White Cross Offshore Wind Farm ES Addendum

Appendix E: Outline Drainage Strategy

WHITE CROSS

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WHITE CROSS

REPORT

White Cross Offshore Windfarm

Drainage Strategy Report

Client: White Cross Offshore Wind Limited

Reference: S2

Status: S2/P4

Date: 2 May 2024

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Document title:	White Cross Offshore Windfarm
Document short title:	Outline Drainage Strategy
Reference:	S2
Status:	P4/S2
Date:	2 May 2024
Project name:	White Cross Offshore Windfarm
Project number:	PC2978
Author(s):	IO
Drafted by:	IO
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Classification
Open

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1 Introduction

1.1 Background

1.1.1 Royal HaskoningDHV was commissioned by White Cross Offshore Wind Limited (here in referred to as 'the Applicant') to prepare a Outline Drainage Strategy to support the proposed construction of onshore infrastructure associated with the White Cross Offshore Windfarm.

1.1.2 The White Cross Offshore Windfarm is a proposed floating offshore windfarm located in the Celtic Sea with a capacity of up to 100MW. The 'Onshore Project', entailing all infrastructure of the project landward of Mean Low Water Springs (MLWS), requires a Town and Country Planning Act 1990 (TCPA) application. A separate Section 36 (under the Electricity Act 1989) and Marine Licence (ML) application for Offshore Project components (seaward of Mean High Water Springs (MHWS)), which has been submitted as a to the Marine Management Organisation (MMO) following the MMO confirming that they would not consent the Onshore Infrastructure of the Windfarm Project.

1.1.3 The Onshore Project includes the infrastructure associated with the Landfall at Saunton Sands (to MLWS) where the onshore elements connect to the Offshore Project infrastructure, Onshore Export Cable (including joint bays and link boxes), Taw Estuary Crossing, a new White Cross Onshore Substation, and an Interconnecting Cable to the Grid Connection Point at the existing East Yelland Substation.

1.1.4 The set of consents/permission required in order for the Project as a whole to proceed are outlined below:

- Planning permission under the Town and Country Planning Act 1990 (TCPA) 1990) is required for the following Onshore Project infrastructure (landward of MLWS):
    - Offshore export cables (from MLWS to above MHWS at the Landfall and Transition Joint Bay (TJB));
    - Onshore export cables (2 x 66 kilovolts (kV) or 1 x 132kV from Landfall to White Cross Onshore Substation and 132kV from the White Cross Onshore Substation to Grid Connection Point) – excluding section below MLWS at the Taw Estuary crossing;
    - White Cross Onshore Substation;
    - Temporary main construction compound and temporary construction compounds;
    - Transition Joint Bay, jointing bays, link boxes, access roads and haul roads; and
    - Grid Connection Point.
- Consent under the Section 36 of the Electricity Act 1989 and a Marine Licence under the Marine and Coastal Access Act 2009 (MCAA 2009) from the MMO are required for the following generation assets (within the Windfarm Site):
    - Wind Turbine Generators;
    - Semi-submersible floating platforms;

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  - Subsea catenary mooring lines;
  - Anchoring solutions (drag embedment anchors, suction anchor or pin piles);
  - Inter-array cables and associated protection; and
  - Other associated offshore infrastructure, such as navigational markers.
- A second Marine Licence is required to enable the option for an Offshore Transmission Owner (OFTO) to be appointed under The Electricity (Competitive Tenders for Offshore Transmission Licences) Regulations 2015 for the following transmission assets (to MHWS):
  - Offshore Substation Platform;
  - Offshore export cable; and
  - Other associated offshore infrastructure, such as navigational markers.

1.1.5 The Section 36 and Marine Licences applications were submitted to the MMO on 14th March 2023.

1.1.6 Further detail on the consenting regime and relevant legislation is presented in **Chapter 3: Policy and Legislative Context of the Onshore Project ES**.

1.2 Purpose of this Document

1.2.1 This document has been revised following comments made by the Lead Local Flooding Authority (LLFA) on **Appendix 5.C: Outline Drainage Strategy Report (Rev 0) of the Onshore Project ES**. Details of the comments and specific responses are presented in **Table 1.1**.

1.2.2 The rainfall data has been revised from the Flood Studies Report data to the Flood Estimation Handbook (FEH) as required, resulting in the slight modification to the volume of the detention basin. Furthermore, the report establishes the onward connectivity of the restricted discharge from the application site as required.

1.2.3 The purpose of this report is to present the proposed Outline Drainage Strategy for the proposed development at the application site and support the Flood Risk Assessment (FRA) in providing justification to regulators and other stakeholders that the proposed development is feasible.

1.2.4 This Outline Drainage Strategy has been prepared in line with national policy requirements, and ultimately aims to support the future outline planning application for the application site. This report should be read in conjunction with the FRA (**Appendix D of the ES Addendum**), prepared by Royal HaskoningDHV.

1.2.5 The information outlined in this report has been developed in accordance with the National Planning Policy Framework (NPPF) along with advice and guidance from the Environment Agency, The Sustainable Drainage System (SuDS) Manual, and LLFA local policies.

1.2.6 During the development of this strategy, Royal HaskoningDHV have undertaken the following exercises:

- Reviewed comments made by the LLFA and update the strategy where required;

- Review of the LIDAR Survey Information;
- Undertook existing surface Water Run-off Calculation;
- Defined allowable surface Water Discharge;
- Undertook a Quick Storage Estimates calculations to define the volume of surface water storage required;
- Outline drainage design following a high-level proposed site level strategy;
- Onward connectivity at the proposed point of restricted discharge;
- Preliminary assessment of compensatory storage taking account of surface water displacement;
- Full microdrainage network assessment of the proposals using (FEH) Rainfall Data; and
- Review of third party development adjacent to the development.

1.2.7 This Report references the priorities and preferences of National policies and in particular Devon County Councils' LLFA Guidance Documents (Devon County Council, 2022). It outlines the drainage strategy by exploring SuDS options which allow regulators and other stakeholders to assess whether the development is feasible.

1.3 Comments from the Lead Local Flooding Authority

1.3.1 The Lead Local Flooding Authority (LLFA) objected to the previously submitted Outline Drainage Strategy (previously **Appendix 5.E of the Onshore Project ES**) on the grounds of insufficient information provided. **Table 1.1** outlines the Applicant's responses and changes to the strategy following the LLFA comments.

Table 1.1 The Applicant's responses to LLFA comments

LLFA Comment	The Applicant's Response
"It is noted that the construction management details have been considered as part of the application. It is recommended that the driving/tracking of plant and equipment to and from the trenching locations is also considered at this stage."	The access strategy for construction plant and equipment is described in **Chapter 5: Project Description.**
"It is noted that the applicant has proposed to use a pond to manage surface water before discharging into a ditch."	The Applicant confirms this. The pond is suitably sized for the critical storm event using FEH Rainfall data. The attenuation pond will function as a detention basin.
"The proposed system appears to account for flows from the substation only. It is recommended that the water quality is considered, based on the event that there is a need for vehicles to enter the site. Permeable paving and swales could be used to convey flows to the proposed pond, these	The use of permeable pavement and swales can be incorporated within the detailed design. As highlighted in **Section 4**, the strategy aligns with the requirement of the Simple Index Approach (SIA). The Pollution Hazard Category of the site (Table 26.2 of CIRIA 753, 2015) is lesser than the

LLFA Comment	The Applicant's Response
features could provide opportunities for interception losses."	proposed Mitigation Index offered by the proposed SuDs component. The management train of the proposed Detention Basin will work in tandem with a proprietary treatment system. Detailed opportunities for SuDs features which offers water quality advantages together with the biodiversity and landscape amenity requirements will be explored at detailed design stage.
"It is noted that there are two sets of model outputs; one set model an attenuation tank and the other set model a pond. The applicant should confirm whether both outputs are relevant for this proposal."	The model output has be revised. The proposed detention basin is modelled as a pond (as presented in the Outline Drainage Drawing).
"50% climate change is required for the modelling of the surface water drainage system. A freeboard of 300mm is required."	The model has been revised and storm simulations extended to 1 in 100-year storm plus 50% climate change allowance. The model shows the inclusion of 300mm freeboard.
"It is also noted that the applicant has referred to an existing ditch adjacent to the Tarka Trail. Confirmation is required to be provided based on the route of this ditch and its eventual outfall."	Onward connectivity of the restricted discharge is via the existing network of adjacent ditches and culvert as outlined in **Section 2.5**.
"The applicant is reminded that Land Drainage Consent will be required for temporary or permanent works within Ordinary Watercourses."	Land Drainage Consent will be made to the appropriate authority at detailed design stage prior to construction.

2 Site Description

2.1 Site Location

2.1.1 A Site Location Plan of the Onshore Substation is shown in **Annex 1**.

2.1.2 The Windfarm Site is located over 52km off the North Cornwall and North Devon coast (west-north-west of Hartland Point). The Offshore Export Cable will connect the Offshore Substation Platform (if required) to shore. The Export Cable will come ashore at a Landfall at Saunton Sands on the North Devon Coast, and then be routed underground to the East Yelland Substation where it connects into the distribution network. Prior to connecting to the East Yelland Substation the cable will connect to a new White Cross Onshore Substation. A full description of the Onshore Project is given in **Chapter 5: Project Description** of the Onshore Project ES.

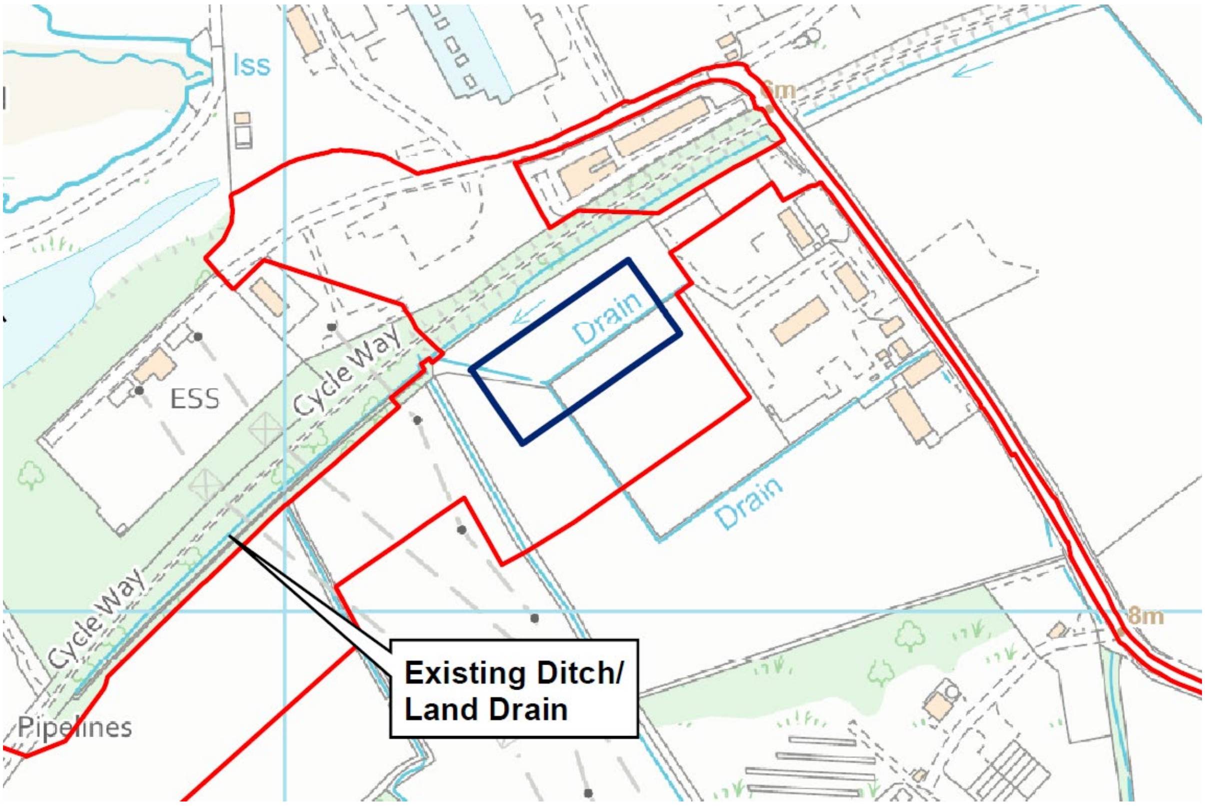

Figure 2.1 Existing Site Location Plan

2.1.3 The site of the proposed Onshore Substation includes land that was previously used as an oil and gas storage facility. The site is situated at the north-east part of Yelland, west of Barnstaple. The River Taw is located to the north of the site.

2.1.4 The total area of the proposed Onshore Substation site is 1.48ha, of which approximately 0.81ha is brownfield, however for the purposes of this Outline Drainage Strategy and in line with the requirement of the Devon County Council SUDs Design Guidance, the entire site will be considered as greenfield site.

Table 2.1 Existing Site Surroundings

Direction	Neighbouring Features Description
West	East Yelland Substation
East	Existing Industrial Depot and B3233. Proposed housing development.
North	Immediately north is an industrial depot and consented housing development. Further north is the River Taw.
South	Existing Solar Farm, far south is B3233-West Yelland

2.1.5 **Table 2.2** presents the site information and a site location plan is shown in **Annex 1**.

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Table 2.2 Site Location Information

Item	Brief Description
Site Address and Location	Land to west of Estuary Business Park. Closest postcode is EX31 3HB
Council Area	North Devon Council / Devon County Council
Approximate Grid Reference	SS 48217 32177
Total impermeable footprint (including Onshore Substation access road, landscaping and drainage)	Approximately 0.81ha

2.2 Topography

2.2.1 The site topography is generally very flat. The existing ground appears to slope in two directions from 5.3mAOD in the north-east direction to approximately 4.83mAOD in the south-west direction.

2.3 Geology

2.3.1 Information presented on the BGS online viewer (2024) indicates that the superficial deposits underlying the Site consist of Alluvium, sand and gravel. The geological formation present within the Onshore Development Area consists of Pilton Mudstone Formation, Blown Sand and Tidal Flat deposits. The Tidal Flat Deposit consist of Clay, silt and sand, a sedimentary superficial deposit formed in the Quaternary period.

2.3.2 Intrusive ground investigation evaluating sub soil strata was completed in September 2023 (refer to **Appendix T: Onshore Ground Investigation Interpretative Report**). The superficial deposits throughout the central site area are recorded in historic borehole consist of medium density to compact grey sand to 7.13m underlain by soft blue silty clay. The cohesive nature of the underlying strata suggests that surface water infiltration via permeability is limited.

2.4 Existing Watercourses and Onward Connectivity of Restricted Discharge

2.4.1 As highlighted in the Surface Water Connectivity Plan presented in the **Annex 5**, the existing drainage pattern in the vicinity of the proposed Onshore Substation consist of greenfield runoff; runoff percolating into the ground and the remainder flowing as overland, towards Tarka Trail ditch running east to west, and located north of the site.

2.4.2 A brick arch culvert (approx. 900mm) directs flow beneath the Tarka Trail. This returns to open channel for a short length before draining through a 900mm diameter culvert. The 900mm culvert discharges into an existing pond located to the northwest of the development. This pond discharges into the Taw estuary via another culvert.

2.4.3 The Surface Water Connectivity Plan (**Annex 5**) highlights the existing drainage route which conveys the restricted discharge offsite. As highlighted in the drawing, the discharge outfalls into a culvert that conveys flow of water under Tarka Trail. The maximum inflow from the proposed Onshore Substation is the restricted greenfield runoff of 3.8l/s (for the 1 in 100 year plus climate change). This inflow represents a reduction to the current surface water loading resulting from the existing site.

Figure 2.2 Culvert beneath Tarka Trail

Figure 2.3 Pond located Northwest of the development site

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Figure 2.4 Outfall Culvert into Taw Estuary

Figure 2.5 Existing bedrock underlying the site (British Geological Society Maps)

3 Proposed Drainage Strategy

3.1.1 The proposal involves the installation of an onshore substation building, control building and associated access road and parking. The proposals consist of a total of 0.7ha of newly introduced impermeable area.

3.1.2 Management of surface water is an essential element for reducing flood risk and SuDS techniques are often designed to achieve this in a way that mimics the natural environment. This SuDS Strategy is based on the principles highlighted in the Devon County Council Sustainable Drainage System - Guidance for Devon (2022) and has been formally consulted by North Devon Council as part of the TCPA planning application process. This strategy has been updated to take into account comments received by the LLFA during the formal consultation (as outlined in **Table 1.1**).

3.1.3 This SuDS Assessment has been developed in line with the SuDS hierarchical approach outlined in the Flood Risk and Coastal Change Section of the Planning Practice Guidance (paragraph 7 to 14) and as recommended CIRIA's SuDs Manual (2015) which recommends that surface water run-off should be discharged as high up the following hierarchy of drainage options as reasonably practicable:

- Infiltration into ground;
- To a surface water body;
- To a surface water sewer, highway drain or other drainage system; or
- To a combined sewer.

3.1.4 As discussed in **Section 2.4**, the intrusive ground investigation suggests made ground underlain by Tidal Flat Deposit which consist of Clay, silt and sand. This is further underlain by Pilton Mudstone Formation. These sub-strata suggest cohesive composition. It is assumed that surface water discharge methods using infiltration techniques are deemed unsuitable for this site.

3.1.5 As noted in **Paragraph 2.1.2**, part of the site was previously used as an oil and gas storage facilities, however the Devon County Council Sustainable Drainage Guidance requires that for developments on brownfield sites, peak flow control must still match the greenfield run-off rate, especially where there is increase in impermeable surface introduced as a result of a proposed development.

3.1.6 The existing greenfield run-off estimate for the site using the HR Wallingford procedure is presented in **Annex 3**. The drainage design strategy is sought that the post development discharge rate is no more that the equivalent greenfield run-off rate up to the 1 in 100-year storm event including a 50% climate change allowance.

3.1.7 This Drainage Strategy is informed by the Flood Risk Assessment (**Appendix D of the ES Addendum**), which suggested an Upper End allowance for the future Extreme Water Levels of 6.43mAOD. The FFL of the substation will therefore be at least 300mm above this level (equating to 6.73mAOD). The proposed ground level is 1.4m above the existing ground at the development site.

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3.2 Proposed Surface Water Strategy

3.2.1 Overall impermeable area contributing surface water run-off is approximately 0.7ha. It is proposed that surface water drainage from all impermeable surfaces are routed via a proprietary treatment system, such as hydro-downstream defenders or similarly equivalent, into an attenuation pond located to the south of the proposed development.

3.2.2 Peak surface water run-off is then restricted to the maximum greenfield run-off rate of 3.8l/s for the 1 in 100-year rainfall event. This is to be restricted, via a proposed hydrobrake flow control device at the downstream end of the pond. The minimum base level of the pond is approximately 3.64mAOD; maximum ponded depth within the pond is approximately 4.593mAOD.

3.2.3 It is proposed to channel the restricted surface-water flow via a 150mm pipe laid at a minimum gradient of 1 in 150, with a pipe roughness *Ks* specified at 0.6. The proposed geometry and arrangement of the drainage pipe network minimises conflict between this proposed pipe network and the proposed/existing underground cables in the vicinity of the works.

3.2.4 The proposed drainage strategy is indicated in drawing PC2978-RHD-ZZ-XX-DR-D-0500 (**Annex 2**).

3.2.5 The proposed attenuation pond contributes approximately 514m^3 of storage. Maximum depth of the pond is approximately 1.2m with a minimum side slope of 1 in 3. The geometry of the pond ensures a free board of approximately 0.30m is secured in the 1 in 100 year plus 50% climate change event. The proposed pond (Detention Basin) will be lined with impermeable geomembrane, the technical specification of the geomembrane/geotextiles will be determined at detailed design.

3.2.6 **Annex 3** presents the Full Microdrainage Network calculations modelling the storage and conveyance capacity of the proposed drainage system. A summary of the SuDS provision is provided in **Table 3.1**.

Table 3.1 Summary of SuDS Provision

SUDs Storage Structure	Surface Water Disposal Mechanism	Volume of Storage (m^3)	Discharge Flowrate (l/s)	Water Level at the 1 in 100 year storm event plus 50% climate change	Freeboard
Detention Basin (Attenuation Pond)	Attenuation	514	3.8l/s	4.593mAOD	300mm

3.2.7 Furthermore, as highlighted in the drawing PC3506-RHD-ZZ-XX-DR-D-0500 (**Annex 2**), allowances are made for a surface water compensatory storage volume of 3,200 cubic.m in the 1 in 100-year storm event. This is as a result of surface water displacement owing from proposed changes in the ground level.

3.2.8 This estimate has been preliminary computed via surface water flood depth layers and must be reiterated as a very conservative value since the proposed development benefits from its proposed surface water drainage strategy.

3.2.9 During exceedance events, beyond the 100 year critical storm surface water runoff will overflow from the aforementioned systems. Overland flow will follow the topography of the site and will route towards convenient holding points (as marked in drawing PC2978-RHD-ZZ-XX-DR-D-0500) where any freeboard beyond the capacity of the attenuation features flows would be directed towards the compensation basins at the lower edge of site, where any available capacity can be utilised.

4 Water Quality

4.1.1 Proposed run-off quality control for the site will include proprietary treatment. A schedule of the size of the oil interceptors is included in **Annex 4**. The proposed oil interceptors ensures that that:

$$\begin{matrix} \textbf{\textit{TOTAL SUDS MITIGATION INDEX}} & \geq & \textbf{\textit{POLLUTION HAZARD INDEX}} \\ (\textbf{\textit{FOR EACH CONTAMINANT}}) & & (\textbf{\textit{FOR EACH CONTAMINANT}}) \end{matrix}$$

4.1.2 **Annex 4** includes details of the results of the SIA tools (CIRIA guidance C753-SuDS Manual, 2015) and demonstrates that the proposals are sufficient to meet the required standards for water quality.

5 Review of Third Party Development

5.1.1 To the east of the proposed Onshore Substation is a proposed mixed use development consisting of predominantly residential and commercial development. A planning application (Application Number: 77453) was submitted in August 2023 and subsequently withdrawn in November 2023. A review of the proposals has been undertaken as part of the update to this Outline Drainage Strategy.

5.1.2 A Drainage Strategy was submitted as part of the application. It was proposed that surface water runoff generated by the proposed development would be intercepted at ground level and be routed through a new storm network towards a series of open SuDS attenuation with attenuated flows conveyed towards the existing Tarka Trail ditch.

5.1.3 According to the Drainage Strategy submitted, the proposed long-term storage for the proposed site, the discharge rate and volume were calculated in line with CIRIA C753 guidance (2015) to achieve a 2 l/s/ha peak based on a 1ha unit of impermeable area. The net development area is 1.67ha and was assumed to be 60% impermeable (1.0ha) including allowance for 10% urban creep.

5.1.4 This implies that a future development, if taken forward, in the vicinity of the proposed site will have a formal surface water drainage system, which will influence and reduce the resultant applicable surface water catchment from the existing greenfield run off discharge rate. The resultant inflow contributed by the proposed third-party development and this proposed development is comparably less than the existing inflow from the same catchment in the 1 in 100 year storm event plus climate change.

6 Conclusions

6.1.1 The Devon County Council Sustainable Drainage Design Guides (2022) requires proposed peak outflow from existing brownfield sites to be the equivalent greenfield run-off rates. The existing ground appear to slope in two directions from 5.3mAOD in the north-east direction to approximately 4.83mAOD in the south-west direction.

6.1.2 Intrusive ground investigation evaluating sub soil strata was completed September 2023 (refer to **Appendix T: Onshore Ground Investigation Interpretative Report**). The superficial deposits throughout the central site area are recorded in historic borehole consist of medium density to compact grey sand to 7.13m underlain by soft blue silty clay. The cohesive nature of the underlying strata suggests that surface water infiltration via permeability is limited

6.1.3 Extensive topographical survey will be undertaken during detailed design to verify the presence of and direction of water flow and the existing invert levels of the land drains in the vicinity of the site.

6.1.4 The surface water drainage from approximately 0.81ha of impermeable surfaces will be routed via a proprietary treatment system, into an attenuation pond providing a storage volume of approximately 514m^3.

6.1.5 Peak surface water run-off is restricted via a hydro-brake flow control device to the maximum greenfield run-off rate of 3.87l/s for the 1 in 100-year rainfall event including climate change allowances. This is to be restricted to ensure surface water outflow is directed into existing land drains located northwest of the development.

6.1.6 There will be no increase in flood risk from the site to the surrounding area due to the restricted run-off rates and inclusion of SuDS. This SuDS Assessment/Drainage Strategy demonstrates to regulators and other stakeholders that the proposed development is feasible.

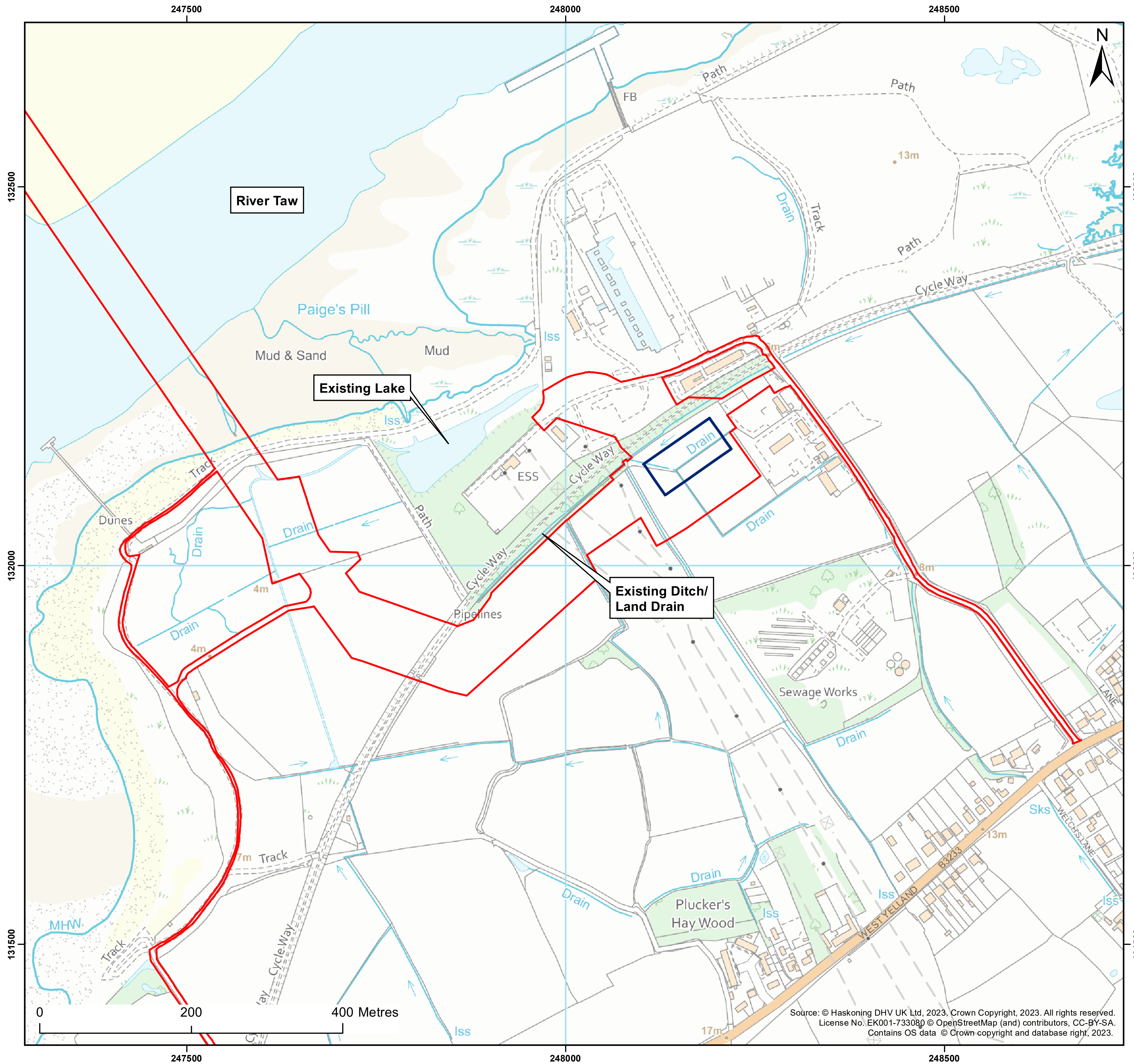
7 References

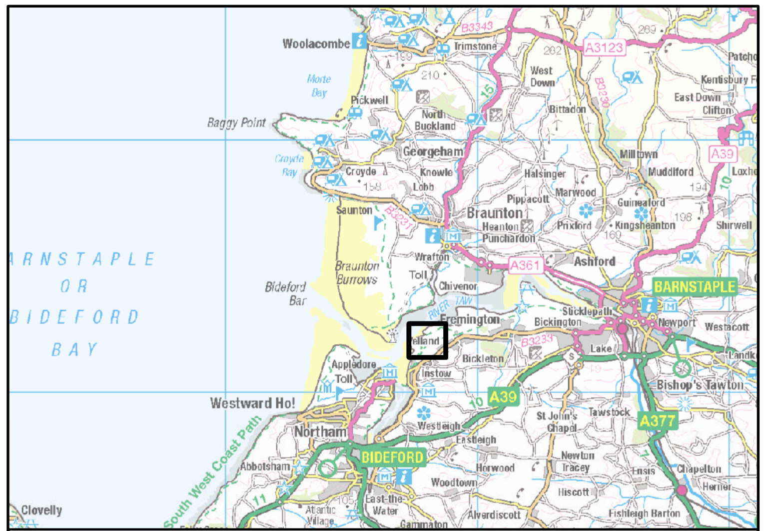
British Geological Society (2024) BGS Geology Viewer. https://www.bgs.ac.uk/map-viewers/bgs-geology-viewer. Accessed: 03/05/2024.

CIRIA (2015). The SuDS Manual C753

Devon County Council (2022). Sustainable Drainage Systems (SuDS) https://www.devon.gov.uk/floodriskmanagement/planning-and-development/sustainable-drainage. Accessed: 03/05/2024.

Annex 1: Site Location Plan





Legend:

- Onshore Development Area
- White Cross Onshore Substation

Client:	Project:
White Cross Offshore Wind Ltd.	White Cross Offshore Windfarm

Title: Annex A: Site Location Plan

Figure: 1.1 | Drawing No: PC2978-RHD-ZZ-XX-DR-Z-0711

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	03/08/2023	AB	LA	A3	1:5,000

Co-ordinate system: British National Grid

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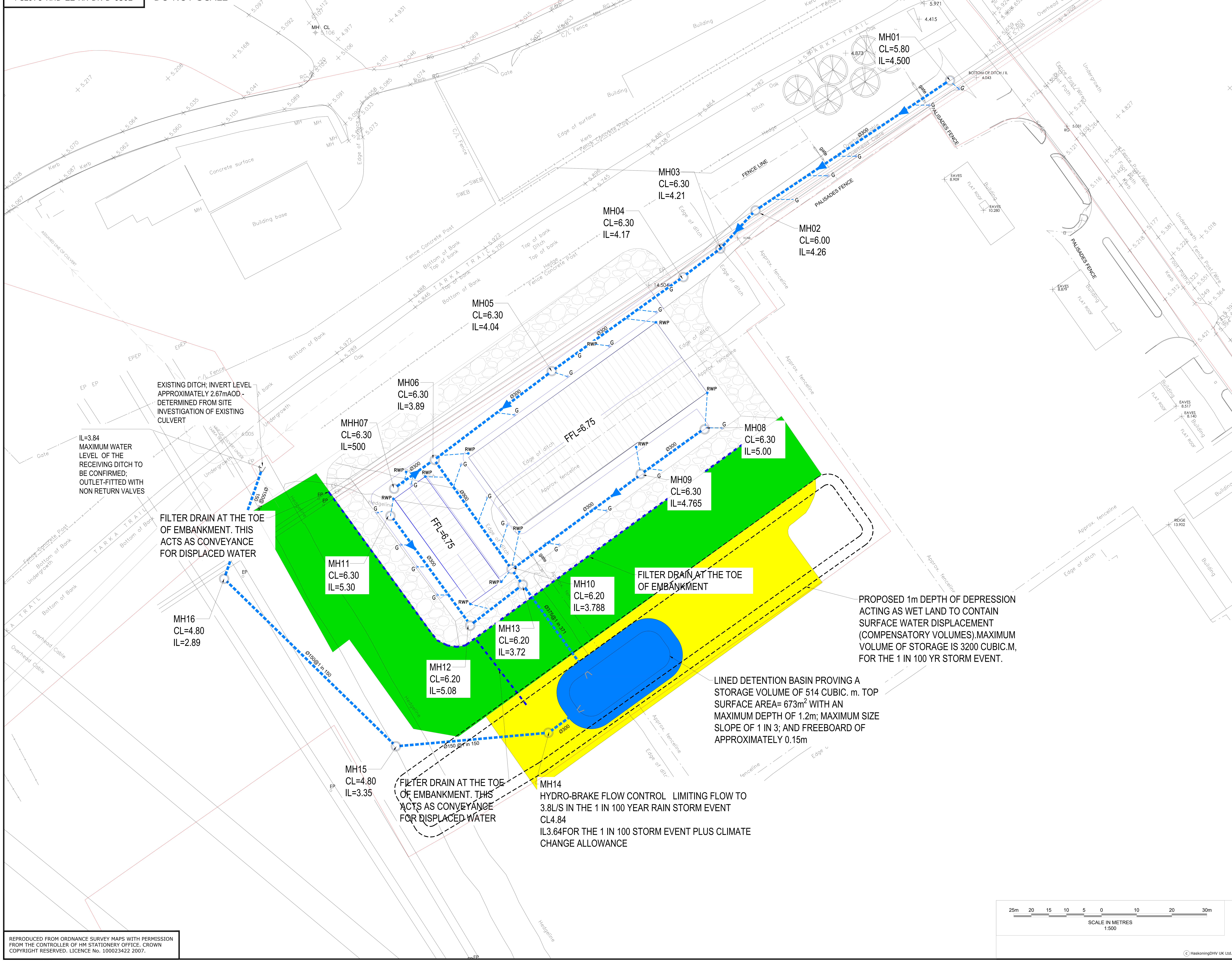
Annex 2: Outline Surface Water Drainage Strategy

DRAWING No.
PC2978-RHD-ZZ-XX-DR-D-0502

DO NOT SCALE



NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE IN METRES ABOVE CHART DATUM UNLESS NOTED OTHERWISE.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS DRAWINGS AND PROJECT SPECIFICATION.
4. WORKS TO BE UNDERTAKEN IN ACCORDANCE WITH THE SPECIFICATION FOR HIGHWAYS WORKS (SHW) UNLESS NOTED OTHERWISE.
5. ALL DIMENSIONS AND LEVELS ARE TO BE VERIFIED AND CONFIRMED ON SITE PRIOR TO WORK COMMENCING.
6. ANY DISCREPENCIES TO OR OMISSIONS ARE TO BE REPORTED TO THE PROJECT MANAGER FOR FURTHER INSTRUCTIONS BEFORE COMMENCEMENT OF WORKS.

LEGEND

- PROPOSED SURFACE WATER SEWER AND MANHOLE
- PROPOSED GULLY
- EXISTING OVERHEAD ELECTRICAL CABLE
- EXISTING UNDERGROUND ELECTRICAL CABLE
- PROPOSED LANDSCAPED AREA
- TEMPORARY CONSTRUCTION COMPOUND
- PROPOSED DETENTION BASIN
- PROPOSED GRADED EMBANKMENT
- PROPOSED FILTER DRAIN AT THE TOE OF EMBANKMENT
- RWP PROPOSED RAINWATER OUTLET FROM ROOF
- EXTENT OF A CONSERVATIVE SURFACE WATER COMPENSATORY STORAGE
- PLOT BOUNDARY

REV	DATE	DESCRIPTION	BY	CHK	APP
P06	27-03-24	INCLUDED COMPENSATORY STORAGE	IO	OA	DJ
P05	08-09-23	GULLY POSITIONS AND MANHOLE REFRENCES	IO	OA	DJ
P04	20-07-23	REVISED TO INCLUDE UPDATED SITE PLAN	IO	OA	DJ
P01	16-05-23	FIRST ISSUE	IO	OA	DJ

REVISIONS

DRAWING STATUS: PRELIMINARY

CLIENT: WHITE CROSS OFFSHORE WIND LIMITED

PROJECT: WHITE CROSS WINDFARM

TITLE: OUTLINE SURFACE WATER DRAINAGE STRATEGY

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DRAWN	CHECKED	APPROVED
IO	BA	DJ
DATE: APRIL 2024	SCALE AT A1: 1:500	PROJECT NUMBER: PC2978

DRAWING No. PC2978-RHD-ZZ-XX-DR-D-0500 | REVISION P06

Annex 3: Hydraulics Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 248217 132177 SS 48217 32177
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.078	4-8	0.466	8-12	0.070

Total Area Contributing (ha) = 0.614

Total Pipe Volume (m³) = 47.956

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	71.553	0.239	300.0	0.023	5.00	0.0	0.600	o	300	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	6.32	4.500	0.023	0.0	0.0	0.0	0.90	63.8	3.1

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.001	14.359	0.048	300.0	0.023	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	13.917	0.046	300.0	0.023	0.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	63.816	0.213	300.0	0.024	5.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	45.487	0.152	300.0	0.024	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.004	36.675	0.122	300.0	0.071	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.000	19.814	0.066	300.0	0.071	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.005	34.169	0.115	298.2	0.071	0.00	0.0	0.600	o	300	Pipe/Conduit	
4.000	25.423	0.085	300.0	0.071	5.00	0.0	0.600	o	150	Pipe/Conduit	
4.001	40.066	0.135	297.6	0.071	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.006	16.825	0.055	303.8	0.071	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.000	43.815	0.219	200.0	0.071	5.00	0.0	0.600	o	300	Pipe/Conduit	
5.001	19.668	0.066	300.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.007	21.995	0.073	300.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.008	9.461	0.010	946.1	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.001	50.00	6.59	4.261	0.046	0.0	0.0	0.0	0.90	63.8	6.2
1.002	50.00	6.84	4.214	0.069	0.0	0.0	0.0	0.90	63.8	9.3
2.000	50.00	6.18	5.400	0.024	0.0	0.0	0.0	0.90	63.8	3.2
1.003	50.00	7.68	4.167	0.117	0.0	0.0	0.0	0.90	63.8	15.8
1.004	50.00	8.36	4.015	0.188	0.0	0.0	0.0	0.90	63.8	25.5
3.000	50.00	5.57	5.000	0.071	0.0	0.0	0.0	0.58	10.2	9.6
1.005	50.00	8.99	3.893	0.330	0.0	0.0	0.0	0.91	64.0	44.7
4.000	50.00	5.74	5.000	0.071	0.0	0.0	0.0	0.58	10.2	9.6
4.001	50.00	6.47	4.765	0.142	0.0	0.0	0.0	0.91	64.1	19.2
1.006	50.00	9.30	3.778	0.543	0.0	0.0	0.0	0.90	63.4«	73.5
5.000	50.00	5.66	5.300	0.071	0.0	0.0	0.0	1.11	78.3	9.6
5.001	50.00	6.02	5.081	0.071	0.0	0.0	0.0	0.90	63.8	9.6
1.007	50.00	9.65	3.723	0.614	0.0	0.0	0.0	1.04	115.0	83.1
1.008	50.00	9.93	3.650	0.614	0.0	0.0	0.0	0.58	64.2«	83.1

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.009	41.476	0.290	143.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.010	66.761	0.460	145.1	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.011	31.041	0.218	142.7	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.009	50.00	10.38	3.640	0.614	0.0	0.0	0.0	1.51	167.1	83.1
1.010	50.00	11.12	3.350	0.614	0.0	0.0	0.0	1.50	165.9	83.1
1.011	50.00	11.47	2.890	0.614	0.0	0.0	0.0	1.51	167.3	83.1

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
01	5.800	1.300	Open Manhole	1200	1.000	4.500	300				
02	6.000	1.739	Open Manhole	1200	1.001	4.261	300	1.000	4.261	300	
03	6.300	2.086	Open Manhole	1200	1.002	4.214	300	1.001	4.214	300	
16	6.400	1.000	Open Manhole	1200	2.000	5.400	300				
04	6.300	2.133	Open Manhole	1200	1.003	4.167	300	1.002	4.167	300	
								2.000	5.187	300	1020
05	6.300	2.285	Open Manhole	1200	1.004	4.015	300	1.003	4.015	300	
H07	6.300	1.300	Open Manhole	1200	3.000	5.000	150				
06	6.300	2.407	Open Manhole	1200	1.005	3.893	300	1.004	3.893	300	
								3.000	4.934	150	891
07	6.300	1.300	Open Manhole	1200	4.000	5.000	150				
08	6.300	1.535	Open Manhole	1200	4.001	4.765	300	4.000	4.915	150	
09	6.200	2.422	Open Manhole	1200	1.006	3.778	300	1.005	3.778	300	
								4.001	4.631	300	853
10	6.300	1.000	Open Manhole	1200	5.000	5.300	300				
11	6.200	1.119	Open Manhole	1200	5.001	5.081	300	5.000	5.081	300	
12	6.200	2.477	Open Manhole	1350	1.007	3.723	375	1.006	3.723	300	
								5.001	5.015	300	1217
13	4.850	1.200	Open Manhole	1350	1.008	3.650	375	1.007	3.650	375	
14	4.840	1.200	Open Manhole	1350	1.009	3.640	375	1.008	3.640	375	
15	4.800	1.450	Open Manhole	1350	1.010	3.350	375	1.009	3.350	375	
16	4.800	1.910	Open Manhole	1350	1.011	2.890	375	1.010	2.890	375	
	4.800	2.128	Open Manhole	0		OUTFALL		1.011	2.672	375	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
01	248285.193	132253.697	248285.193	132253.697	Required	
02	248226.561	132212.682	248226.561	132212.682	Required	
03	248217.121	132201.862	248217.121	132201.862	Required	
16	248243.018	132141.916	248243.018	132141.916	Required	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
04	248205.806	132193.759	248205.806	132193.759	Required	
05	248168.825	132167.275	248168.825	132167.275	Required	
H07	248122.899	132134.384	248122.899	132134.384	Required	
06	248139.034	132145.885	248139.034	132145.885	Required	
07	248212.577	132156.251	248212.577	132156.251	Required	
08	248191.908	132141.449	248191.908	132141.449	Required	
09	248159.204	132118.303	248159.204	132118.303	Required	
10	248127.168	132128.511	248127.168	132128.511	Required	
11	248152.927	132093.068	248152.927	132093.068	Required	
12	248168.895	132104.550	248168.895	132104.550	Required	
13	248181.926	132086.830	248181.926	132086.830	Required	
14	248174.893	132080.503	248174.893	132080.503	Required	
15	248133.462	132078.571	248133.462	132078.571	Required	
16	248091.356	132130.379	248091.356	132130.379	Required	
	248094.426	132161.269			No Entry	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.011		4.800	2.672	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 248217 132177 SS 48217 32177
Data Type	Point
Summer Storms	Yes
Winter Storms	No
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 14, DS/PN: 1.009, Volume (m³): 2.6

Unit Reference	MD-SHE-0090-3800-1200-3800
Design Head (m)	1.200
Design Flow (l/s)	3.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	90
Invert Level (m)	3.640
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	3.8
Flush-Flo™	0.355	3.8
Kick-Flo®	0.735	3.0
Mean Flow over Head Range	-	3.3

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)
0.100	2.8	1.200	3.8	3.000	5.8	7.000	8.7
0.200	3.6	1.400	4.1	3.500	6.3	7.500	9.0
0.300	3.8	1.600	4.3	4.000	6.7	8.000	9.2
0.400	3.8	1.800	4.6	4.500	7.0	8.500	9.5
0.500	3.7	2.000	4.8	5.000	7.4	9.000	9.8
0.600	3.5	2.200	5.0	5.500	7.7	9.500	10.0
0.800	3.2	2.400	5.2	6.000	8.1		
1.000	3.5	2.600	5.4	6.500	8.4		

Storage Structures for Storm

Tank or Pond Manhole: 14, DS/PN: 1.009

Invert Level (m) 3.640

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	350.0	1.200	673.0	1.201	673.0

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 248217 132177 SS 48217 32177
Data Type	Point
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 0, 50

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	01	30 Summer	2	+0%	100/30 Summer				4.542
1.001	02	30 Summer	2	+0%	100/30 Summer				4.329
1.002	03	30 Summer	2	+0%	30/30 Summer				4.295
2.000	16	30 Summer	2	+0%					5.443
1.003	04	30 Summer	2	+0%	30/30 Summer				4.262
1.004	05	30 Winter	2	+0%	30/30 Summer				4.146
3.000	H07	30 Summer	2	+0%	30/30 Summer				5.115
1.005	06	30 Winter	2	+0%	30/30 Summer				4.111
4.000	07	30 Summer	2	+0%	30/30 Summer				5.114
4.001	08	30 Summer	2	+0%	100/30 Summer				4.874
1.006	09	30 Winter	2	+0%	30/30 Summer				4.075
5.000	10	30 Summer	2	+0%					5.370
5.001	11	30 Summer	2	+0%					5.161
1.007	12	30 Winter	2	+0%	30/30 Summer				4.030
1.008	13	30 Winter	2	+0%	30/30 Summer				3.998
1.009	14	360 Winter	2	+0%	30/120 Winter				3.879
1.010	15	360 Winter	2	+0%					3.389

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	01	-0.258	0.000	0.04			2.7	OK	
1.001	02	-0.233	0.000	0.10			5.1	OK	
1.002	03	-0.218	0.000	0.14			7.5	OK	
2.000	16	-0.257	0.000	0.05			3.0	OK	
1.003	04	-0.205	0.000	0.21			12.7	OK	
1.004	05	-0.169	0.000	0.31			18.2	OK	
3.000	H07	-0.035	0.000	0.93			8.9	OK	
1.005	06	-0.082	0.000	0.52			30.3	OK	
4.000	07	-0.036	0.000	0.92			8.9	OK	
4.001	08	-0.192	0.000	0.28			16.8	OK	
1.006	09	-0.003	0.000	0.92			49.5	OK	
5.000	10	-0.230	0.000	0.12			8.8	OK	
5.001	11	-0.220	0.000	0.16			8.9	OK	
1.007	12	-0.068	0.000	0.57			55.6	OK	
1.008	13	-0.027	0.000	1.00			52.9	OK	
1.009	14	-0.136	0.000	0.02			3.7	OK	
1.010	15	-0.336	0.000	0.02			3.7	OK	

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.011	16	360 Winter	2	+0%					2.930

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.011	16	-0.335	0.000	0.02			3.7	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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          Areal Reduction Factor 1.000   Additional Flow - % of Total Flow 0.000
                Hot Start (mins)     0        MADD Factor * 10m³/ha Storage 2.000
             Hot Start Level (mm)     0              Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
   Foul Sewage per hectare (l/s) 0.000

     Number of Input Hydrographs 0 Number of Storage Structures 1
       Number of Online Controls 1 Number of Time/Area Diagrams 0
      Number of Offline Controls 0 Number of Real Time Controls 0
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Synthetic Rainfall Details

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           Rainfall Model                         FEH
      FEH Rainfall Version                       2013
             Site Location GB 248217 132177 SS 48217 32177
                 Data Type                       Point
                Cv (Summer)                      0.750
                Cv (Winter)                      0.840

Margin for Flood Risk Warning (mm) 300.0      DVD Status OFF
                 Analysis Timestep  Fine Inertia Status OFF
                        DTS Status    ON

            Profile(s)                          Summer and Winter
        Duration(s) (mins)    30, 60, 120, 180, 240, 360, 480, 600, 720,
                                960, 1440, 2160, 2880, 4320, 5760, 7200,
                                                             8640, 10080
  Return Period(s) (years)                                     2, 30, 100
        Climate Change (%)                                       0, 0, 50
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PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	01	30 Winter	30	+0%	100/30 Summer				4.566
1.001	02	30 Winter	30	+0%	100/30 Summer				4.528
1.002	03	30 Summer	30	+0%	30/30 Summer				4.546
2.000	16	30 Summer	30	+0%					5.464
1.003	04	30 Summer	30	+0%	30/30 Summer				4.548
1.004	05	30 Summer	30	+0%	30/30 Summer				4.534
3.000	H07	30 Summer	30	+0%	30/30 Summer				5.315
1.005	06	30 Summer	30	+0%	30/30 Summer				4.504
4.000	07	30 Summer	30	+0%	30/30 Summer				5.347
4.001	08	30 Summer	30	+0%	100/30 Summer				4.935
1.006	09	30 Summer	30	+0%	30/30 Summer				4.402
5.000	10	30 Summer	30	+0%					5.402
5.001	11	30 Summer	30	+0%					5.199
1.007	12	30 Summer	30	+0%	30/30 Summer				4.201
1.008	13	480 Winter	30	+0%	30/30 Summer				4.095
1.009	14	480 Winter	30	+0%	30/120 Winter				4.094
1.010	15	1440 Summer	30	+0%					3.389

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	01	-0.234	0.000	0.09			5.2	OK	
1.001	02	-0.033	0.000	0.31			16.4	OK	
1.002	03	0.033	0.000	0.44			23.0	SURCHARGED	
2.000	16	-0.236	0.000	0.10			6.3	OK	
1.003	04	0.081	0.000	0.50			30.0	SURCHARGED	
1.004	05	0.219	0.000	0.66			38.9	SURCHARGED	
3.000	H07	0.165	0.000	1.88			18.0	SURCHARGED	
1.005	06	0.311	0.000	0.91			53.3	SURCHARGED	
4.000	07	0.197	0.000	1.82			17.6	SURCHARGED	
4.001	08	-0.131	0.000	0.60			35.6	OK	
1.006	09	0.324	0.000	1.87			101.1	SURCHARGED	
5.000	10	-0.198	0.000	0.25			18.2	OK	
5.001	11	-0.182	0.000	0.33			18.1	OK	
1.007	12	0.103	0.000	1.22			119.0	SURCHARGED	
1.008	13	0.070	0.000	0.42			22.3	SURCHARGED	
1.009	14	0.079	0.000	0.02			3.7	SURCHARGED	
1.010	15	-0.336	0.000	0.02			3.7	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.011	16	60 Summer	30	+0%					2.930

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.011	16	-0.335	0.000	0.03			3.8	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 248217 132177 SS 48217 32177
Data Type	Point
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2, 30, 100
Climate Change (%)	0, 0, 50

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	01	30 Winter	100	+50%	100/30 Summer				5.581
1.001	02	30 Winter	100	+50%	100/30 Summer				5.568
1.002	03	30 Winter	100	+50%	30/30 Summer				5.555
2.000	16	30 Winter	100	+50%					5.550
1.003	04	30 Winter	100	+50%	30/30 Summer				5.537
1.004	05	30 Winter	100	+50%	30/30 Summer				5.496
3.000	H07	30 Summer	100	+50%	30/30 Summer				6.000
1.005	06	30 Winter	100	+50%	30/30 Summer				5.423
4.000	07	30 Summer	100	+50%	30/30 Summer				6.044
4.001	08	30 Summer	100	+50%	100/30 Summer				5.259
1.006	09	30 Summer	100	+50%	30/30 Summer				5.139
5.000	10	30 Summer	100	+50%					5.448
5.001	11	30 Summer	100	+50%					5.254
1.007	12	960 Winter	100	+50%	30/30 Summer				4.594
1.008	13	960 Winter	100	+50%	30/30 Summer				4.592
1.009	14	960 Winter	100	+50%	30/120 Winter				4.591
1.010	15	1440 Summer	100	+50%					3.389

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	01	0.781	0.000	0.13			7.8	FLOOD RISK	
1.001	02	1.006	0.000	0.50			26.6	SURCHARGED	
1.002	03	1.041	0.000	0.59			31.2	SURCHARGED	
2.000	16	-0.150	0.000	0.18			10.8	OK	
1.003	04	1.070	0.000	0.76			45.4	SURCHARGED	
1.004	05	1.181	0.000	0.98			57.9	SURCHARGED	
3.000	H07	0.850	0.000	3.14			30.0	SURCHARGED	
1.005	06	1.230	0.000	1.61			94.8	SURCHARGED	
4.000	07	0.894	0.000	3.13			30.3	FLOOD RISK	
4.001	08	0.194	0.000	1.01			60.1	SURCHARGED	
1.006	09	1.061	0.000	3.13			169.3	SURCHARGED	
5.000	10	-0.152	0.000	0.48			35.1	OK	
5.001	11	-0.127	0.000	0.63			35.0	OK	
1.007	12	0.496	0.000	0.27			26.4	SURCHARGED	
1.008	13	0.567	0.000	0.50			26.3	FLOOD RISK	
1.009	14	0.576	0.000	0.02			3.7	FLOOD RISK	
1.010	15	-0.336	0.000	0.02			3.7	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.011	16	10080 Summer	100	+50%					2.930

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.011	16	-0.335	0.000	0.03			3.7	OK	

Annex 4: Water Quality

SIMPLE INDEX APPROACH: TOOL

SEPA Scottish Environment Protection Agency | HR Wallingford Working with water | ciria

1. The steps set out in the tool should be applied for each inflow or 'runoff area' (ie each impermeable surface area separately discharging to a SuDS component).

2. The supporting 'Design Conditions' stated by the tool must be fully considered and implemented in all cases.

3. The process that is automated in this tool is described in the SuDS Manual, Chapter 26 (Section 26.7)

3. Relevant design examples are included in the SuDS Manual Appendix C.

4. Each of the steps below are part of the process set out in the flowchart on Sheet 3.

5. Sheet 4 summarises the selections made below and indicates the acceptability of the proposed SuDS components.

6. Interception should be delivered for all upstream impermeable areas as part of the strategy for water quantity and quality control for the site. This is required in order to deliver both of the water quality criteria set out in Chapter 4 of the SuDS Manual

	DROP DOWN LIST	**RELEVANT INPUTS NEED TO BE SELECTED FROM THESE LISTS, FOR EACH STEP**
	USER ENTRY	**USER ENTRY CELLS ARE ONLY REQUIRED WHERE INDICATED BY THE TOOL**

STEP 1: **Determine the Pollution Hazard Index for the runoff area discharging to the proposed SuDS scheme**

This step requires the user to select the appropriate land use type for the area from which the runoff is occurring

If the land use varies across the 'runoff area', either:

- use the land use type with the highest Pollution Hazard Index

- apply the approach for each of the land use types to determine whether the proposed SuDS design is sufficient for all. If it is not, consider collecting more hazardous runoff separately and providing additional treatment.

If the generic land use types suggested are not applicable, select 'Other' and enter a description of the land use of the runoff area and agreed user defined indices in the row below the drop down lists.

	Runoff Area Land Use Description	*Hazard Level*	*Pollution Hazard Indices* Total Suspended Solids	Metals	Hydrocarbons	*DESIGN CONDITIONS* 1	2
Select land use type from the drop down list (or 'Other' if none applicable): →	Standard commercial yard or delivery area	Medium	0.7	0.6	0.7	This classification is not appropriate for haulage yards, lorry parks, waste management areas, or chemical storage/handling zones	
If the generic land use types in the drop down list above are not applicable, select 'Other' and enter a description of the land use of the runoff area and agreed user defined indices in this row:							
	Landuse Pollution Hazard Index	**Medium**	**0.7**	**0.6**	**0.7**		

STEP 2A: **Determine the Pollution Mitigation Index for the proposed SuDS components**

This step requires the user to select the proposed SuDS components that will be used to treat runoff - before it is discharged to a receiving surface waterbody or downstream infiltration component

If the runoff is discharged directly to an infiltration component, without upstream treatment, select 'None' for each of the 3 SuDS components and move to Step 2B

This step should be applied to evaluate the water quality protection provided by proposed SuDS components for discharges to receiving surface waters or downstream infiltration components (note: in England and Wales this will include components that allow any amount of infiltration, however small, even where infiltration is not specifically accounted for in the design).

If you have fewer than 3 components, select 'None' for the components that are not required

If the proposed component is bespoke and/or a proprietary treatment product and not generically described by the suggested components, then 'Proprietary treatment system' or 'User defined indices' should be selected and a description of the component and agreed user defined indices should be entered in the rows below the drop down lists

SuDS Component Description	*Pollution Mitigation Indices* Total Suspended Solids	Metals	Hydrocarbons	*DESIGN CONDITIONS* 1	2	3

Select SuDS Component 1 (i.e. the upstream SuDS component) from the drop down list: →	Pond or wetland		0.7	0.7	0.5	SuDS components can only be assumed to deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters of the SuDS Manual. See also checklists in Appendix B. Ponds/wetlands should be preceded by an upstream component(s) that trap(s) silt, or designed specifically to retain sediment in a separate zone, easily accessible for maintenance, such that the sediment will not be re-suspended in subsequent events
Select SuDS Component 2 (i.e. the second SuDS component in a series) from the drop down list: →	Proprietary treatment system	Enter User Defined Indices in row below				Detailed assessment of performance of designed component in reducing inflow concentrations of each pollutant type required as evidence of adopted indices. Enter indices approved by the environmental regulator in appropriate 'User Defined Indices' row below. SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution where there is a requirement to retrofit treatment. WAT-RM-08 (SEPA, 2014) also provides a flow chart with a summary of checks on suitability of a proprietary system. See Chapter 15 Proprietary treatment systems for approaches to demonstrate product performance. Note: a British Water/Environment Agency assessment Code of Practice is currently under development that will allow manufacturers to complete an agreed test protocol for systems intended to treat contaminated surface water runoff. Full details can be found at: http://www.britishwater.co.uk/Publications/codes-of-practise.aspx.
Select SuDS Component 3 (i.e. the third SuDS component in a series) from the drop down list: →	None		0	0	0	
If the proposed SuDS components are bespoke/proprietary and/or the generic indices above are not considered appropriate, select 'Proprietary treatment system' or 'User defined indices' and enter component descriptions and agreed user defined indices in these rows:			0.8	0.8	0.5	
		SuDS Component 2			0.5	
	Aggregated Surface Water Pollution Mitigation Index		**0.7**	**0.7**	**0.75**	Note: If the total aggregated mitigation index is > 1 (which is not a realistic outcome), then the outcome is fixed at ">0.95". In this scenario, the proposed components are likely to have a very high mitigation potential for reducing pollutant levels in the runoff and should be sufficient for any proposed land use (note: where risk assessment is required, this outcome would need more detailed verification).

Is the runoff now discharged to an infiltration component?

Yes ? Go to Step 2B
No ? Go to Step 2C

STEP 2B: Determine the Pollution Mitigation Index for the proposed Groundwater Protection

This step requires the user to select the type of groundwater protection that is either part of the SuDS component or that lies between the component and the groundwater

This step should be applied where a SuDS component is specifically designed to infiltrate runoff (note: in England and Wales this will include components that allow any amount of infiltration, however small, even where infiltration is not specifically accounted for in the design).

'Groundwater protection' describes the proposed depth of soil or other material through which runoff will flow between the runoff surface and the underlying groundwater.

Where the discharge is to surface waters and risks to groundwater need not be considered, select 'None'

If the proposed groundwater protection is bespoke and/or a proprietary product and not generically described by the suggested measures, then a description of the protection and agreed user defined indices should be entered in the row below the drop down list

DESIGN CONDITIONS

1	2	3	4

		Pollution Mitigation Indices		
		Total Suspended Solids	**Metals**	**Hydrocarbons**
Select type of groundwater protection from the drop down list: →	None			
If the proposed groundwater protection is bespoke/proprietary and/or the generic indices above are not considered appropriate, select 'Proprietary product' or 'User defined indices' and enter a description of the protection and agreed user defined indices in this row:				
	Groundwater Protection Pollution Mitigation Index	**0**	**0**	**0**

STEP 2C: **Determine the Combined Pollution Mitigation Indices for the Runoff Area**

This is an automatic step which combines the proposed SuDS Pollution Mitigation Indices with any Groundwater Protection Pollution Mitigation Indices

	Combined Pollution Mitigation Indices		
	Total Suspended Solids	**Metals**	**Hydrocarbons**
Combined Pollution Mitigation Indices for the Runoff Area	**0.7**	**0.7**	**0.75**

Note: If the total aggregated mitigation index is > 1 (which is not a realistic outcome), then the outcome is fixed at ">0.95". In this scenario, the proposed components are likely to have a very high mitigation potential for reducing pollutant levels in the runoff and should be sufficient for any proposed land use (note: where risk assessment is required, this outcome would need more detailed verification).

STEP 2D: **Determine Sufficiency of Pollution Mitigation Indices for Selected SuDS Components**

This is an automatic step which compares the Combined Pollution Mitigation Indices with the Land Use Hazard Indices, to determine whether the proposed components are sufficient to manage each pollutant category type

When the combined mitigation index exceeds the land use pollution hazard index, then the proposed components are considered sufficient in providing pollution risk mitigation.

In England and Wales, where the discharge is to protected surface waters or groundwater, an additional treatment component (ie over and above that required for standard discharges), or other equivalent protection, is required that provides environmental protection in the event of an unexpected pollution event or poor system performance. Protected surface waters are those designated for drinking water abstraction. In England and Wales, protected groundwater resources are defined as Source Protection Zone 1. In Northern Ireland, a more precautionary approach may be required and this should be checked with the environmental regulator on a site by site basis.

DESIGN CONDITIONS

Sufficiency of Pollution Mitigation Indices		
Total Suspended Solids	**Metals**	**Hydrocarbons**
Sufficient	**Sufficient**	**Sufficient**

Note: In order to meet both Water Quality criteria set out in the SuDS Manual (Chapter 4), Interception should be delivered for all impermeable areas wherever possible. Interception delivery and treatment may be met by the same components, but Interception requires separate evaluation.

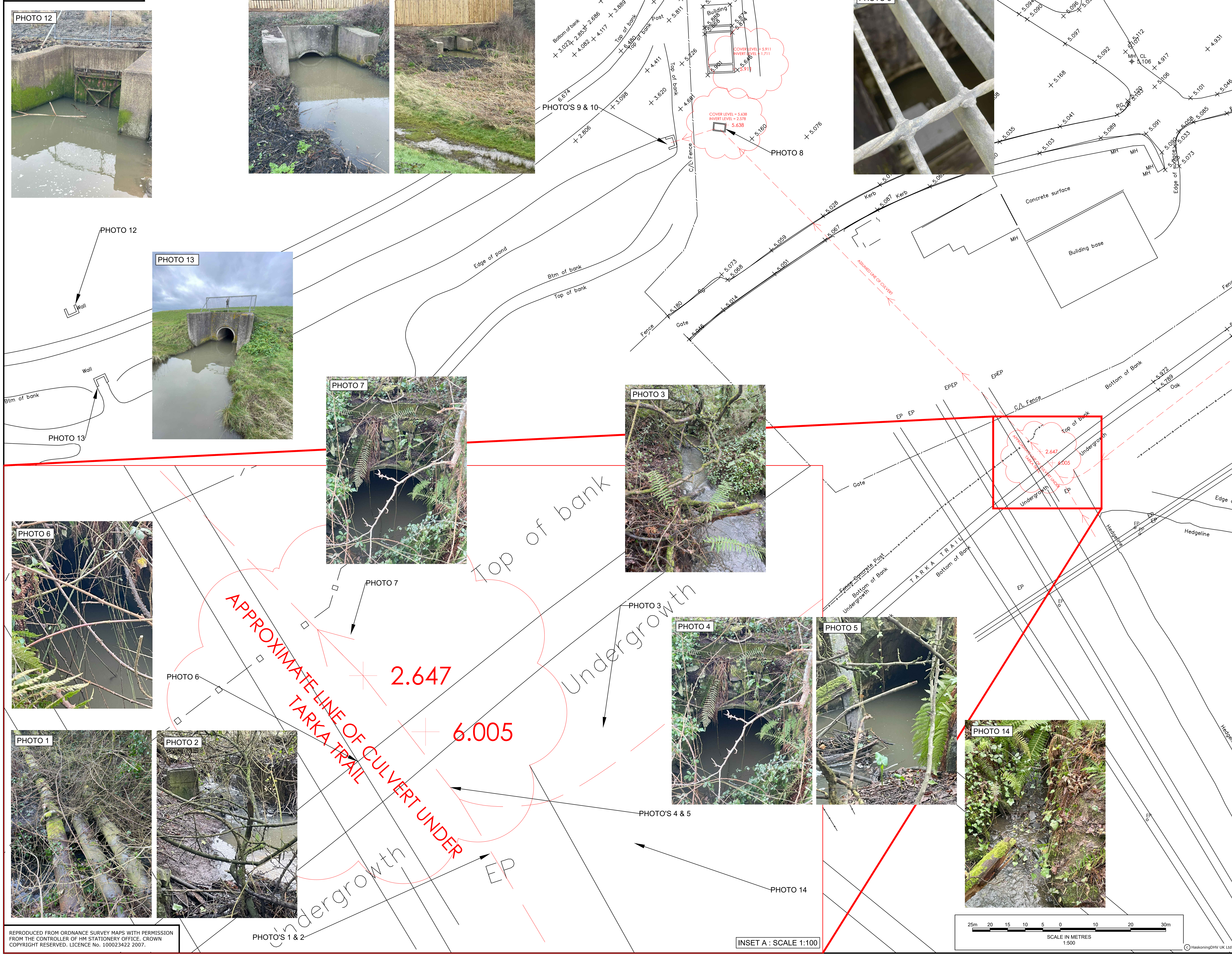
1

Reference to local planning documents should also be made to identify any additional protection required for sites due to habitat conservation (see *Chapter 7 The SuDS design process*). The implications of developments on or within close proximity to an area with an environmental designation, such as a Site of Special Scientific Interest (SSSI), should be considered via consultation with relevant conservation bodies such as Natural England

Annex 5: Surface Water Connectivity Plan

DRAWING No.
PC2978-RHD-ZZ-XX-DR-D-5001

DO NOT SCALE



NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE IN METRES ABOVE CHART DATUM UNLESS NOTED OTHERWISE.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS DRAWINGS AND PROJECT SPECIFICATION.
4. WORKS TO BE UNDERTAKEN IN ACCORDANCE WITH THE SPECIFICATION FOR HIGHWAYS WORKS (SHW) UNLESS NOTED OTHERWISE.
5. ALL DIMENSIONS AND LEVELS ARE TO BE VERIFIED AND CONFIRMED ON SITE PRIOR TO WORK COMMENCING.
6. ANY DISCREPENCIES TO OR OMISSIONS ARE TO BE REPORTED TO THE PROJECT MANAGER FOR FURTHER INSTRUCTIONS BEFORE COMMENCEMENT OF WORKS.

LEGEND

ASSUMED LINE OF CULVERT

PICTURES PRESENTED ARE FROM THE SITE WIDE VISIT CONDUCTED ON 08/02/2024

REV	DATE	DESCRIPTION	BY	CHK	APP
P01	09-02-24	FIRST ISSUE	SS	IO	DJ

REVISIONS

DRAWING STATUS
PRELIMINARY

CLIENT
WHITE CROSS OFFSHORE WIND LIMITED

PROJECT
WHITE CROSS WINDFARM

TITLE
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DRAWN	CHECKED	APPROVED
SS	IO	DJ
DATE: FEB 24	SCALE AT A1: 1:500	PROJECT NUMBER: PC2978

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