East Anglia TWO Offshore Windfarm

Outline Operational Drainage Management Plan

Applicant: East Anglia TWO Limited
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Applicable to
East Anglia TWO

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Executive Summary

1. The Applicant has undertaken a tiered approach to selecting the most suitable Sustainable Drainage System (SuDS) to manage the surface water at the onshore substation and National Grid infrastructure site. The proposed solution has been informed by site specific testing of infiltration rates. The key parameters of the outline design presented within this Outline Operational Drainage Management Plan (OODMP) have been agreed with the Lead Local Flood Authority (LLFA).

2. Based on this process, with the agreement of the LLFA, the Applicant has selected a hybrid infiltration and attenuation design for the onshore substations which will be taken forward to the detailed design phase, and an attenuation only design for the National Grid infrastructure.

3. The consideration of the SuDS solutions is in line with the SuDS drainage hierarchy in Chapter 3 of the CIRIA SuDS Manual (2015), and in line with Suffolk County Council's (as LLFA) SuDS drainage hierarchy.

4. East Suffolk Council also has two key policies (Policy SCLP9.5: Flood Risk; and Policy SCLP9.6: Sustainable Drainage Systems.11) which relate to flood risk and drainage. These have both been reviewed in the context of the Project and the Project is compliant.

5. The Applicant has committed to not increasing flooding to the Projects' infrastructure or to the village of Friston and is surpassing the design standards required as per the CIRIA SuDS Manual (2015).

6. All of the SuDS options proposed within this OODMP are conservative as the Applicant adopts various pre-cautionary measures, as listed below:

   - Factor of Safety of 10 applied to infiltration elements of the SuDS basin;
   - 40% allowance for climate change;
   - A conservative infiltration rate derived from the lowest rates recorded during the initial infiltration testing; and
   - Maximum permitted footprints of the operational infrastructure.

7. This OODMP also provides an overview of the management measures required for surface water and foul water drainage arising from the operation of the onshore substations and National Grid infrastructure.

8. The final surface water drainage design will follow the below stages:

a) Confirm the final infiltration rate for the SuDS basins through further infiltration testing within the proposed SuDS basin locations at the time of detailed design, and establish the ground water levels;

b) Confirm the pre-development greenfield Q_{BAR} runoff rate calculated through detailed hydraulic modelling. This will become the maximum design discharge rate to the Friston Watercourse for events up to and including a 1 in 100 year (plus 40% to account for climate change) event, and will not be exceeded post-development where discharge to the Friston Watercourse is required (see ***Appendix 2*** for details of the indicative connection to the Friston Watercourse);

c) Confirm the optimal SuDS basin(s) configuration, size, capacity and location using the above data. The location of the SuDS basins will seek to maximise the infiltration rates where practicable and reflect both the infiltration rate and the discharge rate to the Friston Watercourse. An integrated approach to design of the final SuDS basins will include optimising amenity, biodiversity, water quality and water quantity benefits.

Glossary of Acronyms

BS	British Standards
BGS	British Geological Survey
BMT	British Maritime Technology
CCS	Construction Consolidation Site
CDA	Critical Drainage Areas
CIRIA	Construction Industry Research and Information Association
DCO	Development Consent Order
DMRB	Design Manual for Roads and Bridges
EIA	Environmental Impact Assessment
ESC	East Suffolk Council
FRA	Flood Risk Assessment
JBA	Jeremy Benn Associates
LLFA	Lead Local Flood Authority
LFRMS	Local Flood Risk Management Strategy
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
ODMP	Operational Drainage Management Plan
OODMP	Outline Operational Drainage Managment Plan
PPG	Pollution Prevention Guidance
PFRA	Preliminary Flood Risk Assessment
Q_{BAR}	Mean Annual Flood
SCC	Suffolk County Council
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems
WDC	Waveney District Council
WFD	Water Framework Directive

Glossary of Terminology

Applicant	East Anglia TWO Limited
Construction consolidation sites	Compounds associated with the onshore works which may include elements such as hard standings, lay down and storage areas for construction materials and equipment, areas for vehicular parking, welfare facilities, wheel washing facilities, workshop facilities and temporary fencing or other means of enclosure.
Development area	The area comprising the onshore development area and the offshore development area (described as the 'Order limits' within the Development Consent Order).
East Anglia TWO project	The proposed project consisting of up to 75 wind turbines, up to four offshore electrical platforms, up to one construction, operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.
National Grid infrastructure	A National Grid substation, cable sealing end compounds, cable sealing end (with circuit breaker) compound, underground cabling and National Grid overhead line realignment works to facilitate connection to the national electricity grid, all of which will be consented as part of the proposed East Anglia TWO project Development Consent Order but will be National Grid owned assets.
National Grid overhead line realignment works	Works required to upgrade the existing electricity pylons and overhead lines (including cable sealing end compounds and cable sealing end (with circuit breaker) compound) to transport electricity from the National Grid substation to the national electricity grid.
National Grid substation	The substation (including all of the electrical equipment within it) necessary to connect the electricity generated by the proposed East Anglia TWO project to the national electricity grid which will be owned by National Grid but is being consented as part of the proposed East Anglia TWO project Development Consent Order.
National Grid substation location	The proposed location of the National Grid substation.
Onshore development area	The area in which the landfall, onshore cable corridor, onshore substation, landscaping and ecological mitigation areas, temporary construction facilities (such as access roads and construction consolidation sites), and the National Grid infrastructure will be located.
Onshore substation	The East Anglia TWO substation and all of the electrical equipment within the onshore substation and connecting to the National Grid infrastructure.

Onshore substation location	The proposed location of the onshore substation for the proposed East Anglia TWO project.
Sustanable Drainage System	A collection of water management practices and measures that aim to align modern drainage systems with natural water processes. This includes, amongst other measures, infiltration and attenuation.
Q_{BAR}	Mean annual flood, the value of the average annual flood event recorded in a river.

1 Introduction

1.1 Overview

1. This Outline Operational Drainage Management Plan (OODMP) addresses operational surface water and foul water drainage management matters and supports the Development Consent Order (DCO) application (the Application) for the East Anglia TWO project (the Project) submitted by East Anglia TWO Limited (the Applicant).

2. Works to be undertaken include (amongst other things) the construction of an onshore substation for the Project; an onshore substation for the East Anglia ONE North Project (subject to a separate DCO application); National Grid infrastructure; associated landscaping; and surface water management infrastructure. A separate OODMP has been submitted for the East Anglia ONE North project that contains the same information as this OODMP, as both contain the maximum development scenario and are therefore applicable to both the Project and the East Anglia ONE North project. Given the integrated design of the surface water infrastructure required for the Project and the East Anglia ONE North project, the onshore substations for both projects are considered together (as 'onshore substations') within this OODMP unless otherwise stated.

3. Requirement 41 of the ***draft DCO*** (document reference 3.1) requires an Operational Drainage Management Plan (ODMP) in respect of the above works to be submitted to, and approved by the relevant planning authority in consultation with Suffolk County Council (SCC) (as Lead Local Flood Authority (LLFA)) and the Environment Agency. The final ODMP must be in line with this OODMP.

1.2 Purpose

4. This OODMP presents an overview of the information to be presented within the final ODMP, including:

   - Operational surface water management: Information on the SuDS measures to be adopted for potential infiltration, attenuation, treatment and conveying of surface water from the onshore substations and National Grid infrastructure; and
   - Operational foul water management: information on wastewater arising from the onshore substations and National Grid infrastructure.

5. Parameters such as the storage volumes, runoff rates and proposed discharge rates quoted in this OODMP relate to the current design envelope of the Project

and will be subject to review during the detailed design of the Project which will seek reductions in infrastructure footprints in line with the ***Substations Design Principles Statement*** (AS-133).

1.3 Basis of Design

6. The Applicant has undertaken infiltration testing at the proposed SuDS basin locations serving the onshore substations and National Grid infrastructure to inform the outline SuDS design. Initial infiltration testing undertaken in April 2021 (AS-121) have been superseded by more comprehensive infiltration testing undertaken in May 2021 (AS-129)). The results of the infiltration testing have ruled out an infiltration only solution for both the onshore substations and National Grid infrastructure SuDS basins. Following the drainage hierarchy, the Applicant has therefore adopted a hybrid infiltration and attenuation system for the onshore substations and an attenuation only solution for the National Grid infrastructure respectively, as agreed with the LLFA. Further details of the modelling to support these options are presented in ***section 6*** and ***section 7*** of this OODMP.

7. The final surface water drainage design will follow the below stages during the detailed design of the Project:

    a) Confirm the final infiltration rates for the SuDS basins through further infiltration testing within the proposed SuDS basin locations and establish the ground water levels;

    b) Confirm the pre-development greenfield Q_{BAR} runoff rate calculated through detailed hydraulic modelling. This will become the maximum design discharge rate to the Friston Watercourse for events up to and including a 1 in 100 year (plus 40% to account for climate change) event, and will not be exceeded post-development should discharge to the Friston Watercourse be required (see ***Appendix 2*** for indicative connection to the Friston Watercourse); and

    c) Confirm the optimal SuDS basin(s) configuration, size, capacity and location using the above data. The location of the SuDS basins will seek to maximise the infiltration rates where practicable and reflect both the infiltration rate and the discharge rate to the Friston Watercourse. An integrated approach to design of the final SuDS basins will include optimising amenity, biodiversity, water quality and water quantity benefits.

2 Relevant Legislation, Policy and Guidance

8. This section sets out the relevant legislation and guidance that have informed the development of this OODMP.

2.1 Legislation

2.1.1 Flood and Water Management Act (2010)

9. Under the Flood and Water Management Act (2010), LLFAs are responsible for managing the risk of flooding from surface water, groundwater and ordinary watercourses. SCC is the LLFA covering the onshore development area and they are required to deliver a strategy for local flood risk management in their area, to investigate flooding and to maintain a register of flood risk assets.

2.1.2 The Electricity Safety, Quality Continuity Regulations 2002

10. Regulation 3(4) places obligations on generators and distributors of electricity to, as far as reasonably practicable, prevent enclosed spaces from being contaminated with fluids (including water) which may cause danger. Environments that would be caught by this regulation include customers' premises (e.g. basements or stairwells), and generators' and distributors' own premises (e.g. substations or cable basements).

2.2 Planning Policy

2.2.1 National Policy Statements

11. Overarching National Policy Statement EN-1 section 5.7 'Flood Risk' has been followed.

2.2.2 National Planning Policy Framework

12. The following National Planning Policies have been followed:

- National Planning Policy Framework (NPPF); and
- National Planning Practice Guidance (NPPG) for Flood Risk and Coastal Change.

2.2.3 East Suffolk Council Policy

13. The ESC Suffolk Coastal Local Plan (which was adopted in September 2020) includes two key policies in relation to flood risk and drainage as follows:

a. Policy SCLP9.5: Flood Risk; and

b. Policy SCLP9.6: Sustainable Drainage Systems.11.

14. Both of the above policies were reviewed in the context of the Project. The onshore substation and National Grid infrastructure locations are within Flood Zone 1, which the Environment Agency classifies as land being at low risk of flooding, having a less than 1 in 1,000 annual probability of river or sea flooding. However, as the site is greater than 1 hectare, and partly within an area that could be affected by surface water conveyance routes, a Flood Risk Assessment (FRA) is still required. The production of the FRA was in accordance with Policy SCLP9.5, whereby there is a requirement to carry out a FRA, specifically meeting the requirements of the Flood Risk National Planning Policy Guidance (and any successor).

2.2.4 Preliminary Flood Risk Assessments

15. A Preliminary Flood Risk Assessment (PFRA) for Suffolk was produced by SCC in June 2011. It was subsequently updated in December 2017.

16. The PFRA provides a high-level overview of the potential risk of flooding from local sources and identifies areas at flood risk which may require more detailed studies. PFRAs are used to identify areas that are at risk of significant flooding. The PFRA is used to inform the Local Flood Risk Management Strategy (LFRMS).

2.2.5 Strategic Flood Risk Assessments

17. Waveney District Council (WDC) and Suffolk Coastal District Council (SCDC) (now merged to form ESC) jointly commissioned a Level 1 Strategic Flood Risk Assessment (SFRA) in 2008. This was subsequently updated in 2018 (WDC and SCDC 2018).

18. A review of information contained within the Level 1 SFRA has been carried out to inform the understanding of flood risk issues within the onshore development area. This can be found in ***Appendix 20.3 Flood Risk Assessment*** (APP-496).

19. A Level 2 SFRA was prepared on behalf of WDC and SCDC and published in June 2018. The purpose of the Level 2 assessment is to analyse the level of flood risk associated with allocated development sites within their study area, in accordance with the NPPF and the NPPG.

20. Five allocated development sites were identified for assessment in the Level 2 SFRA. These sites were allocated during the ongoing formulation of the WDC Local Plan and are all located in the Lowestoft area. As none of the five allocated development sites are within the onshore development area, the Level 2 SFRA was not considered further by the Applicant (***section 20.3.5*** of ***Appendix 20.3 Flood Risk Assessment*** (APP-496)).

2.2.6 Suffolk Flood Risk Management Strategy

21. SCC's Flood Risk Management Strategy (FRMS) was published in 2016 and it outlines the aims and objectives of SCC as the LLFA and provides their policies based on these aims.

22. Critical Drainage Areas (CDAs) are those that fall within Flood Zone 1 that experience critical drainage problems as notified by the Environment Agency[1].

23. The Town and Country Planning (Development Management Procedure) (England) Order 2015 provides that in granting permission for development, other than minor development, which is to be carried out on land in area within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency, the local planning authority must consult the Environment Agency.

24. Consideration of CDAs is therefore necessary to inform key flood risk priorities. The FRMS indicates that local authorities should identify CDAs within their SFRA. The Level 1 SFRA (WDC and SCDC 2018) indicated that SCDC and WDC has no defined CDAs.

2.2.6.1 Appendix A – Sustainable Drainage Systems (SuDS)

25. SCC's FRMS Appendix A – Sustainable Drainage Systems (SuDS) A Local Design Guide, was published in May 2018. It sets out the guidelines for planning applications for all major developments, including the need for a site-specific drainage strategy.

26. It is noted that the Projects are Nationally Significant Infrastructure Projects and require DCOs rather than planning permission.

27. SCC's FRMS Appendix A – Sustainable Drainage Systems (SuDS) A Local Design Guide summarises the local guidelines for Suffolk and sets out in Section 5 the Suffolk Design Principles, specifically noting that SuDS should:

- Not increase flood risk off site (in all events up to the 1 in 100 year return period);
- Provide adequate standards of flood protection on site - in most cases no flooding inside buildings in events up to a 1 in 100 year return period and no flooding in other areas (apart from designated flood paths / storage areas) in events up to 1 in 30 year return period;
- Take account of the construction, operation and maintenance requirements of both surface and subsurface components, allowing for any

[1] https://www.gov.uk/guidance/flood-risk-assessment-in-flood-zone-1-and-critical-drainage-areas

personnel, vehicle or machinery access required to undertake this work; and

- Make allowances for climate change for all return periods.

28. The Suffolk Design Principles also set out requirements related to discharge rates, volume control and climate change allowances.

29. The Suffolk Design Principles advise that the drainage system for a site be designed for a 20% increase in rainfall as a result of climate change and that during the design a sensitivity check should be carried out for a 40% increase in rainfall to assess wider flood risk. However, SCC has requested that the Applicant design a SuDS which accounts for a 40% increase in rainfall as a result of climate change, therefore 40% has been applied throughout this OODMP. Further discussion on how elements of the Suffolk Design Principles will be incorporated into the final Projects drainage designs are discussed further in ***section 4***.

2.3 Guidance

2.3.1 British Standards

30. The following British Standards have informed the outline SuDS design for the onshore substations and National Grid infrastructure:

- Drain and sewer systems outside buildings (British Standard EN 752:2017);
- Separator systems for light liquids (British Standard EN 858 1:2002) and
- Gravity drainage systems inside building (British Standard EN 12056 3:2000).

2.3.2 Construction Industry Research and Information Association

31. The following guidance from the Construction Industry Research and Information Association (CIRIA) has informed the outline SuDS design for the onshore substations and National Grid infrastructure:

- CIRIA C753 SuDS Manual (Dec 2015); and
- CIRIA C762 Environmental Good Practice on Site (4th Edition 2016).

2.3.3 Design Manual for Roads and Bridges

32. The following guidance from the Design Manual for Roads & Bridges (DMRB) has informed the outline SuDS design for the onshore substations and National Grid infrastructure:

- DMRB: Vol 4 Section 2 Part 7 HA 107/04 Design of Outfall and Culvert Details; and
- DMRB: Vol 4 Section 2 Part 1 HA 106/04 Drainage of Runoff from Natural Catchments.

2.3.4 Environment Agency Guidance

33. The following Environment Agency guidance notes and documents[2] have informed the outline SuDS design for the onshore substations and National Grid infrastructure:

- Pollution Prevention Guidance (PPG) 1 General Guide to the Prevention of Water Pollution;
- PPG3 Use and Design of Oil Separators in Surface Water Systems;
- PPG4 Disposal of Sewage where no Mains Drainage is Available; and
- PPG5 Works in, or liable to affect Watercourses.

[2] These publications were all withdrawn in 2015, however still provide useful information to ensure best practice is achieved.

3 Existing Conditions

3.1 Overview

34. This section presents an overview of the existing conditions in and around the onshore substations and National Grid infrastructure locations. In establishing the baseline, existing infiltration rates and greenfield runoff rates can be identified which will allow the final onshore substations and National Grid infrastructure designs to be optimised in order to avoid exceedance of the existing runoff rate.

3.2 Methodology for Establishing Existing Conditions

35. This OODMP has been informed by documentation existing at the time of production. During the detailed design the final ODMP will be informed by any newly published documentation and will include details of how the existing conditions are established.

36. The data sources used to inform the water resources and flood risk baseline as per ***Chapter 20 Water Resources and Flood Risk*** (APP-068) and ***Appendix 20.3 Flood Risk Assessment*** (APP-496) are outlined in ***Table 3.1***.

Table 3.1 Data Sources

Data	Year	Coverage	Confidence
Environment Agency's Flood Map for Planning	2018	Nationwide	High
Environment Agency's Risk of Flooding from Surface Water	2018	Nationwide	Medium
Environment Agency's Risk of Flooding from Rivers and Sea	2018	Nationwide	High
Environment Agency's Catchment Data Explorer for Water Framework Directive (WFD) River Basin Districts Management Catchments, Operational Catchments and WFD water bodies	2017	Nationwide	High
Environment Agency fisheries survey data	2017	Local	High
Environment Agency Product 4 Detailed Flood Risk Assessment Map for Knodishall and Thorpeness	2017	Local	High
Environment Agency groundwater and surface water abstractions data	2018	Local	High
Environment Agency priority species data	2018	Local	High
Suffolk County Council River and Sea Flood Risk and Incident Map	2018	Local	High

Data	Year	Coverage	Confidence
Suffolk County Council Surface Water Flood Risk and Incident Map	2018	Local	High
BMT (2020) Friston Surface Water Study – Technical Report[3]	2020	Local	High

37. The Applicant has also adopted the Environment Agency's surface water flood risk definitions for reference in this report. These are summarised in ***Table 3.2***.

Table 3.2 Summary of Environment Agency Flood Risk Definitions

Probability of Surface Water Flooding	Return Periods
Very low	Land with less than 1 in 1,000 annual probability of surface water flooding (<0.1%).
Low	Land with between 1 in 1,000 and 1 in 100 annual probability of surface water flooding (0.1% - 1%).
Medium	Land with between 1 in 100 and 1 in 30 annual probability of surface water flooding (1% - 3.3%).
High	Land with greater than 1 in 30 annual probability of surface water flooding (>3.3%).

3.3 Existing Land Use

38. The onshore substations and National Grid infrastructure would be located on agricultural land of Grade 2 (very good) and Grade 3 (good to moderate) quality. This is shown in ***Figure 21.3*** (APP-270) and included in this document as ***Figure 1*** (***Appendix 1***). Further details on existing land use is presented in ***Chapter 21 Land Use*** (APP-069).

3.4 Hydrological Catchment(s)

39. The Level 1 SFRA (WDC and SCDC 2018) focussed on fluvial flood risk in a number of key catchments. The onshore substations and National Grid infrastructure are primarily located in the Friston Watercourse catchment, a tributary of the River Alde. The Level 1 SFRA does not cover this watercourse specifically and therefore information on the flood risk from the Friston Watercourse has been based on historic anecdotal information provided by the

[3] A report commissioned by SCC to determine surface flood water risk to the village of Friston following flooding events in 2019

local community. The Friston Watercourse is designated as Main River by the Environment Agency south of Church Road.

40. A small area of the National Grid infrastructure, associated with modifications to the existing overhead lines, are partially located within the Hundred River catchment. The Level 1 SFRA notes that the Hundred River is a coastal draining river which flows through the low-lying Beachfarm Marshland before entering the sea. However, the flood extent within the Level 1 SFRA also confirms that the National Grid infrastructure is located within Flood Zone 1 along with the onshore substations (***Figure 20.2*** (APP-266) included in this document as ***Figure 2*** (***Appendix 1***)). Therefore, the onshore substations and National Grid infrastructure are at low risk of flooding from fluvial sources.

41. The final ODMP will include a topographic survey which validates the existing conditions.

3.5 Existing Ground Conditions

42. The onshore substations and National Grid infrastructure locations are underlain by a Principal Aquifer in the Chalk bedrock (***Figure 18.4*** (APP-255), included in this document as ***Figure 3*** (***Appendix 1***)). The onshore substations and National Grid infrastructure are also underlain by Secondary (A, B and undifferentiated) aquifers in the superficial crag deposits, as reported in section 20.4.3.5 of ***Appendix 20.3 Flood Risk Assessment*** (APP-496).

43. The Level 1 SFRA (WDC and SCDC 2018) indicated that groundwater flooding is most likely to occur in low-lying areas which are underlain by permeable rock (aquifers), particularly after periods of sustained rainfall.

44. The Level 1 SFRA notes that the British Geological Survey (BGS) Susceptibility to Groundwater Flooding map shows the vast majority of the SFRA study area has a designation of *"Limited potential for groundwater flooding to occur"*, except in some concentrated areas surrounding the watercourses where the designation given is *"Potential for groundwater flooding to occur at surface"*.

45. There are five unlicensed (private) abstractions known to the Environment Agency close to (but outside) the onshore development area and a further three observation boreholes in the area (which may also be used for abstraction) (***Figure 18.4*** (APP-255)), included in this document as ***Figure 3*** (***Appendix 1***)). All but one of the unlicensed abstraction points appear to be related to non-industrial abstractions, therefore any abstraction is likely to have minimal impact on local groundwater resources and therefore minimal effect on the risk of flooding from groundwater sources.

46. Given the above, the onshore substations and National Grid infrastructure are considered to be at low risk of flooding from groundwater sources.

47. The final ODMP will be produced to include details of ground investigations which validates the existing conditions.

3.6 Background to Historic Flooding

48. The onshore substations and National Grid infrastructure are located within Flood Zone 1, at low risk from fluvial or tidal sources. There has been no history of flooding from these sources identified as part of the FRA for the onshore substations and National Grid infrastructure (***Appendix 20.3 Flood Risk Assessment*** (APP-496)); however, this does not mean that flooding has not occurred in the past.

49. As the onshore substation and National Grid infrastructure are located within Flood Zone 1, which the Environment Agency classifies as land being at low risk of flooding, a sequential test is not required, as per the UK Government guidance on the sequential test for Applicant (UK Government, 2012, updated 2017). Furthermore, any other potential sources of flood risk will be managed through the adoption of mitigation measures to ensure there is no risk to the Project, or resulting from the Project following development.

50. The National Grid substation, National Grid Construction Consolidation Site (CCS), cable sealing end compounds and permanent substation operational access road are located in an area with varying risk of surface water flooding. The northern and western boundary around the National Grid substation, including the cable sealing end compounds, and part of the footprint of the National Grid substation, includes areas at both high risk of surface water flooding (i.e. greater than 1 in 30 annual probability of surface water flooding) and medium risk of surface water flooding (i.e. between 1 in 100 and 1 in 30 annual probability of surface water flooding). This flood risk is associated with the drainage of surface water from the north in proximity to Little Moor Farm.

51. The onshore substations and onshore substations CCS are located in areas primarily at very low risk of surface water flooding (i.e. land with less than 1 in 1,000 annual probability of surface water flooding).

52. As part of the onshore substations and National Grid infrastructure a permanent substation operational access road will be built, to serve the onshore substations and National Grid infrastructure. In addition, permanent access tracks to the cable sealing end compounds will be built to the north of the National Grid substation. Parts of the substation operational access road are likely to cross areas at both high risk of surface water flooding (i.e. greater than 1 in 30 annual probability of surface water flooding) and medium risk of surface water flooding (i.e. between 1 in 100 and 1 in 30 annual probability of surface water flooding) (***Figure 20.3.3*** of ***Appendix 20.3 Flood Risk Assessment*** (APP-496), included in this document as ***Figure 4*** (***Appendix 1***)).

53. Flood incident records as recorded by the LLFA (received by the Applicant in July 2018) are reported as having a low priority and are generally located along the B1121 Saxmundham Road (section 20.4.3.6 of ***Appendix 20.3 Flood Risk Assessment*** (APP-496)).

54. Subsequent information received from the LLFA (19th November 2019) has indicated that more recent surface water flooding events (occurring in October 2019) has affected the area around Friston.

55. There is a known (variable) risk associated with surface water flooding in proximity to the onshore substation and National Grid infrastructure.

3.6.1 Historic Rainfall and Flooding Events

3.6.1.1 Onshore Substations and National Grid Substation

56. The Product 4 data package (Annex 1 of ***Appendix 20.3 Flood Risk Assessment***) obtained from the Environment Agency does not indicate any records of flooding in the location of the onshore substations or the National Grid infrastructure. The Environment Agency indicate, in their Product 4 data package, that although there are no records of flooding, this does not mean that it has not been subject to flooding, only that no flooding has been reported to them in this location.

57. Information contained within the Level 1 SFRA (WDC and SCDC, 2018) does not show historic flooding to have affected the onshore substation or the National Grid infrastructure location.

58. Within the Level 1 SFRA flood incidents related to foul or surface sewers, groundwater, highways drainage, surface water and other sources were identified. A review of the Level 1 SFRA indicates reports of highway drainage issues in the vicinity of Friston; however, this is outside the area identified for the onshore substation and National Grid infrastructure.

3.6.1.2 Friston

59. SCC appointed BMT in 2019 to undertake an assessment of surface water flood risk in Friston, Suffolk following flooding events (BMT, 2020). BMT produced a hydraulic model[4] with the purpose of assessing both the current and potential future flood risk from surface water including the impact of climate change.

60. The Friston Surface Water Study Technical Report produced by BMT (2020) notes that the village of Friston has a well-documented history of surface water

[4] The Applicant notes that the outputs from the proposed hydraulic model may differ from the Friston Surface Water Study Technical Report (BMT, 2020) as it will be based on site investigation information which will be focused on the substation area and contributing catchments and used to inform the development of the detailed design. The Friston Surface Water Study Technical Report (BMT, 2020) focuses on the local surface water flood risk to the village of Friston.

flooding through anecdotal evidence as well as reported incidents, the most recent significant event occurring in October 2019. On 6th October 2019, a storm event triggered large amounts of surface water runoff from both the upstream catchment through Friston, as well as from surrounding fields which drain toward the village centre and the Friston River which flows North-South, in and out of culvert along Low Road, Friston.

61. The observed event was well documented, with significant flow observed running along Grove Road, Aldeburgh Road, Saxmundham Road and Low Road.

62. The model was informed by rainfall data which was supplied from the Thorpeness rainfall gauge which is 5km from Friston.

3.6.1.3 Return Period of October 2019 Event

63. The modelling carried out by BMT, on behalf of SCC, was assessed against a number of theoretical return period rainfall events and for a variety of different storm durations. The modelling report by BMT (BMT, 2020) does not appear to have carried out a detailed rainfall analysis or provided a conclusion on the return period for the October 2019 rainfall event.

64. SCC indicated via email (25th September 2020) that the return period for this rainfall event was equivalent to approximately a 1 in 40-year event. Rainfall information or data related to this event, where available, will be reviewed further during the detailed drainage design to understand potential implications for the onshore substation and National Grid infrastructure.

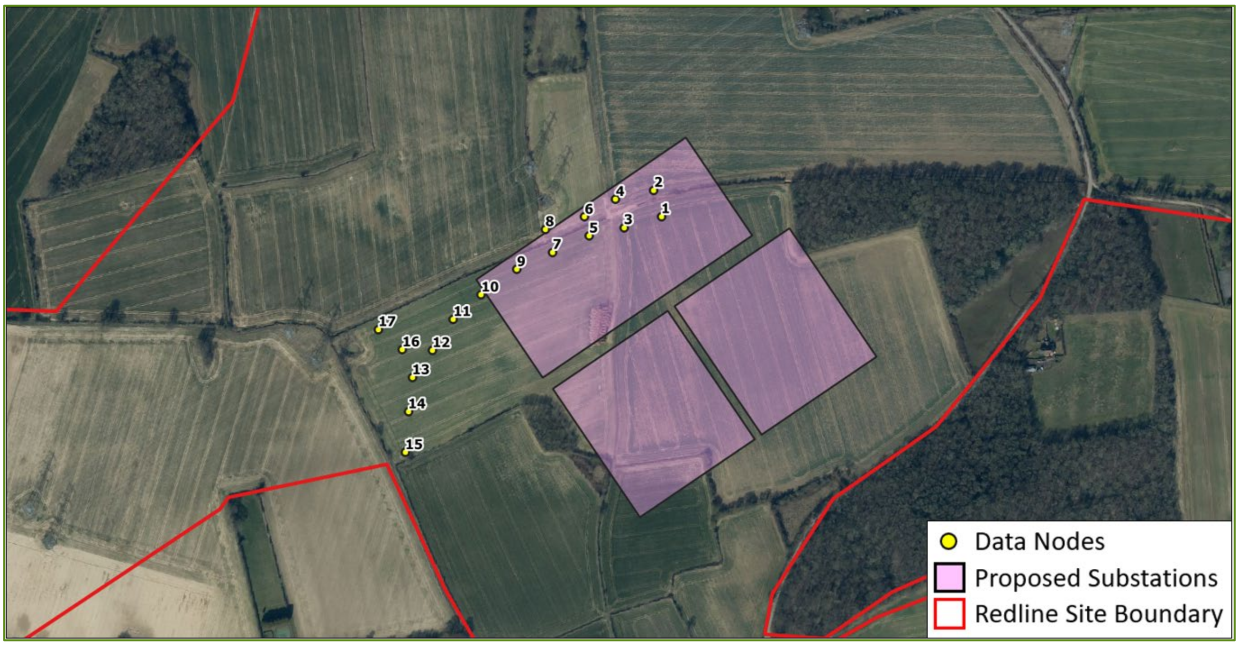
65. No other flooding events with accompanying rainfall data have been identified to understand the significance of key return period events in the area.

3.6.1.4 Applicant's Analysis of Results Data in the Friston Surface Water Study Technical Report

66. The Applicant reviewed the Friston Surface Water Study Technical Report (BMT, 2020) upon publication.

67. Following ISH 11, the Applicant analysed the modelling results, which were carried out in the Tuflow specialist modelling software, by assessing the maximum water depths and velocities at 17 key node points, as shown in ***Plate 3.1***.

Plate 3.1 Node Location Points Used to Collate the Data in *Table 3.3* and *Table 3.4*



68. The outputs of the assessment of these 17 nodes can be seen in ***Table 3.3*** and ***Table 3.4***. ***Table 3.3*** presents information on maximum water depths and ***Table 3.4*** shows data on the maximum velocities, both during a 6 hour storm duration.

Table 3.3 Maximum Water Depths (m) for Baseline Rainfall Events (6 Hour Storm Duration)

Node ID	5yr	20yr	30yr	100yr	100yr (central climate change allowance)	100yr (upper climate change allowance)	1,000yr
1	0.007	0.010	0.011	0.016	0.020	0.023	0.029
2	0.022	0.031	0.034	0.044	0.050	0.057	0.070
3	0.107	0.115	0.118	0.128	0.136	0.144	0.156
4	0.172	0.180	0.183	0.192	0.199	0.205	0.217
5	0.021	0.028	0.030	0.039	0.045	0.051	0.060
6	0.003	0.005	0.006	0.010	0.013	0.016	0.022
7	0.020	0.027	0.030	0.037	0.043	0.048	0.056
8	0.023	0.030	0.033	0.042	0.048	0.055	0.065
9	0.011	0.017	0.019	0.025	0.030	0.034	0.041
10	0.000	0.002	0.003	0.006	0.010	0.014	0.021
11	0.004	0.008	0.010	0.015	0.019	0.023	0.030
12	0.015	0.023	0.026	0.033	0.038	0.043	0.050

Node ID	5yr	20yr	30yr	100yr	100yr (central climate change allowance)	100yr (upper climate change allowance)	1,000yr
13	0.014	0.026	0.029	0.037	0.042	0.047	0.086
14	0.010	0.024	0.027	0.037	0.045	0.051	0.083
15	0.140	0.149	0.151	0.159	0.165	0.170	0.200
16	0.017	0.020	0.021	0.024	0.025	0.027	0.081
17	0.000	0.000	0.000	0.000	0.000	0.000	0.017

Table 3.4 Maximum Velocities (m/s) for Baseline Rainfall Events

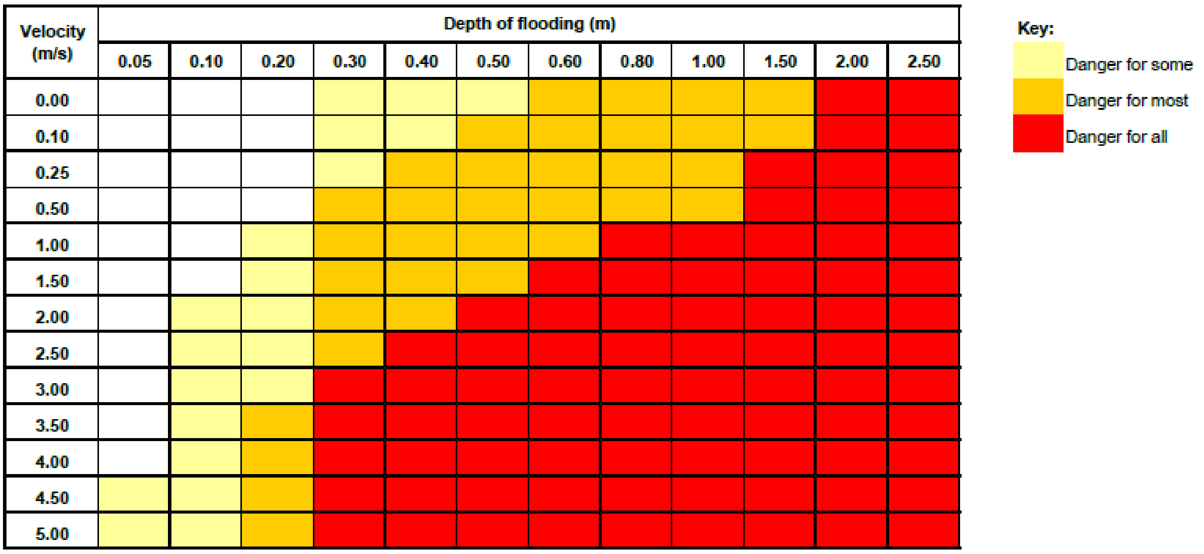
Node ID	5yr	20yr	30yr	100yr	100yr (central climate change allowance)	100yr (upper climate change allowance)	1,000yr
1	0.122	0.152	0.160	0.191	0.215	0.234	0.265
2	0.030	0.054	0.064	0.101	0.129	0.157	0.211
3	0.037	0.035	0.036	0.035	0.036	0.041	0.066
4	0.017	0.018	0.018	0.028	0.038	0.051	0.076
5	0.112	0.149	0.161	0.201	0.232	0.260	0.302
6	0.078	0.126	0.141	0.191	0.227	0.264	0.334
7	0.136	0.182	0.195	0.237	0.267	0.293	0.330
8	0.034	0.060	0.068	0.101	0.121	0.137	0.163
9	0.192	0.245	0.265	0.312	0.347	0.376	0.417
10	0.023	0.056	0.069	0.099	0.119	0.139	0.170
11	0.091	0.138	0.150	0.194	0.224	0.252	0.292
12	0.089	0.104	0.109	0.132	0.153	0.172	0.204
13	0.031	0.029	0.034	0.034	0.043	0.063	0.238
14	0.022	0.086	0.100	0.150	0.182	0.208	0.342
15	0.027	0.027	0.027	0.027	0.031	0.040	0.084
16	0.055	0.056	0.057	0.057	0.056	0.056	0.379
17	0.021	0.023	0.023	0.024	0.026	0.026	0.447

69. The results shown in ***Table 3.3*** and ***Table 3.4*** have confirmed the Applicant's analysis in ***Section 3***; that although there is a surface water conveyance route through the National Grid substation location (see ***Figure 4*** of ***Appendix 1***), there is no flood hazard risk.

70. To demonstrate this, the Applicant refers to Flood Risk Assessment Guidance for New Development Phase 2 Framework and Guidance for Assessing and Managing Flood Risk for New Development – Full Documentation and Tools R&D Technical Report FD2320/TR2 – Flood Risk to People, published by DEFRA and the Environment Agency as part of their Flood and Coastal Defence R&D Programme (October 2005). Within this report a Velocity, Depth and Flood Hazard Matrix is presented which takes into account the depth and velocity of surface water conveyance routes to derive a flood hazard rating (see ***Plate 3.2***).

71. The outputs of the Flood Risk to People report indicate that flood depths below 0.25 m and velocities below 0.5 m/s are considered *'very low hazard'*.

Plate 3.2 Velocity, Depth and Flood Hazard Matrix (DEFRA, 2006)



Flood Hazard Rating (HR)	Colour Code	Hazard to People Classification
Less than 0.75		Very low hazard - Caution
0.75 to 1.25		Danger for some – includes children, the elderly and the infirm
1.25 to 2.0		Danger for most – includes the general public
More than 2.0		Danger for all – includes the emergency services

72. When looking at ***Plate 3.2*** and taking into account the maximum depths and velocities shown in ***Table 3.3*** and ***Table 3.4***, it can be concluded that the flood risk at the onshore substation and National Grid substation locations is <0.75 which is classed as a *'very low hazard'*, as per the DEFRA / Environment Agency (2006) Velocity, Depth and Flood Hazard Matrix.

73. ***Table 3.5*** uses the below formula provided by DEFRA / Environment Agency (2006):

Depth x (Velocity + Velocity Coefficient) + Debris Factor = Flood Hazard Rating

- The Velocity Coefficient is a fixed value of 0.5.
- The Debris Factor is 0 for all land uses with a flood depth of 0m - 0.25m.

74. ***Table 3.5*** summarises the hazard rating for all 17 node points for key return period events. 5 year and 20 year return periods have not been included as they are smaller events than those utilised for surface water flood risk mapping. The two scenarios for 1 in 100 year with climate change allowance are not included as the Applicant is looking to ascertain the current baseline flood risk.

Table 3.5 Summary of Maximum Depths (m) and Velocities (m/s) in relation to the Flood Hazard Matrix (DEFRA / Environment Agency, 2006)

Node ID	30yr depth (m)	30yr velocity (m/s)	30yr hazard	100yr depth (m)	100yr velocity (m/s)	100yr hazard	1,000yr depth (m)	1,000yr velocity (m/s)	1,000yr hazard
1	0.011	0.160	0.007	0.016	0.191	0.011	0.029	0.265	0.022
2	0.034	0.064	0.019	0.044	0.101	0.026	0.070	0.211	0.050
3	0.118	0.036	0.063	0.128	0.035	0.068	0.156	0.066	0.088
4	0.183	0.018	0.095	0.192	0.028	0.101	0.217	0.076	0.125
5	0.030	0.161	0.020	0.039	0.201	0.027	0.060	0.302	0.048
6	0.006	0.141	0.004	0.010	0.191	0.007	0.022	0.334	0.018
7	0.030	0.195	0.021	0.037	0.237	0.027	0.056	0.330	0.046
8	0.033	0.068	0.019	0.042	0.101	0.025	0.065	0.163	0.043
9	0.019	0.265	0.015	0.025	0.312	0.020	0.041	0.417	0.038
10	0.003	0.069	0.002	0.006	0.099	0.004	0.021	0.170	0.014
11	0.010	0.150	0.007	0.015	0.194	0.010	0.030	0.292	0.024
12	0.026	0.109	0.016	0.033	0.132	0.021	0.050	0.204	0.035
13	0.029	0.034	0.015	0.037	0.034	0.020	0.086	0.238	0.063
14	0.027	0.100	0.016	0.037	0.150	0.024	0.083	0.342	0.070
15	0.151	0.027	0.080	0.159	0.027	0.084	0.200	0.084	0.117
16	0.021	0.057	0.012	0.024	0.057	0.013	0.081	0.379	0.071

Node ID	30yr depth (m)	30yr velocity (m/s)	30yr hazard	100yr depth (m)	100yr velocity (m/s)	100yr hazard	1,000yr depth (m)	1,000yr velocity (m/s)	1,000yr hazard
17	0.000	0.023	0.000	0.000	0.024	0.000	0.017	0.447	0.016
Av.	0.043	0.099	0.024	0.050	0.124	0.029	0.076	0.254	0.052

75. ***Table 3.5*** shows that the average (av.) 30 year, 100 year and 1,000 year hazards are 0.024, 0.029 and 0.052, respectively. All of these average values are towards the lower end of the threshold for the hazard rating that is deemed to be *'very low hazard'* (i.e. any values less than 0.75). The greatest hazard rating value within the site is 0.125, which is still well below the threshold value. Therefore, even during a 1 in 1,000 year event, there is no flood hazard risk to the onshore substation and National Grid substation locations.

76. The Applicant notes that the data from the Friston Surface Water Study Technical Report (BMT, 2020) confirms the current understanding of the potential flood risk to the site and does not change any of the material outputs within this OODMP. The above assessment supports the previous conclusions made by the Applicant around the baseline conditions and it can be concluded that there is no flood hazard risk.

3.7 Existing Hydrological and Hydrogeological Context

77. Regionally, the principal groundwater body underlying the onshore development area is the Waveney and East Suffolk Chalk and Crag. WFD classification data (Environment Agency, 2016) demonstrate that groundwater is under pressure from abstractions of groundwater and connected surface waters for arable agricultural uses, and from diffuse source pollution from livestock farming. Saline intrusion is not considered to be an issue, as adverse effects on groundwater-dependent terrestrial ecosystems and surface water bodies are not reported.

3.7.1 Existing Friston Catchment

78. The Friston Surface Water Study Technical Report (BMT, 2020) notes that the upper reaches of the Friston catchment consist of mainly arable land, with a number of large fields constituting most of the land cover. It also notes that the Friston River drains a catchment area of approximately 11km^2 to the southeast of Saxmundham via an open channel which is culverted in parts before flowing in open channel to its confluence with the tidal River Alde.

79. The upstream catchment collects surface water flow before draining into a box culvert which runs along the majority of Low Road (Figure 1-3 of BMT (2020)). Roughly two thirds of the way along Low Road, the watercourse re-emerges

into an open channel which is subject to extensive vegetation growth. Downstream of Friston village, adjacent to a pig farm is a flood storage area and downstream of this the channel widens and becomes much flatter with shallower gradients leading to the confluence with the River Alde.

3.7.2 Existing Ground Conditions

80. The existing ground conditions at the onshore substations and National Grid infrastructure location are described in ***section 3.5*** and are located within an area shown as having a *"limited potential for groundwater flooding to occur"* (WDC and SCDC, 2018). This is supported by section 2.2.2 of the BMT (2020) report which notes that soil types present in the upper catchment are very permeable, with many perforated pipes used to drain the soils, all of which contribute flow to the field drainage ditches and feed the lower catchment. The superficial geology is glacial till and eroded fluvial deposits. The Friston Surface Water Study Technical Report (BMT, 2020) also notes that the upper catchment is predominately made up of clay soils. In the village the soils become sandier.

81. To confirm the validity of the above description of the existing ground conditions, as provided in the Friston Surface Water Study Technical Report (BMT, 2020), the final ODMP will include details of the scope, extent and findings of the soil surveys which are required to validate the existing conditions.

3.7.3 Background to Catchment Hydraulic Modelling

82. Within the Friston Surface Water Study Technical Report (BMT, 2020) it was noted that previously 1D-2D hydraulic modelling of the Friston Catchment was carried out by Jeremy Benn Associates Consulting, on behalf of the Environment Agency, for a wider flood risk mapping study and the results summarised in the report Essex, Norfolk and Suffolk Survey and Model Build: Friston River, (JBA Consulting, November 2016). However, it is noted that the JBA model does not extend further north than Church Road, and therefore does not reflect the entire hydrological catchment or include the proposed area for the onshore substations and National Grid infrastructure.

83. Subsequently BMT developed a 2D model to investigate surface water runoff in the Friston catchment and the flooding to Friston in October 2019. The results of this modelling have been reviewed and considered within this OODMP and will be considered further to inform the drainage design for the onshore substations and National Grid infrastructure. The results of the modelling carried out by BMT (2020) supported the existing understanding of flood risk to the onshore substations and National Grid infrastructure.

84. The final ODMP will be produced to include details of the scope and extent of the catchment hydraulic model required to validate the existing conditions,

informed by a series of surveys including, but not limited to, those described in ***section 3.5*** of this document.

3.7.4 Presence of Existing Gauges in the Catchment (Rainfall and Flow)

85. Rain gauges are located at Thorpeness which is located 5km east from the Friston catchment and Woodbridge which is located approximately 6km northeast of Friston.

86. For the Friston Surface Water Study (BMT, 2020), BMT noted that antecedent rainfall was not included within the Thorpeness data pack, which is a key requirement to calculate the initial soil moisture of the catchment leading up to rainfall events. To determine this for the rainfall event of 6th October 2019, the previous 12 months of rainfall data leading up to the event was obtained for use in the Friston Surface Water Study Technical Report (BMT, 2020) from the Woodbridge rain gauge.

87. Due to the nature of the flood risk in the catchment there are no flow or level gauges that would be beneficial to understanding the surface water flood risk in the upper Friston catchment.

3.8 Infiltration Potential

88. The final ODMP will reflect the findings of further infiltration testing to be undertaken during the detailed design stage, which will confirm the infiltration potential of the soils within the proposed SuDS basin locations and allow the optimisation of infiltration within the SuDS basins where practicable.

3.8.1 Infiltration Testing Results

89. The Applicant undertook an initial infiltration testing at the proposed SuDS basin locations in April 2021, which were superseded by more comprehensive infiltration testing in May 2021. The full methodology and results of these tests are documented in ***Infiltration Test Results (May 2021)*** (AS-129). The results of the testing have been shared with the LLFA and are summarised in ***Table 3.6***.

Table 3.6 Summary of May 2021 Infiltration Testing

Proposed SuDS Basin Location	Test Pit Ref. No.	Test No.	Infiltration Rate (mm/hr)	Average Rate (mm/hr)	Lowest Rate (mm/yr)
National Grid Substation	TP012b	1	36	59	36
		2	46		
		3	95		
	TP013b	1	12	10	7

Proposed SuDS Basin Location	Test Pit Ref. No.	Test No.	Infiltration Rate (mm/hr)	Average Rate (mm/hr)	Lowest Rate (mm/yr)
		2	10		
		3	7		
	TP014c	1	34	30	26
		2	29		
		3	26		
Onshore Substations	TP015b	1	75	76	63
		2	63		
		3	91		
	TP016b	1	46	39	35
		2	35		
		3	36		
	TP017b	1	98	71	50
		2	66		
		3	50		
Between National Grid Substation and Onshore Substations	TP330b	1	8	8	8
		2	-		
		3	-		

90. With the exception of TP017b (Test 1 and Test 2), all test results have been extrapolated to calculated t_{25} (the time for the water level to fall to 25% effective storage depth) to aid with the calculation of the infiltration rates at each location. The real-time recording of water depths at each test pit are presented in ***Appendix 1*** of ***Infiltration Test Results (May 2021)*** (AS-129).

91. The results show a range of infiltration rates at seven different locations. Observations identified that the results at TP012b improved as the tests took place. This mirrors the results achieved at the adjacent TP012a pit (during previous testing in April 2021 (AS-121)), which demonstrates consistency in the soil characteristics. Although this is unusual, as typically the results reduce as the tests progress at that location, it is possible and may be due to the silt washing

away in clusters of more gravely soils, therefore creating more favourable conditions in the infiltration pathway as the three tests progress.

92. For the National Grid substation SuDS basin, the average infiltration rate is considered to be unsuitable for infiltration to be incorporated. Therefore, the Applicant proposes to adopt an attenuation only design for this basin, as agreed with the LLFA.

93. For the onshore substations SuDS basin, the average infiltration rate of the lowest test result for TP015b, TP016b and TP017b is 49.3mm/hr. In order to take a conservative approach at this location, the Applicant has agreed a 40mm/hr infiltration rate with the LLFA for drainage calculations at this outline design stage of the Projects (with storage for a 1 in 30 year return period (plus 40% for climate change)). Ithas been agreed with the LLFA to progress a hybrid SuDS basin (i.e. a combination of infiltration and attenuation) at this location.

94. Post-consent, the infiltration rate of each SuDS basin will be verified by further BRE-365 compliant infiltration testing, the results of which will be used in the detailed design of the SuDS basins.

3.9 Existing Runoff Rate to Friston Watercourse

95. The existing pre-development greenfield runoff rates from the onshore substations and National Grid infrastructure location, used to inform the concept design of the ***Outline Landscape and Ecological Management Strategy*** (document reference 8.7), are summarised in ***Table 3.7*** below.

96. Runoff rates in ***Table 3.7*** below are expressed using a method based on the Flood Estimation Handbook (1999) 2013 depth duration frequency (DDF) rainfall estimates (FEH 2013) produced by the UK Centre for Ecology and Hydrology. As requested by SCC, the Applicant has provided runoff rates using the FEH 2013 method as it ensures a conservative approach.

97. Existing runoff from the onshore substations and National Grid infrastructure site will flow overland and into adjacent field drains with some of the water making its way through the catchment to the Friston Watercourse.

Table 3.7 Pre-Development Runoff Rates (using the FEH 2013 method)

Design Parameters / Assumptions	Onshore Substations FEH 2013 (Total) (l/s)	National Grid Infrastructure FEH 2013 (Total) (l/s)
2 l/s/ha	17.78	12.9
1 Year Return	6.88	4.81

Design Parameters / Assumptions	Onshore Substations FEH 2013 (Total) (l/s)	National Grid Infrastructure FEH 2013 (Total) (l/s)
2 Year Return (Q_{BAR})[5]	**7.91**	**5.52**
30 Year Return	19.38	13.53
100 Year Return	28.15	19.66
200 Year Return	33.3	23.25

3.10 Existing Site Characteristics

98. Currently, there are three natural depressions at the onshore substations and National Grid substation locations which act as natural water storage basins. At this stage of the Project's initial design, the Applicant proposes that one is relocated, and that two will remain where they are currently situated (see ***Appendix 5***). Hydraulic catchment modelling undertaken during the detailed design stage will confirm the functionality of the two remaining depressions and should they be affected will be compensated for within the final surface water drainage design.

99. There is also a natural surface water conveyance route which runs through the National Grid substation location, as show in ***Figure 4*** of ***Appendix 1***. During detailed design the Applicant will ensure that the surface water conveyance route is diverted around the northern perimeter of the National Grid substation. No culverting or piping will be used to divert this flow route, instead the Applicant will seek to work with and refine the natural topography of the area to accommodate the flow, as well as the realignment of existing ordinary watercourses.

100. The Applicant will ensure that any SuDS design developed will account for and work with these natural, existing features and will be reflected in the final design and positioning of the onshore substations and National Grid infrastructure. In limiting runoff from the Project, the site specific SuDS design will reduce the flood risk to the site and to Friston village.

[5] Discharge from the onshore substation, National Grid infrastructure, operational access road and permanent access road would be limited to the Q_{BAR} rate currently calculated as above and to be confirmed during the detailed design stage. Q_{BAR} is the peak rate of flow from a catchment for the mean annual flood.

4 Sustainable Drainage Principles for the Projects

4.1 Overview

101. The Applicant has considered the requirements of the ESC Suffolk Coastal Local Plan (adopted September 2020) with regard to Policy SCLP9.6: Sustainable Drainage Systems, noting that the proposed SuDS are also considered as part of the integration into the landscaping scheme and green infrastructure provision for the development, the extent and nature of which is to be finalised at detailed design.

102. The drainage strategy for the final ODMP will be developed according to the principles of SCC's SuDS hierarchy (2018) and LFRMS (SCC, 2016) as follows:

    i. into the ground (infiltration) (see ***section 4.2***);

    ii. to a surface water body (attenuation) (see ***section 4.3***);

    iii. to a surface water sewer, highway drain or another drainage system (conveyance) (see ***section 4.4***); or

    iv. to a combined sewer.

103. The first three principles are described in more detail in the subsequent sections.

4.2 Infiltration

104. Infiltration refers to allowing or encouraging water to soak into the ground, through the natural hydrologic processes. This is normally the most desirable solution for disposal of surface water from rainfall (and is the first principle of SCC's SuDS discharge hierarchy) as it does not create any additional runoff and contributes directly to the recharge of the underlying groundwater.

105. Pre-construction ground investigations of the onshore substations and National Grid infrastructure ground conditions will be undertaken and will inform the detailed design of the Projects and the final ODMP. As part of these investigations, infiltration tests will confirm the underlying permeability and the feasibility to dispose of surface water directly to ground or other engineered filtration systems, and to what degree. Further infiltration testing will be undertaken during the detailed design stage to complement the infiltration testing undertaken in May 2021 which have informed this OODMP.

4.3 Attenuation

106. Attenuation storage controls the rate of runoff by limiting the peak flow from the development into the receiving watercourse or drainage system. This is typically achieved through the use of a temporary storage facility, with a restricted outlet. The attenuation is sufficiently sized to detain the runoff for a given return period, but will then allow the water to discharge, at a controlled rate, back to the receiving watercourse (in this case the Friston Watercourse), over an extended period.

107. Changes in surface water runoff as a result of the increase in impermeable area from the onshore substations and National Grid infrastructure will be attenuated and discharged at a controlled rate. Requirements relating to attenuation and discharge rates will be established in line with the principles set out in this OODMP and agreed in consultation with the LLFA (SCC) and Environment Agency.

108. For the onshore substations and National Grid infrastructure, the storage will be designed to accommodate runoff from a 1 in 100 year[6] storm event plus a 40% allowance for climate change. These measures will limit the runoff to the equivalent of the pre-development greenfield runoff rate (see ***Table 3.7***) (established by the methodology within this OODMP and which will be subject to review during the detailed design of the Projects as discussed in ***paragraph 5*** above) to ensure there is no increased risk of flooding downstream of the discharge.

109. Whilst the site is operational, drainage from the substation operational access road will continue to be managed and attenuated via the National Grid basin.

4.4 Conveyance

110. Conveyance is the process of transferring surface runoff from one place to another to manage the flow and to link the various SuDS components together. Rainfall collected in impermeable areas such as the substation operational access road or roofs will, where possible, be conveyed utilising SuDS methods (such as swales). In areas where this is not feasible, rainfall will be carried via underground pipes within the drainage system to the various elements of the SuDS system to allow attenuation to take place. Similarly, perforated filter drains will collect water percolating through permeable areas and convey the same to the SuDS attenuation features.

[6] For clarity the ‘1 in 200’ rate from the ES and FRA is comparable to 1 in 100yr + 20% for climate change.

4.5 Pollutant Removal

111. Precautionary measures will be incorporated within the surface water and foul water design to ensure that in the unlikely event of pollutants entering the surface water system from the onshore substations or National Grid infrastructure, these will either be removed or suitably treated prior to discharge, to ensure there is no wider adverse environmental impact.

112. A review of the pollutant removal measures will be carried out in accordance with CIRIA C753 SuDS Manual (CIRIA, 2015). Further details will be set out in the final ODMP. The approach adopted will identify and consider the source and types of pollutants that may occur in the surface and wastewaters and show how these will be managed to prevent pollution of the receiving watercourses.

113. The normal surface water drainage is unlikely to contain elevated suspended solids, or other pollutants, in the operational phase but the drainage design includes the provision to detain and therefore aid in the settlement of any solids in the SuDS basins. The requirements for the management of foul or waste water is further described in ***section 8*** below.

114. In the operational phase, surface water collected from within the transformer bunds, or other oil-filled plant, has the potential to contain oil residues. Water from these areas will be discharged to the surface water drainage system, only after passing through a Class 1 full retention oil interceptor, provided with an oil detection and automatic device which will prevent any discharge in the case of a sudden unexpected influx of oil.

4.6 Application of the SuDS Hierarchy to the Project

115. The Applicant notes that the application of the SuDS hierarchy (SCC, 2018) is dependent on site-specific conditions which will be applied to identify an optimal drainage solution.

116. ***Section 5*** presents the surface water drainage commitments the Applicant has made and provides an overview of SuDS whilst presenting indicative assumptions for calculating a range of runoff rates and storage volumes so that the SuDS hierarchy can be applied to the site of the onshore substations and National Grid infrastructure.

117. In accordance with the SuDS hierarchy, the Applicant presents the viability of a hybrid scheme (utilising both infiltration and attenuation) for the onshore substations in ***Section 6*** and an assessment of an attenuation only scheme for the National Grid substations in ***Section 7***. The final details related to the application of the SuDS hierarchy will be determined during detailed design once site specific infiltration testing and hydraulic modelling has been undertaken.

118. ***Section 8*** considers foul water drainage produced by the onshore substations and National Grid infrastructure in their operational phase, comprising the foul water from the welfare facilities.

119. ***Section 9*** presents the Applicant's position on the optimal drainage design for the onshore substations and National Grid infrastructure, during the operational phase.

120. Drainage during the construction phase will be subject to a separate construction phase surface water and drainage management plan to be produced post consent under Requirement 22(2)(a) of the ***draft DCO*** (document reference 3.1).

5 Surface Water Drainage

121. This section presents the surface water drainage commitments the Applicant has made (***section 5.1***), an overview of SuDS components (***section 5.3***) and the methodology for calculating infiltration rates (***section 5.4***).

5.1 Commitments

122. When considering pre and post development surface water drainage the Applicant commits to the following:

- Maximising infiltration where it is shown to be practicable through further infiltration testing undertaken at the detailed design stage, establishment of the ground water levels and consideration of other land use such as landscaping, biodiversity and access;
- Where attenuation is required there will be no increase in the pre-development greenfield Q_{BAR} run-off rate to the receiving Friston Watercourse catchment;
- Any reduction or removal of existing storage depressions, if any, will be offset and accommodated within the final SuDS design;
- Existing watercourses and flow routes will be appropriately managed to ensure continued conveyance around the northern perimeter of the National Grid substation site; and
- Application of an appropriate Factor of Safety (FoS) for infiltration elements of the SuDS (currently 10 for the purpose of this OODMP).

5.2 Factor of Safety

123. For the purposes of this OODMP the Applicants has adopted a FoS of 10 to the infiltration element of the proposed onshore substations hybrid infiltration and attenuation SuDS basin. The Applicant will discuss this matter further with the LLFA during detailed design.

5.3 Sustainable Drainage System Components

124. The existing topography of the onshore substation and National Grid infrastructure locations is naturally sloping land, with gradients falling away towards the field drains to the west and south-west, so there is natural conveyance in these general directions. The surface water drainage system will be designed to utilise and support this natural change in elevation.

125. The overall drainage layout will be produced in the final ODMP following detailed design post-consent; the key components of this are described below.

5.3.1 Substation Operational Access Road

126. As part of the Projects a permanent operational access road will be built to connect Saxmundham Road to the onshore substations and National Grid infrastructure. Parts of the substation operational access road are likely to cross areas at both high risk of surface water flooding (i.e. greater than 1 in 30 annual probability of surface water flooding) and medium risk of surface water flooding (i.e. between 1 in 100 and 1 in 30 annual probability of surface water flooding). For the purposes of the current concept design and assessment it has been assumed that the substation operational access road is 100% impermeable.

127. Should there be a need for the permanent substation operational access road to be located over an existing surface water flood storage basin, either it will be relocated to an alternative suitable location (as shown in ***Appendix 5***) or the existing volume reduction will be offset and accommodated within the final SuDS design.

5.3.2 SuDS Basins

128. SuDS basins will be included at the onshore substations and National Grid infrastructure in the overall drainage layout. This layout will be informed by the detailed design of the Projects; collation of existing ground conditions data (***section 3***), including further infiltration testing; the production of a catchment hydraulic model (***section 3.7.3***); and agreement through consultation with the LLFA (SCC) of an appropriate infiltration rate and discharge rate into the Friston Watercourse as necessary (***section 5.4***) (based on the existing greenfield runoff rate).

129. In addition, the Applicant retains the option to install further infiltration or attenuation measures along the existing conveyance route during the detailed design phase. The purpose of this is to reduce water in-flow rates to the onshore substation and National Grid infrastructure area and potentially reduce flood risk for the village of Friston. This is in addition to the surface water drainage strategy currently proposed.

130. The specifications of this additional 'surface water management SuDS basin' will require development of an appropriate catchment hydraulic model. The detailed design of the onshore substations and National Grid infrastructure will include the size, volume and location of this basin. Trees or shrubs will not be planted inside or within 5m of the footprint of the SuDS basins.

131. As none of the proposed SuDS basins will be larger than 25,000m^3 they will not fall under the Reservoirs Act (1975). Nevertheless, they will be appropriately designed in line with current standards and undergo regular inspection and maintenance by a suitably qualified engineer, as summarised in ***section 5.5***.

5.3.3 Outfall Pipe

132. New outfall pipe(s) will be installed to manage runoff from the onshore substations and National Grid infrastructure. The outfall pipes are proposed to run Southwards from the site, then to be located below ground, beneath the existing track and connect to the existing Friston Watercourse at Church Road. An indicative design for the cross section of the outfall pipe can be found in ***Appendix 2***. This shows two outfall pipes although the final detail design will confirm whether a single outfall pipe is sufficient. The route adopted for the outfall pipe will be established during the detailed design stage.

5.4 Infiltration Rate and Discharge Rate to the Friston Watercourse

133. The infiltration rate and discharge rate to the Friston Watercourse will be calculated based on the results of site-specific geotechnical surveys and infiltration testing. The acceptable discharge rate will be informed by the engineering design work during the detailed design of the Projects; collation of data on the existing site conditions (***section 3***); and the production of a catchment hydraulic model (***section 3.7.3***). If as presented within this OODMP, discharge to the Friston Watercourse is required, this discharge rate will be set at the existing greenfield runoff rate established through the catchment hydraulic model. This will be agreed in consultation with the LLFA (SCC) and included as part of the design presented within the final ODMP.

134. ***Section 7*** provides further details regarding the embedded flexibility of the development area and the ability to adopt reduced discharge rates (<7.91l/s and <5.52l/s for the onshore substations and National Grid substation respectively). The reduced discharge rates reflect the potential variability of the existing greenfield runoff rates which will be established from the catchment hydraulic model.

5.5 Inspection and Maintenance

135. Inspection and maintenance of the onshore substations and National Grid infrastructure drainage systems (to the point of connection to the Friston Watercourse) will be the responsibility of the site operator during the operational phase of the Projects (until the site is decommissioned).

136. The maintenance of the operational drainage will be secured through the approved final ODMP. The undertaker will ensure that appropriate and clear responsibilities are set out within the approved plan. Given the importance of the infrastructure, maintenance is likely to remain with the operator of the onshore substation.

137. If separate provision is made for the National Grid infrastructure then maintenance may pass to that entity in respect of that infrastructure. The

appropriate time to resolve these matters is once the detailed design has been completed.

138. The SuDS features will be included in a routine inspection and maintenance schedule carried out for the onshore substations and National Grid infrastructure, along with the landscape maintenance as described in the ***Outline Landscape and Ecological Management Strategy*** (document reference 8.7) to ensure they remain in effective operation. This will include checking of the various inlets and outfalls and other structures, if required, for ongoing function and integrity. There will be a need for occasional cutting and removal of the vegetative growth on the inner slopes of any basins and swales and appropriate maintenance of any trees in the wet woodland area of the basins.

139. The maintenance schedule for the various surface water features will be included in the final ODMP once the final design has been confirmed.

5.6 **Regarding the upper section of the Friston main river, the Applicants have submitted an updated signed** Statement of Common Ground with **the** Environment Agency **(ExA.SoCG-3.D12.V4) at Deadline 12 which confirms that a framework to ensure any additional inspection or maintenance works are appropriately undertaken will be agreed between the Applicants and the Environment Agency prior to commencement of Work Nos. 30 and 41.Ordinary Watercourse Consent.**

140. Land Drainage Consent associated with temporary and permanent works at the Projects' and National Grid infrastructure would be applied for separately to Land Drainage Consent for temporary construction works along the onshore cable route. An application for Land Drainage Consent in respect of the onshore substations and National Grid infrastructure works will be submitted to the LLFA post-consent and will include details of the measures to be implemented in relation to any affected Ordinary Watercourses.

6 Onshore Substations SuDS Design

6.1 Basis of Outline Design

141. Based on the pre-development greenfield runoff rate established in ***section 3.9*** and the onshore substation footprints presented in ***Table 6.1***, the design parameters for the onshore substations are summarised in ***Table 6.2.***

142. Based on the infiltration rates (established by the May 2021 infiltration tests, (AS-129)) the Applicant has adopted a conservative infiltration rate of 40mm/hr to be applied to the hybrid element for the onshore substations SuDS basin, informed by the results of the initial testing campaign (see ***section 3.8.1***) and as agreed with the LLFA. The Applicant will undertake further infiltration testing as part of the detailed design process.

Table 6.1 Onshore Substation Hybrid Design Impermeable Areas (all parameters assume 100% impermeable surface)

Component	East Anglia TWO (m^2)	East Anglia ONE North (m^2)
Overall substation operational footprint	32,300	32,300
Operational access road	13,600	
Infiltration / attenuation basin footprint (including perimeter access track)	12,880	
Total impermeable area	**91,080**	

6.2 Results

143. From the information within ***Table 6.1***, infiltration and attenuation storage requirements can be calculated and are summarised below in ***Table 6.2*** (see ***Appendix 3*** for all calculations).

Table 6.2 Hybrid Storage Requirements and Provision

Storage (m^3)	East Anglia TWO and East Anglia ONE North Combined (m^3)
Infiltration storage for 1 in 30 year (+40% for climate change)	6,623
Additional attenuation storage for 1 in 10 year (+40% for climate change)	3,018
Total Storage Required	**9,640**

Storage (m^3)	East Anglia TWO and East Anglia ONE North Combined (m^3)
Total Storage Provided[7]	**10,109**

144. The Applicant notes SCC's comments at Deadline 3 (REP3-101) and Deadline 4 (REP4-064) regarding the need for an infiltration only design to achieve a half drain time of 24 hours under a 1 in 100 year plus 40% for climate change scenario. As shown in ***Appendix 3***, when applying a FoS of 10 for the infiltration element of the onshore substations SuDS basin (see ***Table 6.1***), the half drain time is in exceedance of 24 hours and therefore does not meet SCC's specification for an infiltration only design.

145. As the half drain time exceeded 24 hours, a secondary assessment has been undertaken, as requested by SCC, which requires the SuDS basin to accommodate a 1 in 10 year storm event (plus 40% climate change scenario), 24 hours after the initial 1 in 100 year (plus 40% climate change scenario) storm event This assessment achieved the 24 hour half drain time by virtue of the remaining capacity provided within the SuDS basin.

146. ***Appendix 3*** provides detailed calculations of the above figures and the plan in ***Appendix 5*** presents an indicative layout for the infiltration and attenuation basin.

147. By limiting the runoff from the onshore substations to the Q_{BAR} pre-development greenfield runoff rate for all events up to and including the 1 in 100 year plus 40% allowance for climate change, it is considered that both the peak flows and total flows from the onshore substations have been taken into consideration.

6.3 Conclusion

148. In conclusion, a hybrid infiltration and attenuation scheme for the onshore substations can be accommodated within the site based on the agreed conservative 40mm/hr infiltration rate and a discharge using the FEH 2013 greenfield run-off rate.

149. The final design of this SuDS basin will be undertaken during the detailed design stage.

[7] Design figure for the 1 in 100 year storm (+40% climate change).

7 National Grid Substation SuDS Design

7.1 Basis of Outline Design

150. Based on the pre-development greenfield runoff rate established in ***section 3.9*** and the National Grid infrastructure footprints in ***Table 7.1***, the design parameters for the National Grid infrastructure are summarised in ***Table 7.2***.

Table 7.1 National Grid Substation Attenuation Design Impermeable Areas (all parameters are 100% impermeable)

Component	National Grid Infrastructure (m^2)
Overall substation operational footprint	44,950
Overal cable sealing end compounds operational footprint	10,000
Permanent access road to cable sealing end compounds	1,850
Attenuation basin footprint (including perimeter access track)	10,602
Total impermeable area	**67,402**

7.2 Results

151. From the information within ***Table 7.1***, attenuation storage requirements can be calculated and are summarised below in ***Table 7.2*** (see ***Appendix 4*** for all calculations).

Table 7.2 National Grid Attenuation Storage Requirements and Provision

Component	National Grid Infrastructure (m^3)
Attenuation storage using FEH 2013 rainfall method	8,023
Total storage required	8,023
Total storage provided[8]	**8,041**

[8] Design figure for the 1 in 100 year storm (+40% climate change).

152. ***Appendix 4*** provides detailed calculations of the above figures and the plan in ***Appendix 5*** shows an indicative layout of the attenuation basin.

153. By limiting the runoff from the National Grid substation to the Q_{BAR} pre-development greenfield runoff rate for all events up to and including the 1 in 100 year plus 40% allowance for climate change, it is considered that both the peak flows and total flows from the National Grid substation have been taken into consideration.

7.3 Ability to Accommodate Change in Pre-Development Discharge Rate

154. As discussed above, the SuDS basin will be designed to provide attenuation and a controlled onward flow, limiting the outfall discharge rates to that of the pre-development greenfield runoff rate. This is designed to ensure there is no detrimental impact on the receiving watercourse as a result of increased storm related flows from the development of the National Grid infrastructure and the introduction of an increased impermeable area.

155. The existing greenfield runoff rate will be confirmed during the detailed design stage in line with this OODMP and will not be exceeded post-development.

156. For the purpose of establishing a realistic indicative SuDS attenuation basin design and existing greenfield runoff rate, in compliance with the relevant guidelines set out in ***section 2*** of this document, the Applicant has assessed the storage requirements based on the footprints in ***Table 7.1*** and ***Table 7.2***.

157. As demonstrated by the design assumptions in ***Appendix 4***, these attenuation storage requirements, as summarised in ***Table 7.2***, would allow the discharge rate to be limited to the Q_{BAR} pre-development greenfield runoff rate of 7.91l/s and 5.52l/s for the National Grid substation respectively. Once detailed hydraulic modelling has been undertaken post consent, the actual Q_{BAR} pre-development greenfield runoff rate will be confirmed, and these runoff rates adopted for discharge to the Friston Watercourse.

158. Should the Q_{BAR} rates stated in paragraph 158 reduce as a result of establishing the actual Q_{BAR} rate during the detailed design process (i.e. with reference to the results of detailed hydraulic modelling), the discharge rate to the Friston Watercourse would be reduced by the Applicant accordingly. This would require an increase in capacity of the SuDS attenuation basin.

159. ***Table 7.3*** demonstrates that a larger storage basin can be accommodated within the Order limits and in conjunction with the landscaping proposed within the ***Outline Landscape and Ecological Management Strategy*** (document reference 8.7), should this be required.

160. ***Table 7.3*** also shows that there is flexibility to design a surface water management scheme to reflect the actual pre-development greenfield runoff rates, whilst considering factors such as landscaping, ecology and optimal land use. Note that in ***Table 7.3***, there are no Q_{BAR} rates below 5l/s, as these are generally taken to be the lower limits for discharge due to the technical design constraints related to the risk of blockage to outlets and ensuring that pipes etc can self-cleanse; however, the practicalities associated with this parameter would need to be subject to further consideration during the detailed design.

Table 7.3 National Grid Substation Q_{BAR} Flexibility, Storage Requirements and Order Limit Capacity

Discharge Rate (l/s)	Storage Requirement (m^3)	Within Existing Outline Basin Design?	Accomodated within Order Limits?
5.5 (Q_{BAR})	**8,024**	**Y**	**Y**
5.0	8,088	Y	Y

7.4 Conclusion

161. In conclusion, an attenuation scheme for the National Grid infrastructure can be accommodated within the site based on the discharge using the FEH 2013 greenfield run-off rate.

162. The final design of this SuDS basin will be undertaken during the detailed design stage.

8 Foul Water Drainage

8.1 Introduction

163. The wastewater produced by the onshore substations and National Grid substation in their operational phase comprise the foul water from the welfare facilities. A sustainable approach will be adopted, which is considered appropriate for each type of wastewater and which is also in line with the overall drainage strategy. It is noted that foul water drainage is not a matter for the LLFA but is included within this OODMP for completeness. The final ODMP will confirm the foul water drainage solution to be adopted.

8.2 Onshore Substations and National Grid Substation Foul Water

164. As a first preference, foul drainage at the onshore substations and National Grid substation will be collected through a mains connection to the existing sewer system (where a suitable connection is available) or collected in a septic tank located within the onshore development area and periodically transported off site for disposal at a licensed facility. It is acknowledged that the use of a septic tank may not be appropriate at some locations, and that alternative options would be considered in consultation with the Environment Agency if mains collections are not achievable.

165. Site surveys will inform the approach to be taken for the management of foul water. Subject to permeability, foul water from the onshore substations and National Grid substation will be collected via a piped drainage system and conveyed to be held in a sealed cess tank. Alternatively, a septic tank and soakaway system could be considered if practicable. The location of the building drainage system and cess tank will be confirmed at the detailed design stage and in the final ODMP.

166. If foul water cannot be discharged on site, the cess tank will be designed to have sufficient storage capacity to contain the wastewater generated by the welfare facilities, for a minimum period of three months, sized to minimise the frequency of emptying required. A tank with a capacity to accommodate $8.3m^3$ would be sufficient for this period, allowing for a 20% factor of safety. The cess tank will also be fitted with a monitoring device and high-level alarm system to alert maintenance staff to the need for emptying. The cess tank will be situated adjacent to the substation operational access road near the substation entrance to provide ease of access for a tanker for the routine emptying of contents and their disposal to a suitably licenced wastewater treatment and disposal facility.

8.3 Maintenance

167. The equipment provided to treat the foul and wastewater from the onshore substations and National Grid substation will be included in routine maintenance schedules to ensure they remain fully effective. This would include the routine emptying (if required) and maintenance of the cess tank to remove sewage from site and regular checks on the oil interceptors, auto shut off valves, sensors and alarms to ensure they are all functioning correctly. All maintenance activities shall also be recorded.

9 Summary

168. This OODMP identifies the different elements of the surface water and foul water arising from the operation of the onshore substations and National Grid infrastructure. In considering and outlining how these will be managed and controlled, it addresses the location of the development, hydrology and hydrogeological setting and considers the ways in which the potential impacts of surface and foul water from the onshore substations and National Grid infrastructure, once operational, will be minimised.

169. The overall strategy adopted must therefore be able to ensure that, through the introduction and implementation of suitable control measures, there will be no measurable impacts on the receiving water catchment. This forms the cornerstone of the Applicant's surface water drainage solution.

170. The Applicant has undertaken a tiered approach to selecting the most suitable Sustainable Drainage System (SuDS) to manage the surface water at the onshore substation and National Grid infrastructure site. The proposed solution has been informed by site specific testing of infiltration rates. The key parameters of the outline design presented within this OODMP have been agreed with the LLFA.

171. The Applicant has shared infiltration testing data (***Infiltration Test Results (May 2021)***, AS-129)) with the LLFA who has agreed that current results are insufficient to adopt an infiltration only solution at this stage. Further infiltration testing will be undertaken as part of the detailed design process to confirm final infiltration rates and inform the micro siting of the SuDS basins and maximise the use of infiltration where practicable.

172. As outlined in ***section 6***, a hybrid infiltration and attenuation scheme has proved viable for the onshore substations and is considered acceptable as a means of surface water management in line with the SuDS hierarchy (SCC, 2018). The LLFA are in agreement with this approach.

173. For the National Grid infrastructure the attenuation only solution is presented in ***section 7***. The LLFA are in agreement with this approach. There is flexibility in the outline attenuation design to accommodate a reduced Q_{BAR} rate and increased storage capacity within the Order limits if required.

174. Further ground investigations at the location of the onshore substations and National Grid infrastructure will be undertaken and will inform the final ODMP. This will include infiltration tests to confirm the underlying permeability to allow

final design of the hybrid infiltration and attenuation scheme with a connection to the Friston Watercourse. This process is summarised below in ***Plate 3.***

175. It is recognised that the onshore substations and National Grid infrastructure are situated within an area of existing conveyance routes and watercourses. The Applicant is committed to ensuring that these flow routes are appropriately managed and will ensure continued conveyance around the northern perimeter of the National Grid substation. The Applicant also recognises that there are existing surface water flood storage depressions and commits to offsetting any reduction in volume within the final drainage scheme. This process will be influenced by the detailed design process of the onshore substations and National Grid infrastructure.

176. Finally, the treatment and management of foul water is considered and outlined. As a first preference, foul drainage at the onshore substations and National Grid substation will be collected through a mains connection to the existing Local Authority sewer system. Alternatively, foul sewage will be contained in a sealed cess tank and tankered off-site for disposal, potentially with a soakaway system incorporated depending on ground permeability.

177. Additional sensors, auto shut off valves and alarms will also be added to the drainage equipment installed as appropriate, to provide operators with a warning of any potential problem with pollution control equipment installed, to ensure they can take appropriate action. All equipment and the SuDS elements will be included in routine maintenance to ensure they remain fully effective.

178. The Applicant will be responsible for the maintenance of the SuDS system to the point of discharge to the Friston Watercourse. Regarding the upper section of the Friston main river, the Applicants have submitted an updated signed Statement of Common Ground with the Environment Agency (ExA.SoCG-3.D12.V4) at Deadline 12 which confirms that a framework to ensure any additional inspection or maintenance works are appropriately undertaken will be agreed between the Applicants and the Environment Agency prior to commencement of Work Nos. 30 and 41.

Plate 3. Flow Chart Summarising the Applicant's Application of the SuDS Hierarchy and Strategy Post-Consent

Application: Outline Operational Drainage Management Plan

1. Infiltration only design considered. Initial infiltration rate results indicate this option is not practicable. Further percolation tests post-consent required to confirm data

2. Additional hybrid and attenuation only designs considered (***section 6*** and ***section 7***). Flexibility of controlled discharge rates demonstrated (***section 8***).

3. Applicant Position: Onshore substations SuDS design based on a hybrid solution. National Grid substation design based on attenuation only. Further infiltration testing is required to inform the process.

Post-consent: Operational Drainage Management Plan

1. Final percolation testing to be undertaken and pre-development runoff rate established through a catchment hydraulic model.

2. SuDS design to be considered and presented in the Operational Drainage Management Plan. Infiltration will be maximised where practicable.

3. Operational Drainage Management Plan to be submitted to the relevant planning authority for approval under Requirement 41 of the ***draft DCO*** (document reference 3.1).

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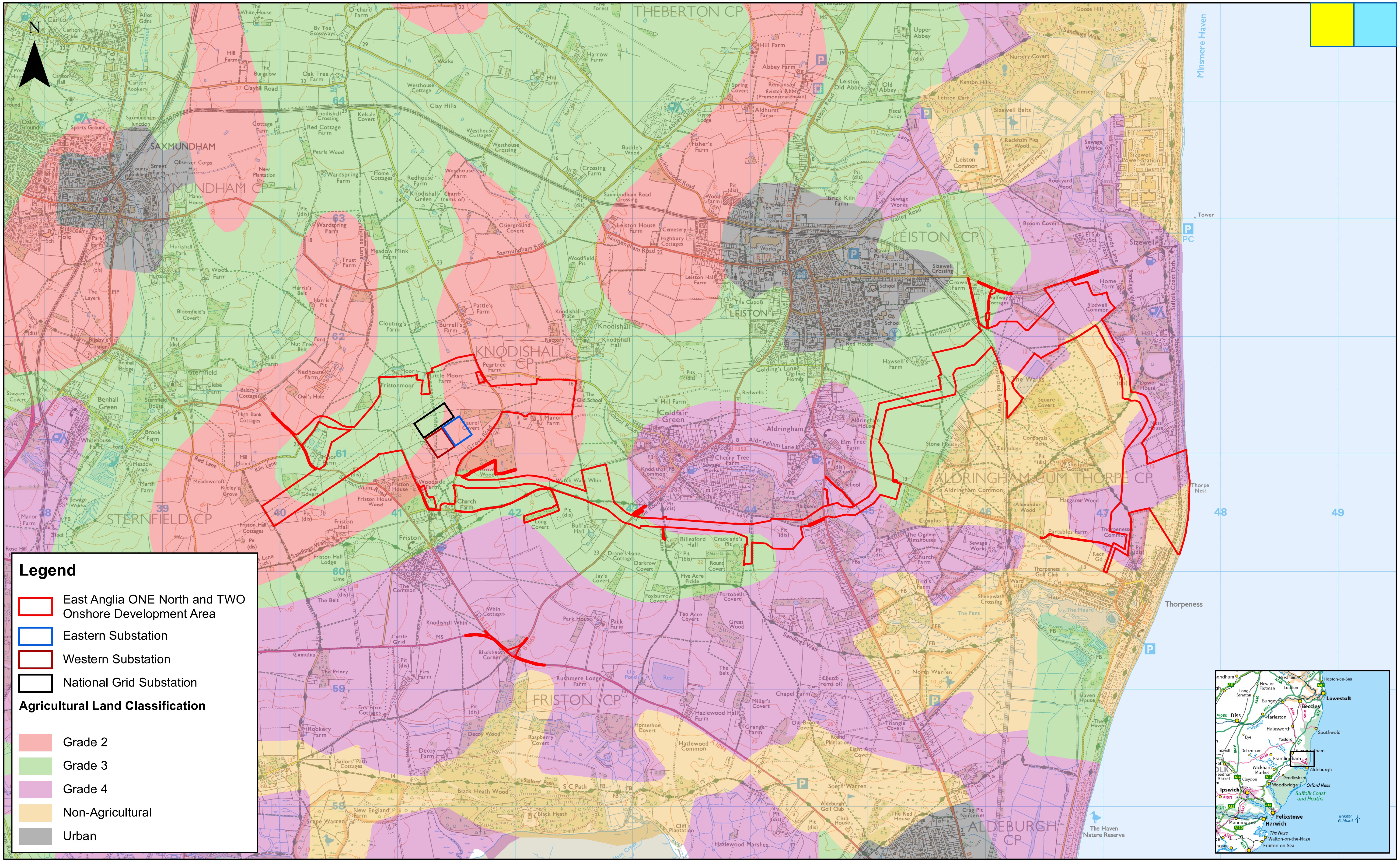
Appendix 1: Figures Showing Existing Site Conditions



Rev	Date	By	Comment
5	10/06/2021	AB	Fifth Issue.
4	22/02/2021	AB	Fourth Issue.
3	04/12/2020	AB	Third Issue.

Prepared: AB
Checked: PB
Approved: FM

1:30,000 Scale @ A3

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SCOTTISHPOWER RENEWABLES

East Anglia ONE North and TWO

Outline Operational Drainage Management Plan

Agricultural Land Classification

Drg No	EA1N-EA2-DEV-DRG-IBR-001128
Rev	5
Date	10/06/21
Figure	1

Coordinate System: BNG
Datum: OSGB36

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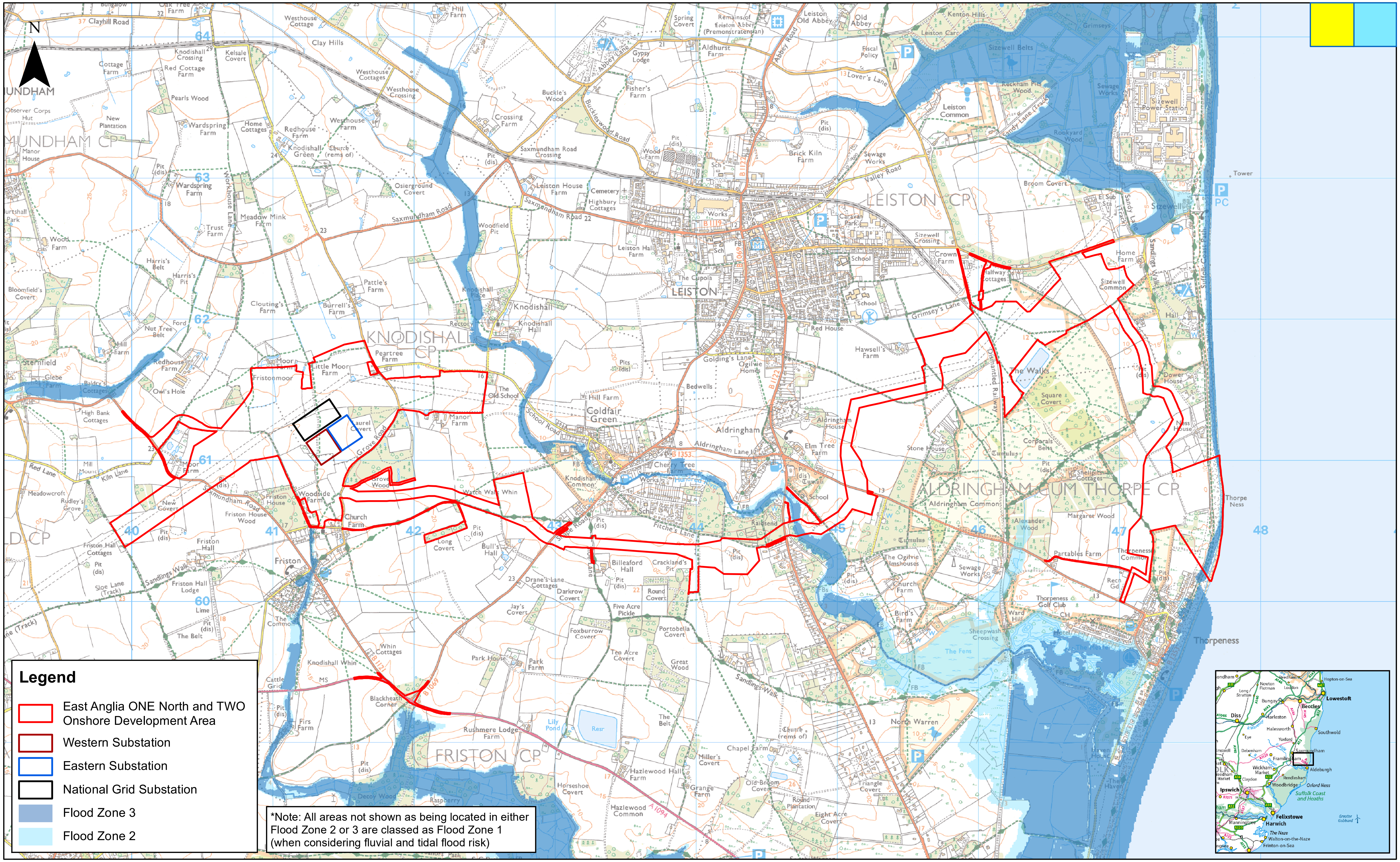

SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment		
5	10/06/2021	AB	Fifth Issue.		
4	22/02/2021	AB	Fourth Issue.	Prepared:	AB
3	04/12/2020	AB	Third Issue.	Checked:	PB
				Approved:	FM

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0 0.5 1 Km

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East Anglia ONE North and TWO

Outline Operational Drainage Management Plan

Environment Agency Flood Zones

Drg No	EA1N-EA2-DEV-DRG-IBR-001129
Rev	5
Date	10/06/21
Figure	2

Coordinate System: BNG
Datum: OSGB36

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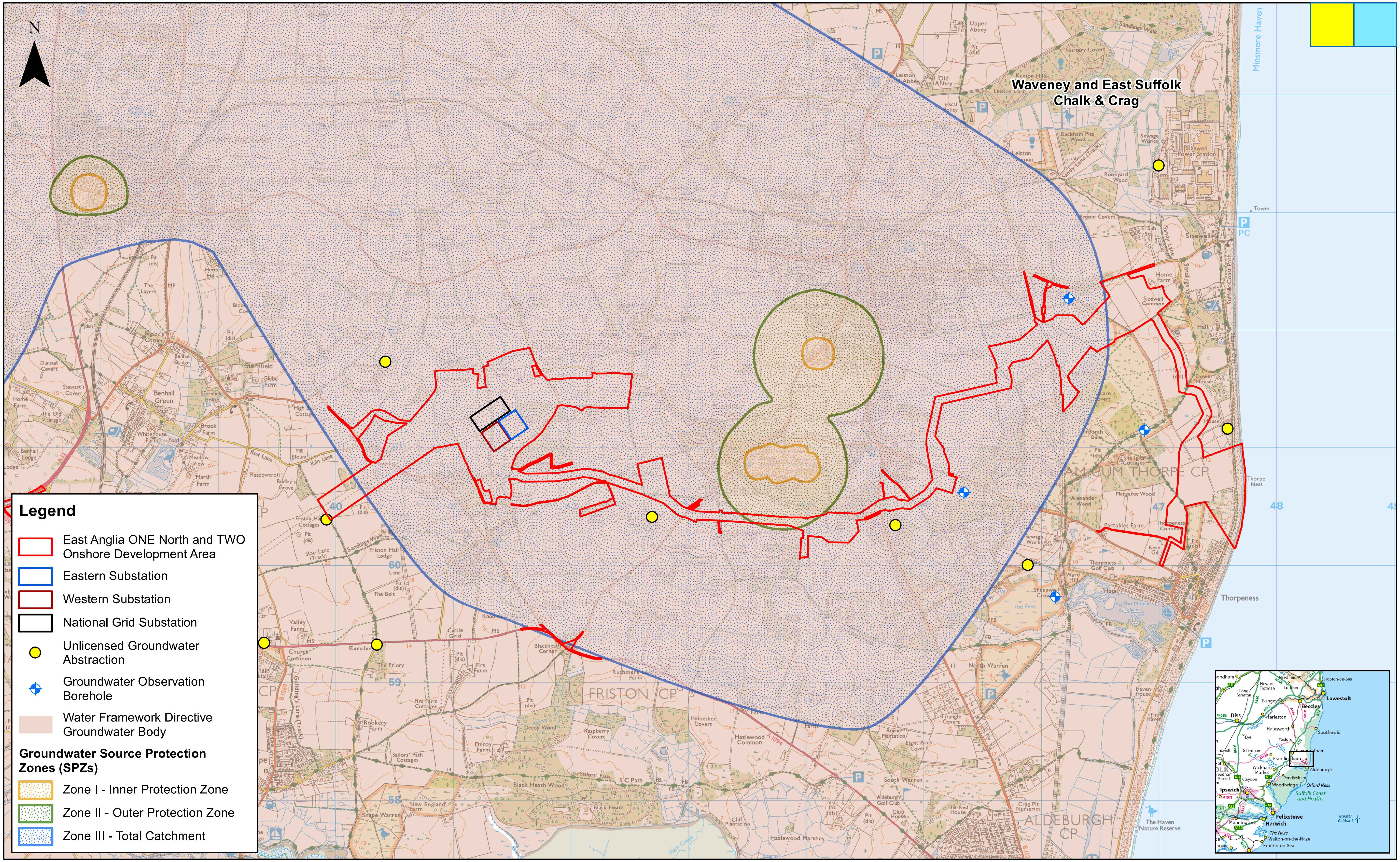

SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment		
5	10/06/2021	AB	Fifth Issue.		
4	22/02/2021	AB	Fourth Issue.	Prepared:	AB
3	04/12/2020	AB	Third Issue.	Checked:	PB
				Approved:	FM

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East Anglia ONE North and TWO

Outline Operational Drainage Management Plan

Groundwater Receptors

Drg No	EA1N-EA2-DEV-DRG-IBR-001130
Rev	5
Date	10/06/21
Figure	3

Coordinate System: BNG
Datum: OSGB36

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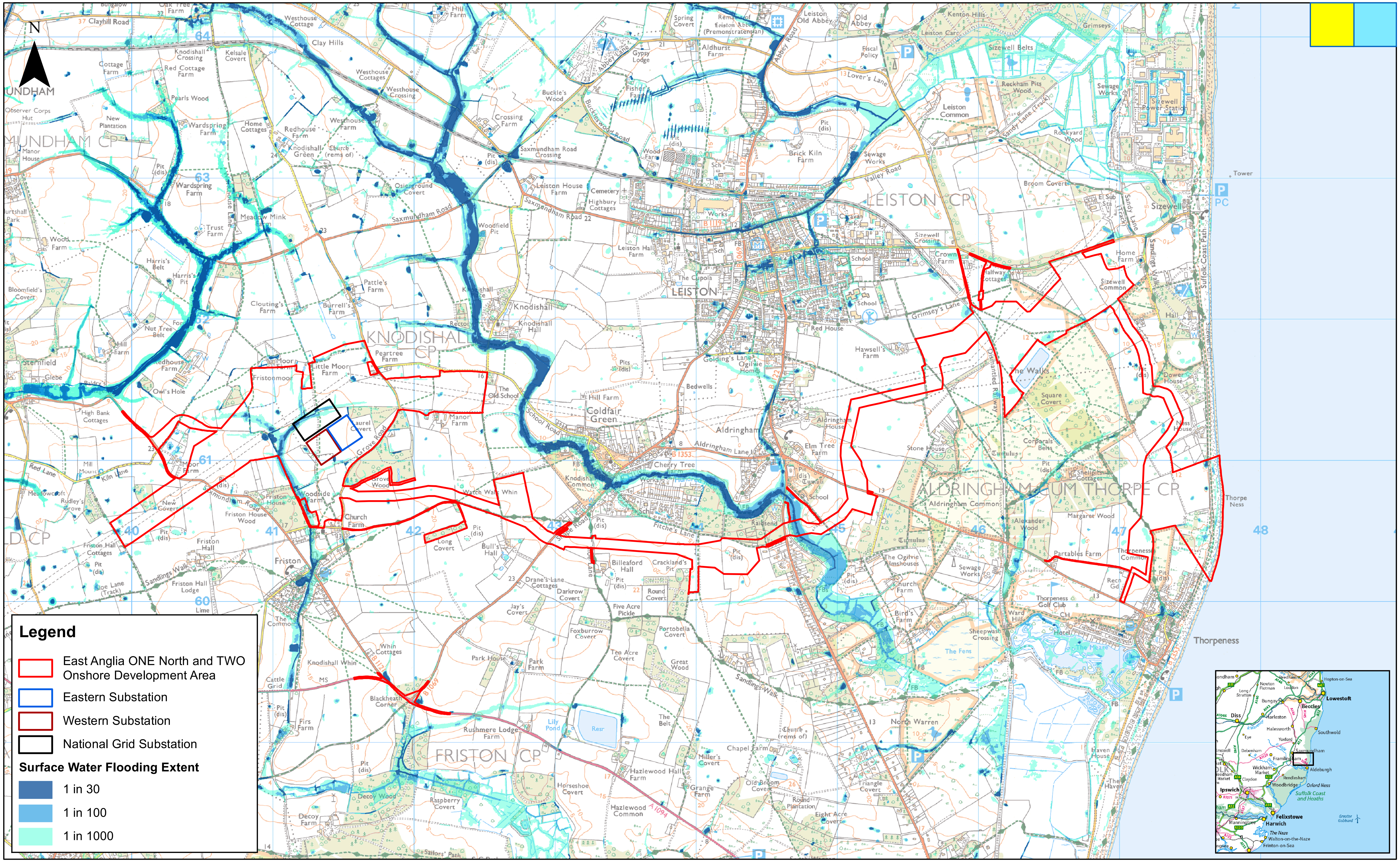

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Rev	Date	By	Comment	Approved:	FM	

SCOTTISHPOWER RENEWABLES

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East Anglia ONE North and TWO

Outline Operational Drainage Management Plan

Surface Water Flood Risk

Drg No	EA1N-EA2-DEV-DRG-IBR-001133	
Rev	5	Coordinate System: BNG
Date	10/06/21	Datum: OSGB36
Figure	4	

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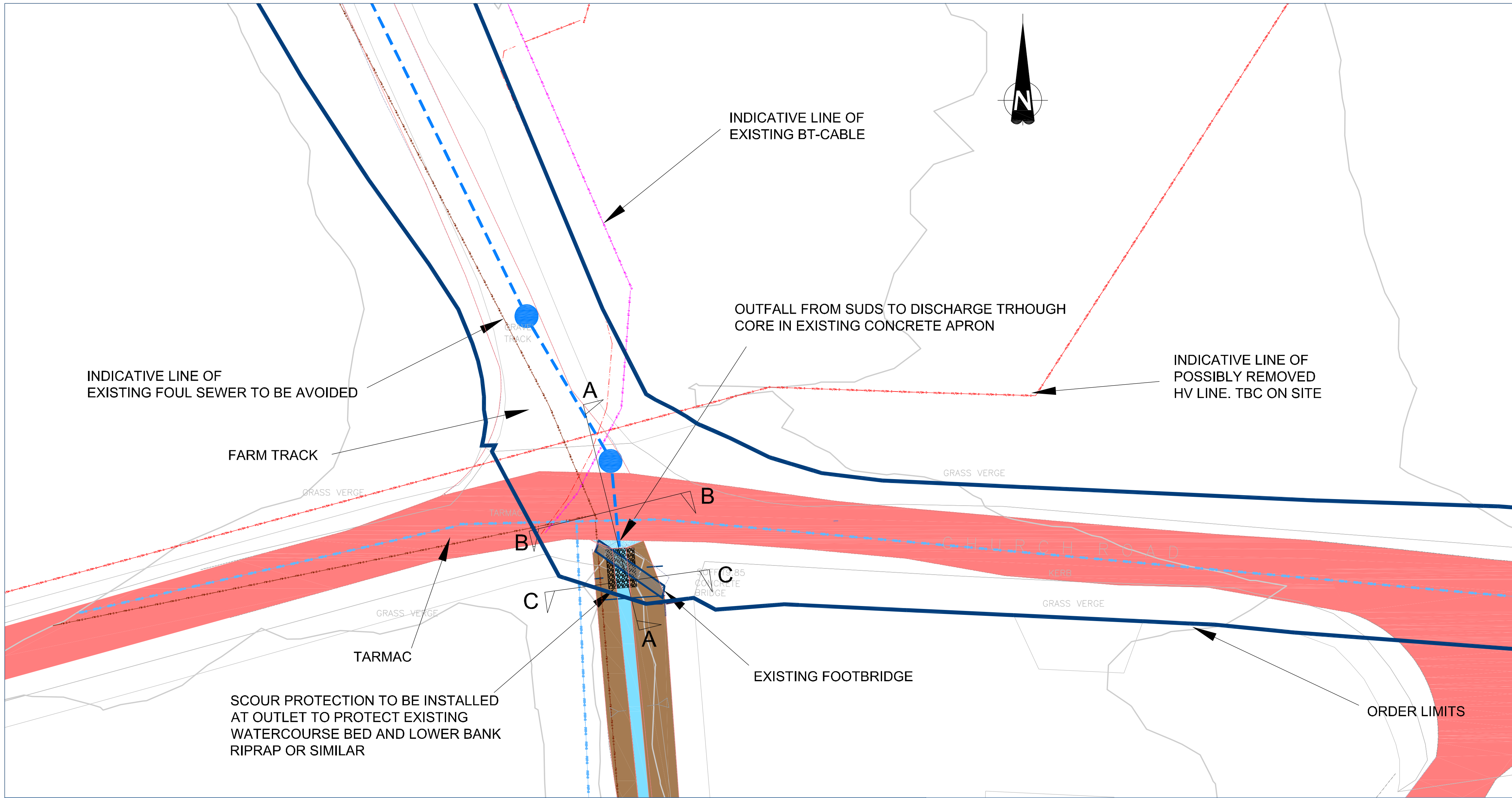
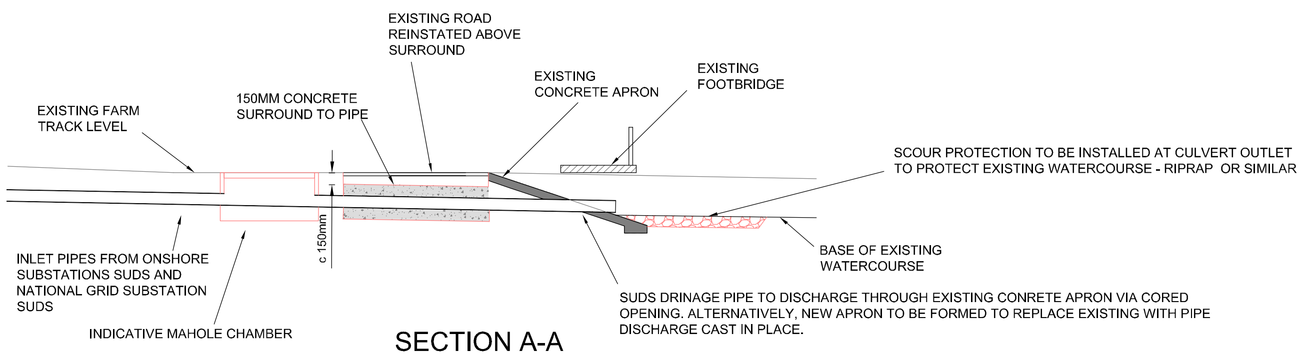
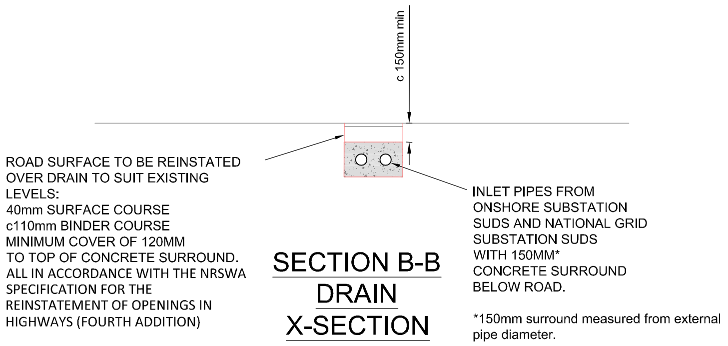
Appendix 2: SuDS Outfall Concept Design to the Friston Watercourse

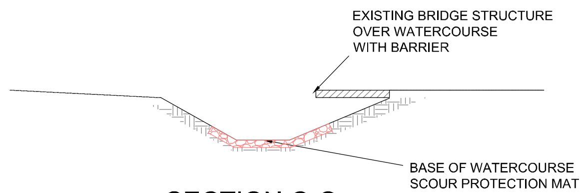




SECTION A-A
LONGITUDINAL
SECTION



SECTION B-B
DRAIN
X-SECTION



SECTION C-C
EXISTING WATERCOURSE
X-SECTION

Drainage Systems

—FW–D –>—	Foul Drainage
– – – – ●	Proposed Surface Water Drainage

Electrical Systems

—HV–D —HV–D—	High Voltage
—HV/OH–D—	High Voltage Overhead
— LV —	Low Voltage

Telecom Systems

—BT–D —BT–D—	British Telecom

Water Systems

—POT–D —POT–D—	Potable Supply

DO NOT SCALE FROM THIS DRAWING

General Notes

1) This drawing is to read in conjunction with the relevant specification and all other relevant drawings issued by the engineer and architect.

2) All dimensions and levels to be checked on site and the engineer notified of any discrepancies prior to commencement of work.

3) All switched off, frozen, or not schedules to print layers within electronic issues of this drawing should be disregarded.

4) All dimensions are in metres unless noted otherwise. All levels are in metres.

5) Utilities indicated for information only. Exact locations to be confirmed on site prior to works commencing.

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT
Haskoning DHV UK Limited

PROJECT
East Anglia Offshore Wind
EA1N & EA2

DRAWING TITLE
SUDS Basin Alternative Outfall
Church Lane Culvert
Surface Water Diversion Concept

DRG No.		REV
ED11892-GE-3016		-
DRG SIZE: A3	SCALE: NTS	DATE: 11/06/2021
DRAWN BY: IA	CHECKED BY: SH	APPROVED BY: SH

wardell armstrong

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☐ EDINBURGH ☐ STOKE ON TRENT

N:\ED\ED11892 - EAST ANGLIA OFFSHORE WIND EA 1\03 - DESIGN\AUTOCAD\ED11892-GE-3016-A JUNE 23RD DWG.DWG

Appendix 3: Onshore Substations Hybrid Scheme Model Outputs

SUDS Design Summary - Hybrid Design - Safety Factor 10 - EA2 / EA1N Only - 09.06.21

Notes:

1. SUDS design proposal to attenuate surface water flows from hardstanding areas associated with EA2 / EA1N and National Grid substations (including access roads and cable sealing compounds).

2. Separate SUDS required for EA2/EA1N project substations and National Grid infrastructure.

3. EA2/EA1N project substations and access roads discharge to SUDS Basin then to ground via infiltration with overflow outfall to existing ditch in Church Lane at pre-development run-off rate. To mimic existing drainage regime and achieve no net increase in flows to receiving watercourse.

4. NG substation and sealing end compounds discharge to SUDS Basin then to ground via infiltration with overflow outfall to existing ditch in field at pre-development run-off rate. To mimic existing drainage regime and achieve no net increase in flows to receiving watercourse.

5. Infiltration rates estimated as 40mm/hr.

6. SUDS design undertaken in line with national and local guidance set out in The SUDS Manual (C753) & Suffolk County Council Sustainable Drainage Systems (SUDS) a Local Design Guide.

7. Pre Development discharge rates estimated using FEH method - HR Wallingford Greenfield Runoff Rate Estimation Online Tool.

8. SUDS sizing estimated using FEH13 Rainfall and Micro Drainage design software.

9. Safety factor of 10 used in initial design for 24 hour half drain down.

10. Additional SUDS to be provided as source control / treatment during detailed design.

Design Parameters / Assumptions	EA2	EA1N	National Grid	Change Notes
Hardstanding (all footprints assumed 100% impermeable)				
Substation operational footprint	32,300 m^2	32,300 m^2	-	
Operational access road	13,600 m^2		-	
Cable sealing end compound operational footprint	-		-	
Permanent access road to sealing end compound	-		-	
SUDS Basin Footprint (including perimeter access track)	12,880 m^2		-	
Total	**91,080 m^2**		-	
Pre-Development Run-Off Rates (calculated from HR Wallingford Greenfield Runoff Rate Estimation Online Tool)				
2 l/s/ha	18.22 l/s		-	
	FEH		-	
1 Year Return	6.49 l/s		-	
2 Year Return (Q_{BAR})	**7.46 l/s**		-	
30 Year Return	18.29 l/s		-	
100 Year Return	26.57 l/s		-	
200 Year Return	31.43 l/s		-	
Unttenuated Flow Discharging to SUDS from Harstanding (calculated from FEH13 Rainfall using Micro Drainage design software)				
	FEH13		-	
1 Year Return + 40% CC	N/A		-	
2 Year Return + 40% CC	68.0 l/s		-	
30 Year Return + 40% CC	173.0 l/s		-	
100 Year Return + 40% CC	285.5 l/s		-	
200 Year Return + 40% CC	362.3 l/s		-	
Attenuated Post Development Run-Off Rates	**Limited to pre-development (2-year FEH) run-off rate. Provides betterment over 2 l/s/ha rate and IH124 rate.**			
Pre / Post Development Reduction In Run-Off Rates (pre development rates minus attenuated post development rates)				
1 Year Return	N/A		-	
2 Year Return	60.54 l/s		-	
30 Year Return	165.54 l/s		-	
100 Year Return	267.21 l/s		-	
200 Year Return	346.65 l/s		-	
Design Infiltration Rates	**40mm/hr**			
Design Storm Event	**1 in 100 year + 40% climate change as per SCC guidance.**			
Attenuation Storage Required (calculated from FEH13 Rainfall using Micro Drainage design software)				
All Hardstanding Areas	**FEH13**		-	
Infiltration Only (up to 1:30 YR + 40% CC)	6,622.2 m^3		-	
Detention Only (up to 1:100 YR +40% CC)	3,017.5 m^3		-	
Total storage required	**9,639.7 m^3**		-	
Attenuation Dimensions				
Design Top area	10,847 m^2		-	
Freeboard Top area	11,311 m^2		-	
Perimeter access track top area	12,714 m^2		-	
Basin Top area	12,880 m^2		-	
Base area	9,370 m^2		-	
Design storage depth	1.0 m		-	
Design freeboard + 0.3m	0.3 m		-	
Overall depth	1.5 m		-	
Side slopes	1 in 4		-	
Attenuation Storage Provided				
Detention Basins				
Hybrid Basin Design	10,108.5 m^3		-	
Freeboard	3,323.70 m^3		-	
Perimeter access track	1,201.25 m^3		-	
Additional storage between track and basin top	1,279.70 m^3		-	
Total (design)	**10,108.50 m^3**		-	
Total (inc. freeboard, access track etc)	15,913.15 m^3		-	
Design storage required < attenuation storage provided?	**YES = OK**		-	
Discharge Location	**Existing watercourse in Church Lane via new outfall pipe as per existing drainage regime. Provides additional betterment over existing arrangment by reducing flood flows down existing farm track.**		**-**	**Design flows up to 1:100 year + 40% CC are attenuated within the basin design depth - including allowance for loss of existing depression adjacent to EA1N substation.** **Additional 300mm freeboard provided provided over and above design capacity with another 200mm to the top of the basin**

Greenfield runoff rate estimation for sites

HR Wallingford — Working with water

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	East Anglia EA1N / EA2
Site location:	Project Substations FEH13

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.

Site Details

Latitude:	52.19346° N
Longitude:	1.52768° E
Reference:	2828587194
Date:	Jun 09 2021 15:36

Runoff estimation approach: FEH Statistical

Site characteristics

Total site area (ha):	9.108

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.729
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.12

Hydrological characteristics

	Default	Edited
SAAR (mm):	585	585
Hydrological region:	5	5
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	2.45	2.45
Growth curve factor 100 years:	3.56	3.56
Growth curve factor 200 years:	4.21	4.21

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):		7.46
1 in 1 year (l/s):		6.49
1 in 30 years (l/s):		18.29
1 in 100 year (l/s):		26.57
1 in 200 years (l/s):		31.43

Summary of Results for 30 year Return Period (+40%)

Half Drain Time : 4572 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	14.671	0.171	11.0	0.0	11.0	1625.9	O K
30 min Summer	14.726	0.226	11.2	0.0	11.2	2158.4	O K
60 min Summer	14.784	0.284	11.3	0.0	11.3	2717.7	O K
120 min Summer	14.857	0.357	11.6	0.0	11.6	3439.4	O K
180 min Summer	14.903	0.403	11.7	0.0	11.7	3896.1	O K
240 min Summer	14.937	0.437	11.8	0.0	11.8	4228.9	O K
360 min Summer	14.983	0.483	12.0	0.0	12.0	4690.8	O K
480 min Summer	15.013	0.513	12.1	0.0	12.1	4995.2	O K
600 min Summer	15.034	0.534	12.2	0.0	12.2	5209.4	O K
720 min Summer	15.050	0.550	12.2	0.0	12.2	5367.1	O K
960 min Summer	15.070	0.570	12.3	0.0	12.3	5574.4	O K
1440 min Summer	15.089	0.589	12.4	0.0	12.4	5765.0	O K
2160 min Summer	15.089	0.589	12.4	0.0	12.4	5772.7	O K
2880 min Summer	15.079	0.579	12.3	0.0	12.3	5662.7	O K
4320 min Summer	15.049	0.549	12.2	0.0	12.2	5365.4	O K
5760 min Summer	15.027	0.527	12.1	0.0	12.1	5137.8	O K
7200 min Summer	14.500	0.000	0.0	0.0	0.0	0.0	O K
8640 min Summer	14.500	0.000	0.0	0.0	0.0	0.0	O K
10080 min Summer	14.500	0.000	0.0	0.0	0.0	0.0	O K
15 min Winter	14.692	0.192	11.0	0.0	11.0	1821.8	O K
30 min Winter	14.753	0.253	11.2	0.0	11.2	2418.9	O K
60 min Winter	14.817	0.317	11.5	0.0	11.5	3046.9	O K
120 min Winter	14.900	0.400	11.7	0.0	11.7	3859.0	O K
180 min Winter	14.951	0.451	11.9	0.0	11.9	4375.1	O K
240 min Winter	14.989	0.489	12.0	0.0	12.0	4751.9	O K
360 min Winter	15.041	0.541	12.2	0.0	12.2	5277.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	95.704	0.0	0.0	19
30 min Summer	63.672	0.0	0.0	34
60 min Summer	40.264	0.0	0.0	64
120 min Summer	25.669	0.0	0.0	124
180 min Summer	19.516	0.0	0.0	184
240 min Summer	15.988	0.0	0.0	244
360 min Summer	11.965	0.0	0.0	364
480 min Summer	9.667	0.0	0.0	484
600 min Summer	8.156	0.0	0.0	604
720 min Summer	7.080	0.0	0.0	722
960 min Summer	5.637	0.0	0.0	962
1440 min Summer	4.057	0.0	0.0	1442
2160 min Summer	2.888	0.0	0.0	2160
2880 min Summer	2.266	0.0	0.0	2880
4320 min Summer	1.613	0.0	0.0	3712
5760 min Summer	1.274	0.0	0.0	4440
7200 min Summer	-0.012	0.0	0.0	0
8640 min Summer	-0.010	0.0	0.0	0
10080 min Summer	-0.008	0.0	0.0	0
15 min Winter	95.704	0.0	0.0	19
30 min Winter	63.672	0.0	0.0	34
60 min Winter	40.264	0.0	0.0	64
120 min Winter	25.669	0.0	0.0	122
180 min Winter	19.516	0.0	0.0	182
240 min Winter	15.988	0.0	0.0	242
360 min Winter	11.965	0.0	0.0	360

Summary of Results for 30 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
480 min Winter	15.075	0.575	12.3	0.0	12.3	5627.3	O K
600 min Winter	15.099	0.599	12.4	0.0	12.4	5876.0	O K
720 min Winter	15.117	0.617	12.5	0.0	12.5	6061.1	O K
960 min Winter	15.142	0.642	12.5	0.0	12.5	6310.5	O K
1440 min Winter	15.166	0.666	12.6	0.0	12.6	6559.5	O K
2160 min Winter	15.172	0.672	12.6	0.0	12.6	6622.2	O K
2880 min Winter	15.165	0.665	12.6	0.0	12.6	6554.1	O K
4320 min Winter	15.139	0.639	12.5	0.0	12.5	6280.1	O K
5760 min Winter	15.109	0.609	12.4	0.0	12.4	5977.0	O K
7200 min Winter	14.500	0.000	0.0	0.0	0.0	0.0	O K
8640 min Winter	14.500	0.000	0.0	0.0	0.0	0.0	O K
10080 min Winter	14.500	0.000	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
480 min Winter	9.667	0.0	0.0	478
600 min Winter	8.156	0.0	0.0	596
720 min Winter	7.081	0.0	0.0	714
960 min Winter	5.637	0.0	0.0	952
1440 min Winter	4.057	0.0	0.0	1414
2160 min Winter	2.888	0.0	0.0	2116
2880 min Winter	2.266	0.0	0.0	2792
4320 min Winter	1.613	0.0	0.0	4068
5760 min Winter	1.274	0.0	0.0	4720
7200 min Winter	-0.012	0.0	0.0	0
8640 min Winter	-0.010	0.0	0.0	0
10080 min Winter	-0.008	0.0	0.0	0

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 641300 260300 TM 41300 60300	Shortest Storm (mins)	15
Data Type	Catchment	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 9.108

Time (mins) From:	To:	Area (ha)
0	4	9.108

Model Details

Storage is Online Cover Level (m) 16.000

Infiltration Basin Structure

Invert Level (m) 14.500 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.04000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.04000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	9370.0	1.000	10847.0	1.300	11311.0	1.400	12714.0	1.500	12880.0

Weir Overflow Control

Discharge Coef 0.544 Width (m) 100.000 Invert Level (m) 15.175

Cascade Summary of Results for Project Subs - Basin - FEH 2YR - FEH13 100 YR + 40% CC - Inf Only 40mm.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	(None)	Project Subs - Basin - FEH 2YR - FEH13 100 YR + 40% CC - Detention Only.SRCX

Half Drain Time : 4718 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	14.718	0.218	11.1	0.0	11.1	2078.8	O K
30 min Summer	14.793	0.293	11.4	0.0	11.4	2803.0	O K
60 min Summer	14.868	0.368	11.6	0.0	11.6	3548.7	O K
120 min Summer	14.960	0.460	11.9	0.0	11.9	4466.5	O K
180 min Summer	15.024	0.524	12.1	0.0	12.1	5112.4	O K
240 min Summer	15.074	0.574	12.3	0.0	12.3	5619.9	O K
360 min Summer	15.150	0.650	12.6	0.0	12.6	6396.0	O K
480 min Summer	15.181	0.681	12.7	74.3	87.0	6716.3	O K
600 min Summer	15.182	0.682	12.7	94.5	107.2	6722.8	O K
720 min Summer	15.183	0.683	12.7	116.2	128.9	6732.5	O K
960 min Summer	15.184	0.684	12.7	151.6	164.3	6749.8	O K
1440 min Summer	15.185	0.685	12.7	164.0	176.7	6754.1	O K
2160 min Summer	15.184	0.684	12.7	139.5	152.1	6742.8	O K
2880 min Summer	15.182	0.682	12.7	105.2	117.9	6728.0	O K
4320 min Summer	15.180	0.680	12.7	64.8	77.5	6707.6	O K
5760 min Summer	15.179	0.679	12.7	39.1	51.8	6691.9	O K
7200 min Summer	14.500	0.000	0.0	0.0	0.0	0.0	O K
8640 min Summer	14.500	0.000	0.0	0.0	0.0	0.0	O K
10080 min Summer	14.500	0.000	0.0	0.0	0.0	0.0	O K
15 min Winter	14.744	0.244	11.2	0.0	11.2	2329.0	O K
30 min Winter	14.827	0.327	11.5	0.0	11.5	3141.0	O K
60 min Winter	14.912	0.412	11.8	0.0	11.8	3978.0	O K
120 min Winter	15.014	0.514	12.1	0.0	12.1	5009.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	122.248	0.0	0.0	19
30 min Summer	82.572	0.0	0.0	34
60 min Summer	52.458	0.0	0.0	64
120 min Summer	33.215	0.0	0.0	124
180 min Summer	25.480	0.0	0.0	184
240 min Summer	21.109	0.0	0.0	244
360 min Summer	16.158	0.0	0.0	364
480 min Summer	13.321	0.0	295.9	458
600 min Summer	11.410	0.0	731.6	466
720 min Summer	10.016	0.0	1068.2	504
960 min Summer	8.080	0.0	1531.5	616
1440 min Summer	5.860	0.0	1992.6	866
2160 min Summer	4.154	0.0	2133.8	1272
2880 min Summer	3.224	0.0	2021.8	1688
4320 min Summer	2.228	0.0	1496.2	2548
5760 min Summer	1.712	0.0	928.2	3504
7200 min Summer	-0.012	0.0	0.0	0
8640 min Summer	-0.010	0.0	0.0	0
10080 min Summer	-0.008	0.0	0.0	0
15 min Winter	122.248	0.0	0.0	19
30 min Winter	82.572	0.0	0.0	34
60 min Winter	52.458	0.0	0.0	64
120 min Winter	33.215	0.0	0.0	124

Cascade Summary of Results for Project Subs - Basin - FEH 2YR - FEH13 100 YR + 40% CC - Inf Only 40mm.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	15.086	0.586	12.3	0.0	12.3	5738.3	O K
240 min Winter	15.142	0.642	12.5	0.0	12.5	6311.1	O K
360 min Winter	15.184	0.684	12.7	139.5	152.1	6743.9	O K
480 min Winter	15.187	0.687	12.7	217.0	229.7	6774.4	O K
600 min Winter	15.189	0.689	12.7	274.7	287.4	6795.5	O K
720 min Winter	15.189	0.689	12.7	289.8	302.5	6800.1	O K
960 min Winter	15.189	0.689	12.7	274.7	287.4	6799.2	O K
1440 min Winter	15.187	0.687	12.7	231.0	243.7	6780.0	O K
2160 min Winter	15.185	0.685	12.7	176.8	189.5	6758.4	O K
2880 min Winter	15.184	0.684	12.7	139.5	152.1	6743.2	O K
4320 min Winter	15.181	0.681	12.7	84.2	96.9	6720.5	O K
5760 min Winter	15.180	0.680	12.7	64.8	77.5	6706.7	O K
7200 min Winter	14.500	0.000	0.0	0.0	0.0	0.0	O K
8640 min Winter	14.500	0.000	0.0	0.0	0.0	0.0	O K
10080 min Winter	14.500	0.000	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
180 min Winter	25.480	0.0	0.0	182
240 min Winter	21.109	0.0	0.0	242
360 min Winter	16.158	0.0	513.4	324
480 min Winter	13.321	0.0	1172.6	346
600 min Winter	11.410	0.0	1672.1	404
720 min Winter	10.016	0.0	2060.4	464
960 min Winter	8.080	0.0	2600.8	594
1440 min Winter	5.860	0.0	3158.8	850
2160 min Winter	4.154	0.0	3379.0	1236
2880 min Winter	3.223	0.0	3315.1	1664
4320 min Winter	2.228	0.0	2849.2	2504
5760 min Winter	1.712	0.0	2278.2	3392
7200 min Winter	-0.012	0.0	0.0	0
8640 min Winter	-0.010	0.0	0.0	0
10080 min Winter	-0.008	0.0	0.0	0

Cascade Rainfall Details for Project Subs - Basin - FEH 2YR - FEH13 100 YR + 40% CC - Inf Only 40mm.SRCX

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 641300 260300 TM 41300 60300	Shortest Storm (mins)	15
Data Type	Catchment	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 9.108

Time (mins) From:	To:	Area (ha)
0	4	9.108

Cascade Model Details for Project Subs - Basin - FEH 2YR - FEH13 100 YR + 40% CC - Inf Only 40mm.SRCX

Storage is Online Cover Level (m) 16.000

Infiltration Basin Structure

Invert Level (m) 14.500 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.04000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.04000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	9370.0	1.000	10847.0	1.300	11311.0	1.400	12714.0	1.500	12880.0

Weir Overflow Control

Discharge Coef 0.544 Width (m) 100.000 Invert Level (m) 15.175

Cascade Summary of Results for Project Subs - Basin - FEH 2YR - FEH13 100 YR + 40% CC - Detention Only.SRCX

Upstream Structures	Outflow To	Overflow To
Project Subs - Basin - FEH 2YR - FEH13 100 YR + 40% CC - Inf Only 40mm.SRCX	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	15.190	0.000	0.0	0.0	O K
30 min Summer	15.190	0.000	0.0	0.0	O K
60 min Summer	15.190	0.000	0.0	0.0	O K
120 min Summer	15.190	0.000	0.0	0.0	O K
180 min Summer	15.190	0.000	0.0	0.0	O K
240 min Summer	15.190	0.000	0.0	0.0	O K
360 min Summer	15.190	0.000	0.0	0.0	O K
480 min Summer	15.218	0.028	0.5	294.5	O K
600 min Summer	15.259	0.069	2.7	717.9	O K
720 min Summer	15.289	0.099	4.8	1031.3	O K
960 min Summer	15.327	0.137	7.3	1433.5	O K
1440 min Summer	15.360	0.170	7.5	1784.2	O K
2160 min Summer	15.361	0.171	7.5	1794.2	O K
2880 min Summer	15.340	0.150	7.4	1574.8	O K
4320 min Summer	15.298	0.108	5.5	1124.5	O K
5760 min Summer	15.263	0.073	2.9	760.6	O K
7200 min Summer	15.190	0.000	0.0	0.0	O K
8640 min Summer	15.190	0.000	0.0	0.0	O K
10080 min Summer	15.190	0.000	0.0	0.0	O K
15 min Winter	15.190	0.000	0.0	0.0	O K
30 min Winter	15.190	0.000	0.0	0.0	O K
60 min Winter	15.190	0.000	0.0	0.0	O K
120 min Winter	15.190	0.000	0.0	0.0	O K
180 min Winter	15.190	0.000	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	122.248	0.0	0.0	0
30 min Summer	82.572	0.0	0.0	0
60 min Summer	52.458	0.0	0.0	0
120 min Summer	33.215	0.0	0.0	0
180 min Summer	25.480	0.0	0.0	0
240 min Summer	21.109	0.0	0.0	0
360 min Summer	16.158	0.0	0.0	0
480 min Summer	13.321	0.0	60.5	512
600 min Summer	11.410	0.0	262.3	626
720 min Summer	10.016	0.0	449.2	740
960 min Summer	8.080	0.0	694.9	976
1440 min Summer	5.860	0.0	809.1	1452
2160 min Summer	4.154	0.0	1451.3	2168
2880 min Summer	3.224	0.0	1304.8	2884
4320 min Summer	2.228	0.0	783.7	3584
5760 min Summer	1.712	0.0	651.8	4584
7200 min Summer	-0.012	0.0	0.0	0
8640 min Summer	-0.010	0.0	0.0	0
10080 min Summer	-0.008	0.0	0.0	0
15 min Winter	122.248	0.0	0.0	0
30 min Winter	82.572	0.0	0.0	0
60 min Winter	52.458	0.0	0.0	0
120 min Winter	33.215	0.0	0.0	0
180 min Winter	25.480	0.0	0.0	0

Cascade Summary of Results for Project Subs - Basin - FEH 2YR - FEH13 100 YR + 40% CC - Detention Only.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
240 min Winter	15.190	0.000	0.0	0.0	O K
360 min Winter	15.239	0.049	1.4	509.0	O K
480 min Winter	15.299	0.109	5.6	1142.5	O K
600 min Winter	15.343	0.153	7.4	1605.9	O K
720 min Winter	15.377	0.187	7.5	1962.9	O K
960 min Winter	15.422	0.232	7.5	2451.5	O K
1440 min Winter	15.466	0.276	7.5	2920.8	O K
2160 min Winter	15.475	0.285	7.5	3017.5	O K
2880 min Winter	15.459	0.269	7.5	2840.8	O K
4320 min Winter	15.398	0.208	7.5	2189.9	O K
5760 min Winter	15.350	0.160	7.4	1679.6	O K
7200 min Winter	15.190	0.000	0.0	0.0	O K
8640 min Winter	15.190	0.000	0.0	0.0	O K
10080 min Winter	15.190	0.000	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	21.109	0.0	0.0	0
360 min Winter	16.158	0.0	159.1	386
480 min Winter	13.321	0.0	539.4	494
600 min Winter	11.410	0.0	830.3	612
720 min Winter	10.016	0.0	984.7	728
960 min Winter	8.080	0.0	1006.3	964
1440 min Winter	5.860	0.0	868.5	1432
2160 min Winter	4.154	0.0	1963.8	2124
2880 min Winter	3.223	0.0	1781.4	2800
4320 min Winter	2.228	0.0	1395.1	4052
5760 min Winter	1.712	0.0	1884.5	4520
7200 min Winter	-0.012	0.0	0.0	0
8640 min Winter	-0.010	0.0	0.0	0
10080 min Winter	-0.008	0.0	0.0	0

Cascade Rainfall Details for Project Subs - Basin - FEH 2YR - FEH13 100 YR + 40% CC - Detention Only.SRCX

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 641300 260300 TM 41300 60300	Shortest Storm (mins)	15
Data Type	Catchment	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	**To:**	**Area (ha)**
0	4	0.000

Cascade Model Details for Project Subs - Basin - FEH 2YR - FEH13 100 YR + 40% CC - Detention Only.SRCX

Storage is Online Cover Level (m) 16.000

Tank or Pond Structure

Invert Level (m) 15.190

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	10378.0	0.310	10847.0	0.610	11311.0	0.710	12714.0	0.810	12880.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0137-7500-0310-7500
Design Head (m)	0.310
Design Flow (l/s)	7.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	137
Invert Level (m)	15.190
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.310	7.5	Kick-Flo®	0.273	7.1
Flush-Flo™	0.187	7.5	Mean Flow over Head Range	-	5.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.9	0.800	11.7	2.000	18.1	4.000	25.2	7.000	33.4
0.200	7.5	1.000	13.0	2.200	19.0	4.500	26.7	7.500	34.6
0.300	7.4	1.200	14.2	2.400	19.8	5.000	28.2	8.000	35.8
0.400	8.4	1.400	15.3	2.600	20.5	5.500	29.6	8.500	36.9
0.500	9.4	1.600	16.3	3.000	22.0	6.000	30.9	9.000	38.0
0.600	10.2	1.800	17.2	3.500	23.5	6.500	32.2	9.500	39.0

Appendix 4: National Grid Substation Attenuation Scheme Model Outputs

SUDS Design Summary

Notes:

1. SUDS design proposal to attenuate surface water flows from hardstanding areas associated with EA2 / EA1N and National Grid substations (including access roads and cable sealing compounds).

2. Separate SUDS required for EA2/EA1N project substations and National Grid infrastructure.

3. EA2/EA1N project substations and access roads discharge to SUDS Basin with outfall to existing ditch in Church Lane at pre-development run-off rate. To mimic existing drainage regime and achieve no net increase in flows to receiving watercourse.

4. NG substation and sealing end compounds discharge to SUDS Basin with outfall to existing ditch in field at pre-development run-off rate. To mimic existing drainage regime and achieve no net increase in flows to receiving watercourse.

5. SUDS design undertaken in line with national and local guidance set out in The SUDS Manual (C753) & Suffolk County Council Sustainable Drainage Systems (SUDS) a Local Design Guide.

6. Pre Development discharge rates estimated using FEH method - HR Wallingford Greenfield Runoff Rate Estimation Online Tool.

7. SUDS sizing estimated using FEH13 Rainfall and Micro Drainage design software.

8. Additional SUDS to be provided as source control / treatment during detailed design.

Design Parameters / Assumptions	EA2	EA1N	National Grid	Change Notes
Hardstanding (all footprints assumed 100% impermeable)				
Substation operational footprint	32,300 m^2	32,300 m^2	44,950 m^2	01.12.20 Updated with areas of SUDS basin footprint (including perimeter access tracks) 05.01.21 Reduced project substation footprints from 36,100m^2 to 32,300m^2 for each substation (previous total 96,510m^2). 02.02.21 Amended design to store 1:100 YR + 40% exceedence within 1m design depth. 10.02.21 Added note on additional volume allowed for existing depression adjacent EA1N substation.
Operational access road	13,600 m^2		-	
Cable sealing end compound operational footprint	-		10,000 m^2	
Permanent access road to sealing end compound	-		1,850 m^2	
SUDS Basin Footprint (including perimeter access track)	18,300 m^2		10,602 m^2	
Total	**96,500 m^2**		**67,402 m^2**	
Additional Volumes				
Existing depression adjacent EA1N substation. Estimated volume to be allowed for in SUDS design (see additional design requirements below).	**3,300 m^3**		-	
Pre-Development Run-Off Rates (calculated from HR Wallingford Greenfield Runoff Rate Estimation Online Tool)				01.12.20 Updated to suit increased contribution areas as above 05.01.21 Updated to suit reduced project subsation contribution areas as above 02.02.21 Amended design to store 1:100 YR + 40% exceedence within 1m design depth.
2 l/s/ha	19.30 l/s		13.48 l/s	
	FEH		**FEH**	
1 Year Return	6.88 l/s		4.81 l/s	
2 Year Return (Q_{BAR})	**7.91 l/s**		**5.52 l/s**	
30 Year Return	19.38 l/s		13.53 l/s	
100 Year Return	28.15 l/s		19.66 l/s	
200 Year Return	33.30 l/s		23.25 l/s	
Unttenuated Flow Discharging to SUDS from Harstanding (calculated from FEH13 Rainfall using Micro Drainage design software)				01.12.20 Updated to suit increased contribution areas as above 05.01.21 Updated to suit reduced project subsation contribution areas as above 02.02.21 Amended design to store 1:100 YR + 40% exceedence within 1m design depth.
	FEH13		**FEH13**	
1 Year Return + 40% CC	N/A		N/A	
2 Year Return + 40% CC	68.0 l/s		79.2 l/s	
30 Year Return + 40% CC	173.0 l/s		204.8 l/s	
100 Year Return + 40% CC	285.5 l/s		310.2 l/s	
200 Year Return + 40% CC	362.3 l/s		389.5 l/s	
Attenuated Post Development Run-Off Rates	**Limited to pre-development (2-year FEH) run-off rate. Provides betterment over 2 l/s/ha rate and IH124 rate.**			No change
Pre / Post Development Reduction In Run-Off Rates (pre development rates minus attenuated post development rates)				01.12.20 Updated to suit increased contribution areas as above 05.01.21 Updated to suit reduced project subsation contribution areas as above 02.02.21 Amended design to store 1:100 YR + 40% exceedence within 1m design depth.
1 Year Return	N/A		N/A	
2 Year Return	60.09 l/s		73.68 l/s	
30 Year Return	165.09 l/s		199.28 l/s	
100 Year Return	277.59 l/s		304.68 l/s	
200 Year Return	354.39 l/s		383.6 l/s	
Design Storm Event	**1 in 100 year + 40% climate change as per SCC guidance.**			02.02.21 Updated to 1:100 year + 40% CC
Attenuation Storage Required (calculated from FEH13 Rainfall using Micro Drainage design software)				01.12.20 Updated to suit increased contribution areas as above 05.01.21 Updated to suit reduced project subsation contribution areas as above 02.02.21 Amended design to store 1:100 YR + 40% exceedence within 1m design depth.
	FEH13		**FEH13**	
All Hardstanding Areas	**11,593.4 m^3**		**8,024.5 m^3**	
Attenuation Dimensions				01.12.20 Added areas for perimeter access track. Access track falls towards top of basin providing an additional 0.1m depth of storage. 02.02.21 Amended design to store 1:100 YR + 40% exceedence within 1m design depth.
Detention Basins				
Design Top area (1.0m Deep)	15,861 m^2		8,721 m^2	
Freeboard Top area (1.3m Deep)	16,421 m^2		9,149 m^2	
Perimeter access track top area (1.4m Deep)	18,106 m^2		10,449 m^2	
Basin Top area (1.5m Deep)	18,303 m^2		10,602 m^2	
Base area	14,062 m^2		7,360 m^2	
Design storage depth	1.0 m		1.0 m	
Design freeboard + 0.3m (1.3m Deep)	0.3 m		0.3 m	
Overall depth	1.5 m		1.5 m	
Side slopes	1 in 4		1 in 4	
Attenuation Storage Provided				01.12.20 Added additional storage volume from perimter access track. Access track falls towards top of basin providing an additional 0.1m depth of storage. 02.02.21 Amended design to store 1:100 YR + 40% exceedence within 1m design depth.
Detention Basins				
Design	14,961.5 m^3		8,040.5 m^3	
Freeboard	4,842.3 m^3		2,680.5 m^3	
Perimeter access track	1,726.35 m^3		979.90 m^3	
Additional storage between track and basin top	1,820.45 m^3		1,052.55 m^3	
Total (design)	**14,961.5 m^3**		**8,040.5 m^3**	
Total (inc. freeboard, access track etc)	23,350.6 m^3		12,753.45 m^3	
Design storage required < attenuation storage provided?	**YES = OK**		**YES = OK**	
Additional Design Requirements				02.02.21 Added to show allowance for existing depression included in basin design.
Offset removal of depression adjacent EA1N substation by allowing additional storage in basin design depth. Additional storage required:	**3,300 m^3**		N/A	
Surplus storage available within basin design depth (1.0m)	**3,368.1 m^3**		N/A	
Design storage required < attenuation storage provided?	**YES = OK**		N/A	
Discharge Location	**Existing watercourse in Church Lane via new outfall pipe as per existing drainage regime. Provides additional betterment over existing arrangment by reducing flood flows down existing farm track.**		**Existing ditch in field. Provides betterment over existing by attenuating flows from greater return period storms.**	**Design flows up to 1:100 year + 40% CC are attenuated within the basin design depth (1m). Additional 300mm freeboard provided provided over and above design capacity with another 200mm to the top of the basin from the bottom edge of the access track (total 1.5m depth).**

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	East Anglia EA1N / EA2
Site location:	Project Substations FEH13

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.

Site Details

Latitude:	52.19357° N
Longitude:	1.52746° E
Reference:	829599236
Date:	Feb 02 2021 10:25

Runoff estimation approach

FEH Statistical

Site characteristics

Total site area (ha):	9.65

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.729
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.12

Hydrological characteristics

	Default	Edited
SAAR (mm):	585	585
Hydrological region:	5	5
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	2.45	2.45
Growth curve factor 100 years:	3.56	3.56
Growth curve factor 200 years:	4.21	4.21

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):		7.91
1 in 1 year (l/s):		6.88
1 in 30 years (l/s):		19.38
1 in 100 year (l/s):		28.15
1 in 200 years (l/s):		33.3

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Christopher Sneddon
Site name:	East Anglia EA1N / EA2
Site location:	National Grid FEH13

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.

Site Details

Latitude:	52.19357° N
Longitude:	1.52746° E
Reference:	2369002495
Date:	Feb 02 2021 12:08

Runoff estimation approach FEH Statistical

Site characteristics

Total site area (ha): 6.74

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.729
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.12

Hydrological characteristics

	Default	Edited
SAAR (mm):	585	585
Hydrological region:	5	5
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	2.45	2.45
Growth curve factor 100 years:	3.56	3.56
Growth curve factor 200 years:	4.21	4.21

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):		5.52
1 in 1 year (l/s):		4.81
1 in 30 years (l/s):		13.53
1 in 100 year (l/s):		19.66
1 in 200 years (l/s):		23.25

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	14.656	0.156	7.4	2207.9	O K
30 min Summer	14.709	0.209	7.7	2979.7	O K
60 min Summer	14.764	0.264	7.9	3779.5	O K
120 min Summer	14.832	0.332	7.9	4772.5	O K
180 min Summer	14.881	0.381	7.9	5478.1	O K
240 min Summer	14.918	0.418	7.9	6037.5	O K
360 min Summer	14.977	0.477	7.9	6904.4	O K
480 min Summer	15.021	0.521	7.9	7561.3	O K
600 min Summer	15.054	0.554	7.9	8067.1	O K
720 min Summer	15.081	0.581	7.9	8468.9	O K
960 min Summer	15.119	0.619	7.9	9049.5	O K
1440 min Summer	15.164	0.664	7.9	9720.7	O K
2160 min Summer	15.191	0.691	7.9	10139.6	O K
2880 min Summer	15.200	0.700	7.9	10283.5	O K
4320 min Summer	15.197	0.697	7.9	10236.3	O K
5760 min Summer	15.186	0.686	7.9	10063.4	O K
7200 min Summer	14.500	0.000	0.0	0.0	O K
8640 min Summer	14.500	0.000	0.0	0.0	O K
10080 min Summer	14.500	0.000	0.0	0.0	O K
15 min Winter	14.674	0.174	7.5	2473.0	O K
30 min Winter	14.734	0.234	7.8	3337.8	O K
60 min Winter	14.796	0.296	7.9	4234.2	O K
120 min Winter	14.872	0.372	7.9	5347.6	O K
180 min Winter	14.925	0.425	7.9	6139.5	O K
240 min Winter	14.968	0.468	7.9	6767.9	O K
360 min Winter	15.033	0.533	7.9	7742.5	O K
480 min Winter	15.082	0.582	7.9	8482.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	122.248	0.0	570.5	19
30 min Summer	82.572	0.0	649.4	34
60 min Summer	52.458	0.0	1325.0	64
120 min Summer	33.215	0.0	1338.4	124
180 min Summer	25.480	0.0	1327.0	184
240 min Summer	21.109	0.0	1310.8	244
360 min Summer	16.158	0.0	1277.5	364
480 min Summer	13.321	0.0	1245.8	484
600 min Summer	11.410	0.0	1215.4	604
720 min Summer	10.016	0.0	1185.5	724
960 min Summer	8.080	0.0	1128.9	964
1440 min Summer	5.860	0.0	1035.1	1444
2160 min Summer	4.154	0.0	2145.4	2164
2880 min Summer	3.224	0.0	2064.3	2884
4320 min Summer	2.228	0.0	1942.5	4324
5760 min Summer	1.712	0.0	4249.0	5760
7200 min Summer	-0.012	0.0	-101.3	0
8640 min Summer	-0.010	0.0	-101.3	0
10080 min Summer	-0.008	0.0	-101.3	0
15 min Winter	122.248	0.0	618.5	19
30 min Winter	82.572	0.0	660.7	34
60 min Winter	52.458	0.0	1341.4	64
120 min Winter	33.215	0.0	1339.4	124
180 min Winter	25.480	0.0	1321.0	182
240 min Winter	21.109	0.0	1300.9	242
360 min Winter	16.158	0.0	1261.5	362
480 min Winter	13.321	0.0	1220.1	482

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
600 min Winter	15.120	0.620	7.9	9053.9	O K
720 min Winter	15.150	0.650	7.9	9509.5	O K
960 min Winter	15.193	0.693	7.9	10169.9	O K
1440 min Winter	15.243	0.743	7.9	10931.8	O K
2160 min Winter	15.274	0.774	7.9	11415.0	O K
2880 min Winter	15.286	0.786	7.9	11593.4	O K
4320 min Winter	15.285	0.785	7.9	11579.2	O K
5760 min Winter	15.275	0.775	7.9	11430.3	O K
7200 min Winter	14.500	0.000	0.0	0.0	O K
8640 min Winter	14.500	0.000	0.0	0.0	O K
10080 min Winter	14.500	0.000	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
600 min Winter	11.410	0.0	1176.1	600
720 min Winter	10.016	0.0	1130.5	720
960 min Winter	8.080	0.0	1069.2	956
1440 min Winter	5.860	0.0	1055.8	1428
2160 min Winter	4.154	0.0	2181.7	2140
2880 min Winter	3.223	0.0	2147.0	2852
4320 min Winter	2.228	0.0	2041.2	4240
5760 min Winter	1.712	0.0	4252.5	5648
7200 min Winter	-0.012	0.0	-113.5	0
8640 min Winter	-0.010	0.0	-113.5	0
10080 min Winter	-0.008	0.0	-113.5	0

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 641300 260300 TM 41300 60300	Shortest Storm (mins)	15
Data Type	Catchment	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 9.650

Time From:	**(mins) To:**	**Area (ha)**
0	4	9.650

Model Details

Storage is Online Cover Level (m) 16.000

Tank or Pond Structure

Invert Level (m) 14.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	14062.0	1.000	15861.0	1.300	16421.0	1.400	18106.0	1.500	18303.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0131-7900-1000-7900
Design Head (m)	1.000
Design Flow (l/s)	7.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	131
Invert Level (m)	14.500
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	7.9	Kick-Flo®	0.660	6.5
Flush-Flo™	0.299	7.9	Mean Flow over Head Range	-	6.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.7	0.800	7.1	2.000	10.9	4.000	15.2	7.000	19.9
0.200	7.7	1.000	7.9	2.200	11.4	4.500	16.1	7.500	20.6
0.300	7.9	1.200	8.6	2.400	11.9	5.000	16.9	8.000	21.2
0.400	7.8	1.400	9.2	2.600	12.4	5.500	17.7	8.500	21.8
0.500	7.6	1.600	9.9	3.000	13.3	6.000	18.5	9.000	22.4
0.600	7.1	1.800	10.4	3.500	14.3	6.500	19.2	9.500	23.0

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	15.356	0.206	5.4	1541.5	O K
30 min Summer	15.426	0.276	5.5	2080.4	O K
60 min Summer	15.498	0.348	5.5	2638.6	O K
120 min Summer	15.586	0.436	5.5	3331.1	O K
180 min Summer	15.647	0.497	5.5	3823.1	O K
240 min Summer	15.696	0.546	5.5	4213.2	O K
360 min Summer	15.770	0.620	5.5	4818.6	O K
480 min Summer	15.826	0.676	5.5	5278.3	O K
600 min Summer	15.868	0.718	5.5	5630.9	O K
720 min Summer	15.902	0.752	5.5	5909.3	O K
960 min Summer	15.949	0.799	5.5	6308.5	O K
1440 min Summer	16.003	0.853	5.5	6760.3	O K
2160 min Summer	16.034	0.884	5.5	7028.8	O K
2880 min Summer	16.043	0.893	5.5	7108.4	O K
4320 min Summer	16.035	0.885	5.5	7039.1	O K
5760 min Summer	16.017	0.867	5.5	6887.7	O K
7200 min Summer	15.150	0.000	0.0	0.0	O K
8640 min Summer	15.150	0.000	0.0	0.0	O K
10080 min Summer	15.150	0.000	0.0	0.0	O K
15 min Winter	15.380	0.230	5.4	1726.8	O K
30 min Winter	15.458	0.308	5.5	2330.5	O K
60 min Winter	15.538	0.388	5.5	2956.2	O K
120 min Winter	15.636	0.486	5.5	3733.1	O K
180 min Winter	15.705	0.555	5.5	4285.7	O K
240 min Winter	15.759	0.609	5.5	4724.6	O K
360 min Winter	15.841	0.691	5.5	5406.2	O K
480 min Winter	15.903	0.753	5.5	5921.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	122.248	0.0	451.4	19
30 min Summer	82.572	0.0	468.2	34
60 min Summer	52.458	0.0	941.7	64
120 min Summer	33.215	0.0	928.6	124
180 min Summer	25.480	0.0	908.6	184
240 min Summer	21.109	0.0	886.6	244
360 min Summer	16.158	0.0	831.7	364
480 min Summer	13.321	0.0	775.6	484
600 min Summer	11.410	0.0	767.8	604
720 min Summer	10.016	0.0	777.8	724
960 min Summer	8.080	0.0	787.4	964
1440 min Summer	5.860	0.0	784.3	1444
2160 min Summer	4.154	0.0	1617.8	2164
2880 min Summer	3.224	0.0	1592.7	2884
4320 min Summer	2.228	0.0	1513.7	4320
5760 min Summer	1.712	0.0	3104.0	5760
7200 min Summer	-0.012	0.0	-70.8	0
8640 min Summer	-0.010	0.0	-70.8	0
10080 min Summer	-0.008	0.0	-70.8	0
15 min Winter	122.248	0.0	460.4	19
30 min Winter	82.572	0.0	471.1	34
60 min Winter	52.458	0.0	941.7	64
120 min Winter	33.215	0.0	918.4	124
180 min Winter	25.480	0.0	889.2	182
240 min Winter	21.109	0.0	852.0	242
360 min Winter	16.158	0.0	779.2	362
480 min Winter	13.321	0.0	790.8	482

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
600 min Winter	15.950	0.800	5.5	6317.4	O K
720 min Winter	15.987	0.837	5.5	6631.2	O K
960 min Winter	16.040	0.890	5.5	7083.0	O K
1440 min Winter	16.100	0.950	5.5	7599.9	O K
2160 min Winter	16.137	0.987	5.5	7917.0	O K
2880 min Winter	16.149	0.999	5.5	8022.2	O K
4320 min Winter	16.144	0.994	5.5	7977.2	O K
5760 min Winter	16.128	0.978	5.5	7839.9	O K
7200 min Winter	15.150	0.000	0.0	0.0	O K
8640 min Winter	15.150	0.000	0.0	0.0	O K
10080 min Winter	15.150	0.000	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
600 min Winter	11.410	0.0	807.2	600
720 min Winter	10.016	0.0	817.9	720
960 min Winter	8.080	0.0	827.6	954
1440 min Winter	5.860	0.0	823.1	1428
2160 min Winter	4.154	0.0	1701.0	2140
2880 min Winter	3.223	0.0	1673.0	2852
4320 min Winter	2.228	0.0	1587.5	4236
5760 min Winter	1.712	0.0	3274.2	5640
7200 min Winter	-0.012	0.0	-79.3	0
8640 min Winter	-0.010	0.0	-79.3	0
10080 min Winter	-0.008	0.0	-79.3	0

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 641300 260300 TM 41300 60300	Shortest Storm (mins)	15
Data Type	Catchment	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 6.740

Time (mins) From:	To:	Area (ha)
0	4	6.740

Model Details

Storage is Online Cover Level (m) 16.650

Tank or Pond Structure

Invert Level (m) 15.150

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	7360.0	1.000	8721.0	1.300	9149.0	1.400	10449.0	1.500	10602.0

Hydro-Brake® Optimum Outflow Control

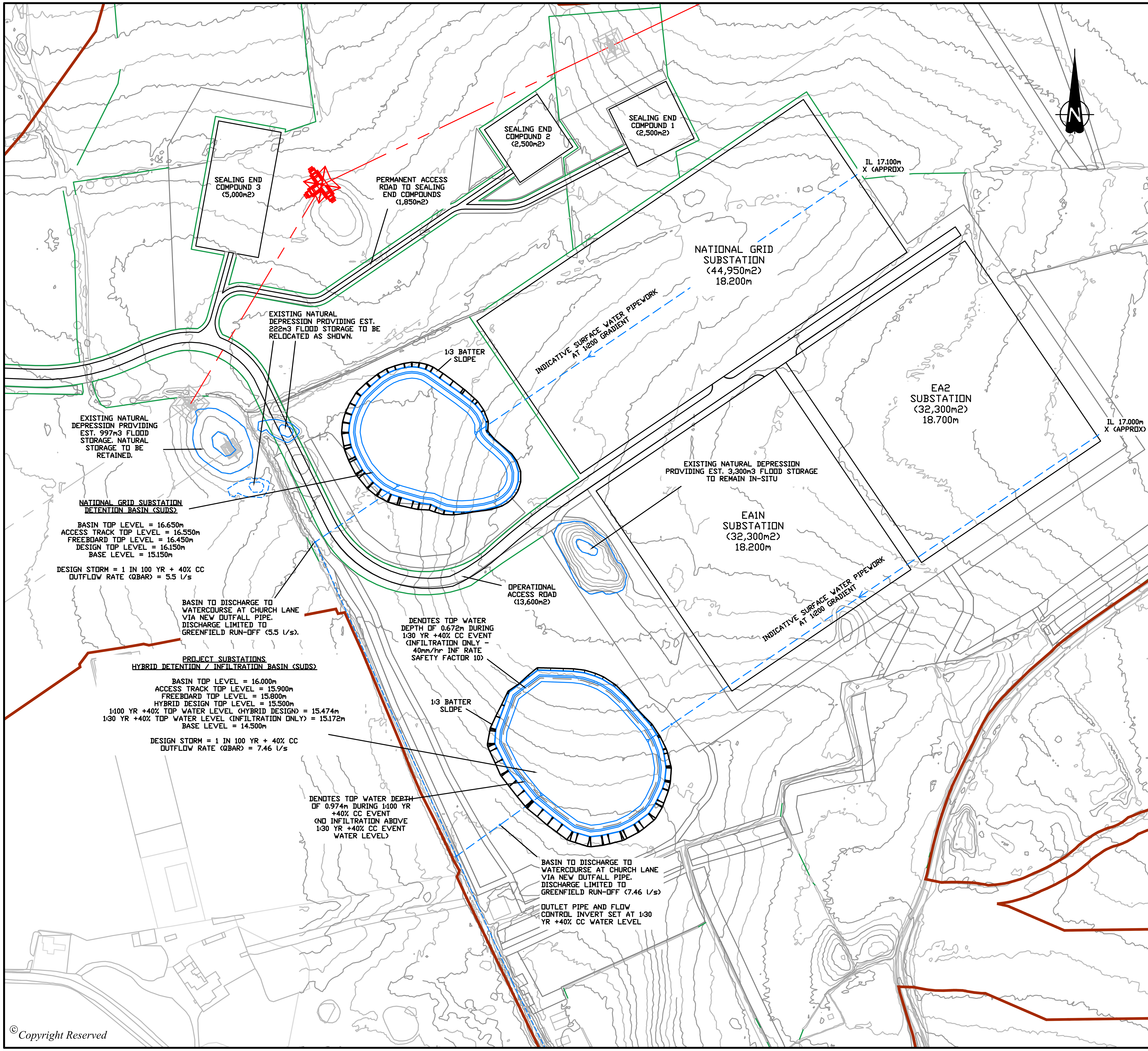
Unit Reference	MD-SHE-0111-5520-1000-5520
Design Head (m)	1.000
Design Flow (l/s)	5.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	111
Invert Level (m)	15.150
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	5.5	Kick-Flo®	0.644	4.5
Flush-Flo™	0.298	5.5	Mean Flow over Head Range	-	4.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	3.8	0.800	5.0	2.000	7.6	4.000	10.5	7.000	13.8
0.200	5.4	1.000	5.5	2.200	7.9	4.500	11.2	7.500	14.2
0.300	5.5	1.200	6.0	2.400	8.3	5.000	11.7	8.000	14.7
0.400	5.4	1.400	6.4	2.600	8.6	5.500	12.3	8.500	15.1
0.500	5.2	1.600	6.8	3.000	9.2	6.000	12.8	9.000	15.5
0.600	4.8	1.800	7.2	3.500	9.9	6.500	13.3	9.500	15.9

Appendix 5: Plan and Cross Sections of Indicative SuDS Basins



DO NOT SCALE FROM THIS DRAWING

NOTES:

HYBRID DETENTION / INFILTRATION BASINS ARE SHOWN INDICATIVELY FOR ILLUSTRATION PURPOSES ONLY. DETAILED DESIGN OF BASINS WOULD BE REQUIRED TO CONFIRM EXACT ELEVATIONS, SHAPES AND LOCATIONS AS APPROPRIATE AND AS PART OF THE MASTERPLANNING PROCESS.

DENOTES DCO ORDER LIMITS

DENOTES INDICATIVE SURFACE WATER PIPEWORK

DENOTES INDICATIVE SUDS FEATURE (SEE ANNOTATION)

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D
E	FINAL ISSUE	11.06.21	GM	CS	SH
D	UPDATED HYBRID DESIGN FOR PROJECT SUBSTATIONS ONLY. ADDED DETENTION ONLY DESIGN AT NATIONAL GRID.	09.06.21	CS	CS	SH
C	UPDATED HYBRID DESIGN FOR PROJECT SUBSTATIONS ONLY	08.06.21	CS	CS	SH
B	UPDATED NG BASIN TO ALLOW FOR ADDITIONAL AREA FROM FUTURE EXPANSION	05.05.21	CS	CS	SH
A	FIRST ISSUE	23.03.21	CS	CS	SH

CLIENT
Haskoning DHV UK Limited

PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

DRAWING TITLE
DETENTION / INFILTRATION BASIN HYBRID
1 IN 100 YR + 40% CC DESIGN

DRG No.		REV
ED11892-C-SK14		D
DRG SIZE: A3	SCALE: NTS	DATE: MAR'21
DRAWN BY: CS	CHECKED BY: CS	APPROVED BY: SH

wardell armstrong

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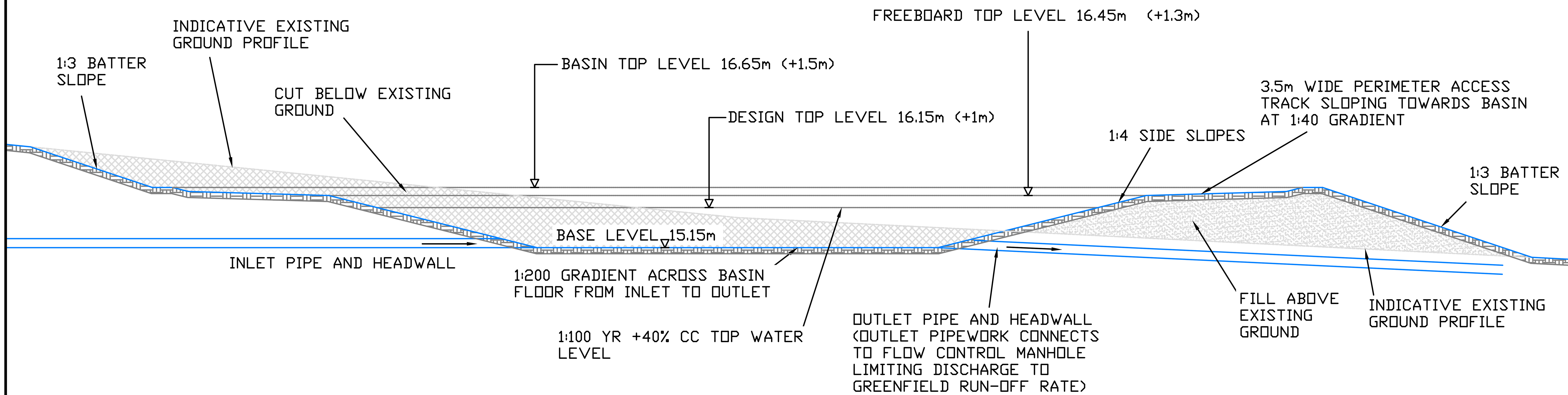
BIRMINGHAM, BOLTON, CARDIFF, CARLISLE, GLASGOW, LEEDS, LONDON, MANCHESTER, NEWCASTLE UPON TYNE, STOKE ON TRENT

N:\ED\ED11892 - EAST ANGLIA OFFSHORE WIND EA 1\03 - DESIGN\AUTOCAD\ED11892-C-SK14-D SK15-D - DETENTION & INFILTRATION HYBRID BASIN.DWG



TYPICAL DETENTION BASIN CROSS SECTION (NATIONAL GRID)

DO NOT SCALE FROM THIS DRAWING

NOTES:

DETENTION BASINS ARE SHOWN INDICATIVELY FOR ILLUSTRATION PURPOSES ONLY. DETAILED DESIGN OF BASINS WOULD BE REQUIRED TO CONFIRM EXACT ELEVATIONS, SHAPES AND LOCATIONS AS APPROPRIATE AND AS PART OF THE MASTERPLANNING PROCESS.

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D
E	FINAL ISSUE	11.06.21	GM	CS	SH
D	REMOVED DETENTION BASIN FOR PROJECT SUBSTATIONS.	10.06.21	CS	CS	SH
C	UPDATED TO SHOW LEVELS FOR NG / PROJECT BASINS.	08.06.21	CS	CS	SH
B	UPDATED TO SHOW INDICATIVE EXISTING GROUND PROFILE AND BATTER SLOPES.	24.02.21	CS	CS	SH
A	FIRST ISSUE	10.02.21	CS	CS	SH

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PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

DRAWING TITLE
DETENTION BASIN
1 IN 100 YR + 40% CC DESIGN
TYPICAL BASIN CROSS SECTION

DRG No.		REV
ED11892-C-SK12		E
DRG SIZE: A3	SCALE: NTS	DATE: FEB'21
DRAWN BY: CS	CHECKED BY: CS	APPROVED BY: SH

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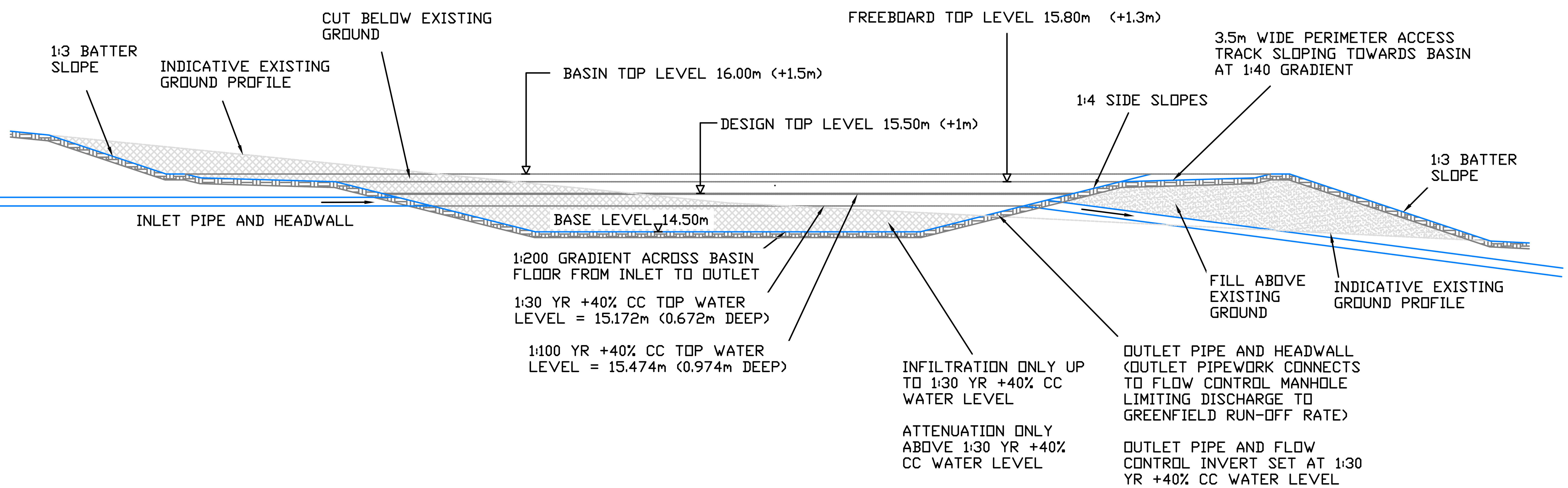
N:\ED\ED11892 - EAST ANGLIA OFFSHORE WIND EA 1\03 - DESIGN\AUTOCAD\ED11892-C-SK11-E SK12-E - DETENTION BASINS.DWG

DO NOT SCALE FROM THIS DRAWING

NOTES:

HYBRID DETENTION / INFILTRATION BASINS ARE SHOWN INDICATIVELY FOR ILLUSTRATION PURPOSES ONLY. DETAILED DESIGN OF BASINS WOULD BE REQUIRED TO CONFIRM EXACT ELEVATIONS, SHAPES AND LOCATIONS AS APPROPRIATE AND AS PART OF THE MASTERPLANNING PROCESS.



TYPICAL HYBRID DETENTION / INFILTRATION BASIN CROSS SECTION
(PROJECT SUBSTATIONS)

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D
D	FINAL ISSUE	11.06.21	GM	CS	SH
C	UPDATED DESIGN AND ADDED LEVELS PROJECT BASINS.	10.06.21	CS	CS	SH
B	UPDATED DESIGN AND ADDED LEVELS PROJECT BASINS.	08.06.21	CS	CS	SH
A	FIRST ISSUE	23.03.21	CS	CS	SH

CLIENT
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PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

DRAWING TITLE
DETENTION / INFILTRATION BASIN HYBRID
1 IN 100 YR + 40% CC DESIGN
TYPICAL BASIN CROSS SECTION

DRG No.		REV
ED11892-C-SK15		D
DRG SIZE: A3	SCALE: NTS	DATE: MAR'21
DRAWN BY: CS	CHECKED BY: CS	APPROVED BY: SH

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☐ GLASGOW ☐ STOKE ON TRENT

N:\ED\ED11892 - EAST ANGLIA OFFSHORE WIND EA 1\03 - DESIGN\AUTOCAD\ED11892-C-SK14-D SK15-D - DETENTION & INFILTRATION HYBRID BASIN.DWG