East Anglia TWO Offshore Windfarm

Outline Operational Drainage Management Plan

Applicant: East Anglia TWO Limited
Document Reference: ExA.AS-1.D6.V3
SPR Reference: EA2-DWF-ENV-REP-IBR-001042

Date: 24th February 2021
Revision: Version 03
Author: Royal HaskoningDHV

Applicable to
East Anglia TWO

Revision Summary				
Rev	**Date**	**Prepared by**	**Checked by**	**Approved by**
001	15/12/2020	Paolo Pizzolla	Lesley Jamieson	Rich Morris
002	13/01/2021	Paolo Pizzolla	Lesley Jamieson	Rich Morris
003	24/02/2021	Paolo Pizzolla	Lesley Jamieson	Rich Morris

Description of Revisions			
Rev	**Page**	**Section**	**Description**
001	n/a	n/a	Final for Deadline 3
002	n/a	n/a	Final for Deadline 4
003	n/a	n/a	Final for Deadline 6

Table of Contents

Executive Summary

1. As is normal for such nationally significant infrastructure projects, only on completion of the detailed design of the East Anglia TWO and East Anglia ONE North projects' onshore substations and National Grid substation; confirmation of the ground conditions and infiltration rates; and establishment of the catchment hydrological model, can the detailed design of the surface water management system be finalised. This will confirm the pre-development greenfield discharge rate to the Friston Watercourse which the Projects will not exceed; confirm the extent of infiltration which is reasonable for the substation area; and establish the size and location of the Sustainable Drainage System (SuDS) attenuation basins.

2. In the interim, the Applicants have assumed a worst-case scenario pre-development greenfield discharge rate to the Friston Watercourse with no infiltration and have demonstrated within this Outline Operational Drainage Management Plan (OODMP) that sufficient space exists in the substation area to accommodate this arrangement. Incorporation of infiltration measures will complement the discharge to the Friston Watercourse.

3. This OODMP summarises the existing hydrological conditions at the location of the proposed East Anglia TWO and East Anglia ONE North projects' onshore substations; the National Grid infrastructure; and within the Friston catchment area.

4. It 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.

5. The strategy presented in this plan has been established to ensure that there will be no increase in the existing pre-development greenfield runoff rates to the receiving Friston Watercourse, and ensure that, if required, any removal of existing depressions which hold surface water will be offset within the final surface water system design.

6. The proposed surface water drainage solution is in compliance with Suffolk County Council's sustainable drainage hierarchy (2018). Assuming a worst-case infiltration rate of 10mm/hr, an infiltration only design would be unviable for the Projects as the required 24hr half drain specification is not met. An additional secondary assessment has been undertaken at the request of Suffolk County Council, to consider an additional 1 in 10 year storm event 24 hours later to ensure sufficient storage can be provided. However, it is important to note that this also does not meet the required half drain time.

7. It is the Applicant's position therefore that the surface water drainage design at the substation location will incorporate infiltration elements, where possible, within an attenuation design with a connection to discharge at a controlled rate to the Friston Watercourse. This is in line with the drainage hierarchy and the detailed design of this system and is wholly appropriate for such nationally significant infrastructure projects. The degree to which infiltration is possible will be subject to ground investigations at the location of the onshore substations and National Grid infrastructure, land use and landscaping requirements. Percolation tests will be undertaken as part of the detailed design process to determine the underlying permeability and the feasibility of a combined infiltration / attenuation drainage design.

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

    a) Confirm the pre-development greenfield Q_{BAR} runoff rate, calculated through detailed hydrological 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;

    b) Confirm the pre-development infiltration rate in the area of the onshore substations and National Grid substation through percolation testing;

    c) Confirm the optimal SuDS basin(s) capacity using the above data. This will reflect the discharge rate to the Friston Watercourse; an appropriate infiltration rate; revisions to the substation infrastructure footprint and its detailed design; landscaping requirements; and the optimum use of land.

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
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
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.
Q_{BAR}	Mean annual flood, the value of the average annual flood event recorded in a river.

1 Introduction

1.1 Overview

9. 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 Applications) for the East Anglia TWO project and the East Anglia ONE North project (the Projects) submitted by East Anglia TWO Limited (the Applicant).

10. Works to be undertaken include (amongst other things) the construction of an onshore substation, one for the East Anglia TWO Project (the Project); an onshore substation for the East Anglia ONE North Project; National Grid infrastructure; associated landscaping; and surface water management infrastructure.

11. Requirement 41 of the ***draft DCO*** (REP5-003) requires an 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) and the Environment Agency and which must be in line with this OODMP.

12. The information presented in this document is based on the updated maximum substation footprints The following Project updates have been submitted to the Examination and are applicable to this plan:

- An updated Outline Landscape Mitigation Plan within the ***Outline Landscape and Ecological Management Strategy*** (submitted at Deadline 6, document reference 8.7);
- The ***Project Update Note*** (REP2-007) submitted at Deadline 2 regarding the approximate 10% reduction in the footprint of the substations;
- Updated Works Plans (Onshore) (REP3-006) to reflect the substation footprint reduction; and
- The ***Project Update Note for Deadline 3*** (REP3-052) which presents the new location of the National Grid substation sustainable drainage system (SuDS) basin.

1.2 Purpose

13. 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.

14. Parameters such as the storage volumes, runoff off rates and proposed discharge rates quoted in this OODMP relate to the current design envelope of the Projects and will be subject to review during the detailed design of the Projects.

1.3 Basis of Design

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

a) Confirm the pre-development greenfield Q_{BAR} runoff rate, calculated through detailed hydrological 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;

b) Confirm the pre-development infiltration rate in the area of the onshore substations and National Grid substation through percolation testing;

c) Confirm the optimal SuDS basin(s) capacity using the above data. This will reflect the discharge rate to the Friston Watercourse; an appropriate infiltration rate; revisions to the substation infrastructure footprint and its detailed design; landscaping requirements; and the optimum use of land.

.

2 Relevant Legislation, Policy and Guidance

16. 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)

17. Under the Flood and Water Management Act (2010), Lead Local Flood Authorities (LLFAs) are responsible for managing the risk of flooding from surface water, groundwater and ordinary watercourses. Suffolk County Council (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

18. 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

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

2.2.2 National Planning Policy Framework

20. 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 Preliminary Flood Risk Assessments

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

22. 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).

2.2.4 Strategic Flood Risk Assessments

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

24. 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).

25. 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.

26. 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)).

2.2.5 Suffolk Flood Risk Management Strategy

27. 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.

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

29. 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.

30. Consideration of CDAs is therefore necessary to inform key flood risk priorities. The FRMS indicates that local authorities should identify CDAs within their SFRA.

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

The Level 1 SFRA (WDC and SCDC 2018) indicated that SCDC and WDC has no defined CDAs.

2.2.5.1 Appendix A – Sustainable Drainage Systems (SuDS)

31. 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.

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

33. 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 personnel, vehicle or machinery access required to undertake this work; and
- Make allowances for climate change for all return periods.

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

35. 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

36. 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

37. 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

38. 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

39. 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

40. This section presents an overview of the existing conditions in and around the onshore substations and National Grid infrastructure. In establishing the baseline, existing 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

41. 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 new documentation and will include details of how the existing conditions are established.

42. 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
Suffolk County Council Surface Water Flood Risk and Incident Map	2018	Local	High

Data	Year	Coverage	Confidence
BMT (2020) Friston Surface Water Study – Technical Report[3]	2020	Local	High

43. 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

44. 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)

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

46. A small area of the National Grid infrastructure, associated with modifications to the existing overhead lines, are partially located within the Hundred River

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

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.

3.5 Ground Investigations

47. The onshore substations and National Grid infrastructure 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).

48. 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.

49. 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”.

50. 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.

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

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

3.6 Background to Historic Flooding

53. 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.

54. 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.

55. 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).

56. 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***)).

57. The surface water flood risk extends downstream to Friston, where there have been several reports of historical flooding, as provided by local residents.

58. 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)).

59. 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.

60. There is a known (variable) risk associated with surface water flooding in proximity to the onshore substation and National Grid infrastructure, as discussed further in ***paragraph 63***.

3.6.1 Historic Rainfall and Flooding Events

3.6.1.1 Onshore Substations and National Grid Substation

61. 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.

62. 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.

63. 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

64. 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 hydrological model with the purpose of assessing both the current and potential future flood risk from surface water including the impact of climate change.

65. 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 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.

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

67. 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

68. 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.

69. SCC indicated via email (25th September 2020) that the return period for this rainfall event was equivalent to approximately a 1 in 42-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.

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

3.7 Existing Hydrological and Hydrogeological Context

71. 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

72. The BMT (2020) report 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.

73. 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

74. 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 BMT report also notes that the upper catchment is predominately made up of clay soils. In the village the soils become sandier.

75. To confirm the validity of the above description of the existing ground conditions, as provided in the BMT report, the final ODMP will include details of the scope, extent and findings of the soil surveys (as part of the surveys described under ***section 3.4***) which are required to validate the existing conditions.

3.7.3 Background to Catchment Hydraulic Modelling

76. Within the Friston Surface Water Study Technical Report (BMT, 2020) report 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.

77. 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 supported the existing understanding of flood risk to the onshore substations and National Grid infrastructure.

78. 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*** of this document.

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

79. 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.

80. 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 BMT report from the Woodbridge rain gauge.

81. 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 Existing Infiltration Potential

82. The final ODMP will be produced to include details of the scope, extent and findings of soil surveys undertaken to determine the existing infiltration potential of the soils within the catchment.

83. ***Section 4.2*** provides further background on the process of infiltration and how infiltration rates will be calculated. ***Section 6*** estimates infiltration values within the Order limits. However, as detailed percolation testing has not yet been undertaken, these calculations are based on indicative, conservative figures.

3.9 Existing Runoff Rate to Friston Watercourse

84. 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*** (updated document submitted at Deadline 6, document reference 8.7), are summarised in ***Table 3.3*** below.

85. Runoff rates in ***Table 3.3*** 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.

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

Table 3.3 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})[4]	**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

87. Currently, there are three natural depressions at the onshore substations and National Grid substation locations (as shown in ***Appendix 3*** and ***Appendix 5***) 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. However, subject to hydrological catchment modelling it has been raised that the existing depression adjacent to the substations (as shown in ***Appendix 3*** and ***Appendix 5***) may no longer fulfil its function and therefore its volume has been included within the SuDS design calculations in ***Section 6*** and ***Section 7***. This volume has been included as a worst-case scenario and will only be accounted for if the hydrological catchment modelling shows it to be necessary .

88. There is also a natural surface water flow 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 flow 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.

89. The Applicant will ensure that any SuDS design developed will account for and work with these natural, existing features and will reflect the final design and positioning of the onshore substations and National Grid infrastructure.

[4] 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

90. The drainage strategy for the final ODMP will be developed according to the principles of SCC's sustainable drainage system (SuDS) discharge hierarchy 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.

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

4.2 Infiltration

92. 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.

93. 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, percolation tests will determine the underlying permeability and the feasibility to dispose of surface water directly to ground or other engineered filtration systems, and to what degree.

4.3 Attenuation

94. 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.

95. 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.

96. For the onshore substations and National Grid infrastructure, the storage will be designed to accommodate runoff from a 1 in 100 year[5] 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 3.3***) (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.

97. 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

98. 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.

4.5 Pollutant Removal

99. 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.

100. 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

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

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.

101. 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.

102. 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 to the Project

103. The Applicant notes that the application of the SuDS hierarchy (SCC, 2018) is an iterative process, dependent on site-specific conditions which will be applied to identify an optimal drainage solution, and not wholly based on the application of a single hierarchy measure as proposed by Suffolk County Council.

104. ***Section 5*** 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.

105. In accordance with the SuDS hierarchy, the Applicant presents an assessment of the viability of an infiltration only design in ***section 6*** with a subsequent assessment of an attenuation only design in ***section 7***.The final details related to the application of the SuDS hierarchy will be determined during detailed design.

106. ***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.

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

108. 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*** (REP5-003)***.***

5 Surface Water Drainage

109. This section presents the surface water drainage commitments the Applicant has made (***section 5.1***), an overview of SuDS system components (***section 5.2***) and the methodology for calculating infiltration rates (***section 5.3***).

5.1 Commitments

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

- There will be no increase in the existing pre-development greenfield runoff rates to the receiving Friston Watercourse catchment;
- Any reduction or removal of existing storage depressions, if required, will be offset and accommodated within the final SuDS design; and
- Existing watercourses and flow routes will be appropriately managed to ensure continued conveyance around the northern perimeter of the National Grid substation site.

5.2 Sustainable Drainage System Components

111. The existing topography of the onshore substations and National Grid infrastructure is located on naturally sloping land, with gradients falling away towards the field drains to the west and south west of the site, so the natural surface water flows in these general directions. The surface water drainage system will be designed to utilise and support this natural change in elevation.

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

5.2.1 Substation Operational Access Road

113. As part of the onshore substations and National Grid infrastructure a permanent substation 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.

114. 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 3*** and

Appendix 5) or the existing volume reduction will be offset and accommodated within the final SuDS design.

5.2.2 SuDS Detention / Infiltration Basins

115. SuDS detention / infiltration basins (provided as part of the SuDS) 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***); the production of a catchment hydrological 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 5.3***) (based on the existing greenfield runoff rate).

116. In addition, the Applicant retains the option to install further attenuation measures along the existing surface water flow 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.

117. The specifications of this additional ‘surface water management SuDS basin’ will require development of an appropriate catchment hydrological model. The detailed design of the onshore substations and National Grid infrastructure will include the size, volume and location of this basin.

118. As none of the proposed detention basins will be larger than 25,000m^3 or are currently designed to be raised above the surrounding ground level, 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 5.4***.

5.2.3 Outfall Pipe

119. A new outfall pipe will be installed to manage runoff from the onshore substations and National Grid infrastructure to the existing Friston Watercourse in the vicinity of Church Lane.

120. It will be necessary to connect this pipe into the Friston Watercourse via a new connection and associated underground structure.

5.3 Infiltration Rate or Discharge Rate to the Friston Watercourse

121. The infiltration rate and/or discharge rate to the Friston Watercourse will be calculated based on the results of site specific geotechnical surveys and infiltration testing (as per ***section 3.4*** and ***3.5***). 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 hydrological model (***section 3.7.3***). 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.

122. ***Section 6*** and ***section 7*** provide 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) to be reflected in the SuDS detailed design. The reduced discharge rates reflect the potential variability of the existing greenfield runoff rates which will be established from the catchment hydraulic model.

5.4 Inspection and Maintenance

123. 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).

124. 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*** (updated version submitted at Deadline 6, document reference 8.7) to ensure they remain in effective operation. This will include checking of the various inlets and outfalls and other structures 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.

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

5.5 Ordinary Watercourse Consent

126. 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 Infiltration

6.1 Guidance

127. SCC's SuDS design guidance (2018) has informed the illustrative infiltration design. Section 5 of the guidance (Suffolk Design Principles) indicates that "*soakage rates need to be above 5-10mm/hr for infiltration to be the sole means of drainage*" (i.e. the first option within the surface water drainage hierarchy).

128. As agreed in Table 13 in the draft ***Statement of Common Ground with SCC and ESC*** (REP1-072), the Applicant has therefore tested the SuDS design at an infiltration rate of 10mm/hr, which is deemed to be a reasonable worst-case feasible infiltration rate.

129. Additionally, a half drain time of 24 hours has been considered within the calculations below, as per SCC guidance.

6.2 Modelling Design Parameters

130. The following parameters have been modelled:

- Infiltration rate of 10mm/hr;
- 100% impermeable surface area for the onshore substations and National Grid infrastructure areas of hardstanding (see ***Table 6.1***);
- 100% impermeable area for the permanent operational access road (see ***Table 6.1***);
- Requirement to provide replacement volume as a result of the potential removal of the existing natural depression adjacent to the substations (see ***Appendix 3***); and
- Attenuation of water during the 1 in 100 year plus 40% climate change scenario.

131. An additional, secondary assessment was also undertaken, as requested by SCC. This included the parameters set out in paragraph 130 and additionally considered attenuation of water during 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.

132. The modelling has used Flood Estimation Handbook (FEH) (1999) 2013 DDF rainfall data produced by the UK Centre for Ecology and Hydrology[6].

133. A Factor of Safety of 10 has also been incorporated in the calculations for the indicative infiltration design. This is a conservative approach based on the

[6] https://fehweb.ceh.ac.uk/

guidance set out in Table 25.2 of the CIRIA SuDS Manual (2015), the nature of the Projects and in line with requests from SCC.

134. The design parameters of the onshore substation and National Grid infrastructure are summarised in ***Table 6.1.***

Table 6.1 Onshore Substation Infiltration Design Impermeable Areas (all parameters are 100% impermeable)

Component	East Anglia TWO (m^2)	East Anglia ONE North (m^2)	National Grid Infrastructure (m^2)
Overall substation operational footprint	32,300	32,300	44,950
Operational access road	13,600		N/A
Overall cable sealing end compound operational footprint	N/A		10,000
Permanent access road to cable sealing end compound	N/A		1,850
SuDS basin footprint (including perimeter access track)	27,383		17,508
Total impermeable area	**105,583**		**74,308**

135. From the above, infiltration storage requirements can be calculated and are summarised below in **Table 6.2** (see ***Appendix 2*** for all calculations).

Table 6.2 Infiltration Storage Requirements and Provision

Infiltration Storage (m^3)	East Anglia TWO (m^3)	East Anglia ONE North (m^3)	National Grid Infrastructure (m^3)	Total (m^3)
Storage Required				
1 in 100 year (+40% for climage change)	12,760		9,082	21,842
1 in 10 year (+40% for climate change)	6,944		4,995	11,939
Potential offset of existing depression adjacent to proposed substation	3,300		N/A	3,300

Infiltration Storage (m^3)	East Anglia TWO (m^3)	East Anglia ONE North (m^3)	National Grid Infrastructure (m^3)	Total (m^3)
Total Storage Required	23,004		14,077	37,081
Total Storage Provided[7]	**23,152**		**14,236**	**37,388**

6.3 Results

136. 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 2,*** when applying a Factor of Safety (FoS) of 10 to the parameters detailed in ***section 6.2***, the drainage time is in exceedance of 7 days and therefore does not meet SCC's specification for an infiltration only design. Pre-construction ground investigations including infiltration testing will be conducted in order to determine whether the baseline infiltration rate is greater than 10mm/hr. This will inform the extent to which infiltration measures can be prioritised and incorporated into the final SuDS design as appropriate.

137. As the half drain time exceeded 24 hours, a secondary assessment was undertaken, as requested by SCC. This considered a 1 in 10 year storm event 24 hours after a 1 in 100 year storm event (both accounting for 40% climate change scenario and a FoS of 10). This assessment did not achieve a 24 hour half drain time, and concluded a half drain time of 8,592 minutes, which is approximately 6 days (see ***Appendix 2*** for all calculations).

6.4 Conclusion

138. When looking at both of the assessments undertaken within ***section 6.3***, it has been confirmed that for both the 1 in 100 year storm event and a 1 in 10 year storm event 24 hours after an initial 1 in 100 year storm event, using an infiltration rate of 10mm/hr, the 24 hour half drain time cannot be achieved.

139. It is considered unlikely that based on the 10mm/hr infiltration rate that the design could be developed to meet both the 24 hour half drain time and deliver other elements of the Project design including landscaping requirements and optimal use of the land. Therefore, an infiltration only scheme is demonstrated to be unviable due to neither assessment criteria achieving a 24 hour half drain time.

[7] Figures do not include freeboard, perimeter access track and additional storage between track and basin top, however do include the volume of the existing depression adjacent to the proposed Western substation

140. Unless the hydrological catchment modelling and the percolation tests, which will be undertaken post consent, conclude that an infiltration only design is feasible, this OODMP concludes that this is not a feasible solution.

141. Therefore, in accordance with SCC's SuDS Guidance (***section 6.1***), it is appropriate for the next level in the SuDS drainage hierarchy, i.e. attenuation and discharge to a surface water body, to also be considered. This considers both peak flows and total flows. ***Section 7*** goes on to consider a scheme based on the use of attenuation features and discharge to the Friston Watercourse for the design of the SuDS at the onshore substations and National Grid infrastructure.

7 Attenuation

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

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

Component	East Anglia TWO (m^2)	East Anglia ONE North (m^2)	National Grid Infrastructure (m^2)
Overall substation operational footprint	32,300	32,300	44,950
Operational access road	13,600		N/A
Overal cable sealing end compounds operational footprint	N/A		10,000
Permanent access road to cable sealing end compounds	N/A		1,850
Attenuation Basin Footprint (including perimeter access track)	18,300		10,602
Total impermeable area	**96,500**		**67,402**

143. 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 Attenuation Storage Requirements and Provision

Attenuation Storage (m^3)	East Anglia TWO (m^2)	East Anglia ONE North (m^2)	National Grid Infrastructure (m^2)	Total (m^2)
Storage Required				
Attenuation strage using FEH 2013 rainfall method	11,593		8,025	19,618
Potential offset of existing depression	3,300		N/A	3,300

Attenuation Storage (m^3)	East Anglia TWO (m^2)	East Anglia ONE North (m^2)	National Grid Infrastructure (m^2)	Total (m^2)
adjacent to proposed substation				
Total Storage Required	14,893		8,024	22,917
Total Storage Provided[8]	**14,962**		**8,041**	**23,032**

144. As shown in ***Table 7.2***, the estimated storage requirements for an infiltration only scheme is larger than the storage required for an attenuation only scheme. ***Appendix 4*** provides detailed calculations of the above figures and ***Appendix 5*** shows an indicative layout of the attenuation basins.

145. By limiting the runoff from the proposed development 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 proposed development have been taken into consideration.

146. This is in accordance with the guidance set out in the SCC FRMS Appendix A – Sustainable Drainage Systems (SuDS) A Local Design Guide Section 5 Suffolk Design Principles in the table entitled Volume Control that:

> "SCC recommend that for all sites discharging to a watercourse, the final permitted discharge rate for the entire site is 2l/s/ha or Qbar for all events up to the 1in 100 + Climate Change event (Approach 2) – this then accounts for any volume control needed as per section 3.2 in EA document."

7.1 Ability to Accommodate Reduction in Pre-development Discharge Rate

147. 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 onshore substations and National Grid infrastructure and the introduction of an increased impermeable area.

[8] Figures do not include freeboard, perimeter access track and additional storage between track and basin top, however, they do include the volume of the existing depression adjacent to the proposed substation

148. 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.

149. 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 Applicants have assessed the storage requirements based on the footprints in ***Table 7.1*** and ***Table 7.2****.*

150. 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 onshore substations and the National Grid substation respectively. Once detailed hydrological 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.

151. Should the Q_{BAR} rates stated in **paragraph 150** 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 hydrological modelling), the discharge rate to the Friston Watercourse would be reduced by the Applicants accordingly. This would require an increase in capacity of the SuDS attenuation basins.

152. ***Table 7.3*** and ***Table 7.4*** demonstrate that larger storage basins can be accommodated within the Order limits and in conjunction with the ***Outline Landscape and Ecological Management Strategy*** (updated version submitted at Deadline 6, document reference 8.7), should this be required.

153. ***Table 7.3*** and ***Table 7.4*** also show 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 both ***Table 7.3*** and ***Table 7.4***, 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 Onshore Substations Q_{BAR} Flexibility, Storage Requirements and Order Limit Capacity

Discharge Rate (l/s)	Storage Requirement (m^3)	Storage Capacity in Existing Outline Basin Design?	Accomodated within Order Limits?
7.9 (Q_{BAR})	**14,893**	**Y**	**Y**
7.5	14,945	Y	Y
7.0	15,029	Y	Y
6.5	15,113	Y	Y
6.0	15,199	Y	Y
5.5	15,283	Y	Y
5.0	15,379	Y	Y

Table 7.4 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

8 Foul Water Drainage

8.1 Introduction

154. 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

155. 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.

156. 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.

157. 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

158. 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

159. 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 water from the onshore substations and National Grid infrastructure, once operational, will be minimised.

160. 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.

161. As discussed in ***Section 6***, although an infiltration only scheme is currently proving unviable due to the infiltration rate assumed, infiltration will be incorporated into the final drainage scheme as far as practicably possible. As outlined in ***Section 7***, although an attenuation only scheme is viable, it is not the Applicant's position that an attenuation only scheme will be adopted. Instead, the Applicant looks to implement a hybrid scheme which incorporates both, in line with the SCC hierarchy, whilst committing to limiting the outfall discharge rates to that of the pre-development greenfield runoff rate. This connection to the surface water body (i.e. Friston Watercourse) additionally allows for design flexibility which will be influenced by pre-construction infiltration testing, detailed design of the onshore substations, National Grid infrastructure and the operational surface water drainage system itself.

162. As presented in ***Section 7***, there is flexibility in the outline attenuation design to accommodate a reduced Q_{BAR} rate and an increased storage capacity within the Order limits if required. Ground investigations at the location of the onshore substations and National Grid infrastructure will be undertaken and will inform the final ODMP. Percolation tests will be undertaken as part of the detailed design process to determine the underlying permeability and the feasibility of adopting an infiltration, combined infiltration / attenuation or attenuation only SuDS design with a connection to the Friston Watercourse. This process is summarised below in ***Plate 9.1.***

163. This hybrid outline drainage scheme has been developed using a combination of sustainable and conventional drainage to manage the various flows. The uncontaminated waters from roofs, hardstanding (including the substation operational access road and water percolating through permeable construction

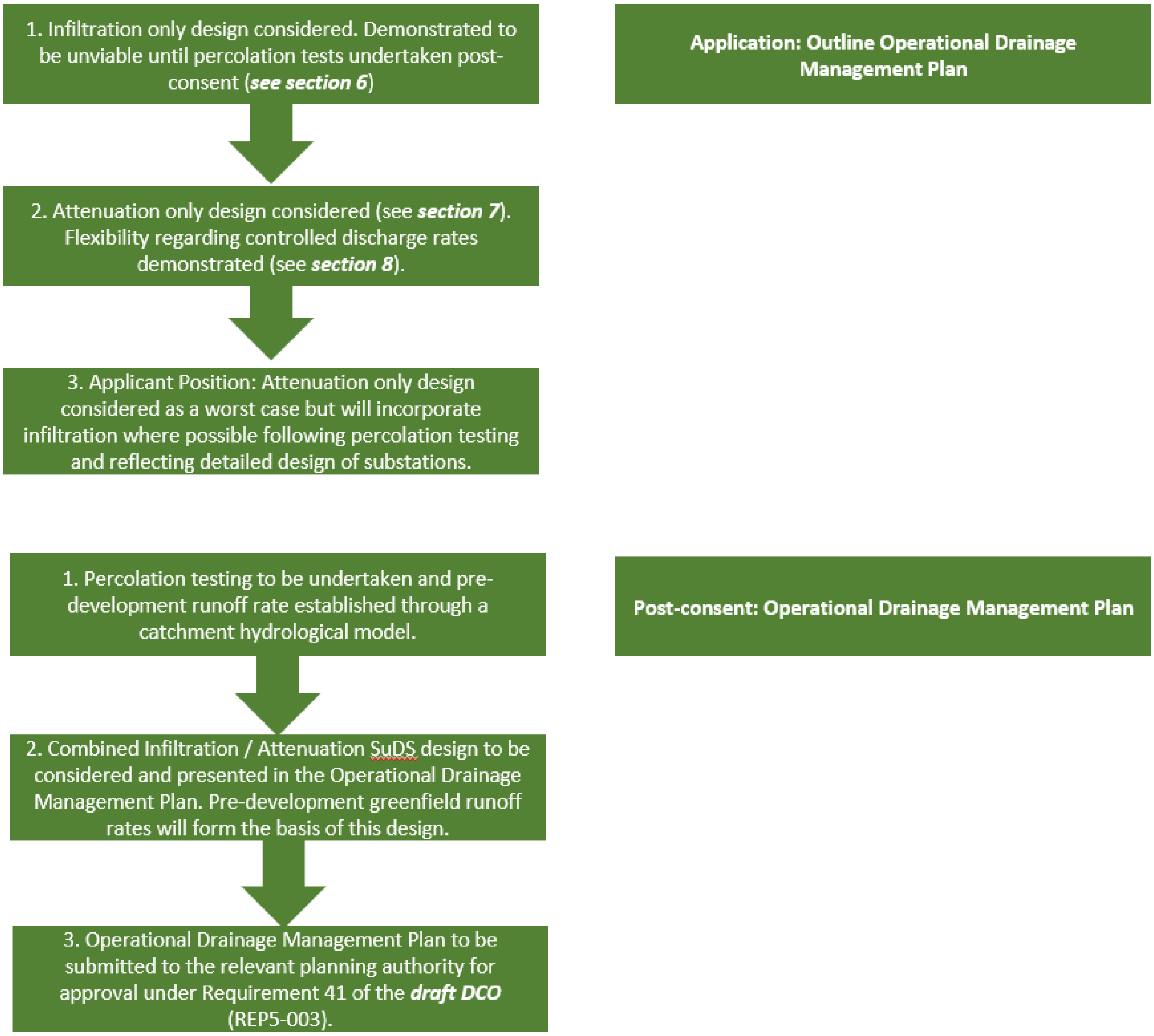
(platform)) will be collected and routed to a detention basin. This basin will be designed to provide attenuation and a controlled onward flow, limiting the Q_{BAR} discharge rate to that of the pre-development greenfield runoff rate. This is designed to ensure there is no detrimental impact on the receiving watercourse as a result of increased storm related flows from the development of the onshore substations and National Grid infrastructure and the introduction of an increased area of impermeable drainage.

164. In addition, it is recognised that the onshore substations and National Grid infrastructure are situated within an area of existing surface water flow 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 (as shown in ***Appendix 3*** and ***Appendix 5***) 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.

165. 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.

166. 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.

Plate 9.1 Flow chart summarising the Applicant's application of the SuDS hierarchy and strategy post-consent



10 References

BMT (2020) Friston Surface Water Study - Technical Report, [Online], Available at: http://www.greensuffolk.org/assets/Greenest-County/Water--Coast/Surface-Water-Management-Plans/FristonSurfaceWaterStudy-TechnicalReport2.0.pdf

Construction Industry and Research Information Association (2015) The SuDS Manual (C753).

DCLG, (2014) National Planning Practice Guidance (NPPG) on Flood Risk and Coastal Change. Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change

Drain and sewer systems outside buildings (British Standard EN 752:2017)

Gravity drainage systems inside building (British Standard EN 12056 3:2000).

Highways Agency (2009). Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 6 (Land Use).

Institute of Hydrology (1999). Flood Estimation Handbook. 5 volumes. Institute of Hydrology, Wallingford.

JBA Consulting (2016) Essex, Norfolk and Suffolk Survey and Model Build: Friston River.

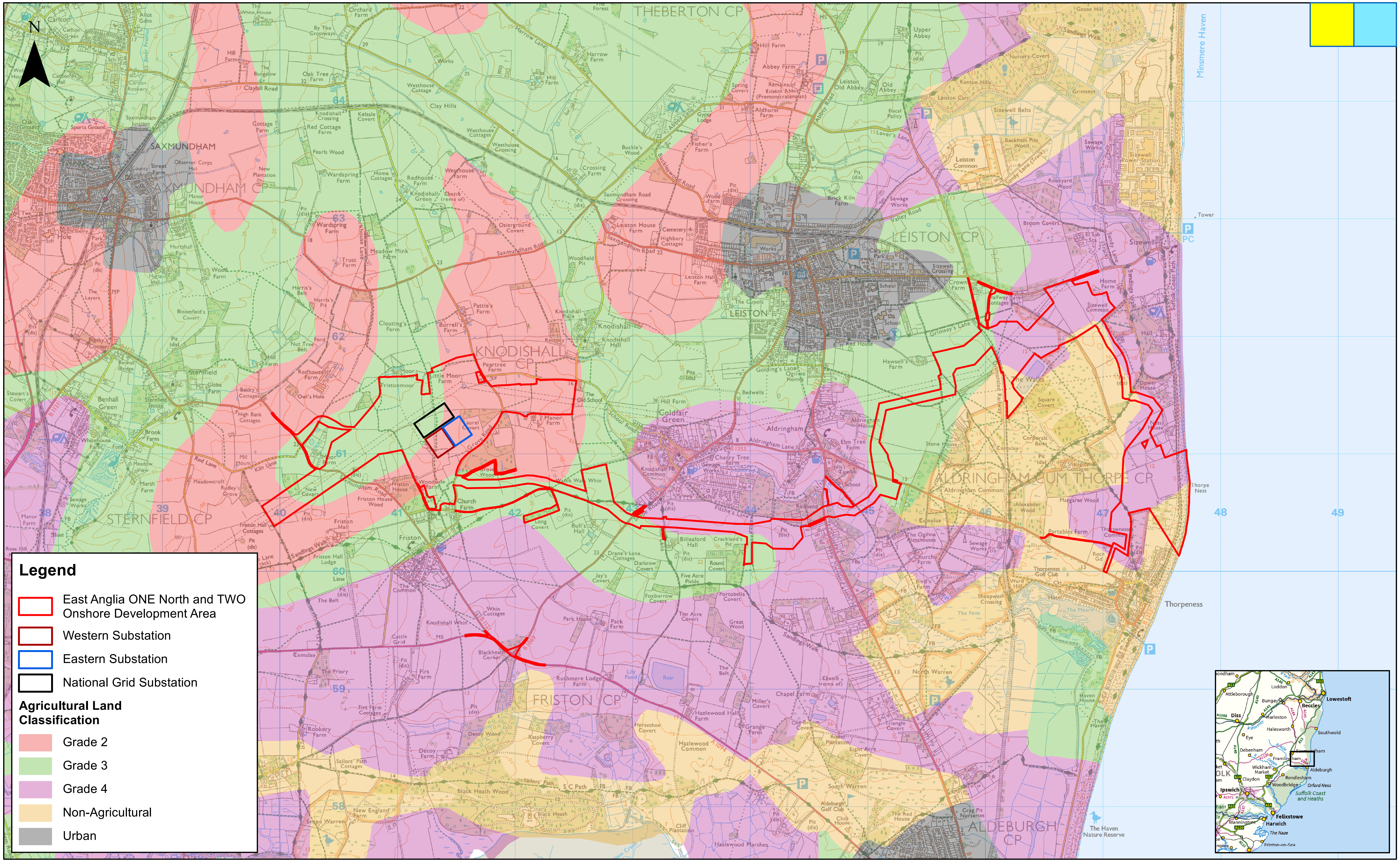
Separator systems for light liquids (British Standard EN 858 1:2002)

Suffolk Coastal and Waveney District Councils, (2018) Level 1 Strategic Flood Risk Assessment, [Online], Available at: http://www.eastsuffolk.gov.uk/planning/localplans/waveney-local-plan/local-plan-background-studies/strategic-flood-riskassessment-level-1-april-2018/

Suffolk County Council (SCC) (2016) Suffolk Flood Risk Management Strategy, [Online], Available at: http://www.greensuffolk.org/assets/Greenest-County/Water--Coast/Suffolk-Flood-Partnership/2018-Strategy-Documents/2016-04-Suffolk-Flood-Risk-Management-Strategy-v12.pdf

Suffolk County Council (2018) Sustainable Drainage Systems (SuDS): a Local Design Guide, Appendix A to the Suffolk Flood Risk Management Strategy, [Online], Avalible at: http://www.greensuffolk.org/assets/Greenest-County/Water--Coast/Suffolk-Flood-Partnership/2018-Strategy-Documents/2018-10-01-SFRMS-SuDS-Guidance-Appendix-A-.pdf

Appendix 1: Figures



SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment
4	22/02/2021	AB	Fourth Issue.
3	04/12/2020	AB	Third Issue.
2	05/11/2020	AB	Second Issue.

Prepared:	AB
Checked:	TF
Approved:	FM

1:30,000 Scale @ A3

0 0.5 1 Km

East Anglia ONE North and TWO

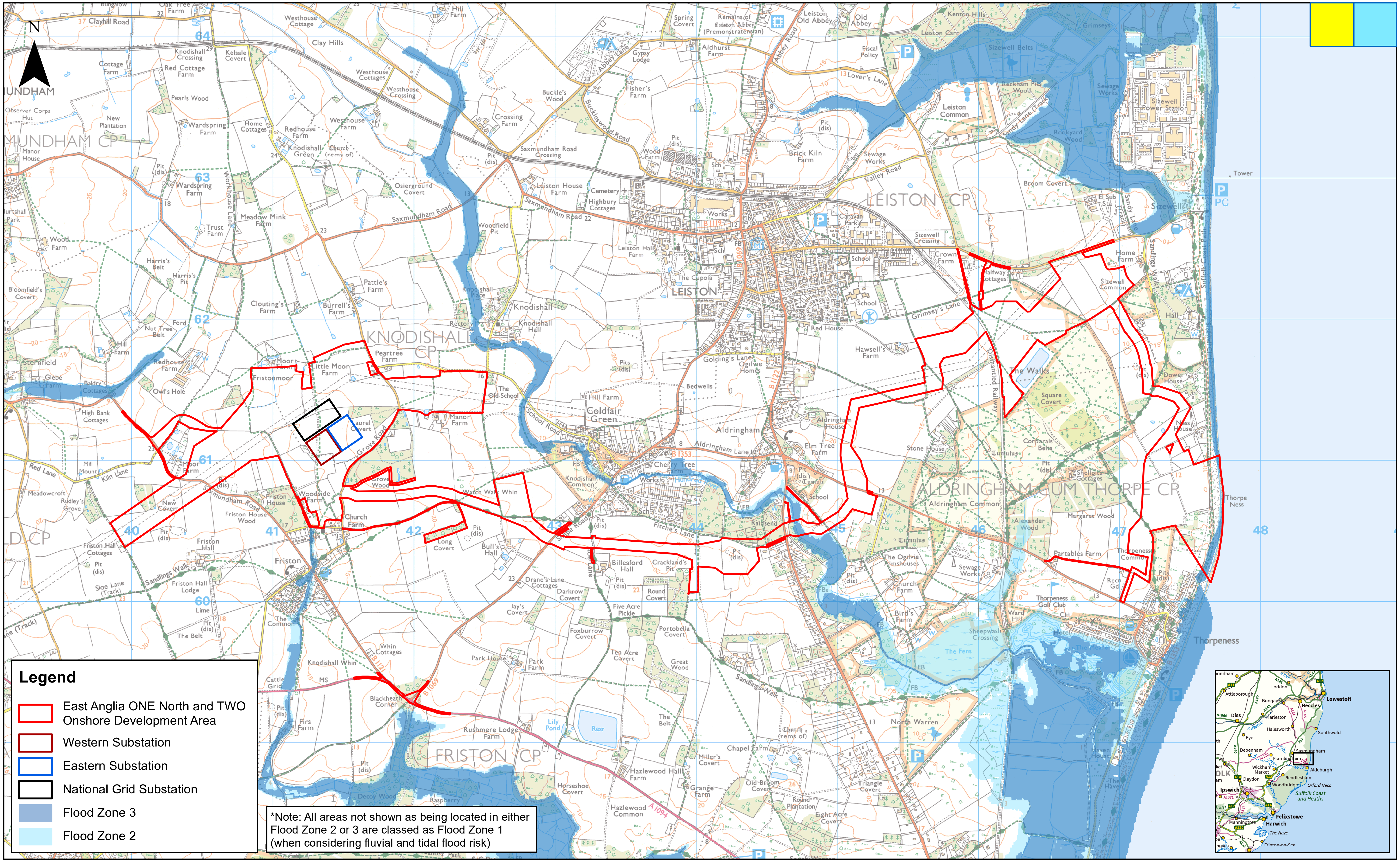
Outline Operational Drainage Management Plan

Agricultural Land Classification

Drg No	EA1N-EA2-DEV-DRG-IBR-001128
Rev	4
Date	22/02/21
Figure	1

Coordinate System: BNG
Datum: OSGB36

D:\Box Sync\PB4842 EA 1N and 2\PB4842 EA 1N and 2 Team\E. TECHNICAL DATA\E03 GIS\EA1N_EA2_Examination\Figures\OutlineOperationalDrainageManagementPlan\Fig_1_AgrLandClass_RH_20201204.mxd



SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment
4	22/02/2021	AB	Fourth Issue.
3	04/12/2020	AB	Third Issue.
2	05/11/2020	AB	Second Issue.

Prepared:	AB
Checked:	TF
Approved:	FM

1:25,000 Scale @ A3

0 0.5 1 Km

East Anglia ONE North and TWO

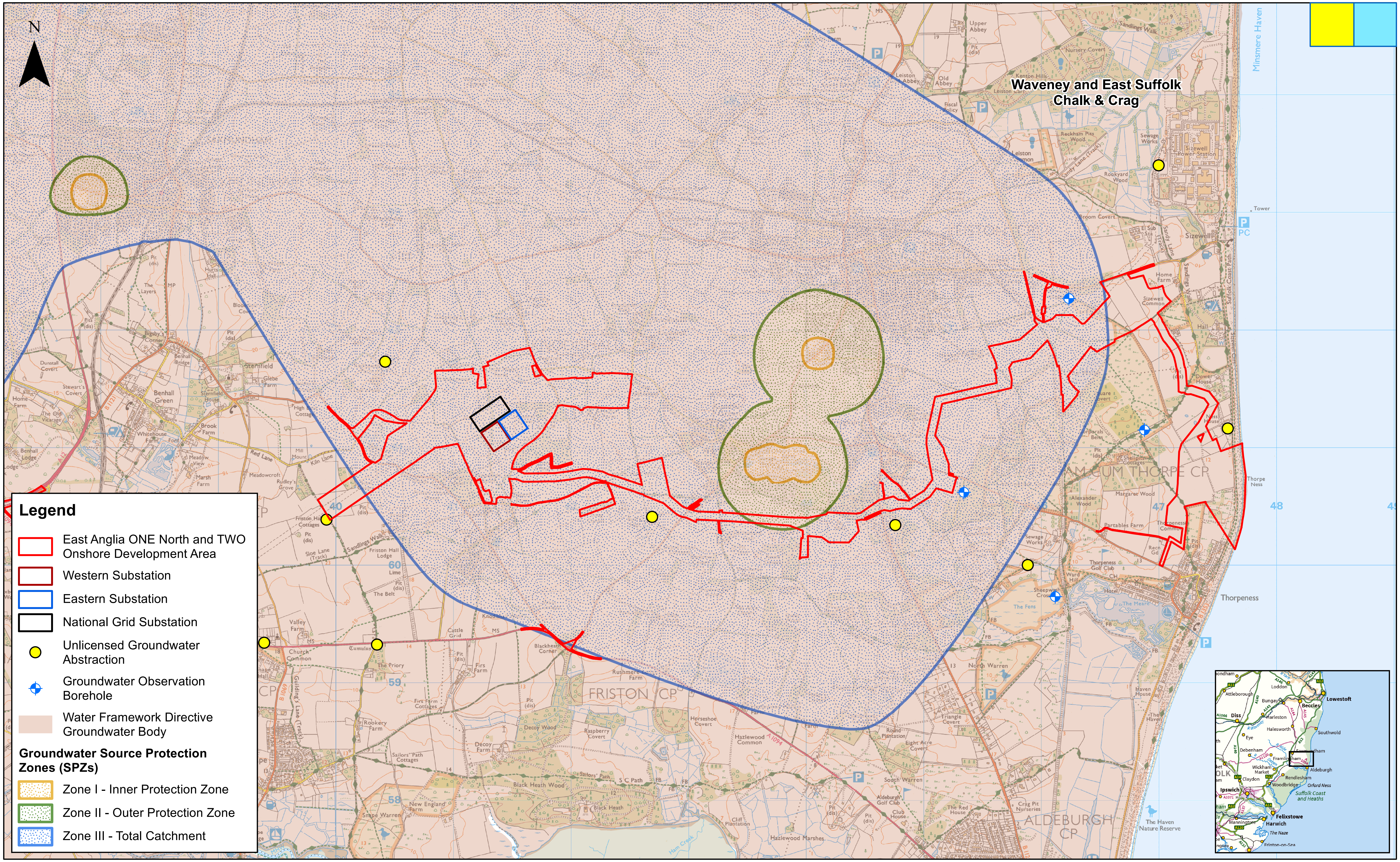
Outline Operational Drainage Management Plan

Environment Agency Flood Zones

Drg No	EA1N-EA2-DEV-DRG-IBR-001129
Rev	4
Date	22/02/21
Figure	2

Coordinate System: BNG
Datum: OSGB36

D:\Box Sync\PB4842 EA 1N and 2\PB4842 EA 1N and 2 Team\E. TECHNICAL DATA\E03 GIS\EA1N_EA2_Examination\Figures\OutlineOperationalDrainageManagementPlan\Fig_2_EAFloodZones_RH_20201204.mxd



Rev	Date	By	Comment
4	22/02/2021	AB	Fourth Issue.
3	22/02/2021	AB	Third Issue.
2	05/11/2020	AB	Second Issue.

Prepared: AB
Checked: TF
Approved: FM

1:30,000
Scale @ A3
0 0.5 1 Km

SCOTTISHPOWER RENEWABLES

East Anglia ONE North and TWO

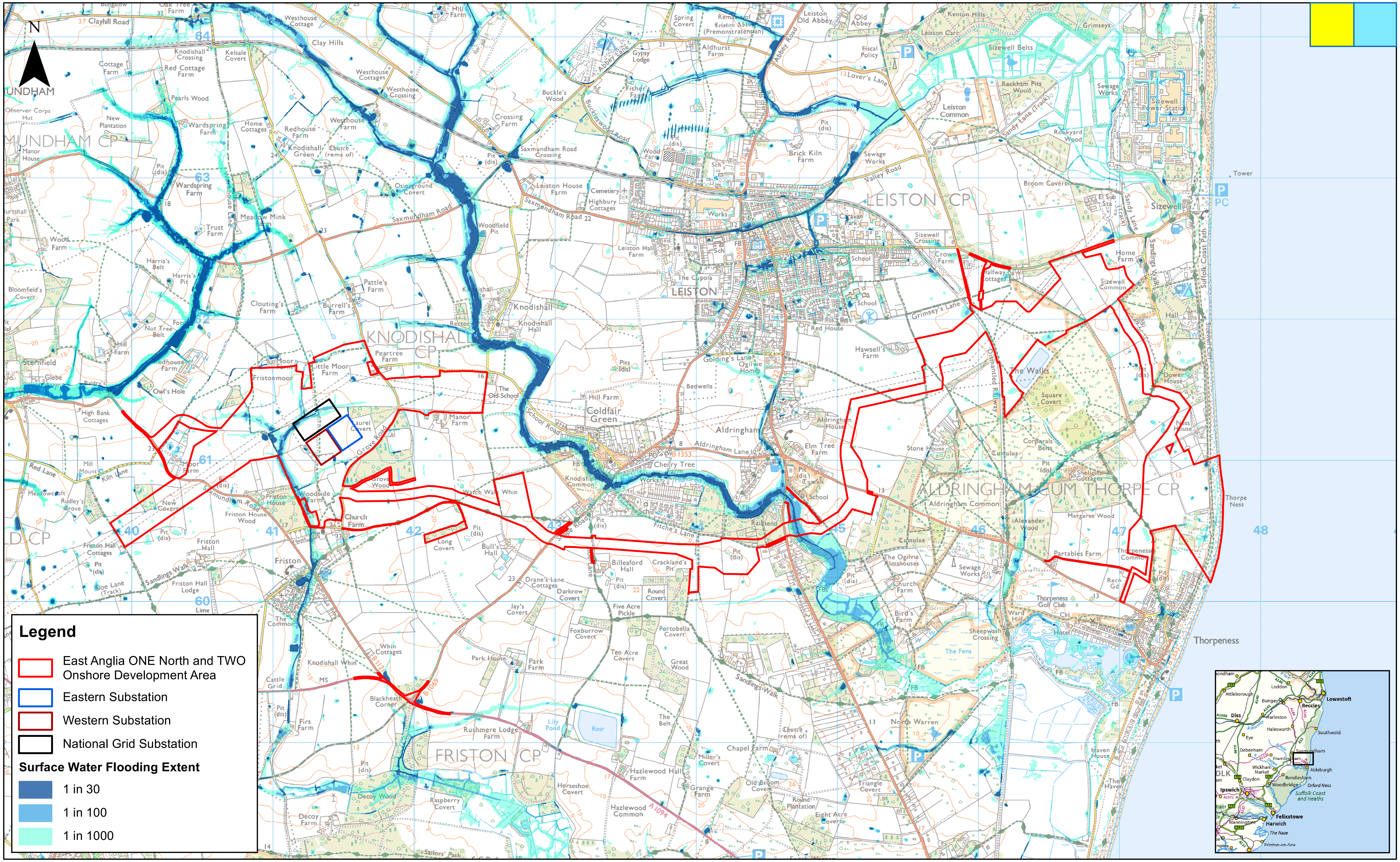
Outline Operational Drainage Management Plan

Groundwater Receptors

Drg No	EA1N-EA2-DEV-DRG-IBR-001130
Rev	4
Date	22/02/21
Figure	3

Coordinate System: BNG
Datum: OSGB36

D:\Box Sync\PB4842 EA 1N and 2\PB4842 EA 1N and 2 Team\E. TECHNICAL DATA\E03 GIS\EA1N_EA2_Examination\Figures\OutlineOperationalDrainageManagementPlan\Fig_3_GroundwaterReceptors_RH_20201204.mxd



Rev	Date	By	Comment		
4	22/02/2021	AB	Fourth Issue.		
3	04/12/2020	AB	Third Issue.	Prepared:	AB
2	05/11/2020	AB	Second Issue.	Checked:	TF
				Approved:	FM

SCOTTISHPOWER RENEWABLES

1:25,000 Scale @ A3

0 0.5 1 Km

East Anglia ONE North and TWO

Outline Operational Drainage Management Plan

Surface Water Flood Risk

Drg No	EA1N-EA2-DEV-DRG-IBR-001133
Rev	4
Date	22/02/21
Figure	4

Coordinate System: BNG
Datum: OSGB36

D:\Box Sync\PB4842 EA 1N and 2\PB4842 EA 1N and 2 Team\E. TECHNICAL DATA\E03 GIS\EA1N_EA2_Examination\Figures\OutlineOperationalDrainageManagementPlan\Fig_4_SurfaceWaterFloodRisk_RH_20201204.mxd

Appendix 2: Infiltration SuDS Design Model Outputs

SUDS Design Summary - Infiltration				
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. 4. NG substation and sealing end compounds discharge to SUDS Basin then to ground via infiltration. 5. Worst case infiltration rates estimated as 10mm/hr. 6. Design checked for half drain down times of 24 hours. 7. 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. 8. SUDS sizing estimated using FEH13 Rainfall and Micro Drainage design software. 9. Safety factor of 1 used in initial design for 24 hour half drain down. An additonal check for a safety factor of 10 (per SCC request) has been undertaken with an allowance for influx of an additional 1 in 10 year + 40% climate change event. 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 Operational access road Cable sealing end compound operational footprint Permanent access road to sealing end compound SUDS Basin Footprint (including perimeter access track) Total	 32,300 m^2 13,600 m^2 - - 27,383 m^2 **105,583 m^2**	 32,300 m^2	 44,950 m^2 - 10,000 m^2 1,850 m^2 17,508 m^2 **74,308 m^2**	Updated with reduced EA2 & EA1N substation footprints and added areas of SUDS basin footprint (including perimeter access tracks) - SUDS basin footprint varies based on design sizing. Total areas shown for 24hr drain down.
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**		-	<u>10.02.21</u> Added note on additional volume allowed for existing depression adjacent EA1N substation.
Design Infiltration Rates	**10mm/hr**			Estimated Worst Case
Design Storm Event	**1 in 100 year + 40% climate change.**			40% sensitivity check as per SCC guidance.
Attenuation Storage Required (calculated from FEH13 Rainfall using Micro Drainage design software)				
Half Drain Down Time	< 24hr		< 24hr	Half drain down time of 24 hours checked (safety factor of 1).
All Hardstanding Areas	**8,461.6 m3**		**6,158.5 m3**	
Attenuation Dimensions **Detention Basins** Design Top area (1m Deep) Freeboard Top area (1.3m Deep) Perimeter access track top area (1.4m Deep) Basin Top area(1.5m Deep) Base area Design storage depth Design freeboard + 0.3m (1.0m Deep) Overall depth Side slopes	 24,302 m^2 25,012 m^2 27,135 m^2 27,383 m^2 22,002 m^2 0.7 m 0.3 m 1 m 1 in 4		 15,116 m^2 15,664 m^2 17,314 m^2 17,508 m^2 13,356 m^2 0.7 m 0.3 m 1 m 1 in 4	Updated to 1m design depth with 0.3m freeboard, 0.1m access track and 0.1m to top, overall depth of 1.5m.
Attenuation Storage Provided **Detention Basins** Design Freeboard Perimeter access track Additional storage between track and basin top Total (design) Total (inc. freeboard and access track)	 23,152 m^3 7,397.1 m^3 2,607.35 m^3 2,725.9 m^3 **23,152 m^3** 35,882.35 m^3		 14,236 m^3 4,617 m^3 1,648.9 m^3 1,741.1 m^3 **14,236 m^3** 22,243 m^3	Checked storage volumes as per the above.
Design storage required < attenuation storage provided?	**YES = OK**		**YES = OK**	
Additional Design Requirements Safety Factor Check (Safety Factor increased from 1 to 10)				Safety factor increased to 10 as per SCC request. Half drain down time exceeds 7 days. Added allowance for additional influx of 1 in 10 year + 40% climate change event.
Attenuation Storage Required (1 in 100 year + 40% CC)	12,759.6 m3 Half drain down time now exceeds 7 days. Allow for additional influx from 1 in 10 year event + 40% CC.		9,082.3 m3 Half drain down time now exceeds 7 days. Allow for additional influx from 1 in 10 year event + 40% CC.	
Additional Attenuation Storage Required (1 in 10 year + 40% CC)	6,944.2 m3		4,994.8 m3	
Offset removal of depression adjacent EA1N substation by allowing additional storage in basin design depth. Additional storage required:	3,300 m3		N/A	
Total Attenuation Storage Required	**23,003.8 m3**		**14,077.1 m3**	
	Additional influx from 1 in 10 year + 40% event and offset of loss of existing depression catered for within 1m design depth.		Additional influx from 1 in 10 year + 40% event catered for within 1m design depth.	
Design storage required < attenuation storage provided?	**YES = OK**		**YES = OK**	
Discharge Location	**To ground via infiltration.**		**To ground via infiltration.**	**Design flows up to 1:100 year + 40% CC are attenuated within the basin design depth (1m) - including allowance for additional 1:10 year + 10% CC influx and 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 from the bottom edge of the access track (total 1.5m depth).**

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

Half Drain Time exceeds 7 days.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	14.609	0.109	6.3	2415.6	O K
30 min Summer	14.647	0.147	6.3	3260.6	O K
60 min Summer	14.686	0.186	6.4	4136.7	O K
120 min Summer	14.735	0.235	6.4	5224.8	O K
180 min Summer	14.769	0.269	6.5	5998.6	O K
240 min Summer	14.796	0.296	6.5	6612.2	O K
360 min Summer	14.838	0.338	6.5	7563.7	O K
480 min Summer	14.870	0.370	6.6	8285.0	O K
600 min Summer	14.894	0.394	6.6	8840.7	O K
720 min Summer	14.913	0.413	6.6	9282.1	O K
960 min Summer	14.941	0.441	6.7	9919.4	O K
1440 min Summer	14.973	0.473	6.7	10653.8	O K
2160 min Summer	14.993	0.493	6.7	11114.7	O K
2880 min Summer	15.000	0.500	6.8	11278.4	O K
4320 min Summer	14.998	0.498	6.8	11242.0	O K
5760 min Summer	14.991	0.491	6.7	11070.9	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	14.622	0.122	6.3	2705.8	O K
30 min Winter	14.665	0.165	6.3	3652.6	O K
60 min Winter	14.708	0.208	6.4	4634.5	O K
120 min Winter	14.763	0.263	6.4	5855.0	O K
180 min Winter	14.801	0.301	6.5	6723.5	O K
240 min Winter	14.831	0.331	6.5	7413.1	O K
360 min Winter	14.878	0.378	6.6	8483.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	122.248	0.0	19
30 min Summer	82.572	0.0	34
60 min Summer	52.458	0.0	64
120 min Summer	33.215	0.0	124
180 min Summer	25.480	0.0	184
240 min Summer	21.109	0.0	244
360 min Summer	16.158	0.0	364
480 min Summer	13.321	0.0	484
600 min Summer	11.410	0.0	604
720 min Summer	10.016	0.0	724
960 min Summer	8.080	0.0	964
1440 min Summer	5.860	0.0	1444
2160 min Summer	4.154	0.0	2164
2880 min Summer	3.224	0.0	2884
4320 min Summer	2.228	0.0	4324
5760 min Summer	1.712	0.0	5760
7200 min Summer	-0.012	0.0	0
8640 min Summer	-0.010	0.0	0
10080 min Summer	-0.008	0.0	0
15 min Winter	122.248	0.0	19
30 min Winter	82.572	0.0	34
60 min Winter	52.458	0.0	64
120 min Winter	33.215	0.0	124
180 min Winter	25.480	0.0	184
240 min Winter	21.109	0.0	242
360 min Winter	16.158	0.0	362

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m^3)	Status
480 min Winter	14.914	0.414	6.6	9295.5	O K
600 min Winter	14.941	0.441	6.7	9922.3	O K
720 min Winter	14.963	0.463	6.7	10421.2	O K
960 min Winter	14.994	0.494	6.7	11144.3	O K
1440 min Winter	15.030	0.530	6.8	11986.1	O K
2160 min Winter	15.054	0.554	6.8	12531.2	O K
2880 min Winter	15.063	0.563	6.8	12743.6	O K
4320 min Winter	15.064	0.564	6.8	12759.6	O K
5760 min Winter	15.058	0.558	6.8	12627.6	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 (m^3)	Time-Peak (mins)
480 min Winter	13.321	0.0	482
600 min Winter	11.410	0.0	602
720 min Winter	10.016	0.0	720
960 min Winter	8.080	0.0	956
1440 min Winter	5.860	0.0	1430
2160 min Winter	4.154	0.0	2140
2880 min Winter	3.223	0.0	2852
4320 min Winter	2.228	0.0	4276
5760 min Winter	1.712	0.0	5648
7200 min Winter	-0.012	0.0	0
8640 min Winter	-0.010	0.0	0
10080 min Winter	-0.008	0.0	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) 10.558

Time From:	**(mins) To:**	**Area (ha)**
0	4	10.558

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) 0.01000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.01000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	22002.0	1.000	24301.0	1.300	25011.0	1.400	27135.0	1.500	27383.0

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

Half Drain Time exceeds 7 days.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	15.276	0.126	3.8	1700.5	O K
30 min Summer	15.320	0.170	3.9	2295.5	O K
60 min Summer	15.365	0.215	3.9	2912.7	O K
120 min Summer	15.421	0.271	4.0	3679.9	O K
180 min Summer	15.460	0.310	4.0	4225.8	O K
240 min Summer	15.491	0.341	4.0	4659.1	O K
360 min Summer	15.539	0.389	4.1	5331.6	O K
480 min Summer	15.576	0.426	4.1	5842.1	O K
600 min Summer	15.604	0.454	4.2	6236.1	O K
720 min Summer	15.626	0.476	4.2	6549.6	O K
960 min Summer	15.658	0.508	4.2	7004.0	O K
1440 min Summer	15.695	0.545	4.2	7532.3	O K
2160 min Summer	15.719	0.569	4.3	7873.8	O K
2880 min Summer	15.728	0.578	4.3	8005.9	O K
4320 min Summer	15.728	0.578	4.3	8013.5	O K
5760 min Summer	15.722	0.572	4.3	7925.4	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	15.291	0.141	3.8	1904.8	O K
30 min Winter	15.340	0.190	3.9	2571.5	O K
60 min Winter	15.391	0.241	3.9	3263.2	O K
120 min Winter	15.453	0.303	4.0	4123.6	O K
180 min Winter	15.497	0.347	4.1	4736.3	O K
240 min Winter	15.532	0.382	4.1	5223.0	O K
360 min Winter	15.585	0.435	4.1	5979.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	122.248	0.0	19
30 min Summer	82.572	0.0	34
60 min Summer	52.458	0.0	64
120 min Summer	33.215	0.0	124
180 min Summer	25.480	0.0	184
240 min Summer	21.109	0.0	244
360 min Summer	16.158	0.0	364
480 min Summer	13.321	0.0	484
600 min Summer	11.410	0.0	604
720 min Summer	10.016	0.0	724
960 min Summer	8.080	0.0	964
1440 min Summer	5.860	0.0	1444
2160 min Summer	4.154	0.0	2164
2880 min Summer	3.224	0.0	2884
4320 min Summer	2.228	0.0	4324
5760 min Summer	1.712	0.0	5760
7200 min Summer	-0.012	0.0	0
8640 min Summer	-0.010	0.0	0
10080 min Summer	-0.008	0.0	0
15 min Winter	122.248	0.0	19
30 min Winter	82.572	0.0	34
60 min Winter	52.458	0.0	64
120 min Winter	33.215	0.0	124
180 min Winter	25.480	0.0	184
240 min Winter	21.109	0.0	242
360 min Winter	16.158	0.0	362

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
480 min Winter	15.626	0.476	4.2	6553.6	O K
600 min Winter	15.657	0.507	4.2	6997.7	O K
720 min Winter	15.682	0.532	4.2	7351.7	O K
960 min Winter	15.718	0.568	4.3	7866.4	O K
1440 min Winter	15.760	0.610	4.3	8470.3	O K
2160 min Winter	15.788	0.638	4.3	8871.0	O K
2880 min Winter	15.799	0.649	4.4	9037.4	O K
4320 min Winter	15.802	0.652	4.4	9082.3	O K
5760 min Winter	15.798	0.648	4.3	9020.9	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)	Time-Peak (mins)
480 min Winter	13.321	0.0	482
600 min Winter	11.410	0.0	602
720 min Winter	10.016	0.0	722
960 min Winter	8.080	0.0	960
1440 min Winter	5.860	0.0	1430
2160 min Winter	4.154	0.0	2144
2880 min Winter	3.223	0.0	2852
4320 min Winter	2.228	0.0	4276
5760 min Winter	1.712	0.0	5656
7200 min Winter	-0.012	0.0	0
8640 min Winter	-0.010	0.0	0
10080 min Winter	-0.008	0.0	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) 7.431

Time (mins) From:	To:	Area (ha)
0	4	7.431

Model Details

Storage is Online Cover Level (m) 16.650

Infiltration Basin Structure

Invert Level (m) 15.150 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.01000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.01000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	13356.0	1.000	15116.0	1.300	15664.0	1.400	17314.0	1.500	17508.0

Summary of Results for 10 year Return Period (+40%)

Half Drain Time : 8592 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	15.125	0.061	6.5	1431.5	O K
30 min Summer	15.145	0.081	6.6	1883.2	O K
60 min Summer	15.165	0.101	6.6	2369.7	O K
120 min Summer	15.197	0.133	6.6	3106.5	O K
180 min Summer	15.216	0.152	6.7	3562.2	O K
240 min Summer	15.230	0.166	6.7	3885.7	O K
360 min Summer	15.248	0.184	6.7	4320.5	O K
480 min Summer	15.260	0.196	6.7	4599.8	O K
600 min Summer	15.268	0.204	6.7	4801.1	O K
720 min Summer	15.275	0.211	6.7	4954.7	O K
960 min Summer	15.284	0.220	6.8	5178.2	O K
1440 min Summer	15.295	0.231	6.8	5443.9	O K
2160 min Summer	15.304	0.240	6.8	5653.0	O K
2880 min Summer	15.309	0.245	6.8	5778.1	O K
4320 min Summer	15.316	0.252	6.8	5935.6	O K
5760 min Summer	15.319	0.255	6.8	6021.8	O K
7200 min Summer	15.064	0.000	0.0	0.0	O K
8640 min Summer	15.064	0.000	0.0	0.0	O K
10080 min Summer	15.064	0.000	0.0	0.0	O K
15 min Winter	15.133	0.069	6.6	1603.6	O K
30 min Winter	15.154	0.090	6.6	2109.9	O K
60 min Winter	15.177	0.113	6.6	2655.3	O K
120 min Winter	15.212	0.148	6.7	3481.8	O K
180 min Winter	15.234	0.170	6.7	3994.0	O K
240 min Winter	15.249	0.185	6.7	4358.1	O K
360 min Winter	15.270	0.206	6.7	4848.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	72.520	0.0	19
30 min Summer	47.768	0.0	34
60 min Summer	30.128	0.0	64
120 min Summer	19.824	0.0	124
180 min Summer	15.209	0.0	184
240 min Summer	12.485	0.0	244
360 min Summer	9.315	0.0	364
480 min Summer	7.485	0.0	484
600 min Summer	6.289	0.0	604
720 min Summer	5.441	0.0	724
960 min Summer	4.316	0.0	964
1440 min Summer	3.096	0.0	1442
2160 min Summer	2.217	0.0	2164
2880 min Summer	1.756	0.0	2880
4320 min Summer	1.278	0.0	4320
5760 min Summer	1.031	0.0	5760
7200 min Summer	-0.012	0.0	0
8640 min Summer	-0.010	0.0	0
10080 min Summer	-0.008	0.0	0
15 min Winter	72.520	0.0	19
30 min Winter	47.768	0.0	34
60 min Winter	30.128	0.0	64
120 min Winter	19.824	0.0	124
180 min Winter	15.209	0.0	182
240 min Winter	12.485	0.0	242
360 min Winter	9.315	0.0	362

Summary of Results for 10 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
480 min Winter	15.283	0.219	6.8	5164.6	O K
600 min Winter	15.293	0.229	6.8	5393.8	O K
720 min Winter	15.300	0.236	6.8	5569.4	O K
960 min Winter	15.311	0.247	6.8	5827.4	O K
1440 min Winter	15.324	0.260	6.8	6140.4	O K
2160 min Winter	15.335	0.271	6.8	6398.3	O K
2880 min Winter	15.342	0.278	6.8	6563.6	O K
4320 min Winter	15.352	0.288	6.8	6792.0	O K
5760 min Winter	15.358	0.294	6.9	6944.2	O K
7200 min Winter	15.064	0.000	0.0	0.0	O K
8640 min Winter	15.064	0.000	0.0	0.0	O K
10080 min Winter	15.064	0.000	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
480 min Winter	7.485	0.0	480
600 min Winter	6.289	0.0	598
720 min Winter	5.441	0.0	716
960 min Winter	4.316	0.0	954
1440 min Winter	3.096	0.0	1428
2160 min Winter	2.217	0.0	2136
2880 min Winter	1.756	0.0	2824
4320 min Winter	1.278	0.0	4196
5760 min Winter	1.031	0.0	5584
7200 min Winter	-0.012	0.0	0
8640 min Winter	-0.010	0.0	0
10080 min Winter	-0.008	0.0	0

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	10	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) 10.558

Time (mins) From:	To:	Area (ha)
0	4	10.558

Model Details

Storage is Online Cover Level (m) 16.000

Infiltration Basin Structure

Invert Level (m) 15.064 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.01000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.01000

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	23286.0	0.436	24301.0	0.736	25011.0	0.836	27135.0	0.936	27383.0

Summary of Results for 10 year Return Period (+40%)

Half Drain Time : 9770 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	15.871	0.069	4.1	1007.8	O K
30 min Summer	15.893	0.091	4.1	1326.0	O K
60 min Summer	15.916	0.114	4.1	1668.8	O K
120 min Summer	15.952	0.150	4.2	2188.4	O K
180 min Summer	15.973	0.171	4.2	2510.3	O K
240 min Summer	15.989	0.187	4.2	2739.0	O K
360 min Summer	16.010	0.208	4.2	3047.2	O K
480 min Summer	16.023	0.221	4.2	3245.9	O K
600 min Summer	16.033	0.231	4.3	3389.9	O K
720 min Summer	16.040	0.238	4.3	3500.1	O K
960 min Summer	16.051	0.249	4.3	3661.9	O K
1440 min Summer	16.064	0.262	4.3	3857.7	O K
2160 min Summer	16.075	0.273	4.3	4018.2	O K
2880 min Summer	16.081	0.279	4.3	4119.3	O K
4320 min Summer	16.091	0.289	4.3	4256.4	O K
5760 min Summer	16.096	0.294	4.3	4343.4	O K
7200 min Summer	15.802	0.000	0.0	0.0	O K
8640 min Summer	15.802	0.000	0.0	0.0	O K
10080 min Summer	15.802	0.000	0.0	0.0	O K
15 min Winter	15.880	0.078	4.1	1128.9	O K
30 min Winter	15.904	0.102	4.1	1485.5	O K
60 min Winter	15.930	0.128	4.2	1869.9	O K
120 min Winter	15.970	0.168	4.2	2452.7	O K
180 min Winter	15.994	0.192	4.2	2814.3	O K
240 min Winter	16.011	0.209	4.2	3071.7	O K
360 min Winter	16.035	0.233	4.3	3419.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	72.520	0.0	19
30 min Summer	47.768	0.0	34
60 min Summer	30.128	0.0	64
120 min Summer	19.824	0.0	124
180 min Summer	15.209	0.0	184
240 min Summer	12.485	0.0	244
360 min Summer	9.315	0.0	364
480 min Summer	7.485	0.0	484
600 min Summer	6.289	0.0	604
720 min Summer	5.441	0.0	724
960 min Summer	4.316	0.0	964
1440 min Summer	3.096	0.0	1442
2160 min Summer	2.217	0.0	2164
2880 min Summer	1.756	0.0	2884
4320 min Summer	1.278	0.0	4320
5760 min Summer	1.031	0.0	5760
7200 min Summer	-0.012	0.0	0
8640 min Summer	-0.010	0.0	0
10080 min Summer	-0.008	0.0	0
15 min Winter	72.520	0.0	19
30 min Winter	47.768	0.0	34
60 min Winter	30.128	0.0	64
120 min Winter	19.824	0.0	124
180 min Winter	15.209	0.0	182
240 min Winter	12.485	0.0	242
360 min Winter	9.315	0.0	362

Summary of Results for 10 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
480 min Winter	16.050	0.248	4.3	3643.9	O K
600 min Winter	16.061	0.259	4.3	3807.5	O K
720 min Winter	16.069	0.267	4.3	3933.4	O K
960 min Winter	16.081	0.279	4.3	4119.6	O K
1440 min Winter	16.097	0.295	4.3	4349.2	O K
2160 min Winter	16.110	0.308	4.3	4544.5	O K
2880 min Winter	16.118	0.316	4.3	4674.0	O K
4320 min Winter	16.131	0.329	4.4	4861.5	O K
5760 min Winter	16.140	0.338	4.4	4994.8	O K
7200 min Winter	15.802	0.000	0.0	0.0	O K
8640 min Winter	15.802	0.000	0.0	0.0	O K
10080 min Winter	15.802	0.000	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
480 min Winter	7.485	0.0	480
600 min Winter	6.289	0.0	598
720 min Winter	5.441	0.0	716
960 min Winter	4.316	0.0	954
1440 min Winter	3.096	0.0	1428
2160 min Winter	2.217	0.0	2136
2880 min Winter	1.756	0.0	2828
4320 min Winter	1.278	0.0	4232
5760 min Winter	1.031	0.0	5592
7200 min Winter	-0.012	0.0	0
8640 min Winter	-0.010	0.0	0
10080 min Winter	-0.008	0.0	0

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	10	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) 7.431

Time From:	**(mins) To:**	**Area (ha)**
0	4	7.431

Model Details

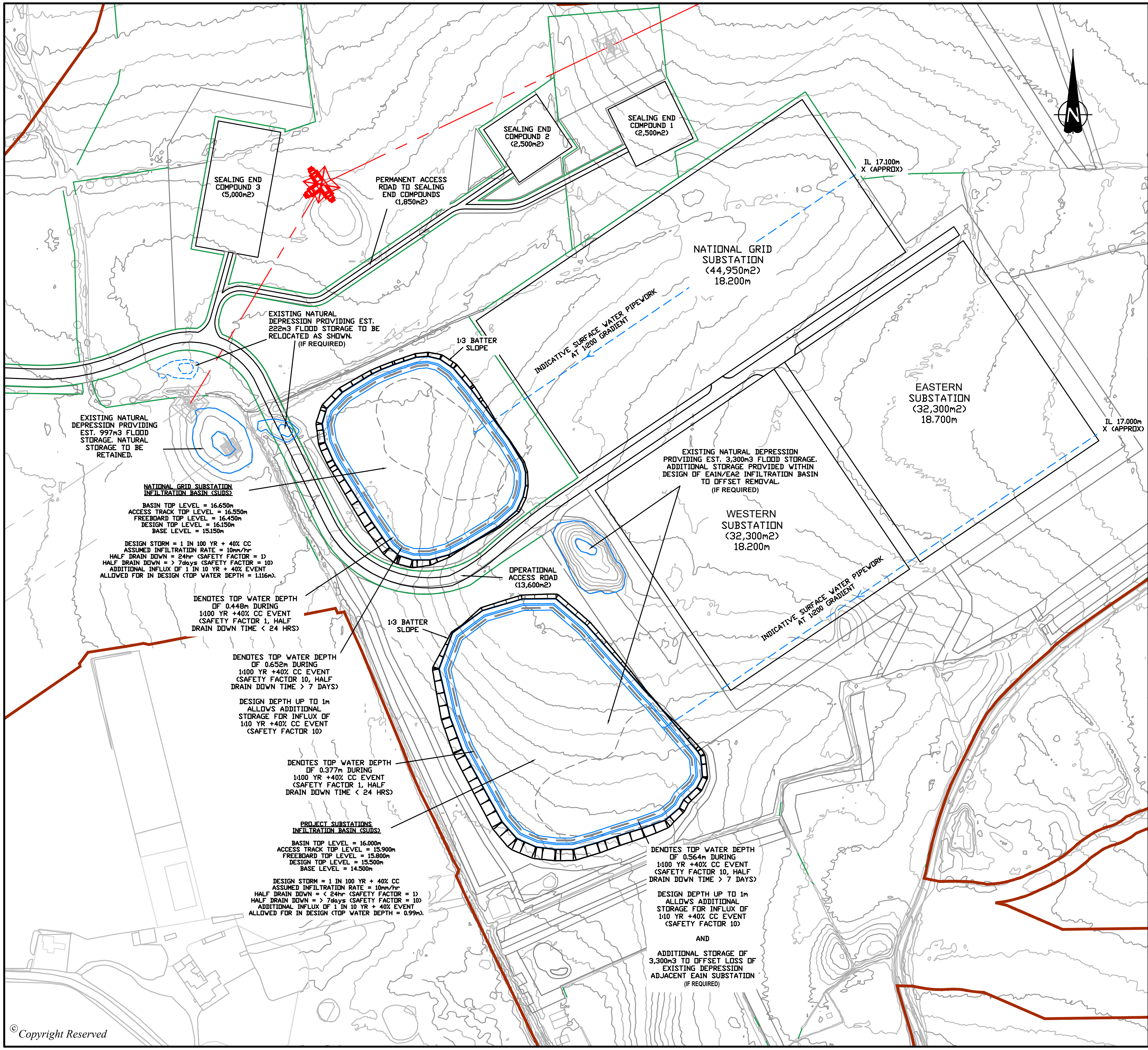
Storage is Online Cover Level (m) 16.650

Infiltration Basin Structure

Invert Level (m) 15.802 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.01000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.01000

Depth (m)	**Area (m^2)**	**Depth (m)**	**Area (m^2)**	**Depth (m)**	**Area (m^2)**	**Depth (m)**	**Area (m^2)**	**Depth (m)**	**Area (m^2)**
0.000	14492.0	0.348	15116.0	0.648	15664.0	0.748	17314.0	0.848	17508.0

Appendix 3: Infiltration Basin Figures



DO NOT SCALE FROM THIS DRAWING

NOTES:

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	DRN	CHK'D	APP'D
G	UPDATED TO SUIT RHDHV COMMENTS	10.02.21	CS	CS	SH
F	DESIGN UPDATED	29.01.21	CS	CS	SH
E	DRAWING UPDATED TO INCORPORATE REVISED HARDSTANDING AREAS AND 100% IMPERMEABILITY.	24.12.20	CS	CS	SH
D	DRAWING UPDATED TO ADDRESS SPR COMMENTS.	17.11.20	SH	SH	SH
C	DRAWING UPDATED FOR CLARITY	06.10.20	JN	JN	SH
B	INFILTRATION BASINS UPDATED.	17.09.20	JN	CS	SH
A	FIRST ISSUE	10.09.20	JN	CS	SH

CLIENT
Haskoning DHV UK Limited

PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

SKETCH

DRAWING TITLE
INFILTRATION BASIN
10mm PER HOUR
OPTIONS SKETCH

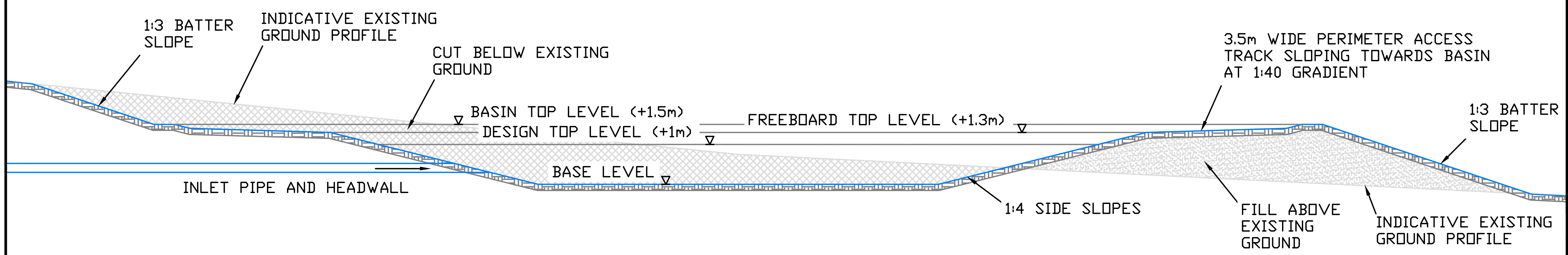
DRG No.		REV
ED11892-C-SK10		G
DRG SIZE: A3	SCALE: NTS	DATE: SEPT'20
DRAWN BY: JN	CHECKED BY: CS	APPROVED BY: SH

wardell armstrong

■ EDINBURGH | TEL 0131 555 3311
WWW.WARDELL-ARMSTRONG.COM

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

N:\ED\ED11892 - EAST ANGLIA OFFSHORE WIND EA 1\03 - DESIGN\AUTOCAD\ED11892-C-SK10-G SK13-A - INFILTRATION BASINS.DWG



TYPICAL INFILTRATION BASIN CROSS SECTION

DO NOT SCALE FROM THIS DRAWING

NOTES:

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.

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

CLIENT
Haskoning DHV UK Limited

PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

SKETCH

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

DRG No.		REV
ED11892-C-SK13		B
DRG SIZE: A3	SCALE: NTS	DATE: FEB'21
DRAWN BY: CS	CHECKED BY: CS	APPROVED BY: SH

wardell armstrong

■ EDINBURGH | TEL 0131 555 3311
WWW.WARDELL-ARMSTRONG.COM

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

N:\ED\ED11892 - EAST ANGLIA OFFSHORE WIND EA 1\03 - DESIGN\AUTOCAD\ED11892-C-SK10-G SK13-B - INFILTRATION BASINS.DWG

Appendix 4: Attenuation SuDS Design 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)				<u>01.12.20</u> Updated with areas of SUDS basin footprint (including perimeter access tracks) <u>05.01.21</u> Reduced project substation footprints from 36,100m^2 to 32,300m^2 for each substation (previous total 96,510m^2). <u>02.02.21</u> Amended design to store 1:100 YR + 40% exceedence within 1m design depth. <u>10.02.21</u> Added note on additional volume allowed for existing depression adjacent EA1N substation.
Substation operational footprint	32,300 m^2	32,300 m^2	44,950 m^2	
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)				<u>01.12.20</u> Updated to suit increased contribution areas as above <u>05.01.21</u> Updated to suit reduced project subsation contribution areas as above <u>02.02.21</u> 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	
	<u>FEH</u>		<u>FEH</u>	
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)				<u>01.12.20</u> Updated to suit increased contribution areas as above <u>05.01.21</u> Updated to suit reduced project subsation contribution areas as above <u>02.02.21</u> Amended design to store 1:100 YR + 40% exceedence within 1m design depth.
	<u>FEH13</u>		<u>FEH13</u>	
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)				<u>01.12.20</u> Updated to suit increased contribution areas as above <u>05.01.21</u> Updated to suit reduced project subsation contribution areas as above <u>02.02.21</u> 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)				<u>01.12.20</u> Updated to suit increased contribution areas as above <u>05.01.21</u> Updated to suit reduced project subsation contribution areas as above <u>02.02.21</u> Amended design to store 1:100 YR + 40% exceedence within 1m design depth.
	<u>FEH13</u>		<u>FEH13</u>	
All Hardstanding Areas	**11,593.4 m^3**		**8,024.5 m^3**	
Attenuation Dimensions				<u>01.12.20</u> Added areas for perimeter access track. Access track falls towards top of basin providing an additional 0.1m depth of storage. <u>02.02.21</u> 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				<u>01.12.20</u> Added additional storage volume from perimter access track. Access track falls towards top of basin providing an additional 0.1m depth of storage. <u>02.02.21</u> 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				<u>02.02.21</u> 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 (mins) From:	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

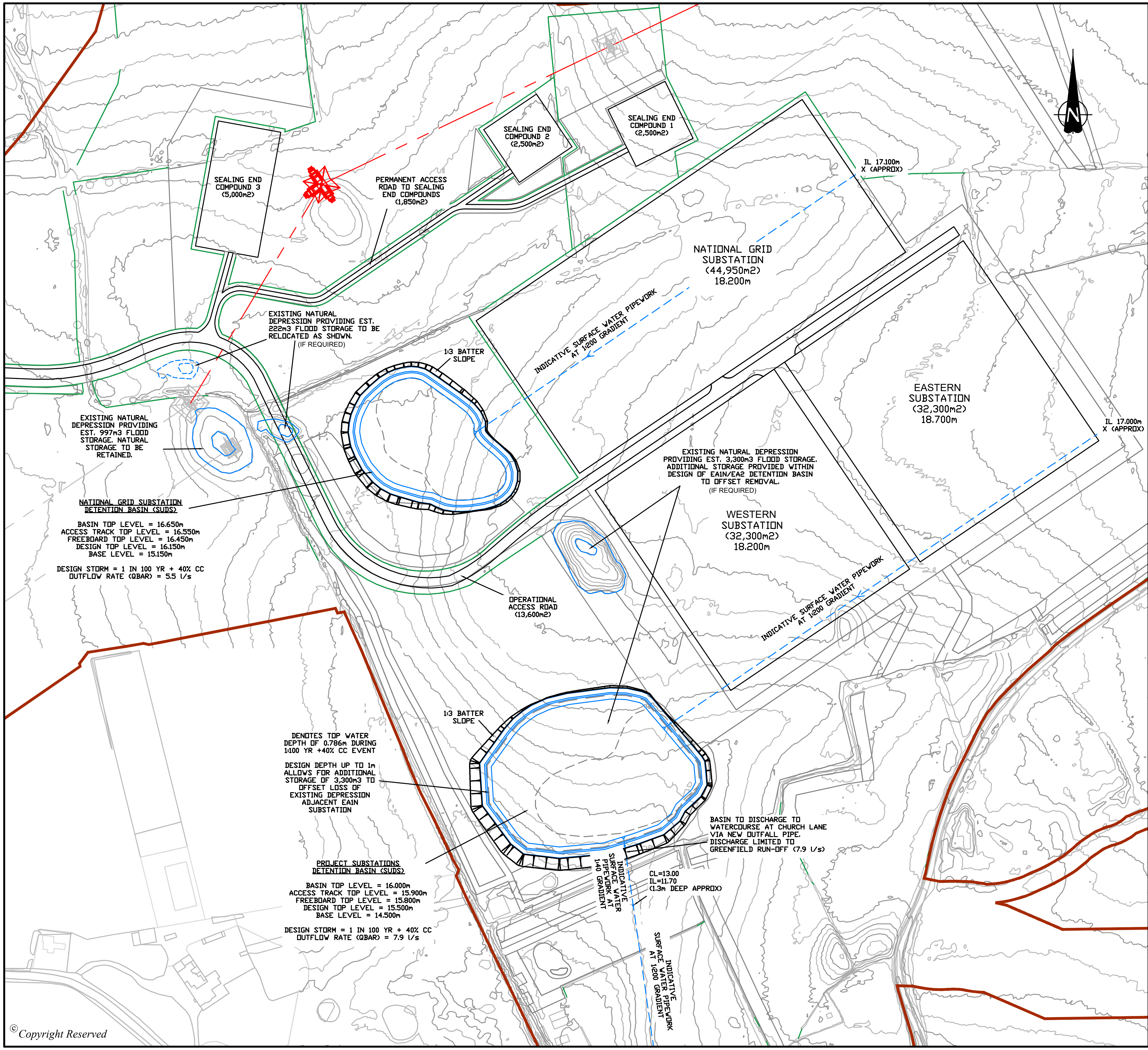
Unit Reference	MD-SHE-0111-5520-1000-5520
Design Head (m)	1.000
Design Flow (l/s)	5.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	111
Invert Level (m)	15.150
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

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: Indicative Attenuation SuDS Basin Figures



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.

DENOTES DCO ORDER LIMITS

DENOTES INDICATIVE SURFACE WATER PIPEWORK

DENOTES INDICATIVE SUDS FEATURE (SEE ANNOTATION)

REVISION	DETAILS	DATE	DRN	CHK'D	APP'D
C	UPDATED TO SUIT RHDHV COMMENTS	24.02.21	CS	CS	SH
B	UPDATED TO SUIT RHDHV COMMENTS	10.02.21	CS	CS	SH
A	FIRST ISSUE	29.01.21	CS	CS	SH

CLIENT
Haskoning DHV UK Limited

PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

SKETCH

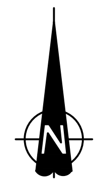
DRAWING TITLE
DETENTION BASIN
1 IN 100 YR + 40% CC DESIGN

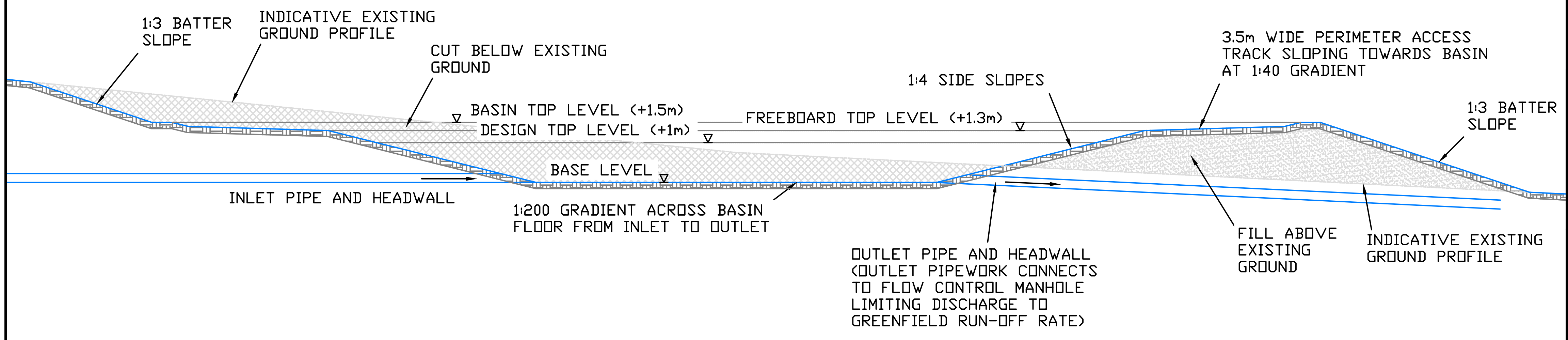
DRG No. ED11892-C-SK11		REV C
DRG SIZE A3	SCALE NTS	DATE JAN'21
DRAWN BY CS	CHECKED BY CS	APPROVED BY SH

wardell armstrong

EDINBURGH | TEL 0131 555 3311
WWW.WARDELL-ARMSTRONG.COM
BIRMINGHAM, LEEDS, BOLTON, LONDON, CARDIFF, MANCHESTER, CARLISLE, NEWCASTLE UPON TYNE, GLASGOW, STOKE ON TRENT

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





TYPICAL DETENTION BASIN CROSS SECTION

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
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

CLIENT
Haskoning DHV UK Limited

PROJECT
EAST ANGLIA OFFSHORE WIND
EA1N & EA2

SKETCH

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

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

wardell armstrong

■ EDINBURGH | TEL 0131 555 3311
WWW.WARDELL-ARMSTRONG.COM

- ☐ 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-SK11-B SK12-B - DETENTION BASINS.DWG