Erebus Floating Wind

Technical Appendix 19.4 Drainage Impact Assessment

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Revision History

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1. Introduction

1.1 Context

ITPEnergised (ITPE) has been appointed by Offshore Wind Consultants Limited (The Client) to undertake a Drainage Impact Assessment (DIA) to support a planning application for a substation as part of the onshore transmission works for Erebus Offshore Windfarm. The Site is located 1km south from the existing Pembroke Power Station, just north of Goldborough Road in Pembrokeshire, Wales.

This report assesses the increase in surface water runoff in accordance with sustainable drainage principles from the substation platform area in order to not increase flood risk to offsite receptors and ensure no deterioration of the water environment.

In addition to the above, a foul water drainage strategy has been included to detail how foul flows generated from the facilities on site will be managed.

1.2 Policy and Guidance

This assessment has been completed in accordance with guidance presented within Planning Policy Wales (PPW)[1], The National Strategy for Flood and Coastal Erosion Risk in Wales[2].

The assessment also references and takes due consideration (where appropriate) of the following principal guidance and policy documents:

- CIRIA (2004) Development and Flood Risk – Guidance for the Construction Industry, Report C624;
- CIRIA (2015) The SuDs Manual, Report C753;
- Pembrokeshire Local Development Plan (2018)
- Western Wales Flood Risk Management Plan (2015)
- Statutory Standards for Sustainable Drainage Systems – Designing, Constructing, Operating and Maintaining Surface Water Drainage Systems (2018)
- Sustainable Drainage (SuDS) Statutory Guidance 2019;

1.3 Site Location and Context

The site is located approximately 1km south of the existing Pembroke Power Station, on an unnamed road off Goldborough Road at approximate National Grid Reference (NGR): SM 93492 01457.

The existing site comprises farmland east of Thorntonloch Holdings and is accessed via the unnamed road off Goldborough Road. There is an existing wind turbine located on site which will be decommissioned prior the construction of the proposed development. The surrounding areas are primarily farmland and occasional farm buildings. The site is approximately 1.5km inland from the Pembroke River estuary to the northeast.

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[1] Planning Policy Wales can be found here: https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11_0.pdf

[2] The National Strategy for Flood and Coastal Erosion Risk in Wales can be found here: https://gov.wales/sites/default/files/publications/2021-03/the-national-strategy-for-flood-and-coastal-erosion-risk-management-in-wales.pdf

There is an existing minor watercourse along the south-western boundary of the site flowing to the south-east, which is a tributary to an unnamed watercourse, discharging to the Pembroke River estuary.

1.4 Proposed Development

The proposed development is for an onshore substation which will receive the electricity generated by the Erebus offshore windfarm for conversion and onward transmission on the national electricity transmission system. This proposal includes two substation layouts named AIS and GIS.

The proposed AIS substation layout requires a larger platform with an approximate area of 1.1ha. The proposed GIS substation layout has a platform area of approximately 0.7ha. Both platforms are designed to a formation level of 46.85mAOD.

At the time of writing of this report, both layout options are considered, therefore a DIA has been undertaken for both.

1.5 Topography

Review of the site topographic survey and freely available Lidar[3] data indicates that the site has a local high point at its north-western corner at approximately 49.22mAOD. There is a general fall across the site to the south. The southwestern and south-eastern borders of the site slope down steeply to approximately 40mAOD. The lowest topography is in the southwest of the site at approximately 39mAOD.

Details of the topography extents within the main site area can be found within the Drawing 001.

1.6 Geology and Hydrogeology

1.6.1 Geology

1.6.1.1 Superficial

Review of the British Geological Survey (BGS) online geology maps[4] indicates no records of superficial deposits for the area.

The bedrock geology at the site is entirely the Ridgeway Conglomerate Formation consisting of sedimentary rocks, ranging from coarse to fine grained.

1.6.2 Hydrogeology

Review of the BGS online hydrogeology maps indicates that the underlying bedrock geology is a low productivity aquifer layered with lower Devonian rocks, yielding small supplies.

1.7 Hydrological Context

1.7.1 Local Hydrology

A minor watercourse (referred to as “spring” throughout the report) is present at the south-western boundary of the site, flowing into an unnamed watercourse, discharging to the estuary.

No formal drainage is present on site and generally any runoff naturally sheds from the north-western high point of the site in all directions off site. There is a slight plateau area towards the

[3] https://remotesensingdata.gov.scot/data#/map (accessed 26th November 2020)
[4] British Geological Survey (2016) Natural Environment Research Council – online Geology of Britain Viewer, available at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html (accessed 26th November 2020)

eastern centre of the site where runoff from the high point to the north-west pond temporarily due to the gentle topography.

An overview of the local hydrology is presented on Drawing 001.

The point data shown below is taken from the FEH Web Service and the catchment of the unnamed watercourse adjacent to the site has been delineated from the NGR: SM 93443 01199. The average annual rainfall for the catchment is 1049mm per year.

Table 1 Hydrological Summary and Catchment Characteristics

Waterbody Catchment	BFIHOST[1]	BFIHOST19[2]	PROPWET[3]	SAAR[4]
SM 93443 01199	0.593	0.487	0.440	1049

[1]BFIHOST = Base Flow Index derived using UK Hydrology of Soil Types (Host) classification (released 1999)
[2]BFIHOST19 = Base Flow Index derived using UK Hydrology of Soil Types (Host) classification (released 2019)
[3]PROPWET = Proportion of Time the Soil Moisture Deficit (SMD) was equal to, or below, 6mm during 1961-1990
[4]SAAR = Standard Annual Average Rainfall

1.7.2 Greenfield Runoff

1.7.2.1 Pre-Development Greenfield Runoff Rates

Greenfield runoff rates have been estimated through application of methodology outline in IH R124 [5] (1994) as set out within the Interim Code of Practice (ICP) for catchment areas of 50ha or less.

The IH R124 method can be used to estimate Greenfield runoff release rates for a range of Annual Exceedance Probability (AEP) events, or return periods, by applying regional growth curve factors to the mean annual peak runoff (i.e. Qbar). The UK hydrological region for the Pembrokeshire area is Region 9, therefore the appropriate growth curve factors for this region have been incorporated into the analysis undertaken in the MicroDrainage (2020) software suite[6].

Greenfield runoff modelling results are presented below in Table 2 for a range of AEP storm events.

Table 2 Estimation of the Greenfield (Pre-Development) Rate of Runoff

AEP (%)	Return Period (1 in X Years)	Unit Greenfield Runoff Rate (l/s/ha)
50	2	2.6
QBAR		2.8
3.3	30	4.9
1	100	6.1
0.5	200	6.63
0.1	1000	8.9

[5] Institute of Hydrology Report No.124 (1994) (IH R124), Flood estimation for small catchments, June 1994
[6] MicroDrainage (2020), Innovyze Drainage Design and Modelling Software (Version 2020.1)

2. Surface Water Management Strategy

2.1 Sustainable Drainage Systems (SuDS)

To satisfy the requirements of current best national / local flood risk and surface water management guidance, SuDS are required to be incorporated into the design proposals to manage, attenuate and treat surface water runoff before discharging from the site.

Current best practice guidance relating to sustainable surface water management is outlined in the SuDS Manual (CIRIA Report C753) which provides details on the use of SuDS for managing surface water runoff.

There are four main categories of SuDS which are referred to as the 'four pillars of SuDS design' as depicted in Figure 1 below.

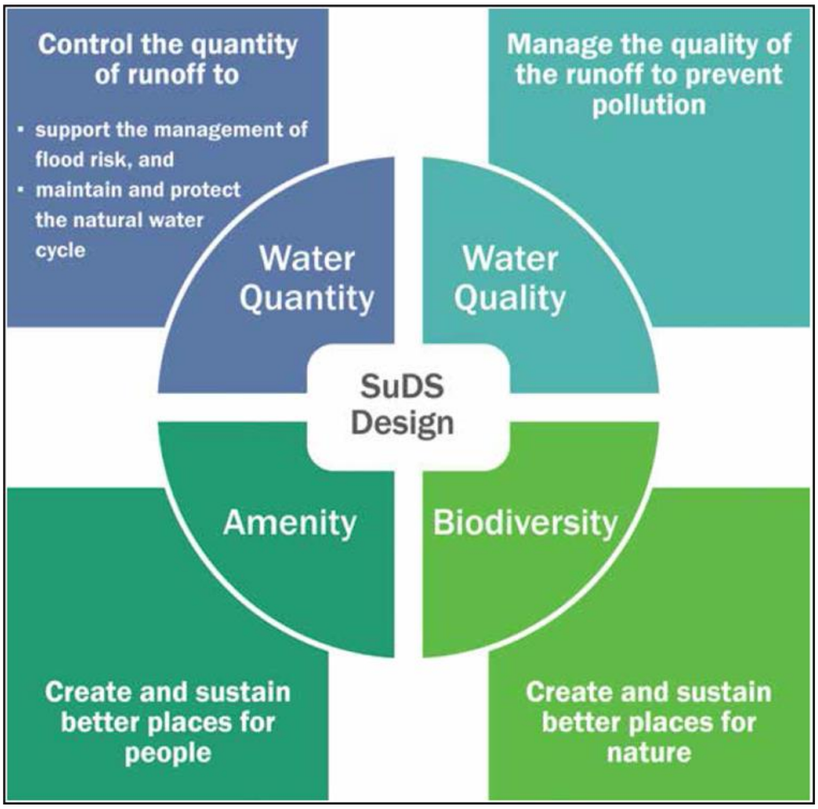


Figure 1 Four Pillars of SuDS (CIRIA Report C753)

The SuDS Manual identifies a hierarchy of SuDS for managing runoff, which is commonly referred to as a 'management train' as depicted in Figure 2.

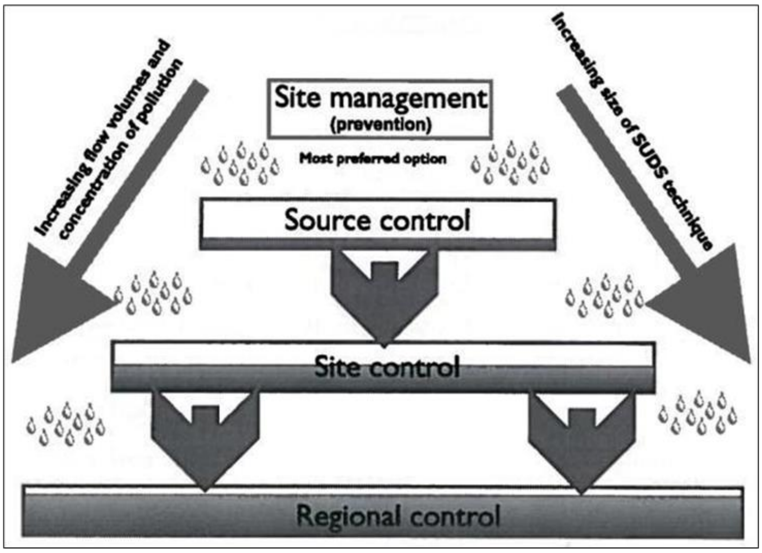


Figure 2 SuDS Management Train

- **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing).
- **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting, permeable paving and green roofs).
- **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one / several soakaways or attenuation ponds for the whole site).
- **Regional Control** – management of runoff from several sites, typically in a retention pond or wetland.

It is generally accepted that the implementation of SuDS as opposed to conventional drainage systems, provides several benefits by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;
- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open spaces and providing biodiversity and wildlife habitat enhancements; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

2.2 Design Overview

The management of surface water drainage from developed areas of the site will comprise a piped gravity network discharging to a proposed wetland then formally discharging to the existing spring at greenfield runoff rates.

2.3 Design Criteria

2.3.1 Proposed Surface Water Discharge Location(s)

In accordance with CIRIA Report C753, the hierarchy for favoured disposal options of surface water runoff from development sites is as follows:

1. Infiltration to Ground;
2. Discharge to Surface Waters; or
3. Discharge to Sewer.

Table 3 below discusses the disposal method suitability in the context of the site and proposed development.

Table 3 Suitability of Surface Water Disposal Methods

Surface Water Disposal Method	Suitability Description	Method Suitable? (Y/N)
Infiltration to Ground	Review of the online geology mapping indicate no superficial deposits present on site and the underling bedrock as conglomerate. Conglomerates are sedimentary rocks composed of coarse fragments held together by clastic matrix which makes them unsuitable for infiltration.	N
Surface Water Discharge	An unnamed spring is located along the south western boundary of the site to permit a gravity connection for surface water disposal.	Y
Sewer Discharge	There are no public sewers with the vicinity of the site due to its rural setting	N

Taking the above into account it is proposed that surface water runoff from the developed site is disposed of via the nearby unnamed spring through attenuated discharge.

2.3.2 Water Quantity

Current best practice for surface water management and SuDS Design (CIRIA Report C753) states the following with respect to the control of post development 'Peak Runoff Rates' and 'Runoff Volume' from 'greenfield' sites:

SuDS Manual (CIRIA Report C753) – Section 24.10.1:

"Additional runoff volumes from developments can cause increases in flood risk downstream of the site, even where peak flows from the site are controlled to greenfield rates.

Therefore, for extreme events, in addition to the standard for controlling the peak rate of runoff, there is also a standard that requires runoff volume control for the 1:100 year, 6 hour event. This is particularly critical for catchments that are susceptible to flooding downstream of the proposed development.

The difference in runoff volume between the development state and the equivalent greenfield (or possibly pre-development state where this is considered to be acceptable) is termed the Long-Term Storage Volume. It is this volume that should be prevented from leaving the site (via rainwater harvesting and/or infiltration) or, where this is not possible, controlled so that it discharges at very low rates that will have negligible impact on downstream flood risk. Only the greenfield (or pre-developed) runoff volume should be allowed to discharge at greenfield (or pre-developed) rates.

Where there is extra volume generated by the development that has to be discharged (because there are no opportunities for it to be infiltrated and/or used on site), this volume should be released at a very low rate (e.g. <2/l/s/ha or as agreed with the local drainage approving body and/or environmental regulator) and the 1:100 year greenfield allowable runoff rate reduced to take account of this extra discharge (Kellagher, 2002).

An alternative approach to managing the extra runoff volumes from extreme events separately from the main drainage system is to release all runoff (above the 1 year event) from the site at a maximum rate of 2 l/s/ha or Q_{BAR}, whichever is the higher value (or as agreed with the drainage approving body and/or environmental regulator). This avoids the need to undertake more detailed calculations and modelling.

Kellagher (2002) demonstrates that if discharges are not limited to less than 3 l/s/ha, the drainage system will generally not be effective at retaining sufficient water on the site to prevent an increase in flood risk in the receiving catchment. A discharge limit of 2 l/s/ha (or $Q_{BAR,}$ which allows for higher discharge rates for specific soil types) has generally been accepted as an appropriate industry standard in the UK, unless alternative site or catchment specific limits are agreed based on local risk evaluation."

Therefore, taking the above into account it is proposed to limit surface water discharge from the developed site area to the mean annual peak flood (i.e. Qbar) rate of runoff thus controlling the 'peak' discharge and discharge volume for all storm events up to and including the design 1:1000-year (0.1% AEP) event.

With reference to Table 2 the Qbar 'Unit Greenfield Runoff Rate' has been estimated to be **2.8 l/s/ha**. Multiplying this unit value by the total drained catchment area (**1.1 ha for AIS layout and 0.7ha for GIS layout**) provides the limiting post development peak runoff rate of **3.1l/s for AIS layout and 1.96l/s for GIS layout** for all storm events up to and including the design 0.1% AEP.

2.3.3 Water Quality Design Criteria

In accordance with CIRIA Report C753 it is necessary to undertake a 'Water Quality Risk Management' assessment to determine the suitability of SuDS methods from a water quality perspective. The approach outlined below is based on the 'Simple Index Approach' for groundwater and surface water as detailed in the SuDS Manual (Section 26.7).

Table 4 below compares the SuDS Mitigation Indices against the Pollution Hazard Indices for the proposed development. This is based on the application of a wetland as the proposed SuDS strategy to manage post development runoff from the Site. The pollution indices are based on the operational site land use. It is anticipated that surface water runoff from the hardstanding areas will be exposed to pollution from the buildings' roofing and infrequent non-residential parking of staff .

Table 4 SuDS Water Quality Design Criteria: Index Approach Review

Land Use	Pollution Hazard and SuDS Mitigation Indices Comparison					
	Total Suspended Solids (TSS)		Metals		Hydro-Carbons	
	Pollution Index	Mitigation Index	Pollution Index	Mitigation Index	Pollution Index	Mitigation Index
Non-residential parking with infrequent change	0.5	**0.7**	0.4	**0.7**	0.4	**0.5**
Roofing	0.2		0.2		0.05	

The *SuDS Mitigation Index* offered by the proposed SuDS is ≥ *Pollution Hazard Index* therefore the water quality assessment criteria are considered to be satisfied.

2.4 Proposed Surface Water Drainage Strategy

2.4.1 Overview

The proposed SuDS approach is for surface water runoff from the impervious areas of the development to be conveyed by a piped network to a proposed SuDS wetland. Surface water runoff will be suitably attenuated (up to 0.1% AEP) within the wetland prior to discharging to the existing spring adjacent to the site at greenfield runoff rates.

Drawings 002 and 003 provides an overview of the proposed drainage strategy and 004 provides typical SuDS design details.

2.4.2 SuDS Outline Performance Analysis

The key outline design parameters for the proposed wetland is as follows:

- Total Depth – 2.5m
- Permanent Water Depth – 0.5m
- Freeboard – 0.3m
- Surface Area – 1160m^2
- 0.1% AEP Design event
- Limiting Discharge – 3.1 l/s for AIS layout and 1.96 l/s for GIS layout (provided by the inclusion of a Hydrobrake Optimum (or similar)

Using the above design details the proposed wetland has been modelled using the MicroDrainage software suite and the results are presented in Table 5 below. The results are presented for the AIS layout which is the worst case in terms of total impermeable area. The 0.1% AEP results for the GIS layout are presented for comparison.

Table 5 Hydraulic Modelling Performance of Provisional SuDS Deign

Annual Probability (%)	Max. Water Depth (m)	Freeboard Allowance (mm)	Max Outflow Rate (l/s)	Maximum Stored Volume (m^3)
50	0.506	1494	2.3	238.1
3.3	0.912	1088	2.3	490.1
1	1.130	870	2.4	650.7
0.5	1.269	731	2.5	762.5
0.1	1.630	370	2.8	1091
For GIS Layout (0.1% AEP most extreme case only)				
0.1	1.212	788	1.6	715.4

Notes – Max Water Depth is water depth above the permanent water level in the wetland. The freeboard is calculated based on permanent water depth and stored water

A copy of the Micro Drainage modelling results is included within Appendix B.

As an added precaution, it is suggested that a high level overflow pipe (min 100mm diameter) is installed into the Hydrobrake chamber to provide continuity in the unlikely event the Hydrobrake becomes blocked. This will allow the drainage system to remain functional until the blockage is removed. The Hydrobrake diameter for the GIS layout is 57mm and 71mm for the AIS layout.

3. Foul Water Management Strategy

3.1 Overview

Under Natural Resources Wales' (NRW) Additional Guidance for Water Discharge and Groundwater, site foul flows have been designed for discharging to the existing spring at the south-western boundary of the site. NRW's order of preference for means of discharge are:

- Connect to a public sewer;
- Discharge to land; and
- Discharge to watercourse.

Connection to a public sewer is not viable due to the rural setting of the site and no public sewers present within the immediate vicinity.

Therefore, the proposed foul water drainage strategy is to collect foul flows from the proposed facilities via conventional piped drainage and collectively passed through a packaged treatment plant providing a secondary level of treatment. An initial overview is provided in Drawing 002 and 003 and further design details presented in the following section.

3.2 Treatment & Discharge

Both the AIS and GIS substation layouts include offices, storage rooms and operational rooms within the site. Both substation layouts will be served by a single toilet facility. The loading to the proposed sewage treatment system is based on the permanent and part-time staff present at the substation. At the time of writing of this report, the final number of staff (both permanent and temporary) that will be present at the operational substation is not confirmed. Given the size of the two layouts, a conservative assumption of 10 permanent and 10 part-time staff is considered in order to estimate the foul discharge loadings. These are presented in and are based on British Water's Flow and Loads – 4 document.

Parameter	Units	Value	Notes
Population Equivalent	No. persons	10 permanent and 10 part-time	Conservative assumption
Loading	l/pp/day	90 for permanent 45 for part-time	Based on "Codes of Practice Flow and Loads – 4 (2013)"
Total Loading	l/s	0.016	p.e. x loading per person

In order to achieve appropriate dilution rates, the installation of a high performance commercial Klargester BioDisc BD (or similar proprietary system) is proposed, which will provide secondary treatment to the effluent. It is proposed that the flow, post secondary treatment, is discharged to the same unnamed spring as the surface water which flows into a larger watercourse (with an catchment area of of 1.61km^2), 100m downstream.

The BioDisc is a high-performance package treatment plant that will produce effluents qualities to mee NRW's requirements. The BioDisc BD package treatment plants can provide primary and secondary treatment to up to 25 permanent and/or temporary staff for both substation layouts.

4. Maintenance Plan

4.1 Overview

To ensure the proposed surface water and foul water management strategies perform at its design operation requirements, drainage components should be inspected and maintained throughout the life of the development. Regular inspection / maintenance will ensure efficient operation and prevent potential failure of drainage components.

The following draft maintenance plan has been developed from best practice guidance, information provided in the CIRIA Report C753 and manufacturer's guidelines.

All drainage components will be retained under private ownership, with the Client (Woodlands Park Lodges Ltd.) remaining responsible for ongoing maintenance. This draft maintenance schedule will be integrated into the overall site operating and maintenance strategy and tailored / refined over time.

4.2 Maintenance Program

4.2.1 SuDS Pond

Table 6 below provides the inspection and maintenance recommendations set out in Table 22.1 of the CIRIA Report C753.

Table 6 SuDS Pond Maintenance Requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly
	Cut the meadow grass	Half yearly
	Inspect marginal and bankside vegetation and remove nuisance plants (for first 3 years)	Monthly (at start, then as required)
	Inspect inlets, outlets, banksides, pipework for evidence of blockage and damage	Monthly
	Inspect for signs of poor water quality	Monthly
	Inspect silt accumulation	Half yearly
	Inspect outlet and Hydrobrake manhole for debris / blockages	Monthly
	Hand cut submerged and emergent aquatic plants	Annually
	Remove 25% of bank vegetation from water's edge	Annually
	Tidy dead growth before start of growing season	Annually

Maintenance Schedule	Required Action	Typical Frequency
Occasional Maintenance	Remove sediment from the main body of pond	As required (likely only every 25-50 years with effective pre-treatment)
Remedial Actions	Repair erosion or other damage	As required
	Replant, where necessary	As required
	Aerate pond if signs of eutrophication are detected	As required
	Repair inlets or outlets	As required

5. Conclusions

ITPEnergised (ITPE) has been appointed by OWC to undertake a Drainage Assessment to the Environmental Impact Assessment for Erebus – Wales Floating Wind.

A Surface Water Management Strategy has been proposed which demonstrates that surface water runoff from the impermeable areas of both proposed substation layouts be managed via a piped network, discharging to the proposed wetland area for all storm events up to and including the design 0.1% AEP.

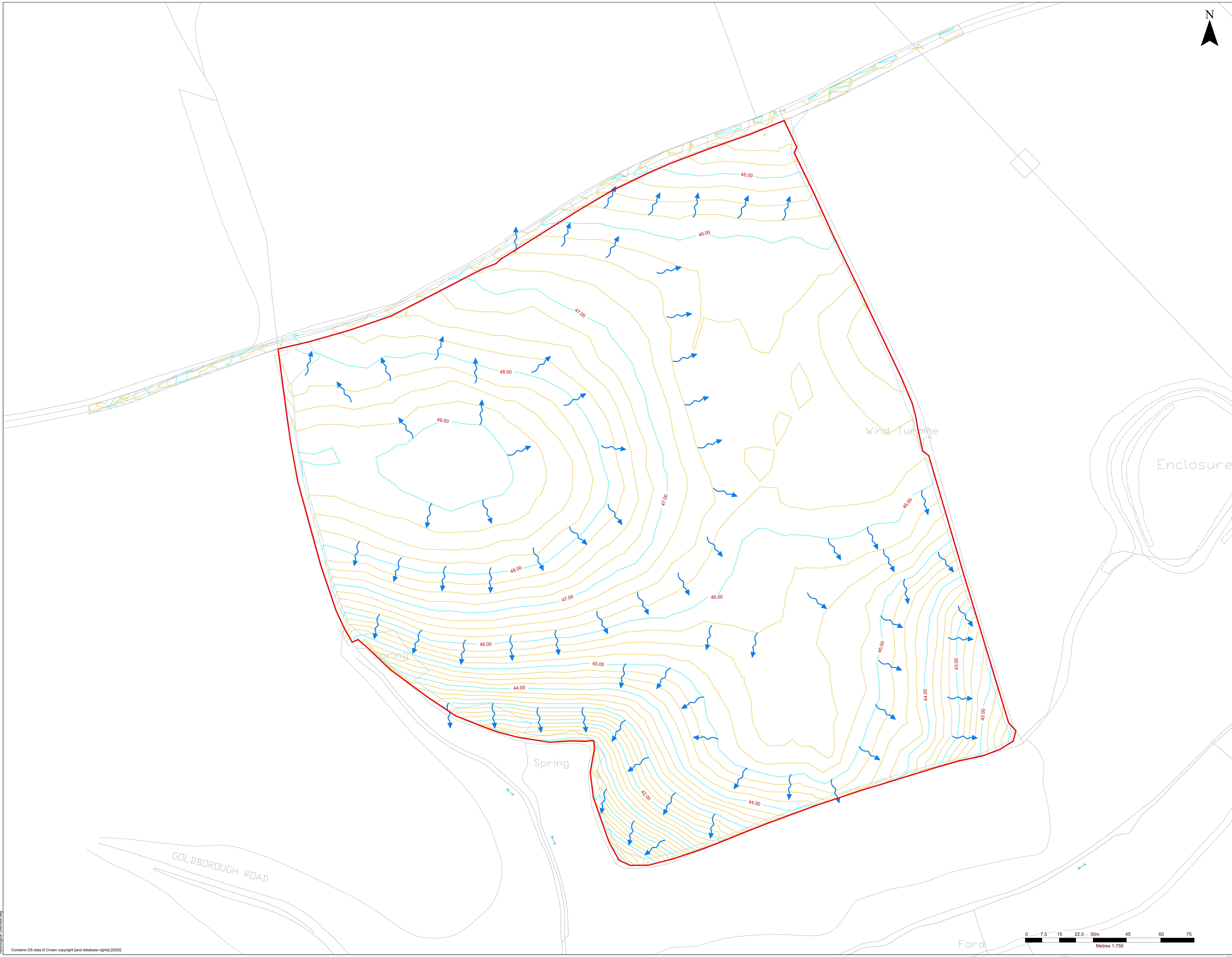
The surface water management design presented at this stage demonstrates that adequate SuDS space provision is afforded within the concept design and both proposed (potential) schemes are feasible and compliant to appropriate best practice and regulatory requirements. Notwithstanding, the final drainage / SuDS arrangements and layout will be confirmed at the next development stages.

Additionally, foul drainage arising from the proposed development has also been incorporated into the site designs and details presented in this assessment. Essentially, the foul water arisings will be managed through conventional gravity sewers, treated via a Klargester Bio Disc (or similar) to two levels of treatment prior to discharge to the existing spring.

The drainage designs (foul and surface water) presented at this stage should be considered provisional and subject to optimisation / refinement as the development stages progress, notwithstanding the overring design concept / principles would remain throughout the development.

Taking all of the above into account it is considered there are no overriding impediments to the development being granted planning permission on the grounds of surface and foul water drainage provisions.

Drawings



Hydrological Overview.dwg

NOTES

1. SITE ELEVATIONS BASED ON TOPO SURVEY PLAN PROVIDED BY WAYNE EVANS SURVEYING, DATED 10/04/21.

LEGEND

- SITE BOUNDARY
- EXISTING OVERLAND FLOW ROUTES
- MAJOR CONTOUR
- MINOR CONTOUR

REV	DATE	DESCRIPTION	BY	CHK
01	09/21	INITIAL ISSUE	KI	SD

CLIENT:
OWC

PROJECT:
EREBUS - WALES FLOATING WIND

DRAWING TITLE:
HYDROLOGICAL OVERVIEW

SCALE:
1:750 @ A1

DATE:
SEPTEMBER 2021

DRAWING NUMBER:
2923-DIA-001

REV:
01

DRAWING STATUS:
FOR INFROMATION ONLY

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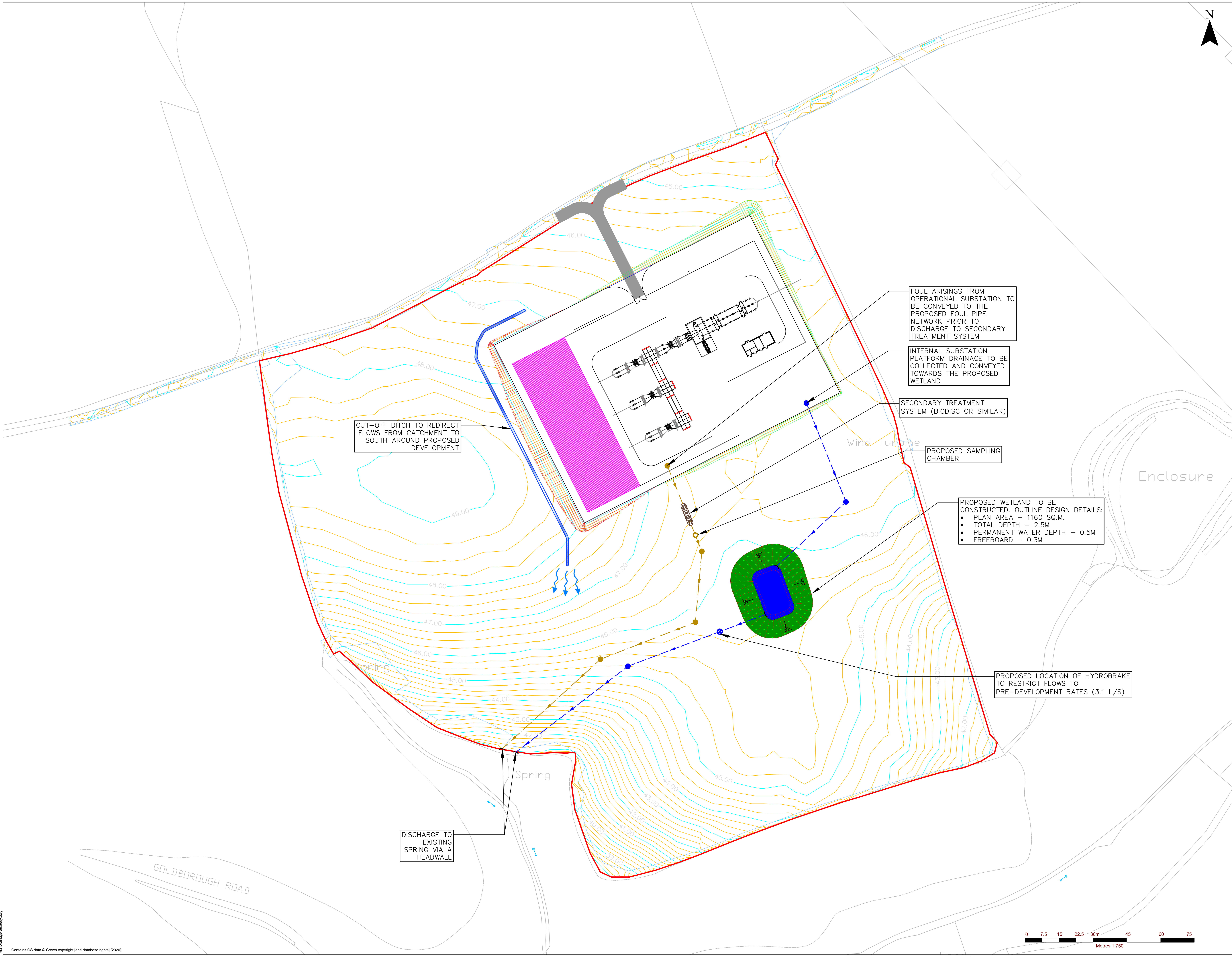

NOTES

1. SITE LAYOUT BASED ON TOPO SURVEY PLAN' PROVIDED BY WAYNE EVANS SURVEYING, DATED 10/04/21.
2. DESIGN SHOWN SHOULD BE CONSIDERED PROVISIONAL OUTLINE DETAIL. FINAL LEVELS, GRADIENTS, ALIGNMENTS AND DETAILS TO BE CONFIRMED AT DETAILED DESIGN STAGE.
3. SUDS DETAILS AND CONSTRUCTION DETAILS ARE SHOWN IN DRAWINGS 2923-DIA-004 AND 005

LEGEND

- SITE BOUNDARY
- PROPOSED VEGETATED WETLAND
- PROPOSED SURFACE WATER PIPEWORK
- PROPOSED FOUL WATER PIPEWORK
- PROPOSED CUT-OFF DITCH
- PROPOSED FLOW CONTROL VIA HYDROBRAKE
- PROPOSED SURFACE WATER MANHOLE
- PROPOSED FOUL WATER MANHOLE
- PROPOSED FOUL WATER INSPECTION CHAMBER

REV	DATE	DESCRIPTION	BY	CHK
01	09/21	INITIAL ISSUE	KI	SD

CLIENT:
OWC

PROJECT:
EREBUS - WALES FLOATING WIND

DRAWING TITLE:
AIS SUBSTATION
OUTLINE DRAINAGE STRATEGY

SCALE: 1:750 @ A1
DATE: SEPTEMBER 2021

DRAWING NUMBER: **2923-DIA-002**
REV: **01**

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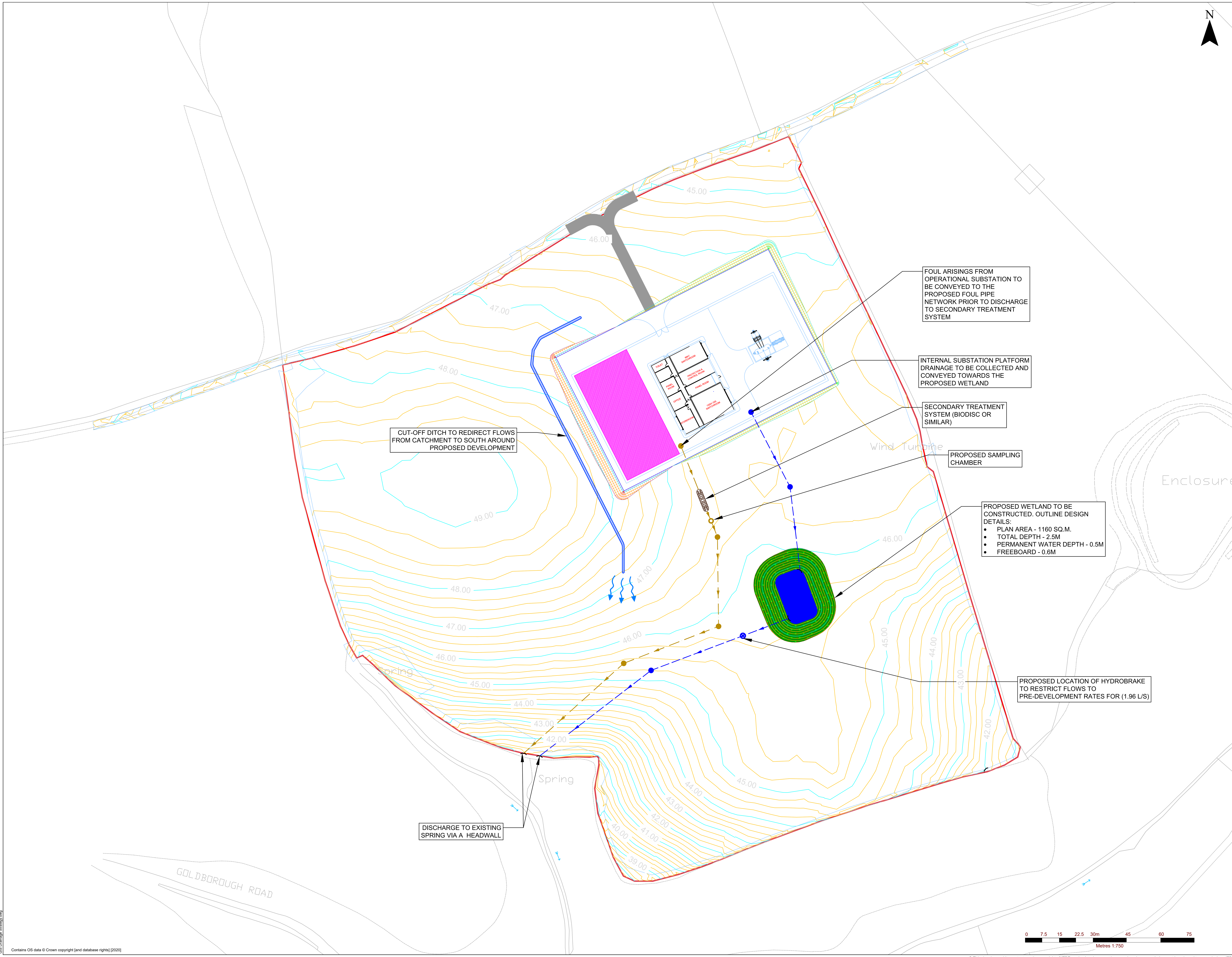

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- SITE BOUNDARY
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- PROPOSED SURFACE WATER PIPEWORK
- PROPOSED FOUL WATER PIPEWORK
- PROPOSED CUT-OFF DITCH
- PROPOSED FLOW CONTROL VIA HYDROBRAKE
- PROPOSED SURFACE WATER MANHOLE
- PROPOSED FOUL WATER MANHOLE
- PROPOSED FOUL WATER INSPECTION CHAMBER

REV	DATE	DESCRIPTION	BY	CHK
01	09/21	INITIAL ISSUE	KI	SD

CLIENT:
OWC

PROJECT:
EREBUS - WALES FLOATING WIND

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GIS SUBSTATION OUTLINE DRAINAGE STRATEGY

SCALE: 1:750 @ A1

DATE: SEPTEMBER 2021

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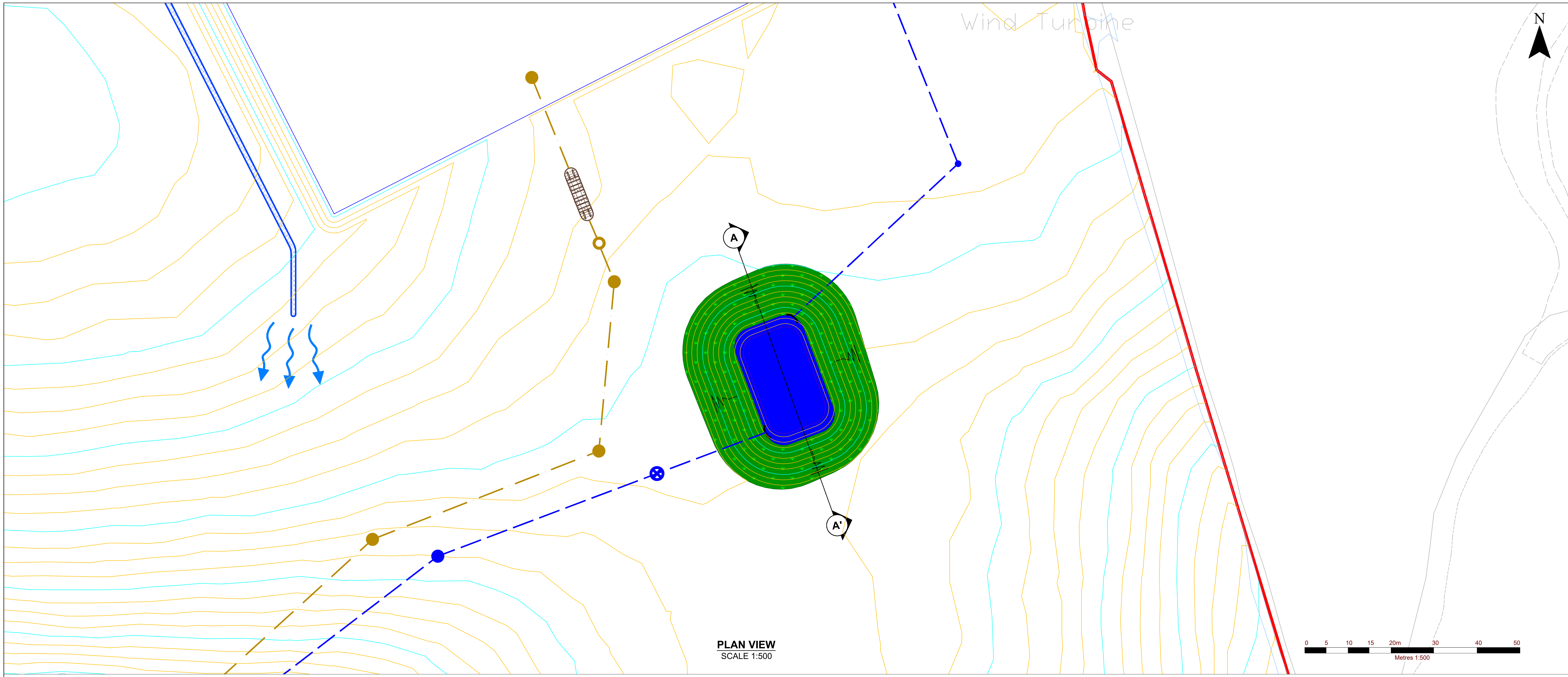
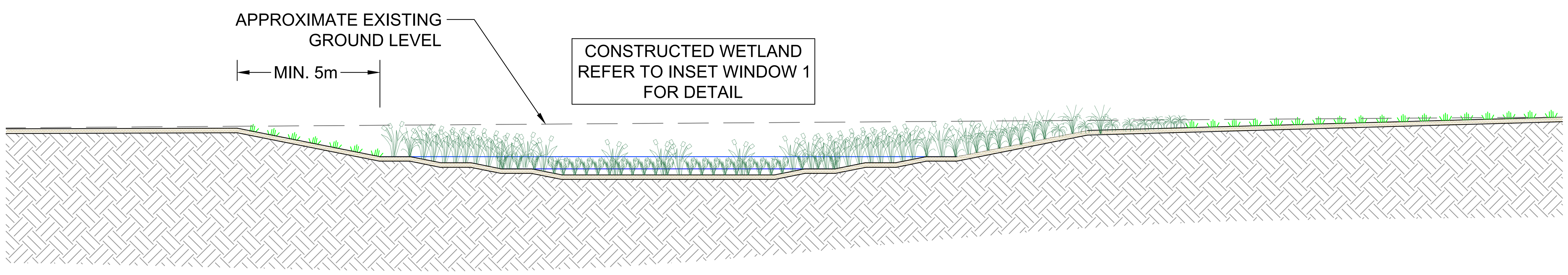
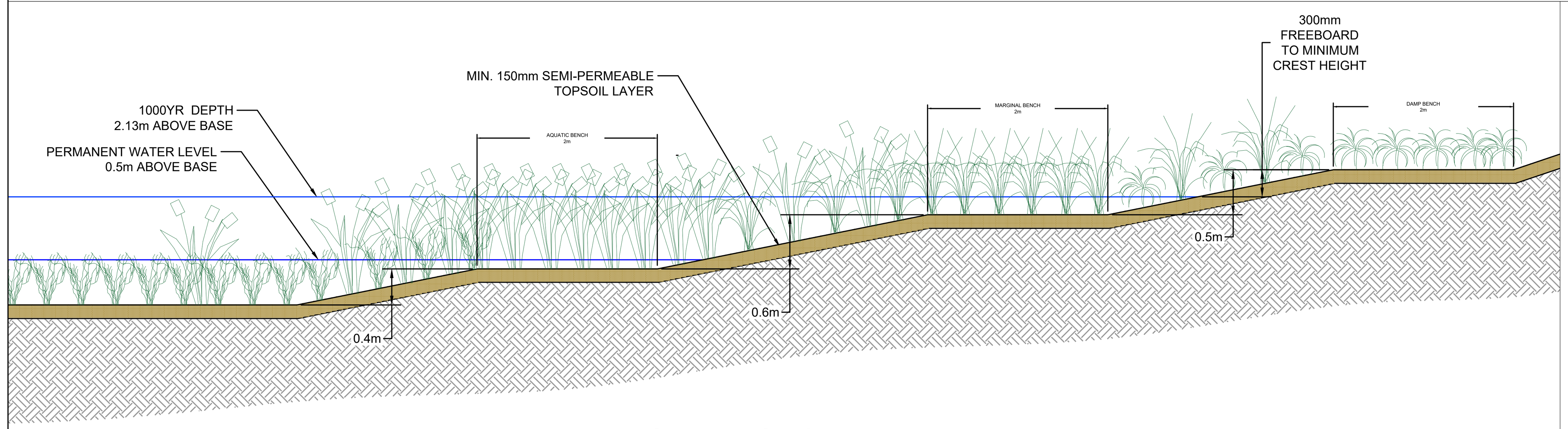


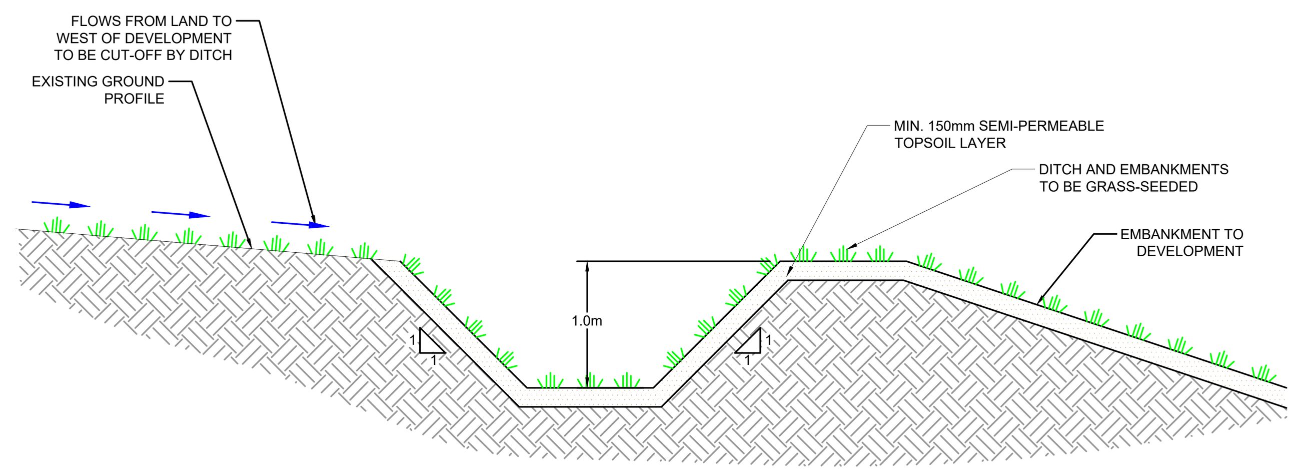
PLAN VIEW
SCALE 1:500



SECTION A-A'
SCALE 1:100



INSET WINDOW 1
SCALE 1:50



TYPICAL SECTION THROUGH PERIMETER CUT-OFF DITCH
1:50

NOTES

1. REFER TO DRAWING DIA-002 AND 003 FOR PROPOSED DRAINAGE STRATEGY
2. REFER TO DRAWING DIA-005 FOR PRELIMINARY CONSTRUCTION DETAILS
3. DESIGN SHOWN SHOULD BE CONSIDERED PROVISIONAL OUTLINE DETAIL. FINAL LEVELS, GRADIENTS, ALIGNMENTS AND DETAILS TO BE CONFIRMED AT DETAILED DESIGN STAGE.

LEGEND

- PROPOSED VEGETATED SWALE / WETLAND
- PROPOSED SURFACE WATER PIPEWORK
- PROPOSED FOUL WATER PIPEWORK
- PROPOSED FLOW CONTROL VIA HYDROBRAKE
- PROPOSED SURFACE WATER MANHOLE
- PROPOSED FOUL WATER MANHOLE
- PROPOSED FOUL WATER INSPECTION CHAMBER

REV	DATE	DESCRIPTION	BY	CHK
01	09/21	INITIAL ISSUE	KI	SD

CLIENT: OWC

PROJECT: EREBUS - WALES FLOATING WIND

DRAWING TITLE: **PRELIMINARY SUDS DETAILS FOR AIS AND GIS LAYOUTS**

SCALE: AS SHOWN

DATE: SEPTEMBER 2021

DRAWING NUMBER: **2923-DIA-004**

REV: **01**

DRAWING STATUS: FOR INFORMATION ONLY

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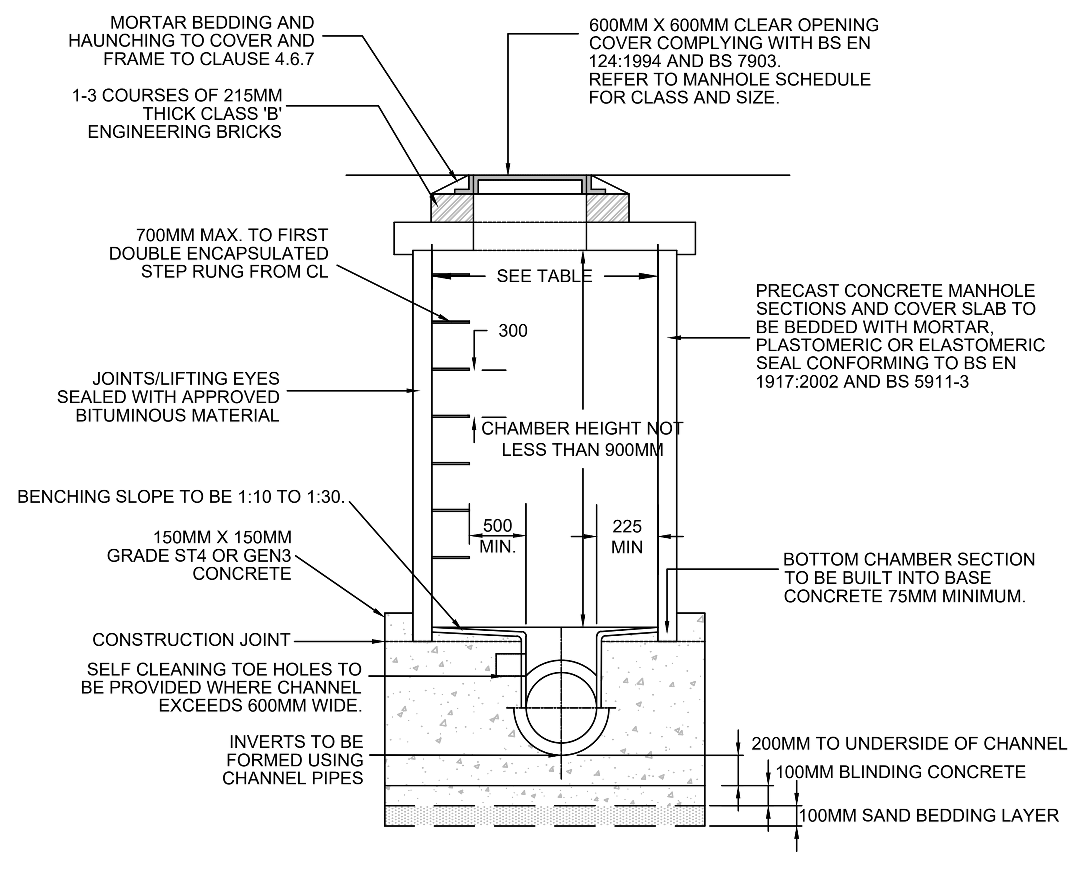
www.itpenergised.com

suds Details.dwg

NOTES

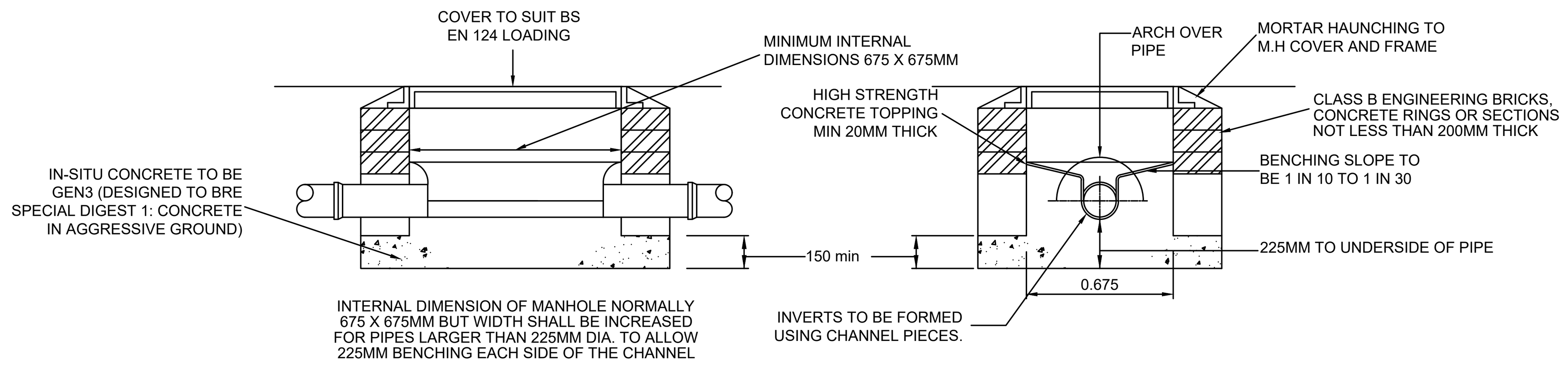
1. DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER SCHEME DRAWINGS.
2. ALL DRAINAGE TO BE CONSTRUCTED IN ACCORDANCE WITH SEWERS FOR SCOTLAND AND / OR THE SCOTTISH TECHNICAL HANDBOOK WHERE REQUIRED.
3. REFER TO DRAWINGS DIA-002 AND 003 FOR PROPOSED DRAINAGE STRATEGY.
4. DRAINAGE INFRASTRUCTURE TO BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS AND INSTRUCTIONS.
5. DESIGN SHOULD BE CONSIDERED PROVISIONAL OUTLINE DETAIL. FINAL LEVELS, GRADIENTS, EXACT ALIGNMENTS AND DETAILS TO BE CONFIRMED AT LATER DESIGN STAGES.



TYPICAL MANHOLE DETAIL - TYPE B

For max. depth from cover to pipe invert of 3.0m

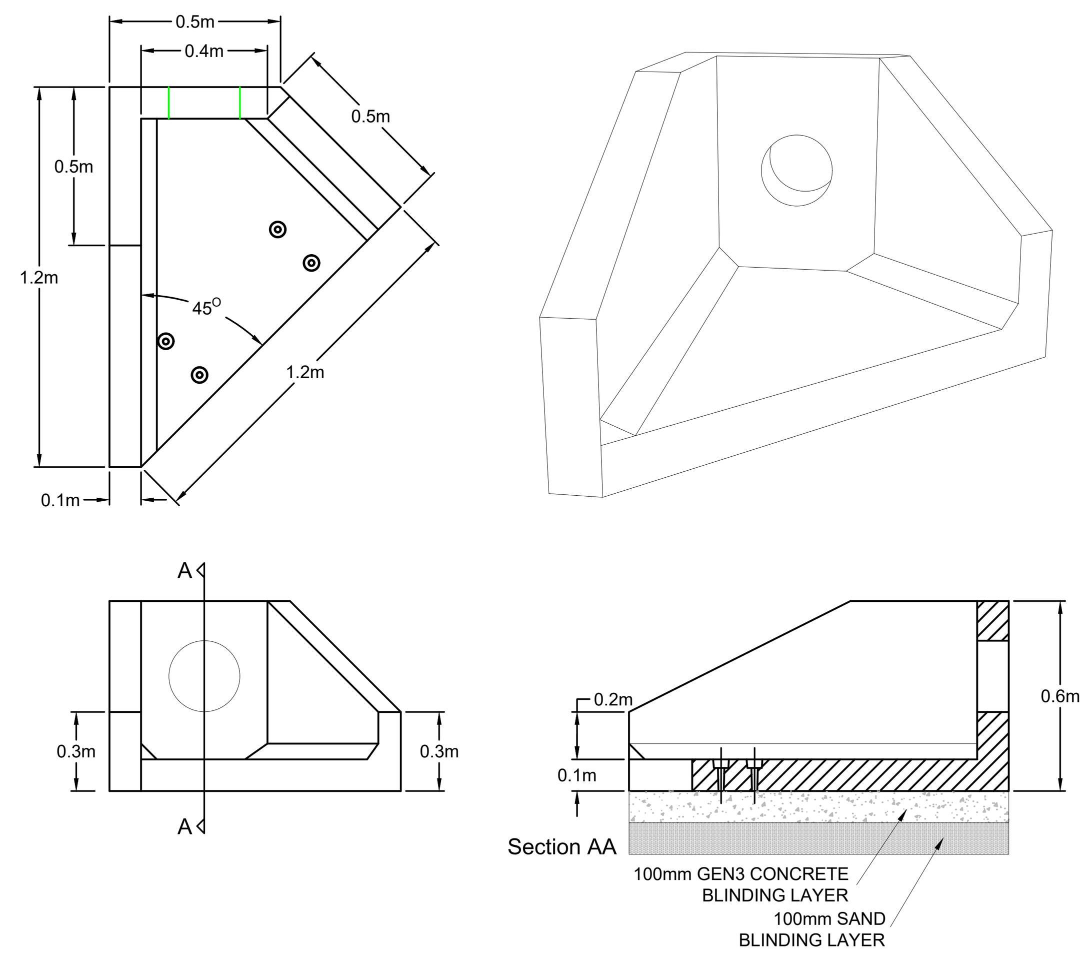
N.T.S.



TYPICAL MANHOLE DETAIL - TYPE C

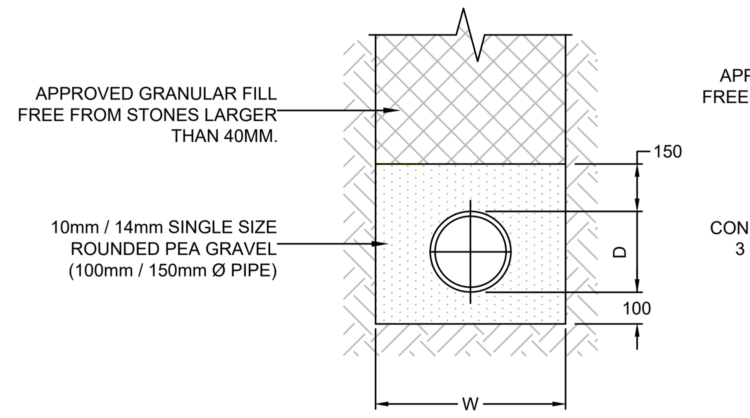
MAXIMUM DEPTH FROM COVER LEVEL TO SOFFIT OF PIPE 1.5M

NTS



PRECAST CONCRETE ANGLED OUTLET HEADWALL - UP TO 300mm Ø (ALTHON A4CA LH OR SIMILAR)

1:20

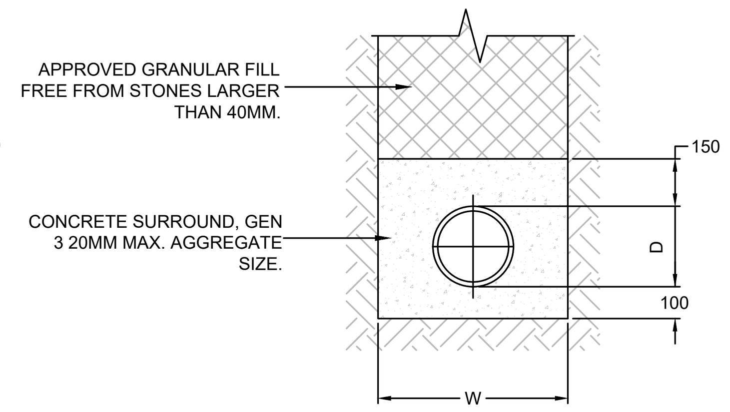


CLASS 'S' PIPE BEDDING & BACKFILLING DETAIL

SCALE 1:20

PIPES WHERE COVER TO CROWN IS GREATER THAN 1200MM UNDER ROADS AND FOOTPATHS

TRENCH DIMENSIONS					
D	100	150	225	300	375
W	450	600	700	850	1050

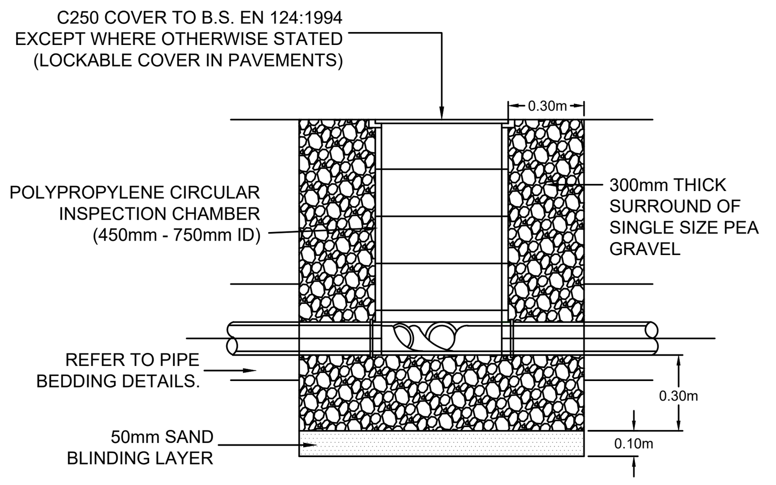


CLASS 'Z' PIPE BEDDING & BACKFILLING DETAIL

SCALE 1:20

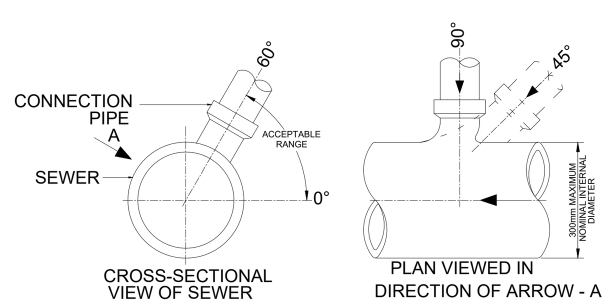
PIPES WHERE COVER TO CROWN IS LESS THAN 1200MM UNDER ROADS AND FOOTPATHS

NOTE: PROVIDE FULL DEPTH FLEXIBLE JOINTS @ 5000MM CENTRES MAX. USING 18MM THK. COMPRESSIBLE FIBREBOARD, PRE-CUT TO PIPE DIA.



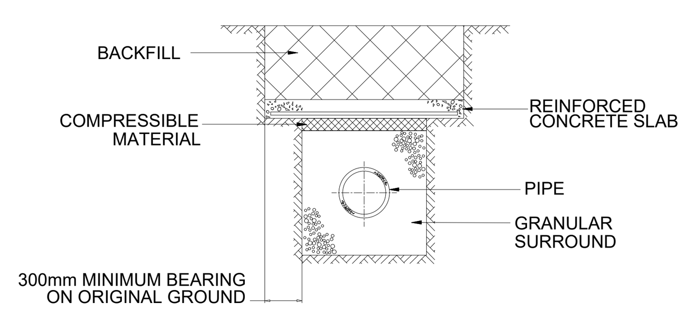
TYPICAL INSPECTION CHAMBER DETAIL (GRAVEL SURROUND - NON-TRAFFICKED AREAS)

1:25



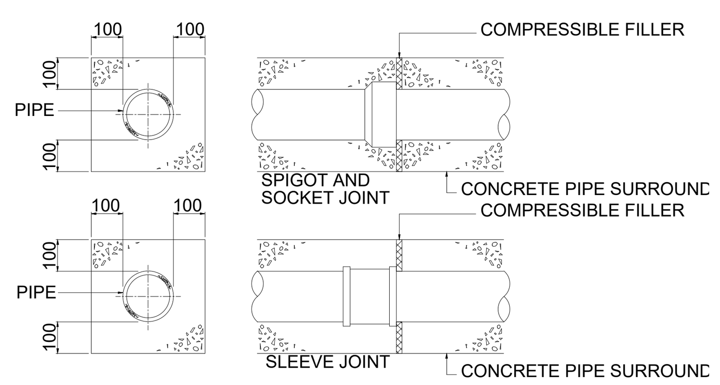
BRANCH SEWER CONNECTION DETAIL

NOT TO SCALE



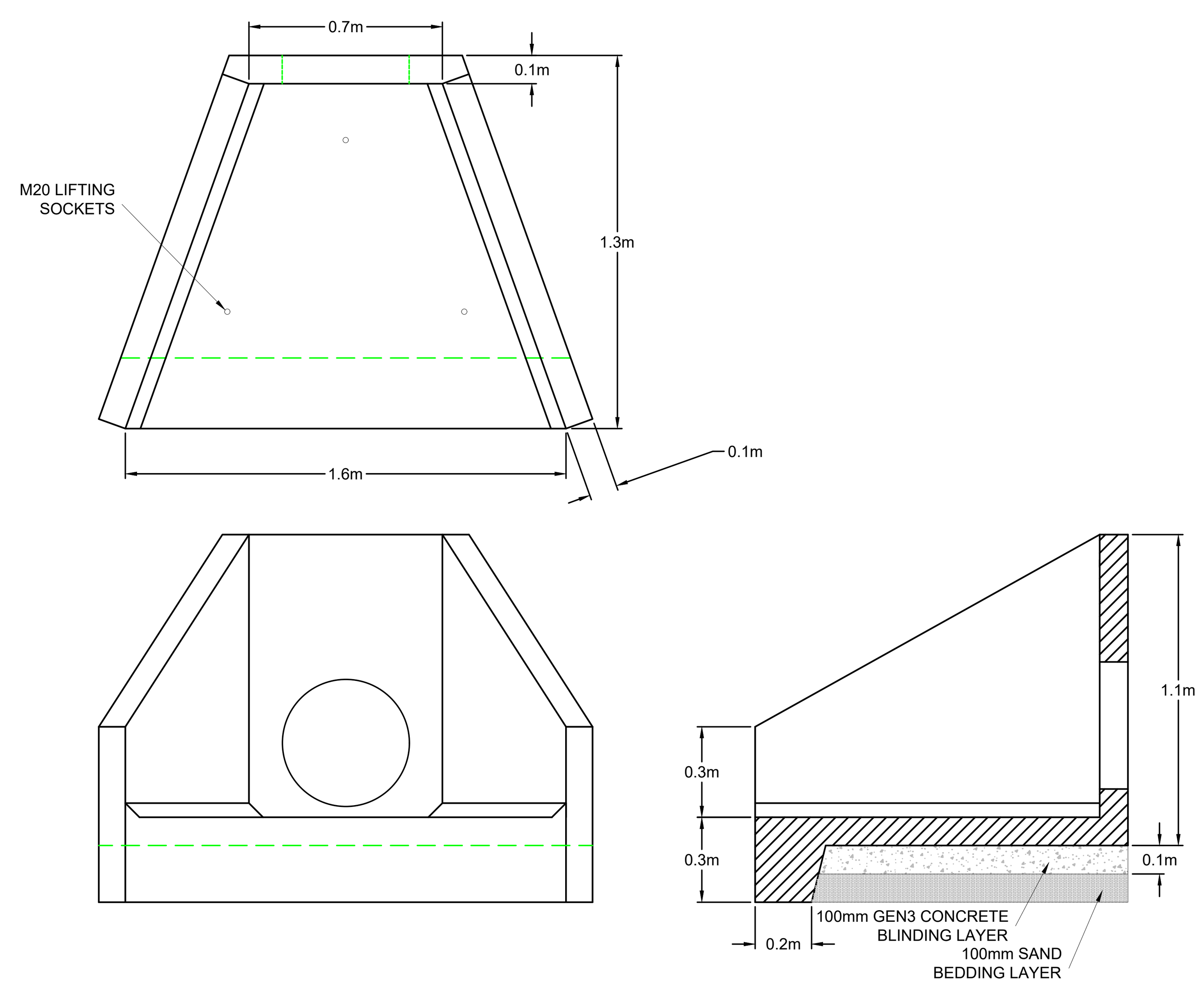
ALTERNATIVE PIPE PROTECTION DETAIL

NOT TO SCALE



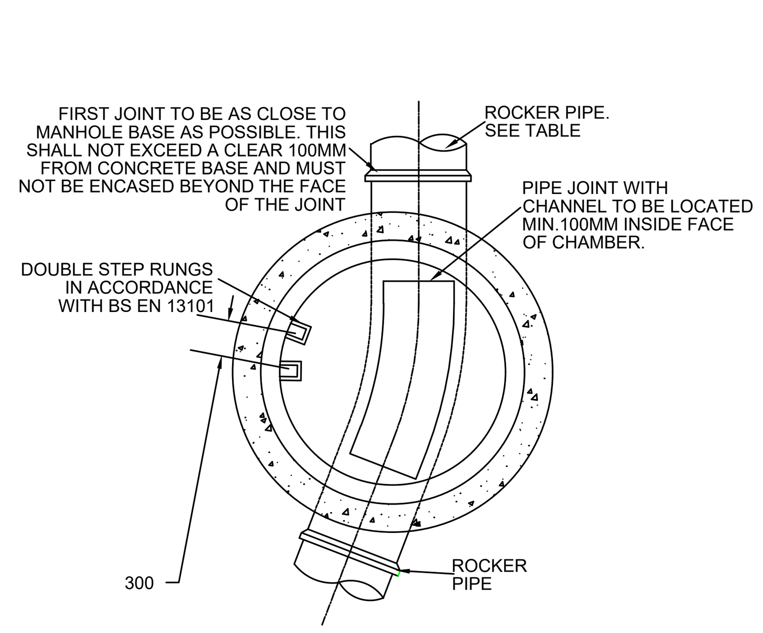
JOINTS FOR CONCRETE ENCASED PIPES

NOT TO SCALE



PRECAST CONCRETE INLET HEADWALL - UP TO 600mm Ø (ALTHON H6CA OR SIMILAR)

1:20



PLAN ON MANHOLE

N.T.S.

NOTE: RIGID PIPES BUILT INTO MANHOLES SHALL HAVE A FLEXIBLE JOINT AS CLOSE AS FEASIBLE TO THE EXTERNAL FACE OF THE STRUCTURE AND THE LENGTH OF THE NEXT ROCKER PIPE SHALL BE AS IN THE TABLE BELOW

MIN ROCKER PIPE LENGTH

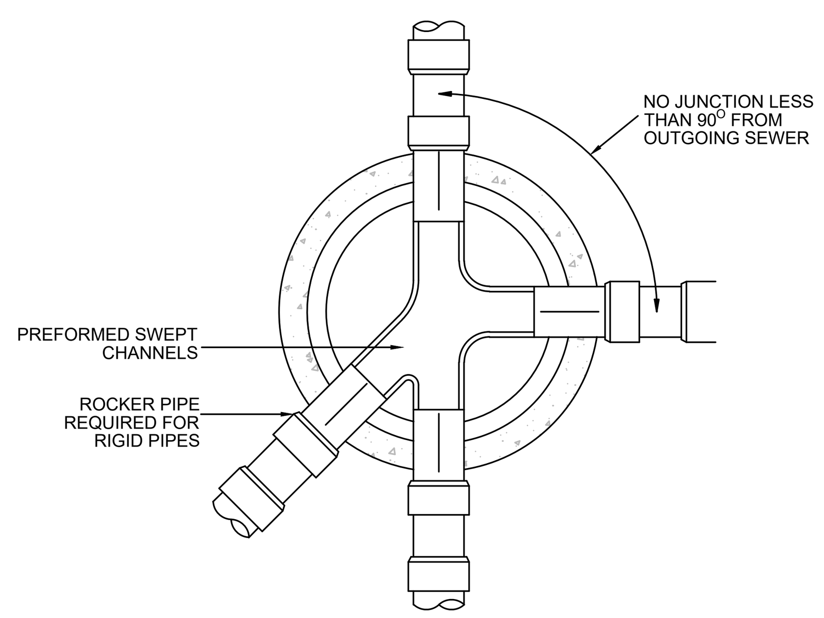
NOMINAL DIAMETER(mm)	L(mm)
150 to 600	600
over 600 to 750	1000
over 750	1250

INTERNAL DIAMETER OF CONCRETE MANHOLES

DIAMETER OF LARGEST PIPE IN MANHOLE (MM)	INTERNAL DIAMETER OF MANHOLE (MM)
LESS THAN 375	1200
375 to 450	1350
450 to 700	1500
750 to 1050	1800
1125 to 1500	2100
>1500	CONSULT SCOTTISH WATER

INTERNAL DIAMETER OF INSPECTION CHAMBERS

DIAMETER OF LARGEST PIPE IN MANHOLE (MM)	DIAMETER OF INSPECTION CHAMBER (MM)
LESS THAN 160	450
160 to 300	600
300 to 450	750



TYPICAL MANHOLE ARRANGEMENT OF PIPE JUNCTIONS

N.T.S.

REV	DATE	DESCRIPTION	BY	CHK
0	09/21	INITIAL ISSUE	KI	RL

CLIENT: OWC

PROJECT: EREBUS - WALES FLOATING WIND

DRAWING TITLE: **PRELIMINARY CONSTRUCTION DETAILS**

SCALE: AS SHOWN @ A1

DATE: SEPTEMBER 2021

DRAWING NUMBER: 2923-DIA-005

REV: 0

DRAWING STATUS: FOR INFORMATION ONLY

ITPENERGISED
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Construction Details.dwg

Appendix A

MicroDrainage Modelling Results

Summary of Results for 1000 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	44.121	0.521	2.3	246.5	O K
30 min Summer	44.294	0.694	2.3	347.9	O K
60 min Summer	44.477	0.877	2.3	466.0	O K
120 min Summer	44.659	1.059	2.3	596.6	O K
180 min Summer	44.758	1.158	2.4	672.5	O K
240 min Summer	44.820	1.220	2.5	722.0	O K
360 min Summer	44.893	1.293	2.5	782.2	O K
480 min Summer	44.944	1.344	2.6	825.7	O K
600 min Summer	44.980	1.380	2.6	857.3	O K
720 min Summer	45.007	1.407	2.6	881.1	O K
960 min Summer	45.042	1.442	2.7	913.2	O K
1440 min Summer	45.074	1.474	2.7	942.1	O K
2160 min Summer	45.075	1.475	2.7	942.7	O K
2880 min Summer	45.050	1.450	2.7	920.4	O K
4320 min Summer	44.996	1.396	2.6	871.2	O K
5760 min Summer	44.942	1.342	2.6	824.8	O K
7200 min Summer	44.899	1.299	2.5	787.2	O K
8640 min Summer	44.858	1.258	2.5	752.9	O K
10080 min Summer	44.818	1.218	2.5	720.8	O K
15 min Winter	44.174	0.574	2.3	276.3	O K
30 min Winter	44.362	0.762	2.3	390.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	120.387	0.0	192.1	19
30 min Summer	85.130	0.0	177.7	34
60 min Summer	57.306	0.0	358.9	64
120 min Summer	37.017	0.0	357.0	124
180 min Summer	28.060	0.0	369.8	184
240 min Summer	22.780	0.0	381.5	244
360 min Summer	16.722	0.0	394.5	364
480 min Summer	13.444	0.0	402.9	482
600 min Summer	11.333	0.0	408.3	602
720 min Summer	9.847	0.0	411.8	722
960 min Summer	7.875	0.0	415.2	962
1440 min Summer	5.724	0.0	413.9	1442
2160 min Summer	4.142	0.0	804.4	2160
2880 min Summer	3.284	0.0	802.0	2680
4320 min Summer	2.357	0.0	773.4	3372
5760 min Summer	1.858	0.0	1455.4	4144
7200 min Summer	1.549	0.0	1426.6	4968
8640 min Summer	1.335	0.0	1364.9	5792
10080 min Summer	1.178	0.0	1308.5	6560
15 min Winter	120.387	0.0	191.5	19
30 min Winter	85.130	0.0	171.5	34

Summary of Results for 1000 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	44.558	0.958	2.3	522.6	O K
120 min Winter	44.755	1.155	2.4	669.7	O K
180 min Winter	44.861	1.261	2.5	755.8	O K
240 min Winter	44.928	1.328	2.6	812.0	O K
360 min Winter	45.007	1.407	2.6	881.4	O K
480 min Winter	45.063	1.463	2.7	932.1	O K
600 min Winter	45.104	1.504	2.7	969.4	O K
720 min Winter	45.134	1.534	2.7	997.8	O K
960 min Winter	45.176	1.576	2.8	1037.7	O K
1440 min Winter	45.217	1.617	2.8	1078.2	O K
2160 min Winter	45.230	1.630	2.8	1091.0	O K
2880 min Winter	45.216	1.616	2.8	1076.6	O K
4320 min Winter	45.153	1.553	2.8	1016.3	O K
5760 min Winter	45.093	1.493	2.7	959.9	O K
7200 min Winter	45.038	1.438	2.7	909.1	O K
8640 min Winter	44.984	1.384	2.6	860.6	O K
10080 min Winter	44.930	1.330	2.6	814.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	57.306	0.0	356.0	64
120 min Winter	37.017	0.0	368.3	122
180 min Winter	28.060	0.0	388.0	182
240 min Winter	22.780	0.0	399.6	240
360 min Winter	16.722	0.0	412.3	360
480 min Winter	13.444	0.0	420.3	478
600 min Winter	11.333	0.0	425.2	596
720 min Winter	9.847	0.0	428.2	714
960 min Winter	7.875	0.0	430.6	944
1440 min Winter	5.724	0.0	427.3	1412
2160 min Winter	4.142	0.0	841.0	2096
2880 min Winter	3.284	0.0	835.9	2740
4320 min Winter	2.357	0.0	804.2	3544
5760 min Winter	1.858	0.0	1528.8	4392
7200 min Winter	1.549	0.0	1484.9	5336
8640 min Winter	1.335	0.0	1444.6	6232
10080 min Winter	1.178	0.0	1399.6	7160

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1000	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.000	Shortest Storm (mins)	15
Ratio R	0.300	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.100

Time From:	**(mins) To:**	**Area (ha)**
0	4	1.100

Model Details

Storage is Online Cover Level (m) 45.600

Tank or Pond Structure

Invert Level (m) 43.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	395.0	1.000	727.1	2.000	1159.7
0.500	548.5	1.500	930.8		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0071-3100-2000-3100
Design Head (m)	2.000
Design Flow (l/s)	3.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	71
Invert Level (m)	43.600
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	3.1
Flush-Flo™	0.313	2.3
Kick-Flo®	0.640	1.8
Mean Flow over Head Range	-	2.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	1.200	2.4	3.000	3.7	7.000	5.6
0.200	2.2	1.400	2.6	3.500	4.0	7.500	5.7
0.300	2.3	1.600	2.8	4.000	4.3	8.000	5.9
0.400	2.3	1.800	2.9	4.500	4.5	8.500	6.1
0.500	2.2	2.000	3.1	5.000	4.7	9.000	6.3
0.600	2.0	2.200	3.2	5.500	5.0	9.500	6.4
0.800	2.0	2.400	3.4	6.000	5.2		
1.000	2.3	2.600	3.5	6.500	5.4		

Summary of Results for 1000 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	43.952	0.352	1.3	157.0	O K
30 min Summer	44.076	0.476	1.3	221.6	O K
60 min Summer	44.210	0.610	1.3	297.2	O K
120 min Summer	44.347	0.747	1.3	380.9	O K
180 min Summer	44.423	0.823	1.3	429.9	O K
240 min Summer	44.471	0.871	1.4	461.9	O K
360 min Summer	44.528	0.928	1.4	501.5	O K
480 min Summer	44.569	0.969	1.4	530.5	O K
600 min Summer	44.599	0.999	1.5	551.9	O K
720 min Summer	44.621	1.021	1.5	568.2	O K
960 min Summer	44.652	1.052	1.5	591.1	O K
1440 min Summer	44.683	1.083	1.5	614.5	O K
2160 min Summer	44.693	1.093	1.5	621.8	O K
2880 min Summer	44.681	1.081	1.5	613.0	O K
4320 min Summer	44.643	1.043	1.5	584.5	O K
5760 min Summer	44.606	1.006	1.5	556.7	O K
7200 min Summer	44.574	0.974	1.4	534.1	O K
8640 min Summer	44.545	0.945	1.4	513.4	O K
10080 min Summer	44.518	0.918	1.4	494.2	O K
15 min Winter	43.989	0.389	1.3	175.9	O K
30 min Winter	44.125	0.525	1.3	248.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	120.387	0.0	111.7	19
30 min Summer	85.130	0.0	108.6	34
60 min Summer	57.306	0.0	208.8	64
120 min Summer	37.017	0.0	202.9	124
180 min Summer	28.060	0.0	207.5	184
240 min Summer	22.780	0.0	214.0	244
360 min Summer	16.722	0.0	221.3	364
480 min Summer	13.444	0.0	226.0	484
600 min Summer	11.333	0.0	229.1	602
720 min Summer	9.847	0.0	231.1	722
960 min Summer	7.875	0.0	233.1	962
1440 min Summer	5.724	0.0	232.3	1442
2160 min Summer	4.142	0.0	457.0	2160
2880 min Summer	3.284	0.0	455.2	2880
4320 min Summer	2.357	0.0	439.2	3548
5760 min Summer	1.858	0.0	847.1	4320
7200 min Summer	1.549	0.0	818.5	5112
8640 min Summer	1.335	0.0	789.0	5888
10080 min Summer	1.178	0.0	762.3	6752
15 min Winter	120.387	0.0	112.3	19
30 min Winter	85.130	0.0	103.5	34

Summary of Results for 1000 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	44.270	0.670	1.3	333.1	O K
120 min Winter	44.419	0.819	1.3	427.3	O K
180 min Winter	44.501	0.901	1.4	482.7	O K
240 min Winter	44.553	0.953	1.4	519.2	O K
360 min Winter	44.616	1.016	1.5	564.5	O K
480 min Winter	44.661	1.061	1.5	598.0	O K
600 min Winter	44.694	1.094	1.5	623.0	O K
720 min Winter	44.720	1.120	1.5	642.3	O K
960 min Winter	44.755	1.155	1.6	670.1	O K
1440 min Winter	44.793	1.193	1.6	700.6	O K
2160 min Winter	44.812	1.212	1.6	715.4	O K
2880 min Winter	44.808	1.208	1.6	712.3	O K
4320 min Winter	44.771	1.171	1.6	682.6	O K
5760 min Winter	44.727	1.127	1.5	648.0	O K
7200 min Winter	44.689	1.089	1.5	619.2	O K
8640 min Winter	44.652	1.052	1.5	590.9	O K
10080 min Winter	44.615	1.015	1.5	563.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	57.306	0.0	205.1	64
120 min Winter	37.017	0.0	207.0	122
180 min Winter	28.060	0.0	217.7	182
240 min Winter	22.780	0.0	224.3	242
360 min Winter	16.722	0.0	231.5	360
480 min Winter	13.444	0.0	236.0	478
600 min Winter	11.333	0.0	238.9	596
720 min Winter	9.847	0.0	240.6	714
960 min Winter	7.875	0.0	242.1	950
1440 min Winter	5.724	0.0	240.3	1414
2160 min Winter	4.142	0.0	477.6	2096
2880 min Winter	3.284	0.0	474.4	2768
4320 min Winter	2.357	0.0	456.4	4020
5760 min Winter	1.858	0.0	874.6	4552
7200 min Winter	1.549	0.0	857.0	5472
8640 min Winter	1.335	0.0	838.6	6392
10080 min Winter	1.178	0.0	812.2	7264

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1000	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.000	Shortest Storm (mins)	15
Ratio R	0.300	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.700

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.700

Model Details

Storage is Online Cover Level (m) 45.600

Tank or Pond Structure

Invert Level (m) 43.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	395.0	1.000	727.1	2.000	1159.7
0.500	548.5	1.500	930.8		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0057-2000-2000-2000
Design Head (m)	2.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	57
Invert Level (m)	43.600
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	2.0
Flush-Flo™	0.247	1.3
Kick-Flo®	0.506	1.1
Mean Flow over Head Range	-	1.5

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	1.2	1.200	1.6	3.000	2.4	7.000	3.6
0.200	1.3	1.400	1.7	3.500	2.6	7.500	3.7
0.300	1.3	1.600	1.8	4.000	2.7	8.000	3.8
0.400	1.3	1.800	1.9	4.500	2.9	8.500	3.9
0.500	1.1	2.000	2.0	5.000	3.0	9.000	4.0
0.600	1.2	2.200	2.1	5.500	3.2	9.500	4.1
0.800	1.3	2.400	2.2	6.000	3.3		
1.000	1.5	2.600	2.3	6.500	3.4		

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