St Asaph PV Farm - Flood Consequence Assessment & Surface Water Drainage Strategy

Anesco Ltd

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Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
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02	14 March 2025	Karen Paez	Helena Preston	Andrew Dannatt
03	29 April 2025	Karen Paez	Chris Middleton	Andrew Dannatt

Basis of Report

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Executive Summary

SLR Consulting Limited (SLR) has prepared this Flood Consequence Assessment and Surface Water Drainage Strategy on behalf of Anesco Ltd to support a pre-application submission for a proposed construction, operation and decommissioning of a ground mounted photovoltaic solar farm, together with associated equipment, infrastructure and ancillary works at St Asaph, Cefnmeiriadog, Denbighshire, Wales, LL17 0HF (the site). A summary of key findings from this report are provided below.

Subject	Element	Findings
Site Flood Risk	Tidal	The site is remote from the coast and tidal flooding is not considered to pose a risk to the site.
	Fluvial	The Flood Maps for Planning indicates the site lies wholly in Flood Zone 1.
	Groundwater	Groundwater levels are not expected above approximately 3m below ground level and are considered unlikely to emerge at the surface. The flood risk at the site is considered very low.
	Surface Water	There are three un-named three watercourses in the vicinity of the site. Flood risk from surface water and small watercourses indicates no areas of elevated flood risk at the site except for some small flow paths intersecting with access tracks and the cable route. This risk to the development is therefore low.
	Sewers and Artificial Sources	Welsh Water do not have any mains or sewerage assets within the vicinity of the site. Therefore, the flood risk at the site is considered very low.
Site Details	Topography	Topographic survey has confirmed LiDAR for the site that indicates that the wider topography is dominated by the presence of local watercourses, with steep slopes rising towards the southwestern of the site.
	Hydrology	No existing drainage systems were observed across the site. Other surface water features observed included; a slurry pond at the southern access point into the fields, a pond along the watercourse at the northwestern boundary of the western field and a pond within Tyn-y-Coed forest to the east.
	Geology	British Geology Survey (BGS) mapping indicates that the site is underlain by Diamicton deposits. Diamicton is described as 'A type of siliciclastic sediment and sedimentary rock.' Diamicton has a low infiltration rate, which at this site is considered to preclude the use of infiltration SuDS.
Planning Requirements	Acceptability Criteria	As the site lies wholly in Flood Zone 1, the acceptability criteria is considered passed.
Mitigation measures	Design Flood Event	The design flood event (DFE) is the 1 % AEP event. A climate change allowance has been considered for peak rainfall intensity (30%) at the development site with no anticipated adverse impact.
	Finished Floor Levels	The site is at low risk of tidal, fluvial, and surface water flooding and there is no necessity to raise finished floor levels from the original design.

Subject	Element	Findings
	Safe access and egress	Safe access and egress to the site under adverse conditions may be provided with attendance with a 4x4 vehicle.
	Floodplain compensation	Not Required.
	Surface water drainage strategy	Runoff from the hardstanding area will be collected, treated and conveyed towards an attenuation swale through a conveyance swale. Discharge of surface water runoff from the swale will be controlled using a hydrobrake to a maximum rate of 1l/s. Flows from the hydrobrake will outfall into a watercourse. This method successfully offset the pollution hazard indices to satisfy the Simple Index Method.
	Residual Risk	Exceedance flood events in excess of the design standard indicates runoff will revert to the pre-existing regime with flows overtopping the swale and flowing to the watercourse.
Conclusion		This Flood Consequence Assessment and Surface Water Drainage Strategy concludes that the requirements of national, regional, and local planning policy can be achieved at the site given the nature of development proposed.

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Acronyms and Abbreviations

AOD	Above Ordnance Datum
BGL	Below Ground Level
FCA	Flood Consequence Assessment
NGR	National Grid Reference
NPPF	National Planning Policy Framework
PPG	Planning Practice Guidance
PV	Photo Voltaic
SAB	Sustainable Drainage Approving Body
SWDS	Surface Water Drainage Strategy
TAN15	Technical Advice Note 15

1.0 Introduction

1.1 Terms of Reference

SLR Consulting Limited (SLR) has been appointed by Anesco Ltd (the client) to produce a Flood Consequence Assessment (FCA) & Surface Water Drainage Strategy (SWDS) for the proposed St Asaph Photo Voltaic (PV) Farm at Cefnmeiriadog, Denbighshire, Wales, LL17 0HF (the site).

This document, an FCA & SWDS, has been prepared in support of a Full Planning Application for the Proposed Development of a PV Farm at the site and records the findings of a site walkover and assessment carried out in January 2022.

This FCA & SWDS has been prepared in accordance with guidance presented within the Planning Policy Wales (PPW)[1], Technical Advice Note 15[2] (TAN15) and taking due account of current best practice documents relating to assessment of flood risk published by the British Standards Institution BS8533[3] under the direction of a Technical Director of SLR who specialises in flood risk and associated planning matters.

1.2 Site Location

The site is centred on National Grid Reference (NGR) SJ02300 72873 and covers a total area of 33.54 ha. Situated to the southwest of St Asaph, Denbighshire, the site comprises two parcels of land (Area 1 and 2) separated by the Llwyn Penwyn Road.

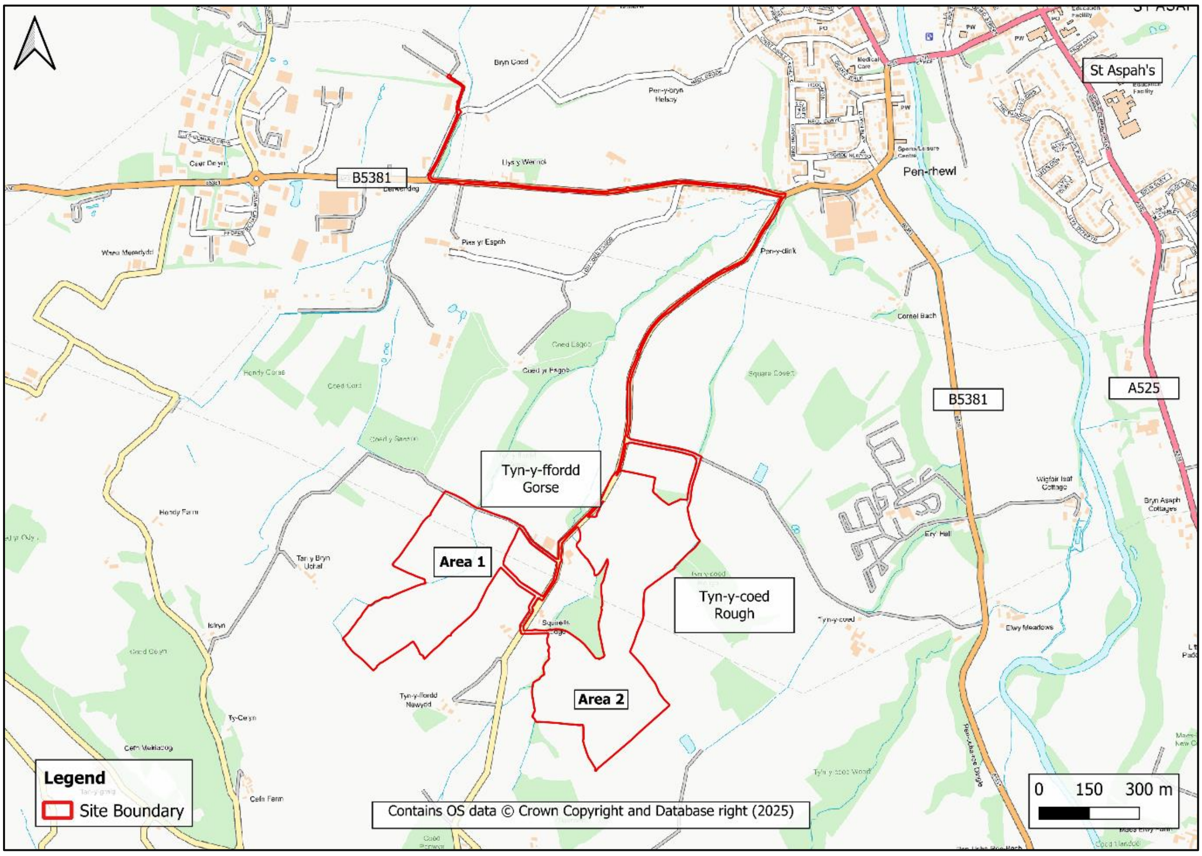
A site location plan is included below in Figure 1-1.

1 Planning Policy Wales, Edition 12. (February 2024)

2 Technical Advice Note 15: Development and Flood Risk to Planning Policy Wales (March 2025)

3 BS8533:2017, Assessing and managing flood risk in development: Code of Practice (December 2017)

Figure 1-1: Site Location Plan



As shown on Figure 1-1, Area 1 is located west of Llwyn Penwyn Road and is currently undeveloped. It is bound on the north by three forests; namely the Coed y Saeson to the north-west, the Coed Esgob to the north and, to the north east, the Tyn-y-ffordd Gorse. Area 1 is generally bounded to the west, south and east by arable land and is accessed from the east off Llwyn Penwyn.

Area 2, as shown on Figure 1-1, is located to the east of Llwyn Penwyn Road and is currently undeveloped. This area is delimited by the Pig-y-fran on the west and by the Tyn-y-coed Rough on the east. This area is accessed to the north by Llwyn Road.

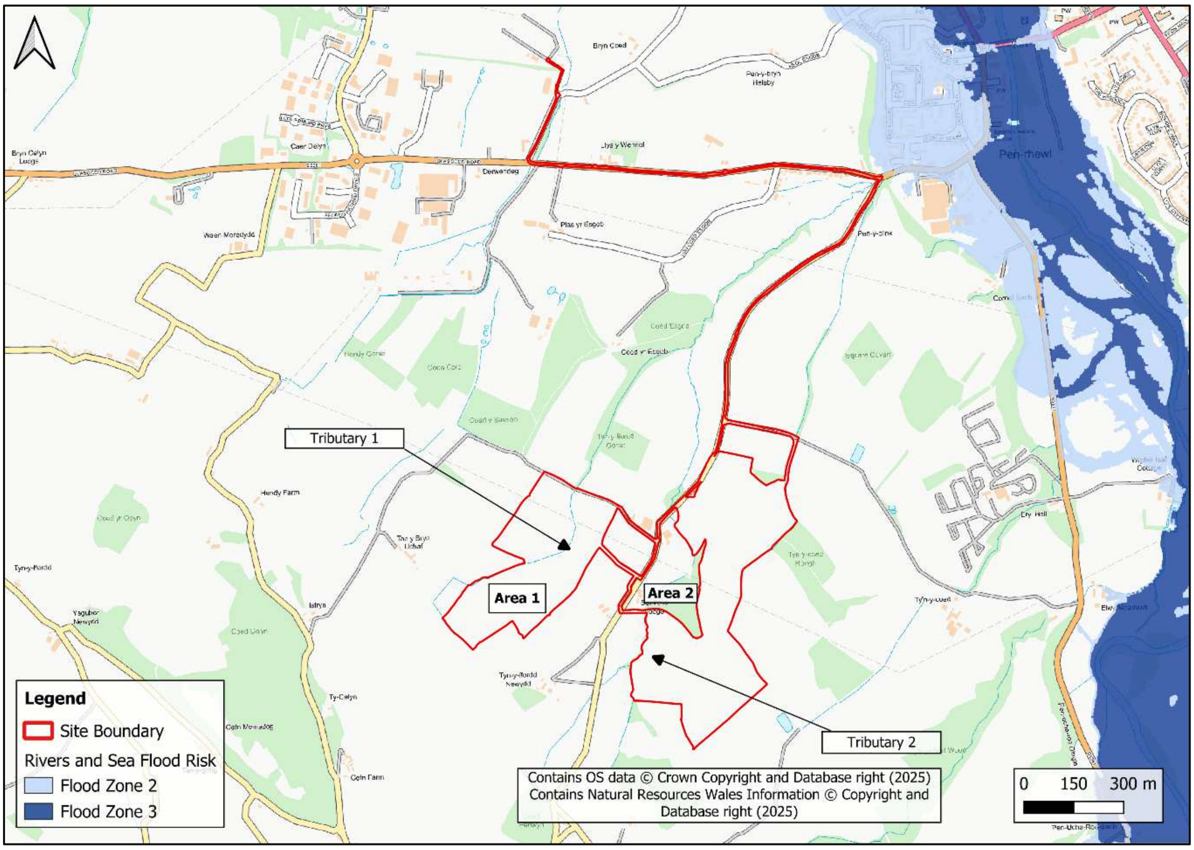
1.3 Background and Aims

With reference to Natural Resources Wales (NRW) Flood Maps for Planning[4], the site lies entirely within an area with Less than 1 in 1000 (0.1%) (plus climate change) chance of fluvial or coastal/tidal flooding in a given year (Flood Zone 1).

An extract of the Flood Maps for Planning is provided in Figure 1-2.

4 Natural Resources Wales (2025) Flood map for planning (April 2025). Natural Resources Wales / Flood map for planning

Figure 1-2: Extract of the Flood Maps for Planning from Rivers and Sea



With reference to the Planning Policy Wales[5] and its associated Technical Advice Note 15[2] (TAN15), the Justification Test is not applicable and there is no need to consider flood risk further.

TAN15 states that developments, change of use or conversions are acceptable in principle when located in Flood Zone 1. However, developments that may affect the course of surface water must be accompanied by an FCA as outlined in Sections 6 TAN15.

1.4 Administrative Context

The site is under the planning jurisdiction of Denbighshire County Council, who are responsible for the outcome of this application. Denbighshire County Council are also the Sustainable Drainage Systems (SuDS) Approving Body (SAB) for the area who deal with issues relating to localised flood risk and drainage.

1.5 Best Practice

This report has been prepared in accordance with the advice and requirements prescribed in the current version of TAN15[2] relating to the management of flood risk in development published by the Construction Industry Research and Information Association (CIRIA)[6] and the Welsh Government Statutory National Standards for Sustainable Drainage Systems.

5 Planning Policy Wales (Edition 11, February 2021)

6 CIRIA Report C624, Development and flood risk – guidance for the construction industry (October 2004)

2.0 Project Description

This FCA has been prepared in support of the proposal for the construction, operation and decommissioning of a ground mounted photovoltaic solar farm, together with associated equipment, infrastructure and ancillary works.

The Proposed Development comprises the installation of solar PV panels and construction of associated infrastructure, including feeder pillars and transformers; customer and Distribution Network Operator (DNO) substation; and ancillary equipment including security fencing and cable routes.

The development masterplan is enclosed as **Appendix 01.**

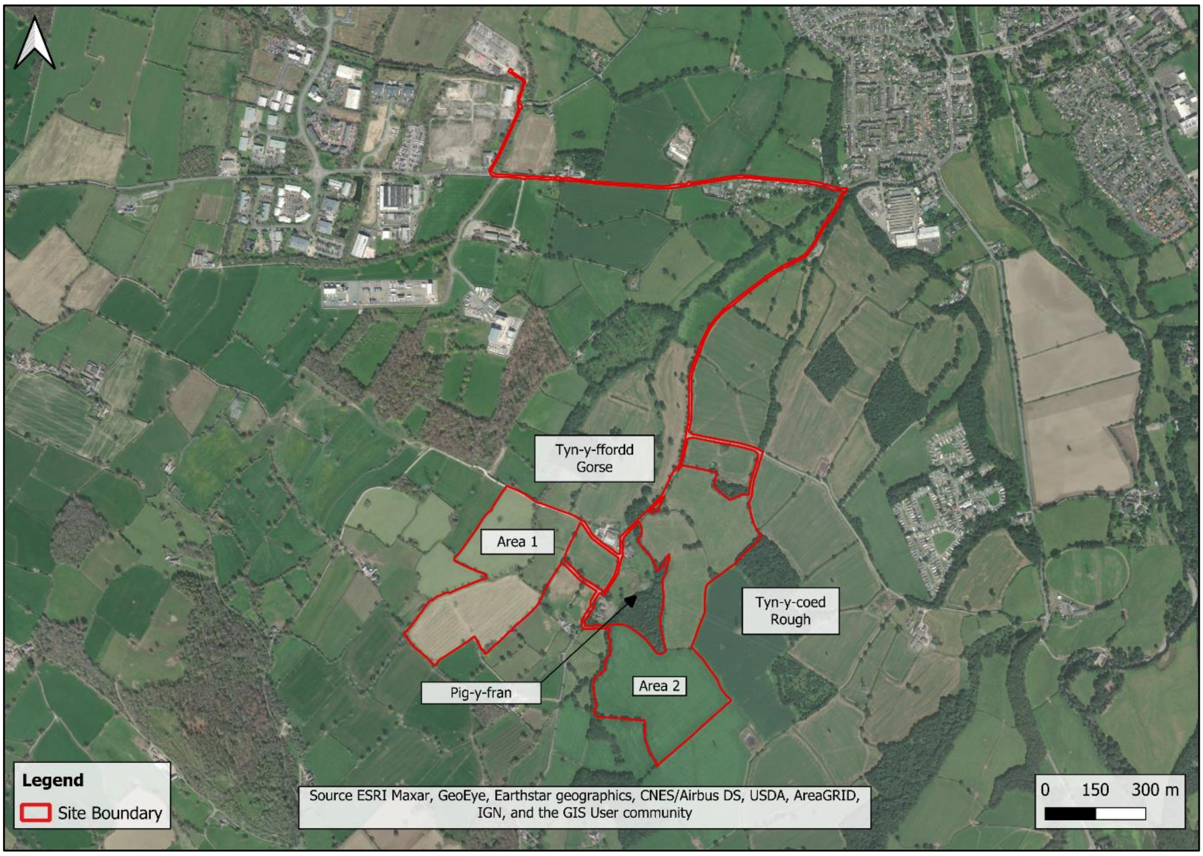
3.0 Site Details

3.1 Existing Site Description

A site walkover was carried out on 06/01/2022 to assess hydrological features across the site and to identify any potential hydrological and drainage issues prior to development. As a result of intermittent rainfall prior to and during the visit, hydrological features were helpfully more clearly defined.

For clarity, the land comprising the site is divided in Area 1 and Area 2 as shown in Figure 3-1 below.

Figure 3-1: Satellite Imagery of the Site



3.1.1 Area 1

Land comprising the site to the west of Llwyn Penwyn Road, as shown in Figure 3-1, is designated as Area 1.

Area 1 is estimated to be c.13.21ha of land and consists of adjacent grassland areas, grouped as a series of three adjacent fields to. These areas are served by a concrete access track, that runs west from the road allowing for easy access.

3.1.2 Area 2

Land defined in Figure 3-1 as Area 2 (east of Llwyn Penwyn Road) comprised three adjacent agricultural fields, measuring c.20.33 hectares (ha). Access to Area 2 is via the northernmost end of the eastern field.

3.1.3 Cable Route

The entire proposed cable route extends approximately 1.6 km north from Areas 1 and 2 along Llwyn Penwyn Road. The route then turns west, continuing for 1.1 km along Glascoed Road, before heading north again under Cwttir Lane for 0.4 km to reach St. Asaph's substation.

The cable route follows an existing highway from the main site to St. Asaph's substation.

3.2 Topography

Aerial photogrammetric data (LiDAR) topographic data for the site and immediate locality has been downloaded from the National Resources Wales (NRW) open data website[7] and is contained in Figure 3-2. Figure 3-2 provides bare earth elevation data using a Digital Terrain Model (DTM) and thus excludes built features and vegetation.

The LiDAR presented in Figure 3-2 indicates that the wider topography is dominated by the presence of local watercourses, with steep slopes rising towards the southwestern of the site. Figure 3-2 presents the data for the two areas of the site.

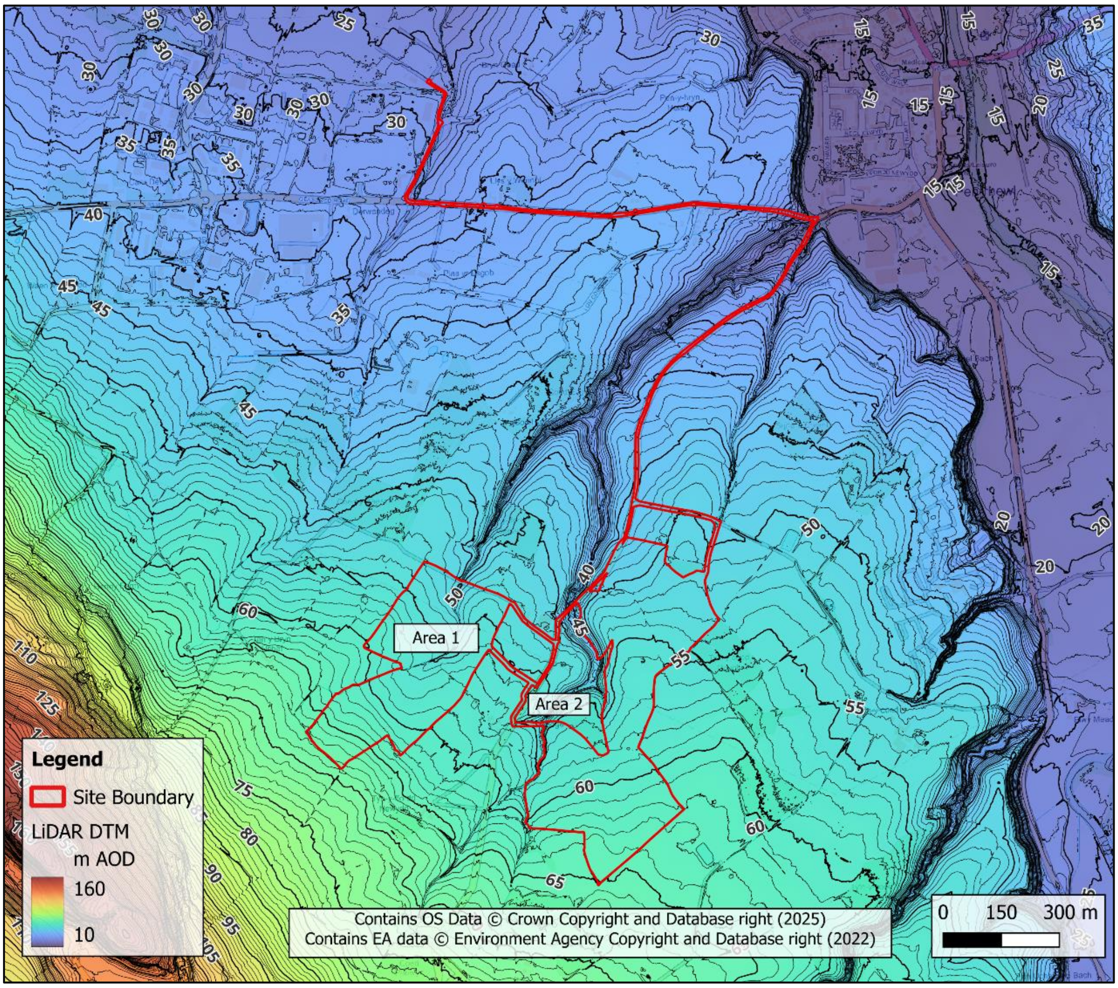
LiDAR shows that ground elevations across Area 1 generally fall towards Tributary 1 (Figure 3-3) from approximately 68.32m Above Ordnance Datum (AOD) in the south west to 50.38m AOD along the northernmost end of Tributary 1.

Excluding the access road, across Area 2, ground elevations generally fall towards Tributary 2 (Figure 3-3) from approximately 65.08m AOD to 46.39m AOD at the northernmost corner of the site. Ground elevations along the access road of Area 2 falls from 51.85m AOD to 46.15 m AOD in a general northerly direction.

The proposed cable route elevations fall generally in a north easterly direction from around 56.68 m AOD from the main site (Area 1 and 2). The route descends to a minimum elevation of 17.93 metres AOD when reaching Glascoed Road. From this point, the elevation rises to approximately 31.09 metres AOD before the route realigns northward along Cwttir Lane, terminating at St. Asaph's substation at an elevation of 25.79 metres AOD.

7 Natural Resources Wales, Lle geoportal, http://lle.gov.wales/Catalogue/Item/LidarCompositeDataset/?lang=en

Figure 3-2: 2m DTM LiDAR plot of the site



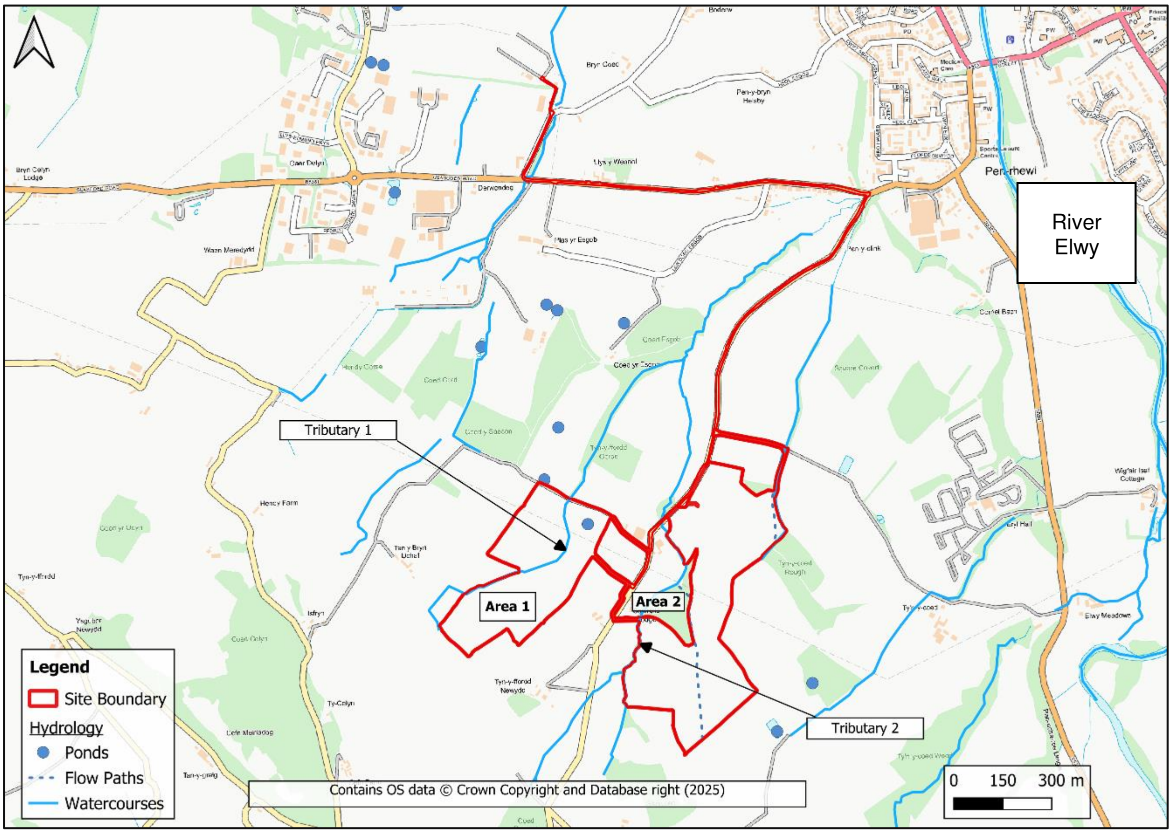
3.3 Hydrology

The River Elwy is situated approximately 750m east of the site at its closest point. River depths are recorded at St Asaph Station, located 2.5km north east, and fluctuate annually between 0.98m to 3.90m[8].

LiDAR[6] data indicates that St Asaph Station is set at an elevation of 10.33m above Ordnance Datum (AOD). The river at its maximum annual recorded level will be, consequently, at 14.23 m AOD, significantly below the elevation of the site. Other small watercourses present in the vicinity of the site are considered to outfall northwards into the Elwy.

8 River levels, rainfall and sea data, Natural Resources Wales, https://rivers-and-seas.naturalresources.wales/Station/4188?

Figure 3-3: Water Features of the site



3.3.1 Area 1

Some drainage ditches were present along the field boundaries during the site walkover. However, as local gradients fall west towards the watercourse (Tributary 1), most incidental rainfall would flow overland towards this regardless. Refer to Figure 3-3: Water Features of the site. Soils were slightly waterlogged at the time of the site visit due to rainfall.

Other surface water features across these areas included; a pond at the southernmost field within the northern area and a pond at the northeastern field within Area 1. No existing drainage systems were observed across either field.

3.3.2 Area 2

Land at these fields were observed to gently undulate across some areas (see Figure 3-3: Water Features of the site), which occasionally creates shallow sumps for surface water to collect within (Flow Path1 and Flow Path 2). Soils at the site however appeared very loamy and were heavily saturated.

A drainage ditch was present at around the eastern border of the two northern field of Area 2 and were observed to be in good condition, holding flowing water. This was similar for the western field, but no clear ditches were observed at the northern border, where ground was heavily saturated. However, at the northwestern boundary of the western field, topography declined at a much steeper rate towards an un-named watercourse, Tributary 2, which flowed along the field boundary to the northeast.

3.3.3 Overall Site

No existing drainage systems were observed across either area of the main site (Area 1 and 2); however, potential underground utilities were observed at a concrete structure at the northern side of the boundary between the two fields. Other surface water features observed included; a slurry pond at the southern access point into the fields, a pond along the watercourse at the north western boundary of the western field and a pond within Tyn-y-Coed forest to the east as shown in Figure 3-3: Water Features of the site.

3.4 Drainage Regime

As the existing site comprises of undeveloped greenfield land and lacks any formal drainage, runoff will therefore 'drain' via a combination of infiltration into the subsoil with any excess flow conveyed overland following local topographic gradients.

3.5 Geological and Hydrogeological Context

3.5.1 Geology

British Geology Survey (BGS) mapping[9] indicates that the site is underlain by Diamicton deposits. Diamicton is described[10] as '*A type of siliciclastic sediment and sedimentary rock. Sediments that are poorly sorted and contain a wide range of clast sizes can be given this root name. The strict descriptive definition relates to range of particle size and not to relative abundance of any or all size classes.'*

The BGS mapping shows a series of private boreholes in the vicinity of the site but no access to their records is available. However, there is a series of boreholes in Diamicton along the A55, approximately 2 km north of the Site. Boreholes SJ07NW90 and SJ07SW222 logs[11] describe the soil as '*stiff brown silty clay*'.

Diamicton is underlain by the Warwickshire Group (Bedrock). The Warwickshire Group is defined by the BGS[12] as '*Predominantly red, brown or purple-grey sandstone, siltstone and mudstone, some grey strata, coals not common, local conglomerates, localised beds of Spirorbis limestone.*'

3.5.2 Hydrogeology

The Warwickshire Group beneath the site has been designated as a *'Secondary A'* Aquifer[13], defined as *''permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers".* Aquifer designation for superficial deposits was not available for the area.

Boreholes SJ07NW90 and SJ07SW22[14] extended to 3.75 and 4.7 m below ground level (bgl) and recorded no groundwater. It is considered that groundwater level at the site would also be no higher than 3.75m bgl. The infiltration rate for the soil described in these boreholes is expected to vary between $1x10^{-8}$ to $3x10^{-6}$ m/s.

9 BGS Geology of Britain Viewer, available at http://mapapps.bgs.ac.uk/geologyofbritain/home.html

10 BGS Geology of Britain: Rock Classification Scheme, available at https://webapps.bgs.ac.uk/bgsrcs/rcs_details.cfm?code=DMTN

11 BGS Geology of Britain: Borehole Records, available at, https://www.bgs.ac.uk/information-hub/borehole-records/

12 BGS Geology of Britain: Rock Classification Scheme, available at, https://webapps.bgs.ac.uk/lexicon/lexicon.cfm?pub=WAWK

13 Magic Map, DEFRA, https://magic.defra.gov.uk/MagicMap.aspx

14 BGS Geology of Britain: Borehole Records, available at, https://www.bgs.ac.uk/information-hub/borehole-records/

4.0 Policy Status for the Proposed Development

4.1 Flood Risk Vulnerability

In line with TAN15 Figure 4, the site proposals are classified as 'Renewable energy generation facilities' and is therefore a *'less vulnerable development'*.

4.2 Anticipated Lifetime of Development

In lieu of further information, a 40-year development lifetime is applied unless there is specific justification for considering a shorter period.

4.3 Planning Policy

The Planning Policy Wales[5] ensures that flood risk is taken into account at all stages in the planning process and that development is sustainable.

This document has been prepared using best practice principals using The SuDS Manual[6], TAN15[2] and Statutory standards for Sustainable Drainage Systems[15].

Technical Advice Note 8 (TAN8): Planning for Renewable Energy[16] was published in July 2005 and sets out the Welsh Government planning policy on renewable energy systems. In accordance with TAN8, the Welsh Government in February 2011 additionally published Planning Guidance - Planning Implications of Renewable and Low Carbon Energy[17] which considers the role of solar PV arrays on hydrology and flood risk.

Paragraph 8.4.18 states:

> *The potential effects of a solar PV array on hydrology and flood risk should be considered. In general, these are unlikely to be significant because the presence of solar arrays will not greatly increase the time for rainwater to reach the ground where it can infiltrate in the usual way and because the panels will typically cover no more than one third of the site area. The effects of the panels, in combination with access tracks, earth works, buildings for inverters, cable trenches and site drainage works will nevertheless need to be assessed. An assessment of existing flood risk at the site should also be undertaken to consider the need for electrical equipment to be raised off the ground and to ensure that any on site works do not exacerbate flooding elsewhere.*

This report, an FCA & SWDS, provides both an assessment of existing flood risk, and where necessary future flood risk, as well as a supportive drainage strategy which covers the fundamental requirements set out in Paragraph 8.4.18.

4.3.1 Denbighshire County Council

The Local Development Plan (2006–2021)[18] (LDP) was adopted in June 2013 and is the development plan for Denbighshire County Council. It provides the basis for decisions, objectives, spatial strategy and vision for the county.

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15 Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems, Welsh Government, 2018

16 Technical Advice Note 8: Planning for Renewable Energy to Planning Policy Wales (2005)

17 Planning Guidance- Planning Implications of Renewable and Low Carbon Energy, Welsh Assembly Government, February 2011

18 Denbighshire County Council Local Development Plan (2006-2021) Adopted June 2013 (Accessed: 29 April 2025)

Relevant policies relating to flood risk, drainage matters and in relation to the development context are outlined in Objective 12 and, 14 of the annual monitoring process and covered accordingly below:

Overarching Polices

Policy VOE 1 - Key Areas of importance

The policy designates statutory areas requiring protection from development that would adversely affect them. The aims to address flood risk by monitoring development compatibility under this policy by:

> *"Directing inappropriate development away from the flood plain"*

Sustainable Drainage Systems

Policy VOE 6, Water Management

Water management in this context refers to the water consumption conservation; however, the policy explicitly address the requirement for Sustainable Drainage Systems:

> "*The use of Sustainable Drainage Systems (SuDS) to manage surface water flows can also be an important tool in minimising flood risk by increasing permeable surfaces in an area which allows water to seep into the ground rather than running off into the drainage system. The effective use of permeable surfaces, soakaways and water storage areas should be incorporated in all new development where technically possible. SuDS can also reduce the impact of diffuse pollution from runoff and flooding securing environmental, biodiversity and aesthetic benefits. Early consideration of SuDS is required in order that a range of techniques can be considered and developers are encouraged to enter into early discussions with the Council."*

This assessment will demonstrate how the development complies the with the LDP in so far as it relates to flood risk and drainage matters.

4.3.2 Development Category

With reference to Section 4.2, the proposed solar farm is considered a 'less vulnerable development'.

With reference to Section 10 of TAN15, all developments in Zone 1 are considered to be acceptable.

4.3.3 Development Acceptability

With reference to Section 11 of TAN15, all new development in Wales should ensure that the following conditions are met;

- No increase in flooding elsewhere
- Occupiers aware of flood risk
- Escape/evacuation routes present
- Flood emergency plans and procedures agreed and in place
- Flood resistant and resilient design
- Acceptable consequences for type of use (*less vulnerable*)

These acceptability criteria are reviewed in Section 5.0.

5.0 Assessment of Flood Risk

5.1 Potential Sources of Flooding

There are a number of potential sources of flooding and these include:

- Flooding from rivers or fluvial flooding;
- Flooding from the sea or tidal flooding;
- Flooding from surface water or pluvial flooding;
- Flooding from groundwater;
- Flooding from sewers; and
- Flooding from reservoirs, canals, and other artificial sources.

The flood risk from each of these potential sources is discussed below.

5.1.1 Flooding from Rivers or Fluvial Flooding and from Sea or Tidal Flooding

With reference to the Flood Maps for Planning (Figure 1-2), the site and proposed cable route length lies wholly within Flood Zone 1 and is therefore outside an area having less than 0.1% Annual Exceedance Probability (AEP) or less than 1 in 1,000-year annual probability of flooding from fluvial and tidal sources.

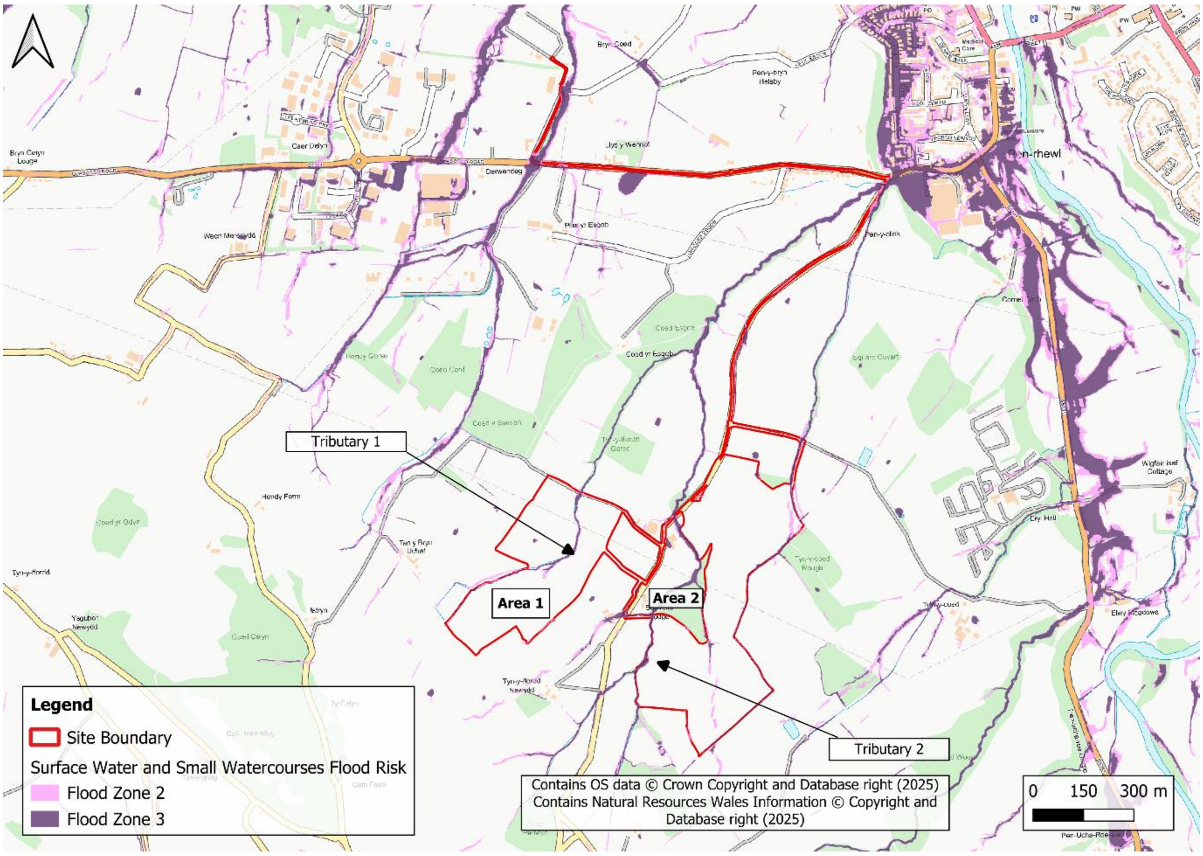
Flooding from these sources is very low and not considered further.

5.1.2 Flooding from Surface Water or Pluvial Flooding

The detailed surface water flood risk maps published by NRW[4], shows areas potentially at risk of flooding from surface water. The surface water flood risk categories are defined as:

- Low: less than 1 in 100 (1% AEP) but greater than or equal to 1 in 1,000 (0.1% AEP) chance of flooding in any given year;
- Medium: between 1 in 100 (1% AEP) and 1 in 30 (3.3% AEP) chance of flooding in any given year; and
- High: greater than 1 in 30 (3.3% AEP) chance of flooding in any given year.

Figure 5-1: Extract of the NRW Surface Water Flood Map



With reference to Figure 5-1, the areas at risk of flooding within the site are shown to be linear and often extend beyond the site boundary. A comparison of these areas against LiDAR shows flood flow pathways aligning with topographical valleys.

These areas at risk of flooding are therefore considered to be flow paths. As these flow paths have relatively small upstream catchments, the resulting overland flow and associated flood extent is expected to be limited to no greater than that shown on Figure 5-1.

The risk of flooding from this source is therefore considered low and not considered further. It should be noted that these conveyance routes will nonetheless be retained as part of the proposed development, thereby maintaining the existing hydrological and hydraulic regime.

During the construction phase, there is a possibility that excavations for the proposed cable may be affected by surface water flooding. However, excavations and installation of the cable is anticipated to be completed within a few months and therefore is not at significant long term flood risk.

5.1.3 Flooding from Groundwater

Groundwater flooding generally occurs during intense, long-duration rainfall events, when infiltration of rainwater into the ground raises the level of the water table until it exceeds ground levels. It is most common in low-lying areas overlain by permeable soils and permeable geology, or in areas with a naturally high-water table.

Groundwater levels are not expected above approximately 3m bgl as discussed at Section 3.3.2, and given the low permeability of the superficial deposits, would be highly unlikely to emerge at the ground surface.

Flooding from this source is not considered to be significant and therefore not assessed further.

5.1.4 Flooding from Sewers

No mains water pipes or wastewater sewers were recorded in the vicinity of the site during the site visit. Flood risk from sewers is therefore nil.

5.1.5 Flooding from Reservoirs, Canals and Other Artificial Sources

There are no reservoirs upgradient of the site and therefore flooding from this source is nil.

Flooding from Reservoirs, Canals and Other Artificial Sources is negligible and not considered further.

5.1.6 Flooding from Infrastructure Failure

The site is not afforded protection from flood defences, nor are there any sewerage pumping stations or other significant infrastructure within the vicinity of the site which may pose a flood risk.

Flooding from Infrastructure Failure is therefore very low and not considered further.

5.2 Flood Risk Summary

A summary of the potential sources of flooding and the flood risk arising from them is presented in Table 5-1.

Table 5-1: Potential Sources of Flooding

Potential Source of flooding	Significant Flood Risk at the Site (Y/N)
Rivers or Fluvial Flooding	N
Sea or Tidal Flooding	N
Surface Water or Pluvial Flooding	N
Groundwater	N
Sewers	N
Reservoirs, Canals and other Artificial Sources	N
Infrastructure Failure	N

The flood screening assessment indicates that the site is not a significant risk of flooding.

5.3 Flood Risk Classification

The description of the flood Zones to control and manage development is described in TAN15 Figure 1 and is summarised below:

Table 5-2: Definition of Flood Map for Planning Flood Zones

Zone	Flooding from river	Flooding from sea	Flooding from surface water and small watercourses
1	Less than 1 in 1000 (0.1%) (plus climate change) chance of flooding in a given year		

Zone	Flooding from river	Flooding from sea	Flooding from surface water and small watercourses
2	Less than 1 in 100 (1%) but greater than 1 in 1000 (0.1%) chance of flooding in a given year, including climate change.	Less than 1 in 200 (0.5%) but greater than 1 in 1000 (0.1%) chance of flooding in a given year, including climate change.	Less than 1 in 100 (0.5%) but greater than 1 in 1000 (0.1%) chance of flooding in a given year, including climate change.
3	A greater than 1 in 100 (1%) chance of flooding in a given year, including climate change	A greater than 1 in 200 (1%) chance of flooding in a given year, including climate change.	A greater than 1 in 100 (1%) chance of flooding in a given year, including climate change.
TAN15 Defended Zones	Areas where flood risk management infrastructure provides a minimum standard of protection against flooding from rivers of 1:100 (plus climate change and freeboard).	Areas where flood risk management infrastructure provides a minimum standard of protection against flooding from the sea of 1:200 (plus climate change and freeboard)	Not applicable

Based on the screening study, the entire site lies within Flood Zone 1 and is therefore at very low risk of flooding from any potential sources.

6.0 Climate Change

In September 2021, NRW[19] issued updated guidance on the impacts of climate change on flood risk, to be used in flood consequence assessments in support of relevant planning applications. This guidance sets out peak rainfall intensity, sea level, peak river flow, and extreme wave heights are all expected to increase in the future as a result of climate change.

The guidance acknowledges that in relation to certain factors there is considerable uncertainty with respect to the absolute level of change that is likely to occur. As such, in these instances, the guidance provides estimates of possible changes that reflect a range of different emission scenarios.

Concerns relating to offshore wind speed and wave height a are only of relevance in contexts that are in direct proximity to the open coast or other large open bodies of water. There are also no associated risks of fluvial flooding from nearby reservoirs or small watercourses. The climate change allowances applicable to the site therefore relate to peak rainfall intensity.

6.1 Peak Rainfall Intensity Allowance

An extract of *Table 2: Change to Extreme Rainfall Intensity* is reproduced as Table 6-1.

Both the central and upper estimates should be assessed to understand the range of impact. The central estimate should be used to inform design levels, whereas where the assessment indicates a significant flood risk for the upper end estimate, the flood consequences assessment will need to provide mitigation measures.

Table 6-1: Change to Extreme Rainfall Intensity (Compared to 1961-90 baseline)

Allowance Category	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper End	25%	40%	75%
Central	15%	25%	30%

Having reviewed the Upper End and Central Allowances and in line with Table 6-1, the Surface Water Drainage Strategy has been developed to take into account increases in rainfall intensity of 30% over the lifetime of the entire development.

This aligns with the consultation response dated 25/02/2025 from the Lead Local Flood Authority (LLFA) which stated that *"the applicant should provide details of the surface water drainage proposals which should be designed to accommodate the 1 in 100 year plus 30% climate change event with any discharge, for example to a watercourse, restricted to the existing greenfield runoff rates."*

19 Flood Consequences Assessments: Climate Change allowance. Natural Resources Wales, September 2021

6.2 Sea Level Rise Allowances

An extract of *Table 3: Estimated mean sea level rise (in metres) for relevant local authority areas* is reproduced as Table 6-2.

Development proposals should be assessed against the relevant regional 70th percentile presented in Table 3 to inform design levels. The 70th percentile should also be assessed inform mitigation measures, access and egress routes and emergency evacuation plans.

Table 6-2 Estimated mean sea level rise (in metres) for relevant local authority areas by 2100 and 2120. Allowances are based on RCP8.5 70th and 95th percentiles

Local Authority Area	Allowance Percentile	Mean Sea Level Rise (metres) by 2100 *(UKCP18 baseline 1981-2000)	Mean Sea Level Rise (metres) by 2120 *(UKCP18 baseline 1981-2000)
Denbighshire	70th	0.75	0.90
	95th	0.95	1.15

The review of tidal flooding at the site will therefore consider the 1.10m uplift associated with the 95th percentile up until 2100. In reality, the anticipated lifetime of development is 40 years (to 2051), and therefore a 0.95m rise is a precautionary approach to assessing tidal flood risk at the site.

The site is located about 10 km south of the coast. Extreme tidal levels from Flood Zone B (past evidence of flooding / 0.1% AEP) have been extrapolated from the flood outline using LiDAR datum. The extrapolation indicates an extreme tidal flood level would be at 21.43m AOD and therefore, at least 30m lower than the site.

It is therefore impractical to consider the effects of sea level rise associated with climate change further with regards to flood risk at the site. It is also confirmed the site will remain in Zone A (c*onsidered to be at little or no risk of fluvial or coastal/tidal flooding)* throughout the lifetime of development.

6.3 Peak River Flow Allowances

An extract of *: Change to Extreme Rainfall Intensity* is reproduced as **Table 6-3.**

Both the central and upper estimates should be assessed to understand the range of impact. The central estimate should be used to inform design levels, whereas where the assessment indicates a significant flood risk for the upper end estimate, the flood consequences assessment will need to provide mitigation measures.

Table 6-3 Table 1: Peak River Flow Allowances by River Basin District (using 1961 to 1990 baseline)

River Basin District	Total Potential Change Anticipated by the 2020s	Total Potential Change Anticipated by the 2050s	Total Potential Change Anticipated by the 2080s
Upper End Estimate	25%	40%	75%
Central Estimate	15%	25%	30%

As discussed in Sections 3.1.3 and 3.1.3, the catchment of the flow paths and tributaries are relatively small, and the topography falls to c.47m (AOD) towards these features. Consequently, any increase in peak river flow is not expected to have a significant impact on flood risk at the site.

7.0 Surface Water Drainage Strategy

7.1 Sustainable Drainage Systems

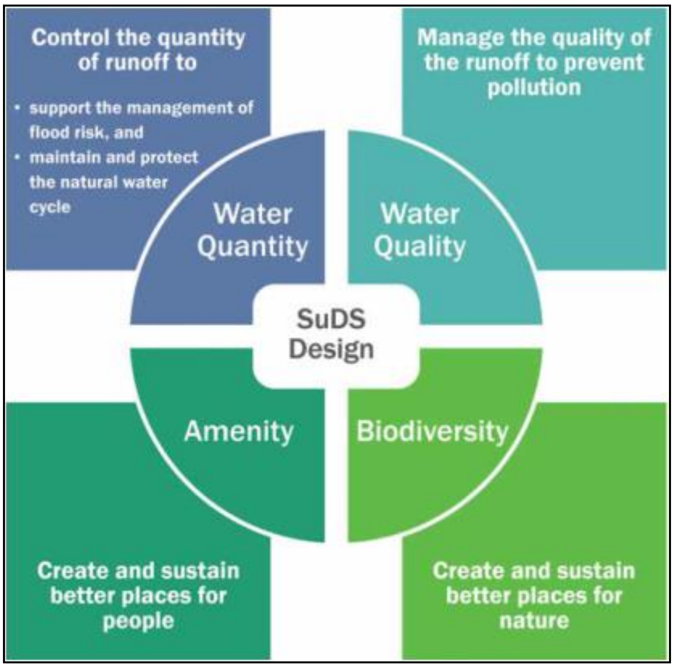
Sustainable drainage systems (SuDS) are required to manage both the rate and volume of runoff and importantly surface water quality.

Surface water drainage provision for new development is subject both to the planning process and, following implementation of Schedule 3 to the Flood and Water Management Act 2010, approval by the SAB.

The current best practice guidance document, The SuDS Manual[20], promotes sustainable water management through the use of SuDS and is required by the Welsh Government Statutory standards for sustainable drainage systems[21]. These systems must be approved by Denbighshire County Council acting in its SAB role before construction work begins. The SAB will have a duty to adopt compliant systems so long as it is built and functions in accordance with the approved proposals, including any SAB conditions of approval.

There are four main categories which are referred to as the '*four pillars of SuDS*' as summarised in Figure 7-1.

Figure 7-1: Four Pillars of SuDS (after CIRIA Report C753)



The SuDS Manual identifies a hierarchy of SuDS for managing runoff, which is commonly referred to as a 'management train' and is depicted in Figure 7-2:

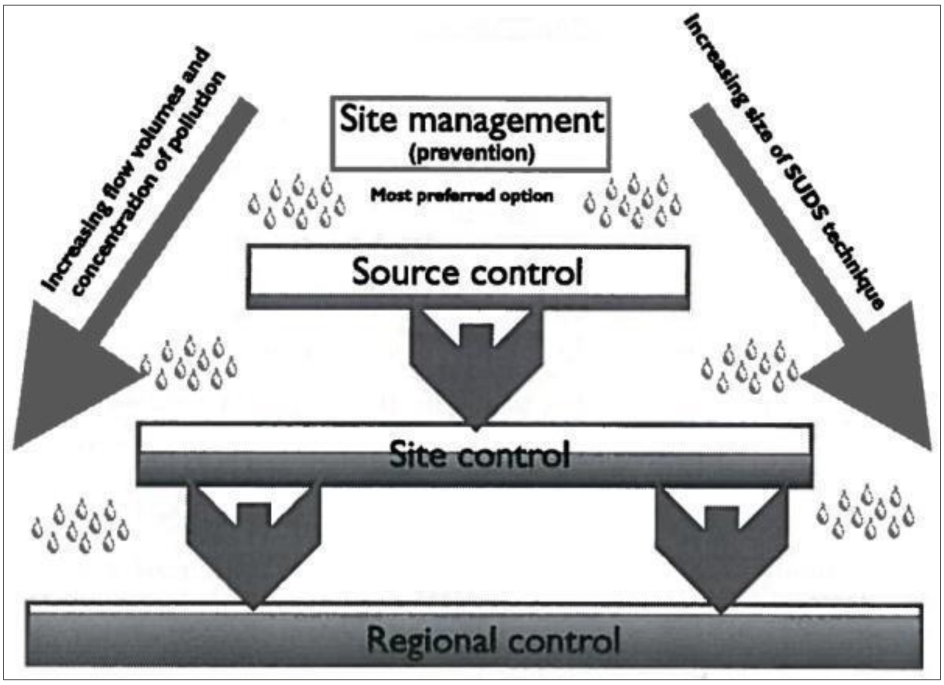
- **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing).
- **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting).

20 CIRIA (2015). Report C753, The SuDS Manual

21 Statutory National Standards for Sustainable Drainage Systems, published on October 2018

- **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site).
- **Regional Control** – management of runoff from several sites, typically in a retention pond or wetland.

Figure 7-2: SuDS Management Train



It is generally accepted that the implementation of SuDS, as opposed to conventional drainage systems, provides a number of 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; and
- Improving amenity through the provision of public open spaces and wildlife habitat; and replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

In addition to the above, Denbighshire County Council, as the (LLFA) and SAB, promote the use of SuDS as set out in the SuDS Pre-Application.

The SAB requirements are extracted from the Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems[1515] which have six key themes:

- S1. Surface water runoff destination
- S2. Surface water runoff hydraulic control
- S3. Water Quality

- S4. Amenity
- S5. Biodiversity
- S6. Design of drainage for construction, operation and maintenance

These themes will be used to adopt an achievable drainage strategy at the site.

7.2 Drained Area

The proposed solar panels will intercept precipitation and shed this onto the ground along the lower edge of each array (the 'drip-line'). However, runoff from each solar panel will continue to infiltrate into the underlying soils in much the same way as existing conditions.

Additionally, the grass vegetation that will be permanently maintained between and beneath the solar panel arrays will also ensure that the runoff generated will continue to drain diffusely across the site following the general topography.

Although there will be a small increase in impermeable surface area due to the construction of the substations, inverters and ancillary buildings, the total increase in effective impermeable surface from these elements of the proposed development is not considered to be significant. The runoff from the roofs of these elements will simply be shed to adjacent ground and as such, there would be no material increase in surface water runoff when compared to existing conditions.

However, it is proposed that the proposed hardstanding area within Area 1 as shown on Drawing No. C0002452_02 Rev. V4 enclosed at **Appendix 01** will be positively drained.

Section 3.2.7 of The SuDS Manual recommends that the potential increase in the *'impermeability of the contributing catchment through the design life of the drainage system should (…) be taken into account.'*

Section 24.7.2 of The SuDS Manual defines urban creep as:

> *'any increase in impervious area that is drained to an existing drainage system without planning permission being required, and therefore without any consideration of whether the capacity of the receiving sewerage system can accommodate the increased flow.'*

The SuDS Manual recommends that an allowance of 10% is made in respect of urban creep. However, as the proposed development is non-residential, the application of urban creep does not apply.

Based on the proposed development masterplan enclosed within **Appendix 01**, the drained impermeable areas are summarised in Table 7-1.

Table 7-1: Drained Areas

Impermeable Land Use Type	Area (m^2)
	Proposed
Hardstanding Area	400
Total	**400**

7.3 Proposed Discharge Arrangement

With reference to The SuDS Manual, the hierarchy of preferred disposal options for surface water runoff from development sites in decreasing order of sustainability is as follows:

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

Table 7-2 summarises the suitability of these disposal methods in the context of the site and the proposed development.

Table 7-2: Suitability of Surface Water Disposal Methods

Surface Water Disposal Method (in Order of Preference)	Suitability Description	Method Suitable? (Y / N)
Infiltration to Ground	With reference to Section 3.5.1, the superficial deposit at the site comprises Diamicton which based on literature review[22], has a low infiltration rate of $3x10^{-6}$ m/s which is unlikely to provide a sufficient degree of infiltration. No infiltration testing has been undertaken to date. This SWDS has assumed that infiltration is not feasible on site.	N
Discharge to Surface Waters	As discussed in Section 3.4, ground elevations across Area 1 generally fall towards Tributary 1. Surface water runoff from the hardstanding area within Area 1 would therefore discharge to this tributary under gravity. In line with the drainage hierarchy, this method of surface water disposal could be adopted either: (i) as a primary means of discharge should infiltration to ground not be viable; or (ii) as a secondary means of discharge if infiltration rate is insufficient to effectively discharge surface water runoff resulting from the proposed development.	Y
Discharge to Sewer	There is no sewerage infrastructure in the vicinity of the site and therefore this method of surface water disposal is not possible.	N

7.4 Proposed Outline SuDS Strategy

It is proposed to manage surface water runoff from the development via the following ‘Source Control’, ‘Conveyance’, and ‘Site Control’ options as summarised in Table 7-3.

22 CIRIA (2015). Report C753, The SuDS Manual: Table 25.1

Table 7-3: Summary of Surface Water Management Strategy SuDS Options

SuDS Management Train Mechanism	Application	Potential Suitable SuDS Features
Source Control	For the interception of surface water runoff at the source such as rainfall shedding from the roof areas.	• Swale
Conveyance	To convey surface water runoff from 'Source Control' mechanisms to 'Site Control'.	• Swale
Site Control	Provides the required surface water attenuation / storage prior to controlled discharge to the water environment.	• Swale

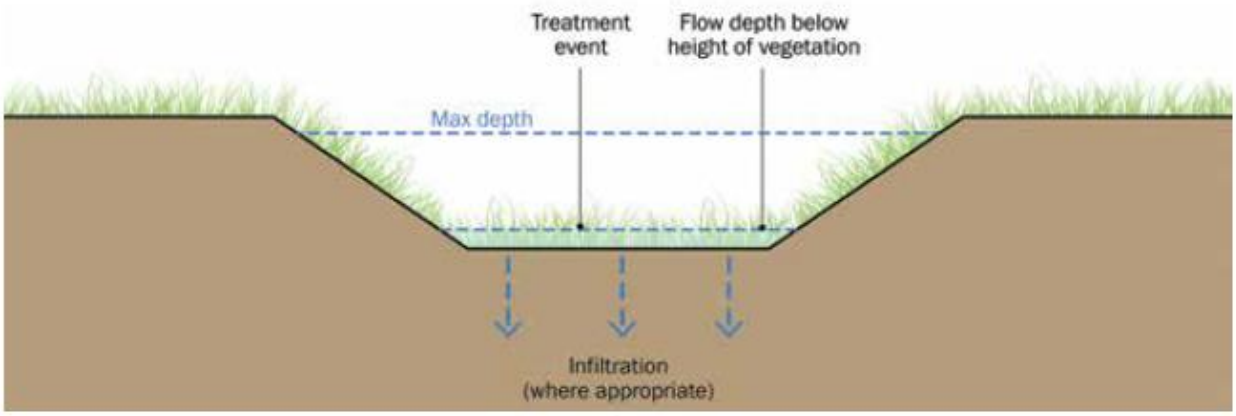
'Source Control', 'Conveyance' and 'Site Control' in the form of a piped network and swale are considered to be viable and beneficial (in terms of attenuation requirements and water quality enhancements) and therefore have been integrated into this SWDS.

A conveyance swale, used to provide 'Source Control' and 'Conveyance', will intercept and convey runoff into a swale. The Attenuation swale will act as the 'Site Control' by providing the required attenuation prior to discharge to ground and/or surface water. The swale has been designed to provide sufficient attenuation of runoff within the site boundary for all events up to and including the 1% AEP plus 30% climate change allowance.

Irrespective of the means of discharge of runoff, the swale will be unlined to promote infiltration to ground..

A typical swale detail is provided below in **Figure 7-3**. Whilst not demonstrated in the diagram, the swale with be lined with gravel to encourage infiltration and pollutant filtration. The banks of the swale will be grassed. A 1:3 side slope is adopted to allow for mowing.

Figure 7-3: Swale: Conceptual Design Details



Indicative locations of the proposed swales serving the proposed development are shown in **Drawing 01.**

7.5 Water Quantity Design Standard

7.5.1 Control of Runoff Volume

Section 3.3.1 of The SuDS Manual sets out volume control criteria for:

- Frequent Rainfall Events
- Extreme Rainfall Events

7.5.1.1 Frequent Rainfall Events

The SuDS Manual requires *'the prevention of runoff from the [site] for the majority of small (frequent) rainfall events (or for the initial depth of rainfall for larger events)'*. This is known as interception. The SuDS Manual states that '*Interception of about 5mm is normally achievable.'*

With reference to Section 24.8 of The SuDS Manual:

'Interception can be delivered using one or a combination of processes:

- *Rainwater harvesting*
- *Infiltration*
- *Evapotranspiration using temporary shallow ponding or storage within the soil or upper aggregate layers.'*

As discussed at Section 7.4, the swale will be unlined to promote infiltration to ground. Additionally, Section 17.4.2 of The SuDS Manual states that swales *'deliver Interception because there is usually no runoff from them for the majority of small rainfall events'.*

The SWDS is therefore deemed to provide the necessary interception of the first 5mm of rainfall.

7.5.1.2 Extreme Rainfall Events

For extreme rainfall events, the drainage system should be designed such that *'the volume of runoff from the site (or development) area [does] not exceed the volume of runoff from the equivalent area in its natural undeveloped or "greenfield" state'.*

As summarised in Table 7-2, if infiltration to ground is not feasible or infiltration rate is insufficient to effectively manage runoff, discharge to surface waters will be used.

In line with Section 3.3.1 of The SuDS Manual, it is proposed that '*all the runoff from the site for the 1:100 year [1% AEP] event [to] be discharged at either a rate of $2ls^{-1}ha^{-1}$ or the average annual peak flow rate (i.e. the mean annual flood, QBAR), whichever is greater.'*

Table 24.1 Summary of runoff estimation methods of The SuDS Manual recommends the application of the Revitalised Rainfall-Runoff Method (ReFH2) to estimate greenfield runoff rates.

ReFH2 has therefore been used to estimate greenfield runoff rate for the 50% AEP (1 in 2 year) rainfall event as summarised within Table 7-4. It should be noted that QBAR has a return period of approximately 1 in 2.3 years, however, only integers can be inputted into ReFH2. A conservative QBAR peak runoff rate has been estimated assuming a 1 in 2-year return period.

The descriptors for the site extracted from the Flood Estimation Handbook (FEH)[23] Web Service were used in the ReFH2 analysis with the AREA set to 1.00ha.

As discussed in Section 7.2, the proposed hardstanding area is 400m^2, or 0.04ha.

The greenfield runoff rate has therefore been estimated based on the proposed impermeable area of 400m^2, or 0.04ha, as summarised within Table 7-4.

Full modelled results from ReFH2 are included as **Appendix 02**.

Table 7-4: Greenfield Runoff Rate

AEP (%)	Estimated Greenfield Runoff Rate	
	l/s/ha	l/s/0.04ha
50	5.2	0.2

The discharge rate of 0.2l/s would require a significantly small orifice (c.11mm diameter) that would not be attainable at the site. As discussed in Section 7.3, the site will adopt a swale feature which, naturally, would have some deposition of sediment, vegetation (i.e., leaves) which inherently would regularly cause blockage to an orifice of such a size. The flood risk associated with a blockage occurrence at the site would be significantly greater than a small increase in discharge rate.

In accordance with Section 20.4 of The SuDS Manual, even for below ground (closed) structures, the absolute minimum size should be 20mm. For open attenuation structures such as a swale, where the presence of debris and therefore blockage is likely, a minimum outflow control diameter of 50mm is recommended. The most effective means of controlling flow while reducing the likelihood of blockage is using a Hydrobrake.

Using a Hydrobrake with a diameter of 54mm would control off site discharge to 1ls^{-1}.

7.5.2 Control of Peak Runoff Rate

Section 3.3.2 of The SuDS Manual sets out the peak rate of runoff criteria for:

- Events likely to impact on morphology, ecology or capacity of the receiving surface waters, or the capacity of receiving sewers.
- Extreme events.

7.5.2.1 Events likely to impact on morphology, ecology or capacity of the receiving surface waters, or the capacity of receiving sewers

As discussed in Section 7.5.1, there will be a small but controlled increase (1l/s) in runoff rate to the receiving watercourse associated with the new impermeable area. Significant changes to the hydrological regime, such as an impoundment or uncontrolled / unmanaged impermeable development, would essentially impact the existing morphology and ecology of the receiving surface waters. It is not considered that a relatively small increase in discharge into the receiving ditch would result in any detrimental impacts to the channel.

An assessment of the capacity of Tributary 1 to receive the small increase in discharge would require further investigation. At this stage, it is considered the dimensions of the

23 Flood Estimation Handbook (Centre for Ecology & Hydrology, 1999)

channel, which from LiDAR indicates a depth of 1.8m, is sufficient to accommodate the extra flows.

7.5.2.2 Extreme Events

In line with Section 3.3.2 of The SuDS Manual, the SWDS *'should be designed so that peak runoff rates for extreme rainfall events (…) are constrained to the greenfield runoff rates for the same event'*.

As discussed above at Section 7.5.1, discharge from the site will be restricted to 1l/s as this is the smallest, viable discharge rate possible.

7.6 Water Quantity Design Standard

Both strategies are based on a total contributing area of 0.04ha. Temporary storage volumes were estimated using the Causeway Flow software, an appropriate methodology for planning and master planning purposes. The attenuation volumes required for the proposed development in response to a range of AEP rainfall events up to and including the 1% AEP storm event +30% have been estimated for both strategies.

The analysis indicates that a 75 mm diameter Hydrobrake flow control device would be required to limit the discharge from the attenuation swale to the maximum allowable discharge rate of $1ls^{-1}$.

Calculations were made on the assumption that no infiltration is possible on a 'worst case scenario' basis, to demonstrate that the drainage feature can manage the surface water generated by the proposed development. When the site-specific infiltration rate of the soil is confirmed, infiltration to the soil will be encouraged resulting in a possible reduction of the size of the swales.

The conveyance swale will therefore have the following parameters:

- Basal Width: 0.4m
- Top Width: 3.4m
- Depth: 0.5m
- Side Slope: 1:3
- Length: 20m
- Estimated Required Total Volume: 19 m^3

The attenuation swale will therefore have the following parameters:

- Basal Width: 1.8m
- Top Width: 4.8m
- Depth: 0.5m
- Side Slope: 1:3
- Length: 6m
- Estimated Required Total Volume: 9.9m^3

Details of the analysis are enclosed in **Appendix 03** and summarised in Table 7-5.

Table 7-5: Drainage Performance and Sizing

AEP (%)	Maximum Discharge Achieved (ls^{-1})	Maximum Water Depth (m)	Maximum Attenuation Storage Required (m^3)
1 + 30%	1	0.488	19.9

7.7 Water Quality Design Standard

The drainage of built development has the potential to reduce water quality through increases in suspended solids, metals and hydrocarbons in the surface water runoff. The risks associated with a number of typically drained surfaces (land uses) are assessed in Section 26 of The SuDS Manual and expressed in Table 26.2 as a potential 'Pollution hazard level'. A review of each of the land uses has been completed with reference to Table 26.2 of the SuDS Manual, to determine the appropriate Pollution Hazard Levels.

It is anticipated that the proposed hardstanding area will be used to site a DNO station and provide vehicular access to this element of the proposed development. As such, with reference to The SuDS Manual, post development surface water runoff generated from the hardstanding area is considered to have a 'Low' Pollution Hazard Level as set out within Table 7-6.

Table 7-6: Pollution Hazard Potential of the Proposed Development

Land Use	Pollution Hazard Level	Pollution Hazard Indices		
		Total Suspended Solids (TSS)	Metals	Hydrocarbons
Low traffic area	Low	0.5	0.4	0.4

As discussed in Table 7-2, surface water runoff from the site will likely discharge to surface waters if future soakage testing indicates that there is no infiltration potential at the site. The indicative SuDS Mitigation Indices for discharge to surface water are summarised in Table 26.3 of The SuDS Manual and included below in Table 7-7 with respect to the proposed SuDS features at the site.

Table 7-7: SuDS Mitigation Indices for Discharge to Surface Water

SuDS Arrangement	Indicative SuDS Mitigation Indices		
	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Swale	0.5	0.6	0.6

A comparison of the *Pollution Hazard Indices* and *Mitigation Indices* for the proposed 'Source Control', 'Conveyance', and 'Site Control' measures are provided in Table 7-8.

Table 7-8: SuDS Performance: Water Quality Indices Assessment (Discharge to Surface Water)

Land Use	Index	SuDS Mitigation Indices Comparison		
		Total Suspended Solids (TSS)	Metals	Hydrocarbons
Low traffic area	Hazard	0.5	0.4	0.4

Land Use	Index	SuDS Mitigation Indices Comparison		
		Total Suspended Solids (TSS)	Metals	Hydrocarbons
	Mitigation	0.5	0.6	0.6
	Water Quality Requirement Met? (Y/N)	**Y**	**Y**	**Y**

Table 7-8 shows that the *Mitigation Indices* are greater than the *Pollution Hazard Indices*, and therefore the water quality requirements are considered met.

7.8 Design Exceedance Arrangement

The proposed SWDS also considers residual events, i.e., those in excess of the design rainfall event (1% AEP + 30% climate change).

As discussed in Section 3.1.1, topography across the Area 1 falls to the south towards Tributary 1. Any excess flow from the hardstanding area which cannot be accommodated within the swale would propagate overland following local topography. I.e. excess flow would be directed to Tributary 1. This is depicted on Drawing 01.

7.9 Amenity

The Proposed Development will generate renewable electricity from the proposed solar panels when operational, which will reduce climate impacts from fossil fuel use. The Site is not open to the public; however, the Proposed Development will be designed to minimise visual impacts. To do this, the existing hedgerows and field patterns will be retained as far as possible, and native tree and woodland planting will be introduced post development, to enhance site amenity.

7.10 Biodiversity

The proposed solar panels will be located within existing fields. The existing ecologically valuable habitats within the Site comprise of grassland, hedgerows, trees and small watercourses. The existing hedgerows and watercourses will be retained and maintained post development to improve biodiversity, via a Landscape and Ecological Management Plan.

The proposed swale shall incorporate planting of native grasses, wildflowers, and shrubs, which will create diverse habitats for local wildlife. This vegetation will provide food and shelter for insects, birds, and small mammals, enhancing the ecological value of the site.

8.0 Principal Operation and Maintenance Requirements

At this time, it is assumed that all surface water drainage and pollution control features (swale, hydrobrake and piped network) associated with the site will remain private and be managed by the site operator.

The following section outlines recommended maintenance requirements for the swale, outflow control (Hydrobrake), and piped network of the drainage system for the development.

8.1 Swale and Hydrobrake

The recommended operation and maintenance plan of the swale and hydrobrake is summarised below in Table 8-1.

Table 8-1: Typical Swale and Hydrobrake Maintenance and Operation Requirements

Maintenance Schedule	Required Action	Minimum 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 and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding > 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 slit removal frequencies.	As required or if bare soil is exposed over 10% or more of the swale treatment area
	Remove sedimentation that has become entrained into the hydrobrake outflow	Every 6 months
Occasional Maintenance	Reseed areas of poor vegetation growth, alter plan types to better suit conditions, if required	Annually
	Periodic measuring of the hydrobrake bore size	Every 3 years
	Checking of the hydrobrake for leakage issues	Annually
Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required.
	Relevel uneven surfaces 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.

Maintenance Schedule	Required Action	Minimum Frequency
	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.

8.2 Underground Pipe Network

A recommended operation and maintenance plan for the piped drainage network is summarised in Table 8-2.

Table 8-2: Typical Pipe System Operation and Maintenance Requirements

Maintenance Schedule	Required Action	Minimum Frequency
Regular Maintenance	Ensuring drainage intakes are clear of debris / silt	Monthly, or as required
Occasional Maintenance	Clear Gully Pots	6 monthly
	Jet clean sewer lines, gully tails and kerb channels to remove grease, grit, sediment and other debris to ensure conveyance capacity is not compromised.	Every 2 years
Intermittent Maintenance	CCTV survey of sewer lines to identify any defects/signs of performance degradation such as: • Cracked / deteriorating pipes; • Leaking joints/seals at manholes; • High water lines showing regular high stage in pipes (sign of lack of capacity or downstream constraint); and • Suspected infiltration or exfiltration.	Every 2-5 years
Remedial Actions	Repair defects using suitable methods. Effective temporary repairs may be sufficient in short term until scheduled/capital improvements can be made	As required
Monitoring	Record areas of surface ponding / intake bypassing / surcharging (photos, inundated areas, depths) during extreme storm events and investigate the reasoning for this post-storm	As required

9.0 Acceptability Criteria

TAN15 Section 11 summarises the acceptability critical for flooding consequences. As discussed in Section 4.3.3 for this development these are as follows:

- ***No increase in flooding elsewhere***

The site is located in Flood Zone 1 from Rivers and Sea and thus has a flood risk less than 1 in 1000 (0.1%) (plus climate change) chance of flooding in a given year.

As identified in Section 5.1.2, there is a flood risk from surface water and small watercourses along the length of the cable route and that there is a possibility that excavations for the proposed cable may be affected by surface water flooding.

A Construction Surface Water Management Plan will therefore be provided to monitoring for weather alerts, dewatering of excavations for safe disposal. When appointed, these measures will be the responsibility of the contractor to ensure that no increase of flood risk occurs during implementation of the cable route.

Ground levels shall be restored following installation to avoid risk of flood risk arising from alterations to the greenfield runoff regime.

- ***Occupiers aware of flood risk***

The development will not be permanently occupied.

- ***Escape/evacuation routes present***

The development will not be occupied; however, the site is almost entirely located in Flood Zone 1 and will be free of flood risk for maintenance crews to during routine inspections.

- ***Flood emergency plans and procedures agreed and in place***

The development will not be occupied. Maintenance activities shall be covered under standard Risk Assessment Method Statements should flood warnings be issued for the local area.

- ***Flood resistant and resilient design***

The development will be supported by a Construction Surface Water Management Plan to ensure flood resistance and resilience measures during construction phases. Management of runoff generated from impermeable areas or intercepted surface water flow paths have been considered under Section 0.

- ***Acceptable consequences for type of use***

The 'less vulnerable development' is located in Flood Zone 1 and is therefore suitable for development.

- ***The scheme will be flood free for the 1 in 100 annual probability flood event with an appropriate allowance for climate change***

The flood risk screening completed in Section 5.0 concludes that the Site lies within Flood Zone 1 meaning that the flood risk probability is less than 0.1% plus allowances for climate change.

- ***That in extreme flood condition the depth of flooding will not exceed 600mm or the velocity of flood water 0.3m/s***

It has been concluded that flood risk to the Site is low and that extreme flood conditions may only occur from Surface Water and Small Water Courses along access roads. No sensitive infrastructure has been located within these extents and will remain flood free for the lifetime of the development.

The steep regional topography confines these flow pathways to narrow channels or fast moving surface water flows. Should access to the site be necessary, attendance with a 4x4 vehicle shall ensure that personnel are safe from significant hazard.

10.0 Conclusions

SLR Consulting Limited (SLR) has been appointed by Anesco Ltd (the client) to produce a Flood Consequence Assessment (FCA) and Drainage Strategy (SWDS) for the proposed St. Asaph's Photo Voltaic (PV) Farm at Cefnmeiriadog, Denbighshire, Wales, LL17 0HF.

With reference to the indicative *Flood Maps for Planning*[4] the site lies entirely within an area considered to be at 'little or no risk of fluvial or coastal/tidal flooding' (Flood Zone 1). With reference to the Planning Policy Wales[1] and its associated Technical Advice Note 15[2] (TAN15), the 'less vulnerable development' is suitable and acceptable to be located at the site.

The site is under the planning jurisdiction of Denbighshire County Council, who are responsible for the outcome of this application and as the SuDS Approving Body (SAB) for the area, they deal with issues relating to localised flood risk and drainage.

This report has been prepared in accordance with the advice and requirements prescribed in current best practice documents relating to the management of flood risk in development published by the Construction Industry Research and Information Association (CIRIA)[6] and the Welsh Government Statutory National Standards for Sustainable Drainage Systems[15].

Technical information provided in this report on behalf of the Client seeks to demonstrate that a robust and sustainable drainage strategy has been prepared for the site, including residual events. This report has proposed for surface water drainage to discharge to surface waters.

The swales provide all attenuation within a 28.9m^3 of storage. A hydrobrake will be used to restrict flows to the smallest viable discharge rate that can be suitably engineered (1l/s) to surface waters.

Modelling of the swale has been developed to a design standard of the 1% AEP plus a 30% allowance for climate change.

The pollution mitigation effects of the vegetated swale for both groundwater and surface water discharge are sufficient to satisfy the criteria of the Simple Index Method for runoff draining from the proposed hardstanding area.

Residual flood events in excess of the design standard have also been considered, and all events greater than the 1% AEP plus 30% climate change will revert to the pre-existing runoff regime discharging towards Tributary 1.

The surface water drainage strategy presented in this report demonstrates that adequate SuDS space provision is afforded within the development and that the proposed scheme is feasible and compliant to appropriate best practice and regulatory requirements and can be maintained in accordance with best practise.

Drawings

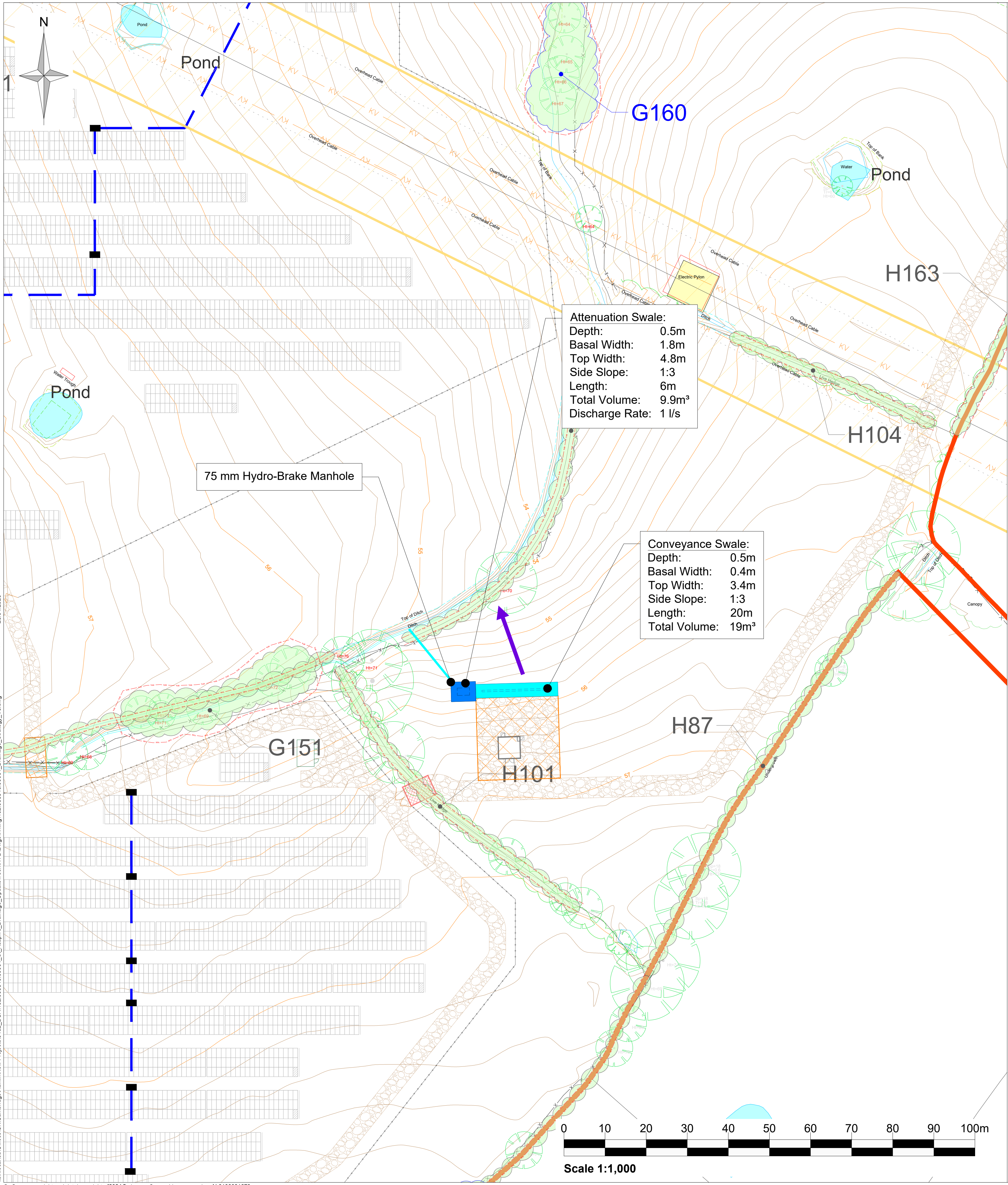
Drawing 01: Conceptual Surface Water Drainage Layout

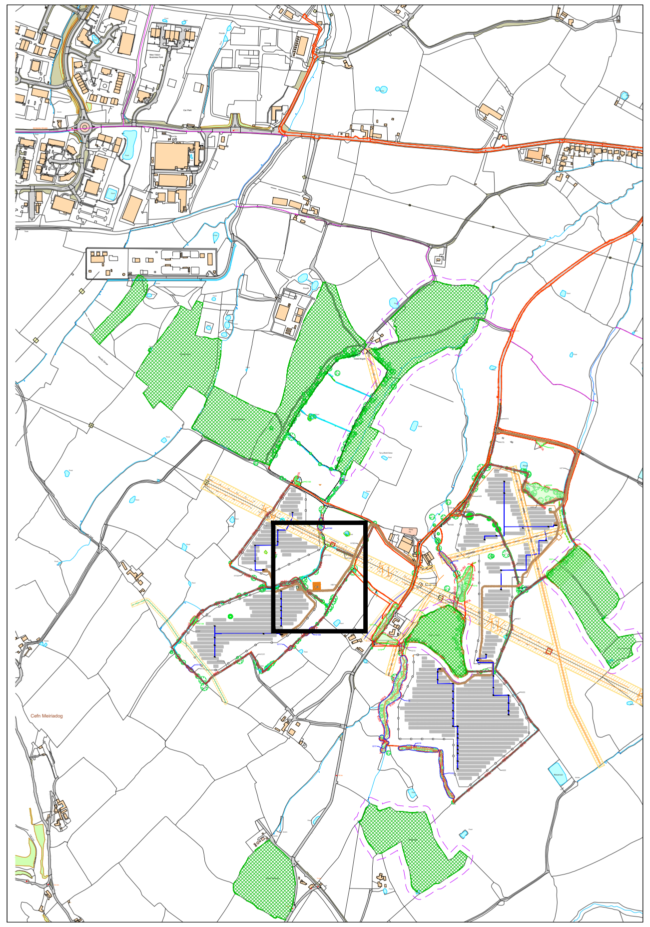
St Asaph PV Farm - Flood Consequence Assessment & Surface Water Drainage Strategy

Anesco Ltd

SLR Project No.: 402.065546.00001

29 April 2025





Location of Detail Within Wider Site

Notes:

1. Drawing is based on client supplied Site Layout Planning drawing, ref: C0002452-02 Rev V4, dated: 31/03/2025.
2. Drawing to be read in conjunction with all relevant documents.
3. All levels are shown in meters above Ordnance Datum.
4. All dimensions are in meters.
5. Drainage strategy design attenuates surface water runoff for the 1 in 100 year event plus 30 % climate change.
6. Layout is preliminary only and subject to refinement / additional detail during future design stages.
7. Pipes and linear drainage channels have not been modelled or sized-subject to detailed design.
8. Swale has not been 3D modelled based on existing topography.

Legend:

- Site Boundary
- DNO Substation Hardstanding
- Attenuation Swale
- Exceedance Route
- Conveyance Swale

Rev	Amendments	Date	By	Chk	Auth
3	Site layout altered	28.04.25	TS	KP	AD

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Client
Anesco Ltd

Project
St Asaph
Flood Consequence Assessment

Figure Title
Conceptual Surface Water Drainage Strategy

Scale	SLR Project No.		
1:1000 @ A3	402.065221.00001		
Designed: KP	Drawn: CT	Checked: KP	Authorised:
Date: Mar 2025	Date: Mar 2025	Date: Mar 2025	Date:

Figure Number: 01
Rev.: 3

\\slr.local\eu\Offices\UK\Cambridge\Admin\New Projects\0402_BOA\402.065546.00001_St_Asaph's_Drainage_Update\Tech\HYD\Dwgs\Working\402.065546.00001_Drainage_Strategy_V3.dwg 28/04/2025

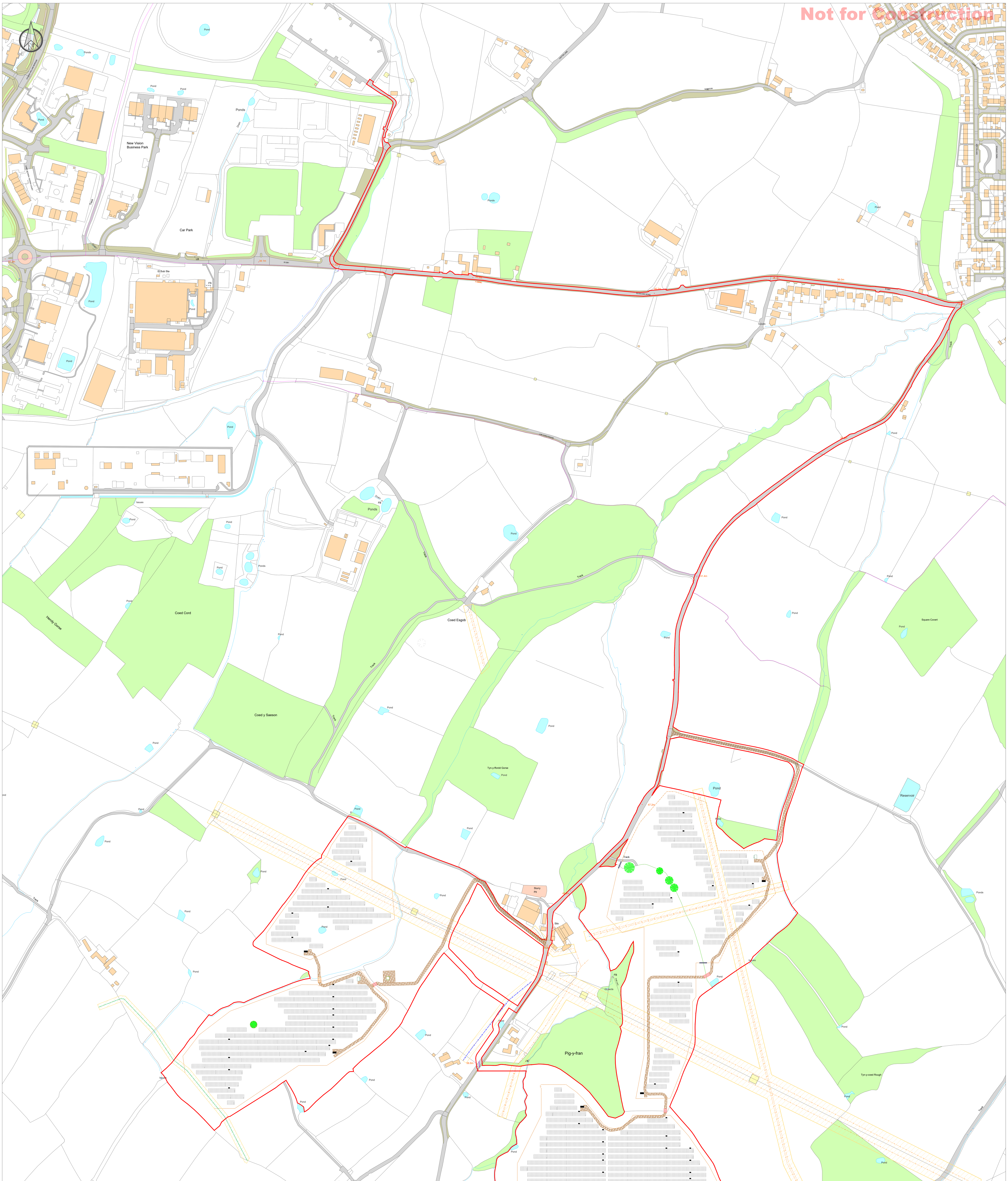
Appendix 01 Development Masterplan

St Asaph PV Farm - Flood Consequence Assessment & Surface Water Drainage Strategy

Anesco Ltd

SLR Project No.: 402.065546.00001

29 April 2025



LEGEND

	SITE BOUNDARY
	SECURITY FENCE
	OVERHEAD ELECTRICAL CABLES (24m/14m OVERALL EASEMENT)
	DNO ACCESS ROUTE
	HV CABLE ROUTE - TRENCH
	LV CABLE ROUTE - TRAY
	PRIVATE HV CABLE ROUTE - TRENCH
	BT OVERHEAD CABLE
	UNDERGROUND WATER TRUNK MAIN
	UTILITY EASEMENT
	HARDSTANDING AREA
	PROPOSED CULVERT CROSSING
	PROPOSED HEDGE REMOVAL FOR TRACK WIDENING
	FENCE PLACEMENT & HEDGE REGROWTH AREA
	PROPOSED TREE REMOVAL
	PV ARRAY
	INVERTER (SUN2000-330KTL)
	SMART TRANSFORMER STATION (JUPITER-6000K/JUPITER3000K)
	DNO SUBSTATION
	CUSTOMER SUBSTATION (PV)

PROJECT NAME: ST ASAPH

GRID REFERENCE :	SJ 02300 72873
SITE AREA:	87.57Acres / 35.42 ha
TOTAL INSTALLED CAPACITY:	18.44MWp
MAX INVERTER AC POWER:	18.304MW

Installer Details

Anesco Ltd.
The Green,
Easter Park,
Benyon Road,
Reading,
RG7 2PQ
Tel: 0845 894 4444

Comments

Revision	Description	Revised By	Date
A	Issued for comment	MS	19/11/2020
B	Land reduced from the North and extended to the South	MS	05/03/2021
C	Boundary Line Extended	MS	05/05/2021
D	Boundary Line Extended and site maximised	MS	12/05/2021
E	Planning Site Layout	JH	10/11/2021
F	Module Wattage Changed	MS	07/12/2021
G	Site resign to 215KTL & Bifacial Modules	JH	02/03/2022
H	Site redesigned due to tree shading implications	MS	16/06/2022
J	Red Line Boundary amended to include Private HV	JH	03/08/2022
K	Site redesign	JH	15/05/2023
L	Site redesign using new modules and new private HV cable	JH	06/07/2023
M	Site area amended and module redesign	JH	22/11/2023
N	DNO Track Added	LD	28/11/2023
P	Red Line Boundary amended & access track added in the North	JH	12/12/2023
Q	Redesign due to array relocation	JS	19/03/2024
R	Redesign	MS	01/08/2024
S	Access Altered	MS	20/09/2024
T	Hedgerow added and panel locations amended	MS	11/11/2024
U	Inverters added	RD	20/01/2024
V4	Topo and service searches added	RD	31/03/2025

Drawn By	JH
Scale	1:3000@ A1
Sheet Size	A1
Installation Address	Cefnmeiriadog, St Asaph, Denbighshire, Wales, LL17 0HF
Project	St Asaph
Title	Site layout planning
Drawing No.	C0002452_02
Rev.	V4

Appendix 02 Greenfield Runoff Rates

St Asaph PV Farm - Flood Consequence Assessment & Surface Water Drainage Strategy

Anesco Ltd

SLR Project No.: 402.065546.00001

29 April 2025

SLR Consulting Limited

Anesco Limited

St Asaph's PV Farm

SLR Project No.: 402.065221.00001

21 February 2024

Revision: 01

Standard Operating Procedure and Summary of Results

ReFH2 Greenfield Runoff Analysis

1.0 Introduction and Background

1.1 This document sets out the Hydrology and Hydrogeology team's standard procedure for Greenfield Runoff Rate and Greenfield Runoff Volume analysis using the ReFH2 methodology.

1.2 References and further reading materials that may help determine which is the most suitable method for each site are outlined at the end of the document.

1.3 This document is designed to provide a step-by-step procedure to undertake any greenfield analysis using ReFH2. A summary of the results specific to the project is provided in Section 3.0 and Appended to this report.

2.0 ReFH2 Methodology

2.1 Data Import

2.1.1 Import the data file from the FEH Webservice[1]. If using Catchment Descriptors, select plot scale equations in ReFH2. However, for greenfield runoff calculations typically

[1] Flood Estimation Handbook Web Service, UK Centre for Ecology & Hydrology, https://fehweb.ceh.ac.uk/Map

Point Descriptors are used. Plot scale equations are automatically selected for Point Descriptors.

2.1.2 Review if the FEH descriptors are representative of the site, paying particular attention to the underlying geology. If the site is underlain by variable geology, please discuss with the hydrology technical team.

Table 2-1: FEH Descriptors

Descriptor	Value
Point Descriptor	E: 302464 N: 372970
SAAR (mm)	747
PROPWET	0.38
BFIHOST19	0.368
Catchment Description: The catchment is underlain by the Warwickshire group (sandstone, siltstone and mudstone) which has a moderate to low permeability overlain by Diamicton (low permeability deposits). This is reflected in the BFIHOST19 value of 0.368, indicating that the catchment has low permeability.	

2.2 Catchment Area

2.2.1 If the catchment area is less than 0.5km^2 (50ha), in line with SuDS guidance, greenfield runoff calculations should be estimated using an area of 0.5km^2 and rescaled to the size of the catchment (see Section 2.4). For catchment areas greater than 0.5km^2, the default catchment area can be used, as no catchment rescaling is required.

Table 2-2: Catchment Scaling Requirements

Catchment / Drained Area	ReFH2 Input
<0.5km^2	0.5km^2
≥0.5km^2	Default catchment area (km^2)

2.3 Rainfall Parameters

2.3.1 On the design rainfall event tab, accept all of the initial defaults. Add the required design rainfall events. It recommended that the 1yr, 2yr, 30yr, 100yr and 100yr + climate change events are assessed. Check the Local Lead Flood Authority (LLFA) guidance on what events are required. Note a 40% climate change allowance is applied by adding a 1.4 climate change factor.

2.3.2 Set the areal reduction factor to 1.0 and accept the default seasonality of a winter storm.

Table 2-3: ARF Adjustments

Initial ARF	Adjusted ARF
0.979	1

2.3.3 ReFH2 will then adjust the Time to Peak (Tp) and the Baseflow Lag (BL) parameters in accordance with the catchment area of 0.5km^2 and ARF of 1.0. These model parameters are recorded below.

Table 2-4: Tp and BL for 0.5km^2 Catchment

Tp (hr)	BL
1.637	30.89

2.4 Rescaling

2.4.1 Reconfigure ReFH2 for the actual extent of the development area (<0.5km^2) or 0.01km^2 if the development area is <0.01km^2. In doing so, the ARF, Tp and BL parameters will automatically be readjusted. Therefore manually overwrite ARF to remain as 1.0 and the Tp and BL parameters to those of the 0.5km^2 catchment area recorded in Table 2-3.

2.5 Extracting Greenfield Runoff Rates

2.5.1 Export peak flows for all return periods to derive greenfield runoff rates and print of the relevant PDF reports for the required rainfall events. Note that this step of the audit trail relates solely to greenfield runoff rates.

2.5.2 It is recommended that the project file is saved at this stage and resaved under a different file name for greenfield runoff volume calculations.

2.6 Extracting Greenfield Runoff Volumes

2.6.1 The next step is to estimate the allowance greenfield runoff volume that can be discharged (at greenfield rates) during an event. Typically, volumetric control for a development site is assessed using the 1 in 100-year 6-hour duration event. Check the LLFA guidance on which events should be assessed.

2.6.2 Reset the recommended duration on the rainfall page to 6 hours and set the timestep to 8mins (45 timesteps). Export the peak flows and direct runoff volumes for all return periods. This provides greenfield volumes in ML which can be converted to m^3 by multiplying by a factor of 1000. Please ensure that the Tp and BL parameters are those for a $0.5km^2$ catchment area recorded in Table 2-4 and ARF is still set to 1.0 once the rainfall parameters have been updated.

3.0 Summary of Results

3.1.1 The following tables summarise the greenfield runoff rates and greenfield runoff volumes results of the ReFH2 analysis. These values will corroborate what is provided within the ReFH2 output reports.

Table 3-1: Greenfield Runoff Rates for 1ha Area

Annual Exceedance Probability	Greenfield Rates (l/s)
100% (1 in 1 year)	4.6
50% (1 in 2 year)	5.2
3.3% (1 in 30 year)	10.8
1.0% (1 in 100 year)	14.1
1.0% + 40 % Climate Change	20.4

Table 3-2: 6-Hour Greenfield Runoff Volumes for 1ha Area

Annual Exceedance Probability	Greenfield Runoff Volume (m^3)
100% (1 in 1 year)	71.6
50% (1 in 2 year)	79.9
3.3% (1 in 30 year)	163.1
1.0% (1 in 100 year)	216.9
1.0% + 40 % Climate Change	322.2

4.0 References and Guidance Documents

- https://refhdocs.hydrosolutions.co.uk/Drainage-Design-Applications/Greenfield-Runoff-Rates-and-Volumes/
- CIRIA C753 The SuDS Manual, 2015

5.0 Closure

This document has been prepared by SLR Consulting Limited (SLR) with reasonable skill, care and diligence, and taking account of the timescales and resources devoted to it by agreement with **Error! Use the Home tab to apply Cover Client Name to the text that you want to appear here.**the Client as part or all of the services it has been appointed by the Client to carry out. It is subject to the terms and conditions of that appointment.

SLR shall not be liable for the use of or reliance on any information, advice, recommendations and opinions in this document for any purpose by any person other than the Client. Reliance may be granted to a third party only in the event that SLR and the third party have executed a reliance agreement or collateral warranty.

Information reported herein may be based on the interpretation of public domain data collected by SLR, and/or information supplied by the Client and/or its other advisors and associates. These data have been accepted in good faith as being accurate and valid.

SLR's standard procedure for Greenfield Runoff Rate and Greenfield Runoff Volume analysis using the ReFH2 methodology has been developed using the latest SuDS and ReFH2 guidance.

This report details the methodology applied and results of the Greenfield Runoff Rate and Volume calculations.

Regards,

SLR Consulting Limited

Prepared by:

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Senior Hydrologist

Approved by:

Chloe Nelson, MSc, BSc
Senior Hydrologist

Making Sustainability Happen

Appendix 03 Hydraulic Performance

St Asaph PV Farm - Flood Consequence Assessment & Surface Water Drainage Strategy

Anesco Ltd

SLR Project No.: 402.065546.00001

29 April 2025

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	5.00	55.843		17.995	66.410	0.500
2		55.608		34.800	66.410	0.500
3		55.460		54.776	66.410	0.500
4		55.460	1200	64.684	66.331	0.533

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	2	20.000	0.013	55.343	55.108	0.235	85.1	500	5.10	50.0
1.001	2	3	6.000	0.030	55.108	54.960	0.148	40.5	500	5.14	50.0
1.002	3	4	5.000	0.030	54.960	54.927	0.033	151.5	150	5.41	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	3.455	3281.9	0.0	0.000	0.000	0.000	0.0	0	0.000
1.001	2.513	4145.9	0.0	0.000	0.000	0.000	0.0	0	0.000
1.002	0.303	5.4	0.0	0.350	0.383	0.000	0.0	0	0.000

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	20.000	85.1	500	Ditch_CC	55.843	55.343	0.000	55.608	55.108	0.000
1.001	6.000	40.5	500	1:3 Swale	55.608	55.108	0.000	55.460	54.960	0.000
1.002	5.000	151.5	150	Circular	55.460	54.960	0.350	55.460	54.927	0.383

Link	US Node	Node Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	1	Junction	2		Junction	
1.001	2	Junction	3		Junction	
1.002	3	Junction	4	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
1	17.995	66.410	55.843	0.500		0	1.000	55.343	500
2	34.800	66.410	55.608	0.500		1	1.000	55.108	500
						0	1.001	55.108	500
3	54.776	66.410	55.460	0.500		1	1.001	54.960	500
						0	1.002	54.960	150
4	64.684	66.331	55.460	0.533	1200	1	1.002	54.927	150

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Detailed	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	0.750	Drain Down Time (mins)	240	Check Discharge Volume	x
Winter CV	0.840	Additional Storage (m^3/ha)	0.0		

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	0	0	0
30	30	0	0
100	0	0	0
100	30	0	0

Node 4 Offline Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Loop to Node		Sump Available	✓
Invert Level (m)	54.927	Product Number	CTL-SHE-0054-1000-0500-1000
Design Depth (m)	0.500	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	1.0	Min Node Diameter (mm)	1200

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.69%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	55.366	0.023	5.7	0.0000	0.0000	OK
30 minute winter	2	26	55.140	0.032	4.3	0.0000	0.0000	OK
30 minute winter	3	26	55.140	0.180	4.2	0.0000	0.0000	SURCHARGED
30 minute winter	4	26	55.139	0.212	1.5	0.2394	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	2	5.7	0.730	0.002	0.1581	
15 minute winter	2	1.001	3	5.7	0.100	0.001	1.3389	
15 minute summer	3	1.002	4	2.6	0.290	0.478	0.0880	
15 minute summer	4	Hydro-Brake®		1.0				2.2

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.69%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	9	55.380	0.037	13.5	0.0000	0.0000	OK
60 minute winter	2	59	55.306	0.198	6.8	0.0000	0.0000	OK
60 minute winter	3	60	55.306	0.346	4.4	0.0000	0.0000	FLOOD RISK
60 minute winter	4	60	55.305	0.378	1.4	0.4278	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	2	13.6	0.917	0.004	1.2184	
15 minute winter	2	1.001	3	12.2	0.141	0.003	3.2827	
15 minute winter	3	1.002	4	2.9	0.309	0.539	0.0880	
15 minute summer	4	Hydro-Brake®		1.0				5.2

Results for 30 year +30% CC Critical Storm Duration. Lowest mass balance: 99.69%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	55.383	0.040	17.6	0.0000	0.0000	OK
120 minute winter	2	112	55.377	0.269	5.6	0.0000	0.0000	OK
120 minute winter	3	112	55.377	0.417	2.9	0.0000	0.0000	FLOOD RISK
120 minute winter	4	112	55.376	0.449	1.2	0.5076	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	2	17.6	0.985	0.005	1.5892	
15 minute winter	2	1.001	3	15.7	0.145	0.004	4.2760	
15 minute winter	3	1.002	4	2.9	0.326	0.534	0.0880	
15 minute summer	4	Hydro-Brake®		1.0				6.8

Results for 100 year Critical Storm Duration. Lowest mass balance: 99.69%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	9	55.383	0.040	17.2	0.0000	0.0000	OK
120 minute winter	2	110	55.373	0.265	5.5	0.0000	0.0000	OK
120 minute winter	3	110	55.373	0.413	2.9	0.0000	0.0000	FLOOD RISK
120 minute winter	4	110	55.372	0.445	1.2	0.5034	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	2	17.2	0.979	0.005	1.5433	
15 minute winter	2	1.001	3	15.3	0.144	0.004	4.1896	
15 minute winter	3	1.002	4	2.8	0.327	0.513	0.0880	
15 minute summer	4	Hydro-Brake®		1.0				6.7

Results for 100 year +30% CC Critical Storm Duration. Lowest mass balance: 99.69%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute winter	1	108	55.450	0.107	7.2	0.0000	0.0000	OK
120 minute winter	2	118	55.448	0.340	7.7	0.0000	0.0000	OK
120 minute winter	3	118	55.448	0.488	3.3	0.0000	0.0000	FLOOD RISK
120 minute winter	4	116	55.447	0.520	1.2	0.5882	0.0000	OK

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	2	22.3	0.987	0.007	2.3565	
15 minute summer	2	1.001	3	18.3	0.132	0.004	4.8364	
15 minute winter	3	1.002	4	3.3	0.322	0.613	0.0880	
120 minute winter	4	Hydro-Brake®		1.0				19.9

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