for these to be a risk to be assessed. The presence of a source is initially screened in **Section 4.2** below. Where a potential source is identified, the risk itself will be assessed with respect to the likelihood and consequence of flooding in the subsequent sub-sections, **Sections 4.3 to 4.5**. Where a detailed assessment is required, this is provided in **Section 5**. Where necessary, appropriate flood risk management measures are set out in **Section 6** to address the identified risks.

4.2 Screening of all potential sources of flood risk

4.2.1 **Table 4-1** provides an initial screening of all potential flood risk across the Project area. Those that are screened in as posing a potential flood risk are then considered further in subsequent sections.

Table 4-1 - Screening of all potential sources of flood risk

Source of Flooding	Risk Posed	Potential Connection to the Project Area	Screened In?
Tidal	No risk	The Project crosses the River Ouse at the lowest elevations of the Order Limits at approximately 10mAOD and approximately 20km upstream of the tidal limit. Based on the coastal flood boundary conditions for UK mainland and islands (2018) the 0.01% Annual Exceedance Probability' (AEP) sea level at Whitby and Immingham are 4.81mAOD and 5.92mAOD, respectively. Therefore, even with the application of H++ scenarios through to 2100 and extreme wave surge considerations, there remains no risk to the Project from flooding from the sea. **The risk of tidal flooding is not considered further in the FRA.**	No
Fluvial	High risk	The primary flood risk to the Project is from fluvial sources. The Project crosses several areas of Flood Zones 2 and 3. The risk posed by fluvial flooding is discussed further in **Section 4.3**	Yes
Surface water run-on	Low risk	The Environment Agency's Surface Water Flood Risk Map shows limited/very low risk of flooding from surface water run-on and ponding	Yes

Source of Flooding	Risk Posed	Potential Connection to the Project Area	Screened In?
		to the Project. There are some more significant areas within the Order Limits where it traverses smaller watercourses and drainage ditches not shown as being at risk within the fluvial Flood Zone mapping. The risk to the Project from surface water run-on is discussed further in **Section 5**. It will also be necessary to ensure that the Project does not impede the drainage management functions provided by the IDB drainage network. This is also covered in **Section 4.4**.	
Surface water run-off	Low risk	The surface water runoff originating from the Project (during both construction and operational phases) will be the primary surface water consideration. Surface water runoff is considered further in **Section 4.4.**	Yes
Groundwater	Low risk	As discussed in **Section 3.1: Geology, hydrogeology and soils,** the geology encountered in the northern part of the Order Limits, north of the River Wharfe, is unlikely to give rise to groundwater flooding (though it is conceivable to have groundwater emergence in low-lying flood plain areas where the water table is naturally close to the surface). However, the limestone geology that predominates south of the River Wharfe may mean there is greater potential for groundwater flooding in the southern part of the Order Limits. The risk posed by groundwater flooding is addressed further in **Section 4.5**.	Yes
Sewer	Very low risk	Due to the rural nature of land which comprises the Order Limits the risk posed by sewer flooding is considered to be very low. In the event that sewer flooding occurs it is anticipated that the flood will follow the natural topography of the landscape and accumulate in low-lying areas, therefore patterns will be similar to that associated with surface water flooding. **The risk of sewer flooding is not considered further in this FRA.**	No
Artificial	Low risk	The Environment Agency's on-line mapping shows that the Main Rivers could convey floodwater originating from the failure of upstream reservoirs. The latest reservoir flood maps show that, in the highly unlikely event of a reservoir flood	Yes

Source of Flooding	Risk Posed	Potential Connection to the Project Area	Screened In?
		event occurring in combination with fluvial flooding, the proposed location of the Overton Substation could be at risk of flooding. On this basis, the additional, residual risk of flooding from reservoirs during a fluvial flood event will be considered further in **Section 4.6**.	

4.3 Fluvial flooding

Flood Zone and modelled flood extents

4.3.1 The Environment Agency's Flood Map for Planning provides an indication of the likelihood of flooding from fluvial sources, with Flood Zones 1 to 3 indicating a Low, Medium, and High likelihood of flooding respectively, as defined in **Table 1-1**. Flood Zones extents are shown on **Figure 9-5** (**A-F**), **Volume 5, Document 5.4.9** which accompany **Chapter 9: Hydrology and Flood Risk, Volume 5, Document 5.2.9** (any area not highlighted/coloured blue on these maps is Flood Zone 1).

4.3.2 The approach to siting of CSECs and substations is compliant with the NPPF and National Policy Statement for Energy (EN-1), in that the sequential approach has been taken to identify potential locations for the new infrastructure, which are preferentially located within Flood Zone 1.

4.3.3 Section A of the Project is mostly situated within Flood Zone 1 (see **Figure 9-6 A, Volume 5, Document 5.4.9**), with part of the access route and overhead line crossing into Flood Zones 2 and 3 from a FIDB adopted drain running parallel to Murton Way.

4.3.4 Much of the North-west of York Area (Section B), particularly the northern part, is located within Flood Zone 1. However, the most significant areas of Flood Zones 2 and 3 are located adjacent to the Main Rivers. There are several areas of Flood Zone 2 and 3a which intersect the Order Limits along Sections B and C (see **Figures 9-6 B** and **9-6 C, Volume 5, Document 5.4.9**). The Order Limits also coincide with modelled extents of Flood Zone 3b, primarily associated with the River Ouse, River Wharfe and the Hurns Gutter (**Figures 9-6 B** and **9-6 C, Volume 5, Document 5.4.9**). In addition, there are more localised areas of Flood Zones 2 and 3 associated with Ordinary Watercourses and IDB adopted drains which could potentially impact access to pylon locations (**Figures 9-6 B** and **9-6 C, Volume 5, Document 5.4.9**).

4.3.5 Due to the raised topography to the south, Sections D-F are mainly designated as Flood Zone 1 (see **Figures 9-6 D** and **9-6 F, Volume 5, Document 5.4.9**), with minor areas of Flood Zone 2 and 3 associated with the Cock Beck, Bishops Dike, and Mill Dike.

4.3.6 Environment Agency Flood Modelling, provided for the Lower Ouse and Wharfe Washland and the York Detailed model, indicates that, although the site of the proposed new Overton Substation is currently in Flood Zone 1, it may be at risk of flooding from the 1% AEP event in the future, based upon 1% AEP + 50% Climate Change modelling results. It is not shown to be at risk of flooding in the York Detailed model flood extents for the 1% AEP + 30% Climate Change scenario (**Figure 9-11, Volume 5, Document 5.4.9**).

Historical fluvial flooding

4.3.7 Records of historical fluvial flooding provided by the Environment Agency are summarised below (**Table 4-2**). The information provided indicates that the proposed substations and CSECs have not been affected by any of the recent flood events for which records exist, however, sections of the existing and proposed overhead lines and access routes are shown to cross areas of historic flooding (mainly associated with the River Ouse and River Wharfe). The details of the historic flood records provided by the Environment Agency are summarised below.

Table 4-2 – Environment Agency records of historic fluvial flooding

Date	Source	Details
24 to 26 March 1968	River Ouse	The channel capacity of the River Ouse was exceeded. There were no raised flood defences, enabling overtopping of banks along the River Ouse and partially upstream of the River Wharfe from its confluence with the Ouse at Cawood. The subsequent flooding affected approximately 150 homes[43].
1 and 31 December 1978	River Ouse, River Nidd and River Wharfe	Records show that the flood event was caused by overtopping of flood defences of the River Ouse, River Nidd, and River Wharfe. Similar, flood events occurred in January 1982, February 1991 and January 1995, at gradually lesser extents.
30 October to 15 November 2000	River Ouse	The Autumn 2000 flood event is recognised as the worst recorded within the twentieth century. The River Ouse reached approximately 5.5m above its normal level, flooding around 540 properties and putting an additional 320 at serious risk[44].
2 to 15 February 2002	River Wharfe	A small flood event on the River Wharfe at Tadcaster, caused by the overtopping of flood defences.
24 to 29 September 2012	River Ouse and River Wharfe	The September flood event occurred as a result of the River Ouse and Wharfe overtopping areas with no raised flood defences, causing limited flooding in York and Tadcaster.
25 to 29 December 2015	River Ouse and Wharfe	An extensive flood event, where the River Ouse and Wharfe overtopped in areas with no raised flood defences causing widespread flooding along their reaches. The flood defence capacity was also exceeded in York which led to extensive

[43] UK Parliament (2021). Floods Volume 772: debated on Monday 4 November 1968. (online))
[44] Environment Agency (2009). Reducing the Risk of Flooding: A guide to our flood defence schemes in York (online). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/297448/gene1208bpbw-e-e.pdf (Accessed 13 July 2021)

Date	Source	Details
		flooding in central York requiring the evacuation of properties and businesses and resulting in major damage[45].
14 to 17 March 2019	River Ouse	Several minor flood events occurred along the River Ouse downstream of York and an isolated event in Tadcaster. The cause of the flooding remains unknown, and the impacts were limited due to the scale.

4.3.8 However, it is important to note that records of historical flood events are by no means exhaustive, so the absence of recorded historical flooding at any particular location should not be interpreted as confirmation that flooding has never occurred.

4.4 Surface water flooding

Surface water flood risk mapping

4.4.1 Whilst much of the area within the Order Limits is at Very Low risk of surface water flooding, there are a number of areas at risk of surface water flooding, according to the Environment Agency's Risk of Flooding from Surface Water (RoFSW) mapping. These are classified as being at High, Medium, Low and Very Low likelihood of surface water flooding (see **Figure 9.7, Volume 5, Document 5.4.9** which accompany **Chapter 9: Hydrology and Flood Risk, Volume 5, Document 5.2.9**). The areas that indicate Medium to High surface water flood risk tend to be low-lying or correspond with the existing river floodplains.

4.4.2 There are some instances where the substation locations coincide with areas of surface water flood risk, these are summarised as follows:

- A small area of surface water accumulation/ponding is located within the Monk Fryston Substation Area towards the south (see **Figure 9.7 Section F, Volume 5, Document 5.4.9**), classified as High, Medium and Low RoFSW. A surface water flow path runs from west of Pollums House Farm to the north on Main Street (A63) and west of Butt's Lane across the Monk Fryston Substation Area (Section F).
- A small area of surface water accumulation is located within the Osbaldwick Substation Area (Section A), to the north-west (see **Figure 9.7 Section A, Volume 5, Document 5.4.9**), which is classified as Low risk.

Historical surface water flooding

4.4.3 The Environment Agency's Historical Flooding records (see **Figure 9.9 Section F, Volume 5, Document 5.4.9**) identify a flood event spanning 15 to 17 June 2007 widespread surface water flooding. Surface water flooding was recorded at numerous locations south of Garforth, including within and adjacent to the existing Monk Fryston Substation.

[45] York Civic Trust (2021) Flood Heights on the Ouse (online).

4.5 Groundwater flooding

4.5.1 Information on flood risk from groundwater was sourced from a review of the LLFA PFRAs and LPA SFRAs. City of York Council concluded there was no significant risk of flooding from groundwater, presently or in the future, and has no record of areas where groundwater emergence is known to be a cause of flooding[46]. NYCC report no substantial evidence of direct groundwater flooding in the majority of North Yorkshire[47]. However, it is aware of specific circumstances where groundwater emergence may exacerbate surface water flooding. For example, it is known to be a cause of flooding to a small number of properties in some areas as a result of natural springs in the hillside next to properties, and, that both groundwater and surface water flooding both pond in the same nearby low-lying areas, however these are located outside of the Order Limits. NYCC hold no local information providing evidence of future groundwater flood risk, however it does note that should groundwater flooding occur, it is likely to be in low points and depressions where surface water flooding occurs. Therefore, it is considered that true groundwater flooding is not going to occur across much of the North Yorkshire area that coincides with the Project.

4.5.2 Envirocheck Reports have been purchased for the Overton (**Annex 9D.1**) and Monk Fryston (**Annex 9D.2**) Substations. The Overton Substation is not shown to be at risk of groundwater flooding, but there are some small areas to the north-west of the substation mapped with 'Limited Potential for Groundwater Flooding to occur' (**Annex 9D.1**). The only areas mapped as showing a potential for groundwater flooding in **Annex 9D.1** are associated with the riparian corridor of the River Ouse. The Monk Fryston Substation is mapped as having a 'Limited Potential for Groundwater Flooding to occur', however, there is small area at the south of the proposed Substation that is mapped as 'Potential for Groundwater Flooding of Property below ground level' (**Annex 9D.2**). However, given the relatively elevated location of the Monk Fryston Substation, relative to much of the surrounding land, especially to the south and south-east, this would likely be very short in duration. There are areas of land mapped as showing a potential for groundwater flooding in **Annex 9D.2**, however these are to the south, close to the villages of Fairburn and Burton Salmon, at elevations approximately 15-20m below the substation.

4.6 Combined reservoir and fluvial flooding

4.6.1 The Environment Agency's long term flood risk mapping[48] presents the scenario of a reservoir flood event occurring simultaneously with a fluvial flood event or 'Wet day'. This modelled extent represents a worst-case scenario, which the Environment Agency

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[46] City of York Council (2017) Preliminary Flood Risk Assessment (addendum). (online) Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/698282/PFRA_York_City_Council_2017.pdf (Accessed October 2022).
[47] North Yorkshire County Council (2017) Preliminary Flood Risk Assessment (addendum) (online). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/698270/PFRA_North_Yorkshire_County_Council__2017.pdf (Accessed October 2022).
[48] Environment Agency. (2019). Check your long term flood risk. (Online) Available at: https://check-long-term-flood-risk.service.gov.uk/map (Accessed 15 July 2022)

highlight, is unlikely to take place although likelihood or probability is not indicated. In a wet-day scenario it assumed that just before reservoir failure[49]:

- *the water level in the reservoir is higher than the top water level and is consistent with the probable maximum precipitation*
- *there's already an additional flow in the downstream watercourse that represents an extreme flood in the present day* (not equivalent to Flood Zone 2 or 3).

4.6.2 The outputs of this modelled flood scenario, as presented in **Figure 9.10, Volume 5, Document 5.4.9**, indicate that the majority of the proposed Overton Substation site would be inundated in such an event, as well as any associated site infrastructure (such as new permanent access tracks). Although the worst-case scenario Environment Agency flood maps indicate parts of the Overton Substation site are at risk of flooding from reservoir failure, the likelihood of this occurring is evaluated to be extremely low. The resulting residual risk is mitigated through the statutory requirements for reservoir owners to inspect and maintain their reservoirs under the Reservoirs Act 1975 (as amended), and local authorities' and other emergency responders' responsibility to maintain appropriate emergency response plans under the Civil Contingencies Act 2004.

4.6.3 Elsewhere, the modelled 'wet-day' flood extent coincides with some construction related elements of the Project, primarily located within Sections B and C. This is due to the low-lying topography surrounding the Rivers Ouse and Foss. Meanwhile the flood extent found in the southern part of the Order Limits is mostly confined to the fluvial flood zones, due to the higher elevations of adjacent land areas.

[49] Environment Agency. (2021). Reservoir flood maps: when and how to use them (Online) https://www.gov.uk/guidance/reservoir-flood-maps-when-and-how-to-use-them (Accessed 15 July 2022)

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5. Assessment of flood risk

5.1 Introduction

5.1.1 Having outlined in broad terms the principal potential flood risks prevailing in and around the Order Limits in **Section 4**, this section assesses specific flood risk to receptors associated with the Project. This will include the potential for flood risks to third-party receptors to increase as a consequence of the Project during the construction and operational phases. Appropriate flood risk management measures are specified to address the identified risks in **Section 6**; these have been incorporated into the design of Project infrastructure or through embedded environmental measures, which are secured either via DCO Requirements or via additional permits or consents, as summarised in **Table 6-1**.

Pylons scoped out of the FRA

5.1.2 Lattice pylons, such as those proposed to be used in the Project, do not displace any significant volume of water and pose minimal obstruction to water flow. Therefore, placing of pylons in floodplain areas will not significantly affect floodplain storage or conveyance and will therefore not cause an increase in flood risk to others external receptors. A similar approach to this was adopted and deemed acceptable for the DCO for the National Grid, Richborough Connection Project. Furthermore, pylons are resilient to water damage from occasional flooding, and the conductors are located well above the highest conceivable flood level (accounting for the most extreme allowances for climate change), thus ensuring that they remain operational in times of flood and do not pose a safety risk. Due to the robust nature of their construction, it is considered highly unlikely that debris carried by floodwater could cause significant damage to a pylon to the extent that the structural integrity of the pylons could not be repaired through standard maintenance activities.

5.1.3 The flood risk associated with new overhead line pylons and conductors, during the operational phase have been scoped out from this assessment. This applies to the risk to the infrastructure itself, as well as any risks to other receptors arising from the presence of the infrastructure. This approach has been accepted on similar National Grid connection projects and was accepted by the Planning Inspectorate in its Scoping Opinion (**Appendix 4A, Volume 5, Document 5.2.4**) '*…on the basis that all permanent infrastructure (except pylons, which would result in minimal displacement relative to overall volumes) will be located in Flood Zone 1, and incorporation of embedded environmental measures, the inspectorate agrees that operational matters in respect of flood risk would not give rise to likely significant effects and can therefore be scoped out of the ES.*'

5.1.4 Activities and temporary infrastructure associated with pylon construction, such as access tracks, construction compounds and working areas will be considered further within the assessment.

5.2 Risks during the construction phase

5.2.1 As outlined in **Chapter 3: Description of the Project, Volume 5, Document 5.2.3**, construction activities and temporary infrastructure will be required in order to support the development of the Project. These construction related elements include:

- approximately 71km of access tracks and 20 associated watercourse crossings (13 new crossings and 7 existing);
- pylon working areas (for both new and refurbished pylons);
- scaffold areas for 'crossing protection' (where the overhead line crosses roads, railway lines and watercourses);
- temporary drainage mitigation areas;
- seven temporary construction compounds (TCCs) associated with the substation and overhead line construction;
- conductor stringing locations;
- four CSECs working areas; and
- two new substation working areas at Overton and Monk Fryston.

5.2.2 Some of the activities listed above are at risk of flooding in some locations (**Figure 9.6** and **Figure 9.7, Volume 5, Document 5.4.9**). All have the potential to impact third party receptors through a combination of loss of flow conveyance (either in channel or on the flood plain), loss of floodplain storage (where located in the floodplain), and increased surface water runoff due to increased impermeable areas. These factors are considered further in the following subsections.

Fluvial flood risk

5.2.3 Activities relating to the construction phase of the Project have the potential to cause changes to watercourse flow conveyance, temporary loss of floodplain storage and compartmentalisation of the floodplain in a limited number of locations where access tracks cross/pass through Flood Zones (2 and 3) and cross watercourses. An assessment of fluvial flood risks, including further details of the Project elements affected, are provided in the sections below.

5.2.4 Flood risk management measures have been set out in **Section 6** which seek to ensure negligible temporary and permanent changes to watercourse flow conveyance and floodplain storage and continuity as a consequence of the Project.

Access and watercourse crossings

5.2.5 Access routes are a key element to the Project and will be installed during the construction phase. The access works include (but are not limited to) the following:

- construction of approximately 44km of temporary access track (stone and trackway);
- construction of new permanent access tracks;
- installation of seven temporary culverts and six temporary bridge crossings; and
- potential upgrade works to seven existing culvert crossings.

5.2.6 The access routes will include the use of existing access tracks where possible, especially where access is required to the existing overhead lines undergoing refurbishment works. However, it is possible that upgrade works will be required for the existing access routes.

5.2.7 The majority of the access improvement works are located in Flood Zone 1 and it should be noted that no new permanent access track would be located within Flood Zones 2 and 3.

5.2.8 However, there are short sections of new temporary access track which will coincide with areas of Flood Zone 2 and 3. Approximately 14.6km of temporary access track will fall within Flood Zone 2, whilst approximately 9.7km will fall within Flood Zone 3. These stretches of track are mainly located in the flood zones associated with the Hurns Gutter and River Ouse, in the northern part of the Order Limits. However, there are several instances in the southern part of the Order Limits where this occurs, as they coincide with the flood zones of the Foss (tributary of Ouse), the Foss (tributary of Wharfe), the River Wharfe and Cock Beck.

5.2.9 Across the Order Limits there are 13 new temporary watercourse crossings proposed, which consist of seven temporary culvert crossings and six temporary bridge crossings (**Figure 9-3 A-F, Document 5.4.9**). All these crossings are of Ordinary Watercourses, although some are IDB-maintained (refer to **Annex C** for further details). All new temporary crossings would be removed when construction is complete.

5.2.10 There are also seven existing culvert crossings over Ordinary Watercourses that may require upgrading; it is anticipated that all existing crossings (whether they are upgraded or not) would remain in-situ following the completion of the construction phase.

Pylons, working areas, cable stringing areas, and crossing protection

5.2.11 Where practicable the Project elements have been sited outside of fluvial Flood Zones 2 and 3; as set out in ES **Chapter 2: Project need and alternatives, Volume 5, Document 5.2.2**. Consequently, the TCCs, substations and CSEC working areas are entirely situated in Flood Zone 1. This is also the case for most of the pylon working areas, stringing areas, and crossing protection, as presented in **Figure 9-6, Volume 5, Document 5.4.9**.

5.2.12 There are specific instances where siting Project elements (generally associated with the overhead line) within fluvial Flood Zones 2, 3a and 3b has been unavoidable. These instances are generally where the Order Limits cross Main Rivers or Ordinary Watercourses. These instances are summarised below:

- There are two proposed new build pylons (YN007 and XC417) located within Flood Zone 2 of the Hurns Gutter and a further three pylons (SP004, SP005 and SP006) located in Flood Zone 3a and 3b (**Figure 9.6 Section B, Volume 5, Document 5.4.9**). Similarly, there is an existing pylon (SP007) to be modified, which is partially located within Flood Zone 3b of the Hurns Gutter. The construction activities and features associated with these elements also fall within these fluvial flood zones; as such there are seven pylon working areas, five stringing areas and three sets of crossing protection located within Flood Zones 2 and 3a of the Hurns Gutter (**Figure 9.6 Section B, Volume 5, Document 5.4.9**). It is also noted that, of these, six pylon working areas, five stringing areas and three sets of crossing protection, also overlap Flood Zone 3b.

- There are six new build pylons (XC429, XC426, XC424, XC423, XC422, and XC421) and three temporary structures (XC430T, XCP006AT and XCP006BT) within the Flood Zone 2 and 3 extents of the River Ouse and its tributaries to the south (**Figure 9.6 Section B and Figure 9.6 Section C, Volume 5, Document 5.4.9**), which include the Foss (tributary of Ouse). Only one of these new build pylons is located within Flood Zone 3b. There are also two existing pylons (XCP002 and XCP003) requiring works located within the Flood Zone 2, and 10 existing pylons (XCP009, XCP008, XCP007, XCP006, XCP005, XC428T, XC429T, XC430, XC431, XC434, XC435 and XC437) located within the Flood Zone 3a of the Ouse tributaries (**Figure 9.6 Section B** and **Figure 9.6 Section C, Volume 5, Document 5.4.9**). Three of the existing pylons also coincide with Flood Zone 3b. The construction elements associated with these pylons that are also located within Flood Zones 2 and 3a, include 26 pylon working areas, six stringing areas and seven sets of crossing protection scaffolds (**Figure 9.6 Section B** and **Figure 9.6 Section C, Volume 5, Document 5.4.9**). Five of the identified pylon working areas also intersect Flood Zone 3b, associated with the Ouse and its tributaries.
- Works to two existing pylons (XC459 and XC460) which are located with Flood Zones 2 and 3a of the Foss (tributary of Wharfe) are proposed (**Figure 9.6 Section C, Volume 5, Document 5.4.9**). These works also include two pylon working areas and one stringing area which also coincide with the fluvial flood zones.
- Works to two existing pylons (XC471 and XC472) in proximity to the River Wharfe, also fall within Flood Zones 2, 3a and 3b (**Figure 9.6 Section C2, Volume 5, Document 5.4.9**). Two pylon working areas and two sets of crossing protection also fall within the flood zones. The edge of a pylon string area (associated with existing pylon XC473) coincides with the River Wharfe's Flood Zone 2.
- One set of crossing protection (associated with existing pylon XC498) falls within Flood Zones 2 and 3a of the Cock Beck (**Figure 9.6 Section E1, Volume 5, Document 5.4.9**).
- The stringing area and crossing protection associated with an existing pylon (XC505), intersects the edge of the Mill Dikes Flood Zones (**Figure 9.6 Section E2, Volume 5, Document 5.4.9**).

5.2.13 Details on fluvial flood risk management measures are provided in **Section 6** of this FRA.

Third party utilities diversions

5.2.1 There are several locations where third-party assets, to be moved as part of the enablement works for the Project, have been identified as being within Flood Zones. These are summarised as follows:

- There are eight third party assets to be undergrounded, diverted, or protected which coincide with the fluvial Flood Zones 2, 3a and 3b of the Hurns Gutter (**Figure 9-6 (A-F), Volume 5, Document 5.4.9**). These include five underground cables and two pipelines as well as one overhead line which requires undergrounding.
- There are three underground cables and one pipeline that may require protecting which fall within Flood Zones 2, 3a and 3b of the River Ouse tributaries to the south of the Main River. There is also an overhead line that requires undergrounding, which is located within Flood Zone 3 of the River Ouse.

- There is one, 33kV overhead line to be undergrounded, which crosses the Cock Beck and coincides with its associated Flood Zones 2 and 3.
- There are two underground cables that may require protecting which fall within the Flood Zones 2 and 3 of the Mill Dike. There is also an underground cable that requires redirecting and an overhead line that requires undergrounding within Flood Zones 2 and 3 of the Mill Dike.

5.2.2 It is assumed an open cut trenching approach will be used for the undergrounding and redirection required as a precautionary approach to this assessment of flood risk.

5.2.3 **Section 6** sets out the proposed flood risk management measures that would suitably control the risk of increased flooding to the third party assets listed above.

Risk to third party receptors

5.2.4 There is a risk of fluvial flooding to third party infrastructure and property within and adjacent to the Order Limits which could be affected during the construction phase if appropriate measures are not implemented to manage floodplain displacement or conveyance effects arising from the construction of the Project infrastructure. Potential third party receptors could include transport infrastructure (roads and railway lines), residential property, agricultural land and business premises in floodplain areas. Measures are set out in **Section 6** to avoid construction phase impacts on fluvial flows to these receptors.

Surface water flood risk

5.2.5 There are numerous instances within the Order Limits where Project construction elements coincide with areas at risk of surface water flooding ('Low' to 'High' risk, as defined in **Table 1-2**), as set out in **Figure 9-7 (A-F), Document 5.4.9, Volume 5**. Areas of surface water accumulation typically align with low-lying areas, or floodplains associated with the Main Rivers. Meanwhile surface water flow paths tend to follow the channels of Ordinary Watercourses.

5.2.6 Should all, or a significant proportion, of the construction compound areas become occupied by impermeable or less permeable surfaces for the duration of construction, this could lead to a significant local increase in runoff rates. The new access roads, temporary crane pads/working areas at new pylon locations are also likely to be constructed of compacted, low permeability aggregate material. In addition, these temporary infrastructure elements could potentially be raised in comparison to the adjacent land, which could, if not managed, impede surface water flow paths, either diverting flood water elsewhere or causing ponding on the upslope side. In the absence of effective surface water management measures, this could lead to a temporary increase in peak runoff rates and a consequent increase in flood risk to third party and on-site receptors downstream. To address this, surface water management measures and drainage strategies, as set out in **Section 6**, will be implemented.

Drainage mitigation

5.2.7 To manage surface water run off throughout the construction phase of the Project, it is proposed that drainage mitigation elements be implemented, which includes the use of SuDS with disposal connections to watercourses and manholes (**Figure 9-6 A-F, Volume 5, Document 5.4.9**). There are some instances where these elements coincide with the fluvial flood zones, as summarised below:

- There are six drainage mitigation elements located within the Flood Zones of the Hurns Gutter; two in Flood Zone 2 and four in Flood Zone 3, of which three are at least partially in Flood Zone 3b. These elements are purposed primarily for surface water management for pylon working areas, with one serving as road drainage management. The three drainage mitigation areas located in Flood Zone 3b along the Hurns Gutter must be located there to manage the runoff generated across the pylon working areas at these locations during rainfall events.
- Three of the drainage mitigation elements are located in the Flood Zones 2/3 that extend from the River Ouse along the Foss (tributary of Ouse). These drainage elements, serve as surface water management features for pylon working areas.

5.2.8 Further details of the drainage mitigation and surface water management is provided in and summarised in **Section 6** of this FRA. A detailed Drainage Management Plan (DMP) for most aspects of construction will be developed post-grant of the DCO by the construction contractors, with approval required prior to works commencing. The DMP is a supporting document to the Code of Construction Practice (**CoCP**, **Appendix 5.3.3B, Volume 5, Document 5.3.3B**) and will be secured via DCO Requirement 6. The Drainage Strategies for Overton and Monk Fryston Substations include consideration of management of surface runoff during construction, as presented in **Annex 9D.5** and **Annex 9D.6**.

Groundwater flood risk

5.2.9 There is the potential to encounter shallow groundwater, either perched in superficial deposits and possibly the main water table at shallow depth in floodplain areas. On this basis there is very limited risk to above ground works associated with the Project and the only conceivable risk that remains is to excavation works (e.g., excavations relating to pylon or substation construction).

5.2.10 It is not expected that significant volumes of groundwater will be encountered during excavations works, except for potential localised perched lenses of more permeable material in the Glacial Till (between XC520 and the existing Monk Fryston Substation). In the event groundwater is encountered in an excavation, there will be a need to dewater to facilitate construction. There is a potential risk to construction personnel and equipment working in excavations below water table level. This would be controlled by pumping under normal circumstances. Even in the event of pump failure, ingress of groundwater into the excavation would be relatively slow, enabling personnel and equipment to be evacuated from the excavation before any harm occurs. The risk of groundwater flooding to site construction and demolition activities is therefore considered to be negligible, and no further specific mitigation measures are proposed above and beyond normal construction best practice, as set out in the **CoCP** (**Appendix 3B, Volume 5, Document 5.3.3B**).

5.3 Risks during the operational phase

5.3.1 As outlined in **Chapter 3: Description of the Project, Volume 5, Document 5.2.3**, there will be permanent elements of the Project required for the operational phase. These operational related infrastructure elements include:

- permanent access tracks;
- new and refurbished pylons;
- four permanent CSECs; and

- two new substations.

5.3.2 As the elements listed above have the potential to impact receptors, as well as the Project itself, through a combination of loss of flow conveyance (either in channel or on the flood plain), loss of floodplain storage (where located in the floodplain), and increased surface water runoff due to increased permanent impermeable areas; an analysis has been undertaken of the permanent Project elements to be located within the fluvial and surface water flood extents.

5.3.3 As identified for the construction phase of the Project, there are a number of new pylons and existing pylons to be refurbished located within Flood Zones 2 and 3. The following assessment addresses the potential changes to flood risk as a result of the presence and operation of Project infrastructure.

Fluvial flood risk

Operational phase infrastructure

5.3.4 The majority of permanent Project elements, including permanent access tracks, CSECs and the Monk Fryston Substation would be located in Flood Zone 1, and are therefore at low risk of fluvial flooding.

5.3.5 Similarly, no new permanent watercourse crossings are being proposed as part of this Project. However, there may be some requirement to upgrade existing crossings in association with the Project; the risks associated with these crossings are addressed under the construction phase of the Project. Flood risk management measures are set out in **Section 6** which would ensure no permanent changes to watercourse flow conveyance as a consequence of the Project.

5.3.6 The presence and operation of the pylons in fluvial flood zones has been scoped out of this FRA, on the basis that there would be minimal displacement of flood storage or disruption of flood conveyance. However, it is noted in this assessment that two permanent pylon structures (SP005 and SP006) will be located in Flood Zone 3b, associated with the Hurns Gutter. The measures presented in **Section 6** would ensure that any changes to flood risk to third party receptors as a result of these elements are negligible.

Overton Substation

5.3.7 Although the proposed location of the Overton Substation is in Flood Zone 1, it is close to the edge of Flood Zones 2 and 3 associated with the floodplain of the River Ouse. Outputs from the Environment Agency’s York Detailed model indicate that the proposed substation location would remain outside of the 1% AEP +30% climate change flood extent but would fall partially within the 1% AEP +50% climate change flood extent (**Figure 9-8, Volume 5, Document 5.4.9)**. It is therefore likely that the fluvial flood risk to the substation location would become significant over the proposed lifetime of the Project.

5.3.8 The Overton Substation is the only permanent infrastructure (except pylons, which are considered resilient to flooding) that could be at risk of flooding due to increased flood flows caused by climate change. Additional modelling has been undertaken for the new Overton Substation, the approach, and outputs of which are detailed in **Annex 9D.4** of this FRA. A summary of the findings is provided below:

- The modelled water elevation within the substation boundary for the 0.1% AEP flood + 34% CC event is 13.41 mAOD (**Figure 9-11, Volume 5, Document 5.4.9**). This means a final flood resilience level of 13.71 mAOD should be used for the design of the substation to account for a 300mm freeboard, based on National Grid's design standards for flood resilience at grid substations[32].
- If the substation or any associated flood resilience measures were to coincide with a future Flood Zone 3, when climate change uplifts are considered, then there would be a requirement for compensatory storage to avoid displacement effects on external receptors. The Environment Agency have advised that the existing Yorkshire Detailed Model output for the 1% AEP +30% climate change event can be used to determine whether compensatory flood storage is required[50]. As the substation and the whole of the elevated platform are to be located outside of the 1% AEP +30% climate change extent, there is no need to provide compensatory storage.
- As is discussed in **Annex 9D.4** of this FRA, the Hurns Gutter, the watercourse in closest proximity to the proposed Overton Substation, is represented in the 2D model domain only. This may mean that the Hurns Gutter capacity is not as accurate as it could be and might be greater than actual, with the channel width in reality being less than the 10m grid being used. A sensitivity test, undertaken to better understand the risk of flooding from the Hurns Gutter, was performed by removing the Hurns Gutter inflow. This demonstrated that the flood risk to the Overton Substation is predominantly from the River Ouse backing up the Hurns Gutter and that the Hurns Gutter alone poses a negligible flood risk to the Substation, as the effect was that the flood depth within the substation footprint was only reduced by 10mm. Removing the Hurns Gutter flow had a negligible effect on the flood extent, with only a minor difference at the upper end of the Hurns Gutter where the inflow comes in to the Yorkshire Detailed Model (**Figure 9-11, Volume 5, Document 5.4.9**).

Operational phase maintenance activities and associated temporary infrastructure

5.3.9 Once construction of the overhead lines is completed, annual inspections would be required. Regular maintenance would also be undertaken at the substation sites, which would require persons visiting the sites throughout the operational phase. Personnel carrying out inspections, maintenance or attending the sites on foot could be at risk of flooding in areas where a fluvial hazard has been identified.

5.3.10 As all the components of the overhead lines have a design lifetime of at least 80 years, refurbishment work would only be required very infrequently during the lifetime of the Project. Refurbishment works would be of a similar character to the proposed construction works, though they would probably be of a lesser scale. Therefore, some or all of the mitigation measures recommended in **Section 6**, to control fluvial flood risk to construction activities would also apply to possible future refurbishment works. On the basis that the flood risk management measures are suitably implemented, it is considered that any change to flood risk would be negligible.

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[50] Confirmed through agreement of the minutes for the consultation call held on 16 June 2022. Email confirmation from Frances Edwards, EA Planning Advisor, Sustainable Places (Yorkshire), dated 30 June 2022 17:15.

Risk to third party receptors during the operational phase

5.3.11 Increased flood risk as a result of the operational elements of the Project listed above has the potential to impact third party receptors (**Table 3-1**). It is determined that there would be negligible change to flood risk during the operational phase if the appropriate measures are implemented to mitigate increased fluvial flooding, as outlined above.

Surface water flood risk

Operational phase infrastructure

5.3.12 Once construction activities are complete, all temporary access infrastructure and hardstanding would be removed and the ground re-instated to its pre-development condition. The only aspects of the permanent infrastructure with new impermeable surfaces that could affect surface runoff rates would be the new substations at Overton and Monk Fryston, the CSECs at Tadcaster and Shipton and associated permanent access roads.

5.3.13 The permanent changes in ground cover associated with the Project have the potential to increase the overall extent of lower permeability surfaces. In the absence of effective surface water management measures, this could lead to an increase in peak runoff rates and a consequent increase in flood risk to third party receptors downstream.

5.3.14 This is particularly the case for the two substations, as their proposed surface areas are significant, at approximately 90,000m^2 for Monk Fryston and 60,000m^2 for Overton respectively. As a consequence, drainage strategies have been developed for the substations to demonstrate that surface runoff from these sites can be appropriately managed in line with relevant policy requirements, so as not to increase downstream flood risk. These are summarised in **Section 6.3** and presented in full in **Annex 9D.5** for Overton and **Annex 9D.6** for Monk Fryston.

5.3.15 The CSEC sites are much smaller than the substations, ranging from approximately 1,150m^2 to 3,825m^2 in surface area. Furthermore, the extent of impermeable surfaces within each of these sites will be even smaller, as they will be mostly surfaced with permeable gravel chippings, with the exception of site access roads, concrete anchor blocks and pylon/ gantry foundations. Therefore, no significant increase in surface runoff is expected from the CSECs once constructed, and drainage strategies have not been prepared for these sites at this stage of the Project.

5.3.16 In line with DCO Requirement 6(4), detailed drainage design for permanent Project infrastructure, comprising substations, CSECs and associated access roads will be carried out post-grant of the DCO, and will be subject to approval from the relevant drainage authority. This will ensure surface runoff from the sites is managed so as to protect the infrastructure at the sites from flooding, as well as ensuring flood risk to downstream third party receptors is not increased, as discussed further in **Section 6.3**.

6. Flood risk management

6.1 Introduction

6.1.1 This section sets out the flood mitigation measures and drainage strategy design principles that are to be embedded into the Project to ensure that flood risk impacts to and from the Project are minimised and appropriately managed during the construction and operational phases.

6.2 Construction phase measures

Measures for flood impacts to the construction works

6.2.1 As was highlighted in **Section 5**, at numerous locations within the Order Limits the construction works and the staff undertaking the works are at risk of flooding from fluvial and pluvial sources. A number of measures will be implemented to minimise and manage these risks, where work within a fluvial Flood Zone cannot be avoided, including the production of a Flood Emergency Response Plan (ERPFE) that will detail how construction will be kept safe, identifying safe access and egress routes and areas of refuge. The ERPFE would include details as to how frequently weather and stream flow observations would be made, how forecasts, alerts and actions would be disseminated, signage, roles and responsibilities, emergency response procedures, including detailed evacuation plan and procedures for making safe plant and equipment. The ERPFE would be prepared post-grant of the DCO and would be subject to approval by the relevant planning authority, in accordance with DCO Requirement 6.

6.2.2 The construction of watercourse crossings in proximity to construction works has the potential to increase fluvial flood risk if not designed appropriately and for a constriction to channel flows. The design specifications for watercourse crossings are set out below in **Table 6-1**; these are incorporated into the **CoCP (Appendix 3B, Volume 5, Document 5.3.3B).** The detailed design and sizing of temporary watercourse crossings for construction access would be undertaken by the construction contractor post-grant of the DCO, according to the parameters that are incorporated into the **CoCP**, prior to the submission of applications for necessary permits and consents from the Environment Agency, LLFAs or IDBs. Requirements for FRAPs for main rivers and OWCs for ordinary watercourses are set out in **Volume 7, Document 7.3: Details of Other Consents and Licences.**

Measures to prevent third party flood impacts

6.2.3 The construction activities could potentially increase flood risk to third party receptors by displacing flood water from flood plains, disrupting overland flow pathways with raised structures and increased surface water runoff from hard new temporary impermeable areas. The measures that will mitigate these potential impacts are set out in detail in **Table 6-1** below, but will include: minimising land raising within fluvial flood zones, positioning of access tracks and stockpiles to minimise obstruction of flood conveyance pathways and provision of appropriate runoff management and drainage measures for all temporary construction infrastructure. These measures will be included in the **CoCP** (**Appendix 5.3.3B, Volume 5, Document 5.3.3B**). In addition, the development of a detailed construction phase Drainage Management Plan (DMP) post-grant of the DCO will be secured via DCO Requirement 6.

6.2.4 Construction phase drainage design in the DMP will be based on a 1% AEP, critical duration rainfall, event with the upper end, 25%, climate change allowance for the 2050s applied. Drainage systems will be designed so that the discharge to watercourses will not exceed the present day QBAR (43% AEP, or 1 in 2.33 year) greenfield runoff rate. The methods used to discharge surface water will be prioritised in the following order: infiltration to ground; discharge to watercourse following attenuation; and combined/surface water sewer following attenuation.

6.3 Operational phase measures

Measures for flood impacts to permanent infrastructure and maintenance activities

6.3.1 All permanent infrastructure is being designed to be resilient to flooding over their lifetime, with considerations made for climate change impacts. There are to be no new permanent access tracks in defined fluvial Flood Zones. Of the new permanent infrastructure, only the pylons noted in the bullet points below **paragraph 5.2.12** and Overton Substation have been identified as potentially being at risk of fluvial flooding. The mitigation/flood resilience measures for Overton Substation are discussed in **Section 6.5**.

6.3.2 As set out in **Section 5.1** lattice pylons, such as those proposed to be used in the Project, do not displace any significant volume of water and pose minimal obstruction to water flow. Therefore, placing of pylons in floodplain areas will not significantly affect floodplain storage or conveyance and will therefore not cause an increase in flood risk to others external receptors. This was agreed as acceptable by the Planning Inspectorate at the scoping stage of this study; therefore no mitigation is required for pylons in fluvial flood zones.

Measures to prevent third party flood impacts

6.3.3 For the permanent works, the National Grid Front-End Engineering Design (FEED) team have developed the drainage strategies for the Overton and Monk Fryston Substations, which are provided in **Annex 9D.5** and **Annex 9D.6** respectively.

6.3.4 Both drainage schemes utilise attenuation storage and have been designed to a 1% AEP standard with the upper end (45%) 2070s epoch allowance for rainfall scenarios. In designing the drainage scheme the principle of management of runoff by exceedance[51] has been followed; this is to ensure that the exceedance of the drainage system does not cause flooding of sensitive aspects of the infrastructure or third-party receptors, rather, the overflow will be routed to grassed areas within the compound or adjacent agricultural land.

6.3.5 Both Overton and Monk Fryston Substations are to be built on top of a platform, established through the import of granular material. The attenuation at both sites is provided by making use of the natural voids in the imported material used to create the platforms. In the development of the strategies a void ratio of 30% in the granular material has been assumed. Modelling has been undertaken for both substations, using

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[51] CIRIA (2006) Designing for exceedance in urban drainage - good practice (C635). CIRIA; London.

Microdrainage software, to demonstrate that there is sufficient volume within the granular material (based on depth and area) to attenuate flow for the 1% AEP rainfall event with a 45% allowance for climate change.

6.3.6 Both strategies propose to discharge to local watercourses with flows that do not exceed the present day QBAR greenfield runoff rate for the associated area drained. The Overton Substation drainage system will discharge to the Hurns Gutter, while the Monk Fryston system will drain to a small, unnamed watercourse, using the existing infrastructure for the existing Monk Fryston substation site.

6.3.7 Both substations include transformers which have been identified a potential source of pollution. These will be drained via Bund Water Control Units (BWCU) (oil discriminating pumps) to a segregated piped system that passes through an Oil Water Interceptor (OWI). The nature of these systems is that they will be deeper than the main site attenuation area (the granular material forming the platform). Flow rates from the BWCUs are typically between 1-2l/s per pump with the bund on each transformer acting as local rainfall attenuation. To reflect this, an allowance has been made for direct discharge from the oily water system. So, for example at Overton Substation, where the greenfield runoff rate is estimated at a maximum of 25l/s and two BWCUs are planned, an allowance of 4.0l/s has been made. The result is that the stone attenuation area will discharge at a rate of 21.1ls/and the oily water system at 4.0l/s with no attenuation.

6.3.8 The proposed substation drainage strategies are considered fit for purpose and compliant with relevant planning policy requirements.

6.3.9 In line with DCO Requirement 6(4), detailed drainage design for permanent project infrastructure with new impermeable surfaces, comprising substations, CSECs and associated access roads, will be carried out post-grant of the DCO, and will be subject to approval from the relevant drainage authority. The detailed drainage design for the substations will be consistent with the drainage strategies produced to support the DCO application (**Annexes 9D.5 and 9D.6**). Detailed drainage design for the CSECs and access roads will be to the same standard, including the use of appropriate SuDS. This will ensure surface runoff from the sites is managed so as to protect the infrastructure at the sites from flooding, as well as ensuring flood risk to downstream third-party receptors is not increased.

6.4 Flood risk management measures

Construction and operational phases

6.4.1 The flood risk management measures for all phases of the Project are set out in **Table 6-1**. Those that relate to specific elements or phases will be identified in the wording of the measures or will be identifiable by the matter being discussed (e.g., temporary measures will apply to the construction phase only).

Table 6-1 - Proposed flood risk management measures for the Project

Ref no.	Project Element	Project phase	Flood Risk Management Measure	Reason
FM1	All Project construction infrastructure (e.g., substations, CSECs, access routes, overhead line pylons)	Construction and operation	**Standard Good Practice to Minimise Impacts on Floodplain Storage and Flow Conveyance** The design/planning of construction/temporary activities will consider the potential impacts to flood risk and adhere to good working practices. Several measures may be implemented to avoid significant impacts to flood risk including: • Avoid siting/storing any activity/material in Flood Zone 3 wherever possible, although noting that it may not be possible to move soil between different fields/land holdings. Soil stockpile impacts in the floodplain, where unavoidable, will be mitigated through appropriate alignment, leaving gaps and cross-drainage. • Removing obstacles, plant, and debris from watercourse pathways. • Access roads (and working areas) in the floodplain are to be as close to ground level as possible (a slight raised surface is often required to allow to for drainage). Cross drainage would be provided as necessary at topographic low points. Works will not be carried out during flood flows to avoid undue erosion of the riverbeds and/or banks, to protect construction personnel and plant, and to ensure that flood conveyance is not reduced. To be secured via the **CoCP** (**Volume 5, Document 5.3.3B,** DCO Requirement 5)**.**	Standard good practice to mitigate flood risk.
FM2	All Project construction infrastructure	Construction	**Standoff distances** Where possible, a stand-off distance from the top of bank of all watercourses/waterbodies will be established (with the exception	Reduce permitting requirements and

Ref no.	Project Element	Project phase	Flood Risk Management Measure	Reason
	(e.g., substations, CSECs, access routes, overhead line pylons)		of crossings and where existing field access roads are already located adjacent to watercourses are to be utilised). To align with Environment Agency and IDB consenting requirements, it is proposed that this will be 8m for non-tidal Main Rivers, 7m from adopted drains within the KUOIDB district and 9m from adopted watercourses within the AIDB district. These stand-off distances would also apply to flood defences. Appropriate stand-off distances should also be implemented where Project construction activities coincide with water supply and sewerage infrastructure. These are to be agreed on a case-by-case basis. To be secured via the **CoCP** (**Volume 5, Document 5.3.3B,** DCO Requirement 5)**.**. For any instances where the stand-off distances stated above cannot be achieved between construction works and watercourses, these works would be subject to the appropriate consent by the relevant drainage authority (FRAP for main rivers, OWC for ordinary watercourses, see **Volume 7, Document 7.3: Details of Other Consents and Licences**).	to maintain floodplain storage and conveyance as far as possible
FM3	Substations, and CSECs, construction compounds	Construction	**Drainage Management Plan (Construction)** Appropriate control of runoff from working areas will be achieved through implementation of a Drainage Management Plan (DMP) for the construction phase. The DMP will use SuDS principles, promoting infiltration of runoff wherever possible and specifying appropriate treatment and attenuation storage to ensure any discharges to watercourses are uncontaminated and limited to greenfield rates. The DMP will cover all aspects of construction works and temporary infrastructure. It will be developed by the construction contractor post granting of the DCO and prior to commencement of works and will be secured through DCO Requirement 6.	To ensure no increase in flood risk downstream.

Ref no.	Project Element	Project phase	Flood Risk Management Measure	Reason
			Drainage measures will be phased to be completed before the commencement of earthwork operations, in a specific area, and will be retained until the drainage system of the completed Project is fully operational, or site restoration works are completed. This will include the temporary diversion of existing agricultural drainage around working areas, if required, followed by reinstatement on completion of works. Reinstatement will be secured through DCO Requirement 11.	
FM4	New Overton Substation and extension of existing Monk Fryston substation, CSECs at Tadcaster and Shipton, and associated access roads.	Operation	**Detailed Drainage Design (Operational)** Detailed drainage design for permanent project infrastructure with new impermeable surfaces, comprising substations, CSECs and associated access roads, will be carried out post-grant of the DCO, and will be subject to approval from the relevant drainage authority. The detailed drainage design for the substations will be consistent with the drainage strategies produced to support the DCO application (**Annexes 6D.5 and 6D.6**). Detailed drainage design for the CSECs and access roads will be to the same standard, including the use of appropriate SuDS. This will be secured via DCO Requirement 6(4).	To ensure no increase in flood risk downstream.
FM5	Watercourse crossings (construction) access	Construction	**Construction access watercourse Crossing Design** Where possible, existing watercourse crossings would be used. However, in some locations new temporary crossings may be required. Temporary bridges will be used in preference to culverts for main rivers and WFD reportable watercourses and designed to ensure an appropriate level of flood conveyance in the construction phase and to avoid the requirement for in-channel works. Culverts will be used for crossing of other watercourses. These will either be arch culverts, leaving the natural bed undisturbed, or	Maintain existing conveyance capacity.

Ref no.	Project Element	Project phase	Flood Risk Management Measure	Reason
			they would be installed with the invert set below the natural bed level to allow for a semi natural bed to establish within the culvert. All construction related, temporary crossings will be designed to ensure that existing channel conveyance and floodplain storage are preserved. These design principles will be secured via the **CoCP** (**Volume 5, Document 5.3.3B,** DCO Requirement 5). Specific detailed designs for each watercourse crossing, consistent with these design principles, will be prepared by the construction contractor post-grant of the DCO. These will be subject to the appropriate consent by the relevant drainage authority (FRAP for main rivers, OWC for ordinary watercourses, see **Volume 7, Document 7.3: Details of Other Consents and Licences**). Temporary watercourse crossings will be removed within 12 months of completion of construction, and the bed and banks restored to their pre-construction condition, as far as possible. This would secured via DCO Requirement 13**.**	
FM6	Temporary access routes (including watercourse crossings), working areas and construction compounds	Construction	**Reinstatement of working areas** Once construction is complete, all temporary access route and temporary working area construction material will be removed and the ground reinstated to its pre-construction state (or similar), with the soil stockpile material used to backfill any excavations (to a level slightly above natural ground level to allow for settlement). This would be secured via DCO Requirement 11.	To return the temporary access routes, working areas and temporary construction compounds to a pre-development condition, in terms of their rainfall infiltration and runoff generation characteristics.

Ref no.	Project Element	Project phase	Flood Risk Management Measure	Reason
FM7	Areas located in, or requiring access, via the floodplain.	Construction	**An Emergency Response Plan for Flood Events (ERPFE)** An Emergency Response Plan for Flood Events (ERPFE) will be prepared for those construction activities which must take place in areas of higher flood risk. This will describe the flood hazard, assess the risk to infrastructure and personnel, specify roles and responsibilities, arrangements for receiving flood warnings, responses to flood warnings (including evacuation as required), and evacuation routes. In addition, the ERPFE will set out arrangements for cessation of excavation dewatering activities, should a flood alert or flood warning be received, to minimise any impacts on flood flow conveyance and to maintain access for watercourse maintenance. The ERPFE will be developed by the construction contractor post granting of the DCO and prior to commencement of works and will be secured via DCO Requirement 6.	For the safety of site operatives who may be working within the floodplain, or may need to cross it to access/egress the part of the Order Limits they are working in.

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6.5 Additional flood mitigation measure

6.5.1 As was identified in **Section 5.3,** the new Overton Substation has been identified as likely being at risk of flooding with future climate change. To ensure the substation is resilient to flooding to the National Grid design standard as set out in **Section 5.3** the Overton Substation will be built on a raised platform with a floor level of 13.71 mAOD. This has been specified as the minimum platform level for the substation on the design drawings submitted for DCO and will therefore be secured via DCO Requirement 3, which states that the development should be carried out in general accordance with the design drawings.

6.5.2 The substation platform has been designed to be outside of the 1% AEP +30% climate change flood extent so that there is no requirement to provide compensatory flood storage. Site access and egress is entirely via Flood Zone 1.

6.6 Summary

6.6.1 It is concluded that, subject to the adherence to the flood risk and drainage management measures set out in this section, as supported by the substation drainage strategies in **Annexes 6D.5 and 6D.6**, flood risks to the Project would be appropriately managed, and there would be no increase in flood risk arising from the Project during its construction and operational phases.

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7. Planning policy requirements

7.1 The Sequential Test

7.1.1 A sequential approach has been taken in determining the location of the new overhead lines, substations and CSECs with flood risk being considered in the route selection process along with the numerous other technical, environmental, and socio-economic constraints (set out in **Chapter 2: Project need and alternatives, Volume 5, Document 5.2.2**). The Sequential Test ensures that the Project elements are sited in the lowest flood risk areas, where possible, whilst acknowledging the expansive floodplains of the wider area, the need to reach existing substations and to connect to the wider electricity network. The Overton Substation was found to be at risk of flooding in future climate scenarios. An alternative location for the Overton Substation, to the north of the A19, relative to the favoured proposed location was considered. **Chapter 2: Project need and alternatives, Volume 5, Document 5.2.2** provides further information on the alternatives considered as part of the development of the Project design, including alternative options. Additional flood modelling was performed as part of this study to assess the flood risk at the alternative location and is discussed in **Annex 9D.4** of this FRA. The flood risk at the alternative location was found to be greater than the proposed location.

7.1.2 Based on the information contained within this FRA and **Chapter 2, Volume 5, Document 5.2.2**, the Sequential Test is considered to have been satisfied.

7.2 The Exception Test

7.2.1 The requirements of the Exception Test were set out in **Section 2.2** of this report, along with the flood risk vulnerability and flood zone 'compatibility' matrix in **Table 2-2**, which confirmed that the Exception Test needs to be passed for the Essential Infrastructure elements of the Project located in Flood Zone 3a and 3b.

Wider sustainability benefits

7.2.2 Part 1 of the Exception Test requires the Project to provide wider sustainability benefits to the community that outweigh flood risk. As stated in EN-1 (Department of Energy and Climate Change, 2011a), this would include the benefits (including need) for the infrastructure.

7.2.3 In line with the UK government's legal commitment to reduce greenhouse gas emissions by at least 100% of 1990 levels (net zero) by 2050, growth in offshore wind generation and interconnectors to Europe has seen a significant number of connections planned in Scotland and coastal areas of the North of England.

7.2.4 The existing electricity transmission network was not designed to transfer the current and increasing volume of generation capacity from the North to major centres of electricity demand which continue to exist in central and southern England. The network will require significant reinforcement in the Yorkshire area to provide capacity for these connections and customers to ensure that power can be transferred securely to onshore demand centres in the south to meet the needs of Great Britain electricity consumers.

7.2.5 Further details on Project need can be found in Updated Need Case Document (**Volume 7, Document 7.4**) and **Chapter 2: Project need and alternatives, Volume 5, Document 5.2.2**). On this basis, it is considered that the Project provides the wider sustainability benefits required to satisfy Part 1 of the Exception Test.

Flood risk

7.2.6 Part 2 of the Exception Test requires that the Project would be safe, without increasing flood risk elsewhere (subject to the exception below) and, where possible, would reduce flood risk overall. 'Essential Infrastructure' in Flood Zone 3a and 3b should also be designed and constructed to remain operational and safe in times of flood.

7.2.7 Part 2 of the Exception Test for the Project is considered to be passed on the basis that:

- The potential effects during the construction phase of the proposed overhead line (and associated construction infrastructure) are expected to be localised and not significant. It is expected that the embedded flood management measures will suitably manage the potential changes in flood risk to receptors so that any potential effects are negligible.
- The footings of the pylons that are located in Flood Zone 3a and 3b are considered to be water compatible and will not displace significant floodplain storage volumes, compartmentalise the floodplain nor obstruct surface water or floodplain flows. As outlined in **Section 4.6**, pylons do not displace any significant volume of water and pose minimal obstruction to water flow. Therefore, placing of pylons in floodplain areas will not significantly affect floodplain storage or conveyance and will therefore not cause an increase in flood risk to others external receptors. Consequently, the pylons will not impact the flood risk to vulnerable third party receptors and where pylons along Hurns Gutter have been identified within Flood Zone 3b, these effects would be very local, increases in flood levels or extents, but due to the rural location there is no increase in risk to potential receptors.
- Overton Substation is to be elevated on a platform to ensure that the National Grid design standard for flood resilience of the 0.1% AEP flood + 34% CC event is achieved. The Environment Agency have advised that the existing York Detailed model output for the 1% AEP +30% climate change event was acceptable to demonstrate that compensatory flood storage is not required if the substation, and the flood resilience platform, are located outside of this flood extent. The whole of the Overton Substation will be located outside of the 1% AEP +30% climate change event extent; therefore it is concluded that there will not increase in flood risk to third parties from the construction of the Overton Substation (See **Annex 9D.4** for further information).

7.2.8 With the proposed Overton Substation identified as potentially being within a future Flood Zone 3, further assessment of flood risk has been undertaken for this site, as set out in **Annex 9D.4 and Section 5.3** of this document. This sets out the proposal to build the substation on a raised platform, to ensure the substation is resilient to flooding whilst not increasing the risk to third party receptors and with safe access and egress to Flood Zone 1, both now and throughout the development lifetime.

7.2.9 It is therefore concluded in light of the above that the Project satisfies both parts of the Exception Test.

8. Summary and conclusions

8.1 Summary

8.1.1 This FRA has been produced to support the National Grid DCO application for Yorkshire GREEN. National Grid are seeking to construct, operate and maintain new overhead lines, underground cables, two substations, cable sealing end compounds (CSECs), to link up two existing overhead lines, and to reinforce the system to increase the capacity of the network north of York.

8.1.2 As the Project is classified as an NSIP, the FRA has been carried out in accordance with relevant National Policy Statements EN-1 and EN-5 for electricity transmission NSIPs. However, reference has also been made to the NPPF and the associated PPG where relevant, for additional guidance regarding flood risk and development, as appropriate. Consultation with key stakeholders, including the Environment Agency, York Consortium of IDBs (Ainsty and Foss IDB) and North Yorkshire County Council (LLFA) has also been undertaken to discuss the Project and the management of flood risk. Parts of the Project must necessarily be located in areas with a medium or high likelihood of flooding (Flood Zones 2 and 3), and therefore consideration has been given to the Sequential and Exception Tests, as defined in EN-1 and NPPF.

8.1.3 This FRA considers the flood risks associated with the construction of the proposed overhead lines, substations, CSECs and associated construction infrastructure, in addition to refurbishment or removal of existing infrastructure.

8.1.4 Flood risks associated with fluvial, and surface water sources have been identified during the construction and operation phase of the Project. Flood risk receptors include construction activities themselves, operational infrastructure, maintenance and repair activities, plus third-party receptors for which flood risk could be increased because of the works.

8.1.5 The flood risk management standards, including the appropriate climate change uplifts to be applied, for all elements of the Project, during both the construction and operational phases were set out in **Section 2**.

8.1.6 The flood risk from other sources have been identified to be low or negligible. The Project is sufficiently far from the coast and elevated to not be affected by tidal flooding. Due to the rural nature of land which comprises the Order Limits the risk posed by sewer flooding is considered to be very low. There is the potential to encounter shallow groundwater, either perched in superficial deposits and possibly the main water table at shallow depth in floodplain areas. On this basis there is very limited risk to above ground works associated with the Project and the only conceivable risk that remains is to excavation works (e.g., excavations relating to pylon or substation construction).

8.1.7 It is not expected that significant volumes of groundwater will be encountered during excavations works, except for potential localised perched lenses of more permeable material in the Glacial Till (between XC520 and the existing Monk Fryston Substation). In the event groundwater is encountered in an excavation, there will be a need to dewater to facilitate construction.

8.1.8 During both the phases of the Project there will be an increase in impermeable area which would result in greater surface water runoff. To manage the increased runoff from these areas, SuDS will be utilised, and the discharge of the runoff will be prioritised in the following order: infiltration to ground; discharge to watercourse following attenuation; and combined/surface water sewer following attenuation. The detailed, construction phase, drainage strategies will be developed by Construction contractors and will be submitted for approval to the relevant LLFA/IDB ahead of works commencing. The operational phase drainage strategies for Overton and Monk Fryston Substations are provided in **Annex 9D.5** and **Annex 9D.6**.

8.1.9 Further modelling has been undertaken to establish the design requirements of the Overton Substation to achieve the National Grid 0.1% AEP + climate change (34%), design standard. The modelling approach and outputs are detailed in **Annex 9D.4** which support this FRA.

8.1.10 The worst-case scenario Environment Agency flood maps indicate parts of the Overton Substation site are at risk of flooding from reservoir failure, the likelihood of this occurring was evaluated to be extremely low. The resulting residual risk is mitigated through the statutory the requirements for reservoir owners to inspect and maintain their reservoirs under the Reservoirs Act 1975 (as amended), and local authorities' and other emergency responders' responsibility to maintain appropriate emergency response plans under the Civil Contingencies Act 2004.

8.2 Conclusions

8.2.1 Overall, the permanent infrastructure associated with the Project (pylons, substations (excluding the new Overton Substation) and CSECs) are not considered to be at significant risk of flooding based on their NPPF vulnerability being appropriate for the Flood Zones in which they are located (**Table 3-1**); nor is it indicated that they pose an increased risk of flooding to third party receptors, provided all the embedded mitigation is implemented.

8.2.2 The flood mitigation measures detailed in **Section 6** are considered to be sufficient in mitigating the risks associated with the Project (excluding the new Overton Substation), during construction and operation. It is therefore concluded that the Project, with the mitigation measures described above in place, is not at significant risk of flooding, nor will it increase flood risk elsewhere.

8.2.3 However, it is noted from this FRA that the new Overton Substation could potentially become at risk of flooding over its lifetime, due to the impacts of climate change. Although currently in Flood Zone 1, the Environment Agency's York Detailed model indicates that the substation site is partially within the 1% AEP +50% CC flood extent.

8.2.4 Therefore additional flood mitigation measures have been embedded into the design of the proposed Overton Substation. For the substation to achieve the National Grid 0.1% AEP + climate change (34%), design standard plus 300mm freeboard, it will be built on a platform with a flood resilience level of 13.71 mAOD. The substation has been designed so that it and all associated flood resilience measures remain outside the 1% AEP +30% CC flood extent. On this basis, it has been agreed with the Environment Agency, that there is no requirement for compensatory flood storage to be provided. In this respect, it is consistent with the requirements of the Exception Test.

8.2.5 The residual risk associated with flooding from reservoirs is evaluated to be very low and does not place any constraints or requirements for environmental measures on the Project.

Annex 9D.1
Overton Substation – BGS Groundwater Flooding Susceptibility

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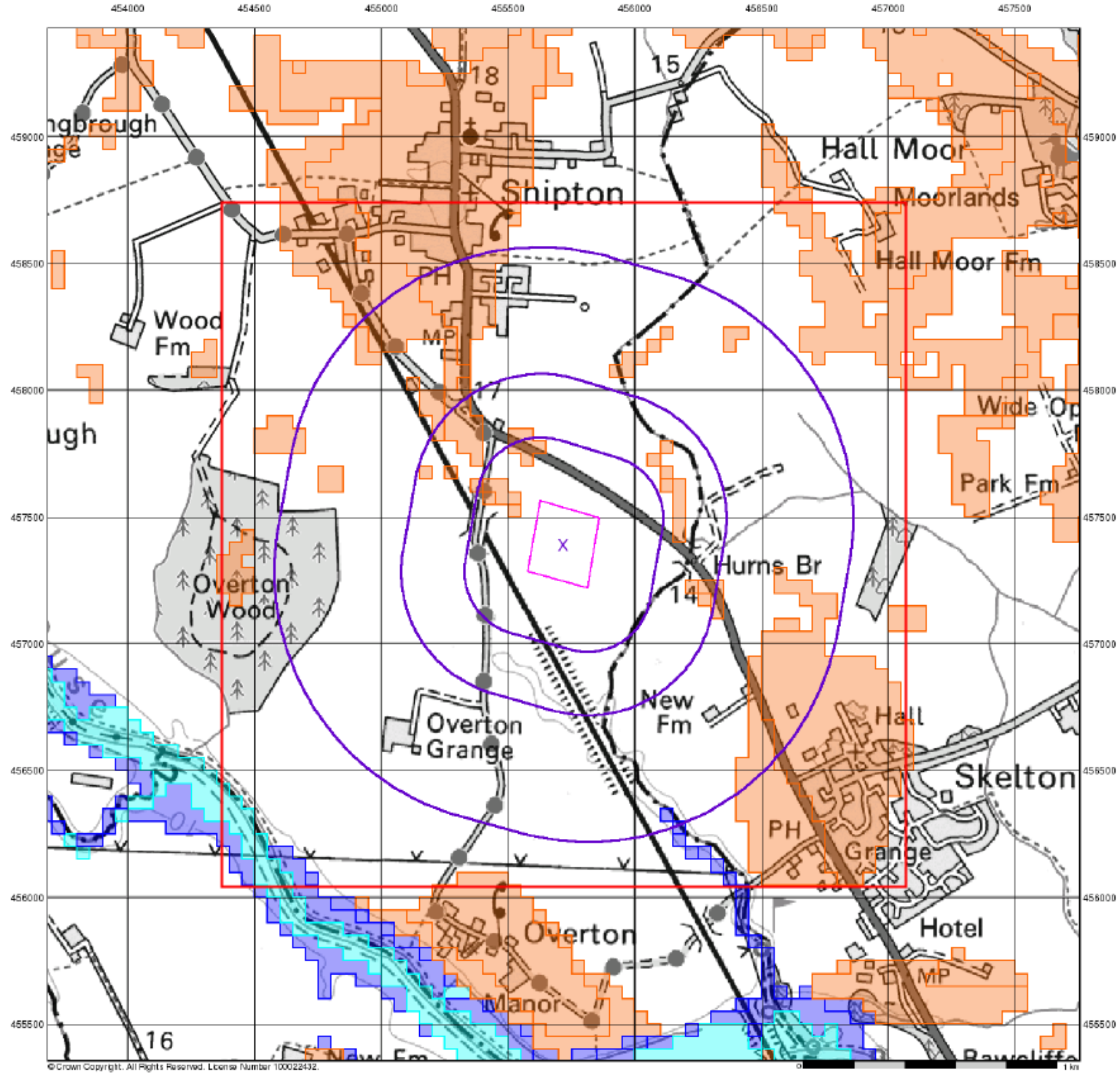

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BGS Flood GFS Data

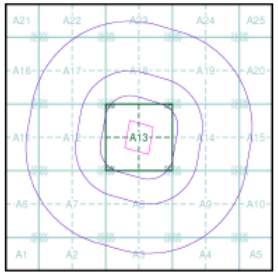
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice

Agency and Hydrological (Flood)

- Limited Potential for Groundwater Flooding to Occur
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Potential for Groundwater Flooding to Occur at Surface

Site Sensitivity Context Map - Slice A



Order Details

Order Number:	276596223_1_1
Customer Ref:	100102545 SS03
National Grid Reference:	455720, 457390
Slice:	A
Site Area (Ha):	6.87
Search Buffer (m):	1000

Site Details

York North 275kV, Shipton, North Yorkshire

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

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Annex 9D.2
Monk Fryston Substation – BGS Groundwater Flooding Susceptibility

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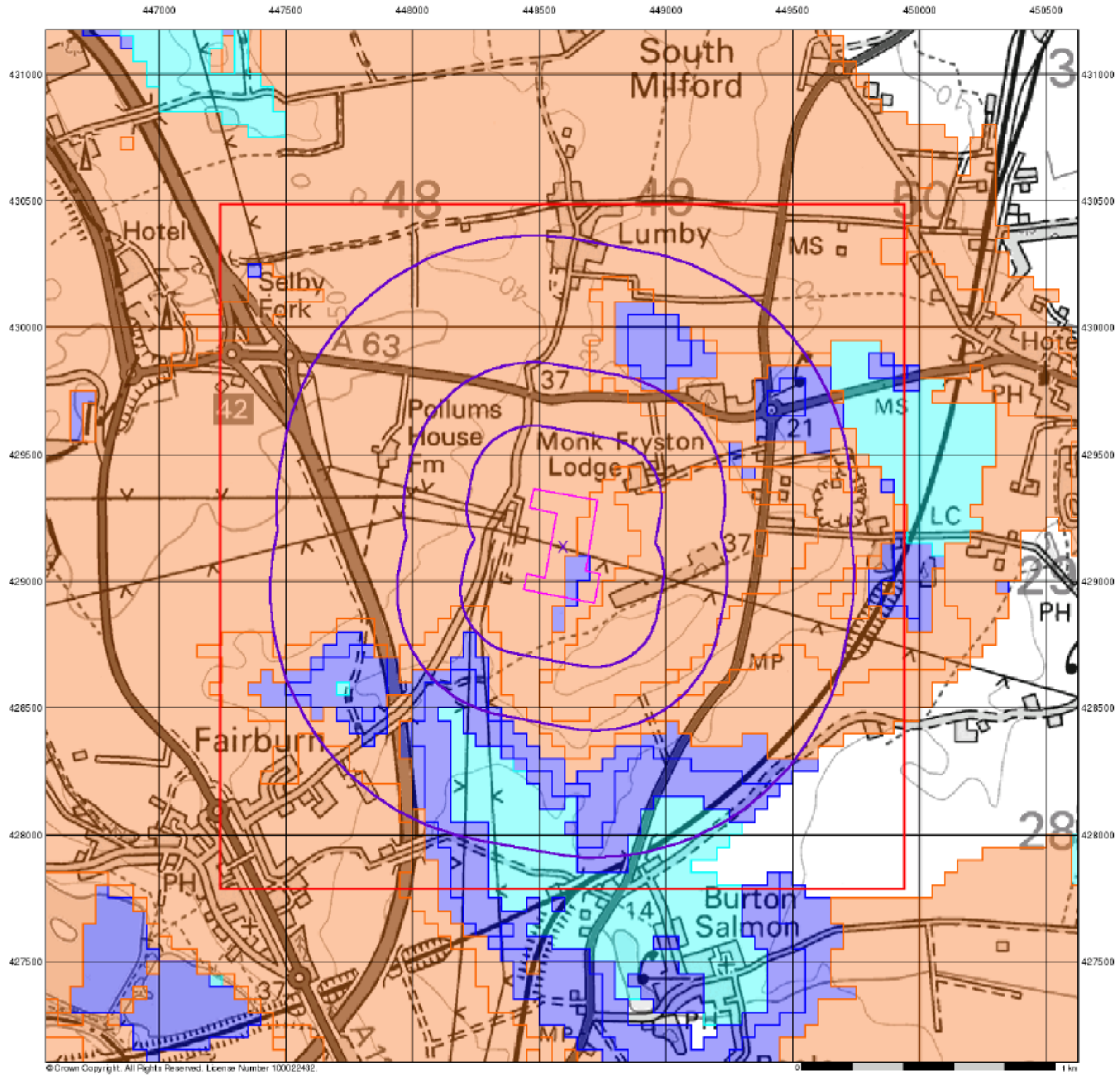

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BGS Flood GFS Data

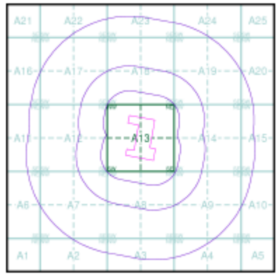
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice

Agency and Hydrological (Flood)

- Limited Potential for Groundwater Flooding to Occur
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Potential for Groundwater Flooding to Occur at Surface

Site Sensitivity Context Map - Slice A



Order Details

Order Number:	276594815_1_1
Customer Ref:	100102545 SS03
National Grid Reference:	448590, 429140
Slice:	A
Site Area (Ha):	8.1
Search Buffer (m):	1000

Site Details

Site at, Monk Fryston 400kV, North Yorkshire

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

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Annex 9D.3
Watercourse crossings

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Watercourse crossing	X coordinate	Y coordinate	Watercourse Type	Name	WFD Water body
New temporary bridge crossing					
New bridge over watercourse	447493	444014	OWC	Unnamed	N
New bridge for crossing large field drain	455391	457102	IDB	36	N
New bridge for crossing Hurns Gutter	456122	456329	IDB	Hurns Gutter	Y
New bridge for crossing Hurns Gutter	455881	456693	IDB	Hurns Gutter	Y
New bridge for crossing Hurns Gutter	455926	458050	IDB	Hurns Gutter	Y
Bridge potentially required to cross the Foss to northern stringing area if required by the contractor	448388	447676	IDB	The Foss (trib. of Wharfe)	Y
New temporary culvert crossing					
New culvert over drain	447311	443989	OWC	Unnamed	N
New culvert over ditch	452572	456339	IDB	MM052	N
New culvert for crossing field drain	456238	458354	OWC	Unnamed	N
New culvert for crossing field drain	453998	456176	OWC	Unnamed	N
Temporary culvert under existing Network Rail emergency access track	455423	457439	OWC	Unnamed	N
New culvert potentially required	448851	429102	OWC	Unnamed	N
New culvert required over drain	454110	455303	OWC	Unnamed	N
Existing culvert crossings					
Clearance of vegetation and condition check. Possibly replace with new culvert if clearance not possible.	448310	448475	OWC	Unnamed	N

Watercourse crossing	X coordinate	Y coordinate	Watercourse Type	Name	WFD Water body
Clearance of vegetation and condition check. Culvert capacity okay.	447290	431327	OWC	Unnamed	N
Upgrade or replace existing culvert if unsuitable for construction traffic	451312	456312	IDB	MM051	N
Upgrade existing culvert if unsuitable	450239	453363	IDB	MM060	N
Upgrade existing culvert if not suitable for construction traffic	451975	456592	IDB	MM050	N
Clearance of vegetation and condition check. Culvert capacity okay.	447272	431285	OWC	Unnamed	N
New culvert (replacement of existing subsided culvert) potentially required for construction traffic. Currently used by farm vehicles	451141	454620	OWC	Unnamed	N

Annex 9D.4
Overton Substation Flood Modelling Technical Note

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1. Introduction

1.1.1 Overton Substation is to be located adjacent to the Hurns Gutter, a tributary of the River Ouse, north of York. Although the proposed location of the Overton Substation is in Flood Zone 1, it is close to the edge of Flood Zones 2 and 3 associated with the floodplain of the River Ouse. Outputs from the Environment Agency's York Detailed Model (YDM) indicate that the proposed substation location would remain outside of the 1% AEP +30% climate change flood extent but would fall partially within the 1% AEP +50% climate change flood extent **(Figure 9.8, Volume 5, Document 5.4.9** of the ES**)**. It is therefore likely that the fluvial flood risk to the substation location would become significant over the proposed lifetime of the Project **(Figure 9.8, Volume 5, Document 5.4.9)**.

1.1.2 As noted in **Section 2.5** of the FRA, the National Grid design criteria requires substations to be resilient to flooding up to and including a 0.1% AEP event with an allowance for climate change, plus 300mm freeboard. The climate change allowance for Essential Infrastructure is the Higher Central allowance which is +34% in the Swale, Ure, Nidd and Upper Ouse Management Catchment (see **Figure 9.3, Volume 5, Document 5.4.9**) where the Overton Substation is to be located. However, there are no modelling results for this scenario that can be used to inform the design. Therefore, This Annex documents the modelling that has been undertaken to establish the 0.1% AEP +34% CC event flood resilience level for the substation.

1.1.3 An alternative location for the Overton Substation, to the north of the A19, relative to the favoured proposed location has also been considered and the results of flood modelling for this alternative location are also summarised in this annex.

1.1.4 The Environment Agency advised that the existing YDM output for the 1% AEP +30% climate was acceptable to demonstrate that compensatory flood storage would not be required, provided the substation and any necessary flood resilience measures are located outside of this flood extent[50].

1.2 Annex Structure

1.2.1 The remainder of this Annex is structured as follows:

- **Section 2** provides an overview of the YDM, including a review of the model structure and hydrology in the vicinity of the Hurns Gutter, adjacent to the preferred proposed Overton Substation location;
- **Section 3** summarises the results of modelling undertaken to establish a flood resilience level for the preferred substation location and for the alternative location north of the A19; and
- **Section 4** presents the conclusions of the modelling study.

2. The York Detailed Model

2.1.1 The YDM study was undertaken over 2015-16 by Mott MacDonald[52]. This study was commissioned following significant fluvial flooding events in the River Ouse and River Foss catchments in 2012. The overarching objective of the study was to create a baseline, from which the flood risk authorities could formulate credible, robust and reliable solutions to better manage flood risk in the future. While the YDM project was being undertaken there was a severe flood on the Rivers Ouse and Foss in December 2015. The model calibration and hydrological analysis was reviewed following this event and the model was refined using the data collected during the event.

2.1.2 A linked 1D-2D, ISIS-TUFLOW hydraulic model was developed to assess the current and future flood risk in the catchments. The model covers a 17km stretch of the River Ouse extending from Skelton Bridge to Naburn Bridge; 15km of the River Foss from Strensall to the Foss Barrier and 13km of the main tributaries of the River Foss.

2.1.3 The hydrology used in the YDM was updated in 2016 following the December 2015 flood event. Whilst the hydrological analysis of the River Foss and its tributaries is assessed through a combination of rainfall runoff modelling (ReFH1) and peak flow statistical analysis, the hydrological analysis of the River Ouse is primarily based on observed data from Skelton gauging station and on levels through York, using an approach set out in the YDM hydrology report[53].

2.2 Overview of the YDM and the Hurns Gutter

2.2.1 The Hurns Gutter, the watercourse in closest proximity to the proposed Overton Substation, is represented in the 2D domain of the YDM only. This may mean that the conveyance capacity of the Hurns Gutter channel is represented as accurately as it could be and is likely over estimated due to the 10m resolution grid on which the 2D domain is based.

2.2.2 A statistical assessment of flood peaks was not undertaken specifically for the Hurns Gutter (14.75km^2) in the YDM. A ReFH1 inflow unit was used with the hydrograph scaled using the same statistical/ReFH flood peak ratio as derived for the River Ouse. This was deemed to be acceptable as the River Ouse was identified as the primary source fluvial flood risk at the Substation site.

2.2.3 To model the 0.1% AEP + 34% CC flood event, all inflows to the existing YDM for the 0.1% AEP event were scaled up by 34%. A sensitivity test has been undertaken to determine the relative significance of inflows from the upstream catchment Hurns Gutter versus the backing-up of flood levels from the River Ouse for flood risk at the preferred Overton Substation location. This sensitivity test was performed by simply removing the Hurns Gutter inflow from the model.

[52] Mott MacDonald. (2016). York Detailed Modelling Study. Final Report. Mott Macdonald; London.
[53] Mott MacDonald. (2016). Ouse, Foss and Wharfe Model Review – Detailed York Modelling. Hydrology Report Updated Following December 2015 Flood Event. Mott Macdonald; London.

2.3 Flood modelling approach for alternative substation locations

2.3.1 There are currently no mapped Flood Zone 3 extents for the alternative substation location proposed, north of the A19. The existing YDM was extended north of the A19 to cover the alternative site and the two channels in proximity to the site, one of which is the Hurns Gutter. The extended model consisted of a 2D domain, only, developed using Environment Agency Lidar data. A Flood Estimation Handbook (FEH) statistical flood peak assessment was undertaken for the Hurns Gutter to the A19, with the median annual flood (QMED) established from catchment descriptors with a single site donor adjustment and a pooled growth curve analysis performed. A statistical assessment was undertaken for input to the extended model as the Hurns Gutter was identified as the primary source of flooding for the alternative site, where for the preferred site it is the River Ouse. The Hurns Gutter inflow, to the A19, was split and entered in to the 2D at the top of the two channels in proximity to the site. The modelling considered only a flood event along the Hurns Gutter. It did not consider an in combination Hurns Gutter event with a flood event along the River Ouse, the results of which would likely have meant greater flood risk than is shown.

3. Modelling results

3.1 Flood Resilience Level

3.1.1 The modelled water elevation within the substation boundary for the 0.1% AEP flood + 34% CC event is 13.41 mAOD (**Figure 9.11, Volume 5, Document 5.4.9** of the ES). This means a final flood resilience level of 13.71 mAOD should be used for the design of the substation to account for a 300mm freeboard.

3.2 Sensitivity test

3.2.1 Removing the Hurns Gutter inflow only reduced the flood depth within the proposed Substation site by 10mm, demonstrating that the flood risk to the Overton Substation is primarily from the River Ouse backing up the Hurns Gutter and that the Hurns Gutter alone poses a negligible flood risk to the substation. Removing the Hurns Gutter flow had a negligible effect of the flood extent, with only a minor difference at the upper end of the Hurns Gutter where the inflow comes in to the YDM (**Figure 9.11, Volume 5, Document 5.4.9** of the ES).

3.3 Alternative substation location extents

3.3.1 As is shown in **Figure 9.12, Volume 5, Document 5.4.9** the access to the alternative location for the Overton Substation was at greater flood risk than the preferred location with the substation completely surrounded on all four sides by flood water from the events with at least a 1% AEP. Permanent access roads to the site would have to be elevated and cut across flood flows, displacing flood water and potentially increasing flood risk. Therefore, this site was not considered further for a number of reasons, including flood risk, as is set out in **Chapter 2: Project need and alternatives, Volume 5, Document 5.2.2.**

4. Conclusions and recommendations

4.1.1 The modelling has shown that to achieve the National Grid design standard of the substation being resilient to flooding for the 0.1% AEP flood + 34% CC plus a 300mm freeboard the infrastructure should be built at a minimum level of 13.71 mAOD. National Grid plan to achieve this flood resilience level by building the substation on a platform with a finished floor level of 13.71 mAOD. Removing the Hurns Gutter inflow only reduced the flood depth with the substation by 10mm, demonstrating that the flood risk to the Overton Substation is primarily from the River Ouse backing up the Hurns Gutter and that the Hurns Gutter alone poses a negligible flood risk to the Substation.

4.1.2 Further modelling of an alternative substation location indicated that the access would be at higher risk of flooding than the preferred location.

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Annex 9D.5
Overton Substation – Drainage Strategy

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Yorkshire Green Project
Overton Site

Drainage Strategy

April 2022

Mott MacDonald
4th Floor
Derwent House
150 Arundel Gate
Sheffield S1 2JY
United Kingdom

T +44 (0)114 2761242
mottmac.com

National Grid

Yorkshire Green Project
Overton Site

Drainage Strategy

April 2022

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	05 April 2022	A Precious	A Sims	P McLoughlin	
B	27 May 2022	A Precious	A Sims	P McLoughlin	
C	02 August 2022	A Precious			

Document reference: 100102545-MMD-01-XX-RP-C-0042

Information class: Standard

Contents

1 Introduction

This report sets out the drainage criteria, subsequent drainage strategy and current stage design of the drainage system for the proposed Overton site as part of the Yorkshire Green Project.

It is noted that the site is to be prepared for the development and that site levels are to be elevated by 600mm to remove the site from future flood risk.

1.1 Existing site

The Overton development is to be located in an existing agricultural field to the north of the settlement of Overton and the River Ouse.

The approximate site grid reference is 455764E, 457335N.

The topography of the field is captured on topographical survey included as Appendix A. The survey shows that the site falls from north-west to the south-east which corresponds to the flow route of Hurn's Gutter to the east of the site which drains into the River Ouse to the south.

1.2 Existing site drainage regime

It is not known if the agricultural field is positively drained either by tile drains or land drainage.

The natural topography of the site suggests that there is sufficient existing gradient to channel overland flows in extreme events to either the River Ouse to the south or Hurn's Gutter to the east.

Site information indicates that the site is underlain by topsoil (0.2 to 0.5m thick) on Alne Formation deposits (glaciolacustrine deposits) which are between 10 to 15m thick. These lower deposits are considered to be relatively low permeability soils.

Soakaway testing has bene undertaken on the site with the results indicating negligible residual infiltration potential in this area.

Site information also indicates that groundwater may be in the order of 5.0 to 17.5m below ground level.

1.3 Proposed development

The proposed new substation and associated compound covers an area of approximately 61,700m^2 (6.17 hectares).

The site development comprises transformer bunds, duct routes, electrical equipment, access roads and a site control building.

As noted previously, the site is to be elevated to mitigate flood risk associated with Hurn's Gutter and the River Ouse. This elevated platform is to be constructed using permeable granular material (DoT Type 3 or similar Specification for Highway works Clause 805) with a layer of single sized aggregate as a top layer.

Across the site this granular layer will be set lower than adjacent access roads and buildings.

1.4 Design criteria

The site has FSR (Flood Studies Report) characteristics of:

- M5-60 = 19.00
- Ratio R = 0.400

A conservative C_v value for the volumetric runoff has been used in accordance with industry best practice as all rainfall will be deposited on the site directly.

The total site area of 6.17ha yields an equivalent greenfield runoff rate (Q_{bar}) of 25.11l/s (see Appendix B) using the ICOP SuDS method (4.1l/s/ha).

Until proven on site, the use if infiltration for the disposal of large volumes of rainfall has not been pursued. If site testing can demonstrate any infiltration potential the drainage strategy should be amended accordingly.

The drainage design will be carried out with reference to the National Grid Standards TS_2.10.09 (site drainage) and TS_2.10.01 (Oil Containment) and Building Regulations Part H where appropriate.

The drainage systems will be designed for 1% Annual Exceedance Probability (AEP) event with a 30% central allowance for climate change, with a check made for the performance for the system for 45% Upper end climate change and for the 0.1%AEP event.

2 Proposed design strategy

The nature of the proposed enabling works provides an opportunity to utilise the natural voids in the imported material used to create the plateau as in-situ attenuation which by limiting the offsite peak runoff rate will not only provide protection for the site but will also positively impact on flood risk downstream.

2.1 Allowable site discharge

The proposed development should restrict flows to the equivalent greenfield runoff rate this is estimated to be a maximum of 25.1l/s.

It is noted that a separate drainage system will be required for the areas of the site identified by TS_2.10.01 as pollution risk locations – principally the transformers. These will be drained via Bund Water Control Units (BWCU) (oil discriminating pumps) to a segregated piped system that passes through an Oil Water Interceptor (OWI). The nature of these systems is that they will be between 900mm and 1.2m below ground and as such, in this case, deeper than the main site attenuation area (the granular material forming the plateau).

Flow rates from the BWCU's are typically between 1-2l/s per pump with the bund on each transformer acting as local rainfall attenuation. To reflect this, an allowance of 4.0l/s for direct discharge from the oily water system has been made.

The result is that the stone attenuation area will discharge at a rate of 21.1ls/ and the oily water system at 4.0l/s with no attenuation.

2.2 Attenuation provision

The overall area of the development site is 61,700m^2 however, some of this area will be occupied by building and equipment foundations, duct runs, trenches and bunds. It is therefore conservatively estimated that 70% of the area will be available as in-situ storage on the site to give an equivalent area of approximately 42,900m^2.

The platform will have a minimum level at the surface of 13.79mAOD and would be formed by a raised granular blanket across the site. The platform will have a minimum depth of around 450mm that indicates a total potential available volume of around 5,900m^3 assuming a void ratio of 30% in the granular material.

A positive outfall to the Hurn's Gutter, to the east of the site will be provided in addition to a new headwall. This will require the consent of the Lead Local Flood Authority and will be subject to an ordinary watercourse consent.

As the flow through the granular sub-base will receive a high level of percolation, it is proposed that flow rates from the site are controlled via an orifice plate device in a flow control chamber upstream of the connection to the offsite pipe.

The preliminary design indicates that using a 104mm orifice plate will restrict flows to 21.0l/s and mobilise 4630m^3 of storage at a working depth of approximately 366mm in the stone sub-base for the 1 in 100-year + 30% climate change event, and 419mm for the +45% event

In order to mobilise this storage, it will be necessary to place a layer of low permeability membrane at the base of the granular material a minimum of 450mm below the finished surface of the sub-station area (approximate level of 13.34mAOD) and returned at the faces of the platform (with 1m of cover). This will prevent water percolating vertically though to the underlying soil and horizontally though the embankments. The attenuated water will be collected via a perforated collection pipe measuring a minimum of 10m in length and 150mm in diameter on the eastern side of the platform.

Calculations for this are included in Appendix C and is shown on the masterplan in Appendix D.

2.3 Oily water system

Runoff from the transformer oil retention areas (bunds) will need to be treated by an OWI before leaving the development site.

This will require a positively drained, piped system and BWCU's on each of the 4 transformers.

As noted previously, the BWCU and the associated transformer bund will provide flow control and local attenuation for rainfall events and so this system does not require additional inline attenuation.

In order to avoid duct and cable trenches on the site, at this stage the piped system within the development site is set at a minimum depth of cover of 1.2m. This is a conservative estimate and can be reviewed when the duct and cable system have been designed.

The system will discharge to a suitably sized full retention OWI arranged as a Type 1 system with up and downstream isolation points and a downstream sampling chamber.

The OWI will be draining an area of approximately 1660m^2. This corresponds to a Class 1 Full retention NS30 unit (Spel P030/1CSC or similar).

The OWI is not designed to store water from a major leak at the transformer this will be done in the bund by the BWCU pumps but it will treat any runoff that contains oil to a maximum of 5 parts per million.

2.4 Temporary drainage

The Contractor's compound to the northwest of the proposed sub-station development will require temporary drainage and associated attenuation for the duration of its operation.

The compound area is estimated to be 1.265ha in area. Within this compound there will be variety of uses such as cabins, vehicle parking and storage. It should be noted that areas with particular pollution risks such as chemical and fuel storage areas will need to be separately bunded, drained and discharge via a closed system.

2.4.1 Allowable site discharge

Based on the calculated Q_{bar} rate of 4.1l/s/ha noted in Section 1.4, the allowable discharge rate for the compound will be 5.2l/s. It is proposed that the outfall from this system will be to the newly installed drainage outlet for the permanent drainage as shown in Appendix D.

2.4.2 Attenuation provision

Based on the allowable discharge noted above and the total site compound area, the volume of attenuation required for the compound is estimated to be 865m^3 for the 1 in 100-year (1%AEP) event. It is noted that as the compound is a temporary feature that will be removed after construction of the sub-station and therefore with reference to DEFRA's Climate Change Allowance guidance[1] a 25% allowance should be included.

[1] https://environment.data.gov.uk/hydrology/climate-change-allowances/rainfall?mgmtcatid=3088

The general slope of the compound as currently designed is from northwest to southeast, with the southern boundary being lower than the north. Given the topography a combined conveyance and attenuation swale is proposed to the southern boundary with a flow control device located to the southeast corner.

2.4.3 Water quality features

The topography of the compound is conducive to collecting flows as sheet surface runoff directly into the swale. This would not require collection and conveyance systems in the compound provided that the overland flow routes are unobstructed and manageable within he compound.

In this case the sheet flow can be more easily treated than if it were concentrated into a point flow. For note, with spatial planning, features such as the cabins should be located away from the main overland flow routes and could possibly discharge directly to the swales as runoff from the roofs will be much cleaner than runoff form the compound itself.

The use of a swale will provide significant in system water quality benefits, this can be further enhanced with the use of a filter strip between the site compound southern boundary and the swale itself, this is a 1.5m wide grassed strip laid at 1v:40h that will act to catch the majority of sediments as the flow leaves the compound area.

Maintenance of both the swale and the filter strip will comprise general grass cutting throughout the year, with gras a maximum of 250mm cut to 100mm. The swale should be cleared of all arisings from grass cutting and should be scrapped of sediment as required but at least bi-annually.

2.5 Foul drainage

The Overton site lies remote from adopted drainage assets and so will need to provide a site-specific solution for foul flows. Sewer records included in Appendix E.

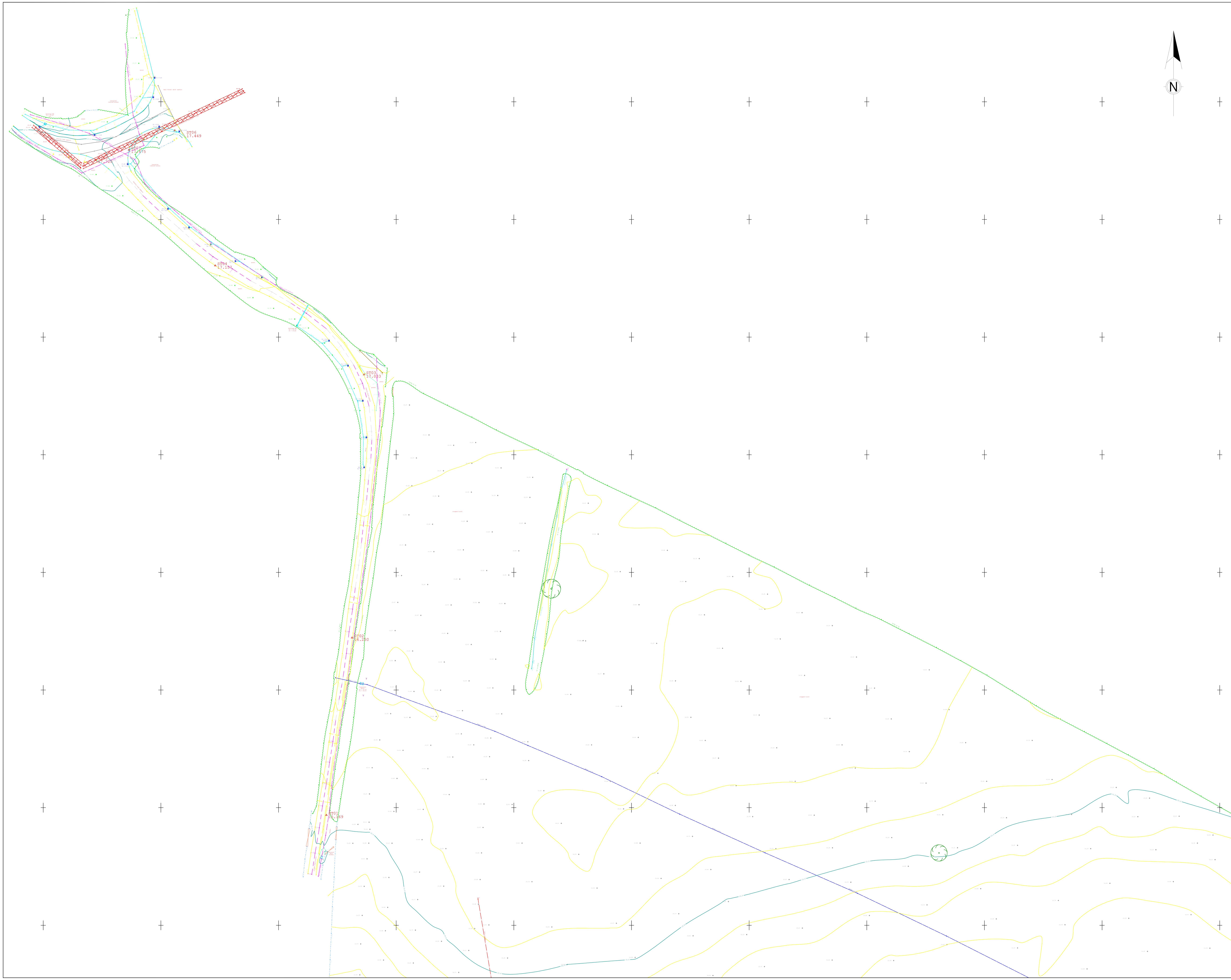
It is assumed that the occupancy of the site is intermittent and for a peak of 5 personnel at any one time.

The likely variation in flow is problematic, and while a package treatment option would provide the highest level of treatment the flow regime may not be suitable for these systems.

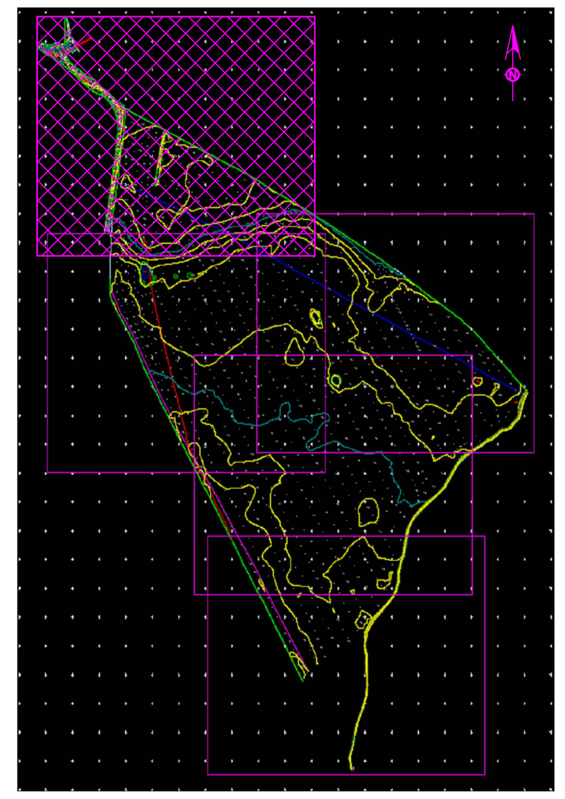
At this stage it is assumed that a sealed cesspit will be provided. To be compliant with Building Regulations Part H (H2 - 1.61) the minimum volume would be 38.4m^3.

With more information on the accurate attendance regime, it may be possible to identify a package treatment plant that could accommodate the flow variation at the next stage.

A. Site topographical survey



KEY PLAN



LEGEND

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Buried Utility Linetypes

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Electricity cable	ELEC
GPR unknown	GPR
Water main	W
Foul water	W
Storm water	W

Overhead Hatching

OHL/Electricity	ELEC
Cables	COMS

150 / 100
Main Pipe Diameter / Incoming Pipe(s) Diameter

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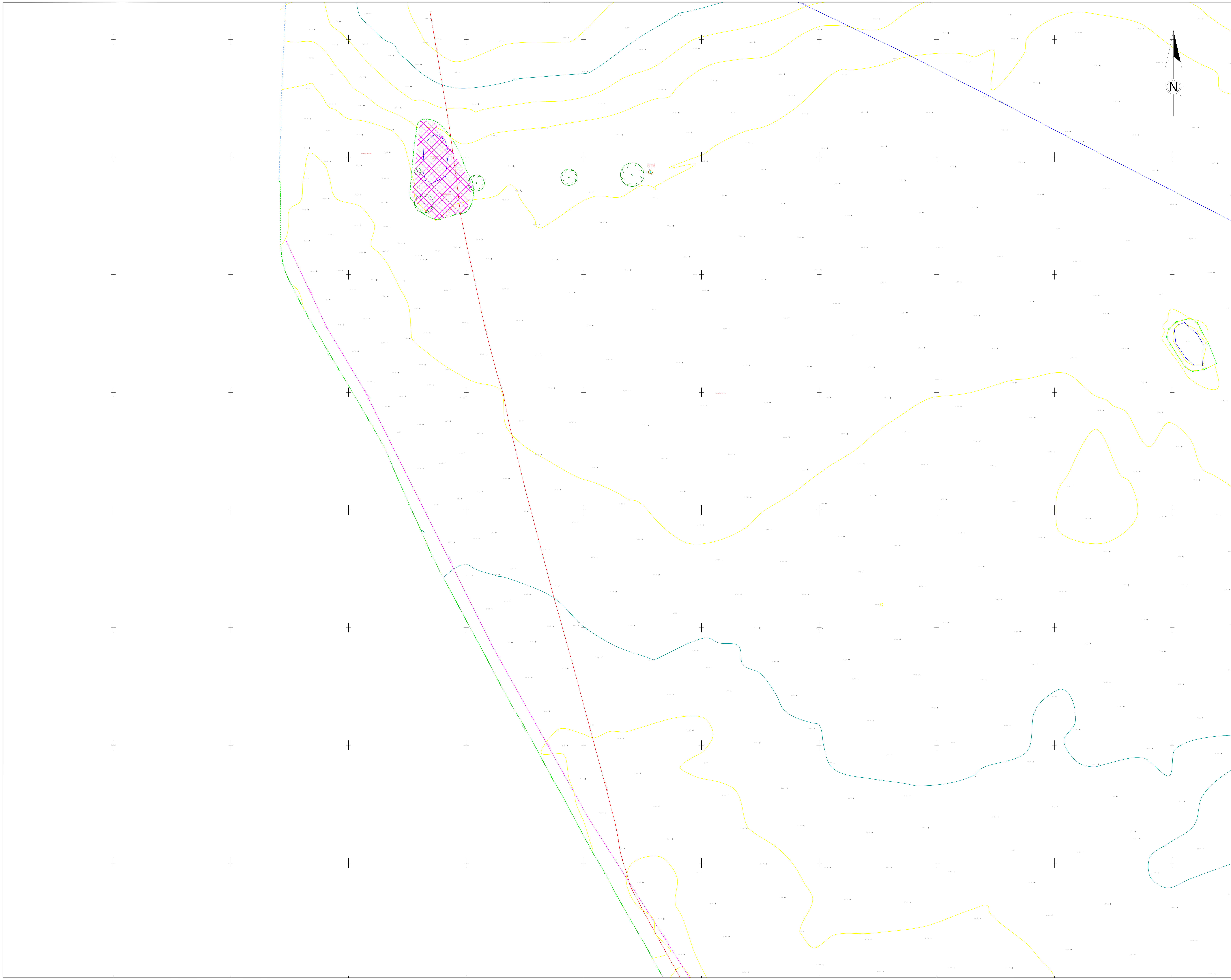
Client: Mott MacDonald Limited

Location: Overton

Type of Survey: Land & Utility Survey

Plotted Scale 1:500 @ A0	Date 22/08/2021
Ref No DES21013_1	QA Checked SV
Drawing No 100	Revision REV1



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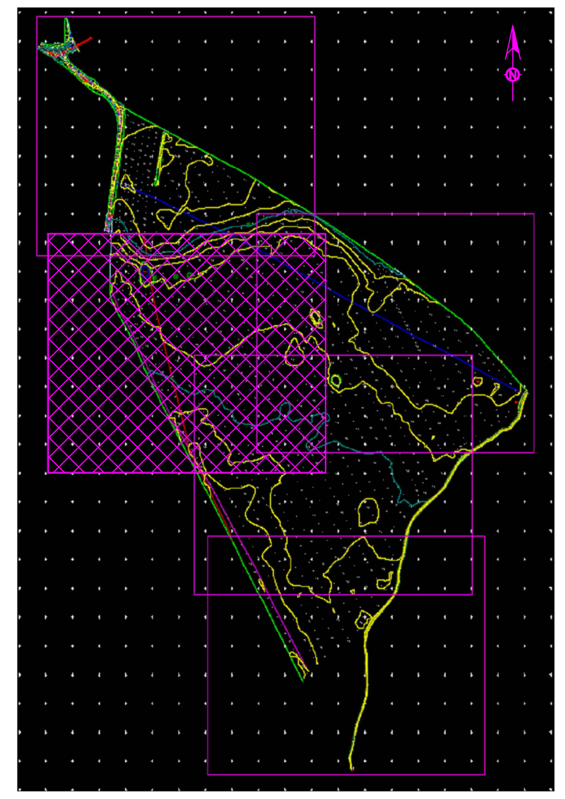

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SC	Stop Cock	Core	Coring Sample
SV	Stop Valve	Tar	Tarmac
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TP	Telegraph Pole	BT	British Telecom
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EB	Electric Box	CATV	Cable Television Inspection Cover

Buried Utility Linetypes

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Electricity cable	ELEC
GPR unknown	GPR
Water main	W
Foul water	W
Storm water	W

Overhead Hatching

OHL/Electricity	ELEC
Cables	COMS

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150 / 100
Main Pipe Diameter / Incoming Pipe(s) Diameter

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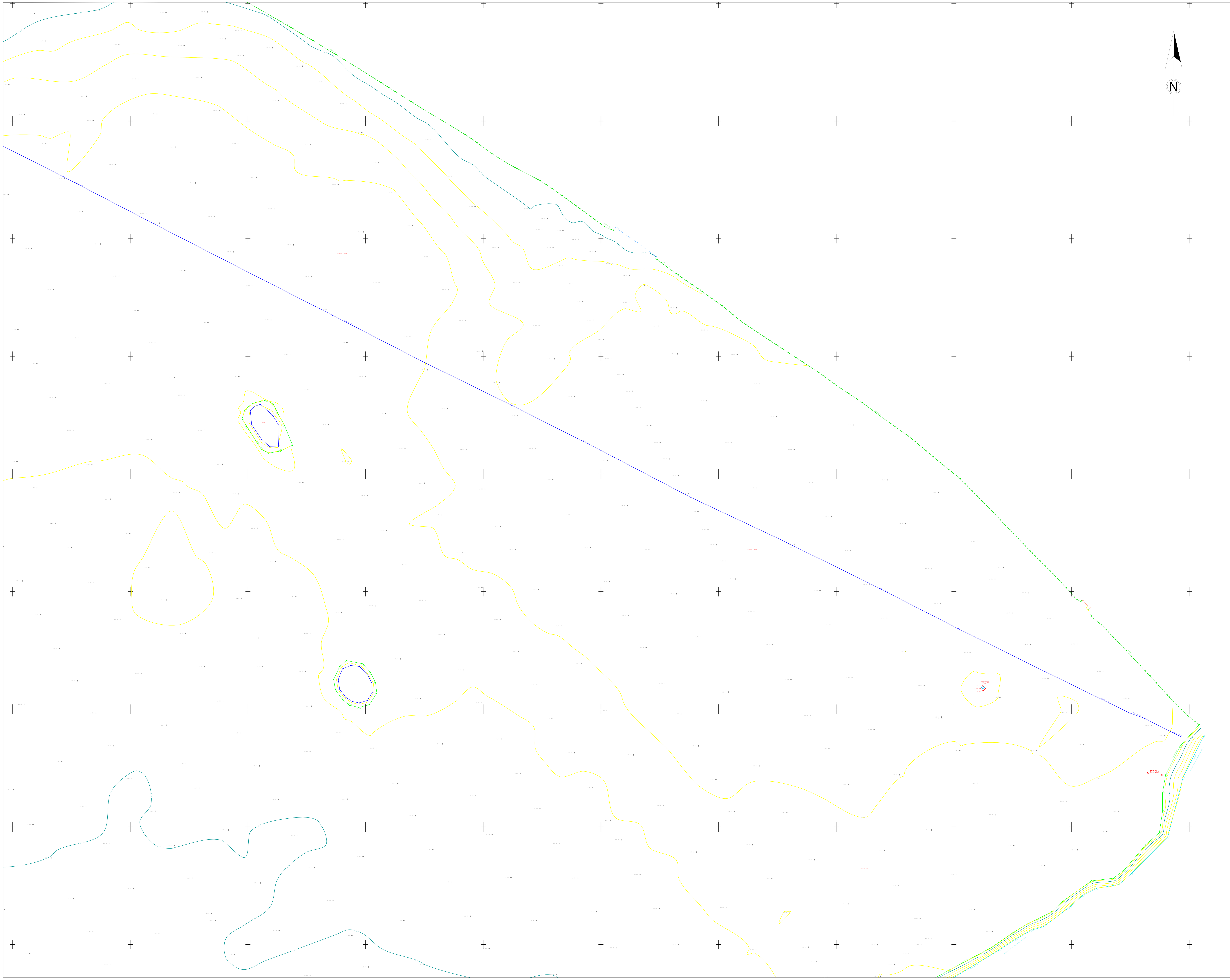
Client	Mott MacDonald Limited
Location	Overton
Type of Survey	Land & Utility Survey
Plotted Scale 1:500 @ A0	Date 22/08/2021
Ref No DES21013_1	QA Checked SV
Drawing No 101	Revision REV1



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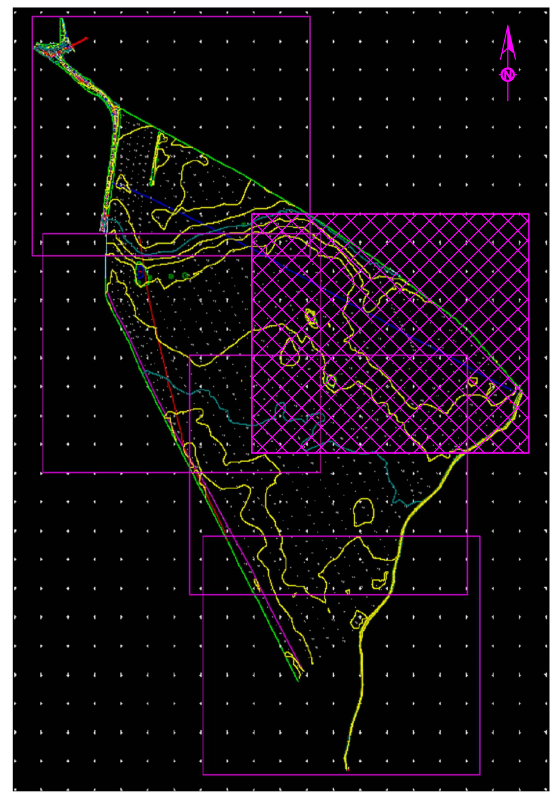

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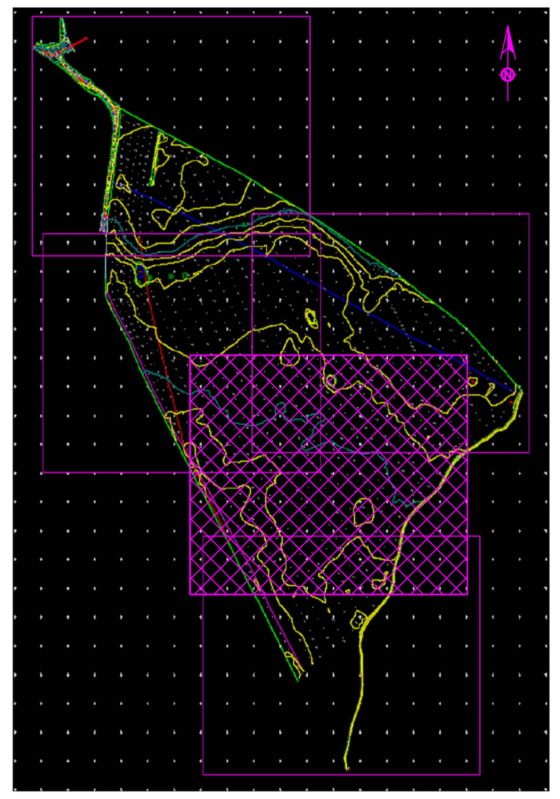
Client: Mott MacDonald Limited

Location: Overton

Type of Survey: Land & Utility Survey

Plotted Scale 1:500 @ A0	Date 22/08/2021
Ref No DES21013_1	QA Checked SV
Drawing No 102	Revision REV1

KEY PLAN



LEGEND

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Buried Utility Linetypes

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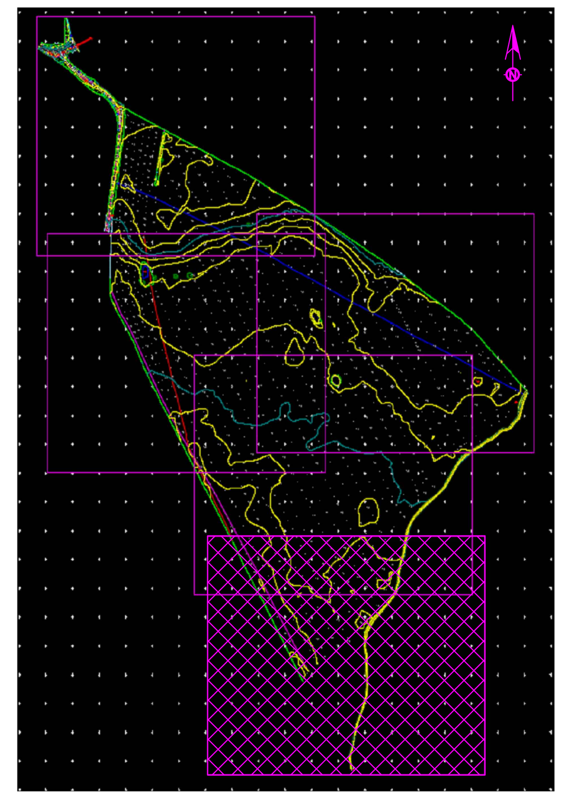
KEY PLAN



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Overhead Hatching

OHL/Electricity	ELEC
Cables	COMS

EART	Earthing Rod
ECB	Electricity Control Box
ES	Electricity Supply
MH	Manholes
IC	Inspection Cover
CL	Cover Level
IL	Invert Level

150 / 100
Main Pipe Diameter / Incoming Pipe(s) Diameter

STATION SCHEDULE

Station	Easting	Northing	Level
ST01	455420.318	457596.864	15.169
ST02	455431.222	457672.223	16.250
ST03	455436.338	457784.091	17.033
ST04	455373.081	457830.404	17.157
ST05	455322.295	457875.353	17.720
ST06	455355.899	457887.814	17.449
ST07	455336.440	457879.585	17.475

Depending on their individual suitability, a variety of detection methods were applied using all reasonable skill and care, in order to obtain the underground information needed to produce these survey results.
Variations in ground conditions, density of services and/or other external influences may affect the accuracy of the data recorded for this non-invasive survey. The detection and accuracy of any subsurface feature detected using non-invasive techniques is not guaranteed.
ALWAYS EXERCISE CAUTION WHEN EXCAVATING.
The definition of an anomalous area is an area where the radar data shows a substantial change in uniform data from its surrounding area. These areas could be voids, heavily saturated ground, buried tanks or other subsurface features.
Unless otherwise stated all coordinates and levels are related to OSGB36 & Newlyn datum by GPS via OSTN15 & OSGM15.
This survey should be read in conjunction with survey report.

Survey record drawings used include:
Combined Utility Input files 2021.05.20.dgn

1. Depths derived via EML are taken to the centre of the conductor (cable, metallic pipe) and those derived via GPR are usually to the crown of the utility unless otherwise indicated. Where drainage levels are taken from the invert of the pipe from above ground level unless confined space is requested on the survey.
2. GPR techniques has been used in the detection of non-metallic utilities as outlined in Table 2 of PAS 128:2014. The interpretation of these results is not infallible and success will depend on a number of factors including soil type, ground water levels and surface conditions.
3. Fibre optic cables are often difficult to detect due to lack of metallic content and access to chambers can be locked and thereby made inaccessible by the utility provider. All reasonable efforts have been made to locate these ducts using tracing rods and GPR.
4. All cable and pipes shown on records not located have been transposed from records and shown as taken from records (TFR).
5. If a utility is incomplete end of trace (EOT) is marked.

QUALITY LEVEL

As laid out in Section 5 of PAS 128:2014 Specification For: Underground Utility Detection Verification and Location.
B2P-Postprocessing=Horizontal+/-250mm,Vertical+/-40% of detected depth. All detected utility aparatus achieved this standard and if less, it would be stated next to the buried utility as appropriate.

3D ENGINEERING SURVEYS LIMITED
sales@3dengineeringsurveys.com
www.3dengineeringsurveys.com
The Cavendish Centre
Winnal Close
Winchester
SO23 0LB
01962 808 462

Client	Mott MacDonald Limited		
Location	Overton		
Type of Survey	Land & Utility Survey		
Plotted Scale	1:500 @ A0	Date	22/08/2021
Ref No	DES21013_1	QA Checked	SV
Drawing No	104	Revision	REV1

B. Greenfield runoff estimate

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Andrew Precious
Site name:	Yorkshire Green
Site location:	Overton

Site Details

Latitude:	53.99546° N
Longitude:	1.15703° W
Reference:	2192416835
Date:	Mar 09 2022 17:28

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach: IH124

Site characteristics

Total site area (ha): 6.17

Methodology

Q_{BAR} estimation method: Calculate from SPR and SAAR

SPR estimation method: Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	605	605
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	25.11	25.11
1 in 1 year (l/s):	21.6	21.6
1 in 30 years (l/s):	43.95	43.95
1 in 100 year (l/s):	52.24	52.24
1 in 200 years (l/s):	59.52	59.52

C. Preliminary attenuation sizing

C.1 Overton Main Site 1% AEP +30%

C.2 Overton Main Site 1% AEP +45%

C.3 Overton Compound 1% AEP +25%

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 2150 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	13.468	0.128	0.0	16.2	16.2	1639.1	O K
30 min Summer	13.512	0.172	0.0	16.9	16.9	2214.8	Flood Risk
60 min Summer	13.559	0.219	0.0	17.6	17.6	2809.5	Flood Risk
120 min Summer	13.605	0.265	0.0	18.2	18.2	3405.3	Flood Risk
180 min Summer	13.631	0.291	0.0	18.6	18.6	3737.6	Flood Risk
240 min Summer	13.648	0.308	0.0	18.8	18.8	3957.2	Flood Risk
360 min Summer	13.669	0.329	0.0	19.1	19.1	4226.4	Flood Risk
480 min Summer	13.683	0.343	0.0	19.3	19.3	4407.5	Flood Risk
600 min Summer	13.692	0.352	0.0	19.4	19.4	4527.9	Flood Risk
720 min Summer	13.699	0.359	0.0	19.5	19.5	4608.8	Flood Risk
960 min Summer	13.705	0.365	0.0	19.6	19.6	4697.1	Flood Risk
1440 min Summer	13.706	0.366	0.0	19.6	19.6	4700.6	Flood Risk
2160 min Summer	13.692	0.352	0.0	19.4	19.4	4531.3	Flood Risk
2880 min Summer	13.678	0.338	0.0	19.2	19.2	4339.5	Flood Risk
4320 min Summer	13.651	0.311	0.0	18.9	18.9	4001.5	Flood Risk
5760 min Summer	13.629	0.289	0.0	18.6	18.6	3718.5	Flood Risk
7200 min Summer	13.609	0.269	0.0	18.3	18.3	3457.4	Flood Risk
8640 min Summer	13.590	0.250	0.0	18.0	18.0	3211.1	Flood Risk
10080 min Summer	13.572	0.232	0.0	17.8	17.8	2977.1	Flood Risk
15 min Winter	13.444	0.104	0.0	15.8	15.8	1340.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	121.269	0.0	1322.2	23
30 min Summer	79.695	0.0	1378.2	38
60 min Summer	49.937	0.0	2736.9	68
120 min Summer	30.267	0.0	2847.1	128
180 min Summer	22.297	0.0	2905.9	186
240 min Summer	17.851	0.0	2940.8	246
360 min Summer	12.957	0.0	2981.2	366
480 min Summer	10.330	0.0	3002.1	486
600 min Summer	8.659	0.0	3012.7	604
720 min Summer	7.492	0.0	3016.3	724
960 min Summer	5.959	0.0	3006.6	962
1440 min Summer	4.309	0.0	2952.5	1440
2160 min Summer	3.110	0.0	5730.6	1864
2880 min Summer	2.466	0.0	5654.7	2228
4320 min Summer	1.775	0.0	5336.7	3028
5760 min Summer	1.405	0.0	7583.3	3856
7200 min Summer	1.171	0.0	7804.5	4680
8640 min Summer	1.008	0.0	7969.2	5448
10080 min Summer	0.889	0.0	8094.7	6256
15 min Winter	121.269	0.0	1289.8	23

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	13.482	0.142	0.0	16.4	16.4	1822.4	O K
60 min Winter	13.520	0.180	0.0	17.0	17.0	2317.5	Flood Risk
120 min Winter	13.559	0.219	0.0	17.6	17.6	2813.7	Flood Risk
180 min Winter	13.580	0.240	0.0	17.9	17.9	3089.1	Flood Risk
240 min Winter	13.594	0.254	0.0	18.1	18.1	3266.6	Flood Risk
360 min Winter	13.611	0.271	0.0	18.3	18.3	3481.7	Flood Risk
480 min Winter	13.622	0.282	0.0	18.5	18.5	3621.6	Flood Risk
600 min Winter	13.629	0.289	0.0	18.6	18.6	3710.2	Flood Risk
720 min Winter	13.633	0.293	0.0	18.6	18.6	3769.1	Flood Risk
960 min Winter	13.637	0.297	0.0	18.7	18.7	3821.3	Flood Risk
1440 min Winter	13.635	0.295	0.0	18.7	18.7	3790.4	Flood Risk
2160 min Winter	13.619	0.279	0.0	18.4	18.4	3590.5	Flood Risk
2880 min Winter	13.604	0.264	0.0	18.2	18.2	3389.0	Flood Risk
4320 min Winter	13.574	0.234	0.0	17.8	17.8	3011.3	Flood Risk
5760 min Winter	13.546	0.206	0.0	17.4	17.4	2646.9	Flood Risk
7200 min Winter	13.519	0.179	0.0	17.0	17.0	2300.6	Flood Risk
8640 min Winter	13.494	0.154	0.0	16.6	16.6	1977.3	Flood Risk
10080 min Winter	13.470	0.130	0.0	16.3	16.3	1677.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	79.695	0.0	1338.3	37
60 min Winter	49.937	0.0	2360.8	66
120 min Winter	30.267	0.0	2734.4	126
180 min Winter	22.297	0.0	2782.4	184
240 min Winter	17.851	0.0	2812.3	242
360 min Winter	12.957	0.0	2844.0	360
480 min Winter	10.330	0.0	2859.9	476
600 min Winter	8.659	0.0	2866.9	592
720 min Winter	7.492	0.0	2865.8	708
960 min Winter	5.959	0.0	2852.6	936
1440 min Winter	4.309	0.0	2793.3	1376
2160 min Winter	3.110	0.0	5389.5	1924
2880 min Winter	2.466	0.0	5309.7	2220
4320 min Winter	1.775	0.0	4990.1	3120
5760 min Winter	1.405	0.0	6256.6	4032
7200 min Winter	1.171	0.0	6427.7	4896
8640 min Winter	1.008	0.0	6547.4	5704
10080 min Winter	0.889	0.0	6627.8	6464

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	1.000
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 6.170

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	3.000	4	8	3.170

Model Details

Storage is Online Cover Level (m) 13.790

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	207.0
Membrane Percolation (mm/hr)	1000	Length (m)	207.0
Max Percolation (l/s)	11902.5	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	13.340	Membrane Depth (m)	0

Orifice Outflow Control

Diameter (m) 0.104 Discharge Coefficient 0.600 Invert Level (m) 12.900

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 2398 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	13.484	0.144	0.0	16.5	16.5	1854.8	O K
30 min Summer	13.534	0.194	0.0	17.2	17.2	2497.3	Flood Risk
60 min Summer	13.586	0.246	0.0	18.0	18.0	3162.5	Flood Risk
120 min Summer	13.638	0.298	0.0	18.7	18.7	3832.8	Flood Risk
180 min Summer	13.667	0.327	0.0	19.1	19.1	4209.0	Flood Risk
240 min Summer	13.687	0.347	0.0	19.4	19.4	4458.0	Flood Risk
360 min Summer	13.711	0.371	0.0	19.7	19.7	4770.2	Flood Risk
480 min Summer	13.728	0.388	0.0	19.9	19.9	4981.8	Flood Risk
600 min Summer	13.739	0.399	0.0	20.0	20.0	5125.9	Flood Risk
720 min Summer	13.747	0.407	0.0	20.1	20.1	5227.2	Flood Risk
960 min Summer	13.756	0.416	0.0	20.2	20.2	5346.6	Flood Risk
1440 min Summer	13.759	0.419	0.0	20.3	20.3	5391.8	Flood Risk
2160 min Summer	13.748	0.408	0.0	20.1	20.1	5238.7	Flood Risk
2880 min Summer	13.733	0.393	0.0	19.9	19.9	5047.5	Flood Risk
4320 min Summer	13.704	0.364	0.0	19.6	19.6	4676.7	Flood Risk
5760 min Summer	13.680	0.340	0.0	19.3	19.3	4372.6	Flood Risk
7200 min Summer	13.659	0.319	0.0	19.0	19.0	4097.7	Flood Risk
8640 min Summer	13.639	0.299	0.0	18.7	18.7	3840.2	Flood Risk
10080 min Summer	13.620	0.280	0.0	18.4	18.4	3593.5	Flood Risk
15 min Winter	13.458	0.118	0.0	16.1	16.1	1521.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	135.261	0.0	1344.7	23
30 min Summer	88.891	0.0	1407.0	38
60 min Summer	55.699	0.0	2805.9	68
120 min Summer	33.759	0.0	2926.4	128
180 min Summer	24.870	0.0	2990.6	186
240 min Summer	19.910	0.0	3030.4	246
360 min Summer	14.452	0.0	3074.9	366
480 min Summer	11.522	0.0	3099.6	486
600 min Summer	9.658	0.0	3112.9	604
720 min Summer	8.357	0.0	3117.8	724
960 min Summer	6.647	0.0	3110.0	964
1440 min Summer	4.806	0.0	3056.0	1442
2160 min Summer	3.469	0.0	5956.3	1972
2880 min Summer	2.750	0.0	5880.3	2308
4320 min Summer	1.980	0.0	5580.4	3072
5760 min Summer	1.567	0.0	8542.9	3912
7200 min Summer	1.306	0.0	8806.4	4688
8640 min Summer	1.125	0.0	9000.5	5536
10080 min Summer	0.991	0.0	9125.9	6352
15 min Winter	135.261	0.0	1309.8	23

Summary of Results for 100 year Return Period (+45%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	13.500	0.160	0.0	16.7	16.7	2060.3	Flood Risk
60 min Winter	13.544	0.204	0.0	17.4	17.4	2616.1	Flood Risk
120 min Winter	13.587	0.247	0.0	18.0	18.0	3172.4	Flood Risk
180 min Winter	13.611	0.271	0.0	18.3	18.3	3483.2	Flood Risk
240 min Winter	13.627	0.287	0.0	18.5	18.5	3686.5	Flood Risk
360 min Winter	13.646	0.306	0.0	18.8	18.8	3937.5	Flood Risk
480 min Winter	13.659	0.319	0.0	19.0	19.0	4102.6	Flood Risk
600 min Winter	13.668	0.328	0.0	19.1	19.1	4212.9	Flood Risk
720 min Winter	13.673	0.333	0.0	19.2	19.2	4286.5	Flood Risk
960 min Winter	13.680	0.340	0.0	19.3	19.3	4365.1	Flood Risk
1440 min Winter	13.680	0.340	0.0	19.3	19.3	4366.1	Flood Risk
2160 min Winter	13.666	0.326	0.0	19.1	19.1	4188.7	Flood Risk
2880 min Winter	13.649	0.309	0.0	18.9	18.9	3974.9	Flood Risk
4320 min Winter	13.618	0.278	0.0	18.4	18.4	3574.0	Flood Risk
5760 min Winter	13.589	0.249	0.0	18.0	18.0	3199.9	Flood Risk
7200 min Winter	13.561	0.221	0.0	17.6	17.6	2840.2	Flood Risk
8640 min Winter	13.534	0.194	0.0	17.2	17.2	2500.1	Flood Risk
10080 min Winter	13.510	0.170	0.0	16.9	16.9	2181.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	88.891	0.0	1362.6	37
60 min Winter	55.699	0.0	2660.6	66
120 min Winter	33.759	0.0	2803.7	126
180 min Winter	24.870	0.0	2858.0	184
240 min Winter	19.910	0.0	2891.0	242
360 min Winter	14.452	0.0	2926.4	360
480 min Winter	11.522	0.0	2946.0	476
600 min Winter	9.658	0.0	2954.3	594
720 min Winter	8.357	0.0	2955.8	710
960 min Winter	6.647	0.0	2943.8	938
1440 min Winter	4.806	0.0	2885.3	1386
2160 min Winter	3.469	0.0	5591.6	2008
2880 min Winter	2.750	0.0	5511.0	2252
4320 min Winter	1.980	0.0	5208.0	3164
5760 min Winter	1.567	0.0	7066.7	4088
7200 min Winter	1.306	0.0	7265.1	4968
8640 min Winter	1.125	0.0	7409.3	5792
10080 min Winter	0.991	0.0	7521.1	6648

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	1.000
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 6.170

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	3.000	4	8	3.170

Model Details

Storage is Online Cover Level (m) 13.790

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	207.0
Membrane Percolation (mm/hr)	1000	Length (m)	207.0
Max Percolation (l/s)	11902.5	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	13.340	Membrane Depth (m)	0

Orifice Outflow Control

Diameter (m) 0.104 Discharge Coefficient 0.600 Invert Level (m) 12.900

Summary of Results for 1000 year Return Period

Half Drain Time : 2474 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	13.506	0.166	0.0	16.8	16.8	2128.5	Flood Risk
30 min Summer	13.566	0.226	0.0	17.7	17.7	2908.9	Flood Risk
60 min Summer	13.629	0.289	0.0	18.6	18.6	3718.7	Flood Risk
120 min Summer	13.691	0.351	0.0	19.4	19.4	4513.2	Flood Risk
180 min Summer	13.724	0.384	0.0	19.8	19.8	4937.2	Flood Risk
240 min Summer	13.745	0.405	0.0	20.1	20.1	5201.1	Flood Risk
360 min Summer	13.768	0.428	0.0	20.4	20.4	5504.2	Flood Risk
480 min Summer	13.784	0.444	0.0	20.6	20.6	5711.3	Flood Risk
600 min Summer	13.853	0.513	0.0	21.4	21.4	5847.7	FLOOD
720 min Summer	13.941	0.601	0.0	22.5	22.5	5935.9	FLOOD
960 min Summer	14.027	0.687	0.0	23.4	23.4	6021.6	FLOOD
1440 min Summer	14.010	0.670	0.0	23.2	23.2	6005.1	FLOOD
2160 min Summer	13.807	0.467	0.0	20.9	20.9	5801.2	FLOOD
2880 min Summer	13.770	0.430	0.0	20.4	20.4	5533.7	Flood Risk
4320 min Summer	13.732	0.392	0.0	19.9	19.9	5035.9	Flood Risk
5760 min Summer	13.701	0.361	0.0	19.5	19.5	4642.2	Flood Risk
7200 min Summer	13.675	0.335	0.0	19.2	19.2	4300.0	Flood Risk
8640 min Summer	13.650	0.310	0.0	18.9	18.9	3988.5	Flood Risk
10080 min Summer	13.628	0.288	0.0	18.6	18.6	3697.2	Flood Risk
15 min Winter	13.476	0.136	0.0	16.3	16.3	1751.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	153.019	0.0	1372.7	23
30 min Summer	102.278	0.0	1447.7	38
60 min Summer	64.742	0.0	2909.5	68
120 min Summer	39.310	0.0	3047.9	128
180 min Summer	28.843	0.0	3117.4	186
240 min Summer	22.960	0.0	3157.7	246
360 min Summer	16.467	0.0	3196.3	366
480 min Summer	13.033	0.0	3218.4	486
600 min Summer	10.859	63.1	3229.1	606
720 min Summer	9.349	151.3	3237.7	724
960 min Summer	7.374	237.0	3240.2	964
1440 min Summer	5.266	220.5	3185.8	1442
2160 min Summer	3.750	16.6	6129.9	2052
2880 min Summer	2.943	0.0	6027.4	2368
4320 min Summer	2.087	0.0	5700.6	3112
5760 min Summer	1.632	0.0	8930.5	3920
7200 min Summer	1.348	0.0	9118.1	4752
8640 min Summer	1.152	0.0	9242.9	5536
10080 min Summer	1.008	0.0	9204.4	6352
15 min Winter	153.019	0.0	1333.9	23

Summary of Results for 1000 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	13.527	0.187	0.0	17.1	17.1	2405.9	Flood Risk
60 min Winter	13.580	0.240	0.0	17.9	17.9	3081.8	Flood Risk
120 min Winter	13.631	0.291	0.0	18.6	18.6	3743.6	Flood Risk
180 min Winter	13.659	0.319	0.0	19.0	19.0	4095.3	Flood Risk
240 min Winter	13.675	0.335	0.0	19.2	19.2	4309.9	Flood Risk
360 min Winter	13.694	0.354	0.0	19.5	19.5	4551.5	Flood Risk
480 min Winter	13.707	0.367	0.0	19.6	19.6	4714.1	Flood Risk
600 min Winter	13.715	0.375	0.0	19.7	19.7	4816.5	Flood Risk
720 min Winter	13.720	0.380	0.0	19.8	19.8	4883.2	Flood Risk
960 min Winter	13.724	0.384	0.0	19.8	19.8	4941.6	Flood Risk
1440 min Winter	13.721	0.381	0.0	19.8	19.8	4901.8	Flood Risk
2160 min Winter	13.703	0.363	0.0	19.6	19.6	4662.8	Flood Risk
2880 min Winter	13.681	0.341	0.0	19.3	19.3	4377.2	Flood Risk
4320 min Winter	13.641	0.301	0.0	18.7	18.7	3871.6	Flood Risk
5760 min Winter	13.607	0.267	0.0	18.3	18.3	3427.1	Flood Risk
7200 min Winter	13.574	0.234	0.0	17.8	17.8	3011.0	Flood Risk
8640 min Winter	13.544	0.204	0.0	17.4	17.4	2624.3	Flood Risk
10080 min Winter	13.516	0.176	0.0	17.0	17.0	2267.4	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	102.278	0.0	1398.0	37
60 min Winter	64.742	0.0	2790.6	66
120 min Winter	39.310	0.0	2910.1	126
180 min Winter	28.843	0.0	2968.7	184
240 min Winter	22.960	0.0	3003.0	242
360 min Winter	16.467	0.0	3034.9	360
480 min Winter	13.033	0.0	3051.0	478
600 min Winter	10.859	0.0	3057.1	594
720 min Winter	9.349	0.0	3054.5	710
960 min Winter	7.374	0.0	3037.4	942
1440 min Winter	5.266	0.0	2967.5	1388
2160 min Winter	3.750	0.0	5742.8	2028
2880 min Winter	2.943	0.0	5642.3	2284
4320 min Winter	2.087	0.0	5317.5	3200
5760 min Winter	1.632	0.0	7388.6	4096
7200 min Winter	1.348	0.0	7523.8	4968
8640 min Winter	1.152	0.0	7612.0	5800
10080 min Winter	1.008	0.0	7669.0	6656

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1000	Cv (Summer)	1.000
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 6.170

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	3.000	4	8	3.170

Model Details

Storage is Online Cover Level (m) 13.790

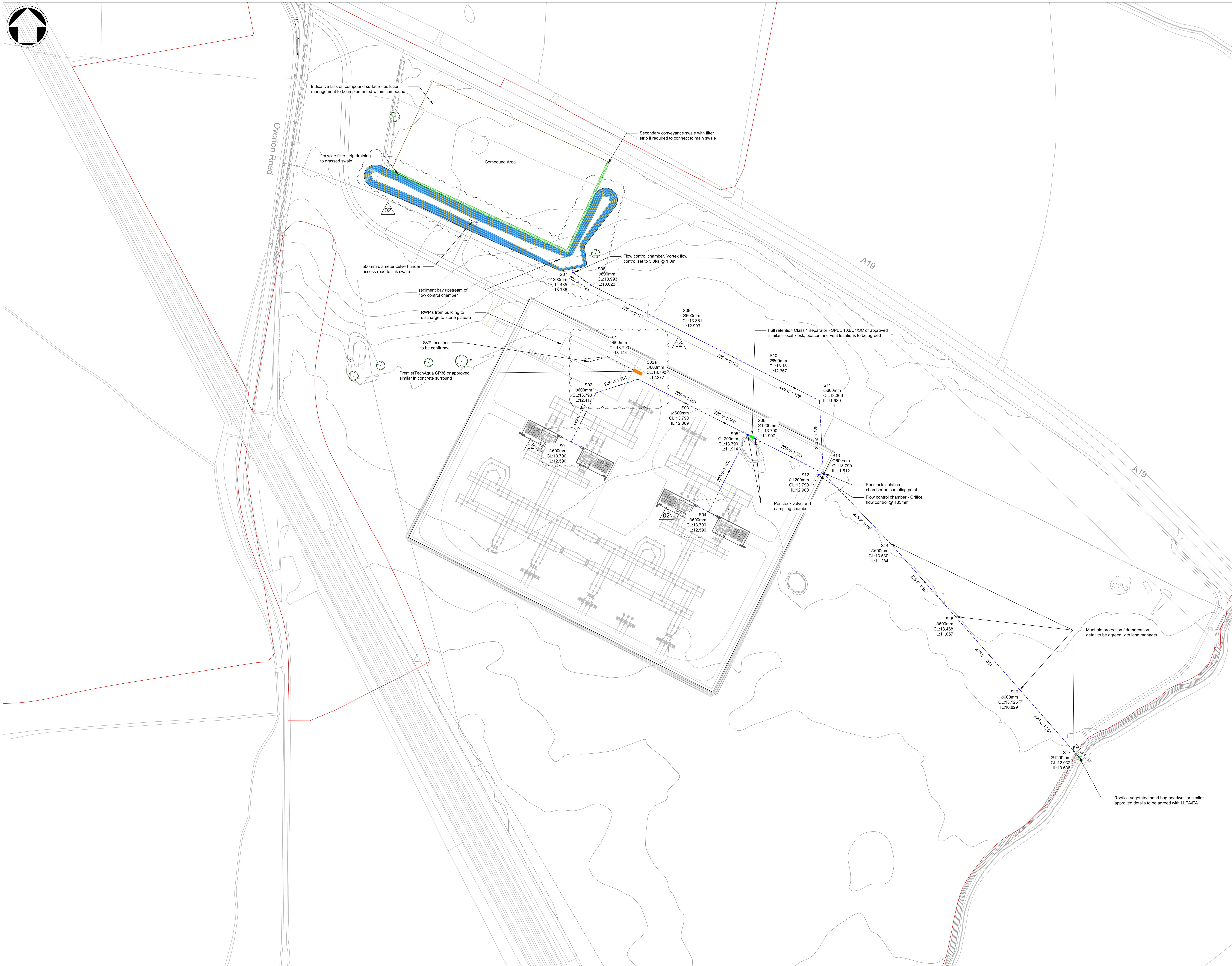
Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	207.0
Membrane Percolation (mm/hr)	1000	Length (m)	207.0
Max Percolation (l/s)	11902.5	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	13.340	Membrane Depth (m)	0

Orifice Outflow Control

Diameter (m) 0.104 Discharge Coefficient 0.600 Invert Level (m) 12.900

D. Proposed drainage masterplan



Notes

1. Do not scale from this drawing.
2. All dimensions are in metres/millimetres unless otherwise stated.
3. This drawing is to be read in conjunction with all relevant documents and drawings.
4. No unauthorised disclosures, storage or copying.
5. All spatial coordinates relate to the Ordnance Survey, British National Grid (OSGB36).
6. All levels are in meters and relate to AOD (Ordnance Survey, Newlyn).
7. For Overton Drainage Strategy refer to document reference PDD-33754-REP-042.
8. This drawing is for development purposes only. Not to be used for construction.

Key to symbols

- Indicative red line boundary
- Proposed surface water drainage
- Proposed foul water drainage
- Proposed full retention class 1 separator
- Proposed cesspool unit
- Proposed alternative surface water drainage

Reference drawings

PDD-33754-LAY-019 Overall Electrical Layout
PDD-33754-LAY-027 Civil Enabling Works GA (Earthworks/Temporary Drainage/Access Road)
PDD-33754-LAY-241 Site Hazard Plan
PDD-33754-LAY-247 Overall Civil Layout
DES21013_1 Topographic/GPR Drawing

Rev	Date	Drawn	Description	Ch'k'd	App'd
02	28/07/2022	CC	PRELIMINARY ISSUE	AJP	PMcL
01	06/04/2022	CC	PRELIMINARY ISSUE	AJP	PMcL

Client

nationalgrid

Master Scheme No:	Sub-Scheme No:	Site:
33754		Overton

Scheme Name: Yorkshire Green

Document Title:

Overton 275kV
Permanent Drainage Layout

Created by:	Date:	Checked by:	Date:	Approved by:	Date:
C Chau	06/04/2022	A Precious	06/04/2022	P McLoughlin	06/04/2022

Development Eng:	Document Type:	Scale:	Format:	Sheet(s):	Rev:
A Precious	Drawing	1:1000	A0	01 of 02	02

National Grid Document Number: PDD-33754-LAY-032

FEED Document Number: 100102545-MMD-01-XX-DR-C-0032

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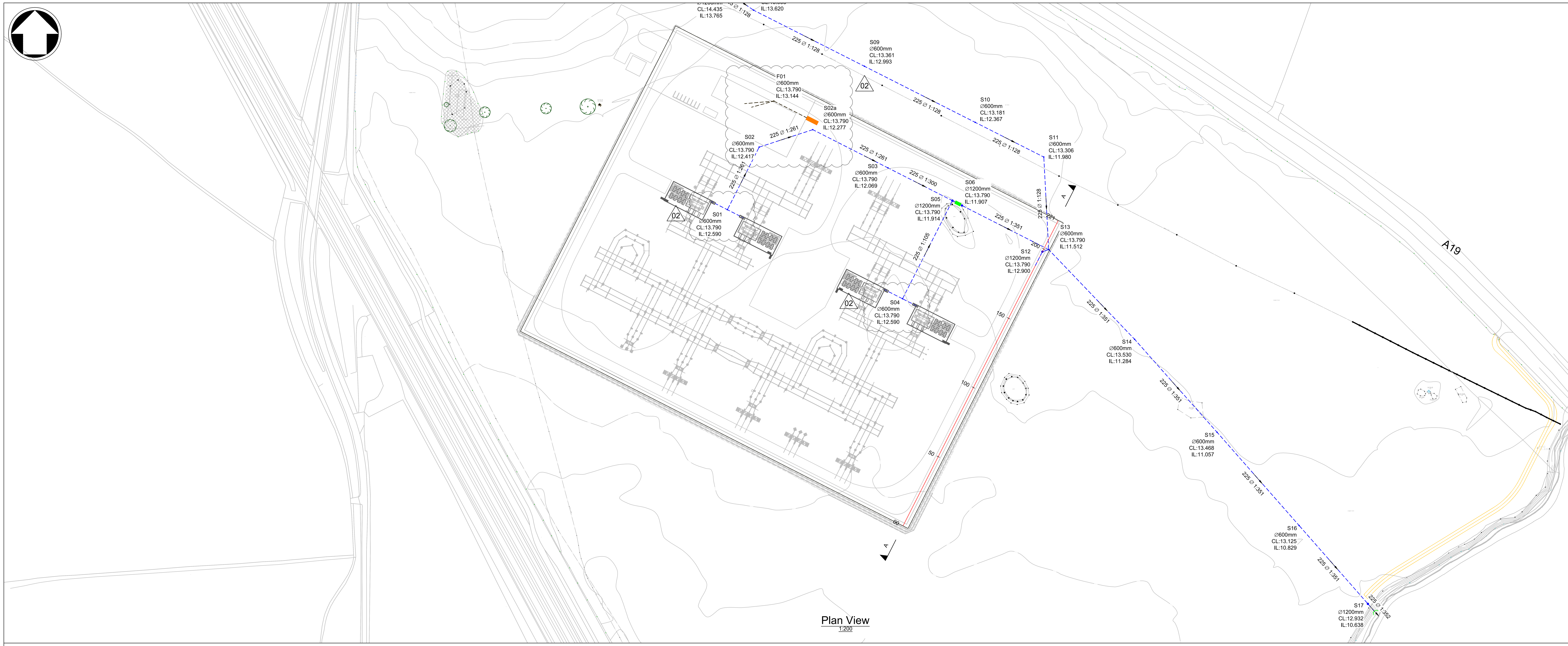

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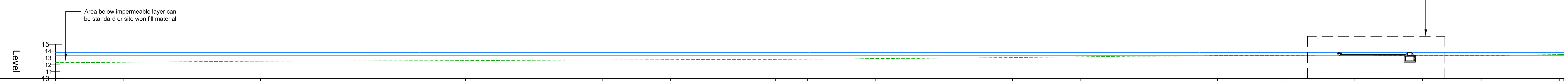
Key to symbols

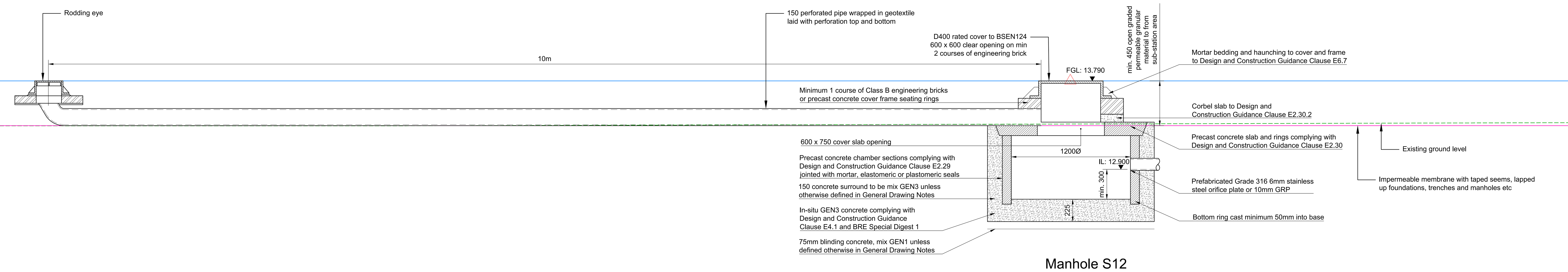
- Proposed surface water drainage
- Proposed foul water drainage
- Proposed full retention class 1 separator
- Proposed cesspool unit
- Proposed alternative surface water drainage

A - A ALIGNMENT - LONGSECTION (1)

SCALE: H 1:250, V 1:250. DATUM: 10.000



CHAINAGE	EXISTING LVLS
	12.349
10.000	12.376
20.000	12.460
30.000	12.527
40.000	12.563
50.000	12.589
60.000	12.620
70.000	12.666
80.000	12.712
90.000	12.756
100.000	12.792
105.359	
110.000	12.824
120.000	12.921
130.000	12.977
140.000	13.066
150.000	13.173
160.000	13.265
170.000	13.366
180.000	13.367
190.000	13.338
200.000	13.361
208.574	
210.000	13.391
220.000	13.506 13.500



Manhole S12

Scale 1:20

Reference drawings

PDD-33754-LAY-019 Overall Electrical Layout
PDD-33754-LAY-027 Civil Enabling Works GA (Earthworks/Temporary Drainage/Access Road)
PDD-33754-LAY-241 Site Hazard Plan
PDD-33754-LAY-247 Overall Civil Layout
DES21013_1 Topographic/GPR Drawing

Rev	Date	Drawn	Description	Ch'k'd	App'd
02	28/07/2022	CC	PRELIMINARY ISSUE	AJP	PMcL
01	27/05/2022	CC	PRELIMINARY ISSUE	AJP	PMcL

Client

nationalgrid

Master Scheme No:	Sub-Scheme No:	Site:
33754	TBC	OVERTON 275 kV

Scheme Name: YORKSHIRE GREEN

Document Title:

Overton 275kV Manhole S12 Profile

Created by:	Date:	Checked by:	Date:	Approved by:	Date:
C Chau	27/05/2022	A J Precious	27/05/2022	P McLoughlin	27/05/2022

Development Eng:	Document Type:	Scale:	Format:	Sheet(s):	Rev:
A J Precious	DRAWING	As Shown	A0	02 of 02	02

National Grid Document Number: PDD-33754-LAY-032

FEED Document Number: 100102545-MMD-01-XX-DR-C-0032

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E. Yorkshire Water sewer records

YORKSHIRE WATER
PROTECTION OF MAINS AND SERVICES

1. The position of Yorkshire Water Services Ltd (YWS) apparatus shown on the existing mains record drawing(s) indicates the ***general*** position and nature of our apparatus and the accuracy of this information cannot be guaranteed. Any damage to YWS apparatus as a result of your works may have serious consequences and you will be held responsible for all costs incurred. Prior to commencing major works, the exact location of apparatus must be determined on site, if necessary by excavating trial holes. The actual position of such apparatus and that of service pipes which have not been indicated must be established on site by contacting the Customer Helpline on 0845 124 24 24 for both water and sewerage.

2. The public sewer and water network is lawfully retained in its existing position and the sewerage and water undertaker is entitled to have it remain so without any disturbance. The provisions of section 159 of the Water Industry Act 1991 provides that the undertaker may "inspect, maintain, adjust, repair or alter" the network. Those rights are given to enable the undertaker to perform its statutory duties. Any development of the land or any other action that unacceptably hindered the exercise of those rights would be unlawful. The provisions contained in Section 185 of the Water Industry Act 1991 state that where it is reasonable to do so, a person may require the water supply undertaker to alter or remove a pipe where it is necessary to enable that person to carry out a proposed change of use of the land. The provisions contained in Section 185 also require the person making the request to pay the full cost of carrying out the necessary works.

3. Ground levels over existing YWS apparatus are to be maintained. Sewers in highways will ***generally*** be laid to give 1200mm of cover from finished ground level working to kerb races, other permanent identification of the limits of the road or to an agreed line and level. Substantial increases or decreases to this 1200mm depth of cover will result in the sewer being re-laid at your expense. Water mains and services will ***generally*** be laid with a minimum of 750mm depth of cover however some mains and services usually those installed over 50 years ago may have less ground cover.

4. If surface levels are to be decreased / increased significantly the effects on existing water supply apparatus will be carefully considered and if any alterations are necessary, the costs of the alterations will be recharged to you in full. Outlets on fire hydrants must be no more than 300mm below the new levels and all surface boxes must be adjusted as part of the scheme.

5. To enable future repair works to be carried out without hindrance; any pipe, cable, duct, etc. installed parallel to a water main or service pipe should not be installed directly over or within 300mm of a water main or service pipe or 1000mm of a waste water asset. Where a pipe, cable, duct, etc. crosses a main or service it should preferably cross perpendicular or at an angle of no less than 45o and with a minimum clearance of 150mm. These requirements apply to activities within an existing highway and are relevant to the installation of pipes, cables, ducts, etc. up to and including 250mm in diameter *(see illustration below).* Necessary protection measures for installations greater than 250mm in diameter and/or in private land will need to be agreed on an individual basis. Installations within a new development site must comply with the National Joint Utilities Group publication Volume 2: NJUG Guidelines On The Positioning Of Underground Utilities Apparatus For New Development Sites.

6. All excavation works near to YW apparatus should be by hand digging only.

7. Backfilling with a suitable material to a minimum 300mm above YW apparatus is required.

8. Adequate support must be provided where any works pass under YW apparatus.

9. Jointing chambers, lighting columns and other structures must be installed in such a way that future repair or maintenance works to YW apparatus will not be hindered.

10. Apparatus such as; railings, sign posts, etc. must not be placed in such a way that they prevent access to or full operation of controlling valves, hydrants or similar apparatus. YWS surface boxes must not be covered or buried. Any adjustment, alteration or replacement of manhole covers must be agreed on site prior to the commencement of the works with a YWS Inspector who may be contacted via our Call Centre on 0845 124 24 24.

11. Explosives shall not be used within 100 metres of any Yorkshire Water Services apparatus or installations.

12. Vibrating plant should not be used directly over any apparatus. Movement or operation by vehicles or heavy plant is not to be permitted in the immediate vicinity of YWS plant or apparatus unless there has been prior consultation and, if necessary, adequate protection provided without cost to YWS.

13. ***Under no circumstances*** should thrust boring or similar trenchless techniques commence until the actual position of the Company's mains/services along the proposed route have been confirmed by trial holes.

14. Any alterations to the highway should be notified following the procedures outlined in the New Road and Street Works Act 1991 Code of Practice; Measures Necessary Where Apparatus Is Affected By Major Works (Diversionary Works).

15. You will be held responsible for any damage or loss to YWS apparatus during and after completion of work, caused by yourselves, your servant or agent. Any damage caused or observed to YWS plant or apparatus should be immediately reported to YWS. Should YW incur any costs as a result of non-compliance with the above, all costs will be rechargeable in full.

16. You should ensure that nothing is done on the site to prejudice the safety or operation of YWS employees, plant or apparatus.

17. In accordance with the New Roads and Street Works Act 1991, Chapter 22, Part 3, Section 80. The location of any identified YW asset "*which is not marked, or is wrongly marked, on the records made available*" should be communicated back to Yorkshire Water. The location of the apparatus should be identified on copies of the supplied plans which should be returned to Yorkshire Water (Asset Records Team) with photographic supporting evidence where possible.

18. The Government has decided that responsibility for private sewers serving two or more properties and lateral drains (the section of pipe beyond the boundary of a single property, connecting it to the public sewer) will be transferred to the water companies on Oct 1 2011.

Private pumping stations will also transfer during the period 1 October 2011 – 1 Oct 2016. Records of these assets may not yet be shown on the existing mains record drawing(s). If you encounter any of these assets you must inform Yorkshire Water Services Ltd (YWS).

19. Please note that the information supplied on the enclosed plans is reproduced from Ordnance Survey material with the permission of the Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office, © Crown Copyright. Unauthorised reproduction infringes Crown Copyright and may lead to prosecution or civil proceedings. Licence Number 1000019559.

20. This information is for guidance only and the position and depth of any YW apparatus is approximate only. Likewise, the nature and condition of any YW apparatus cannot be guaranteed. YW has no responsibility for recording the locations of privately owned apparatus. As of 1 October 2011, there may be some lateral drains and/or public sewers which are not documented on YW records but may still be present. For the avoidance of doubt, this information is not a substitute for appropriate professional and/or legal advice. YW accepts no responsibility for any inaccuracy or omissions in this information. The actual position of YW apparatus must be determined on site by excavating trail holes by hand. YW requires a minimum of two working days' written notice of the intention to excavate any trial holes before any excavation can be undertaken. If there are any queries in this respect please contact Yorkshire Water on 0845 124 24 24.

Property Identfier

or +

Sewer Legend

Combined Sewer

S24 Combined Sewer

Surface Water Sewer

S24 Surface Water Sewer

Foul Sewer

S24 Foul Sewer

Section 104 Sewer

Rising Main

Overflow Sewer

Abandoned Sewer

Syphone Sewer &
Vacuum Sewer

Pumping Station

STW Public Sewer Tretment Works

Water Legend

Water Main 4" and below

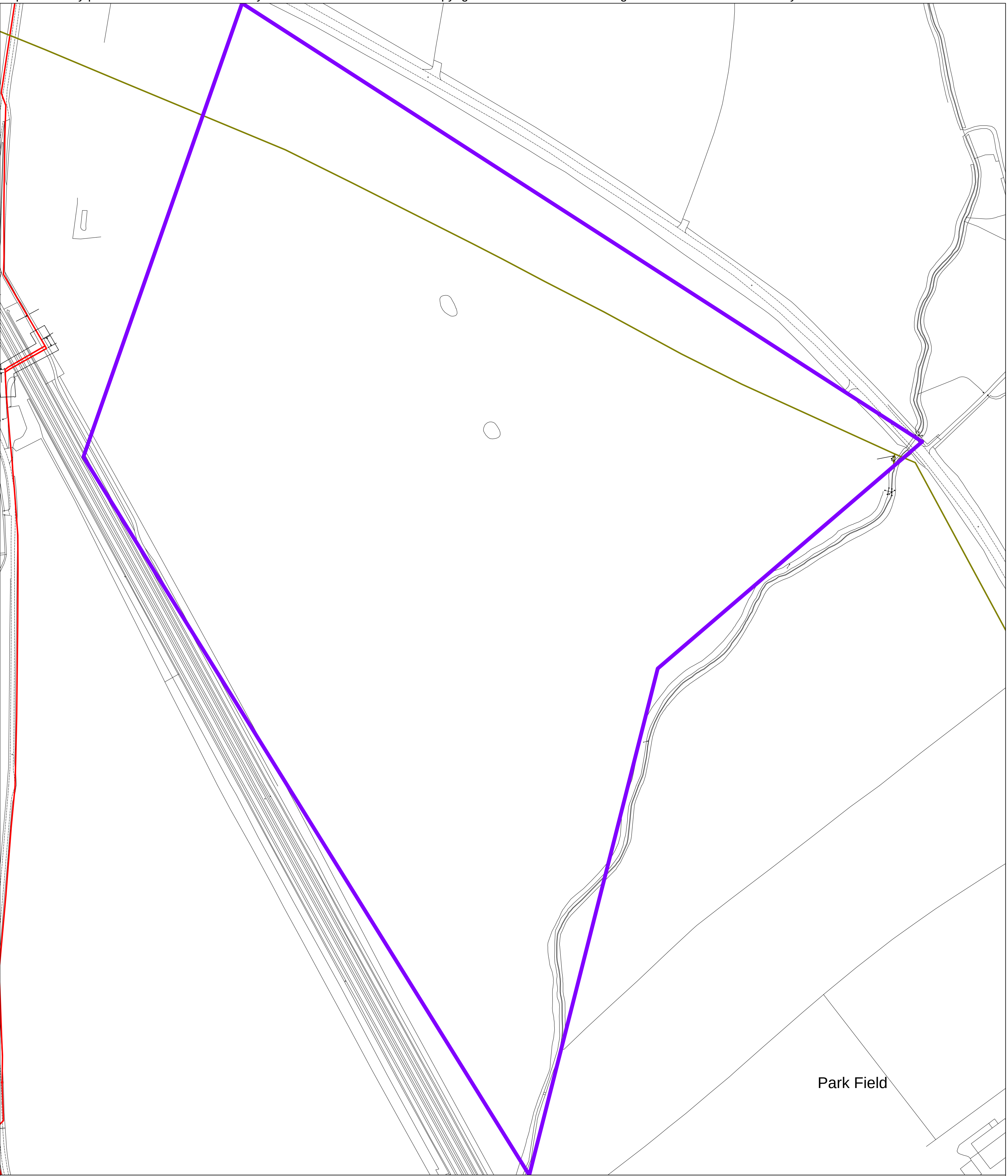
Water Main 4" and above

Raw Water Main

Private Water Main

Fire Hydrant

Pumping Station



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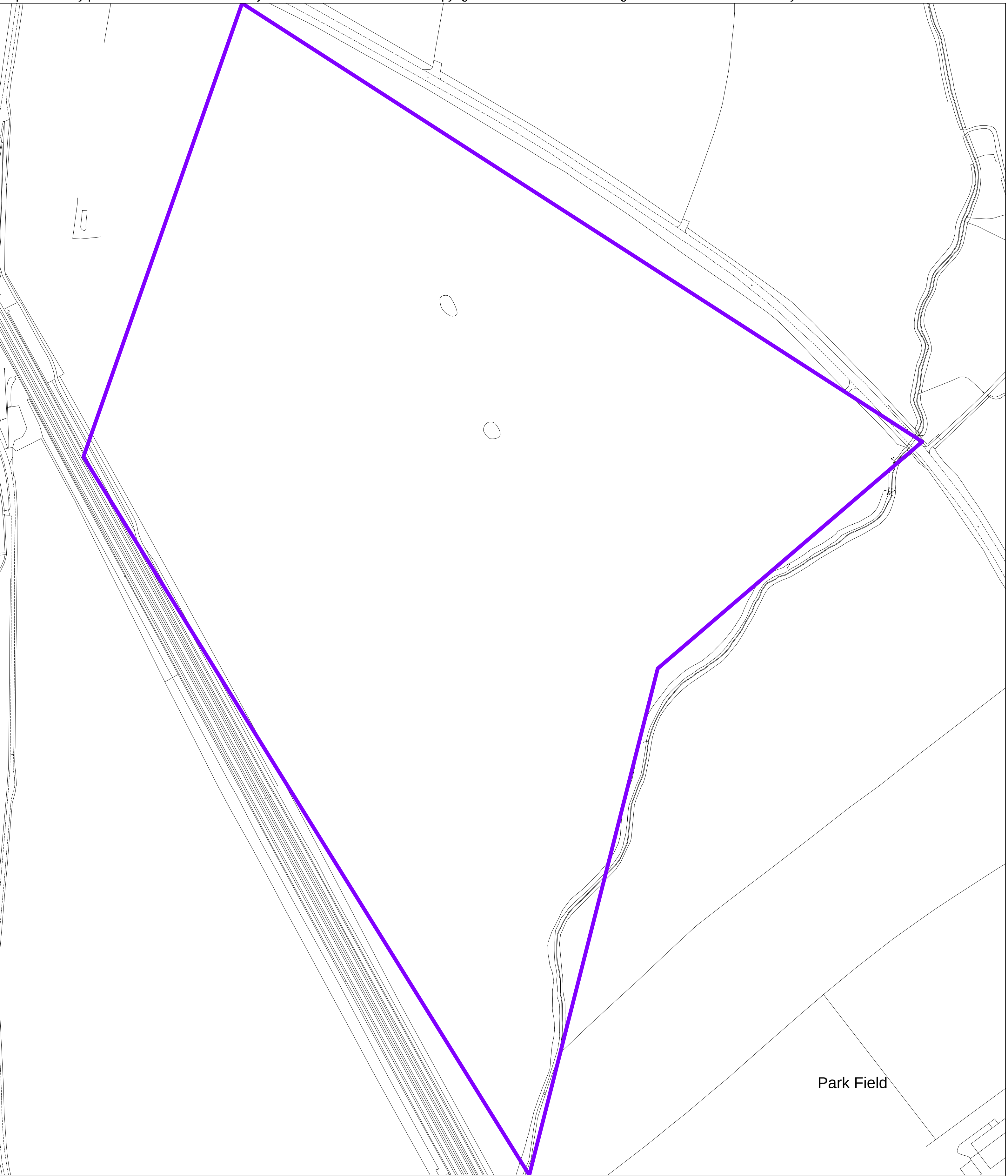

Public Waste Water Network 05/04/2022 17:08:26 OS Grid Coordinates: 455415 : 456659 Map Name : SE5556NW svcGISSafeMovePD mottmac.com

Annex 9D.6
Monk Fryston – Drainage Strategy

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MOTT MACDONALD

Yorkshire Green Project Monk Fryston Site

Drainage Strategy

April 2022

Mott MacDonald
4th Floor
Derwent House
150 Arundel Gate
Sheffield S1 2JY
United Kingdom

T +44 (0)114 2761242
mottmac.com

National Grid

Yorkshire Green Project
Monk Fryston Site

Drainage Strategy

April 2022

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	20 April 2022	A Precious	A I Ruiz-Diaz	P McLoughlin	
B	03 August 2022	A Precious			

Document reference: 100102545-MMD-02-XX-RP-C-0085

Information class: Standard

Contents

1 Introduction

This report sets out the drainage criteria, subsequent drainage strategy and current stage design of the drainage system for the proposed Monk Fryston site as part of the Yorkshire Green Project.

It is noted that the development site is an extension to an existing operational National Grid (NG) site and that upon completion the site will be one linked site.

1.1 Existing site

The Monk Fryston site is located approximately 2km west of the settlement of Monk Fryston

The approximate site grid reference is 448632E, 429100N.

The topography of the development site is captured on the topographical survey included as Appendix A. The survey shows that the site has a slope of around 1v:130h from north to south-west with high level to the north of 37.7mAOD sloping to levels of 35.0mAOD in the south-west.

There are two large bunds on the boundary of the existing site which are to be removed to facilitate the development.

1.2 Existing site drainage regime

The location of the proposed development is currently in use as agricultural land and is anecdotally noted to be drained by sub-surface drainage. The extent, nature and outfall of this system is not known and no formal records have been uncovered to date.

site information indicates that the site is underlain by topsoil (0.3 to 0.9m thick) on Alne Formation deposits (glaciolacustrine deposits). These lower deposits are considered to be relatively low permeability soils.

Site testing of the strata across the site has indicated a very low information potential.

Site information also indicates that groundwater may be in the order of 5.0 to 17.5m below ground level.

Schematic drainage plans for the site to the west, show that this is drained via a piped system to the southwest corner. Here there is a pump station which lifts flow to join a historic offsite piped connection which discharge, via a soakaway of unknown size and performance, to a drainage ditch further to the southwest.

Other than the schematic information none of the existing site drainage information has been verified at this stage.

1.3 Proposed development

The proposed new substation covers an area of approximately 83,500m^2 (8.35 hectares) which includes a flat northern portion measuring 41,400m^2 and a sloping southern area with access road measuring 42,100m^2.

The southern area has a section with a gradient of approximately 1v:70h sloping to the southern boundary and the access road therein.

The site development comprises transformer bunds, duct routes, electrical equipment, access roads and a site control building.

The control building will require its own foul drainage provision.

1.4 Design criteria

The site has FSR (Flood Studies Report) characteristics of:

- M5-60 = 19.00
- Ratio R = 0.400

A conservative C_v value for the volumetric runoff has been used in accordance with industry best practice as all rainfall will be deposited on the site directly a value of 0.95 has been used.

It is noted that the online greenfield estimate tool and the MicroDrainage source control module the soil data maps indicate more permeable soils with soil classification of SPR = 0.1 and SOIL = 0.15 respectively. However, the Geotechnical Parameters Technical Note describes less permeable strata for a significant depth on the site (Alne formation), it is considered that the soil maps may not represent fully the observed site conditions and that the soil classification may be less permeable than shown on the mapping. As such a modified value of SPR = 0.3 has been included in the Q_{bar} calculation in Appendix B.

The total site area of 8.35ha yields an equivalent greenfield runoff rate (Q_{bar}) of 12.93l/s (see Appendix B) using the ICOP SuDS method (1.54l/s/ha).

Site testing has demonstrated that infiltration will not be viable for this development.

The drainage design will be carried out with reference to the National Grid Standards TS_2.10.09 (site drainage) and TS_2.10.01 (Oil Containment) and Building Regulations Part H where appropriate.

The drainage systems will be designed for 1% Annual Exceedance Probability (AEP) event with a 30% allowance for climate change, with a check made for the performance for the systems for 45% climate change in accordance with DEFRA guidance[1] and for the 0.1%AEP event.

[1] https://environment.data.gov.uk/hydrology/climate-change-allowances/rainfall?mgmtcatid=3001

2 Proposed design strategy

The nature of the proposed topography on the new site will be the principal driver of the drainage strategy. The site is effectively split in two areas, the flatter north and the sloping south. As the strategy will differ between the two areas they have been addressed separately below.

2.1 Outfall locations

The natural topography of the area is a slope from northeast to southwest, this corresponds to the outfall location of the existing site which ultimately discharges to the drain/ditch to the southwest of the site.

For the proposed development site, the formation of the tie in levels and the presence of a separate development to the south prevents an independent outfall for the new development being constructed and it is necessary to match the outfall strategy of the existing site to the existing ditch.

If possible, it is proposed to utilise the same offsite connection to the ditch. This is subject to survey of the existing assets to the outfall and approval of the connection by the Lead local Flood Authority (LLFA).

2.2 Allowable site discharge

2.2.1 North site

The level plateau formed for the north site at a level of 37.5mAOD and covers an area of 4.140ha. The associated level formation is conducive to the use of infiltration-based systems, even where the residual infiltration is very low. The large plan area available and the depth of ballast will optimise the residual infiltration rate and available storage volume.

However, as infiltration has been proven to be unsuitable for the discharge of large volumes of runoff, it will be necessary to provide a positive discharge from the new part of the site via a controlled connection to the existing site drainage system.

The Q_{bar} runoff from this area will be (4.14 x 1.54) = 6.4l/s.

2.2.2 South site

The sloping nature of the site will induce flow to the southern boundary of this area and so residual infiltration will be ineffective at the formation layer of the granular material.

As such the area will need to be treated like a drained impermeable area albeit with the flow at a sub-surface level.

The Q_{bar} runoff from this area will be (4.21 x 1.54) = 6.5l/s.

2.2.3 Transformers

It is noted that a separate drainage system will be required for the areas of the site identified by TS_2.10.01 as pollution risk locations – principally the transformers. These will be drained via Bund Water Control Units (BWCU) (oil discriminating pumps) to a segregated piped system that passes through an Oil Water Interceptor (OWI). The nature of these systems is that they will be between 900mm and 1.2m below ground.

Flow rates from the BWCU's are typically between 1-2l/s per pump with the bund on each transformer acting as local rainfall attenuation.

The transformers to the north of the site are proposed to discharge via gravity to an existing manhole located to the east of the proposed transformer location noted as MH C102 on schematic records.

This drain already discharges via an OWI to the existing site systems and it is considered that the small increase in flows of 2.0l/s will not negatively impact on the performance of the existing site system.

For the south area the transformers will be drained to a new gravity system and new OWI. At the outlet, the discharge will be pumped again to the flow control chamber on the south site attenuation where it will join the attenuated 'clean' flow.

2.3 Attenuation provision

2.3.1 North site

The majority of the 4.14ha of the northern site should be available as passive storage for the proposed site. At this stage it is assumed that 80% of the area will be available as active storage equating to an area of approximately 3.31ha.

The granular material is assumed to have a void ratio of 30% (this is a conservative estimate), the base should be left unlined to promote infiltration but it has not been included in the attenuation assessment.

Based on this data, for the 1 in 100-year +45% climate change scenario, the peak depth of water in the sub-base would be 430mm and would generate approximately 4,265m^3 of storage.

To mobilise this attenuation volume, the southern boundary of the north site would require an impermeable membrane to be installed vertically at the interface of the flat and sloping parts of the site. The sub-base will need to be interconnected below the site access road to mobilise the full area for attenuation.

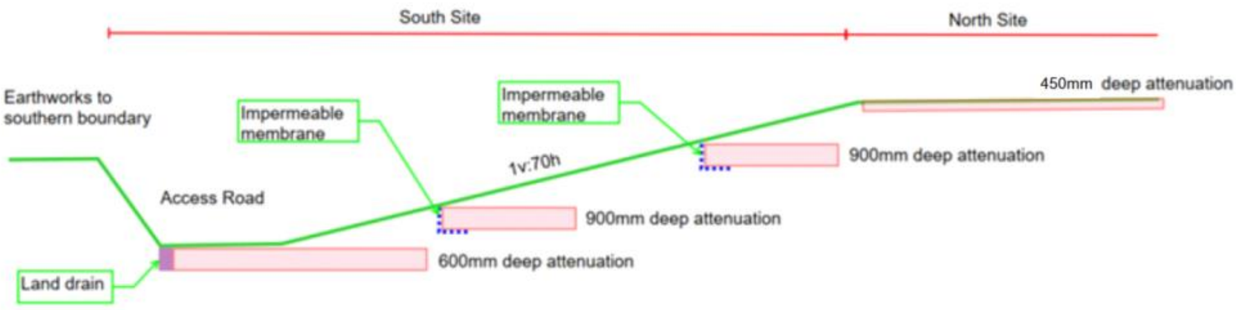
2.3.2 South site

This area is bound by significant earthworks required to create the level access to the existing site. This effectively creates a basin along the southern boundary with the ground levels rising at 1v:70h from the boundary.

The sloping nature of the site will limit the available volume in the sub-base for storage at the low spot.

However, the use of terraced storage could be implemented to optimise additional dig while maximising attenuation on the site, this is shown schematically in Figure 2.1 below.

Figure 2.1: Schematic attenuation section



Source: MM 2022

The terraces would be formed by extending the excavation of the granular material back into the slope to create a flat attenuation feature. These features mobilise between 600 and 900mm of storage in each location with each feature drained using an independent flow control device set to 2.1l/s. The flow is mobilised by using an impermeable membrane on the southern face of each area to prevent water flowing through the sub-base to the south of the site.

There would be a new collector drain on the western edge of the development, along the existing site access road to pick up these flows.

The outlet from this system will drain to the existing offsite discharge point at a level of approximately 33.03mAOD. The pipe from the site to this connection will be laid effectively flat, however as this is downstream of the flow control device and given the silt management upstream of this point, self-cleansing velocities are not as critical in this section of pipework.

Calculations for these areas are included in Appendix C with the general arrangement shown on the separately issued drawings 100102545-MMD-02-XX-DR-C-0075 Sheet 1 and Sheet 2.

2.4 Oily water system

Runoff from the transformer oil retention areas (bunds) will need to be treated by an OWI before leaving the development site.

This will require a positively drained, piped system and BWCU's on each of the 4 transformers.

As noted previously, the BWCU and the associated transformer bund will provide flow control and local attenuation for rainfall events and so this system does not require additional inline attenuation.

In order to avoid duct and cable trenches on the site, at this stage the piped system within the development site is set at a minimum depth of cover of 1.2m. This is a conservative estimate and can be reviewed when the duct and cable system have been designed.

The system will discharge to a suitably sized full retention OWI arranged as a Type 1 system with up and downstream isolation points and a downstream sampling chamber.

The transformers to the north are to discharge to existing manhole C102 which drains via an existing oil separator.

The transformers to the south comprise and area of approximately 830m^2 and will be draining an area of approximately 1660m^2. This corresponds to a Class 1 Full retention NS30 unit (Spel P030/1CSC or similar).

The OWI is not designed to store water from a major leak at the transformer, this will be done in the bund by the BWCU pumps but it will treat any runoff that contains oil to a maximum of five parts per million.

2.5 Land Drain

A land drain is proposed at the toe of the cutting forming the southern boundary of the site, this is to prevent runoff and silt contaminating the permeable sub-base of the sub-station plateau.

The land drain will be formed using a lined granular trench with a 200mm sacrificial layer of granular material at the surface, a geotextile wrapped perforated pipe will be laid 50mm above the bottom of the trench and will eb connected to intermittent catchpits along the run and on the outlet form the system. This robust silt management provision will prevent silts from migrating through the system.

The sacrificial layer on top of the filter drain should be replaced every 10-15 years.

2.6 Temporary compound drainage

The Contractor's compound to the north of the proposed sub-station development will require temporary drainage and associated attenuation for the duration of its operation.

The compound area is estimated to be 1.265ha in area. Within this compound there will be variety of uses such as cabins, vehicle parking and storage. It should be noted that areas with particular pollution risks such as chemical and fuel storage areas will need to be separately bunded, drained and discharge via a closed system.

2.6.1 Allowable site discharge

Based on the calculated Q_{bar} rate of 1.54l/s/ha noted in Section 1.4, the allowable discharge rate for the compound will be 2.0l/s. This flow rate will be very difficult to provide in an operable system as the diameter of the flow control would be too small.

Given this, a flow control with a minimum diameter of between 50-75mm is proposed which would reduce flows to between 2.0 to 3.0l/s.

Infiltration has been proven to be unsuitable for the discharge of large volumes of surface water runoff.

It is proposed that the positive outfall from this system will require a temporary pumping arrangement to discharge flows to the existing site drainage system to the south as shown in Appendix A and drawing 100102545-MMD-02-XX-DR-C-0075 Sheet 2.

2.6.2 Attenuation provision

It is noted that as the compound is a temporary feature that will be removed after construction of the sub-station, this means that the site will need to consider a climate change allowance of 25% for the 2050 epoch in line with DEFRA guidance[2]. The attenuation volumes have been calculated for the 1 in 100-year (1.0% AEP).

For the pumped option a basin/swale with a top water level area of around 2,075m^2, side slopes of 1v:3h and a working depth of 650mm would provide approximately 1150m^3 of attenuation.

[2] https://environment.data.gov.uk/hydrology/climate-change-allowances/rainfall?mgmtcatid=3001

2.6.3 Water quality features

The topography of the compound is conducive to collecting flows as sheet surface runoff directly into a boundary conveyance swale. This would discharge into the main infiltration/attenuation basin. This would not require collection and conveyance systems in the compound provided that the overland flow routes are unobstructed and manageable within the compound.

In this case the sheet flow can be more easily treated than if it were concentrated into a point flow. For note, with spatial planning, features such as the cabins should be located away from the main overland flow routes and could possibly discharge directly to the swales as runoff from the roofs will be much cleaner than runoff from the compound itself.

The use of a swale will provide significant in system water quality benefits, this can be further enhanced with the use of a filter strip between the site compound southern boundary and the swale itself, this is a 1.5m wide grassed strip laid at 1v:40h that will act to catch the majority of sediments as the flow leaves the compound area.

Maintenance of both the swale and the filter strip will comprise general grass cutting throughout the year, with grass a maximum of 250mm cut to 100mm. The swale should be cleared of all arisings from grass cutting and should be scrapped of sediment as required but at least bi-annually.

2.7 Foul drainage

The Monk Fryston site lies remote from adopted drainage assets, with the existing site utilising a septic tank for foul flows. Provision of a similar system is proposed for the new site.

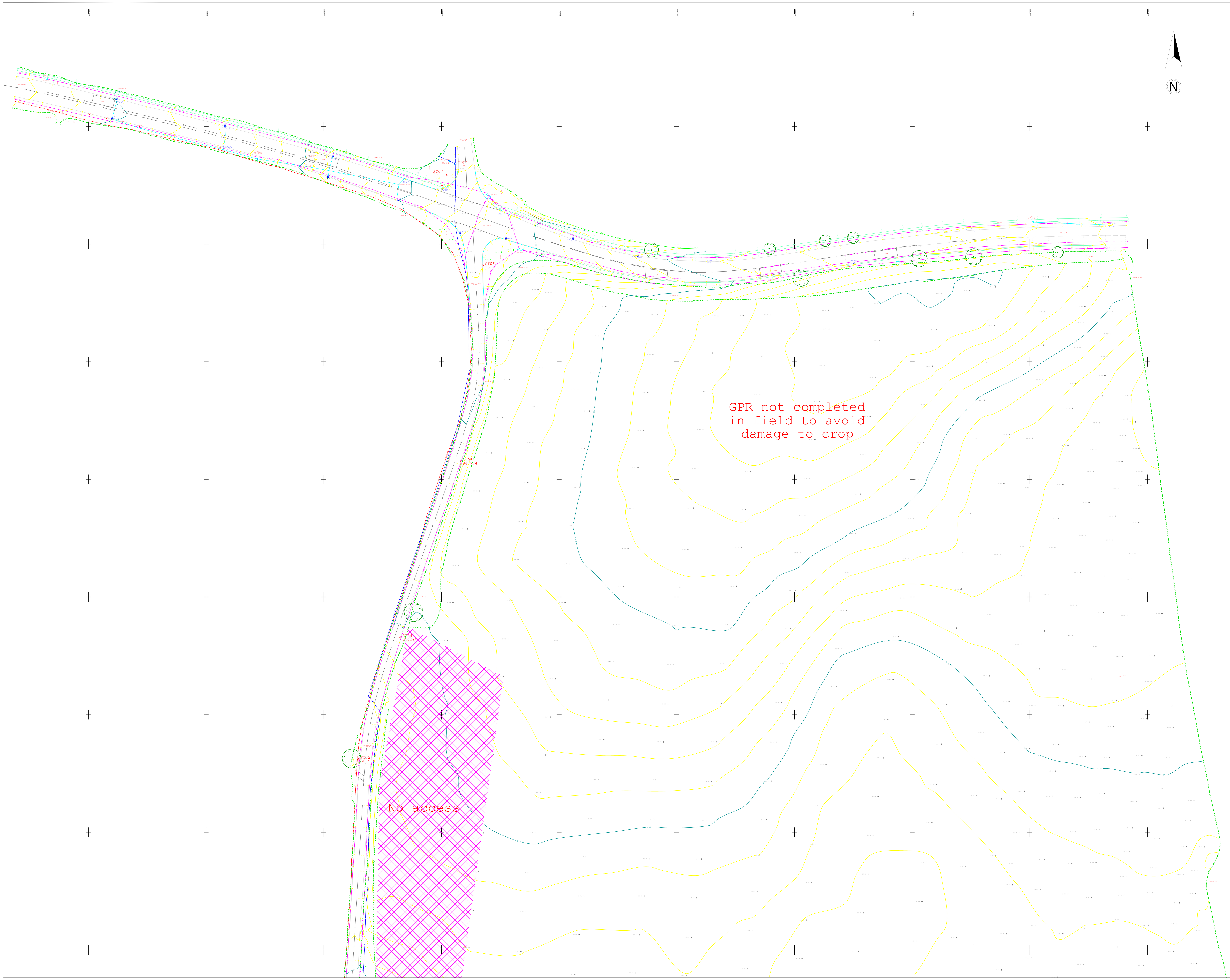
It is assumed that the occupancy of the site is intermittent and for a peak of 5 personnel at any one time.

The likely variation in flow is problematic, and while a package treatment option would provide the highest level of treatment the flow regime may not be suitable for these systems.

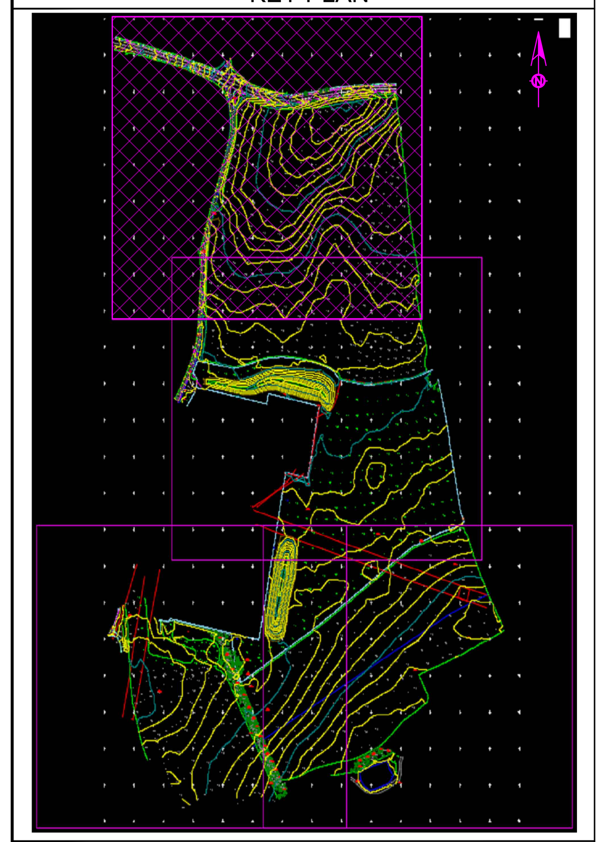
At this stage it is assumed that a sealed cesspit will be provided. To be compliant with Building Regulations Part H (H2 - 1.61) the minimum volume would be 38.4m^3.

With more information on the accurate attendance regime, it may be possible to identify a package treatment plant that could accommodate the flow variation at the next stage.

A. Site topographical survey



KEY PLAN



LEGEND

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Storm water	W

Overhead Hatching

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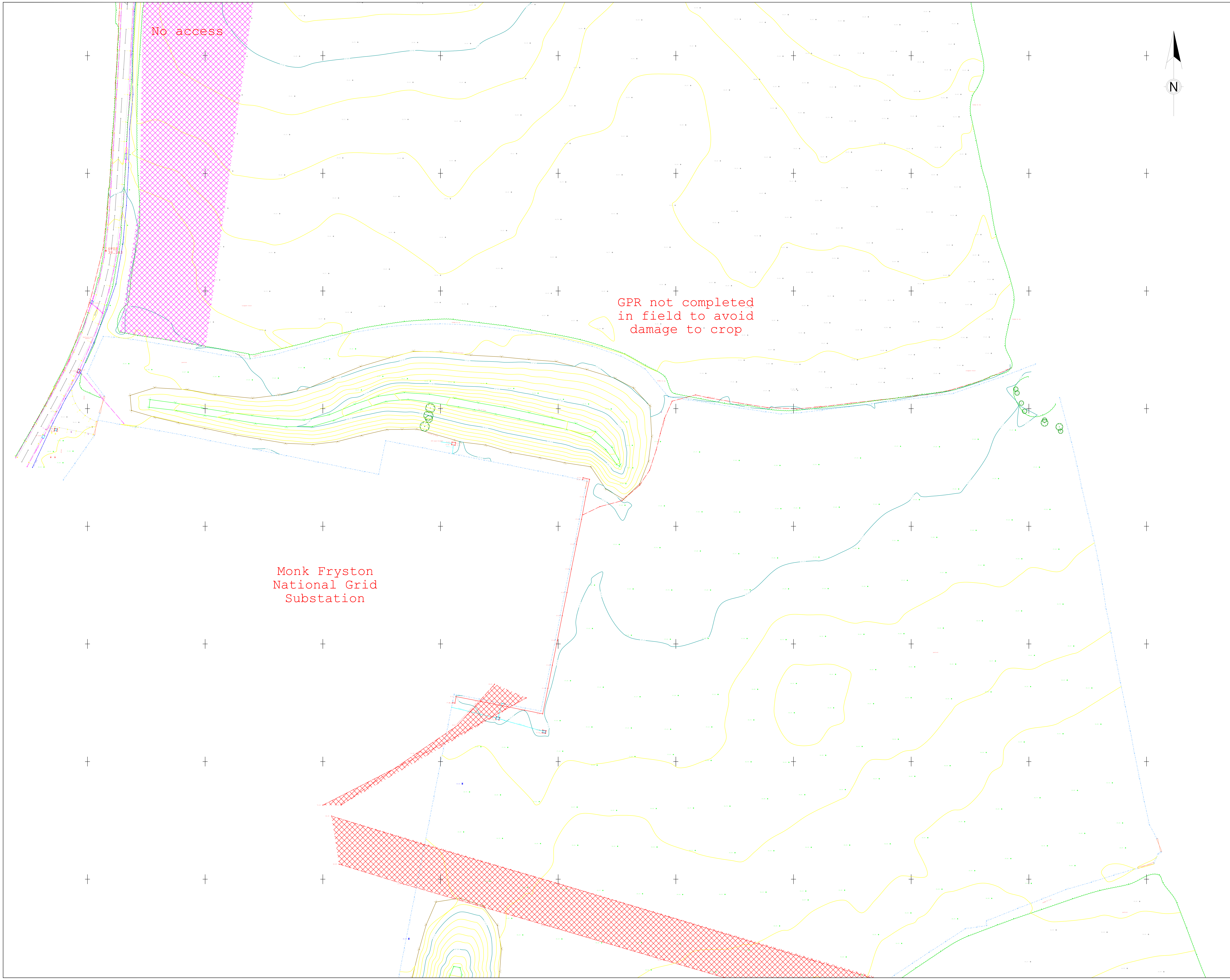
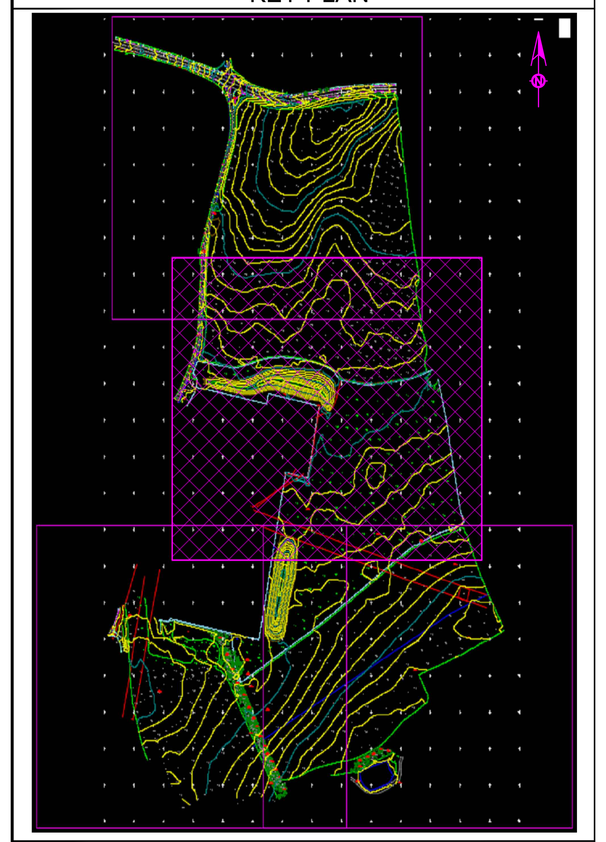
01962 808 462

Client	Mott MacDonald Limited
Location	Monk Fryston
Type of Survey	Land & Utility Survey
Plotted Scale 1:500 @ A0	Date 22/08/2021
Ref No DES21014_1	QA Checked SV
Drawing No 100	Revision REV1



KEY PLAN



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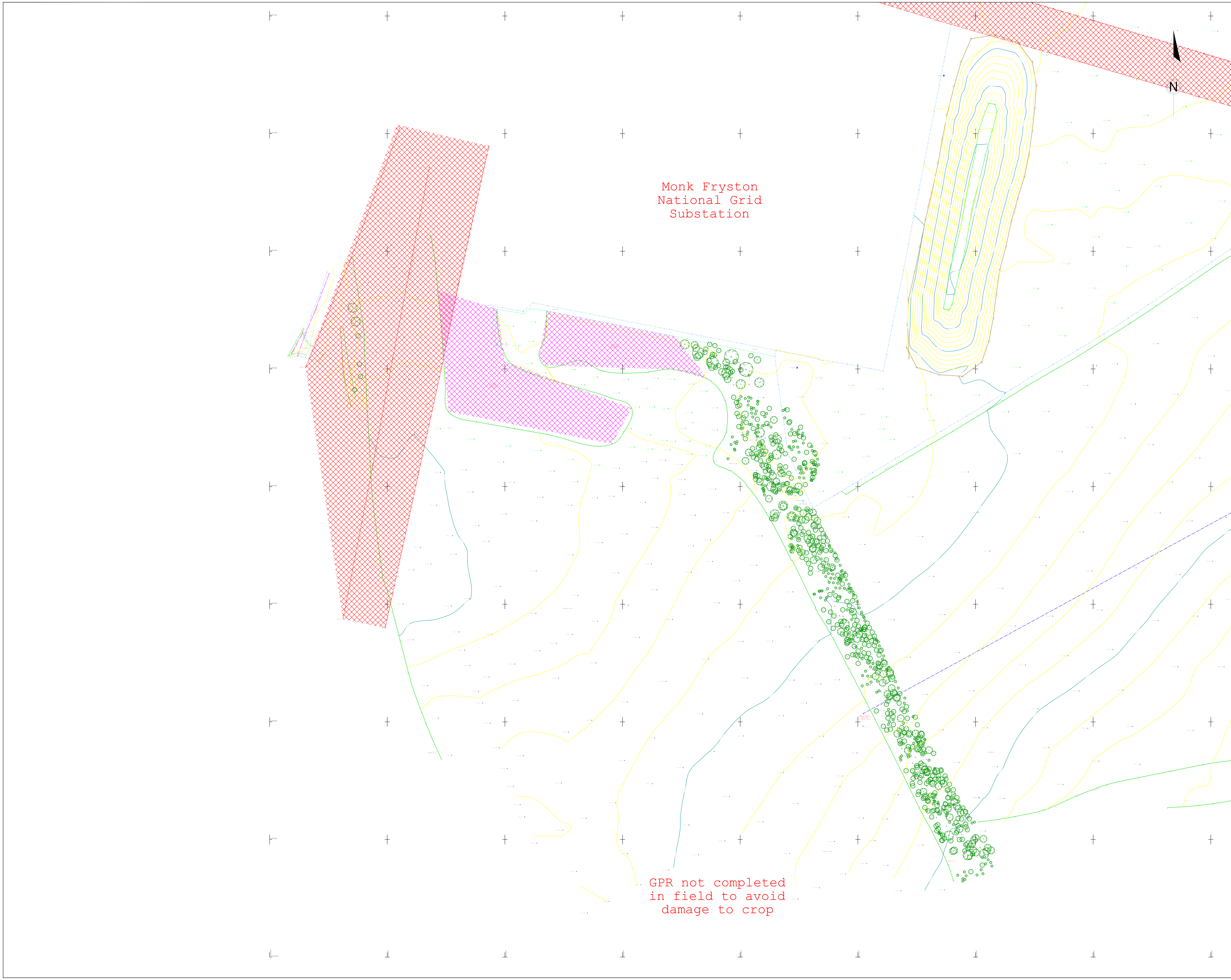
Client: Mott MacDonald Limited	
Location: Monk Fryston	
Type of Survey: Land & Utility Survey	
Plotted Scale: 1:500 @ A0	Date: 22/08/2021
Ref No DES21014_1	QA Checked: SV
Drawing No: 101	Revision: REV1



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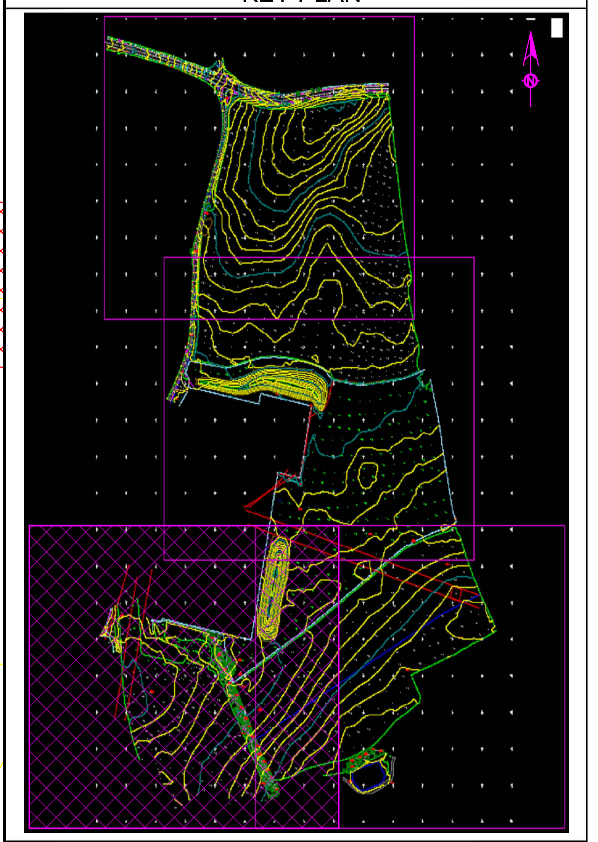

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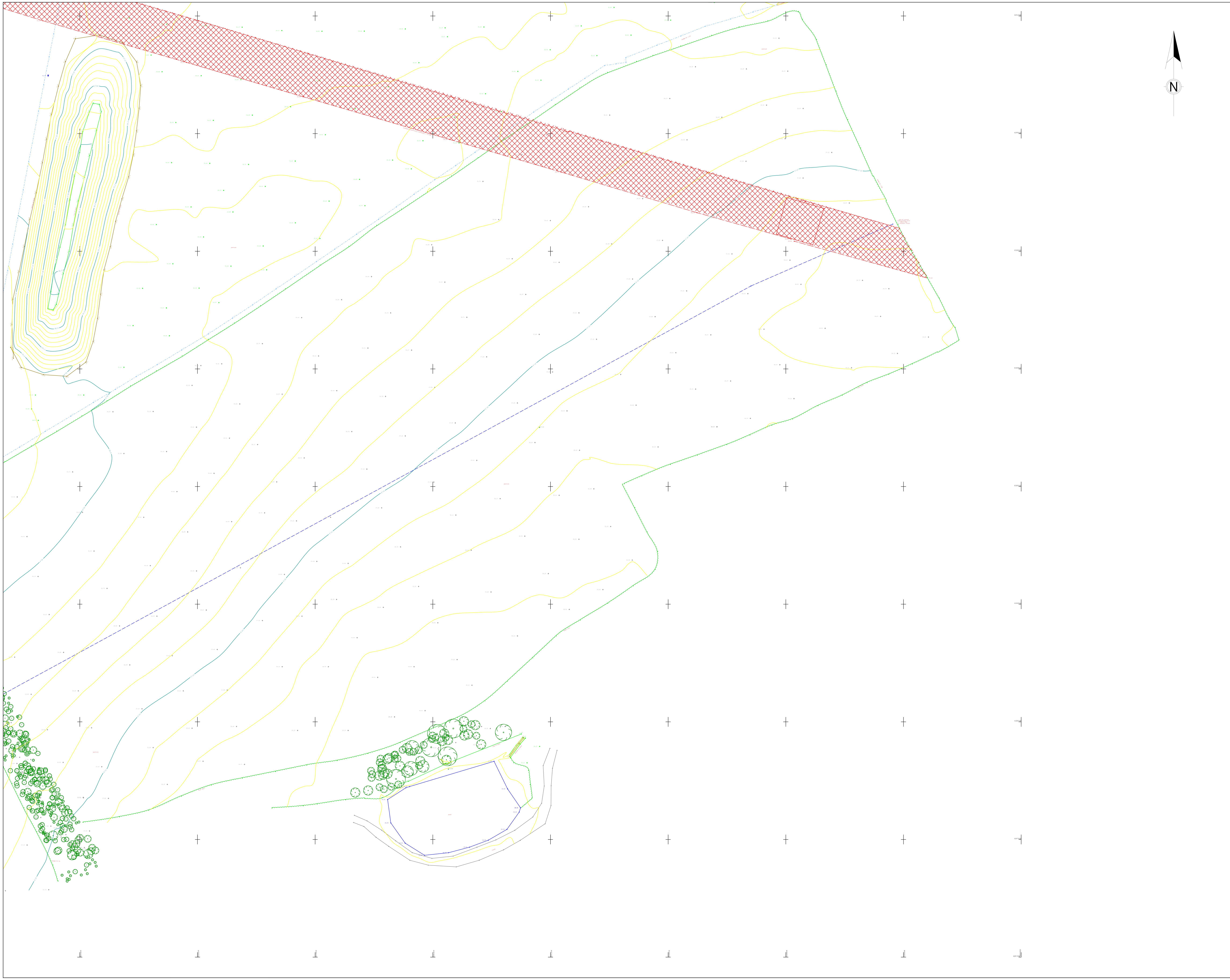
Ref No DES21014_1	QA Checked SV
Drawing No 102	Revision REV1



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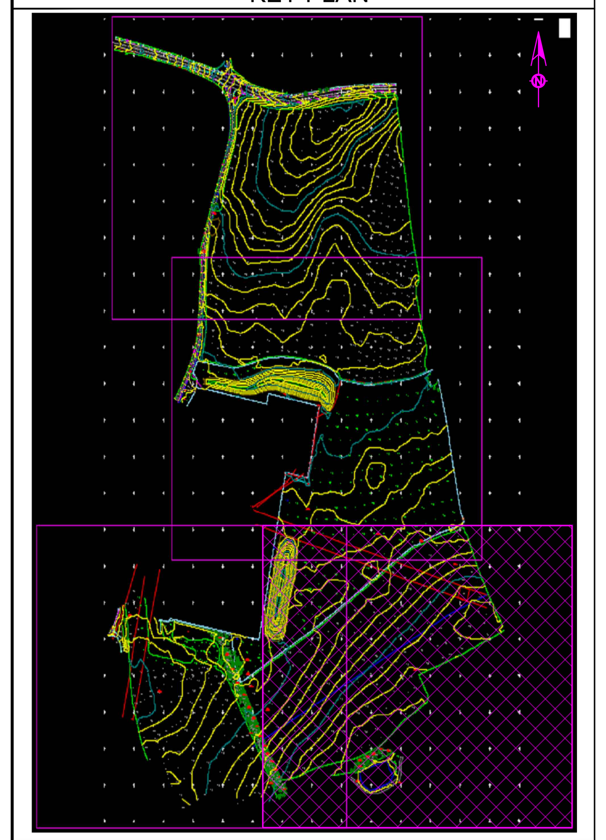

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Client	Mott MacDonald Limited
Location	Monk Fryston
Type of Survey	Land & Utility Survey
Plotted Scale	1:500 @ A0
Date	22/08/2021
Ref No	DES21014_1
QA Checked	SV
Drawing No	103
Revision	REV1

B. Greenfield runoff estimate

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Andrew Precious
Site name:	Monk Fryston
Site location:	Yorkshire Green Feed

Site Details

Latitude:	53.75497° N
Longitude:	1.2623° W
Reference:	1352479610
Date:	Mar 29 2022 10:41

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 8.35

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	1	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.1	0.3

Hydrological characteristics	Default	Edited
SAAR (mm):	609	609
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):	1.19	12.93
1 in 1 year (l/s):	1.03	11.12
1 in 30 years (l/s):	2.09	22.63
1 in 100 year (l/s):	2.48	26.89
1 in 200 years (l/s):	2.82	30.64

C. Preliminary attenuation sizing

C.1 North site positive discharge – 1% AEP +45%

C.2 South site terraced attenuation Area 1 – 1% AEP +45%

C.3 South site terraced attenuation Area 2 – 1% AEP +45%

C.4 South site terraced attenuation Area 3 – 1% AEP +45%

C.5 North Compound positive discharge – 1% AEP +25%

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 6168 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	37.174	0.124	0.0	4.8	4.8	1230.1	O K
30 min Summer	37.218	0.168	0.0	5.1	5.1	1665.6	Flood Risk
60 min Summer	37.264	0.214	0.0	5.3	5.3	2122.0	Flood Risk
120 min Summer	37.312	0.262	0.0	5.5	5.5	2591.4	Flood Risk
180 min Summer	37.339	0.289	0.0	5.7	5.7	2864.7	Flood Risk
240 min Summer	37.358	0.308	0.0	5.8	5.8	3052.2	Flood Risk
360 min Summer	37.384	0.334	0.0	5.9	5.9	3303.3	Flood Risk
480 min Summer	37.402	0.352	0.0	6.0	6.0	3486.9	Flood Risk
600 min Summer	37.416	0.366	0.0	6.0	6.0	3626.3	Flood Risk
720 min Summer	37.427	0.377	0.0	6.1	6.1	3736.8	Flood Risk
960 min Summer	37.444	0.394	0.0	6.1	6.1	3901.5	Flood Risk
1440 min Summer	37.464	0.414	0.0	6.2	6.2	4099.8	Flood Risk
2160 min Summer	37.478	0.428	0.0	6.3	6.3	4232.7	Flood Risk
2880 min Summer	37.481	0.431	0.0	6.3	6.3	4265.6	Flood Risk
4320 min Summer	37.473	0.423	0.0	6.3	6.3	4184.1	Flood Risk
5760 min Summer	37.459	0.409	0.0	6.2	6.2	4045.5	Flood Risk
7200 min Summer	37.444	0.394	0.0	6.1	6.1	3904.3	Flood Risk
8640 min Summer	37.430	0.380	0.0	6.1	6.1	3766.3	Flood Risk
10080 min Summer	37.418	0.368	0.0	6.0	6.0	3644.3	Flood Risk
15 min Winter	37.152	0.102	0.0	4.7	4.7	1006.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	135.261	0.0	407.3	19
30 min Summer	88.891	0.0	426.4	34
60 min Summer	55.699	0.0	874.9	64
120 min Summer	33.759	0.0	911.3	124
180 min Summer	24.870	0.0	930.0	184
240 min Summer	19.910	0.0	941.7	244
360 min Summer	14.452	0.0	954.0	364
480 min Summer	11.522	0.0	960.7	484
600 min Summer	9.658	0.0	963.5	604
720 min Summer	8.357	0.0	963.7	724
960 min Summer	6.647	0.0	959.1	962
1440 min Summer	4.806	0.0	938.7	1442
2160 min Summer	3.469	0.0	1919.3	2160
2880 min Summer	2.750	0.0	1885.2	2880
4320 min Summer	1.980	0.0	1787.5	4280
5760 min Summer	1.567	0.0	3644.4	4896
7200 min Summer	1.306	0.0	3551.4	5616
8640 min Summer	1.125	0.0	3434.5	6392
10080 min Summer	0.991	0.0	3287.7	7160
15 min Winter	135.261	0.0	396.6	19

Summary of Results for 100 year Return Period (+45%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	37.189	0.139	0.0	4.9	4.9	1371.6	O K
60 min Winter	37.227	0.177	0.0	5.1	5.1	1753.9	Flood Risk
120 min Winter	37.267	0.217	0.0	5.3	5.3	2145.5	Flood Risk
180 min Winter	37.290	0.240	0.0	5.4	5.4	2373.2	Flood Risk
240 min Winter	37.305	0.255	0.0	5.5	5.5	2528.5	Flood Risk
360 min Winter	37.326	0.276	0.0	5.6	5.6	2735.3	Flood Risk
480 min Winter	37.341	0.291	0.0	5.7	5.7	2884.8	Flood Risk
600 min Winter	37.353	0.303	0.0	5.7	5.7	2997.8	Flood Risk
720 min Winter	37.362	0.312	0.0	5.8	5.8	3086.4	Flood Risk
960 min Winter	37.375	0.325	0.0	5.8	5.8	3215.7	Flood Risk
1440 min Winter	37.390	0.340	0.0	5.9	5.9	3365.8	Flood Risk
2160 min Winter	37.399	0.349	0.0	5.9	5.9	3455.2	Flood Risk
2880 min Winter	37.400	0.350	0.0	5.9	5.9	3463.6	Flood Risk
4320 min Winter	37.390	0.340	0.0	5.9	5.9	3364.5	Flood Risk
5760 min Winter	37.374	0.324	0.0	5.8	5.8	3205.0	Flood Risk
7200 min Winter	37.359	0.309	0.0	5.8	5.8	3059.7	Flood Risk
8640 min Winter	37.344	0.294	0.0	5.7	5.7	2915.2	Flood Risk
10080 min Winter	37.331	0.281	0.0	5.6	5.6	2780.7	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	88.891	0.0	412.8	34
60 min Winter	55.699	0.0	842.2	64
120 min Winter	33.759	0.0	873.7	122
180 min Winter	24.870	0.0	889.5	182
240 min Winter	19.910	0.0	899.2	242
360 min Winter	14.452	0.0	908.7	360
480 min Winter	11.522	0.0	913.8	478
600 min Winter	9.658	0.0	915.1	596
720 min Winter	8.357	0.0	914.1	714
960 min Winter	6.647	0.0	908.5	952
1440 min Winter	4.806	0.0	886.7	1414
2160 min Winter	3.469	0.0	1807.3	2100
2880 min Winter	2.750	0.0	1771.7	2792
4320 min Winter	1.980	0.0	1674.6	4064
5760 min Winter	1.567	0.0	3398.9	4672
7200 min Winter	1.306	0.0	3306.5	5552
8640 min Winter	1.125	0.0	3188.2	6480
10080 min Winter	0.991	0.0	3042.9	7368

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	1.000
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 4.140

Time From:	**(mins) To:**	**Area (ha)**
0	4	4.140

Model Details

Storage is Online Cover Level (m) 37.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	165.0
Membrane Percolation (mm/hr)	1000	Length (m)	200.0
Max Percolation (l/s)	9166.7	Slope (1:X)	0.0
Safety Factor	10.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	37.050	Membrane Depth (m)	0

Orifice Outflow Control

Diameter (m) 0.059 Discharge Coefficient 0.600 Invert Level (m) 36.700

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 5682 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	35.525	0.289	0.0	1.2	1.2	350.9	O K
30 min Summer	35.626	0.390	0.0	1.4	1.4	480.6	O K
60 min Summer	35.731	0.495	0.0	1.6	1.6	616.7	O K
120 min Summer	35.839	0.603	0.0	1.7	1.7	756.8	Flood Risk
180 min Summer	35.899	0.663	0.0	1.8	1.8	838.4	Flood Risk
240 min Summer	35.936	0.700	0.0	1.9	1.9	894.5	Flood Risk
360 min Summer	35.983	0.747	0.0	1.9	1.9	969.6	Flood Risk
480 min Summer	36.015	0.779	0.0	2.0	2.0	1024.5	Flood Risk
600 min Summer	36.039	0.803	0.0	2.0	2.0	1066.3	Flood Risk
720 min Summer	36.057	0.821	0.0	2.0	2.0	1099.3	Flood Risk
960 min Summer	36.083	0.847	0.0	2.1	2.1	1148.6	Flood Risk
1440 min Summer	36.113	0.877	0.0	2.1	2.1	1208.0	Flood Risk
2160 min Summer	36.133	0.897	0.0	2.1	2.1	1247.8	Flood Risk
2880 min Summer	36.137	0.901	0.0	2.1	2.1	1257.9	FLOOD
4320 min Summer	36.129	0.893	0.0	2.1	2.1	1240.4	Flood Risk
5760 min Summer	36.118	0.882	0.0	2.1	2.1	1218.0	Flood Risk
7200 min Summer	36.106	0.870	0.0	2.1	2.1	1193.2	Flood Risk
8640 min Summer	36.092	0.856	0.0	2.1	2.1	1167.0	Flood Risk
10080 min Summer	36.078	0.842	0.0	2.1	2.1	1139.5	Flood Risk
15 min Winter	35.474	0.238	0.0	1.1	1.1	284.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	135.261	0.0	94.7	19
30 min Summer	88.891	0.0	111.6	34
60 min Summer	55.699	0.0	240.5	64
120 min Summer	33.759	0.0	267.9	124
180 min Summer	24.870	0.0	281.7	184
240 min Summer	19.910	0.0	289.8	244
360 min Summer	14.452	0.0	298.3	364
480 min Summer	11.522	0.0	302.3	484
600 min Summer	9.658	0.0	303.7	604
720 min Summer	8.357	0.0	303.5	724
960 min Summer	6.647	0.0	300.0	962
1440 min Summer	4.806	0.0	286.7	1442
2160 min Summer	3.469	0.0	596.0	2160
2880 min Summer	2.750	1.0	575.8	2880
4320 min Summer	1.980	0.0	520.2	3764
5760 min Summer	1.567	0.0	1080.1	4544
7200 min Summer	1.306	0.0	1036.5	5256
8640 min Summer	1.125	0.0	982.4	6056
10080 min Summer	0.991	0.0	920.0	6864
15 min Winter	135.261	0.0	84.5	19

Summary of Results for 100 year Return Period (+45%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	35.558	0.322	0.0	1.3	1.3	393.2	O K
60 min Winter	35.646	0.410	0.0	1.4	1.4	507.3	O K
120 min Winter	35.737	0.501	0.0	1.6	1.6	624.4	O K
180 min Winter	35.790	0.554	0.0	1.7	1.7	692.6	O K
240 min Winter	35.826	0.590	0.0	1.7	1.7	739.2	O K
360 min Winter	35.873	0.637	0.0	1.8	1.8	801.3	Flood Risk
480 min Winter	35.904	0.668	0.0	1.8	1.8	846.4	Flood Risk
600 min Winter	35.927	0.691	0.0	1.9	1.9	880.4	Flood Risk
720 min Winter	35.944	0.708	0.0	1.9	1.9	907.1	Flood Risk
960 min Winter	35.969	0.733	0.0	1.9	1.9	946.3	Flood Risk
1440 min Winter	35.996	0.760	0.0	2.0	2.0	992.3	Flood Risk
2160 min Winter	36.013	0.777	0.0	2.0	2.0	1020.8	Flood Risk
2880 min Winter	36.016	0.780	0.0	2.0	2.0	1025.3	Flood Risk
4320 min Winter	36.002	0.766	0.0	2.0	2.0	1002.1	Flood Risk
5760 min Winter	35.986	0.750	0.0	1.9	1.9	975.2	Flood Risk
7200 min Winter	35.969	0.733	0.0	1.9	1.9	945.8	Flood Risk
8640 min Winter	35.948	0.712	0.0	1.9	1.9	913.5	Flood Risk
10080 min Winter	35.927	0.691	0.0	1.9	1.9	879.9	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	88.891	0.0	100.2	34
60 min Winter	55.699	0.0	215.5	64
120 min Winter	33.759	0.0	240.9	122
180 min Winter	24.870	0.0	253.7	182
240 min Winter	19.910	0.0	261.4	242
360 min Winter	14.452	0.0	269.9	360
480 min Winter	11.522	0.0	274.5	478
600 min Winter	9.658	0.0	276.6	596
720 min Winter	8.357	0.0	277.1	714
960 min Winter	6.647	0.0	274.9	950
1440 min Winter	4.806	0.0	263.4	1412
2160 min Winter	3.469	0.0	541.5	2096
2880 min Winter	2.750	0.0	524.6	2764
4320 min Winter	1.980	0.0	474.5	3976
5760 min Winter	1.567	0.0	958.0	4488
7200 min Winter	1.306	0.0	920.4	5400
8640 min Winter	1.125	0.0	873.0	6312
10080 min Winter	0.991	0.0	817.7	7256

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	1.000
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 1.232

Time From:	(mins) To:	Area (ha)
0	4	1.232

Model Details

Storage is Online Cover Level (m) 36.136

Complex Structure

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	123.0
Membrane Percolation (mm/hr)	1000	Length (m)	35.0
Max Percolation (l/s)	1195.8	Slope (1:X)	1000.0
Safety Factor	5.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	35.236	Membrane Depth (m)	0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	123.0
Membrane Percolation (mm/hr)	1000	Length (m)	70.0
Max Percolation (l/s)	2391.7	Slope (1:X)	69.0
Safety Factor	5.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	35.836	Membrane Depth (m)	0

Orifice Outflow Control

Diameter (m) 0.033 Discharge Coefficient 0.600 Invert Level (m) 35.236

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 6428 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	34.270	0.280	0.0	1.2	1.2	391.1	O K
30 min Summer	34.364	0.374	0.0	1.4	1.4	533.8	O K
60 min Summer	34.462	0.472	0.0	1.5	1.5	683.6	O K
120 min Summer	34.564	0.574	0.0	1.7	1.7	838.1	O K
180 min Summer	34.623	0.633	0.0	1.8	1.8	928.3	Flood Risk
240 min Summer	34.661	0.671	0.0	1.8	1.8	990.6	Flood Risk
360 min Summer	34.709	0.719	0.0	1.9	1.9	1074.3	Flood Risk
480 min Summer	34.742	0.752	0.0	1.9	1.9	1136.0	Flood Risk
600 min Summer	34.767	0.777	0.0	2.0	2.0	1183.1	Flood Risk
720 min Summer	34.786	0.796	0.0	2.0	2.0	1220.7	Flood Risk
960 min Summer	34.814	0.824	0.0	2.0	2.0	1277.3	Flood Risk
1440 min Summer	34.848	0.858	0.0	2.1	2.1	1347.6	Flood Risk
2160 min Summer	34.871	0.881	0.0	2.1	2.1	1398.9	Flood Risk
2880 min Summer	34.880	0.890	0.0	2.1	2.1	1417.3	Flood Risk
4320 min Summer	34.875	0.885	0.0	2.1	2.1	1406.5	Flood Risk
5760 min Summer	34.864	0.874	0.0	2.1	2.1	1383.5	Flood Risk
7200 min Summer	34.853	0.863	0.0	2.1	2.1	1358.6	Flood Risk
8640 min Summer	34.841	0.851	0.0	2.1	2.1	1332.6	Flood Risk
10080 min Summer	34.828	0.838	0.0	2.1	2.1	1305.2	Flood Risk
15 min Winter	34.235	0.245	0.0	1.1	1.1	338.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	135.261	0.0	94.0	19
30 min Summer	88.891	0.0	110.1	34
60 min Summer	55.699	0.0	238.3	64
120 min Summer	33.759	0.0	264.6	124
180 min Summer	24.870	0.0	277.9	184
240 min Summer	19.910	0.0	285.8	244
360 min Summer	14.452	0.0	294.2	364
480 min Summer	11.522	0.0	298.4	484
600 min Summer	9.658	0.0	300.0	604
720 min Summer	8.357	0.0	299.9	724
960 min Summer	6.647	0.0	296.8	962
1440 min Summer	4.806	0.0	284.2	1442
2160 min Summer	3.469	0.0	593.9	2160
2880 min Summer	2.750	0.0	574.1	2880
4320 min Summer	1.980	0.0	519.7	4104
5760 min Summer	1.567	0.0	1093.3	4728
7200 min Summer	1.306	0.0	1048.0	5472
8640 min Summer	1.125	0.0	993.0	6224
10080 min Summer	0.991	0.0	930.2	7056
15 min Winter	135.261	0.0	87.1	19

Summary of Results for 100 year Return Period (+45%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	34.318	0.328	0.0	1.3	1.3	464.2	O K
60 min Winter	34.405	0.415	0.0	1.4	1.4	596.5	O K
120 min Winter	34.495	0.505	0.0	1.6	1.6	732.7	O K
180 min Winter	34.547	0.557	0.0	1.7	1.7	812.2	O K
240 min Winter	34.583	0.593	0.0	1.7	1.7	866.9	O K
360 min Winter	34.630	0.640	0.0	1.8	1.8	940.2	Flood Risk
480 min Winter	34.663	0.673	0.0	1.8	1.8	994.0	Flood Risk
600 min Winter	34.686	0.696	0.0	1.9	1.9	1034.9	Flood Risk
720 min Winter	34.705	0.715	0.0	1.9	1.9	1067.4	Flood Risk
960 min Winter	34.731	0.741	0.0	1.9	1.9	1116.0	Flood Risk
1440 min Winter	34.763	0.773	0.0	2.0	2.0	1175.4	Flood Risk
2160 min Winter	34.784	0.794	0.0	2.0	2.0	1217.3	Flood Risk
2880 min Winter	34.791	0.801	0.0	2.0	2.0	1231.0	Flood Risk
4320 min Winter	34.785	0.795	0.0	2.0	2.0	1218.6	Flood Risk
5760 min Winter	34.769	0.779	0.0	2.0	2.0	1186.4	Flood Risk
7200 min Winter	34.754	0.764	0.0	2.0	2.0	1158.4	Flood Risk
8640 min Winter	34.737	0.747	0.0	1.9	1.9	1126.5	Flood Risk
10080 min Winter	34.719	0.729	0.0	1.9	1.9	1092.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	88.891	0.0	102.4	34
60 min Winter	55.699	0.0	221.2	64
120 min Winter	33.759	0.0	246.1	124
180 min Winter	24.870	0.0	258.6	182
240 min Winter	19.910	0.0	266.2	242
360 min Winter	14.452	0.0	274.5	360
480 min Winter	11.522	0.0	279.0	478
600 min Winter	9.658	0.0	281.0	596
720 min Winter	8.357	0.0	281.4	714
960 min Winter	6.647	0.0	279.1	952
1440 min Winter	4.806	0.0	267.8	1414
2160 min Winter	3.469	0.0	556.1	2100
2880 min Winter	2.750	0.0	538.6	2792
4320 min Winter	1.980	0.0	487.9	4064
5760 min Winter	1.567	0.0	1010.2	4664
7200 min Winter	1.306	0.0	969.5	5544
8640 min Winter	1.125	0.0	919.3	6480
10080 min Winter	0.991	0.0	861.6	7360

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.950
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 1.425

Time From:	**(mins) To:**	**Area (ha)**
0	4	1.425

Model Details

Storage is Online Cover Level (m) 34.890

Complex Structure

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	115.0
Membrane Percolation (mm/hr)	1000	Length (m)	44.0
Max Percolation (l/s)	1405.6	Slope (1:X)	1000.0
Safety Factor	5.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	33.990	Membrane Depth (m)	0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	115.0
Membrane Percolation (mm/hr)	1000	Length (m)	70.0
Max Percolation (l/s)	2236.1	Slope (1:X)	69.0
Safety Factor	5.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	34.590	Membrane Depth (m)	0

Orifice Outflow Control

Diameter (m) 0.033 Discharge Coefficient 0.600 Invert Level (m) 33.990

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 6799 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	33.283	0.183	0.0	1.3	1.3	412.1	O K
30 min Summer	33.322	0.222	0.0	1.4	1.4	561.1	Flood Risk
60 min Summer	33.363	0.263	0.0	1.6	1.6	717.6	Flood Risk
120 min Summer	33.405	0.305	0.0	1.7	1.7	878.9	Flood Risk
180 min Summer	33.429	0.329	0.0	1.8	1.8	973.2	Flood Risk
240 min Summer	33.446	0.346	0.0	1.8	1.8	1038.3	Flood Risk
360 min Summer	33.469	0.369	0.0	1.9	1.9	1126.0	Flood Risk
480 min Summer	33.486	0.386	0.0	1.9	1.9	1190.5	Flood Risk
600 min Summer	33.499	0.399	0.0	2.0	2.0	1239.9	Flood Risk
720 min Summer	33.509	0.409	0.0	2.0	2.0	1279.4	Flood Risk
960 min Summer	33.525	0.425	0.0	2.0	2.0	1338.9	Flood Risk
1440 min Summer	33.544	0.444	0.0	2.1	2.1	1413.1	Flood Risk
2160 min Summer	33.558	0.458	0.0	2.1	2.1	1467.8	Flood Risk
2880 min Summer	33.563	0.463	0.0	2.1	2.1	1488.3	Flood Risk
4320 min Summer	33.561	0.461	0.0	2.1	2.1	1478.4	Flood Risk
5760 min Summer	33.554	0.454	0.0	2.1	2.1	1450.9	Flood Risk
7200 min Summer	33.546	0.446	0.0	2.1	2.1	1422.4	Flood Risk
8640 min Summer	33.539	0.439	0.0	2.1	2.1	1392.8	Flood Risk
10080 min Summer	33.531	0.431	0.0	2.0	2.0	1362.7	Flood Risk
15 min Winter	33.268	0.168	0.0	1.2	1.2	356.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	135.261	0.0	105.4	19
30 min Summer	88.891	0.0	117.5	34
60 min Summer	55.699	0.0	249.3	64
120 min Summer	33.759	0.0	270.2	124
180 min Summer	24.870	0.0	280.7	184
240 min Summer	19.910	0.0	287.1	244
360 min Summer	14.452	0.0	294.1	364
480 min Summer	11.522	0.0	297.8	484
600 min Summer	9.658	0.0	299.4	604
720 min Summer	8.357	0.0	299.7	724
960 min Summer	6.647	0.0	297.7	962
1440 min Summer	4.806	0.0	287.5	1442
2160 min Summer	3.469	0.0	598.4	2160
2880 min Summer	2.750	0.0	581.8	2880
4320 min Summer	1.980	0.0	533.5	4276
5760 min Summer	1.567	0.0	1113.9	4848
7200 min Summer	1.306	0.0	1070.6	5552
8640 min Summer	1.125	0.0	1018.3	6312
10080 min Summer	0.991	0.0	959.0	7152
15 min Winter	135.261	0.0	100.4	19

Summary of Results for 100 year Return Period (+45%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	33.303	0.203	0.0	1.4	1.4	488.5	Flood Risk
60 min Winter	33.339	0.239	0.0	1.5	1.5	626.6	Flood Risk
120 min Winter	33.376	0.276	0.0	1.6	1.6	768.8	Flood Risk
180 min Winter	33.398	0.298	0.0	1.7	1.7	851.9	Flood Risk
240 min Winter	33.413	0.313	0.0	1.7	1.7	909.1	Flood Risk
360 min Winter	33.433	0.333	0.0	1.8	1.8	985.8	Flood Risk
480 min Winter	33.447	0.347	0.0	1.8	1.8	1042.1	Flood Risk
600 min Winter	33.458	0.358	0.0	1.8	1.8	1085.0	Flood Risk
720 min Winter	33.467	0.367	0.0	1.9	1.9	1119.1	Flood Risk
960 min Winter	33.481	0.381	0.0	1.9	1.9	1170.3	Flood Risk
1440 min Winter	33.497	0.397	0.0	1.9	1.9	1233.1	Flood Risk
2160 min Winter	33.509	0.409	0.0	2.0	2.0	1278.0	Flood Risk
2880 min Winter	33.513	0.413	0.0	2.0	2.0	1293.5	Flood Risk
4320 min Winter	33.510	0.410	0.0	2.0	2.0	1282.3	Flood Risk
5760 min Winter	33.500	0.400	0.0	2.0	2.0	1245.7	Flood Risk
7200 min Winter	33.492	0.392	0.0	1.9	1.9	1214.3	Flood Risk
8640 min Winter	33.483	0.383	0.0	1.9	1.9	1180.0	Flood Risk
10080 min Winter	33.474	0.374	0.0	1.9	1.9	1143.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	88.891	0.0	111.6	34
60 min Winter	55.699	0.0	235.9	64
120 min Winter	33.759	0.0	255.2	124
180 min Winter	24.870	0.0	265.0	182
240 min Winter	19.910	0.0	271.0	242
360 min Winter	14.452	0.0	277.4	360
480 min Winter	11.522	0.0	280.7	478
600 min Winter	9.658	0.0	282.2	596
720 min Winter	8.357	0.0	282.4	714
960 min Winter	6.647	0.0	280.3	952
1440 min Winter	4.806	0.0	270.5	1414
2160 min Winter	3.469	0.0	560.9	2116
2880 min Winter	2.750	0.0	545.0	2792
4320 min Winter	1.980	0.0	499.3	4104
5760 min Winter	1.567	0.0	1034.9	5184
7200 min Winter	1.306	0.0	994.4	5616
8640 min Winter	1.125	0.0	945.6	6488
10080 min Winter	0.991	0.0	890.2	7464

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.950
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+45

Time Area Diagram

Total Area (ha) 1.488

Time From:	(mins) To:	Area (ha)
0	4	1.488

Model Details

Storage is Online Cover Level (m) 33.600

Complex Structure

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	170.0
Membrane Percolation (mm/hr)	1000	Length (m)	75.0
Max Percolation (l/s)	3541.7	Slope (1:X)	500.0
Safety Factor	5.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	33.100	Membrane Depth (m)	0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	170.0
Membrane Percolation (mm/hr)	1000	Length (m)	1.0
Max Percolation (l/s)	47.2	Slope (1:X)	69.0
Safety Factor	5.0	Depression Storage (mm)	5
Porosity	0.10	Evaporation (mm/day)	3
Invert Level (m)	33.400	Membrane Depth (m)	0

Orifice Outflow Control

Diameter (m) 0.039 Discharge Coefficient 0.600 Invert Level (m) 33.100

Summary of Results for 100 year Return Period (+25%)

Half Drain Time : 4633 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	31.174	0.232	0.0	2.0	2.0	366.6	O K
30 min Summer	31.241	0.299	0.0	2.0	2.0	480.8	O K
60 min Summer	31.309	0.367	0.0	2.0	2.0	599.8	O K
120 min Summer	31.376	0.434	0.0	2.0	2.0	721.6	Flood Risk
180 min Summer	31.414	0.472	0.0	2.0	2.0	791.8	Flood Risk
240 min Summer	31.439	0.497	0.0	2.0	2.0	839.5	Flood Risk
360 min Summer	31.472	0.530	0.0	2.0	2.0	902.3	Flood Risk
480 min Summer	31.495	0.553	0.0	2.0	2.0	947.5	Flood Risk
600 min Summer	31.513	0.571	0.0	2.0	2.0	981.1	Flood Risk
720 min Summer	31.526	0.584	0.0	2.0	2.0	1007.1	Flood Risk
960 min Summer	31.545	0.603	0.0	2.0	2.0	1044.6	Flood Risk
1440 min Summer	31.565	0.623	0.0	2.0	2.0	1085.3	Flood Risk
2160 min Summer	31.574	0.632	0.0	2.0	2.0	1103.2	Flood Risk
2880 min Summer	31.570	0.628	0.0	2.0	2.0	1094.9	Flood Risk
4320 min Summer	31.542	0.600	0.0	2.0	2.0	1038.4	Flood Risk
5760 min Summer	31.513	0.571	0.0	2.0	2.0	982.2	Flood Risk
7200 min Summer	31.490	0.548	0.0	2.0	2.0	938.0	Flood Risk
8640 min Summer	31.471	0.529	0.0	2.0	2.0	899.7	Flood Risk
10080 min Summer	31.452	0.510	0.0	2.0	2.0	864.8	Flood Risk
15 min Winter	31.138	0.196	0.0	2.0	2.0	307.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	116.605	0.0	172.8	19
30 min Summer	76.630	0.0	172.7	34
60 min Summer	48.017	0.0	345.6	64
120 min Summer	29.103	0.0	345.5	124
180 min Summer	21.439	0.0	345.4	184
240 min Summer	17.164	0.0	345.4	244
360 min Summer	12.459	0.0	345.4	364
480 min Summer	9.933	0.0	345.4	484
600 min Summer	8.326	0.0	345.4	604
720 min Summer	7.204	0.0	345.4	724
960 min Summer	5.730	0.0	345.2	962
1440 min Summer	4.143	0.0	345.1	1442
2160 min Summer	2.991	0.0	690.6	2160
2880 min Summer	2.371	0.0	690.2	2880
4320 min Summer	1.707	0.0	689.3	4192
5760 min Summer	1.351	0.0	1364.9	4792
7200 min Summer	1.126	0.0	1334.9	5544
8640 min Summer	0.970	0.0	1296.5	6232
10080 min Summer	0.854	0.0	1252.3	7056
15 min Winter	116.605	0.0	172.7	19

Summary of Results for 100 year Return Period (+25%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	31.196	0.254	0.0	2.0	2.0	403.2	O K
60 min Winter	31.254	0.312	0.0	2.0	2.0	502.8	O K
120 min Winter	31.311	0.369	0.0	2.0	2.0	604.0	O K
180 min Winter	31.343	0.401	0.0	2.0	2.0	662.1	Flood Risk
240 min Winter	31.365	0.423	0.0	2.0	2.0	701.0	Flood Risk
360 min Winter	31.392	0.450	0.0	2.0	2.0	751.9	Flood Risk
480 min Winter	31.412	0.470	0.0	2.0	2.0	787.8	Flood Risk
600 min Winter	31.426	0.484	0.0	2.0	2.0	814.1	Flood Risk
720 min Winter	31.436	0.494	0.0	2.0	2.0	834.0	Flood Risk
960 min Winter	31.451	0.509	0.0	2.0	2.0	861.5	Flood Risk
1440 min Winter	31.465	0.523	0.0	2.0	2.0	888.4	Flood Risk
2160 min Winter	31.467	0.525	0.0	2.0	2.0	893.3	Flood Risk
2880 min Winter	31.459	0.517	0.0	2.0	2.0	877.3	Flood Risk
4320 min Winter	31.427	0.485	0.0	2.0	2.0	816.7	Flood Risk
5760 min Winter	31.396	0.454	0.0	2.0	2.0	758.3	Flood Risk
7200 min Winter	31.371	0.429	0.0	2.0	2.0	712.0	Flood Risk
8640 min Winter	31.345	0.403	0.0	2.0	2.0	665.4	Flood Risk
10080 min Winter	31.320	0.378	0.0	2.0	2.0	619.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	76.630	0.0	172.7	34
60 min Winter	48.017	0.0	345.4	64
120 min Winter	29.103	0.0	345.4	122
180 min Winter	21.439	0.0	345.2	182
240 min Winter	17.164	0.0	345.2	242
360 min Winter	12.459	0.0	344.8	360
480 min Winter	9.933	0.0	344.6	478
600 min Winter	8.326	0.0	344.4	596
720 min Winter	7.204	0.0	344.2	714
960 min Winter	5.730	0.0	343.7	950
1440 min Winter	4.143	0.0	342.6	1414
2160 min Winter	2.991	0.0	686.3	2100
2880 min Winter	2.371	0.0	683.7	2768
4320 min Winter	1.707	0.0	675.8	4020
5760 min Winter	1.351	0.0	1345.6	4552
7200 min Winter	1.126	0.0	1311.3	5472
8640 min Winter	0.970	0.0	1272.3	6320
10080 min Winter	0.854	0.0	1229.8	7256

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	1.000
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+25

Time Area Diagram

Total Area (ha) 1.265

Time From:	(mins) To:	Area (ha)
0	4	1.265

Model Details

Storage is Online Cover Level (m) 31.642

Infiltration Basin Structure

Invert Level (m) 30.942 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	1490.0	0.700	2075.0

Pump Outflow Control

Invert Level (m) 30.942

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.001	2.0000	1.000	2.0000

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National Grid plc
National Grid House,
Warwick Technology Park,
Gallows Hill, Warwick.
CV34 6DA United Kingdom

Registered in England and Wales
No. 4031152