LLŶR FLOATING OFFSHORE WIND PROJECT

Llŷr 1 Floating Offshore Wind Farm

Environmental Statement

Volume 6: Appendix 10A, Annex A – Drainage Strategy

August 2024

Prepared by: Llŷr Floating Wind Ltd

Document Status

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Acronyms and abbreviations

Acronym or Abbreviation	Definition	Acronym or Abbreviation	Definition
AEP	Annual Exceedance Probability	mAOD	Meter Above Ordnance Datum
AOD	Above Ordnance Datum	NGR	National Grid Reference
BFIHOST	Base Flow Index derived using UK Hydrology of Soil Types (1999)	NRW	Natural Resources Wales
BFIHOST19	Base Flow Index derived using UK Hydrology of Soil Types (2019)	PCC	Pembrokeshire County Council
BGS	British Geological Survey	PPW	Planning Policy Wales
FEH	Flood Estimation Handbook	PROPWET	Proportion of Time the Soil Moisture Deficit was equal to, or below, 6mm
FFL	Finished Floor Level	SAAR	Standard Annual Average Rainfall
ha	Hectares	SuDS	Sustainable Drainage Systems
LLFA	Lead Local Flood Authority	TSS	Total Suspended Solids
m	Meters	TAN	Technical Advice Note
m^2	Square meters	SMD	Soil Moisture Deficit
m^3	Cubic meters		

Glossary of project terms

Term	Definition
The Applicant	The developer of the Project, Llŷr Floating Wind Limited
Array	All wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure within the Array Area, as defined, when considered collectively, excluding the offshore export cable(s).
Array Area	The area within which the wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure will be located
Floventis Energy	A joint venture company between Cierco Ltd and SBM Offshore Ltd of which Llŷr Floating Wind Limited is a wholly owned subsidiary.
Landfall	The location where the offshore export cable(s) from the Array Area, as defined, are brought onshore and connected to the onshore export cables (as defined) via the transition joint bays (TJB).
Llŷr 1	The proposed Project, for which the Applicant is applying for Section 36 and Marine Licence consents. Including all offshore and onshore infrastructure and activities, and all project phases.
Marine Licence	A licence required under the Marine and Coastal Access Act 2009 for marine works which is administered by Natural Resources Wales (NRW) Marine Licensing Team (MLT) on behalf of the Welsh Ministers.
Offshore Development Area	The footprint of the offshore infrastructure and associated temporary works, comprised of the Array Area and the Offshore Export Cable Corridor, as defined, that forms the offshore boundary for the S36 Consent and Marine Licence application
Offshore Export Cable	The cable(s) that transmit electricity produced by the WTGs to landfall.

Term	Definition
Offshore Export Cable Corridor (OfECC)	The area within which the offshore export cable circuit(s) will be located, from the Array Area to the Landfall.
Onshore Development Area	The footprint of the onshore infrastructure and associated temporary works, comprised of the Onshore Export Cable Corridor and the Onshore Substation, as defined, and including new access routes and visibility splays, that forms the onshore boundary for the planning application.
Onshore Export Cable(s)	The cable(s) that transmit electricity from the landfall to the onshore substation
Onshore Export Cable Corridor (OnECC)	The area within which the onshore export cable circuit(s) will be located.
proposed Project	All aspects of the Llŷr 1 development (i.e. the onshore and offshore components).
Onshore Substation	Located within the Onshore Development Area, converts high voltage generated electricity into low voltage electricity that can be used for the grid and domestic consumption.
Section 36 consent	Consent to construct and operate an offshore generating station, under Section 36 (S.36) of the Electricity Act 1989. This includes deemed planning permission for onshore works.

Contents

List of Figures

List of Tables

10. ANNEX A: DRAINAGE STRATEGY

10.1 Introduction

10.1.1. Context

1. AECOM has been appointed by Llŷr Floating Wind Ltd (The Applicant) to undertake drainage strategy to support a planning application for a proposed Project of a substation as a part of the onshore transmission works for Llŷr Floating Wind Farm (the proposed Project). The proposed Project substation is located approximately 1.6 km southwest of the existing Pembroke Power station, just north of the Wallaston Green in Pembrokeshire, Wales.
2. This report focuses on the proposed substation and assesses the increase in surface water runoff in accordance with sustainable drainage principles from the substation platform area to not increase flood risk to any downstream area and ensure no deterioration of the water environment.

10.1.2. Policy and Guidance

3. This assessment has been completed in accordance with guidance presented within Planning Policy Wales (PPW) (Welsh Government, 2024), The National Strategy for Flood and Coastal Erosion Risk in Wales (Welsh Government, 2020).
4. 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); and
   - Sustainable Drainage (SuDS) Statutory Guidance 2019.

10.1.3. Substation Location and Context

5. The proposed Project substation land parcel is located approximately 1.6 km southwest of the existing Pembroke Power station just north of the Wallaston Green at approximate National Grid Reference (NGR): SM 92343 01065 (**Annex A**: Figure 10A-1).

Annex A: Figure 10A-1 Substation land parcel location

6. The land parcel identified for the substation is currently entirely greenfield and comprises of arable land. The land parcel is bounded by a solar farm to the immediate west side, unnamed roads to the north and east side and further greenfield areas to the south side of the development.
7. There is an existing unnamed watercourse to the south of the land parcel which flows in the western direction and discharges to Angle Bay.

10.1.4. Proposed Project substation

8. The proposed Project substation will receive the electricity generated by the Llŷr 1 offshore windfarm for conversion from either 66 kV or 132 kV to 400 kV and onward transmission on the national electricity transmission system.
9. The proposed substation layout requires a platform which is approximately 1.5 ha in size. The formation level for the proposed platform is set at 65.0 m AOD.

10.1.5. Topography

10. At the time of writing of this report, no specific topographical survey was undertaken, therefore an online freely available LiDAR data has been reviewed to inform this report (Welsh Government, 2023). The LiDAR data indicates the proposed substation compound parcel has a general south westerly fall with a high point of around 67 m AOD located in the northeastern portion of the land parcel. The elevations decrease towards the bottom left corner of the proposed substation land parcel where they reach elevations of around 52 m AOD. The elevations continue to decrease towards the existing ordinary watercourse and are shown to be around 47 m AOD in that area.

10.1.6. *Geology and Hydrogeology*

Geology

11. Geological data from the British Geological Survey (BGS) has been reviewed and shows the northern portion of the land parcel identified for substation to be underlaid by Ridgeway Conglomerate Formation (Conglomerate), and the southern portion of the land parcel to be underlaid by Milford Haven Group (Argillaceous rocks and Sandstone). There are no records of superficial deposits overlying the land parcel area.

Hydrogeology

12. Review of the DEFRA Magic Map indicates that the bedrock underlying the land parcel identified for substation is classified as Secondary A aquifer.

13. The Cranfield University Soilscapes website indicates the proposed substation land parcel area to be intercepted by freely draining slightly acid loamy soils.

10.1.7. *Hydrological Context*

Local Hydrology

14. There are no main rivers shown on the Main Rivers Map published by Natural Resources Wales in the close proximity of the substation land parcel. The closest ordinary watercourse is located south of the land parcel area. This unnamed ordinary watercourse is generally considered as a field boundary ditch assumed to assist with the drainage of the existing agricultural fields. The watercourse is flowing in a westerly direction into the existing pond.

15. As the entirety of the proposed Project substation land parcel is currently greenfield, it is unlikely that there is an existing underground drainage network located within the land parcel boundary.

Flood Estimation Handbook (FEH) Data

16. The point data shown in **Table 10A-1** below is taken from the FEH Web Service (UK Centre for Ecology & Hydrology, 2024) and the catchment of the ordinary watercourse located south of the proposed Project has been delineated from the NGR: SM 91950 00750. The average annual rainfall for the catchment is 1053 mm per year.

Table 10A-1 Hydrological summary and catchment characteristics

Waterbody Catchment	BFIHOST	BFIHOST19	PROPWET	SAAR
SM 91950 00750	0.581	0.487	0.44	1053

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

Pre-development Greenfield Runoff rates

17. The greenfield runoff rates have been calculated using the IH124 method as set out within the Interim Code of Practice for catchment areas of 50 ha or less (National SuDs Working Group, 2004].

18. Greenfield runoff modelling results are presented below in the **Table 10A-2** for a range of AEP storm events.

Table 10A-2 Estimation of greenfield (pre-development) rate of runoff

AEP (%)	Return Period (1 in x Years)	Unit Greenfield Runoff Rate (l/s/ha)
100	1	2.50
50	2	2.64
QBAR		2.84
3.3	30	5.01
1	100	6.20
0.5	200	7.02
0.1	1000	9.07

10.1.8. Climate Change

19. The “Flood Consequences Assessments: Climate Change Allowances Guidance” published in September 2021 (last update December 2021) indicates that increases in rainfall intensity due to climate change are likely to affect river levels, particularly within smaller catchments (less than 5 km^2) and on land and urban drainage systems. Rainfall allowances should be used to better understand the impacts of climate change on smaller watercourses, which may see their channel capacity reduced as a result of increased run-off.

20. **Table 10A-3** shows the anticipated changes in peak rainfall intensity for use in small catchments. Both the central and upper estimates should be assessed to understand the range of impact. In line with the “Flood Consequences Assessments: Climate Change Allowances Guidance“, as a minimum, development proposals should be assessed against the central estimate to inform design levels. Where the assessment indicates a significant flood risk for the upper estimate (e.g. depths, velocity), the flood consequences assessment will need to indicate the mitigation measures required to protect people and property.

21. The drainage network design will ensure that there is no increase in rate of runoff discharged from the land parcel for the upper estimate, in line with the above mentioned guidance for climate change allowance. Total potential change anticipated for the 2080’s (2070-2115) therefore, the peak intensity allowance is 40%.

Table 10A-3 Change to extreme rainfall intensity (compared to a 1961-90 baseline)

Applies across all of Wales	Total potential change anticipated for 2020s (2015-2039)	Total potential change anticipated for (2040-2069)	Total potential change anticipated for 2080s (2070-2115)
Upper estimate	10%	20%	40%
Central estimate	5%	10%	20%

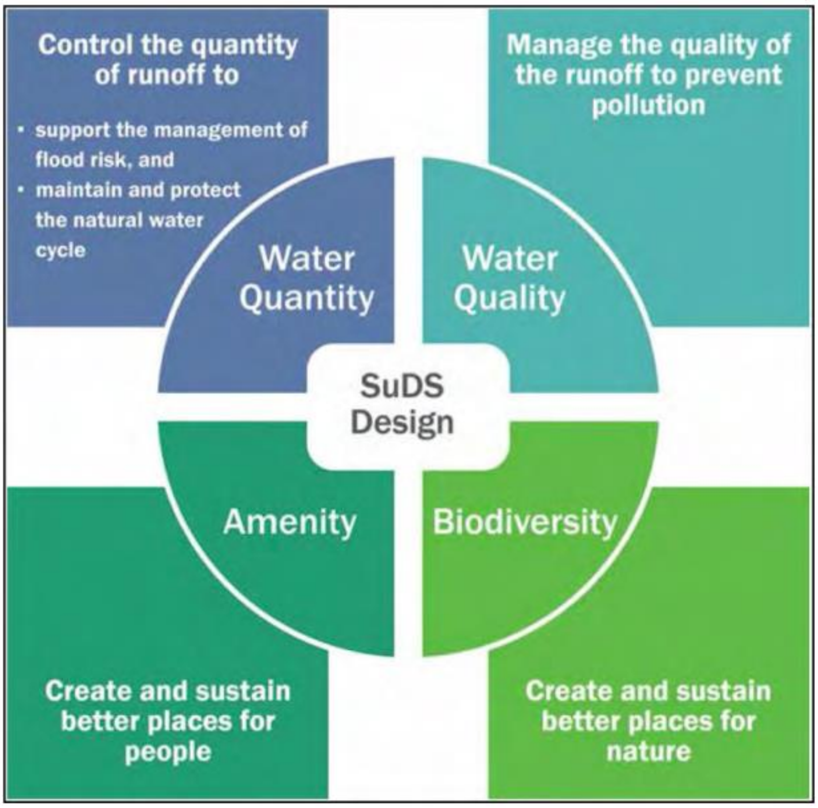
10.2 Surface Water Management Strategy

10.2.9. Sustainable Drainage Systems (SuDS)

22. 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.

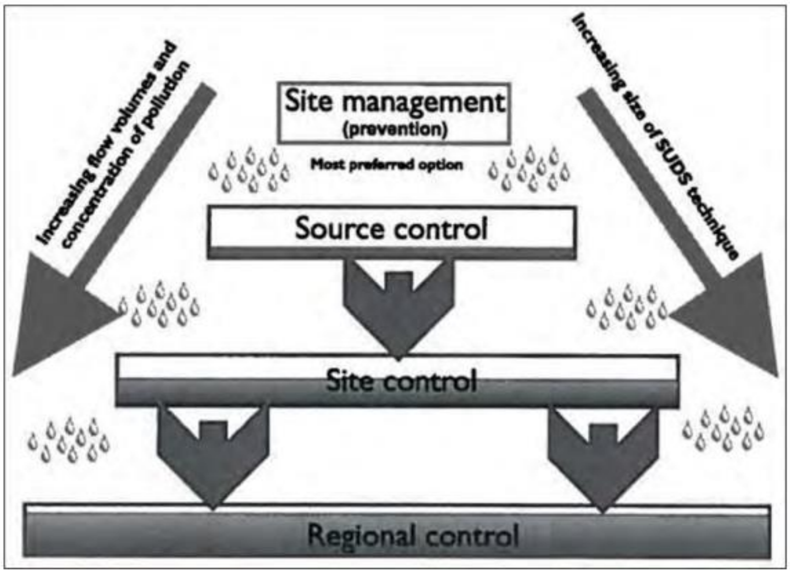
23. Current best practice guidance relating to sustainable surface water management is outlined in the SuDS Manual (CIRIA Report C753) which provides details on the use of SuDS for managing surface water runoff.

24. There are four main categories of SuDS which are referred to as the 'four pillars of SuDS design' as depicted in **Annex A**: Figure 10A-2 below.



Annex A: Figure 10A-2 Four pillars of SuDS (CIRIA Report C753)

25. The SuDS Manual identifies a hierarchy of SuDS for managing runoff, which is commonly referred to as a 'management train' as described in **Annex A**: Figure 10A-3**.**



Annex A: Figure 10A-3 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); and
- Regional Control – management of runoff from several sites, typically in a retention pond or wetland.

26. 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.

10.2.10. Design Overview

27. The management of surface water drainage from the proposed Project will comprise a piped gravity network which will discharge to a proposed attenuation basin located southwest of the proposed substation. The surface water flows will be conveyed from the attenuation

basin either a piped network or a new swale to the existing ordinary watercourse located south of the proposed Project at the restricted greenfield runoff rate.

28. An additional SuDS feature (swale) has been included to capture, convey, and redirect surface water flows around the northern boundary of the proposed substation area. The surface water flows are expected to slowly disperse and infiltrate into the surrounding ground, away from the proposed Project.

10.2.11. Design Criteria

Proposed Surface Water Discharge

29. In accordance with CIRIA Report C753, the hierarchy demands that surface water runoff should be disposed of as high up the following list as practically possible:

- Into the ground (infiltration) and re-use;
- To a surface waterbody;
- To a surface water sewer, highway drain or another drainage system; and
- To a combined sewer.

30. **Table 10A-4** below presents the disposal method suitability in the context of the land parcel and proposed Project.

Table 10A-4 Suitability of surface water disposal methods

Surface Water Disposal Method	Suitability Description	Method Suitable (Y/N)
Infiltration into the Ground	Review of the BGS data shows no records of superficial deposits overlying the site. The bedrock geology which comprises of Conglomerate Argillaceous and Sandstone is generally considered permeable. Soilscapes data show the site to be 'Freely Draining'. These ground conditions are considered suitable for infiltration. This is, however, subject to further ground investigation and infiltration testing onsite, to be carried out at the next stage of the design.	Y
Surface Waterbody	An ordinary watercourse is located south of the site which permits a gravity connection for surface water disposal.	Y
Surface water sewer	Due to the general rural setting around the site, it is unlikely that public sewers exist close to the site.	N

31. Further to the above, **Table 10A-5** identifies in more details the SuDS techniques proposed within the proposed land parcel and the benefits to flood risk, pollution reduction, biodiversity, and the environment. The reasons are stated where it is not practicable to include a particular SuDS feature.

Table 10A-5 SuDS hierarchy

SuDS Method	Water Quantity Benefit	Water Quality Benefit	Amenity Benefit	Biodiversity Benefit	Practicable	Potential Use in Development or Reasons for exclusion
Green/Brown Roofs	✓	✓	✓	✓	N	Not considered feasible due to type of the proposed Project (electrical substation).
Store Rainwater for later use	✓	N/A	N/A	N/A	N	Not considered feasible due to type proposed Project (electrical substation).
Use Infiltration techniques	✓	✓	N/A	N/A	Y	Could be considered at a later stage, subject to infiltration testing onsite.
Filter strips such as 'French Drains' and 'Rain Gardens'	✓	✓	✓	✓	N	Not considered at this stage.
Ponds or Open Water Features for Gradual Release to Watercourse	✓	✓	✓	✓	Y	Is considered as a main source of surface water attenuation.
Attenuate rainwater by storing in tanks or sealed water features for gradual release to a watercourse	✓	N/A	N/A	N/A	N	Could be used but should be avoided.
Discharge rainwater direct to a watercourse	✓	N/A	N/A	N/A	N	Water will be attenuated prior to discharge to watercourse.
Attenuate rainwater by storing in tanks or sealed water features for gradual release to a surface water sewer	✓	N/A	N/A	N/A	N	There are no sewers in the close proximity of the site.
Discharge rainwater directly to a surface water sewer	✓	N/A	N/A	N/A	N	There are no sewers in the close proximity of the site.
Attenuate rainwater by storing in tanks or sealed water features for gradual release to a combined sewer	✓	N/A	N/A	Negative	N	There are no sewers in the close proximity of the site.
Discharge rainwater directly to a combined sewer.	N/A	N/A	N/A	Negative	N	There are no sewers in the close proximity of the site.

32. It is proposed to discharge surface water runoff from the substation infrastructure into the existing ordinary watercourse. Surface water flows will be temporary stored in an attenuation basin and discharged to the watercourse at restricted rate.

Water Quantity

33. 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:

34. SuDS Manual (CIRIA Report C753) – Section 24.10.1:

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

35. 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 hours event. This is particularly critical for catchments that are susceptible to flooding downstream of the proposed Project.

36. 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.

37. 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).

38. 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 Qbar, 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.

39. Kallagher (2002) demonstrates that if discharges are not limited to less than 3l/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 Qbar, 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.

40. It is proposed to restrict surface water discharge from the development site area to the Greenfield Runoff Rate with the return period of 1 year (100% AEP). With reference to the Table 10A-2, Q1 'Unit Greenfield Runoff Rate' has been estimated to be 2.50 l/s/ha. The calculated impermeable area is 1.15 ha, therefore the limiting post development peak runoff rate has been set at 2.88 l/s for all storm events up to and including 1 in 100 year return period (0.1% AEP).

Water Quality Design Criteria

41. As outlined in the CIRIA Report C753 (Section 26.7) the design of surface water drainage should consider minimizing contaminants in surface water runoff discharge from the site. The level of treatment required depends on the proposed land use, according to the pollution hazard indices.

42. **Table 10A-6** below compares the SuDS Mitigation Indices against the Pollution Hazard Indices for the proposed Project. The pollution indices are based on the operational 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 10A-6 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
Industrial Roofs	0.3	0.95	0.2	1.0	0.05	0.8
Non-residential parking with infrequent change	0.5		0.4		0.4	

43. As shown in the **Table 10A-6**, each individual pollution mitigation indices exceeds the development pollution indices. Therefore, the mitigation measures are considered to be satisfied for the proposed Project.

10.2.12. *Proposed Surface Water Drainage Strategy*

Overview

44. The proposed SuDS approach is for surface water runoff from the impermeable areas of the proposed Project to be conveyed by a gravity piped network to the proposed SuDS attenuation basin. Surface water runoff will be suitably attenuated (up to 1% AEP plus climate change allowance of 40%) within the attenuation basin prior to discharging into the existing ordinary watercourse located south of the proposed Project. A copy of the Drainage Strategy Drawing and typical SuDS design details can be found in an **Appendix A.**

45. Overland flow coming from the north of the proposed Project will captured and conveyed from the proposed infrastructure via a cut-off swale which will discharge the flows into the surrounding area away of the proposed Project and slowly infiltrate into the surrounding ground.

SuDS Outline Design

46. The outline design parameters for the proposed attenuation basin is as follows:

- Total Depth – 1.2 m;
- Freeboard – min. 300 mm;
- Slope – 1:4;
- Surface Area – 1709 m^2;
- 1% AEP + 40% climate change allowance – Design event; and
- Limited Discharge – 2.88 l/s.

47. The proposed attenuation basin has been modelled using the MicroDrainage software and the results are presented in **Table 10A-7** below (40% climate change allowance has been added to 1% AEP).

Table 10A-7 Hydraulic modelling performance of provisional SUDS design

Annual Probability AEP (%)	Max. Water Depth (m)	Freeboard Allowance (mm)	Max Outflow Rate (l/s)	Maximum Stored Volume (m^3)
50	0.29	910	2.88	305
3.3	0.50	700	2.88	563
1	0.89	300	2.88	1102

48. A copy of the MicroDrainage modelling results is included within **Appendix B.**

10.3 Foul Water Management Strategy

10.3.13. Overview

49. Under Natural Resources Wales' (NRW) Additional Guidance for Water Discharge and Groundwater, foul flows from the proposed land parcel have been designed for discharging to the existing ordinary watercourse located south of the proposed Project. NRW's order of preference for means of discharge are:

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

50. 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.

51. 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.

10.3.14. Treatment & Discharge

52. The substation compound will comprise of offices, storage rooms and operational rooms within the site. 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 number of staff (both permanent and temporary) that will be present at the operational substation is not confirmed. Given the size of the layout, 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.

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Table of Loadings for Sewage Treatment Systems

Per person / activity / day (unless otherwise specified)	FLOW	BOD	Ammonia as N
DOMESTIC DWELLINGS (Grams)	(Litres)	(Grams)	
Standard residential	150	60	8
Mobile home type caravans with full services	150	60	8
INDUSTRIAL			
Office / Factory without canteen	50	25	5
Office / Factory with canteen	100	38	5
Open industrial site, e.g. construction, quarry, without canteen	60	25	5
*Full-time Day Staff	90	38	5
*Part-time Staff (4 hr shift)	45	25	3

Annex A: Figure 10A-4 Excerpt British flows and loads

Table 10A-8 British water's flow and loads

Parameter	Units	Value	Notes
Population Equivalent	No. persons	10 permanent and 10 part-time	Assumption (to be confirmed post-consent)
Loading	l/pp/day	90 for permanent 45 for part-time	Based on 'Code of Practice Flows and Loads – 4 (2013)'
Total Loading	l/s	0.016	p.e. x loading per person

53. It is proposed that a sewage treatment plan (Klargester BioDisc or similar) is used to provide secondary treatment to the effluent and, foul water post-secondary treatment, is discharged to the same ordinary watercourse as the surface water.

10.4 Maintenance Plan

10.4.15. Overview

54. 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.

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

56. All drainage components will be retained under private ownership, with the Applicant 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.

10.4.16. Maintenance Program

SuDS Pond

57. **Table 10A-9** below provides the inspection and maintenance recommendations for ponds set out in Table 23.1 of the CIRIA Report C753.

Table 10A-9 SuDS pond maintenance requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass – public areas	Monthly (during growing season)
	Cut the meadow grass	Half yearly (spring, before nesting season, and autumn)
	Inspect marginal and bankside vegetation and remove nuisance plants (for first 3 years)	Monthly (at start, then as required)
	Inspect inlets, outlets, banksides, pipework etc for evidence of blockage and/or physical damage	Monthly
	Inspect waterbody for signs of poor water quality	Monthly (May – October)
	Inspect silt accumulation rates in any forebay and in main body of the pond and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
	Check any mechanical devices, eg penstocks	Half yearly
	Hand cut submerged and emergent aquatic plants (at minimum of 0.1m above pond base; include max 25% of pond surface)	Annually
	Remove 25% of bank vegetation from water's edge to a minimum of 1m above water level	Annually
	Tidy dead growth (scrub clearance) before start of growing season (Note: tree maintenance is usually part of overall landscape management contract)	Annually
	Remove sediment from any forebay	Every 1-5 years, or as required
	Remove sediment and planting from one quadrant of the main body of ponds without sediment forebays	Every 5 years, or as required
Occasional Maintenance	Remove sediment from the main body of ponds when pool volume is reduced by 20%	With effective pre-treatment, this will only be required rarely, eg every 25-50 years
Remedial Actions	Repair erosion or other damage	As required
	Replant, where necessary	As required
	Aerate pond if signs of eutrophication are detected	As required
	Realign rip-rap or repair other damage	As required
	Repair/rehabilitate inlets, outlets and overflows	As required

SuDS Swale

58. **Table 10A-10** below provides the inspection and maintenance recommendations for swales set out in Table 17.1 of the CIRIA Report C753.

Table 10A-10 SuDS swale maintenance requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets, and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional Maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial Actions	Repair erosion or other damage	As required
	Relevel uneven surface and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

Klargester BioDisc

59. **Table 10A-11** below provides the inspection and maintenance recommendations for Klargester BioDisc.

Table 10A-11 Klargester BioDisc maintenance requirements

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Emptying	Annually, or as required
	Motor, gearbox and bearings service	Every 6 months

10.5 Consultation

60. The Lead Local Flood Authority (LLFA) for this project, Pembrokeshire County Council (PCC) was consulted (Meeting name: Onshore Flood Risk and Drainage; Meeting date: 28th November 2023).

61. It was confirmed that no local specific guidance is available and national design guidance for drainage design should be followed with 1 in 1 year greenfield run off rate as discharge rate from the proposed land parcel.

62. A Full SuDS Scheme Application for SuDS Approving Body (SAB) will be required at the post-consent stage, when further details for the proposed drainage will be developed.

63. Further details on consultation with LLFA can be found in **Chapter 10: Terrestrial Water Environment.**

10.6 Conclusion

64. A Surface Water Management Strategy has been proposed which demonstrates that surface water runoff from the impermeable areas of the substation will be managed via a piped network and stored in the proposed attenuation pond before discharging to the unnamed watercourse located approx. 520 m from the substation, at 1 in 1 year greenfield for all storm events up to and including the 1 in 100 year plus 40% allowance for climate change.

65. The surface water management design presented at this stage demonstrates that adequate SuDS space provision is allocated within the land parcel selected for the proposed substation compound and is considered 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.

66. Foul drainage arising from the proposed substation has also been incorporated into the site designs and details presented in this assessment. The foul water flows will be managed through conventional gravity sewers, treated via a sewage treatment plant (Klargester BioDisc or similar) prior to discharge to the existing watercourse located south of the development.

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

68. A Full SuDS Scheme Application for SuDS Approving Body (SAB) will be required at post-consent stage of the design when further details for the proposed drainage will be developed.

10.7 References

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Appendix A

ISO A1 594mm x 841mm

Approved: DS

Checked: TB

Drawn: MR

Project Management Initials:

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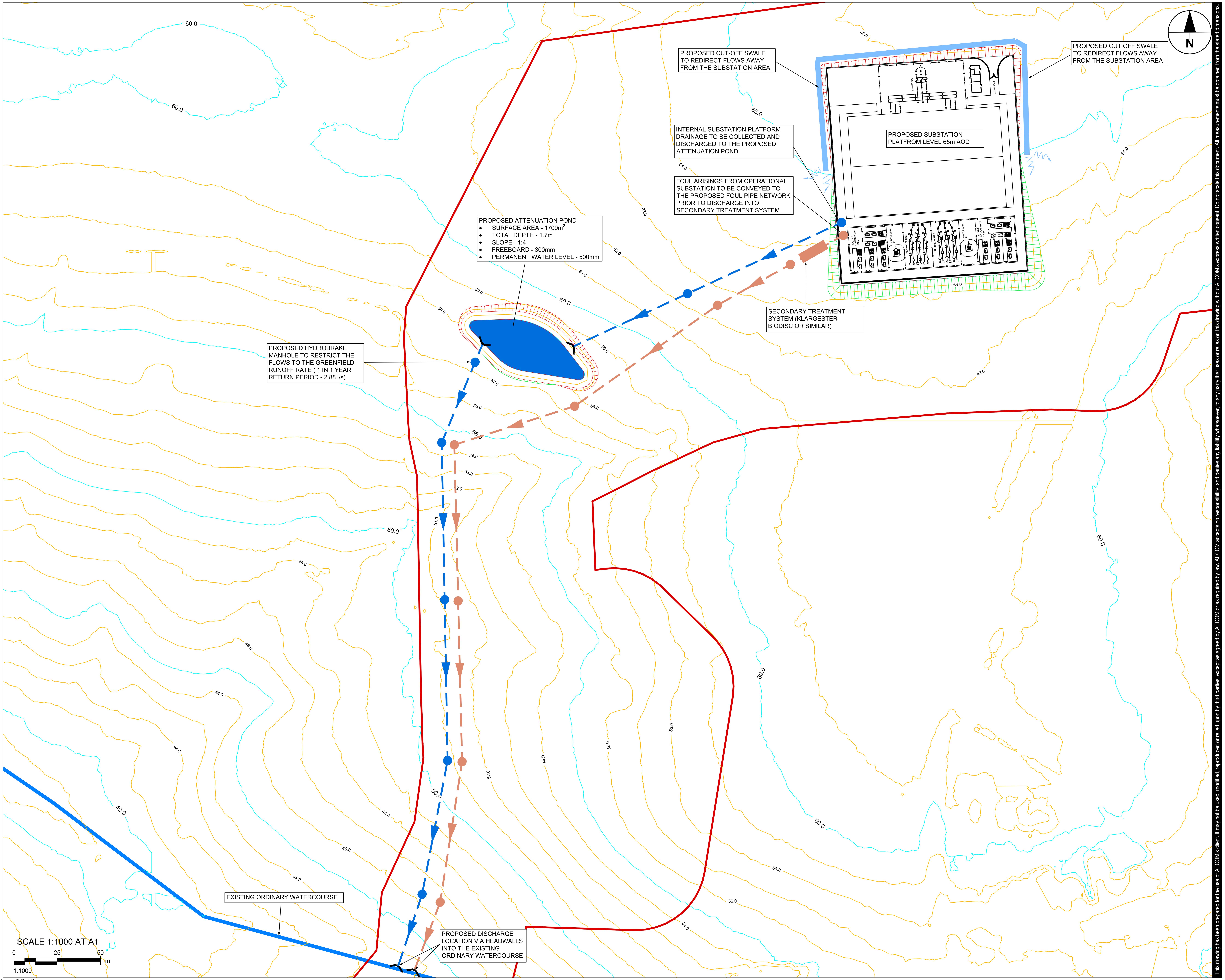

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LONDON, E1 8FA
www.aecom.com

GENERAL NOTES

1. TOPOGRAPHICAL SURVEY BASED ON 2020-2022 LiDAR DATA AVAILABLE ON WELSH GOVERNMENT WEBSITE - DATAMAP WALES.
2. PROPOSED DESIGN SHOWN ON THE DRAWING IN PROVISIONAL AND SUBJECT TO DETAIL DESIGN.
3. REFER TO DRAWING 60669422-AEC-NA-NA-C-DR-000002 FOR TYPICAL CONSTRUCTION DETAILS.

KEY:

- SITE BOUNDARY
- PROPOSED SURFACE WATER PIPEWORK
- PROPOSED FOUL WATER PIPEWORK
- PROPOSED SURFACE WATER MANHOLE
- PROPOSED FOUL WATER MANHOLE
- PROPOSED CUT-OFF SWALE
- PROPOSED CUT-OFF SWALE DISCHARGE ROUTE
- CUT AREA
- FILL AREA

ISSUE/REVISION

I/R	DATE	DESCRIPTION
P1	14.02.2024	PRELIMINARY ISSUE

PROJECT NUMBER

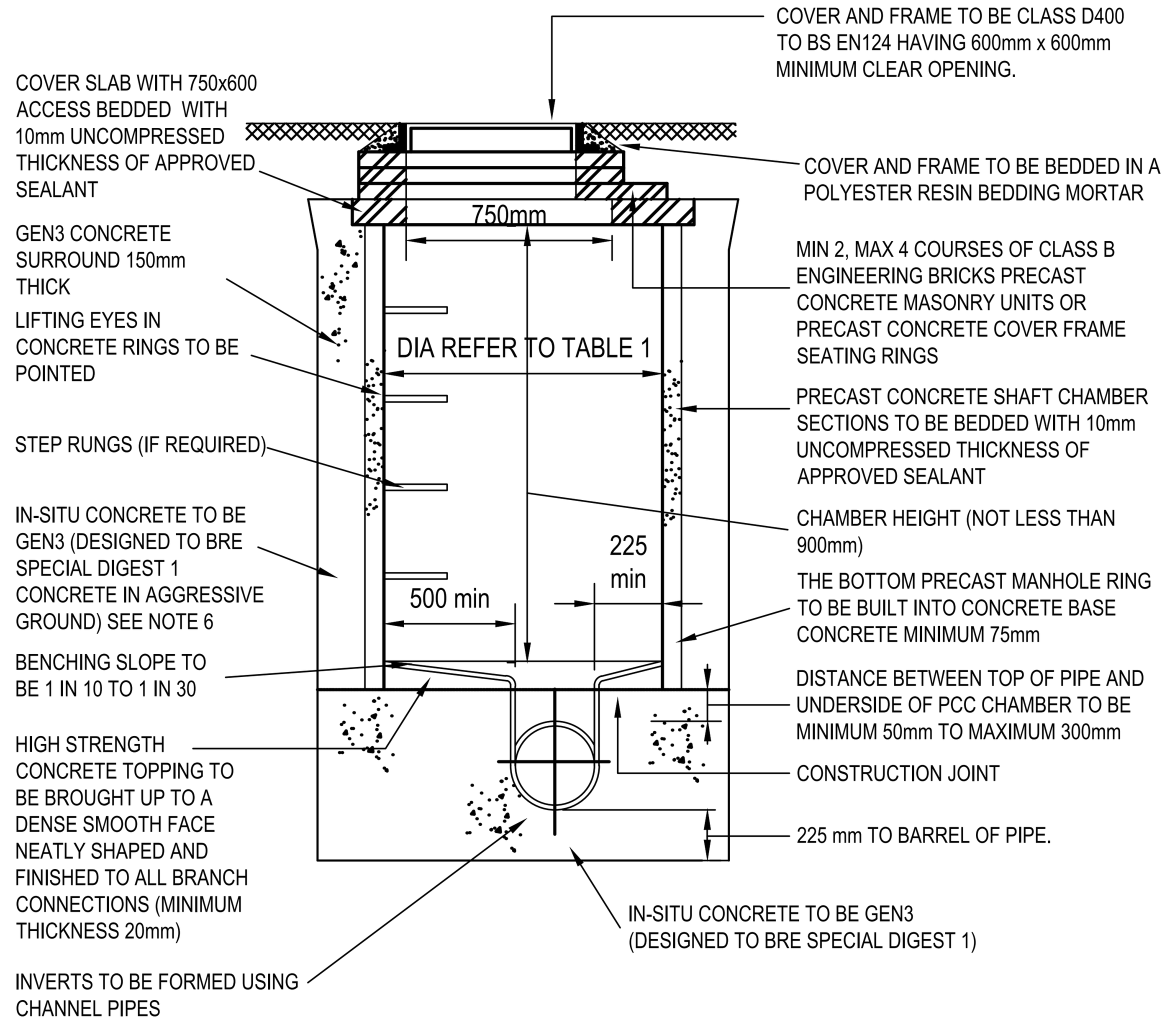
60669422

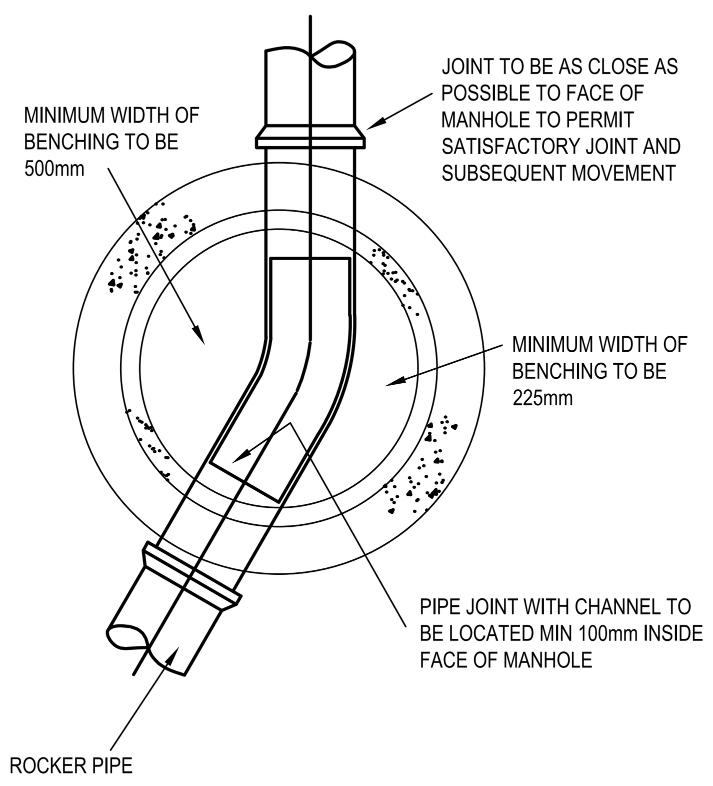
SHEET TITLE

PROPOSED DRAINAGE STRATEGY

SHEET NUMBER

60669422-AEC-NA-NA-C-DR-000001

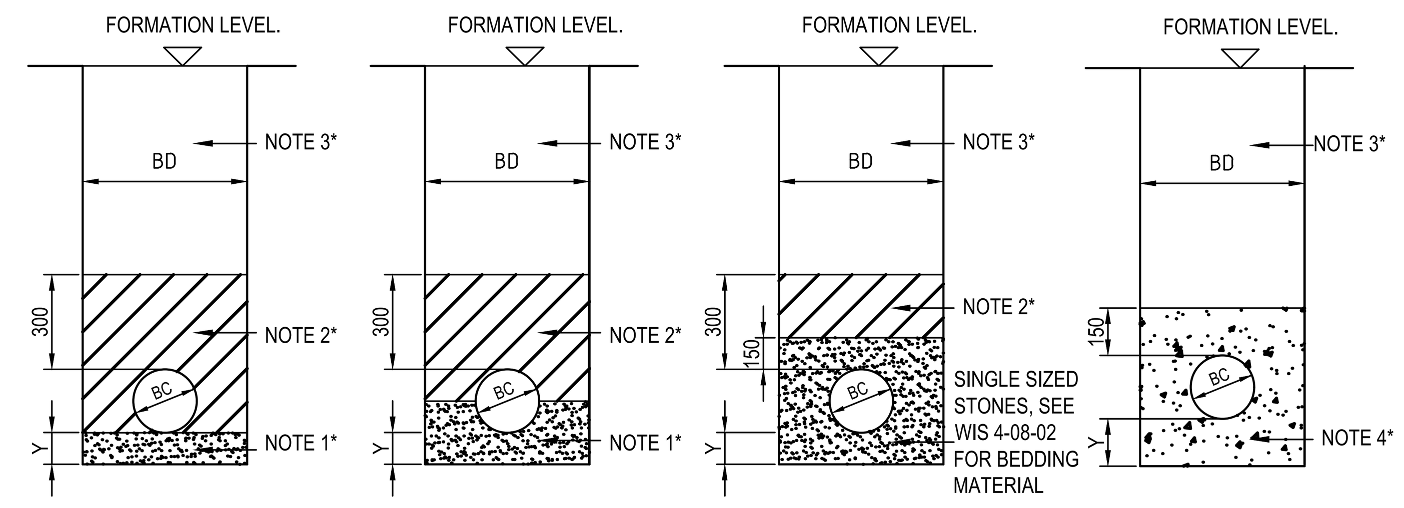




UNLESS SPECIFIED ELSEWHERE CONCRETE TO BE GEN3

TYPE B MANHOLE - DEPTH TO SOFFIT UP TO 3.0m

REFER TO MANHOLE SCHEDULES



TYPE F GRANULAR BED

TYPE B GRANULAR BED AND HAUNCH

TYPE S GRANULAR SURROUND

TYPE Z CONCRETE SURROUND (SEE NOTE 5) - FOR GULLY CONNECTIONS ONLY

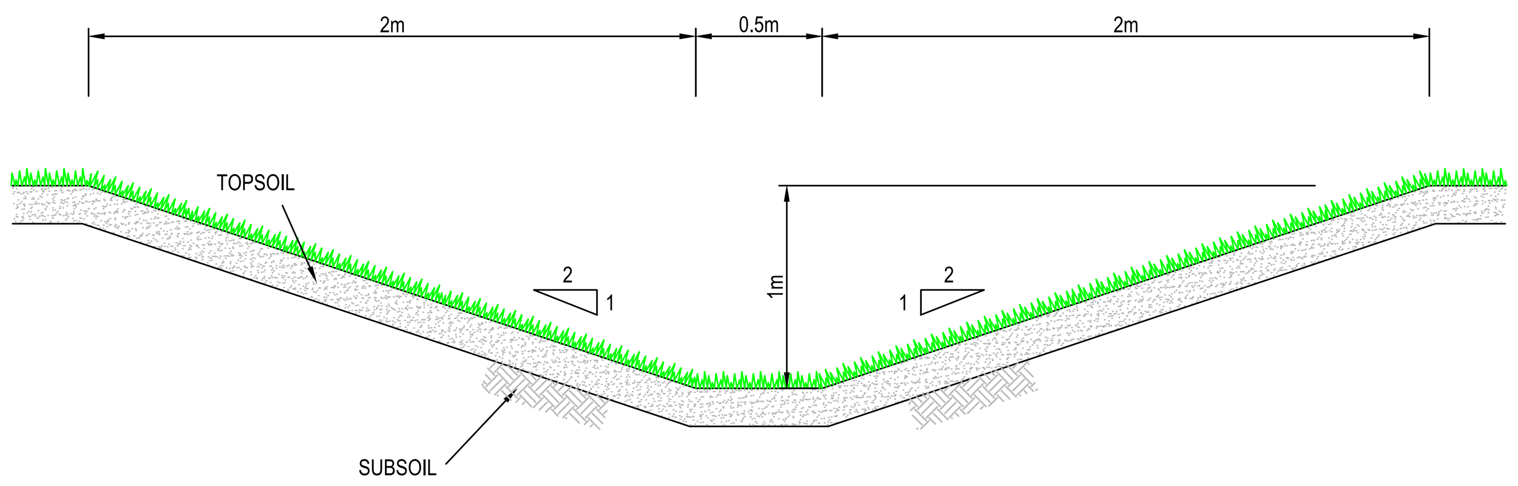
*NOTES:

1. PIPE BEDDING MATERIAL TO TABLE 5/3 OF CLAUSE 503 OF D OF T SPEC.
2. ACCEPTABLE FILL CLASS 1, 2, OR 3 TO TABLE 6/1 OF CLAUSE 601 OF D OF T SPEC. LIGHTLY COMPACTED BY HAND. (SEE NOTE 6)
3. ACCEPTABLE FILL CLASS 1, 2, OR 3 TO TABLE 6/1 OF CLAUSE 601 OF D OF T SPEC. WELL COMPACTED. (SEE NOTE 6)
4. GRADE ST2 CONCRETE.
5. 150mm GULLY CONNECTIONS TO HAVE 150mm CONCRETE SURROUND WITH POLYSTYRENE FORMER FLEXIBLE JOINTS AT NO MORE THAN 5m CENTRES.
6. ACCEPTABLE FILL BELOW CARRIAGEWAYS/PAVED AREAS TO BE CLASS 1 MATERIAL.
7. TRENCH WIDTH BD (mm)

PIPE DIA (mm)	TRENCH WIDTH BD (mm) MAX. MEASURED 300mm ABOVE PIPE SOFFIT
100	550
150	600
225	700
300	750
375	1050
450	1150
525	1200
600	1350
675	1450
750	1500
825	1600
900	1900
1000	2000

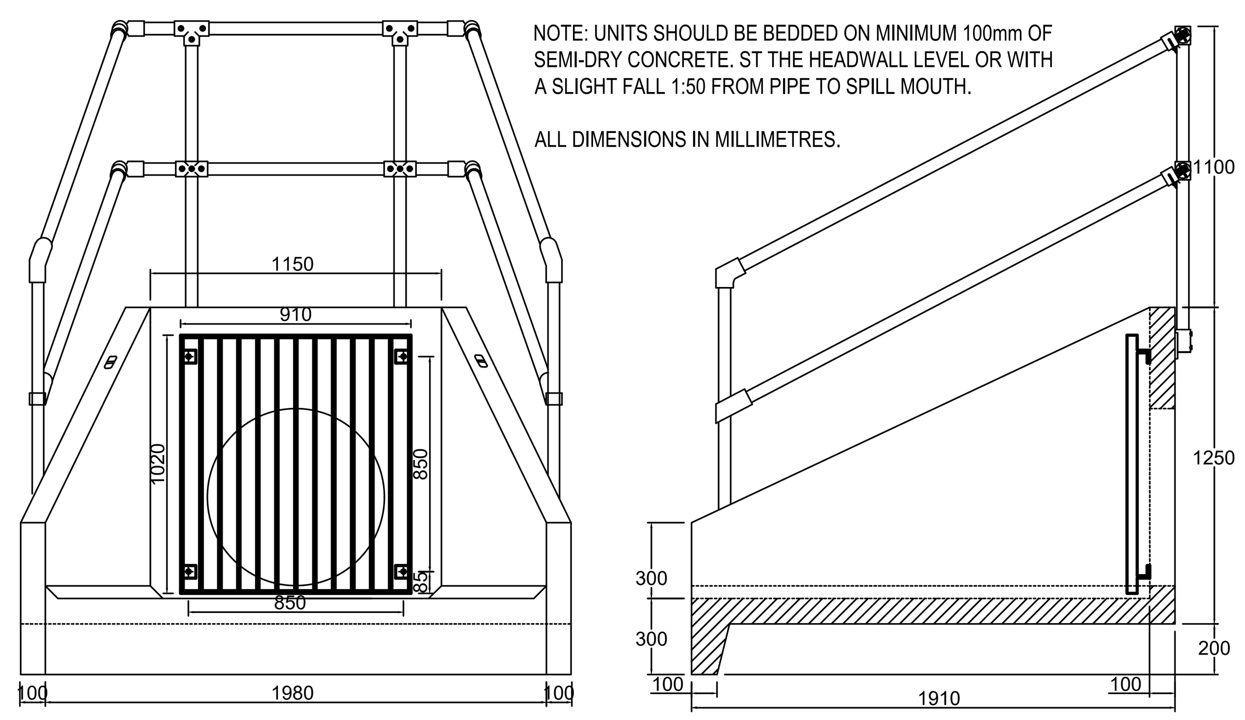
Y=1/4BC OR 150mm MINIMUM UP TO 600mm DIA
Y=1/6BC OR 100mm MINIMUM FOR 675mm DIA AND ABOVE
BC=PIPE EXTERNAL DIA

8. FOR PIPE MATERIALS, CLASS OF PIPE AND DEPTH SEE SEWER LONG SECTIONS.



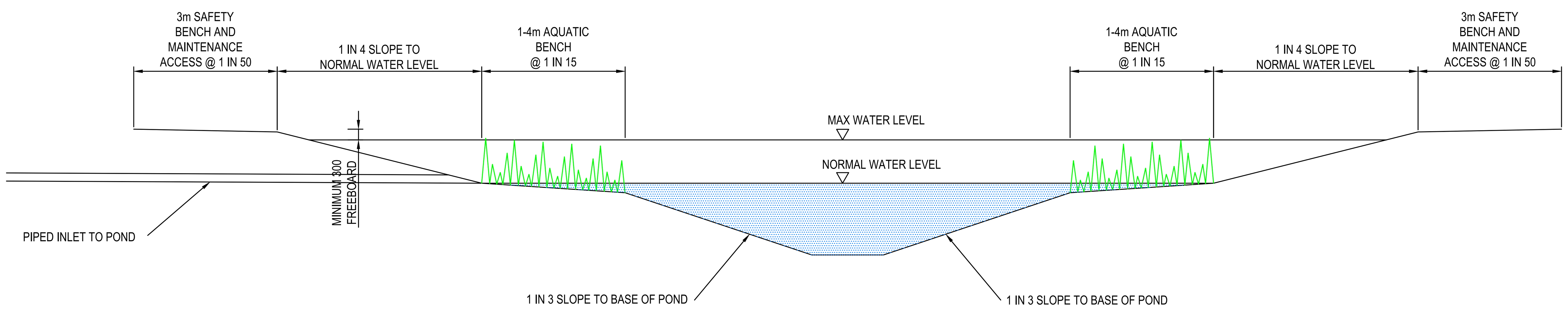
CUT-OFF SWALE

1:25



TYPE HEADWALL ATHON H10C A

NOT TO SCALE



TYPICAL POND CROSS SECTION

1:100

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GENERAL NOTES

1. PROPOSED DESIGN SHOWN ON THE DRAWING IN PROVISIONAL AND SUBJECT TO DETAIL DESIGN.
2. REFER TO DRAWING 60669422-AEC-NA-NA-C-DR-000001 FOR PROPOSED DRAINAGE STRATEGY.

ISSUE/REVISION

I/R	DATE	DESCRIPTION
P1	14.02.2024	PRELIMINARY ISSUE

PROJECT NUMBER

60669422

SHEET TITLE

TYPICAL CONSTRUCTION DETAILS

SHEET NUMBER

60669422-AEC-NA-NA-C-DR-000002

ISO A1 594mm x 841mm
Approved: DS
Checked: TB
Drawn: MR
Project Management Initials:

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Appendix B

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	56.376	0.076	1.9	75.9	O K
30 min Summer	56.399	0.099	2.4	99.6	O K
60 min Summer	56.424	0.124	2.6	126.1	O K
120 min Summer	56.462	0.162	2.8	166.2	O K
180 min Summer	56.486	0.186	2.8	191.5	O K
240 min Summer	56.503	0.203	2.9	209.4	O K
360 min Summer	56.524	0.224	2.9	232.6	O K
480 min Summer	56.536	0.236	2.9	246.2	O K
600 min Summer	56.543	0.243	2.9	254.3	O K
720 min Summer	56.548	0.248	2.9	259.4	O K
960 min Summer	56.554	0.254	2.9	265.6	O K
1440 min Summer	56.557	0.257	2.9	269.6	O K
2160 min Summer	56.555	0.255	2.9	266.9	O K
2880 min Summer	56.549	0.249	2.9	260.8	O K
4320 min Summer	56.537	0.237	2.9	247.2	O K
5760 min Summer	56.525	0.225	2.9	234.6	O K
7200 min Summer	56.516	0.216	2.9	224.5	O K
8640 min Summer	56.509	0.209	2.9	216.5	O K
10080 min Summer	56.503	0.203	2.9	210.2	O K
15 min Winter	56.385	0.085	2.1	84.9	O K
30 min Winter	56.411	0.111	2.6	111.6	O K
60 min Winter	56.439	0.139	2.7	141.6	O K
120 min Winter	56.482	0.182	2.8	187.0	O K
180 min Winter	56.508	0.208	2.9	215.9	O K
240 min Winter	56.527	0.227	2.9	236.5	O K
360 min Winter	56.552	0.252	2.9	263.8	O K
480 min Winter	56.567	0.267	2.9	280.5	O K
600 min Winter	56.576	0.276	2.9	291.1	O K
720 min Winter	56.582	0.282	2.9	297.7	O K
960 min Winter	56.587	0.287	2.9	303.4	O K
1440 min Winter	56.588	0.288	2.9	304.7	O K
2160 min Winter	56.581	0.281	2.9	297.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	35.594	0.0	57.5	19
30 min Summer	23.610	0.0	80.1	33
60 min Summer	15.210	0.0	119.4	64
120 min Summer	10.289	0.0	164.2	122
180 min Summer	8.087	0.0	194.7	182
240 min Summer	6.777	0.0	218.0	242
360 min Summer	5.230	0.0	252.6	362
480 min Summer	4.320	0.0	277.8	480
600 min Summer	3.710	0.0	297.5	596
720 min Summer	3.270	0.0	313.5	656
960 min Summer	2.667	0.0	337.5	772
1440 min Summer	1.991	0.0	365.5	1038
2160 min Summer	1.485	0.0	450.7	1448
2880 min Summer	1.213	0.0	489.5	1848
4320 min Summer	0.924	0.0	553.5	2680
5760 min Summer	0.772	0.0	634.4	3464
7200 min Summer	0.679	0.0	697.0	4256
8640 min Summer	0.617	0.0	758.1	5016
10080 min Summer	0.572	0.0	816.8	5840
15 min Winter	35.594	0.0	65.8	19
30 min Winter	23.610	0.0	91.1	33
60 min Winter	15.210	0.0	134.7	62
120 min Winter	10.289	0.0	184.8	120
180 min Winter	8.087	0.0	218.8	180
240 min Winter	6.777	0.0	244.8	238
360 min Winter	5.230	0.0	283.2	352
480 min Winter	4.320	0.0	311.0	468
600 min Winter	3.710	0.0	332.4	578
720 min Winter	3.270	0.0	349.5	688
960 min Winter	2.667	0.0	374.4	894
1440 min Winter	1.991	0.0	397.9	1112
2160 min Winter	1.485	0.0	505.1	1580

Summary of Results for 2 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
2880 min Winter	56.571	0.271	2.9	284.8	O K
4320 min Winter	56.547	0.247	2.9	258.4	O K
5760 min Winter	56.525	0.225	2.9	233.9	O K
7200 min Winter	56.507	0.207	2.9	213.8	O K
8640 min Winter	56.491	0.191	2.8	197.4	O K
10080 min Winter	56.479	0.179	2.8	184.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
2880 min Winter	1.213	0.0	548.4	2020
4320 min Winter	0.924	0.0	619.0	2896
5760 min Winter	0.772	0.0	711.0	3696
7200 min Winter	0.679	0.0	781.4	4536
8640 min Winter	0.617	0.0	850.1	5280
10080 min Winter	0.572	0.0	916.8	6048

Model Details

Storage is Online Cover Level (m) 57.500

Tank or Pond Structure

Invert Level (m) 56.300

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	980.0	1.200	1709.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0082-2900-0900-2900	Sump Available	Yes
Design Head (m)	0.900	Diameter (mm)	82
Design Flow (l/s)	2.9	Invert Level (m)	56.300
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	100
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	2.9	Kick-Flo®	0.564	2.3
Flush-Flo™	0.265	2.9	Mean Flow over Head Range	-	2.5

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)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	2.7	2.000	4.2	4.000	5.8	7.000	7.5
0.200	2.8	1.000	3.0	2.200	4.4	4.500	6.1	7.500	7.8
0.300	2.9	1.200	3.3	2.400	4.6	5.000	6.4	8.000	8.0
0.400	2.8	1.400	3.6	2.600	4.7	5.500	6.7	8.500	8.3
0.500	2.6	1.600	3.8	3.000	5.1	6.000	7.0	9.000	8.5
0.600	2.4	1.800	4.0	3.500	5.4	6.500	7.3	9.500	8.7

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	56.456	0.156	2.8	159.3	O K
30 min Summer	56.508	0.208	2.9	214.9	O K
60 min Summer	56.564	0.264	2.9	277.4	O K
120 min Summer	56.610	0.310	2.9	330.1	O K
180 min Summer	56.639	0.339	2.9	363.7	O K
240 min Summer	56.660	0.360	2.9	388.3	O K
360 min Summer	56.689	0.389	2.9	422.1	O K
480 min Summer	56.707	0.407	2.9	444.0	O K
600 min Summer	56.719	0.419	2.9	458.8	O K
720 min Summer	56.728	0.428	2.9	469.0	O K
960 min Summer	56.737	0.437	2.9	480.0	O K
1440 min Summer	56.739	0.439	2.9	483.2	O K
2160 min Summer	56.735	0.435	2.9	477.5	O K
2880 min Summer	56.728	0.428	2.9	468.9	O K
4320 min Summer	56.712	0.412	2.9	449.4	O K
5760 min Summer	56.697	0.397	2.9	431.6	O K
7200 min Summer	56.686	0.386	2.9	418.8	O K
8640 min Summer	56.678	0.378	2.9	409.1	O K
10080 min Summer	56.672	0.372	2.9	402.5	O K
15 min Winter	56.474	0.174	2.8	178.5	O K
30 min Winter	56.531	0.231	2.9	241.0	O K
60 min Winter	56.594	0.294	2.9	311.2	O K
120 min Winter	56.646	0.346	2.9	371.0	O K
180 min Winter	56.678	0.378	2.9	409.4	O K
240 min Winter	56.702	0.402	2.9	437.6	O K
360 min Winter	56.734	0.434	2.9	477.1	O K
480 min Winter	56.756	0.456	2.9	503.4	O K
600 min Winter	56.771	0.471	2.9	521.8	O K
720 min Winter	56.781	0.481	2.9	535.1	O K
960 min Winter	56.795	0.495	2.9	551.5	O K
1440 min Winter	56.803	0.503	2.9	562.6	O K
2160 min Winter	56.795	0.495	2.9	552.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	74.590	0.0	132.5	19
30 min Summer	50.584	0.0	179.1	34
60 min Summer	32.930	0.0	266.4	64
120 min Summer	19.931	0.0	321.9	124
180 min Summer	14.866	0.0	358.4	184
240 min Summer	12.072	0.0	385.3	242
360 min Summer	8.988	0.0	422.1	362
480 min Summer	7.275	0.0	443.0	482
600 min Summer	6.165	0.0	452.0	602
720 min Summer	5.381	0.0	453.0	722
960 min Summer	4.334	0.0	445.6	960
1440 min Summer	3.190	0.0	424.6	1338
2160 min Summer	2.347	0.0	708.3	1668
2880 min Summer	1.894	0.0	753.8	2072
4320 min Summer	1.411	0.0	778.7	2896
5760 min Summer	1.157	0.0	952.6	3696
7200 min Summer	1.004	0.0	1032.5	4536
8640 min Summer	0.902	0.0	1111.0	5360
10080 min Summer	0.830	0.0	1187.0	6152
15 min Winter	74.590	0.0	148.9	19
30 min Winter	50.584	0.0	198.1	33
60 min Winter	32.930	0.0	298.4	64
120 min Winter	19.931	0.0	359.2	122
180 min Winter	14.866	0.0	397.8	180
240 min Winter	12.072	0.0	424.9	240
360 min Winter	8.988	0.0	455.4	358
480 min Winter	7.275	0.0	463.5	474
600 min Winter	6.165	0.0	461.1	590
720 min Winter	5.381	0.0	456.5	706
960 min Winter	4.334	0.0	445.1	934
1440 min Winter	3.190	0.0	422.2	1384
2160 min Winter	2.347	0.0	786.3	1992

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
2880 min Winter	56.784	0.484	2.9	538.4	O K
4320 min Winter	56.758	0.458	2.9	506.6	O K
5760 min Winter	56.732	0.432	2.9	474.0	O K
7200 min Winter	56.710	0.410	2.9	447.0	O K
8640 min Winter	56.691	0.391	2.9	424.2	O K
10080 min Winter	56.675	0.375	2.9	405.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
2880 min Winter	1.894	0.0	825.1	2248
4320 min Winter	1.411	0.0	802.2	3156
5760 min Winter	1.157	0.0	1067.0	4040
7200 min Winter	1.004	0.0	1156.3	4904
8640 min Winter	0.902	0.0	1243.8	5792
10080 min Winter	0.830	0.0	1328.5	6656

Model Details

Storage is Online Cover Level (m) 57.500

Tank or Pond Structure

Invert Level (m) 56.300

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	980.0	1.200	1709.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0082-2900-0900-2900	Sump Available	Yes
Design Head (m)	0.900	Diameter (mm)	82
Design Flow (l/s)	2.9	Invert Level (m)	56.300
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	100
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	2.9	Kick-Flo®	0.564	2.3
Flush-Flo™	0.265	2.9	Mean Flow over Head Range	-	2.5

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)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	2.7	2.000	4.2	4.000	5.8	7.000	7.5
0.200	2.8	1.000	3.0	2.200	4.4	4.500	6.1	7.500	7.8
0.300	2.9	1.200	3.3	2.400	4.6	5.000	6.4	8.000	8.0
0.400	2.8	1.400	3.6	2.600	4.7	5.500	6.7	8.500	8.3
0.500	2.6	1.600	3.8	3.000	5.1	6.000	7.0	9.000	8.5
0.600	2.4	1.800	4.0	3.500	5.4	6.500	7.3	9.500	8.7

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	56.565	0.265	2.9	278.6	O K
30 min Summer	56.654	0.354	2.9	381.3	O K
60 min Summer	56.753	0.453	2.9	499.8	O K
120 min Summer	56.822	0.522	2.9	586.2	O K
180 min Summer	56.867	0.567	2.9	644.3	O K
240 min Summer	56.901	0.601	2.9	688.5	O K
360 min Summer	56.949	0.649	2.9	752.9	O K
480 min Summer	56.982	0.682	2.9	798.2	O K
600 min Summer	57.008	0.708	2.9	832.7	O K
720 min Summer	57.027	0.727	2.9	860.0	O K
960 min Summer	57.056	0.756	2.9	900.9	O K
1440 min Summer	57.087	0.787	2.9	944.2	O K
2160 min Summer	57.096	0.796	2.9	957.1	O K
2880 min Summer	57.088	0.788	2.9	946.4	O K
4320 min Summer	57.068	0.768	2.9	917.9	O K
5760 min Summer	57.053	0.753	2.9	896.3	O K
7200 min Summer	57.047	0.747	2.9	887.9	O K
8640 min Summer	57.046	0.746	2.9	886.6	O K
10080 min Summer	57.049	0.749	2.9	890.8	O K
15 min Winter	56.595	0.295	2.9	312.2	O K
30 min Winter	56.693	0.393	2.9	427.4	O K
60 min Winter	56.802	0.502	2.9	560.6	O K
120 min Winter	56.878	0.578	2.9	658.5	O K
180 min Winter	56.928	0.628	2.9	724.2	O K
240 min Winter	56.965	0.665	2.9	774.0	O K
360 min Winter	57.018	0.718	2.9	847.3	O K
480 min Winter	57.055	0.755	2.9	899.5	O K
600 min Winter	57.083	0.783	2.9	939.7	O K
720 min Winter	57.106	0.806	2.9	971.8	O K
960 min Winter	57.139	0.839	2.9	1021.0	O K
1440 min Winter	57.177	0.877	2.9	1076.5	O K
2160 min Winter	57.194	0.894	2.9	1101.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	130.023	0.0	220.3	19
30 min Summer	89.239	0.0	244.3	34
60 min Summer	58.786	0.0	454.2	64
120 min Summer	34.828	0.0	476.3	124
180 min Summer	25.741	0.0	466.2	184
240 min Summer	20.796	0.0	454.0	244
360 min Summer	15.404	0.0	437.6	364
480 min Summer	12.441	0.0	427.6	482
600 min Summer	10.540	0.0	421.1	602
720 min Summer	9.205	0.0	417.1	722
960 min Summer	7.441	0.0	414.8	962
1440 min Summer	5.493	0.0	417.5	1442
2160 min Summer	4.023	0.0	853.1	2160
2880 min Summer	3.223	0.0	830.4	2680
4320 min Summer	2.358	0.0	795.3	3412
5760 min Summer	1.905	0.0	1553.6	4160
7200 min Summer	1.635	0.0	1613.4	5040
8640 min Summer	1.456	0.0	1552.5	5872
10080 min Summer	1.330	0.0	1478.6	6752
15 min Winter	130.023	0.0	234.6	19
30 min Winter	89.239	0.0	245.6	34
60 min Winter	58.786	0.0	477.1	64
120 min Winter	34.828	0.0	466.3	122
180 min Winter	25.741	0.0	450.9	182
240 min Winter	20.796	0.0	440.8	240
360 min Winter	15.404	0.0	429.6	360
480 min Winter	12.441	0.0	425.0	478
600 min Winter	10.540	0.0	424.8	596
720 min Winter	9.205	0.0	427.8	714
960 min Winter	7.441	0.0	434.4	944
1440 min Winter	5.493	0.0	437.0	1412
2160 min Winter	4.023	0.0	867.0	2092

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
2880 min Winter	57.192	0.892	2.9	1098.9	O K
4320 min Winter	57.166	0.866	2.9	1060.2	O K
5760 min Winter	57.147	0.847	2.9	1032.7	O K
7200 min Winter	57.136	0.836	2.9	1016.5	O K
8640 min Winter	57.130	0.830	2.9	1006.4	O K
10080 min Winter	57.127	0.827	2.9	1002.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
2880 min Winter	3.223	0.0	859.2	2740
4320 min Winter	2.358	0.0	839.1	3588
5760 min Winter	1.905	0.0	1705.1	4440
7200 min Winter	1.635	0.0	1671.8	5400
8640 min Winter	1.456	0.0	1611.7	6312
10080 min Winter	1.330	0.0	1561.9	7264

Model Details

Storage is Online Cover Level (m) 57.500

Tank or Pond Structure

Invert Level (m) 56.300

Depth (m)	Area (m²)	Depth (m)	Area (m²)
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Hydro-Brake® Optimum Outflow Control

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Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
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Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	2.7	2.000	4.2	4.000	5.8	7.000	7.5
0.200	2.8	1.000	3.0	2.200	4.4	4.500	6.1	7.500	7.8
0.300	2.9	1.200	3.3	2.400	4.6	5.000	6.4	8.000	8.0
0.400	2.8	1.400	3.6	2.600	4.7	5.500	6.7	8.500	8.3
0.500	2.6	1.600	3.8	3.000	5.1	6.000	7.0	9.000	8.5
0.600	2.4	1.800	4.0	3.500	5.4	6.500	7.3	9.500	8.7