# Botley West Solar Farm

Environmental Statement

## Volume 3

## Appendix 10.2: Conceptual Drainage Strategy

November 2024

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## Approval for issue

| | |
|---|---|
| Jonathan Alsop | 15 November 2024 |

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# Glossary

| Term | Meaning |
|---|---|
| The Applicant | SolarFive Ltd |
| The Project | The Botley West Solar Farm (Botley West) Project |
| Aquifer | A body of permeable rock or superficial deposit which can contain or transmit groundwater. |
| Bedrock geology | Bedrock geology is a term used for the main mass of rocks forming the Earth that are present everywhere |
| Cable corridor | The corridor within which the cables will be located. |
| Climate change | A long term change in weather patterns, in the context of flood risk, climate change will produce more frequent severe rainfall. |
| Code of Construction Practice | A document detailing the overarching principles of construction, contractor protocols, construction-related environmental management measures, pollution prevention measures, the selection of appropriate construction techniques and monitoring processes. |
| Discharge Consents | Consent granted by the Environment Agency to discharge into watercourses, subject to conditions. |
| Development Consent Order (DCO) | An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Project (NSIP). |
| EIA Scoping Report | A report setting out the proposed scope of the EIA process. |
| Environmental Statement | The document presenting the results of the Environmental Impact Assessment process. |
| Essential infrastructure | Is considered to be essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk; Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including infrastructure for electricity supply including generation, storage and distribution systems; including electricity generating power stations, grid and primary substations storage; and water treatment works that need to remain operational in times of flood; Wind turbines or; Solar farms. |
| Exception Test | The Exception Test ensures that development is permitted in flood risk areas only in exceptional circumstances and when strict qualifying conditions have been met. It is carried out if the Sequential Test demonstrates that a development cannot be located in areas of low flood risk. |
| Field drainage | Limiting the effect of flooding by maintaining surface water and land drainage systems. |
| Flood Risk Assessment | A Flood Risk Assessment is an assessment of the risk of flooding from all flood mechanisms, including the identification of flood mitigation measures, in order to satisfy the requirements of the NPPF and PPG ID7. |
| Flood defences | A structure that is used to reduce the probability of floodwater affecting a particular area. |
| Flood Zone 1 | Low Probability Land having a less than 1 in 1,000 annual probability of river or sea flooding. |

| Term | Meaning |
|---|---|
| Flood Zone 2 | Medium Probability Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. |
| Flood Zone 3 | High Probability Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. |
| Flood Zone 3b | The Functional Floodplain. This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. |
| Greenfield runoff rate | Rates of surface water runoff from a site that is undeveloped (greenfield). |
| Ground conditions | The chemical and physical characteristics of the soil at a particular location and how it has been affected by historical land uses. . |
| Hydrological catchment | An area that serves a watercourse with rainwater. Every part of land where the rainfall drains to a single watercourse is in the same catchment. |
| Lead Local Flood Authority | Lead Local Flood Authorities have responsibility for developing a Local Flood Risk Management Strategy for their area identifying local sources of flooding. The local strategy produced must be consistent with the national strategy. It will set out the local organisations with responsibility for flood risk in the area, partnership arrangements to ensure co-ordination between these organisations, an assessment of the flood risk, and plans and actions for managing the risk. |
| Local Authority | An administrative body in local government. |
| Main Rivers | The term used to describe a watercourse designated as a Main river under the Water Resources Act 1991 and shown on the Main river Map. These are usually larger rivers or streams and are managed by the Environment Agency. |
| Maximum design scenario | The scenario within the design envelope with the potential to result in the greatest impact on a particular topic receptor, and therefore the one that should be assessed for that topic receptor. |
| Mean Annual Flood | The value of the average annual flood event recorded in a river. |
| Ordinary watercourses | A river, stream, ditch, cut, sluice, dyke or non-public sewer that is not a designated Main river, and for which the local authority has flood risk management responsibilities and powers. |
| Sequential test | A sequential test is carried out to ensure development is sited on land that has the lowest risk of flooding within the Local Council area. |
| Strategic Flood Risk Assessment | A Strategic Flood Risk Assessment provides information on areas at risk from all sources of flooding. |
| Superficial Deposits | Superficial deposits are the youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 2.6 million years from the present. They rest on older deposits or rocks referred to as bedrock. |
| Surface water runoff | Surface water runoff is flow of water that occurs when excess stormwater, meltwater, or other sources of water flows over a surface. |

| Term | Meaning |
|---|---|
| Substation | Part of an electrical transmission and distribution system. Substations transform voltage from high to low, or the reverse by means of electrical transformers. |
| Sustainable urban Drainage Systems | A sequence of management practices and control measures designed to mimic natural drainage processes by allowing rainfall to infiltrate, and by attenuating and conveying surface water runoff slowly at peak times. |
| UK Climate Projections | Climate projections expressed in terms of absolute values. A projection of the response of the climate system to emission scenarios of greenhouse gases and aerosols, or radiative forcing scenarios based upon climate model simulations and past observations. |
| Water Quality | The physical, chemical and biological characteristics of water. |

## Abbreviations

| Abbreviation | Meaning |
|---|---|
| AEP | Annual Exceedance Probability |
| BEIS | Department of Business, Energy and Industrial Strategy |
| bgl | Below ground level |
| BGS | British Geological Survey |
| BWSF | Botley West Solar Farm |
| CC | Climate Change |
| CDC | Cherwell District Council |
| CoCP | Code of Construction Practice |
| DCO | Development Consent Order |
| DECC | Department of Energy and Climate Change (now BEIS) |
| DEFRA | Department for Environment, Food and Rural Affairs |
| EA | Environment Agency |
| EIA | Environmental Impact Assessment |
| ES | Environmental Statement |
| FEH | Flood Estimation Handbook |
| FMP | Flood Modeller Pro |
| FRA | Flood Risk Assessment |
| GIS | Geographic Information Systems |
| HDD | Horizontal Directional Drilling |
| HVAC | High Voltage Alternating Current |
| ICP | Interim Code of Practice |
| IDB | Internal Drainage Board |

| Abbreviation | Meaning |
|---|---|
| IH24 | Institute of Hydrology Report 124 |
| LiDAR | Light Detection and Ranging |
| LLFA | Lead Local Flood Authority |
| LPA | Local Planning Authority |
| NPPF | National Planning Policy Framework |
| NPS | National Policy Statement |
| NSIP | Nationally Significant Infrastructure Projects |
| OCC | Oxfordshire County Council |
| PCS | Power Converter Stations |
| PDE | Project Design Envelope |
| PEI | Preliminary Environmental Information |
| PEIR | Preliminary Environmental Information Report |
| PPG | Planning Practice Guidance |
| PROW | Public right of way |
| PV | Photovoltaic |
| PVDP | PhotoVolt Development Partners GmbH |
| SAC | Special Area of Conservation |
| SFRA | Strategic Flood Risk Assessment |
| SPA | Special Protection Area |
| SPZ | Source Protection Zone |
| SSSI | Site of Special Scientific Interest |
| SuDS | Sustainable Drainage System |
| UK | United Kingdom |
| UKCP18 | United Kingdom Climate Projections 2018 |
| WFD | Water Framework Directive |
| WODC | West Oxfordshire District Council |
| VoWH | Vale of the White Horse |

# Units

| Unit | Description |
|---|---|
| % | Percentage |
| g | Gram (weight) |
| GW | Gigawatt (power) |

| Unit | Description |
|---|---|
| ha | Hectare (area) |
| kg | Kilogram (weight) |
| km | Kilometre |
| $km^2$ | Square kilometres |
| kV | Kilovolt (electrical potential) |
| kW | Kilowatt (power) |
| l/s | Litres per second (flow rate) |
| m | Meters (distance) |
| mAOD | Metres above Ordnance Datum |
| $m^2$ | Meters squared (area) |
| $m^3$ | Meters cubed (volume) |
| mm/yr | Millimetres per year (rainfall) |
| MW | Megawatt (power) |

## Figures

# 1 Introduction

## 1.1 Overview

1.1.1 This Appendix of the Environmental Statement (ES) has been prepared by RPS on behalf of Photovolt Development Partners GmbH. (PVDP) for the Applicant, SolarFive Ltd. (SolarFive). This Appendix supports Environmental Statement Volume 1 Chapter 10: Hydrology and Flood Risk of the ES **[EN010147/APP/6.3]**.

1.1.2 PVDP intends to submit an application on behalf of SolarFive for development consent to the Planning Inspectorate (PINS) under the Planning Act 2008. The proposal is to install and operate approximately 840MWe of solar generation in parts of West Oxfordshire, Cherwell and Vale of White Horse Districts (the Project). This Appendix is in accordance with the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017, as amended (the EIA Regulations), and other required documents including a statement on pre-application consultation.

1.1.3 PVDP is proposing to build and operate a new ground mounted solar farm in Oxfordshire. Botley West Solar Farm (the Project) covers approximately 1400 ha (excluding connecting cable routes), within the administrative areas of Cherwell, West Oxfordshire and The Vale of White Horse Districts.

1.1.4 The Project comprises the construction, operation, maintenance and decommissioning of solar photovoltaic (PV) arrays and associated infrastructure, including a cable route to connect the site to the national grid.

1.1.5 A conceptual Sustainable Drainage Systems (SuDS) Strategy is part of the application process for the proposed application for a DCO to be submitted by the Applicant in relation to the Project.

1.1.6 For the purposes of the SuDS Strategy, given their different functions and geographic locations, the Scheme infrastructure is assessed as four separate elements for the permanent features as follows:

- Solar PV Array Area (including site accesses and maintenance tracks)
- Ancillary buildings (including High voltage (HV) transformers / secondary substations, and Power Converter Stations)
- Applicant Substation
- National Grid Energy Transmission (NGET) Substation

1.1.7 The SuDS Strategy also discusses drainage during construction and decommissioning phases of the above permanent features. As well as the additional Temporary Features:

- Cable Route Corridor
- Temporary Construction Compounds
- Temporary Field Compounds
- Access Tracks and Haul Roads

1.1.8 The aim of the SuDS strategy is to outline the impact of the development on surface water runoff and the proposed measures which could be incorporated into the Project to mitigate any identified risk. Foul flows are only anticipated within the substations and are therefore, included in these relevant sections. The report has been produced in accordance with the guidance detailed in National Policy Statements (NPS), National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance (PPG).

1.1.9 The key objectives of the SuDS strategy are:

- To ensure surface water runoff will not adversely affect the hydraulic performance of the existing environment, nor will it materially affect overland flow paths and will not threaten other sensitive receptors.
- To assess the potential impact of the Project on surface water runoff and to demonstrate the feasibility of appropriate design, such that the Project would not increase flood risk elsewhere.
- To satisfy the requirements of the legislative planning guidance set out in section 2 which require FRAs to be submitted in support of DCO applications.

1.1.10 Further information regarding the project description is presented within Volume 1 Chapter 6: Project Description of the ES **[EN010147/APP/6.3]**.

## 1.2 Methodology

### Sources of Information

1.2.1 The SuDS Strategy has been produced in accordance with the National Policy Statements (NPSs) EN-1, EN-3 and EN-5; issued in March 2023. Reference has also been made to the NPPF, PPG-ID7 and local flood risk documents and provides an outline of the relevant local planning policies in addition to potential flood risk and hydrological constraints to the Project. The policies cover the requirements in respect to NSIP.

1.2.2 To achieve the key objectives above, a staged approach was adopted in preparing the SuDS Strategy in accordance with relevant NPS, NPPF and PPG-ID7. Initially, screening studies have been undertaken utilising publicly available information within the hydrology and flood risk study area which may warrant further consideration. Identified potential flooding issues are then assessed further within a specific flood risk section. The outputs of this assessment are:

- A review of all available information and a qualitative analysis of the flood risk to the Project has been produced.
- Identification of any impact the Project has on flood risk elsewhere.

### Information Sources

1.2.3 Information and reports used in the preparation of the report is set out in **Table 1.1** and **Table 1.2**, respectively below.

## Table 1.1: Information sources consulted during the preparation of the SuDS Strategy

| Source | Year | Author | Date accessed |
|---|---|---|---|
| Source | Year | Author | Date accessed |
| https://environment.data.gov.uk/catchment-planning/ | 2023 | Environment Agency (EA) | 29/07/2024 |
| https://environment.data.gov.uk/hydrology/climate-change-allowances/rainfall | 2022 | EA | 29/07/2024 |
| https://environment.maps.arcgis.com/apps/webappviewer/index.html?id=363522b846b842a4a905829a8d8b3d0c | 2021 | EA | 29/07/2024 |
| reference GSIP-2023-13424-13080_1 to _16 and<br>GSIP-2023-13424-13081 | 2023 | Groundsure | 29/07/2024 |
| https://fehweb.ceh.ac.uk/GB/map | 2023 | Flood Estimation Handbook (FEH) | 29/07/2024 |
| https://flood-map-for-planning.service.gov.uk/ | 2023 | EA | 29/07/2024 |
| https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances | 2022 | UK Government | 29/07/2024 |
| https://www.bgs.ac.uk/map-viewers/geoindex-onshore/ | 2023 | BGS | 29/07/2024 |
| https://www.ada.org.uk/idb-map/ | 2023 | Internal Drainage Board (IDB) | 29/07/2024 |
| https://check-long-term-flood-risk.service.gov.uk/map | 2023 | EA | 29/07/2024 |
| https://magic.defra.gov.uk/MagicMap.aspx | 2026 | DEFRA | 29/07/2024 |
| https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf | 2021 | UK Government (Ministry of Housing Communities & Local Government) | 29/07/2024 |
| https://maps.the-hug.net/ | 2023 | Ordnance Survey (OS) | 29/07/2024 |
| https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf | 2023 | Department of Energy and Climate Change | 29/07/2024 |
| National Policy Statement for renewable energy infrastructure (EN-3) - GOV.UK (www.gov.uk) | 2023 | Department for Energy Security and Net Zero | 29/07/2024 |
| National Policy Statement for electricity networks infrastructure (EN-5) - GOV.UK (www.gov.uk) | 2023 | Department for Energy Security and Net Zero | 29/07/2024 |

| Source | Year | Author | Date accessed |
|---|---|---|---|
| https://www.gov.uk/guidance/flood-risk-and-coastal-change | 2022 | UK Government (Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government) | 29/07/2024 |

## Table 1.2: Reports Consulted during preparation of the SuDS Strategy

| Title | Source | Year | Author | Date accessed |
|---|---|---|---|---|
| Cassington Neighbourhood Plan (2021 – 2041 Submission Plan) | https://www.westoxon.gov.uk/media/pdplutja/submission-draft-cassington-neighbourhood-plan.pdf | 2022 | Cassington Parish Council | 29/07/2024 |
| Cassington NFM report | n/a | 2020 | EA | 29/07/2024 |
| The Cherwell Local Plan 2011 - 2031 | https://www.cherwell.gov.uk/downloads/download/45/adopted-cherwell-local-plan-2011-2031-part-1-incorporating-policy-bicester-13-re-adopted-on-19-december-2016 | 2016 | Cherwell District Council. North Oxfordshire | 29/07/2024 |
| Cherwell Level 1 Strategic Flood Risk Assessment (Update) | https://www.cherwell.gov.uk/downloads/download/366/cherwell-level-1-strategic-flood-risk-assessment-update-may-2017 | 2017 | Cherwell Distirct Council (CDC) | 29/07/2024 |
| Cumnor Parish Neighbourhood Development Plan 2021 to 2031 | [redacted] | 2021 | Cumnoor Parish Council | 29/07/2024 |
| Cassington NFM report. | n/a | 2020 | EA | 29/07/2024 |
| Enviro and Geo Insight digital reports | reference GSIP-2023-13424-13080_1 to _16 and GSIP-2023-13424-13081 | 2023 | Groundsure | 29/07/2024 |
| Eynsham Neighbourhood Plan 2018 – 2031 | https://www.westoxon.gov.uk/media/ngkckyhi/eynsham-neighbourhood-plan.pdf | 2020 | Eynsham Parish Council | 29/07/2024 |
| Oxfordshire County Council Local Standards and guidance for surface water drainage on major | [redacted] | 2021 | Oxfordshire County Council (OCC) | 29/07/2024 |

| Title | Source | Year | Author | Date accessed |
|---|---|---|---|---|
| development in Oxfordshire | [redacted] | | | |
| Oxfordshire County Council Local Flood Risk Management Strategy | [redacted] | 2016 | Oxfordshire County Council (OCC) | 29/07/2024 |
| Oxfordshire County Council Local Flood Risk Management Strategy | [redacted] | 2024 | Oxfordshire County Council (OCC) | 29/07/2024 |
| Vale of the White Horse District Council – Local Plan Part 1 2031 | https://www.whitehorsedc.gov.uk/vale-of-white-horse-district-council/planning-and-development/local-plan-and-planning-policies/local-plan-2031/ | 2016 | Vale of the White Horse (VoWH) District Council | 29/07/2024 |
| Vale of the White Horse District Council – Local Plan Part 2 2031 | https://data.whitehorsedc.gov.uk/java/support/dynamic_serve.jsp?ID=1173080763&CODE=481ECD6ACC86E6C4A6FE38F6391274B7 | 2019 | VoWH District Council | 29/07/2024 |
| Vale of the White Horse District Council – SFRA | https://data.whitehorsedc.gov.uk/java/support/dynamic_serve.jsp?ID=1954970524&CODE=E1F38F2C2D52A12711B6F45AB26D5181 | 2017 | AECOM on behalf of Vale of the White Horse District Council | 29/07/2024 |
| West Oxfordshire District Council – Level 1 SFRA | https://www.westoxon.gov.uk/media/0adg2zs5/env9-west-oxfordshire-district-council-strategic-flood-risk-assessment-update-report-november-2016.pdf | 2016 | AECOM on behalf of West Oxfordshire District Council (WODS) | 29/07/2024 |
| West Oxfordshire District Council – Level 2 SFRA | https://www.westoxon.gov.uk/media/mngkh35q/ev24-level-2-strategic-flood-risk-assessment-land-north-and-west-of.pdf | 2020 | JBA Consulting on behalf of behalf of West Oxfordshire District Council | 29/07/2024 |

## 1.3 Surface Water Modelling

1.3.1 As part of the consultation, it was identified that an existing surface water risk exists within the site boundary north of the Cassington Village and adjacent south of the site within Cassington Village. The identified surface water risk is shown in the online EA Risk of Flooding from Surface Water (RoFSW).

1.3.2 The RoFSW map is derived from a national model with varying resolution. As such it is not able to capture site-specific conditions. The updated modelling is in support of providing a more detailed understanding of the baseline conditions. The modelling is used to support the design of Sustainable Urban Drainage Features to provide appropriate mitigation and a betterment where feasible.

1.3.3 The hydraulic model produced extents and flood depths within the study area and how flood depths and extents will evolve with climate change. The flood annual exceedance probability (AEP) events that were assessed as a part of the flood analysis include:

- 1 in 30-year;
- 1 in 100-year
- 1 in 100-year + 30% Climate Change (CC)
- 1 in 1000-year

1.3.4 For more information, please see Volume 3 Appendices 10.5 Surface Water Modelling Report of the ES.

### Format of assessment

1.3.5 There are three main Project sites (Northern, Central and Southern) the Southern Site includes the Primary Substation. The three main Project sites will be connected via 220kV underground cables. These 220kV cables are required to connect all Project sites with the Primary Substation.

1.3.6 The Conceptual Drainage Strategy has been split into four strategies for the following features:

- Solar PV Array Area (including site accesses and maintenance tracks);
- Ancillary buildings (including High voltage (HV) transformers / secondary substations, and Power Converter Stations);
- Applicant Substation;
- NGET Substation.

1.3.7 The Conceptual Drainage Strategy also considers the additional Temporary Features:

- Cable Corridor;
- Temporary Construction Compounds;
- Temporary Field Compounds;
- Access Tracks and Haul Roads.

# 2 Legislation and Guidance

## 2.1 National Policy Legislation and Guidance

### National Policy Statements

2.1.1 Planning policy for Nationally Significant Infrastructure Projects, specifically in relation to hydrology and flood risk is contained 2023 NPS EN-1, EN-3 and EN-5. It sets out the aims of planning policy on development and flood risk to ensure that flood risk from all sources of flooding is taken into account at all stages in the planning process. Guidance on what is to be considered in the application is set out below within **Table 2.1.**

**Table 2.1: NPS requirements**

| Summary of NPS requirements | How and where considered in the FRA |
| --- | --- |
| **Climate change adaption** | |
| A robust approach to flood risk management is a vital element of climate change adaptation; the applicant and the Secretary of State should take account of the policy on climate change adaptation in Section 4.9.<br>[paragraph 5.8.5 NPS EN-1] | An assessment of an increase of peak rainfall intensities driven by climate change has been made within the Conceptual Drainage Strategy to the end of the Project's development lifetime in **sections 264, 5, 6 and 7** for the Solar Arrays, Ancillary Buildings, Applicant Substation and NGET Substation respectively.<br>Appropriate attenuation has been provided up to the relevant 100 year plus climate change event, |
| As climate change is likely to increase risks to the resilience of some of this infrastructure, from flooding for example, … applicants should in particular set out to what extent the proposed development is expected to be vulnerable, and, as appropriate, how it has been designed to be resilient to:<br>• flooding, particularly for substations that are vital to the network; and especially in light of changes to groundwater levels resulting from climate change; and<br>earth movement or subsidence caused by flooding or drought (for underground cables).<br>[paragraph 2.3.2, of NPS EN-5]. | The impacts to flooding as a result of climate change has been taken into account within this Flood Risk Assessment (FRA) **sections 2.4, 3.4, 4.4** and **5.4.**<br>The Conceptual Drainage Strategy assesses drainage requirements for new impermeable areas of the site, taking into account increases in peak rainfall intensity as a result of climate change.<br>The Conceptual Drainage Strategies to the end of the Project's development lifetime are set out in **sections 4, 5, 6 and 7** for the Solar Arrays, Ancillary Buildings, Applicant Substation and NGET Substation respectively. |
| **Flood Risk** | |
| In determining an application for development consent, the decision maker should be satisfied that where relevant:<br>• the proposal is in line with any relevant national and local flood risk management strategy SuDS (as required in the next paragraph on National Standards) have been used unless there is clear evidence that their use would be inappropriate<br>not prevent or hinder its construction, operation or maintenance. [paragraph 5.8.36, of NPS EN-1]. | The conceptual drainage strategy is presented within and has been developed in accordance with 2023 NPS, NPPF, PPG ID7 the SuDS Manual and local council policy.<br>The conceptual drainage strategy considers existing and proposed runoff rates, the hierarchy of drainage and how SuDS can be incorporated within the proposed design.<br>New proposed impermeable areas are to be served by an on-site surface water drainage system which |

| Summary of NPS requirements | How and where considered in the FRA |
| --- | --- |
| Development should be designed to ensure there is no increase in flood risk elsewhere, accounting for the predicted impacts of climate change throughout the lifetime of the development. There should be no net loss of floodplain storage and any deflection or constriction of flood flow routes should be safely managed within the site. Mitigation measures should make as much use as possible of natural flood management techniques.<br>[paragraph 5.8.10 – 5.8.12, of NPS EN-1]. | will accommodate flows from the 1 in 100-year plus climate change storm event, with details provided within **Section 4, 5, 6 and 7.** This document also provides details regarding event exceedances, ownership of SuDS and maintenance and management of features.<br>SuDS features proposed as part of the conceptual drainage strategy include filter strips comprising of appropriate seeded vegetation, gravel-filled infiltration trenches and surface water detention basins. |
| Vulnerable aspects of the development should be located on parts of the site at lower risk and residual risk of flooding. Applicants should seek opportunities to use open space for multiple purposes such as amenity, wildlife Overarching National Policy Statement for Energy (EN-1)  habitat and flood storage uses. Opportunities should be taken to lower flood risk by reducing the built footprint of previously developed sites and using SuDS.<br>[paragraphs 5.8.29 of NPS EN-1]. | |
| To satisfactorily manage flood risk, arrangements are required to manage surface water and the impact of the natural water cycle on people and property.<br>In this NPS, the term SuDS refers to the whole range of sustainable approaches to surface water drainage management including, where appropriate:<br>• source control measures including rainwater recycling and drainage<br>• infiltration devices to allow water to soak into the ground, that can include individual soakaways and communal facilities<br>• filter strips and swales, which are vegetated features that hold and drain water downhill mimicking natural drainage patterns<br>• filter drains and porous pavements to allow rainwater and run-off to infiltrate into permeable material below ground and provide storage if needed<br>• basins, ponds and tanks to hold excess water after rain and allow controlled discharge that avoids flooding<br>• flood routes to carry and direct excess water through developments to minimise the impact of severe rainfall flooding<br>Site layout and surface water drainage systems should cope with events that exceed the design capacity of the system, so that excess water can be safely stored on or conveyed from the site without adverse impacts.<br>The surface water drainage arrangements for any project should, accounting for the predicted impacts of climate change throughout the development's lifetime, be such that the volumes and peak flow rates of | The conceptual drainage strategy is presented within and has been developed in accordance with 2023 NPS, NPPF, PPG ID7 the SuDS Manual and local council policy.<br>The conceptual drainage strategy considers existing and proposed runoff rates, the hierarchy of drainage and how SuDS can be incorporated within the proposed design.<br>New proposed impermeable areas are to be served by an on-site surface water drainage system which will accommodate flows from the 1 in 100-year plus climate change storm event, with details provided within **Section 4, 5, 6 and 7.** This document also provides details regarding event exceedances, ownership of SuDS and maintenance and management of features.<br>SuDS features proposed as part of the conceptual drainage strategy include filter strips comprising of appropriate seeded vegetation, gravel-filled infiltration trenches and surface water detention basins. |

| Summary of NPS requirements | How and where considered in the FRA |
|---|---|
| surface water leaving the site are no greater than the rates prior to the proposed project, unless specific off-site arrangements are made and result in the same net effect.<br>It may be necessary to provide surface water storage and infiltration to limit and reduce both the peak rate of discharge from the site and the total volume discharged from the site. There may be circumstances where it is appropriate for infiltration facilities or attenuation storage to be provided outside the project site, if necessary through the use of a planning obligation.<br>[paragraph 5.8.24 – 5.8.28, of NPS EN-1]. | |
| **Consultation** | |
| Applicants for projects which may be affected by, or may add to, flood risk should arrange pre-application discussions before the official pre-application stage of the NSIP process with the EA, and, where relevant, other bodies such as Lead Local Flood Authorities, Internal Drainage Boards, sewerage undertakers, navigation authorities, highways authorities and reservoir owner and operators.<br>Such discussions should identify the likelihood and possible extent and nature of the flood risk, help scope the FRA, and identify the information that will be required by the Secretary of State to reach a decision on the application when it is submitted.<br>If the EA or another flood risk management authority has reasonable concerns about the proposal on flood risk grounds, the applicant should discuss these concerns with the EA and take all reasonable steps to agree ways in which the proposal might be amended, or additional information provided, which would satisfy the authority's concerns.<br>[paragraph 5.8.18 - 5.8.20 of NPS EN-1] | The applicant has engaged with the Environment Agency and LLFA with meetings and technical notes in support of the FRA and Conc. The approach has been agreed in principle.<br>Key consultation summaries are presented within **[EN010147/APP/5.1].** |

### National Planning Policy Framework

2.1.2 Paragraph 175 of the updated NPPF identifies that major developments (developments of 10 homes or more and to major commercial development) should incorporate Sustainable Drainage Systems unless there is clear evidence that this would be inappropriate. The systems used should:

a. Take account of advice from the Lead Local Flood Authority;

b. Have appropriate proposed minimum operational standards;

c. Have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the Project; and

d. Where possible, provide multifunctional benefits.

2.1.3 Defra published their 'Non-statutory technical standards for sustainable drainage systems' in March 2015. These are supported by the revised NPPF.

### Planning Practice Guidance

2.1.4 Paragraph 055 of the 2022 Planning Practice Guidance states that the implementation of SuDS 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 open spaces and wildlife habitat; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

## 2.2 Local Planning Policy

2.2.1 The relevant local planning policies applicable to the FRA are summarised in Table 2.2.

**Table 2.2: Summary of local planning policy relevant to this chapter**

| Policy | Key Provisions |
|---|---|
| **West Oxfordshire Local Plan 2031** | |
| Policy EH7: Flood Risk | […] 8.61 The use of SuDS will be required as part of all major development, unless demonstrated to be inappropriate. An important consideration in the provision and design of SuDS is that there are clear arrangements in place for ongoing maintenance. Advice should be sought from Oxfordshire County Council, the relevant lead local flood authority […] |
| **Vale of White Horse District Council Local Plan 2031** | |
| Core Policy 42: Flood Risk | All development will be required to provide a drainage strategy. Developments will be expected to incorporate sustainable drainage systems and ensure that runoff rates are attenuated to greenfield run-off rates. Higher rates would need to be justified and the risks quantified. Developers should strive to reduce run-off rates for existing developed sites.<br>Sustainable drainage systems should seek to enhance water quality and biodiversity in line with the Water Framework Directive (WFD). |
| Chapter 2 – Key Challenges and Opportunities | Responding to Climate Change<br>• The Vale will need to play its part in meeting Government targets for reducing Greenhouse Gas emissions through low carbon and renewable energy generation, improving the energy efficiency of development and promoting more efficient use of materials and natural resources. |

| Policy | Key Provisions |
|---|---|
| | • Equipping new development to adapt to the warmer, wetter winters and hotter, drier summers that are predicted for the UK.<br>Protecting Water Resources<br>• Ensuring there is enough water available to meet needs, as the Vale is in an area of water stress, through prudent water resources management, including preventing flooding through the use of Sustainable Urban Drainage Systems (SUDS) and climate change adaptation.<br>• Waste water treatment facilities and resources within the district are in need of upgrading and new facilities are required to allow new housing and employment growth to be sustainably delivered. |
| Development Policy 30: Watercourses | • Development of land that contains or is adjacent to a watercourse will only be permitted where it would not have a detrimental impact on the function or setting of the watercourse or its biodiversity, or the detrimental impact can be appropriately mitigated.<br>• Plans for development adjacent to or encompassing a watercourse should include a minimum 10m buffer zone along both sides of the watercourse to create a corridor of land and water favourable to the enhancement of biodiversity.<br>• Proposals which involve culverting a watercourse are unlikely to be considered acceptable.<br>• Development which is located within 20m of a watercourse will require a construction management plan to be agreed with the Council before commencement of work to ensure that the watercourse will be satisfactorily protected from damage, disturbance or pollution. |
| **Cherwell Local Plan 2011 - 2031** | |
| Policy ESD 1: Mitigating and Adapting to Climate Change | […] The incorporation of suitable adaptation measures in new development to ensure that development is more resilient to climate change impacts will include consideration of the following:<br>• Taking into account the known physical and environmental constraints when identifying locations for development<br>• Demonstration of design approaches that are resilient to climate change impacts including the use of passive solar design for heating and cooling<br>• Minimising the risk of flooding and making use of sustainable drainage methods, and Reducing the effects of development on the microclimate (through the provision of green infrastructure including open space and water, planting, and green roofs) |
| Policy ESD 6: Sustainable Flood Risk Management | Flood risk assessments should assess all sources of flood risk and demonstrate that:<br>• There will be no increase in surface water discharge rates or volumes during storm events up to and including the 1 |

| Policy | Key Provisions |
| --- | --- |
| | in 100 year storm event with an allowance for climate change (the design storm event).<br>• Developments will not flood from surface water up to and including the design storm event or any surface water flooding beyond the 1 in 30 year storm event, up to and including the design storm event will be safely contained on site. |
| Policy ESD 7: Sustainable Drainage Systems (SuDS) | All development will be required to use sustainable drainage systems (SuDS) for the management of surface water run-off.<br>Where site specific Flood Risk Assessments are required in association with development proposals, they should be used to determine how SuDS can be used on particular sites and to design appropriate systems.<br>In considering SuDS solutions, the need to protect ground water quality must be taken into account, especially where infiltration techniques are proposed. Where possible, SuDS should seek to reduce flood risk, reduce pollution and provide landscape and wildlife benefits. SuDS will require the approval of Oxfordshire County Council as LLFA and SuDS Approval Body, and proposals must include an agreement on the future management, maintenance and replacement of the SuDS features. |

### Strategic Flood Risk Assessments

2.2.2 Oxfordshire County Council is the Lead Local Flood Authority (LLFA) for all the three sites and provides the local standards and guidance for surface water drainage on major developments in Oxfordshire. Relevant information from the guidance has been included and reproduced during this SuDS Strategy report.

**Local Standards and Guidance for Surface Water Drainage on Major Development In Oxfordshire – December 2021**

2.2.3 OCC developed this guide in December 2021 in order to assist developers in the design of surface water Drainage Systems and support Local Planning Authorities (LPA) in considering drainage system, for new developments within the County.

## 2.3 Climate Change Guidance

2.3.1 In May 2022 the EA released revised climate change allowances, which updates the 2020 and 2011 version of 'Adapting to Climate Change: Advice to Flood & Coastal Risk Management. The EA has used the UKCP18 projections to update the peak river flow allowances and have based them on management catchments instead of river basin districts.

2.3.2 The Project site boundary is located across the boundary of three catchments with differing climate change allowances:

- Cherwell and Ray Management Catchment;
- Gloucestershire and the Vale Management Catchment; and

- Cotswolds Management Catchment.

### Peak Rainfall Allowances

2.3.3 Peak Rainfall Allowances are used to consider how increased rainfall affects surface water flood risk and the design of drainage systems to manage the increased rainfall.

2.3.4 Increased rainfall affects surface water flood risk and how drainage systems need to be designed. In May 2022 the EA released revised peak rainfall climate change allowances, to also reflect the Management Catchment geography. The anticipated increases for each catchment are the same and are presented within **Table 2.3** below. It is noted all three management catchments have the same peak rainfall allowance uplifts.

**Table 2.3: Cotswold, Gloucestershire and Cherwell & Ray Management Catchment peak rainfall allowances**

| 1% Annual Exceedance Rainfall Event | | |
|---|---|---|
| **Epoch** | **Central** | **Upper** |
| **2050s** | 20% | 40% |
| **2070s** | 25% | 40% |

2.3.5 Run-off and attenuation calculation for any development design would have to take into account the above change in climate change policy, which is determined by the type and lifetime of the Project.

- Developments with a lifetime beyond 2100 must assess the upper end allowance for the 2070s epoch. The Project should be designed so that there is no increased flood risk elsewhere and the Project is safe from surface water flooding for the upper end allowance in the 1% AEP event (1 in 100-year rainfall event).
- Developments with a lifetime between 2061 and 2100 should consider the central allowance for the 2070s epoch.
- Developments with a lifetime up to 2060 should consider the central allowance for the 2050s epoch.

2.3.6 The Project is to be fully operational by 2029. For the purposes of this assessment, the Project is expected to have a 37.5-year operating lifetime. Therefore, the development will no longer be operational by the end of 2066.

2.3.7 Based on the above information, and the type of development proposed, the 2070's central allowance is considered to be appropriate, and a 25% climate change allowance is to be used.

## 2.4 Consultation

2.4.1 On 15 June 2023, the Applicants submitted a Scoping Report to the Planning Inspectorate, which described the scope and methodology for the technical studies being undertaken to provide an assessment of any likely significant effects for the construction, operation and maintenance and decommissioning phases. It also described those topics or sub-topics which are proposed to be scoped out of the EIA process and provided justification as to why the Project would not have the potential to give rise to significant environmental effects in these areas.

2.4.2 Following consultation with the appropriate statutory bodies, the Planning Inspectorate (on behalf of the Secretary of State) provided a Scoping Opinion on 24 July 2023. Key issues raised during the scoping process specific to Hydrology and Flood Risk are listed in **Section 10.4** of the ES chapter.

### Preliminary Environmental Information Report

2.4.1 The preliminary findings of the EIA process were published in the Preliminary Environmental Information Report (PEIR) on 30 November 2023. The PEIR was prepared to provide the basis for statutory public consultation under the Planning Act 2008. This included consultation with statutory bodies under section 42 of the Planning Act 2008.

2.4.3 The PEIR was issued to inform the statutory consultation carried out on the Project between 30 November 2023 and 8 February 2024.

2.4.4 A summary of the key items raised specific to hydrology and flood risk is presented in **Table 10.5** of the ES. This table also sets out how these issues have been considered in the production of the ES chapter and relevant supporting appendices.

### Further Engagement

2.4.5 Throughout the EIA process, consultation and engagement (in addition to scoping and section 42 consultation) with interested parties specific to hydrology and flood risk has been undertaken.

2.4.6 The engagement has been used to inform a Statement of Common Ground (SoCG) Flood/Drainage report which is included in **[EN010147/APP/7.5]**.

2.4.7 A summary of the key items raised specific to hydrology and flood risk is presented in **Table 10.5** of the ES. This table also sets out how these issues have been considered in the production of the ES chapter and relevant supporting appendices.

# 3 Surface Water Drainage

## 3.1 Introduction

3.1.1 The sustainable management of surface water is an essential element of reducing future flood risk to the site and its surroundings. Legislation and guidance relating to sustainable drainage systems (SuDS) are presented within **Section 2**, legislation and guidance.

3.1.2 Undeveloped sites generally rely on natural drainage to convey or absorb rainfall, with water infiltrating into the ground or coalescing across the surface towards watercourses.

3.1.3 Modelling work undertaken by Cook and McCuen (2013) shows that solar panels themselves do not have a significant effect on runoff volumes, peak flows or times to peak. However, where design decisions or lack of maintenance lead to bare ground then the peak discharge may increase requiring storm water management.

3.1.4 Ancillary development is expected to increase hardstanding within each site. Reducing the permeability of at least part of the site will, however, lead to marked changes in each site's response to rainfall. Without specific measures to manage surface water, the volume of water and peak flow rate are likely to increase.

3.1.5 Inadequate surface water drainage arrangements can threaten the Project itself and increase the risk of flooding to others.

3.1.6 Surface water arising from a developed site should as far as is practicable be managed in a sustainable manner to mimic the natural hydrology of the site while reducing the risk of flooding and elsewhere, taking climate change into account.

## 3.2 Sustainable Drainage Options

3.2.1 NPS EN-1, the NPPF and associated PPG, SuDS Manual (CIRIA 2015) and associated Local Plans to promote sustainable water management through the use of SuDS. A hierarchy of techniques is identified:

- Prevention;
- source control;
- site control; and
- regional control.

3.2.2 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 open spaces and wildlife habitat; and
- Replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.
- An assessment of the current and proposed runoff rates was undertaken to determine the surface water attenuation requirements for individual hardstanding areas. In line with The SuDS Manual (2015) the proposed

discharge rate must not exceed the greenfield discharge rate prior to development.

## 3.3 Greenfield Runoff Rates

3.3.1 The QBAR greenfield runoff rate were calculated using the HR Wallingford 'Greenfield Runoff Rate Estimation for Sites' tool, in line with normal best practice criteria in line with EA guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (CIRIA, 2015) and the non-statutory standards for SuDS (Defra, 2015).

3.3.2 Due to the close proximity of the Applicant Substation and NGET Substations locations, the runoff rate calculations for each location used the same following parameters were incorporated into each substation calculation:

- Standard-period Average Annual Rainfall: 638 mm/yr
- BFIHOST: 0.415
- Region number: 6 (catchment based on Flood Studies Report Figure I.2.4.).

**Table 3.1: Greenfield run-off rates per hectare**

| Return period (years) | Runoff rate (l/s/ha) |
|---|---|
| 1 in 1 | 4.19 |
| QBAR* | 3.56 |
| 1 in 30 | 9.64 |
| 1 in 100 | 13.37 |
| 1 in 200 | 15.68 |

*Mean Annual Flood

## 3.4 Proposed SuDS

3.4.1 The proposed drainage strategy for elements of the project and the associated proposed SuDS features and attenuation requirements are discussed in the following sub-sections of the report:

- Solar PV array land parcels are discussed within **section 4**
- Ancillary buildings are discussed within **Section 5;**
- The Applicant Substation is discussed within **Section 6**; and
- The NGET substation is discussed within **Section 7.**

3.4.2 The solar panels are proposed to be elevated above the ground and would therefore not contribute to a significant increase in runoff volumes. Vegetated areas (Filter strip SuDS) comprising of appropriate seeded vegetation are proposed within the solar arrays to combat potential erosion and channelisation. The access tracks are also proposed to remain permeable.

3.4.3 Ancillary building infrastructure (including the PCS Units and HV Transformers) are proposed to be situated on gravel subbases which will provide surface water attenuation prior to infiltration.

3.4.4 The Applicant Substation and the NGET Substation are to be attenuated by attenuation ponds.

## 3.5 Construction and Decommissioning Phase

3.5.1 The nature of hydrological incidents that could result from construction activities will be mitigated through the implementation of construction phase SuDS and the application of industry good practice as per CIRIA Guidance (C741)35.

3.5.2 To prevent sediment increase in associated runoff during the construction of the Scheme, construction measures will effectively prevent sediment entering surrounding watercourses. The implementation of such construction phase drainage is to be confirmed prior to the construction phase within the Code of Construction Practice (CoCP). There requirement for this is set out in the Outline CoCP **[EN010147/APP/7.6.1]**.

3.5.3 The provision of safe access and escape for flood risk during construction and decommissioning will be considered within the detailed Code of Construction Practice (COCP) and Decommissioning Environmental Management Plans DEMP(s). An Outline CoCP **[EN010147/APP/7.6.1]** and Outline DEMP **[EN010147/APP/7.6.4]** includes the commitment to prepare Flood Management Plan for each stage.

3.5.4 During high river levels and flood warnings areas of the Project would be evacuated.

## 3.6 Operation and Maintenance

3.6.1 It will be the responsibility of the Applicant to maintain effective drainage measures and rectify drainage measures that are not functioning adequately. A nominated person will also have responsibility for reporting on the functionality of drainage measures.

3.6.2 Where impermeable areas remain through the operational phase of the Scheme, the SuDS measures serving these areas will be checked on a regular basis. Should drainage measures require dredging or unblocking, this will be undertaken as soon as practicable by the Development operator or nominated personnel.

3.6.3 Outline maintenance strategies for each SuDS feature have been provided within relevant chapters below.

3.6.4 Detailed Operational Management Plan (OMP) (s) will set out the requirement for detailed maintenance and inspection. An Outline OMP **[EN010147/APP/7.6.2]** includes the commitment for this.

3.6.5 The provision of safe access and escape for flood risk during operations will be considered within the detailed Operational Management Plan (OMP)

[EN010147/APP/7.6.2]. An Outline OMP includes the commitment to prepare a Flood Management Plan.

3.6.6 During high river levels and flood warnings areas of the Project would be evacuated.

# 4 Solar PV Array Land Parcels Drainage Strategy

## 4.1 Effects of Solar Farm use on Run-off

4.1.1 Compared to agricultural (arable and livestock) use, solar PV modules are likely to create an overall betterment in surface water drainage than a continuation of the existing use.

4.1.2 The primary reason for this is the significant advantage from full year-round organically managed vegetated ground cover within solar PV module areas compared with intensive arable or livestock grazing uses. Research undertaken by Cook and McCuen (2013) found that if full vegetation cover beneath the solar PV modules is maintained, the alteration in run-off characteristics from solar PV module areas is likely to be insignificant and that ground cover has a much more important control over runoff.

4.1.3 A second environmental benefit of solar PV modules are soil quality improvement from cessation of intensive arable use and organic management of the land. It is expected that soil health will be improved through increase in soil organic matter, increase in the diversity of soil flora, fauna and microbes, and improved soil structure (for more information, please see Chapter 1 Volume 17 Agricultural Land Use and Public Rights of Way of the ES). All of the elements of solar PV modules can be removed with minimal topsoil disturbance which should leave the improved and enriched soil as a benefit for the return to arable use.

4.1.4 When the operational phase ends, the Project will be decommissioned. The anticipated period of operation and decommissioning is 42 years. All solar PV array infrastructure including solar PV modules, mounting structures, cabling, inverters and transformers will be removed from the site and recycled or disposed of in accordance with good practice and market conditions at that time.

4.1.5 As the land will be returned to full agricultural after the expiration of the solar farm consent, SuDS features that require a straightforward restoration to existing agricultural use with minimal ground disturbance or disruption to new and improved ecological features.

### Literature Review

4.1.6 Consultation responses received cited published scientific literature on the environmental impacts of solar farms on hydrology. Some hydrological parameters included surface water runoff, evapotranspiration, soil compaction and erosion.

4.1.7 A referenced study by Pisinaras et. Al. (2014) is based in semi-arid and arid climate conditions typical of the Mediterranean region which can be considered unrepresentative of the conditions applicable to the Project. Nevertheless, present works demonstrate that the effects of land use change from agriculture to solar farms does not significantly affect surface water runoff at the basin scale, even for large sites. At a local/sub basin scale, solar developments have potential impacts but this is dependent on the local hydrological impacts. Surface water modelling was undertaken at Cassington, which was a highlighted area subject to existing flood risk, and the report is provided Volume 3, Appendix 10.5: Surface Water Modelling Report. The modelling is in support of providing a more detailed understanding of the local baseline conditions and includes a consideration of climate change in line with current EA guidance.

4.1.8 The Pisinaras et. Al. (2014) study applied three impact scenarios to a hydraulic model. The 'low' impact scenario comprised reasonably spaced solar panels located on piles with vegetation beneath whereas the 'medium' and high' impact scenarios saw solar panels closer together, involved extensive earth works and included more ground impact such as concrete footing. The 'low' impact scenario appears in line with typical UK solar farms and the Project.

4.1.9 Another referenced scientific article by Yavari (2022) provided a review of literature relating to hydrology and solar farm developments. Like the Pisinaras et. al. (2014) study, the effects of solar farm developments are stated to be very dependent on the climatic conditions and ground conditions of the region - with more detrimental effects associated with arid and semi-arid regions. The report concludes that, at this time, there is an inability to find any study that directly evaluated runoff generation on solar farms through field measurement.

4.1.10 Research undertaken by Cook and McCuen (2013) found that provided full vegetation cover beneath the solar panels is maintained, the change in runoff characteristics from solar farm sites is likely to be insignificant and that ground cover has a much more important control over runoff. The Project includes for seeded vegetation below and between rows of the solar PV modules to help interrupt and slow the channelised flows, reducing erosion and also enhance and promote the infiltration and interception capacity.

4.1.11 The aim of the FRA and Conceptual Drainage Strategy is to outline the potential for the site to be impacted by flooding, the impacts of the proposed development on flooding in the vicinity of the Project, and the proposed measures which could be incorporated into the Project to mitigate the identified risk. Scientific literature related to the hydrological affects of solar developments has been reviewed and considered and this FRA has been produced in accordance with national and local guidance.

## 4.2 Development Impacts

### Solar Modules Piles

4.2.1 The majority of each solar PV installation area will be occupied by solar PV modules. Although modules have a large land take, the actual ground impact is negligible. The only intrusion will be from the driven-piled or screw piled posts, driven 1.0 – 2.5m bgl.

4.2.2 Posts are made of galvanised steel and aluminium and are not solid poles. Across the entire Project solar PV array installation areas, it is proposed there will be a maximum of 2,500,000 piled posts, each with a surface area of $0.00103m^2$. Total post area is therefore expected to be $2,575m^2$ / 0.275ha. Development therefore equates to a ground impact of 0.02% across the Project.

### Access Tracks

4.2.3 It is proposed that the internal access tracks will comprise of gravel and be fully permeable with no tarmac or other hardstanding type surface. Geotextile membrane layers will help to secure the aggregate to prevent it sinking into the soil and this will help prevent ground compaction.

4.2.4 The majority of access tracks will follow existing farm tracks however certain new purpose-built permeable access tracks are to be proposed.

4.2.5 Given there will be no increase in surface water runoff into the surrounding hydrological network associated with the Cable Corridor no drainage based upon SuDS principles are deemed appropriate.

## 4.3 Proposed SuDS Strategy

### Surface Water Modelling

4.3.1 Surface water modelling of the catchment upstream of Cassington was undertaken to provide a greater understanding of the existing baseline risk at this location. Baseline results indicate that between the upstream section of the model and immediately upstream of Cassington village there is an increase in flow rates and volumes of water. This indicates that approximately $2.037m^3/s$ of flow and a volume of $13,807.1m^3$ accumulates in the fields within the catchment area.

4.3.2 The flood risk occurs from the runoff from the fields upstream of Cassington Catchment. Water runoffs the fields via the drains and collects and pools upwards of Cassington village within the sports field.

4.3.3 Depths remain below 0.50 m in all scenarios, there are two significant water pooling areas within the proposed solar farm extent at the downstream area adjacent to Cassington. Downstream of the proposed solar farm site water enters a formal stream which is culverted along sections of Cassington village. The channel capacity is exceeded at multiple locations and depths of up to 0.50 m.

4.3.4 Although there is no significant alteration as part of the development to the baseline conditions. Given the existing risk baseline mitigation has been proposed which will also provide additional benefit to the proposed development. As such this is detailed in the mitigation of the solar panels set out below.

4.3.5 Further information is provided in Volume 3, Appendix 10.5: Surface Water Modelling of the ES.

### Solar Panels

4.3.6 Solar panels themselves should not have a significant impact on runoff volumes or peak rates, provided the ground beneath the panels remains vegetated.

4.3.7 The primary concern of solar panels is 'water sheeting'. It is expected that between 25% to 40% of precipitation falling onto the site would be intercepted by solar PV modules instead of landing directly onto the ground. Intercepted rainfall will either run down the face of the panels and drip onto the ground below or will be lost due to evaporation from the face of the panels.

4.3.8 Without mitigation there is a risk of the rainwater 'drip effect' where concentrated rainwater dripping onto the ground from the edge of the solar panels could cause erosion. This could result in the formation of rivulets (channelisation) which could increase the flow speed of surface water runoff, creating further rivulets.

4.3.9 The potential for erosion to occur as a result of the 'drip effect' is appropriately mitigated by features of the solar arrays themselves; typical solar arrays are constructed with gaps between each panel on an array which reduces the concentration of surface water drips falling to the vegetated ground beneath. Whilst there is not anticipated to be a significant impact a cautionary approach has been taken and further measures to prevent the 'drip effect' is discussed below. The approach seeks to provide a betterment in reducing runoff rates at pertinent locations and mitigating channelisation.

### Solar Array Orientation

4.3.10 As part of the Project, solar arrays are to be each placed with a 1.5 m to 3 m gap to provide adequate spacing to prevent the concentration of surface water dripping from the solar arrays.

4.3.11 The solar PV modules are to have a 12 to 18 degree pitch on the horizontal plane. This will reduce the flow velocity of run-off landing on the solar PV modules, reducing the peak surface water runoff and risk of water sheeting and run-off from the lower edge of the modules.

4.3.12 Where reasonably possible, solar panel rows have been arranged parallel to local topographical contours of each solar PV installation area.

### Vegetative Areas (Filter Strips)

4.3.13 Filter strip comprising of appropriate seeded vegetation will be provided below and between rows of the solar PV modules to help interrupt and slow the channelised flows, reducing erosion and also enhance and promote the infiltration and interception capacity. Bare ground will be avoided at the location of the solar panels.

4.3.14 A seed mix will be used to ensure permanent vegetation beneath the solar panels as opposed to agricultural use which has periods of bare ground and exposed soil which is more vulnerable to erosion and compaction (and hence a reduction in infiltration capabilities) than vegetated ground.

4.3.15 The vegetation will be managed organically and will either be mowed or used for light grazing. It is expected grassed areas will be managed through quarterly mowing, especially in the early years while the newly operational solar farm is 'bedding in'.

### Landscape and Ecology Management Plan

4.3.16 An Outline Landscape and Ecology Management Plan (LEMP) has been completed as part of the ES **[EN010147/APP/7.6.3]**.

### Cassington (Shallow Pond, Bunds and Ditch Widening)

4.3.17 Surface water modelling was undertaken to assess the baseline flood risk at Cassington; for more information, please see Volume 3 Appendix 10.5 Surface Water Modelling Report. Upon review of the baseline surface water model results a range of surface water attenuation features were proposed, including:

- Shallow ponds at a proposed 500mm depth to provide storage of surface water runoff during high intensity rainfall events;
- Ditch widening to provide an increase in surface water storage capacity within ditches, and to enable greater rates of surface water runoff to be conveyed from fields to reduce surface water ponding to the north of Cassington;
- Re-use of cut material from earthworks associated with pond creation and ditch widening to create bunds (elevated ground) to direct surface water runoff from the fields surface water storage features rather than towards Cassington.

4.3.18 Surface water attenuation features will also provide attenuation for any residual surface water flows occurring as a result of the development.

### Access Tracks

4.3.19 It is proposed that the internal access tracks will be left untreated and unsurfaced to be fully permeable with no tarmac or other hardstanding type surface. Where ground is boggy or where vehicle use is proposed on certain parts of the site during construction, surfacing would only be temporary and would be removed after use. Geotextile membrane layers will help to secure the aggregate to prevent it sinking into the soil and this will help prevent ground compaction.

4.3.20 The majority of access tracks will follow existing farm tracks however certain new purpose-built permeable access tracks are to be proposed during construction for temporary use.

4.3.21 Further details of all vehicular access points, including temporary compounds, will be identified, described, assessed and appropriate plans produced at the detailed design stage.

## 4.4 Event Exceedance

4.4.1 Solar farm components are not vulnerable in the event of exceedances. There is no need to mitigate a risk that does not exist, or for infiltration testing when there is no reason to expect a negative impact on the current baseline and every reason to expect at least modest betterment from gravel storage vs. topsoil storage.

# 5 Ancillary Buildings Drainage Strategy

## 5.1 Development Impacts

### Power Conversion Station units

5.1.1 There will be 156 Power Conversion Station (PCS) units located within the solar PV installation areas, each containing two inverter and one MV transformers. Each PCS unit is expected to measure up to 14 m long and up to 2.9 m wide (area of 40.6 $m^2$). Therefore, these 156 PCS across the Solar PV installation areas could potentially give rise to 6,333.6 $m^2$ / 0.633 ha of new impermeable surface, accounting for 0.065% of the total solar PV installation area (971ha).

5.1.2 The report takes a conservative approach and suggests that the PCS units on site will entail new hardstanding. However, this is not entirely accurate. The transformer units are prefabricated containers. They are not intended as permanent buildings. The site will require full reinstatement of the land to agricultural use at the end of the Project's operational life.

### HV Transformers (Secondary Substations)

5.1.3 There will be up to 6 HV Transformers  located within the red line boundary. Each HV Transformer is expected to measure up to 18 m long and up to 10 m wide (area of 180 $m^2$). By taking a conservative approach, these 6 HV Transformers located across the Solar PV installation areas could potentially give rise to 480 $m^2$ / 0.048 ha of new impermeable surface, however it is not anticipated buildings will occupy the entire area.

5.1.4 The report takes a conservative approach and suggests that the HV Transformers on site will entail new hardstanding. However, this is not entirely accurate. The transformer units are prefabricated containers. They are not intended as permanent buildings. The site will require full reinstatement of the land to agricultural use at the end of the Project's operational life.

## 5.2 Proposed SuDS Strategy

### Power Converter Stations units

5.2.1 Due to the small size of the units, and the widespread nature of their locations across the Project, it is impractical to connect them into a drainage scheme. The units will be in the form of containerised shipping units.

5.2.2 Surface water runoff from the PCS units will slowly drain into the underlying geology through infiltration.

5.2.3 Each PCS unit is to be placed upon a permeable gravel-filled infiltration trench filled with a 30% void ratio to provide surface water attenuation. The gravel trench will not alter the underlying condition beyond the topsoil; what would otherwise be topsoil will be replaced by gravel, which has 30% more porosity and storage capacity than the existing topsoil would have.

5.2.4 Conceptual drainage calculations have been undertaken using the industry standard Causeway Flow software. Calculations are presented within **Annex B.1** to assess attenuation requirements for the 1 in 100-year rainfall event plus a 25% uplift to account for climate change.

5.2.5 In order to accommodate surface water flows from each PCS impermeable area, 6.00$m^3$ of attenuation will be required and is expected to be provided within a gravel base 14m by 4.0m and 300mm deep with a 30% void ratio.

5.2.6 Current drainage design is based on a set of maximum design perimeters and no confirmed plans are available at this stage of the Project. The discharge location and method of surface water flows is to be determined at detailed design stage, following soakaway testing.

### HV Transformers (Secondary Substations)

5.2.7 Due to the small size of the units, and the widespread nature of their locations across the Project, it is impractical to connect them into a drainage scheme. The units will be in the form of containerised shipping units. Water runoff from these buildings will slowly drain into the underlying geology through infiltration.

5.2.8 Each HV Transformer is expected to be placed upon a gravel-filled infiltration trench filled with a 30% void ratio to provide surface water attenuation. The gravel trench will not alter the underlying condition beyond the topsoil; what would otherwise be topsoil will be replaced by gravel, which has 30% more porosity and storage capacity than the existing topsoil would have.

5.2.9 Conceptual drainage calculations have been undertaken using the industry standard Causeway Flow software. Calculations are presented within **Annex B.2** to assess attenuation requirements for the 1 in 100-year rainfall event plus a 25% uplift to account for climate change. In order to accommodate surface water flows from each Transformer (Secondary Substation) impermeable area, 28$m^3$ of attenuation will be required and is expected to be provided within a gravel base 21m by 13m and 300mm deep with a 30% void ratio.

5.2.10 Current drainage design is based on a set of maximum design perimeters and no confirmed plans are available at this stage of the Project. The discharge location and method of surface water flows is to be determined at detailed design stage, following soakaway testing.

## 5.3 Exceedance

5.3.1 The proposed surface water drainage strategy caters for the 1 in 100 year plus 25% climate change event. In the event the attenuation measures reach capacity excess water will overtop and be conveyed by gravity across the fields mimicking the existing Site runoff characteristics. The proposed mitigation seeks to improve grass planting which will improve infiltration capacity and prevent soil erosion. Therefore, any exceedance runoff will be reduce from comparison to baseline conditions. This approach will aid in managing flood flows, whilst at the same time ensuring that the vegetated ground cover and existing and new boundary vegetation receive suitable hydration.

## 5.4 Pollution Mitigation

5.4.1 SuDS provide a number of water quality benefits, and the proposed surface water management strategy utilises gravel compounds for interception and attenuation of flows. The risk posed by surface water runoff to the receiving environment is a function of:

- the pollution hazard at a particular site (i.e. the pollutant source)
- the effectiveness of SuDS treatment components in reducing levels of pollutants to environmentally acceptable levels, groundwater (i.e. the pollutant pathway)
- the sensitivity of the receiving environment (i.e. the environmental receptor).

5.4.2 To demonstrate that surface water arising from the development will be appropriately treated prior to discharge, the Simple Index Approach, as outlined within the SuDS Manual (CIRIA C753) has been followed. The simple index method provides a way of quantifying the benefit to water quality of the SuDS Management Train.

5.4.3 The total SuDS mitigation is the summation of the first components mitigation index and half the mitigation index of any subsequent component.

5.4.4 Bunds will be placed around the transformers and PCS units where there is potential for contaminants i.e. oils. Therefore, this section assesses the remainder of the units and the pollutants are considered as such.

5.4.5 With reference to the SuDS Manual, the most significant pollutant load from the Ancillary Buildings has an identified pollutant hazard level of ‘Low’ as per the SuDS Manual (CIRIA C753) Table 26.2. The identified pollutant hazard indices are 0.3 for Total Suspended Solids (TSS), 0.2 for Metals, and 0.05 for Liquid Hydrocarbons.

5.4.6 The proposed drainage system is required to demonstrate sufficient treatment capability to manage the specified Pollution Hazard Indices. To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index (for each contaminant type) that equals or exceeds the pollution hazard index (for each contaminant type).

5.4.7 As discussed above it is proposed that flows from the ancillary buildings will discharge through the gravel subbase of the compound. **Table 5.1** provides the mitigation indices for the SuDS components for each element of the ancillary buildings. This confirms that the total level of surface water treatment required by the simple index approach is exceeded.

**Table 5.1: Ancillary Infrastructure Mitigation Indices**

| Pollution hazard indices | TSS | Metals | Hydrocarbons |
|---|---|---|---|
| | 0.3 | 0.2 | 0.05 |
| SuDS Component: Gravel subbases (infiltration trench) | 0.4 | 0.4 | 0.4 |
| **Total Mitigation Score** | **0.4** | **0.4** | **0.4** |

## 5.5 Maintenance and Management

5.5.1 A full SuDS maintenance plan will be produced as part of the detailed drainage design for the Project and included within the detailed drainage strategy. The precise requirements will depend on manufacture specifications of the final design.

5.5.2 The **Table 5.2** below shows a typical drainage maintenance plan suitable for gravel subbases (extracted from SuDS Manual C753).

**Table 5.2: Gravel Subbase Maintenance**

| Maintenance schedule | Required Action | Typical Frequency |
|---|---|---|
| **Regular maintenance** | Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices | Monthly, or as required |
| | Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage | Monthly |
| | Inspect gravel for silt accumulation, and establish appropriate silt removal frequencies | Six monthly |
| | Remove sediment from gravel | Six monthly, or as required |
| **Occasional maintenance** | Remove or control tree roots where they are encroaching the sides of the gravel (if applicable), using recommended methods (e.g. NJUG, 2007 or BS 3998:2010) | As required |

# 6 Applicant Substation Drainage Strategy

## 6.1 Development Impacts

6.1.1 One Applicant Substation with two HV Transformers is proposed within the Southern Site. It is assumed that the substation itself will occupy a footprint of approximately 140 m by 62 m (area of 8,680 $m^2$ / 0.868 ha). Whilst a 100% impermeable area is currently assumed, it is understood as the design process progresses buildings will not occupy the entire substation area.

## 6.2 Proposed Runoff Discharge Rates

6.2.1 The greenfield runoff rate for the proposed impermeable area (0.868ha) has been calculated using the HR Wallingford 'Greenfield Runoff Rate Estimation for Sites' tool and are provided in **Table 6.1** below. Greenfield runoff rates for 1ha are included in **Annex A.**

**Table 6.1: Applicant Substation Greenfield Runoff Rates**

| Return period (years) | Runoff rate (l/s) |
|---|---|
| 1 in 1 | 2.41 |
| QBAR* | 2.84 |
| 1 in 30 | 6.52 |
| 1 in 100 | 9.04 |

*Mean Annual Flood

6.2.2 In line with Oxfordshire County Council guidance, it should be ensured that runoff rates are attenuated to the 1 in 1 year greenfield run-off rates.

## 6.3 Attenuation requirements

6.3.1 The attenuation volume required to restrict the surface water runoff from 0.868ha impermeable area to the greenfield runoff rate for a 1 in 100-year rainfall event plus climate change (25%) has been determined using the industry standard Causeway Flow software suite incorporating the following parameters. Indicative attenuation requirements are presented within **Annex B.3.**

6.3.2 The parameters used in the calculations are as follows:

- Rainfall methodology: FEH-22
- Summer CV: 1.0
- Winter CV: 1.0
- Drain Down time: 240 minutes
- Additional storage ($m_3$/ha): 0.0

6.3.3 The system was modelled within Causeway Flow as a tank/pond with restricted discharge rate achieved via an orifice outflow control. The Causeway Flow calculation sheets are included within **Annex B.3.**

6.3.4 The attenuation volume required to restrict runoff from a 1 in 100-year storm event, plus a 25% allowance for climate change, to the greenfield runoff rate of 3.1 l/s, has been determined to be approximately 1,811.6m$^3$.

## 6.4 Consideration of Drainage Hierarchy

6.4.1 The drainage hierarchy has been considered as follows.

### Infiltration

6.4.2 The soils within the Southern Site are described as 'slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils' by the National Soils Research Institute.

6.4.3 An Agricultural Land Classification and Soil Resources survey conducted by Reading Agricultural Consultants in November 2023 indicates that there is farm land present within the Southern Site that has some permanent pasture, functioning ditches and underdrains and non-calcareous clay or silty clay topsoil.

6.4.4 The discharge location and method of surface water flows is to be determined at detailed design stage, following soakaway testing.

### To a Surface Water Body

6.4.5 It is proposed to discharge to a surface water body in the vicinity of the site.

## 6.5 Proposed SuDS Strategy

6.5.1 It is expected surface water attenuation within the applicant substation will be provided via a gravel bases and a detention basin. An oil interceptor is also proposed to provide pollution treatment for any potential contaminants from the substation with the area bunded.

6.5.2 Current drainage design is based on a set of maximum design perimeters and no confirmed plans are available at this stage of the ES. The discharge location and method of surface water flows is to be determined at detailed design stage.

## 6.6 Event Exceedance

6.6.1 The proposed surface water drainage strategy caters for the 1 in 100 year plus 25% climate change event. In the event the attenuation measures reach capacity excess water within the attenuation basin will overtop and be conveyed by site levels towards low-vulnerability areas of the site.

## 6.7 Pollution Mitigation

6.7.1 SuDS provide a number of water quality benefits, and the proposed surface water management strategy utilises gravel compounds for interception and attenuation of flows. The risk posed by surface water runoff to the receiving environment is a function of:

- the pollution hazard at a particular site (i.e. the pollutant source)
- the effectiveness of SuDS treatment components in reducing levels of pollutants to environmentally acceptable levels, groundwater (i.e. the pollutant pathway)
- the sensitivity of the receiving environment (i.e. the environmental receptor).

6.7.2 To demonstrate that surface water arising from the development will be appropriately treated prior to discharge, the Simple Index Approach, as outlined within the SuDS Manual (CIRIA C753) has been followed. The simple index method provides a way of quantifying the benefit to water quality of the SuDS Management Train.

6.7.3 With reference to the SuDS Manual, the most significant pollutant load from the Applicant Substation is assessed as a site 'where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured' which has an identified pollutant hazard level of 'high' as per the SuDS Manual (CIRIA C753) Table 26.2. The identified pollutant hazard indices are 0.8 for Total Suspended Solids (TSS), 0.8 for Metals, and 0.9 for Liquid Hydrocarbons.

6.7.4 The proposed drainage system is required to demonstrate sufficient treatment capability to manage the specified Pollution Hazard Indices. It is noted that the pollution hazard indices are not cumulative, and that the mitigation should be designed to the maximum pollutant use. Furthermore, it is not anticipated that there would be coarse sediments for removal at the site, therefore specific design for this purpose would not be required.

6.7.5 It is expected surface water attenuation within the applicant substation will be provided via a gravel bases and a detention basin. It is expected an oil interceptor will provide pollution treatment to any oily runoff prior to discharge off site. **Table 6.2** provides the mitigation indices for the SuDS components for each element of the Applicant Substation. This confirms that the total level of surface water treatment required by the simple index approach is exceeded.

### Table 6.2: Applicant Substation Pollution Mitigation Indices

| Pollution hazard indices | TSS | Metals | Hydrocarbons |
|---|---|---|---|
| | 0.8 | 0.8 | 0.9 |
| Gravel base* | 0.4 | 0.4 | 0.4 |
| Oil interceptor** | 0.5 | 0.4 | 0.5 |
| Detention Basin | 0.5 | 0.5 | 0.6 |
| **Total Mitigation Score** | **0.90** | **0.85** | **>0.95** |

*denoted as an infiltration trench from SuDS Manual table 26.4 due to similar properties

**denoted as a hydro international vortex plus Downstream Defender®

## 6.8 Maintenance and Management

6.8.1 A full SuDS maintenance plan will be produced as part of the detailed drainage design for the Project and included within the detailed drainage strategy. The precise requirements will depend on manufacture specifications of the final design.

6.8.2 **Table 6.3, Table 6.4, Table 6.5** and **Table 6.6,** below shows a typical drainage maintenance plan suitable for the proposed attenuation and pollution treatment features (extracted from SuDS Manual C753).

**Table 6.3: Gravel base maintenance requirements**

| Maintenance schedule | Required Action | Typical Frequency |
|---|---|---|
| **Regular maintenance** | Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices | Monthly, or as required |
| | Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage | Monthly |
| | Inspect gravel for silt accumulation, and establish appropriate silt removal frequencies | Six monthly |
| | Remove sediment from gravel | Six monthly, or as required |
| **Occasional maintenance** | Remove or control tree roots where they are encroaching the sides of the gravel (if applicable), using recommended methods (eg NJUG, 2007 or BS 3998:2010) | As required |

**Table 6.4: Inlet and Outlet Headwalls maintenance requirements**

| Maintenance schedule | Require Action | Typical Frequency |
|---|---|---|
| **Regular Maintenance** | Litter removal | As required |
| | Inspect vegetation above and around headwall and remove nuisance plants (for first 3 years) | Monthly (at start, then as required) |
| | Tidy all dead growth before start of growing season | Annually |
| | Remove sediment from aprons | Annually |
| | Flap valves and grilles: Check for and clear obstructions | Quarterly |
| **Remedial Actions** | Repair of erosion or other damage around headwalls | As required |
| **Monitoring** | Inspect structures for evidence of poor operation | Monthly/after large storms |
| | Inspect structures, pipework etc. for evidence of physical damage | Monthly/after large storms |
| | Inspect silt accumulation rates and establish appropriate removal frequencies | Half yearly |
| | Check flap valves | Half yearly |

## Table 6.5: Flow Control Manhole maintenance requirements

| Maintenance schedule | Require Action | Typical Frequency |
|---|---|---|
| **Regular Maintenance** | Inspect vegetation above and around flow control chamber and remove nuisance plants (for first 3 years) | Monthly (at start, then as required) |
| | Remove sediment from flow control chambers | Annually |
| | Flow control devices: Check for and clear obstructions | Quarterly |
| **Remedial Actions** | Repair of Penstock and flow control device | As required |
| **Monitoring** | Inspect structures for evidence of poor operation | Monthly/after large storm |
| | Inspect structures, flow control and pipework etc. for evidence of physical damage | Monthly/after large storm |
| | Inspect silt accumulation rates and establish appropriate removal frequencies | Half yearly |

## Table 6.6: Detention basins maintenance requirements

| Maintenance schedule | Required action | Typical frequency |
|---|---|---|
| **Regular maintenance** | Remove litter and debris | Monthly |
| | Cut grass – for spillways and access routes | Monthly (during growing season), or as required |
| | Cut grass – meadow grass in and around basin | Half yearly (spring – before nesting season, and autumn) |
| | 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 inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies. | Monthly |
| | Check any penstocks and other mechanical devices | Annually |
| | Tidy all dead growth before start of growing season | Annually |
| | Remove sediment from inlets, outlet and forebay | Annually (or as required) |
| | Manage wetland plants in outlet pool – where provided | Annually |
| **Occasional maintenance** | Reseed areas of poor vegetation growth | As required |
| | Prune and trim any trees and remove cuttings | Every 2 years, or as required |
| | Remove sediment from inlets, outlets, forebay and main basin when required | Every 5 years, or as required |
| **Remedial actions** | Repair erosion or other damage by reseeding or re-turfing | As required |

| Maintenance schedule | Required action | Typical frequency |
|---|---|---|
| | Realignment of rip-rap | As required |
| | Repair/rehabilitation of inlets, outlets and overflows | As required |
| | Relevel uneven surfaces and reinstate design levels | As required |

## 6.9 Foul drainage

6.9.1 Detailed plans of welfare stations within the Applicant substation have yet to be confirmed. Based on a MDS that the substation will be permanently manned by on-site operatives, it is anticipated that any foul water flows from the site will drain to a septic tank or package treatment plant prior to discharge to ground or a nearby watercourse. The discharge method of flows will be determined at the detailed design stage.

# 7 NGET Substation Drainage Strategy

## 7.1 Development Impacts

7.1.1 A NGET substation is proposed within the Southern Site. The area to be set aside for the NGET substation amounts to between 2.3ha to 3.8 ha. Within that area it is assumed that the substation itself will occupy a footprint of approximately 87m by 30m (area of 2,610 $m^2$ / 0.261 ha). Whilst a 100% impermeable area is currently assumed, it is understood as the design process progresses buildings will not occupy the entire substation area.

## 7.2 Proposed Runoff Discharge Rates

7.2.1 The greenfield runoff rate for the proposed impermeable area (0.261ha) has been calculated using the HR Wallingford 'Greenfield Runoff Rate Estimation for Sites' tool and are provided in **Table 7.1** below. Greenfield runoff rates for 1ha are included in **Annex A.**

**Table 7.1: Applicant Substation Greenfield Runoff Rates**

| Return period (years) | Runoff rate (l/s) |
|---|---|
| 1 in 1 | 0.85 |
| QBAR* | 0.72 |
| 1 in 30 | 1.96 |
| 1 in 100 | 2.72 |

*Mean Annual Flood

7.2.2 In line with Oxfordshire County Council guidance, it should be ensured that runoff rates are attenuated to the 1 in 1 year greenfield run-off rates.

7.2.3 To ensure self-cleansing of a hydrobrake control it is anticipated to set the runoff rate to 2 l/s.

## 7.3 Attenuation requirements

7.3.1 The attenuation volume required to restrict the surface water runoff from 0.868ha impermeable area to the greenfield runoff rate for a 1 in 100-year rainfall event plus climate change (25%) has been determined using the industry standard Causeway Flow software suite incorporating the following parameters. Indicative attenuation requirements are presented within **Annex B.4.**

7.3.2 The parameters used in the calculations are as follows:

- Rainfall methodology: FEH-22
- Summer CV: 1.0
- Winter CV: 1.0
- Drain Down time: 240 minutes
- Additional storage ($m_3$/ha): 0.0

7.3.3 The system was modelled within Causeway Flow as a tank/pond with restricted discharge rate achieved via an orifice outflow control. The Causeway Flow calculation sheets are included within **Annex B.4**. The attenuation volume required to restrict runoff from a 1 in 100-year storm event, plus a 25% allowance for climate change, to the 1 in 1-year current runoff rate of 3.1 l/s, has been determined to be approximately 1,811.6$m^3$.

## 7.4 Consideration of Drainage Hierarchy

7.4.1 The drainage hierarchy has been considered as follows.

### Infiltration

7.4.2 The soils within the Southern Site are described as ‘slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils’ by the National Soils Research Institute.

7.4.3 An Agricultural Land Classification and Soil Resources survey conducted by Reading Agricultural Consultants in November 2023 indicates that there is farm land present within the Southern Site that has some permanent pasture, functioning ditches and underdrains and non-calcareous clay or silty clay topsoil.

7.4.4 The discharge location and method of surface water flows is to be determined at detailed design stage, following soakaway testing.

### To a Surface Water Body

7.4.5 It is proposed to discharge to a surface water body in the vicinity of the site.

## 7.5 Proposed SuDS Strategy

7.5.1 It is expected surface water attenuation within the NGET substation will be provided via a gravel bases and a detention basin. An oil interceptor is also proposed to provide pollution treatment for any potential contaminants from the relevant substation features.

7.5.2 Current drainage design is based on a set of maximum design perimeters and no confirmed plans are available at this stage of the ES. The discharge location and method of surface water flows is to be determined at detailed design stage.

## 7.6 Event Exceedance

7.6.1 The proposed surface water drainage strategy caters for the 1 in 100 year plus 25% climate change event. In the event the attenuation measures reach capacity excess water within the attenuation basin will overtop and be conveyed by site levels towards low-vulnerability areas of the site.

7.6.2 Detailed drainage design will include exceedance flow paths from the attention basin to ensure only treated flows overtop.

## 7.7 Pollution Mitigation

7.7.1 SuDS provide a number of water quality benefits, and the proposed surface water management strategy utilises gravel compounds for interception and attenuation of flows. The risk posed by surface water runoff to the receiving environment is a function of:

- the pollution hazard at a particular site (i.e. the pollutant source)
- the effectiveness of SuDS treatment components in reducing levels of pollutants to environmentally acceptable levels, groundwater (i.e. the pollutant pathway)
- the sensitivity of the receiving environment (i.e. the environmental receptor).

7.7.2 To demonstrate that surface water arising from the development will be appropriately treated prior to discharge, the Simple Index Approach, as outlined within the SuDS Manual (CIRIA C753) has been followed. The simple index method provides a way of quantifying the benefit to water quality of the SuDS Management Train.

7.7.3 With reference to the SuDS Manual, the most significant pollutant load from the Applicant Substation is assessed as a site 'where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured' which has an identified pollutant hazard level of 'high' as per the SuDS Manual (CIRIA C753) Table 26.2. The identified pollutant hazard indices are 0.8 for Total Suspended Solids (TSS), 0.8 for Metals, and 0.9 for Liquid Hydrocarbons.

7.7.4 The proposed drainage system is required to demonstrate sufficient treatment capability to manage the specified Pollution Hazard Indices. It is noted that the pollution hazard indices are not cumulative, and that the mitigation should be designed to the maximum pollutant use. Furthermore, it is not anticipated that there would be coarse sediments for removal at the site, therefore specific design for this purpose would not be required.

7.7.5 It is expected surface water attenuation within the NGET substation will be provided via a gravel bases and a detention basin. It is expected an oil interceptor will provide pollution treatment to any oily runoff prior to discharge off site. Table 7.2 provides the mitigation indices for the SuDS components for each element of the Applicant Substation. This confirms that the total level of surface water treatment required by the simple index approach is exceeded.

### Table 7.2: NGET Substation Pollution Mitigation Indices

| Pollution hazard indices | TSS | Metals | Hydrocarbons |
|---|---|---|---|
| | 0.8 | 0.8 | 0.9 |
| Gravel base* | 0.4 | 0.4 | 0.4 |
| Oil interceptor** | 0.5 | 0.4 | 0.5 |
| Detention Basin | 0.5 | 0.5 | 0.6 |
| **Total Mitigation Score** | **0.90** | **0.85** | **>0.95** |

*denoted as an infiltration trench from SuDS Manual table 26.4 due to similar properties

**denoted as a hydro international vortex plus Downstream Defender®

## 7.8 Maintenance and Management

7.8.1 A full SuDS maintenance plan will be produced as part of the detailed drainage design for the Project and included within the detailed drainage strategy. The precise requirements will depend on manufacture specifications of the final design.

7.8.2 **Table 7.3, Table 7.4, Table 7.5** and **Table 7.6** below shows a typical drainage maintenance plan suitable for the proposed attenuation and pollution treatment features (extracted from SuDS Manual C753).

### Table 7.3: Gravel base maintenance requirements

| Maintenance schedule | Required Action | Typical Frequency |
|---|---|---|
| **Regular maintenance** | Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices | Monthly, or as required |
| | Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage | Monthly |
| | Inspect gravel for silt accumulation, and establish appropriate silt removal frequencies | Six monthly |
| | Remove sediment from gravel | Six monthly, or as required |
| **Occasional maintenance** | Remove or control tree roots where they are encroaching the sides of the gravel (if applicable), using | As required |

recommended methods (eg NJUG, 2007 or BS 3998:2010)

## Table 7.4: Inlet and Outlet Headwalls maintenance requirements

| Maintenance schedule | Require Action | Typical Frequency |
|---|---|---|
| Regular Maintenance | Litter removal | As required |
| | Inspect vegetation above and around headwall and remove nuisance plants (for first 3 years) | Monthly (at start, then as required) |
| | Tidy all dead growth before start of growing season | Annually |
| | Remove sediment from aprons | Annually |
| | Flap valves and grilles: Check for and clear obstructions | Quarterly |
| Remedial Actions | Repair of erosion or other damage around headwalls | As required |
| Monitoring | Inspect structures for evidence of poor operation | Monthly/after large storms |
| | Inspect structures, pipework etc. for evidence of physical damage | Monthly/after large storms |
| | Inspect silt accumulation rates and establish appropriate removal frequencies | Half yearly |
| | Check flap valves | Half yearly |

## Table 7.5: Flow Control Manhole maintenance requirements

| Maintenance schedule | Require Action | Typical Frequency |
|---|---|---|
| Regular Maintenance | Inspect vegetation above and around flow control chamber and remove nuisance plants (for first 3 years) | Monthly (at start, then as required) |
| | Remove sediment from flow control chambers | Annually |
| | Flow control devices: Check for and clear obstructions | Quarterly |
| Remedial Actions | Repair of Penstock and flow control device | As required |
| Monitoring | Inspect structures for evidence of poor operation | Monthly/after large storm |
| | Inspect structures, flow control and pipework etc. for evidence of physical damage | Monthly/after large storm |
| | Inspect silt accumulation rates and establish appropriate removal frequencies | Half yearly |

## Table 7.6: Detention basins maintenance requirements

| Maintenance schedule | Required action | Typical frequency |
|---|---|---|
| Regular maintenance | Remove litter and debris | Monthly |
| | Cut grass – for spillways and access routes | Monthly (during growing season), or as required |

| Maintenance schedule | Required action | Typical frequency |
| --- | --- | --- |
| | Cut grass – meadow grass in and around basin | Half yearly (spring – before nesting season, and autumn) |
| | 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 inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies. | Monthly |
| | Check any penstocks and other mechanical devices | Annually |
| | Tidy all dead growth before start of growing season | Annually |
| | Remove sediment from inlets, outlet and forebay | Annually (or as required) |
| | Manage wetland plants in outlet pool – where provided | Annually |
| **Occasional maintenance** | Reseed areas of poor vegetation growth | As required |
| | Prune and trim any trees and remove cuttings | Every 2 years, or as required |
| | Remove sediment from inlets, outlets, forebay and main basin when required | Every 5 years, or as required |
| **Remedial actions** | Repair erosion or other damage by reseeding or re-turfing | As required |
| | Realignment of rip-rap | As required |
| | Repair/rehabilitation of inlets, outlets and overflows | As required |
| | Relevel uneven surfaces and reinstate design levels | As required |

## 7.9 Foul drainage

7.9.1 Detailed plans of welfare stations within the NGET substation have yet to be confirmed. Based on a MDS that the substation will be permanently manned by on-site operatives, it is anticipated that any foul water flows from the site will drain to a septic tank or package treatment plant prior to discharge to ground or a nearby watercourse. The discharge method of flows will be determined at the detailed design stage.

# 9 Conclusion

9.1.1 This Outline Drainage Strategy has been developed to demonstrate that the requirements of national, regional, and local planning policy can be achieved at the Site given the nature and the quantum of development proposed. The drainage strategy has been devised following a review of local policy and having regard to consultation responses.

## 9.2 Solar PV Arrays

9.2.1 The solar panels themselves would not have a significant impact on runoff volumes as the ground beneath the panels is to remain vegetated.

## 9.3 Access Tracks

9.3.1 It is proposed that the access tracks will be left untreated and unsurfaced, therefore they are considered fully permeable. Any surfacing would be temporary and removed after use.

## 9.4 PCS Units

9.4.1 Up to 156 PCS units are proposed, each measuring an area of approximately 40.6 $m^2$. Each unit is to be placed on a permeable gravel-filled infiltration blanket capable of storing runoff up to the 1 in 100-year rainfall event plus a 25% uplift to account for climate change.

## 9.5 HV Transformers

9.5.1 Up to 6 HV Transformers (secondary substations) are proposed each measuring an area of 180 $m^2$. Each unit is to be placed on a permeable gravel-filled infiltration blanket capable of storing runoff up to the 1 in 100-year rainfall event plus a 25% uplift to account for climate change.

## 9.6 Applicant Substation

9.6.1 One applicant substation measuring up to 8,680 $m^2$ / 0.868 ha is proposed within the Southern Site. The Applicant Substation would be assigned two HV Transformers.

## 9.7 NGET Substation

9.7.1 One NGET substation measuring up to 2,610 $m^2$ / 0.261 ha is proposed within the Southern Site. The NGET Substation would be assigned two HV Transformers.

9.7.2 In common with most drainage strategies put forward in support of planning applications, the strategy presented here will need to be subject to approval of the detailed design and any relevant consents.

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# Annex A: Greenfield Runoff Rates

# Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

| | |
|---|---|
| **Calculated by:** | Anna-Lisa Morse |
| **Site name:** | General Site Location |
| **Site location:** | West Botley |

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

## Site Details

| | |
|---|---|
| **Latitude:** | 51.74507° N |
| **Longitude:** | 1.34644° W |
| **Reference:** | 2697217349 |
| **Date:** | Jul 16 2024 17:14 |

## Runoff estimation approach

FEH Statistical

## Site characteristics

| | |
|---|---|
| **Total site area (ha):** | 1 |

## Methodology

| | |
|---|---|
| **$Q_{MED}$ estimation method:** | Calculate from BFI and SAAR |
| **BFI and SPR method:** | Specify BFI manually |
| **HOST class:** | N/A |
| **BFI / BFIHOST:** | 0.27 |
| **$Q_{MED}$ (l/s):** | |
| **$Q_{BAR}$ / $Q_{MED}$ factor:** | 1.14 |

## Hydrological characteristics

| | Default | Edited |
|---|---|---|
| **SAAR (mm):** | 640 | 626 |
| **Hydrological region:** | 6 | 6 |
| **Growth curve factor 1 year:** | 0.85 | 0.85 |
| **Growth curve factor 30 years:** | 2.3 | 2.3 |
| **Growth curve factor 100 years:** | 3.19 | 3.19 |
| **Growth curve factor 200 years:** | 3.74 | 3.74 |

## Notes

### (1) Is $Q_{BAR}$ < 2.0 l/s/ha?

When $Q_{BAR}$ is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

### (2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

### (3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

## Greenfield runoff rates

| | Default | Edited |
|---|---|---|

| | | |
|---|---|---|
| $Q_{BAR}$ (l/s): | | 4.19 |
| 1 in 1 year (l/s): | | 3.56 |
| 1 in 30 years (l/s): | | 9.64 |
| 1 in 100 year (l/s): | | 13.37 |
| 1 in 200 years (l/s): | | 15.68 |

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

# Annex B.1: Attenuation Calculations – PCS Units

## 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 | 1.000 | 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 | Area (ha) | T of E (mins) | Cover Level (m) | Diameter (mm) | Easting (m) | Northing (m) | Depth (m) |
|---|---|---|---|---|---|---|---|
| 1-POND | 0.004 | 5.00 | 100.000 | 1200 | 1010.000 | 1000.000 | 1.425 |
| 2-FC | | | 100.000 | 1200 | 1020.000 | 1000.000 | 1.484 |
| 3-OF | | | 100.000 | 1200 | 1030.000 | 1000.000 | 1.543 |

## Simulation Settings

| | | | | | |
|---|---|---|---|---|---|
| Rainfall Methodology | FEH-22 | Analysis Speed | Normal | Additional Storage ($m^3$/ha) | 0.0 |
| Summer CV | 1.000 | Skip Steady State | x | Check Discharge Rate(s) | x |
| Winter CV | 1.000 | Drain Down Time (mins) | 2880 | Check Discharge Volume | x |

**Storm Durations**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 60 | 180 | 360 | 600 | 960 | 2160 | 4320 | 7200 | 10080 |
| 30 | 120 | 240 | 480 | 720 | 1440 | 2880 | 5760 | 8640 | |

| Return Period (years) | Climate Change (CC %) | Additional Area (A %) | Additional Flow (Q %) |
|---|---|---|---|
| 100 | 25 | 0 | 0 |

## Node 2-FC Online Hydro-Brake® Control

| | | | |
|---|---|---|---|
| Flap Valve | x | Objective | (HE) Minimise upstream storage |
| Replaces Downstream Link | ✓ | Sump Available | ✓ |
| Invert Level (m) | 98.516 | Product Number | CTL-SHE-0056-1000-0300-1000 |
| Design Depth (m) | 0.300 | Min Outlet Diameter (m) | 0.075 |
| Design Flow (l/s) | 1.0 | Min Node Diameter (mm) | 1200 |

## Node 1-POND Carpark Storage Structure

| | | | | | |
|---|---|---|---|---|---|
| Base Inf Coefficient (m/hr) | 0.00000 | Invert Level (m) | 98.575 | Slope (1:X) | 1000.0 |
| Side Inf Coefficient (m/hr) | 0.00000 | Time to half empty (mins) | 0 | Depth (m) | 0.300 |
| Safety Factor | 2.0 | Width (m) | 2.900 | Inf Depth (m) | |
| Porosity | 0.30 | Length (m) | 14.000 | | |

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**Results for 100 year +25% CC Critical Storm Duration. Lowest mass balance: 100.00%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 30 minute summer | 1-POND | 24 | 98.627 | 0.052 | 2.7 | 0.6078 | 0.0000 | OK |
| 30 minute summer | 2-FC | 22 | 98.635 | 0.119 | 2.4 | 0.1344 | 0.0000 | OK |
| 15 minute summer | 3-OF | 1 | 98.457 | 0.000 | 1.0 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 30 minute summer | 1-POND | 1.001 | 2-FC | 2.4 | 0.282 | 0.059 | 0.1398 | |
| 30 minute summer | 2-FC | Hydro-Brake® | 3-OF | 1.0 | | | | 1.7 |

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# Annex B.2: Attenuation Calculations – HV Transformers

## 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) | 9.000 |
| CV | 1.000 | 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 | Area (ha) | T of E (mins) | Cover Level (m) | Diameter (mm) | Easting (m) | Northing (m) | Depth (m) |
|---|---|---|---|---|---|---|---|
| 1-POND | 0.018 | 5.00 | 100.000 | 1200 | 1010.000 | 1000.000 | 1.425 |
| 2-FC | | | 100.000 | 1200 | 1020.000 | 1000.000 | 1.484 |
| 3-OF | | | 100.000 | 1200 | 1030.000 | 1000.000 | 1.543 |

## Simulation Settings

| | | | | | |
|---|---|---|---|---|---|
| Rainfall Methodology | FEH-22 | Analysis Speed | Normal | Additional Storage (m³/ha) | 0.0 |
| Summer CV | 1.000 | Skip Steady State | x | Check Discharge Rate(s) | x |
| Winter CV | 1.000 | Drain Down Time (mins) | 2880 | Check Discharge Volume | x |

**Storm Durations**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 60 | 180 | 360 | 600 | 960 | 2160 | 4320 | 7200 | 10080 |
| 30 | 120 | 240 | 480 | 720 | 1440 | 2880 | 5760 | 8640 | |

| Return Period (years) | Climate Change (CC %) | Additional Area (A %) | Additional Flow (Q %) |
|---|---|---|---|
| 100 | 25 | 0 | 0 |

## Node 2-FC Online Hydro-Brake® Control

| | | | |
|---|---|---|---|
| Flap Valve | x | Objective | (HE) Minimise upstream storage |
| Replaces Downstream Link | ✓ | Sump Available | ✓ |
| Invert Level (m) | 98.516 | Product Number | CTL-SHE-0056-1000-0300-1000 |
| Design Depth (m) | 0.300 | Min Outlet Diameter (m) | 0.075 |
| Design Flow (l/s) | 1.0 | Min Node Diameter (mm) | 1200 |

## Node 1-POND Carpark Storage Structure

| | | | | | |
|---|---|---|---|---|---|
| Base Inf Coefficient (m/hr) | 0.00000 | Invert Level (m) | 98.575 | Slope (1:X) | 1000.0 |
| Side Inf Coefficient (m/hr) | 0.00000 | Time to half empty (mins) | 0 | Depth (m) | 0.300 |
| Safety Factor | 2.0 | Width (m) | 18.000 | Inf Depth (m) | |
| Porosity | 0.30 | Length (m) | 10.000 | | |

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**Results for 100 year +25% CC Critical Storm Duration. Lowest mass balance: 100.00%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 60 minute winter | 1-POND | 57 | 98.698 | 0.123 | 6.5 | 6.4968 | 0.0000 | OK |
| 60 minute summer | 2-FC | 58 | 98.703 | 0.187 | 2.7 | 0.2120 | 0.0000 | OK |
| 15 minute summer | 3-OF | 1 | 98.457 | 0.000 | 1.0 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 60 minute winter | 1-POND | 1.001 | 2-FC | 2.9 | 0.260 | 0.072 | 0.2869 | |
| 60 minute summer | 2-FC | Hydro-Brake® | 3-OF | 1.0 | | | | 9.6 |

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# Annex B.3: Attenuation Calculations – Applicant Substation

## 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) | 9.000 |
| CV | 1.000 | 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 | Area (ha) | T of E (mins) | Cover Level (m) | Diameter (mm) | Easting (m) | Northing (m) | Depth (m) |
|---|---|---|---|---|---|---|---|
| 1-POND | 0.868 | 5.00 | 100.000 | 1350 | 1010.000 | 1000.000 | 1.650 |
| 2-FC | | | 100.000 | 1350 | 1020.000 | 1000.000 | 1.675 |
| 3-OF | | | 100.000 | 1350 | 1030.000 | 1000.000 | 1.700 |

## Simulation Settings

| | | | | | |
|---|---|---|---|---|---|
| Rainfall Methodology | FEH-22 | Analysis Speed | Normal | Additional Storage (m³/ha) | 0.0 |
| Summer CV | 1.000 | Skip Steady State | x | Check Discharge Rate(s) | x |
| Winter CV | 1.000 | Drain Down Time (mins) | 2880 | Check Discharge Volume | x |

**Storm Durations**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 60 | 180 | 360 | 600 | 960 | 2160 | 4320 | 7200 | 10080 |
| 30 | 120 | 240 | 480 | 720 | 1440 | 2880 | 5760 | 8640 | |

| Return Period (years) | Climate Change (CC %) | Additional Area (A %) | Additional Flow (Q %) |
|---|---|---|---|
| 100 | 25 | 0 | 0 |

## Node 2-FC Online Hydro-Brake® Control

| | | | |
|---|---|---|---|
| Flap Valve | x | Objective | (HE) Minimise upstream storage |
| Replaces Downstream Link | ✓ | Sump Available | ✓ |
| Invert Level (m) | 98.325 | Product Number | CTL-SHE-0075-2500-1000-2500 |
| Design Depth (m) | 1.000 | Min Outlet Diameter (m) | 0.100 |
| Design Flow (l/s) | 2.5 | Min Node Diameter (mm) | 1200 |

## Node 1-POND Depth/Area Storage Structure

| | | | | | |
|---|---|---|---|---|---|
| Base Inf Coefficient (m/hr) | 0.00000 | Safety Factor | 2.0 | Invert Level (m) | 98.350 |
| Side Inf Coefficient (m/hr) | 0.00000 | Porosity | 1.00 | Time to half empty (mins) | 0 |

| Depth (m) | Area (m²) | Inf Area (m²) | Depth (m) | Area (m²) | Inf Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 948.1 | 0.0 | 1.000 | 1795.3 | 0.0 |

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**Results for 100 year +25% CC Critical Storm Duration. Lowest mass balance: 100.00%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 1440 minute winter | 1-POND | 1410 | 98.998 | 0.648 | 27.9 | 792.7020 | 0.0000 | SURCHARGED |
| 1440 minute winter | 2-FC | 1410 | 98.998 | 0.673 | 2.6 | 0.9626 | 0.0000 | SURCHARGED |
| 15 minute summer | 3-OF | 1 | 98.300 | 0.000 | 2.5 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 1440 minute winter | 1-POND | 1.001 | 2-FC | 2.6 | 0.149 | 0.016 | 1.5844 | |
| 1440 minute winter | 2-FC | Hydro-Brake® | 3-OF | 2.5 | | | | 554.2 |

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# Annex B.4: Attenuation Calculations – NGET Substation

## 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) | 9.000 |
| CV | 1.000 | 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 | Area (ha) | T of E (mins) | Cover Level (m) | Diameter (mm) | Easting (m) | Northing (m) | Depth (m) |
|---|---|---|---|---|---|---|---|
| 1-POND | 0.261 | 5.00 | 100.000 | 1200 | 1010.000 | 1000.000 | 1.500 |
| 2-FC | | | 100.000 | 1200 | 1020.000 | 1000.000 | 1.541 |
| 3-OF | | | 100.000 | 1200 | 1030.000 | 1000.000 | 1.582 |

## Simulation Settings

| | | | | | |
|---|---|---|---|---|---|
| Rainfall Methodology | FEH-22 | Analysis Speed | Normal | Additional Storage (m³/ha) | 0.0 |
| Summer CV | 1.000 | Skip Steady State | x | Check Discharge Rate(s) | x |
| Winter CV | 1.000 | Drain Down Time (mins) | 2880 | Check Discharge Volume | x |

**Storm Durations**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 60 | 180 | 360 | 600 | 960 | 2160 | 4320 | 7200 | 10080 |
| 30 | 120 | 240 | 480 | 720 | 1440 | 2880 | 5760 | 8640 | |

| Return Period (years) | Climate Change (CC %) | Additional Area (A %) | Additional Flow (Q %) |
|---|---|---|---|
| 100 | 25 | 0 | 0 |

## Node 2-FC Online Hydro-Brake® Control

| | | | |
|---|---|---|---|
| Flap Valve | x | Objective | (HE) Minimise upstream storage |
| Replaces Downstream Link | ✓ | Sump Available | ✓ |
| Invert Level (m) | 98.459 | Product Number | CTL-SHE-0067-2000-1000-2000 |
| Design Depth (m) | 1.000 | Min Outlet Diameter (m) | 0.100 |
| Design Flow (l/s) | 2.0 | Min Node Diameter (mm) | 1200 |

## Node 1-POND Depth/Area Storage Structure

| | | | | | |
|---|---|---|---|---|---|
| Base Inf Coefficient (m/hr) | 0.00000 | Safety Factor | 2.0 | Invert Level (m) | 98.500 |
| Side Inf Coefficient (m/hr) | 0.00000 | Porosity | 1.00 | Time to half empty (mins) | 0 |

| Depth (m) | Area (m²) | Inf Area (m²) | Depth (m) | Area (m²) | Inf Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 257.4 | 0.0 | 1.000 | 456.3 | 0.0 |

**Results for 100 year +25% CC Critical Storm Duration. Lowest mass balance: 100.00%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 480 minute winter | 1-POND | 472 | 99.109 | 0.609 | 20.9 | 194.1798 | 0.0000 | SURCHARGED |
| 480 minute winter | 2-FC | 472 | 99.109 | 0.650 | 2.1 | 0.7347 | 0.0000 | SURCHARGED |
| 15 minute summer | 3-OF | 1 | 98.418 | 0.000 | 2.0 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 480 minute winter | 1-POND | 1.001 | 2-FC | 2.1 | 0.185 | 0.029 | 0.7042 | |
| 480 minute winter | 2-FC | Hydro-Brake® | 3-OF | 2.0 | | | | 238.9 |