

Llandyfaelog Substation Drainage Statement



On behalf of **National Grid**

nationalgrid

Llandyfaelog 400kV Substation – SuDS Strategy

Sustainable Drainage Systems (SuDS) Strategy

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Executive Summary

The purpose of this report is to demonstrate how the proposed SuDS strategy detailed in this report meets Welsh Statutory SuDS Standards and is intended to help the SuDS Approval Board approve the SuDS design. The aim of the appraisal is to assist with discussions to obtain approval from Carmarthenshire County Council, as SAB, for the proposed SuDS solutions.

This report presents a Sustainable Drainage System (SuDS) Strategy for National Grid's Llandyfaelog 400kV Substation Project, which aims to install a new 400kV substation, near Llandyfaelog, Carmarthenshire. This document supplements the Planning Application for the Proposed Development to meet the requirements for a Drainage Statement set out under TAN 15 2025

This SuDS strategy employs the use of National Grid standard substation design, SuDS basins, wetlands, filter strips and swales to manage runoff generated by the new build and to intercept water likely to enter the site. This strategy provides a sufficient volume of attenuation and long-term storage to accommodate all of the runoff generated by the new impermeable areas during the design rainfall event (whilst taking climate change into account). This means that for most events, discharges are likely to remain at - or close to - zero and will limit discharges to the 1 in 100 year greenfield runoff rate. This SuDS Strategy also incorporates elements that will help to clean surface water runoff and prevent pollution incidents which will also provide biodiversity and amenity benefits.

Abbreviations

AOD	Above Ordnance Datum
CIRIA	Construction Industry Research and Information Association
FCA	Flood Consequences Assessment
LLFA	Lead Local Flood Authority
NRW	Natural Resources Wales
SAB	SuDS Approval Body
SuDS	Sustainable Drainage Systems
TAN	Technical Advice Note

1.0 INTRODUCTION

1.1 SCOPE

National Grid Energy Transmission (NGET) is currently undertaking the design of a new 400 kV substation referred to hereafter as the Proposed Development. The Proposed Development aims to provide new electricity infrastructure on greenfield land to the north of Llandyfaelog in Carmarthenshire, Wales (National Grid reference: SN 41797 13516).

Measuring 260 metres by 640 metres the platform comprises of hardstanding with drainage and earthing for electrical equipment. It will be surfaced with grey stone chippings. The National Grid 400 kV AIS substation will be located on the level platform in a fenced compound measuring 155 metres by 602 metres.

The remaining space on the platform will be used for two smaller 132 kV substations, built and operated by NGED and Green Gen Cymru respectively. NGED (referred to as Customer One) and Green GEN Cymru (referred to as Customer Two) will apply for separate consent to construct their proposed substation compounds, as well as the connections into the proposed 400 kV substation.

Stantec UK Ltd has been commissioned by NGET to produce a Sustainable Drainage System (SuDS) Strategy for the Proposed Development. This document sets out the proposed scope and methodology for this SuDS Strategy.

Some components of the Proposed Development will introduce the following new impermeable hardstanding areas:

- Concrete platforms for substation kiosks, generators, towers and associated infrastructure
- Concrete slabs for substation equipment
- Access roads within the site
- A new access road connecting the A484 to the substation platform

A site location plan is included in **Appendix A** and a site layout plan is included in **Appendix B**. This SuDS strategy only considers the new permanent areas of impermeable hardstanding associated with the Proposed Development listed above (i.e., the above-ground operational phase components) including the new areas of hardstanding that fall under the relevant planning applications. The sustainable management of surface water during the construction phase will be covered by an Outline Construction Environmental Management Plan (OCEMP).

1.2 OBJECTIVES

The proposed new areas of permanent impermeable hardstanding listed in Section 1.1 above have the potential to increase the amount of surface water runoff generated given that they will be constructed on previously 'Greenfield' sites. This could increase flood risk to the sites themselves and elsewhere. The principal aims of this strategy are to calculate the runoff generated from the footprint of these impermeable areas and to present a SuDS strategy for these areas that accords with the requirements of statutory Welsh legislation on SuDS, and local planning policy and guidance.

2.0 LEGISLATION AND POLICY

2.1 LEGISLATION

On 07 January 2019, Section 32 and Schedule 3 (Sustainable Drainage) of the Flood and Water Management Act 2010¹ came into force via the Flood and Water Management Act 2010 (Commencement No. 2) (Wales) Order 2018 (2018 No. 557).

The aim of these regulations is to reduce flood risk and improve water quality, and from 07 January 2019:

- All new developments of more than 1 house or where the construction area is 100m² or more, require sustainable drainage systems (SuDS) for managing surface water;
- Drainage systems for all new developments must be designed and built in accordance with statutory SuDS standards;
- Local authorities become the SuDS Approving Body (SAB). Carmarthenshire County Council will be the SAB for the Proposed Development;
- SuDS schemes must be evaluated and approved by the local authority, as the SAB, before construction work can begin; and
- The SAB has a duty to adopt compliant SuDS so long as it is built and functions in accordance with the approved proposals, including any SAB conditions of approval. The adoption duty does not apply if the drainage system, or part of it, is designed to provide drainage for a single property. Developers are to be encouraged to request adoption by the SAB.

Key relevant supporting documents include:

- Flood and Water Management Act 2010 Schedule 3, plus supporting regulations;
- Sustainable Drainage (SuDS) Statutory Guidance (Welsh Government, January 2019)²;
- National standards for sustainable drainage systems (Welsh Government, June 2025)³;
- Implementation of Schedule 3 of the Flood and Water Management Act 2010 for mandatory Sustainable Drainage Systems (SuDS) on new developments. (DRAFT) Frequently Asked Questions. Guidance for local authorities, developers, and statutory and non-statutory consultees (Welsh Government, January 2019); and
- The SuDS Manual (C753, CIRIA)⁴.

Therefore, the Proposed Development must demonstrate that SuDS for the management of runoff are being put in place, in order to mimic natural processes, for the components listed in Section 1.1 above, unless demonstrated to be inappropriate.

2.1.1 Statutory SuDS Standards

The Statutory SuDS Standards contain 11 principles which underpin the design of surface water management schemes. Applications for SAB approval must demonstrate how they have complied with these principles or provide justification for any departure.

These principles are to:

¹ [Flood and Water Management Act 2010](#)

² <https://www.gov.wales/sites/default/files/publications/2019-06/statutory-guidance.pdf>

³ [National standards for sustainable drainage systems - GOV.UK](#)

⁴ [The SuDS Manual, CIRIA](#)

1. Manage water on or close to the surface and as close to the source of the runoff as possible;
2. Treat rainfall as a valuable natural resource;
3. Ensure pollution is prevented at source, rather than relying on the drainage system to treat or intercept it;
4. Manage rainfall to help protect people from increased flood risk, and the environment from morphological and associated ecological damage resulting from changes in flow rates, patterns and sediment movement caused by the development;
5. Take account of likely future pressures on flood risk, the environment and water resources such as climate change and urban creep;
6. Use the SuDS Management Train, using drainage components in series across a site to achieve a robust surface water management system (rather than using a single “end of pipe” feature, such as a pond, to serve the whole development);
7. Maximise the delivery of benefits for amenity and biodiversity;
8. Seek to make the best use of available land through multifunctional usage of public spaces and the public realm;
9. Perform safely, reliably and effectively over the design life of the development taking into account the need for reasonable levels of maintenance;
10. Avoid the need for pumping where possible; and
11. Be affordable, taking into account both construction and long-term maintenance costs and the additional environmental and social benefits afforded by the system.

There are six Statutory SuDS Standards. Standard S1 is a hierarchical standard, with Standards S2 to S6 being fixed standards setting minimum design criteria and providing guidance on how SuDS could be built. Developers must demonstrate compliance with these standards within their applications.

These standards are:

- Standard S1 – Surface water runoff destination:
 - Priority 1: Surface water runoff is collected for non-potable use, e.g. rainwater harvesting systems;
 - Priority 2: Surface water runoff is infiltrated to ground;
 - Priority 3: Surface water runoff is discharged to surface water body;
 - Priority 4: Surface water runoff is discharged to surface water sewer, highway drain or another drainage system; and
 - Priority 5: Surface water runoff is discharged to combined sewer.

Exception criteria apply to each level, and movement to lower levels must demonstrate that exception criteria apply and give appropriate justification. Development can have a mix of levels within one site, or more than one level may be needed.

- Standard S2 – management of everyday rainfall:
 - Apply a ‘SuDS approach’ so that at least the first 5mm of rainfall for the majority of rainfall events does not result in runoff from the site to surface waters or piped drainage systems.
 - Evidence shall be provided that the approach to managing runoff from ‘everyday’ rainfall has been developed alongside and in support of the management of runoff quality (standard 4) and the delivery of amenity and biodiversity benefits (standards 5 and 6). Standard S3 - management of extreme rainfall and flooding:
- Standard S3
 - A ‘SuDS approach’ shall be adopted to address the management of development runoff during extreme rainfall, including allowances for climate change and urban creep to:

- protect people and property on the development from flooding of the surface water drainage system
 - mitigate any increased flood risk to people and property adjacent to or downstream of the development
 - protect the receiving water body from morphological damage or minimise the impact on sewer capacity
- When discharging to an above ground surface water body, sewer or other piped drainage system, the surface water runoff (rate and volume) for the 1% annual exceedance probability (AEP) event shall be controlled to ensure the runoff from the development does not increase flood risk elsewhere.
- When discharging to an above ground surface water body, sewer or other piped drainage system, the surface water runoff rate for the 50% AEP event shall be controlled to ensure development runoff from an event of this magnitude has no negative impact.
- Any flooding from the surface water drainage system for events up to the 1% AEP event shall be managed within the development.
- Any flooding from off-site sources for the 1% AEP event should be managed on site or safely routed through the site, ensuring any downstream risks are not increased compared to the pre-development scenario.
- The risks (both on and off the development) associated with flooding from the surface water drainage system for exceedance events greater than the 1% AEP event shall be appropriately managed.
- Standard S4 – Water Quality:
 - Apply a ‘SuDS approach’ that protects surface waters, groundwater and coastal waters by managing the quality of the surface water runoff to adequately address water quality risks from the development.
 - The proposed SuDS management train(s) shall be based on a robust water quality risk assessment, appropriate to the pollution hazard and sensitivity of receiving waters, reflecting industry recognised guidance or other quantitative assessment as agreed with the approving body and permitting requirements.
- Standard S5 – Amenity:
 - A ‘SuDS approach’ shall be adopted that maximises benefits for amenity through the creation of multi-functional places and landscapes.
- Standard S6 – Biodiversity:
 - A ‘SuDS approach’ shall be adopted to ensure the surface water drainage system maximises biodiversity benefits throughout the development lifecycle.
 - The surface water drainage system shall add biodiversity value by:
 - creating diverse, self-sustaining, resilient local ecosystems which contribute to net gains in biodiversity
 - supporting and promoting natural local habitat and species, for example, through local nature recovery strategies (LNRS)
 - contributing to the delivery of local biodiversity strategies
 - contributing to habitat connectivity
- Standard S7 – design of drainage for construction, operation, maintenance, decommissioning and structural integrity:
 - A ‘SuDS approach’ shall be adopted to ensure that surface water drainage systems are designed so they can be easily and safely constructed, operated and maintained taking account of the need to minimise negative impacts on natural resources and the environment.

- The designer shall provide a management and maintenance plan that supports the design objectives detailed in standards 1 to 6 and ensures the performance of the surface water drainage system with regards to runoff destinations, everyday and extreme rainfall, water quality, amenity and biodiversity is maintained throughout the lifetime of the development.
- Surface water drainage design shall examine for the likelihood and consequences of potential failure scenarios that may occur during the operation phase and safely manage the associated risks.
- The surface water drainage system shall be designed to ensure structural integrity of all components under anticipated loading conditions for the design life of the development so that it does not affect the structural integrity of any existing or proposed components within, or adjacent to, the development.

2.2 NATIONAL POLICY

2.2.1 Planning Policy Wales (Edition 10, July 2024)⁵

Paragraphs 6.6.17 to 6.6.19 inclusive of this document specifically address SuDS and new development and reflect the new legislative requirements set out in Section 2.1. It emphasises that the provision of SuDS must be considered as an integral part of the design of new development and considered at the earliest possible stage and identifies that the incorporation of measures at an individual site scale can secure cumulative benefits over a wider area, including whole catchments.

Development proposals are encouraged to design surface water management based on principles which work with nature to facilitate, where possible, multiple benefits such as environmental enhancements (i.e. in terms of hydromorphology, water quality and biodiversity), health and well-being, and amenity.

2.2.2 The Future Wales Plan (2021)⁶

Future Wales – the National Plan 2040 is the national development framework, setting the direction for development in Wales to 2040. It is a development plan with a strategy for addressing key national priorities through the planning system, including sustaining and developing a vibrant economy, achieving decarbonisation and climate-resilience, developing strong ecosystems and improving the health and well-being of our communities. Chapter 4 sets out Policy 8 Flooding.

2.2.3 TAN 15: Development, Flood and Coastal Erosion (2025)⁷

Technical Advice Note (TAN) 15 provides technical guidance which supplements the policy set out in Planning Policy Wales in relation to development and flood risk. It advises on development and flood risk as this relates to sustainability principles and provides a framework within which risks arising from both river and coastal flooding, and from additional runoff from development in any location, can be assessed. TAN15 has been updated as of March 2025.

2.3 LOCAL PLANNING POLICY

2.3.1 Local Flood Risk Management Strategy⁸

The Local Flood Risk Management Strategy was published by Carmarthenshire County Council in August 2024.

⁵ [Planning policy Wales | GOV.WALES](#)

⁶ [Future Wales: The National Plan 2040 | GOV.WALES](#)

⁷ [Technical advice note \(TAN\) 15: development, flooding and coastal erosion | GOV.WALES](#)

⁸ [Carmarthenshire County Council Flood Risk Management and Coastal Adaptation Local Strategy 2024-2030](#)

The document advocates a risk management approach to flood risk, working with natural processes to contribute to a more sustainable ecosystem management approach. This includes deploying SuDS for surface water management for both new and existing developments.

Carmarthenshire County Council will be the SAB for any SuDS applications associated with the Proposed Development.

Strategic Policy 14: Protection and Enhancement of the Natural Environment, outlines the need for development to protect and enhance the county's natural environment, including Regional and Locally important sites, statutory designated sites, and natural assets.

Policy EP3 Sustainable Drainage: Proposals for development will be required to demonstrate that the impact of surface water drainage, including the effectiveness of incorporating Sustainable Drainage Systems (SUDS), has been fully investigated. The details and options resulting from the investigation must show that there are justifiable reasons for not incorporating SUDS into the scheme in accordance with section 8 of TAN 15.

Policy EP1 Water Quality and Resources: Proposals for development will be permitted where they do not lead to a deterioration of either the water environment and/or the quality of controlled waters. Proposals will, where appropriate, be expected to contribute towards SuDS and Planning

Combined planning and SuDS applications can be made, but the processes are separate and not dependent on the outcome of one another. Developers are required to demonstrate compliance with the Statutory SuDS Standards and local policy when submitting planning applications.

2.4 SUDS ASSESSMENT APPROACH

SuDS are designed to replicate the natural drainage behaviour of a site prior to development. They aim to manage rainfall close to where it lands by promoting infiltration into the ground and evaporation, thereby reducing surface runoff. Any remaining runoff is attenuated and conveyed to a nearby watercourse or sewer at a controlled rate, equal to or less than the pre-development runoff rate, to prevent any increase in downstream flood risk.

The SuDS management train (also known as the treatment train) approach is a four-stage process of best practice to mimic the natural drainage environment of a site. This is discussed further in Section 5.1 of this report.

This SuDS Strategy presents a surface water drainage solution for the operational components of the Proposed Development listed in Section 1.1, in order to align with the above guidance. It demonstrates that the most sustainable and appropriate drainage solution has been chosen, considering the scale and nature of the Proposed Development. Reference has been made to the following guidance, where appropriate, to help develop the SuDS Strategy:

- Technical Advice Note 15 (March, 2025);
- Sustainable Drainage (SuDS) Statutory Guidance (Welsh Government, January 2019);
- National standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems (Welsh Government, June 2025);
- Implementation of Schedule 3 of the Flood and Water Management Act 2010 for mandatory Sustainable Drainage Systems (SuDS) on new developments. (DRAFT) Frequently Asked Questions. Guidance for local authorities, developers, and statutory and non-statutory consultees (Welsh Government, January 2019);
- The SuDS Manual (version 6, CIRIA C753, 2015);
- Relevant Pollution Prevention Guidance notes, including the relevant replacement guidance series: Guidance for Pollution Prevention; and

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Legislation and Policy

- NRW Guidance: Flood Consequences Assessments: Climate change allowances⁹.

⁹ [Flood Consequences Assessments: Climate change](#)

3.0 LLANDYFAELOG 400KV SUBSTATION

3.1 DEVELOPMENT PROPOSALS

3.1.1 Llandyfaelog Substation components

Stantec has been commissioned to provide support to the 4.3 stage Front End Engineering Design (FEED) of National Grid's Llandyfaelog Substation. The Proposed Development comprises the following components:

- Construction of a single level platform (260 metres by 640 metres) on which an Air Insulated Substation (AIS) is sited measuring 155 metres by 602 metres
- Bellmouth access to the A484 with an operational access road to connect the platform to the A484
- Modification works to the existing 400kV Overhead Line (OHL) to connect the substation to the existing OHL involving the installation of two new towers (pylons) and one replacement tower (pylon) circa 18 metres and 62 metres
- Associated drainage, and hard and soft landscaping

The Proposed Development incorporates a single platform design for various reasons including drainage. The Stantec holistic drainage design for the platform is based on the NGET substation layout and assumptions for impermeable areas for the customers substations. **Figure 1** shows the split between the three areas. The impermeable areas are summarised in **Table 1**. Impermeable features of the development that would contribute to increased hardstanding include:

- Substation equipment,
- Concrete slabs, and
- Access roads through the site.

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Llandyfaelog 400kV Substation



Figure 1 Platform Areas

Table 1 New impermeable areas associated with the substation at Llandyfaelog.

Site Ownership	Total area (ha)	Impermeable area (ha)
National Grid	9.29	1.59
Customer One	2.46	0.78
Customer Two	3.18	0.36
Additional Areas outside of 3 platforms	1.79	0.61
Total	16.73	3.34

4.0 BASELINE CONDITIONS

4.1 TOPOGRAPHY

The site is located on the western slope of a hill, at an elevation of approximately 132mAOD. Existing ground levels in the area are around 132m AOD on the north-eastern side and fall to 122m AOD on the western side of the site. A detailed topography map can be found in **Appendix C** Appendix B.

The site is within the hydrological catchment of Afon Tywi / River Towy, which is located 2.1km to the west of the site.

4.2 GROUND CONDITIONS

Stantec has commissioned SOCOTEC to conduct a Ground Investigation, shown in the Ground Investigation Report, also included as part of this application. Appendix C in the GI Factual Report presents the results of soakaway tests. All tests were terminated due to no infiltration. Therefore, it is concluded that infiltration is not viable for the SuDS Strategy.

Cranfield University's Soilscales website¹⁰ provides high-level information on soil characteristics across the UK and classifies the soil type for the site as: *"Slowly permeable seasonally wet acid loamy and clayey soils"*.

The British Geological Survey's Geology Viewer website¹¹ describes the bedrock geology and superficial deposits beneath these locations as:

- Bedrock geology: Milford Haven Group - Argillaceous rocks and sandstone and conglomerate, interbedded. Sedimentary bedrock formed between 427.4 and 407.6 million years ago during the Silurian and Devonian periods.
- Superficial deposits: Till, Devensian - Diamicton. Sedimentary superficial deposits formed between 116 and 11.8 thousand years ago during the Quaternary period.

4.3 FLOOD RISK

The site is located entirely within Flood Zone 1 therefore it is not identified as at significant risk of Fluvial, Tidal or Groundwater flooding.

The site is shown to be at risk of surface water flooding so a 2D Direct Rainfall Flood Model was built in InfoWorks ICM to identify flow paths; the results from this modelling can be seen **Appendix D**.

4.4 EXISTING DRAINAGE

There are two ordinary watercourses located to the west of the Site (**Appendix C**): the Nant Morlais, which is a tributary of the Gwendraeth Fach and an unnamed watercourse that is a tributary of the River Towy.

The Site is currently drained by a network of ditches, with most flowing north-east to south-west towards the unnamed tributary of the River Towy. A rainfall model was built, and results (including a map of flow velocity) can be found in **Appendix D**. No sewers are present in the vicinity of the Site (either surface water or combined).

¹⁰ <http://www.landis.org.uk/soilscales/>

¹¹ <https://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html>

5.0 WATER CONSERVATION STATEMENT

As required by policy PCYFF 6 detailed in Section 2.3, a Water Conservation Statement is required to support a planning application for a development over 1,000m².

The Proposed Development will incorporate water conservation measures into its design, where appropriate. These measures include the adoption of SuDS features to manage surface water runoff and the installation of water saving devices to manage water more efficiently. These water conservation measures are set out below.

5.1 SUDS FEATURES

This SuDS Strategy report focuses mainly on SuDS features and describes the SuDS features that are incorporated into the design of the Proposed Development. SuDS are used in order to manage surface water runoff and as a means to minimise flood risk by increasing permeable surfaces and storage capacity. This is presented in further detail in **Section 6.0** and **7.0**.

5.2 RAINWATER HARVESTING

Rainwater Harvesting is not proposed for this site as it is a substation that will not be manned frequently. Therefore, the proposals do not include any infrastructure or features that require water use.

During the construction phase, a rainwater harvesting system will be implemented for grey water use (i.e. wheel washing and toilet flushing) to reduce the demand for potable water.

5.3 WATER SAVING DEVICES

In terms of installing water saving devices, the following measures will be implemented to reduce potable water usage and improve water conservation:

- Motion sensors or timer flush controls on urinals;
- The use of water efficient toilets including options such as dual control toilets. A dual flush mechanism can be retrofitted into a traditional toilet if required; and
- Installation of flow restrictors/aerators to all taps.

No washing facilities are currently foreseen at the Site however, the above water saving devices could be installed on these if required.

During the construction phase, eco-cabins for working compounds will be used which will be fitted with water saving devices as standard.

6.0 PROPOSED SUDS STRATEGY

Section 2.0 of this document discusses current national SuDS legislation, national and local policy for drainage design and the need for early stakeholder engagement. The following section sets out the proposed SuDS Strategy, based on the baseline conditions, and the scale and nature of the Proposed Development. The aim of the appraisal is to assist with discussions to obtain approval from Carmarthenshire County Council, as SAB, for the proposed SuDS solutions.

6.1 SUDS MANAGEMENT TRAIN

To determine a list of appropriate surface water drainage options the SuDS management (or treatment) train has been followed. The principles of the train are discussed in Table 2.

Table 2 SuDS Management Train Hierarchy

Principle (in priority order)		Explanation
	Prevention/Re-use	Techniques to prevent surface water runoff from areas. Techniques include reducing impermeable areas and good housekeeping measures for reducing pollution to prevent the need for treatment so runoff can progress through a drainage system naturally. These techniques also include rainwater harvesting techniques that allow rainfall to be captured and re-used, for example, for flushing toilets.
	Source Control	Sustainable drainage systems that deal with surface water runoff from developments as close as possible to where it falls as rain.
	Site Control	Sustainable drainage systems that manage surface water runoff within a site boundary.
	Regional Control	Sustainable drainage systems that manage surface water regionally serving multiple sites.

This hierarchy is in line with the principles of the SuDS Standards for Wales, Standard S1:

- Level 1: Surface water runoff is collected for use;
- Level 2: Surface water runoff is infiltrated to ground;
- Level 3: Surface water runoff is discharged to a surface water body;
- Level 4: Surface water runoff is discharged to a surface water sewer, highway drain or another drainage system; and
- Level 5: Surface water runoff is discharged to combined sewer.

SuDS Standard S4 also advocates the use of a ‘management train’ approach to deliver the required improvement in water quality and to help ensure accidental spills are trapped and managed.

6.1.1 Proposed SuDS Strategy

The SuDS have been separated into two discrete systems, one for the substation itself, and one for the access road connecting the A484 to the substation. The substation SuDS will take advantage of the gravel platform upon which it will be constructed. The platform will be 600mm deep and filled with MOT Type 3 gravel, providing a permeable storage area for runoff generated by the substation. All concrete pads/buildings/structures will shed runoff directly to this gravel fill; perimeter access roads will be graded to achieve the same so that no runoff generated from the substation will exit the site without first having passed through this gravel fill, which represents the first component in the SuDS ‘train’. The long term storage volume will be provided at its base, in the form of a sump set 200mm above the base of the gravel (the ‘sump’ provision will occupy elevations between the base of the gravel fill at 126.0 mAOD, and 200mm above this elevation, at 126.2 mAOD). Long-term storage is defined by the CIRIA SuDS Manual (C753, 2015) as the additional volume of runoff generated by a development that exceeds the volume from the site in its natural (greenfield) state. For volumes above the long term storage provision, the attenuation volume will be discharged at a controlled rate into swales (with check dams/notch weirs).

The gravel fill within the substation platform will be served by x14 (100mm diameter, each with a maximum discharge rate of 10l/s) perforated pipes, each with an outlet invert set at 126.2m AOD. These pipes will allow the attenuation volume to leave the gravel fill, as water levels contained within begin to rise above the long term storage ‘sump’. Each pipe will outlet through the substation embankment at strategic locations that will allow each of the x3 separately owned development platforms to drain independently. Each pipe will discharge into the perimeter swales which, in turn, will convey surface water to a new ephemeral wetland area created using a natural block stone retaining wall laid across the existing contours. The swales will also intercept offsite runoff to prevent it running into the site and direct offsite flows to existing receptors, mimicking natural flow paths. 2D ‘baseline’ rainfall modelling was undertaken to understand the movement of water across the project site, which identified flow paths all leading to a downstream receptor (a ditch in the field to the west).

To illustrate this proposed SuDS Strategy, **Figure 2 in Appendix D**, shows the results of a 2D rainfall model built in InfoWorks ICM, which shows existing flow paths, depths and velocities downstream and the results of the proposed SuDS strategy.

The proposed drainage strategy is separated into a substation management chain and an access road chain. Details and justification for each are covered in the rest of this section.

6.1.1.1 Substation SuDS

Surface Water Runoff Volume Estimation

The first stage of the SuDS design is to account for the loss of ditches covering the site. A rainfall model was built to model these ditches and identify flow paths and to assess flood risk on site, which can be seen in **Appendix D**. The HR Wallingford Surface water storage volume estimation tool¹² was used to estimate surface water storage requirements for the site using the information shown in Table 1. The output of this tool can be viewed in **Appendix F**. The areas are summarised in **Table 3**. The site discharge rate for the 1 in 100-year return period ‘baseline’ event was estimated as 128l/s.

The three substation ownership areas were calculated separately so that each of the calculations are provided for each developer. This approach enabled the drainage strategy to be demonstrated to be fit to size for the individual stakeholders as well as the total site and therefore NGET and customers have proportionate parts of the drainage strategy to maintain.

¹² [Surface water storage volume estimation | UK SuDS](#)

Table 3 Platform Area storage requirements

Site ownership	Area (ha)	Long term storage requirement (m ³)	Attenuation storage requirement (m ³)	Permissible discharge (l/s) - 100 year greenfield runoff rate
NGET	9.30	2894	7202	78.60
Customer 1	2.46	820	2029	22.50
Customer 2	3.21	979	2422	26.90

Platform

The SuDS plan for the substation is illustrated in **Appendix E**. The drainage for the substation platform will take advantage of National Grid's standard substation design. The gravel platform will be used as storage for rainfall runoff. Runoff will drain from the areas of hardstanding and percolate into the gravel platform, which will be 600mm deep. Hydraulic calculations shown in **Appendix G** show that long term storage can be achieved in the gravel, via a sump created by outfall pipes placed 200m above the bed level of the gravel platform. The SuDS management train for the Substation Platform is summarised in **Figure 2**.

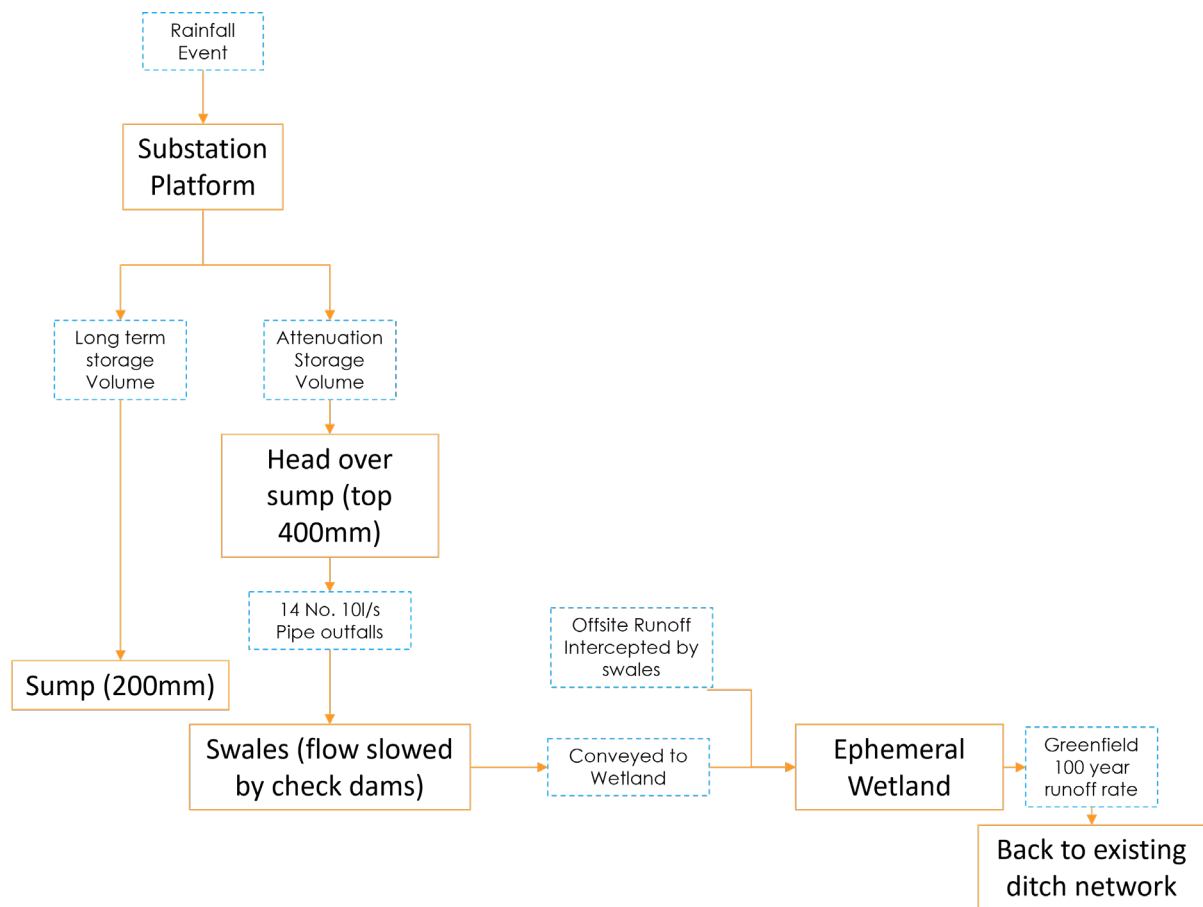


Figure 2 SuDS Management Train for Platform SuDS

The proposed development was initially modelled in MicroDrainage. Rainfall volume was estimated using FEH22 Rainfall to a design event of 100 years plus 40% Climate Change (as per the Welsh Government’s Peak Rainfall intensity climate change allowances¹³). The time area diagram accounted for the entire 13.66 hectare site.

The proposed platform will be filled in with MOT Type 3 aggregate gravel with impermeable features built over, resulting in a porosity of 30%. This creates a total of 16.72 ha of permeable area, which has been represented as cellular storage in MicroDrainage, with an average depth of 600mm and a porosity of 0.3. Infiltration was assumed to be 0 due to the failure of infiltration testing on the site in SOCOTEC ground investigations. Rainfall was first tested on this and was shown to achieve the required total storage.

The dimensions of the platform are summarised in **Table 4**. The individual site compounds equal at total of 14.93 ha. However, extra access road and ‘no man’s land’ that is necessary to fit fence lines within the compound account for an extra 0.59 ha, which makes up to a grand total of 16.73 ha. This total figure has been accounted for in hydraulic calculations for the site

¹³ [climate-change-allowances-and-flood-consequence-assessments_0.pdf \(gov.wales\)](#)

Table 4 Platform Dimensions

Site	Total (ha)	Gravel depth (m)	Gravel porosity (%)	Cover level	Sump Invert
NGET	9.28	0.60	30	126.60	126.20
Customer 1	2.46	0.60	30	126.60	126.20
Customer 2	3.18	0.60	30	126.60	126.20

To achieve long term storage, a sump with a depth of 200mm from the base of the gravel platform will be created by 14 outfall pipes set to achieve a total discharge rate of 140l/s which have been placed around the platform, proportional to ownership area. The outlet invert elevation of each pipe will be 126.20m AOD, thus creating the aforementioned long term storage 'sump'. Water will exit this 'sump' only via evaporation or via any minor infiltration to ground that may actually occur in reality (both, however, only occurring after the storm event has passed). **Appendix E** shows the locations of these outfalls. This will provide the long-term storage generated by the HR Wallingford storage tool. Each pipe will discharge into the perimeter swales as shown in **Figure 2** above. Details of the MicroDrainage results for the platform are summarised in **Table 5** Substation Gravel Platform Storage Volumes

The gravel platform will allow rainfall to drain freely through the site and will not impede flood water flows as it will drain into the sump and the outfall pipes will allow water to discharge into the two swales that flow around the site.

Table 5 Substation Gravel Platform Storage Volumes

Site Ownership	Storage volume available as LTS (first 200mm)	Storage volume available as attenuation (top 400mm)
NGET	4628.5	9256.9
Customer 1	1123.9	2247.7
Customer 2	1707.5	3415.1

Swales - Interception Design

Onsite rainfall has been accounted for in the onsite section of the SuDS strategy, but the current drainage of the proposed site has a network of ditches, shown in **Appendix D**. To prevent runoff from the southern and eastern hills draining into the substation gravel platform, the two swales receiving the discharge from the platform have been sized to intercept and redirect offsite runoff around the platform and into the wetland. The location and function of these swales are shown in **Appendix E**. Offsite flow was measured in TUFLOW. The measured flows are presented in **Appendix F**.

The principle behind these swales is to re-route greenfield runoff around the substation and reconnect it into the ditch system downstream of the site. They have been designed to convey flows from the 1 in 100 year plus 40% climate change event modelled by the rainfall model. This was then represented in ICM, and shown in **Appendix D**. Dimensions of the swales are outlined in **Table 6**. Inflows were calculated by taking modelled flows from all ditches that would be conveying flow into the site.

Both swales have been designed with notch weir check dams due to the steep fall in elevation from the platform to the drainage ditch downstream of the site. An example is shown in **Figure 3**. They will be made of natural rock to slow flow within the swales and account for their relatively steep gradient. This will reduce velocities in the swale and reduce the risk of channel incision. This will also have the co-benefit of providing in-channel retention time to settle sediment and improve water quality.

Table 6 Swale details

Detail	Eastern Swale	Western Swale
Length (m)	746	276
Upstream Top of bank Elevation (mAOD)	125.89	125.72
Upstream Bed Elevation (mAOD)	125.70	125.7
Upstream Top of bank width (m)	1.96	1.12
Upstream Bed width (m)	1	1
Downstream Top of bank Elevation (mAOD)	118.80	118.9291
Downstream Bed Elevation (mAOD)	118.56	118.85
Downstream Top of bank width (m)	4.33	1.53
Side Slope	1:4	1:4
No. Notch Weirs	14	11



Figure 17.8 Dry swale with overlying flow control, Upton, Northamptonshire (courtesy Peterborough City Council)

Figure 3 Example of swale with notch weir (from Ciria SuDS manual, page 313)

Wetland

The final destination for surface water runoff from the platform is a wetland. From here, runoff is discharged close to the 100 year greenfield runoff rate for the entire catchment, including the runoff from the platform, and the offsite runoff entering the swales, mimicking existing natural processes. This design philosophy has been adopted to preserve the wetland-like habitat that has been identified in the ICM modelling results. The final discharge rate from the wetland is proposed to be 400l/s. This is slightly less than the estimated flow from the swales of 467 l/s¹⁴. This reduction in flow is to allow the wetland to fill with water for the formation of the wetland. The outfall has also been set 200mm above the bed level of the wetland to allow the wetland to remain wet throughout most of the year, except for extended dry periods. This will enhance local biodiversity.

Table 7 summarises details for the wetland, which can be seen operating in **Appendix D**.

To create the wetland, a retaining wall is proposed. This will be constructed of natural, locally available material such as rock and wood, to maintain a natural aesthetic. The retaining wall has been proposed to be placed at a top level of 118.2 mAOD, using the existing topography of the land to create a natural

¹⁴ Note, this value is higher than the 'greenfield' runoff rate for the substation. This is deliberate and reflects the calculated flow from off-site areas that will be intercepted and conveyed by the perimeter swales. The outfall rate for the wetland is, therefore, a 'composite' outfall rate comprising the existing peak flows that would be intercepted and conveyed by the swales, and the 'greenfield' runoff rate for the substation – see Table 7 below.

shape. The lowest point in the valley is 116.9 mAOD, meaning that the wetland (if full) is 1.3 m at its deepest, with the existing contours of the valley providing a slope and morphological variation across the bed of the wetland.

Table 7 Wetland details

Inflow from substation (l/s)	Estimated additional offsite flow	Bed level (mAOD)	Top of Retaining Wall (mAOD)	Outflow (l/s)
140	327	116.9	118.2	400

Summary

The platform will be served by a SuDS train that takes advantage of the gravel construction of the substation platform. Attenuation and Long-term storage requirements are fulfilled by the platform's 600mm deep gravel layer, where a sump set 200mm above the base of the platform will hold the long-term storage volume, and the 400mm gravel depth above the sump will provide the attenuation storage volume.

From the platform, 14 outfall pipes will discharge volumes above the sump into swales running along the platform. They have been sized to convey both discharge from the platform and offsite runoff trying to enter the site. The swales will have notch weirs that will act as check dams to reduce velocity and provide settlement for sediment discharged from the platform.

The swales convey runoff to a wetland that has been constructed by installing a retaining wall across the existing valley contours. This is then discharged at a rate of 400l/s to the fields downstream of the site. Therefore, the SuDS strategy mimics existing natural processes as closely as possible to maintain downstream wet habitats, ensure the substation doesn't flood, and flood risk is not made worse by the development.

6.1.1.2 Access Road

The platform will be accessed via a new road that will drain away to the west. As such, a separate SuDS train has been designed to manage runoff generated by the access road, as well as provide biodiversity and amenity benefits.

The Access Road will be served by a filter strip and swale (with check dams/notch weirs) conveying runoff generated by the road to two basins that will provide sufficient attenuation volume and discharge at the greenfield Qbar rate to the A484's existing drainage network. Hydraulic modelling has been undertaken to demonstrate that this will not increase flood risk on the A484. The SuDS management train is shown in **Figure 4**.

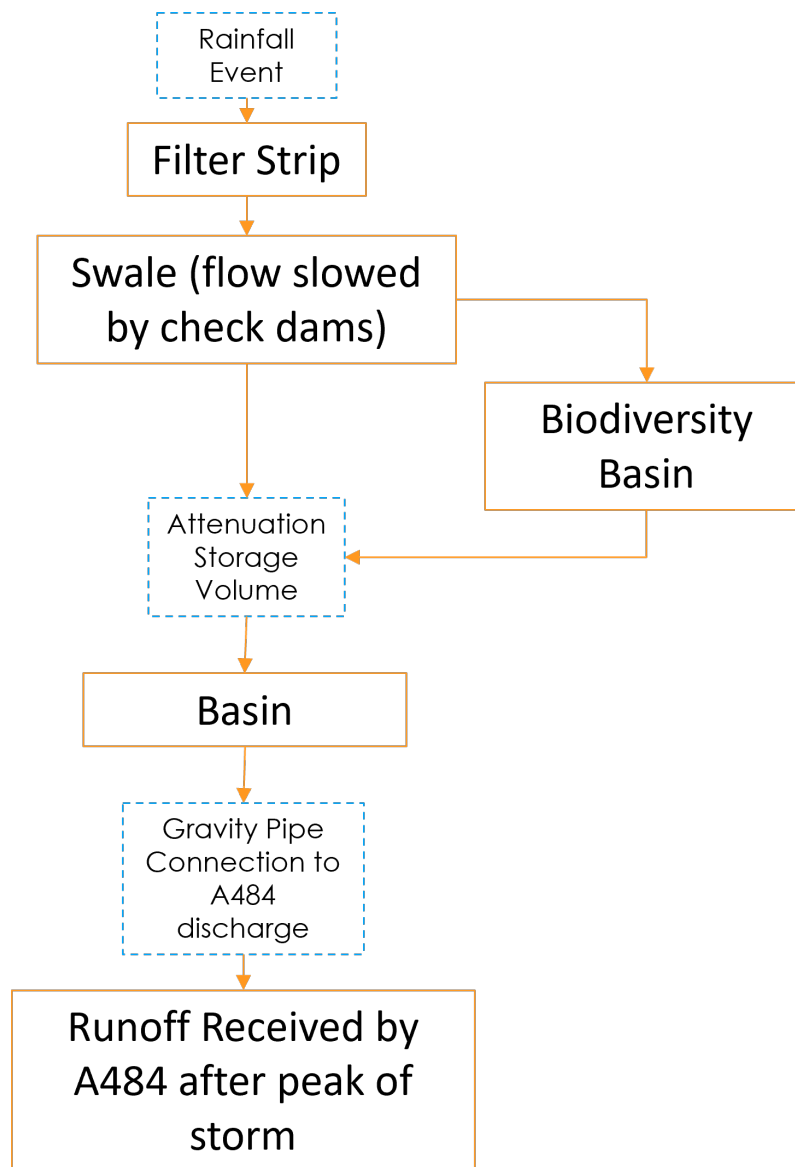


Figure 4 Access Road SuDS Management Train

Surface Water Runoff Volume Estimation and Destination

The HR Wallingford Surface Water Runoff Volume Estimation tool was used to size the SuDS for the access road. The results are shown in **Appendix F** and summarised in **Table 8**. The swale has been sized using MicroDrainage and then modelled in ICM. The ICM results are shown in **Appendix D**. Details of dimensions are shown in **Table 9** and **Appendix E** shows the alignment and arrangement of the Access Road SuDS.

Table 8 surface water storage estimate results for Access Road

Total Contributing area (ha)	0.98
Qbar (l/s)	6.9
Design rainfall event	1 in 100 year + 40% climate change
Storage requirement (m ³)	799.8

Existing LiDAR data was used to identify the sub-catchment that the new access road alignment lies within and identify the appropriate downstream receptor. This determined that water would be draining to a watercourse to the north, separated by the A484 and multiple buildings. The most appropriate receptor for the new access road drainage is to connect into the A484's highway drainage.

A survey of the A484 highway drainage was undertaken. Data on the highway drainage features and condition was incorporated into a hydraulic model to test the A484's capacity to receive extra runoff from the access road. The model found that flows from the access road attenuation basin would be received by the A484 highway drainage after the peak of the storm event on the road and therefore concluded that connection into the highway drainage would not impact its performance or reduce its capacity during a storm event and would not increase flood risk on the A484. This is summarised in **Appendix H**.

Swale

The access road will be drained by a filter strip and swale that will convey flow along the southern side of the access road (the road surface will be constructed to achieve a mild cross-fall to allow runoff from its surface to enter the filter strip/swale arrangement). The swale has been initially sized in MicroDrainage, and then represented in the ICM holistic model (shown in **Appendix D**). Details of the swale are shown in **Table 9**. The first length of road will be served by a drain, this is due to the first portion of the road being in cut, therefore restricting the provision of a swale. This cut and fill arrangement can be seen in **Appendix E**. The swale then discharges into the attenuation basin, with some flow siphoned into the biodiversity basin.

Table 9 Access Road Swale Details

Detail	Swale
Length (m)	350
Upstream Top of bank Elevation (mAOD)	125.903
Upstream Bed Elevation (mAOD)	125.403
Top of bank width (m)	5
Bed width (m)	2
Downstream Top of bank Elevation (mAOD)	121.582

Downstream Bed Elevation (mAOD)	121.082
Side Slope	1:3
No. Notch Weirs	3

Basin details

There will be a biodiversity basin and an attenuation basin. The first basin, as shown in **Appendix E** will siphon flow from the swale and fill up to provide biodiversity benefit. The biodiversity basin will have an outflow 200mm above the bed level. This will allow the bed of the basin to remain wet throughout most of the year, drying out only in the driest months. This mimics a natural ephemeral pond. It will not contribute to attenuation storage. It has a top overflow weir that will discharge to the attenuation basin when full. The details of the basins are summarised in **Table 10**.

Table 10 Details of Access Road Basins

	Biodiversity Basin	Attenuation basin
Cover level (mAOD)	122	121.5
Top area (m ²)	704.1	1387.9
Bed level	121	120.5
Total Storage Volume	n/a	800
Discharge rate	n/a	4.7l/s

A484 Connection

The downstream receptor for the access road SuDS train will be the surface water sewer in the A484, which is shown in **Appendix E**. A condition and capacity survey has been conducted of the A484 drainage. This is shown in **Appendix H**. This has been used to model the road drainage in ICM. The discharge from the basin is shown to not flood the existing drainage network. In a storm event, the attenuation basin will not discharge to the A484 until after the storm has ended and runoff from the A484 has already passed through the system.

ICM Results Analysis

Flow rate and volume measurements were taken from the Baseline and Proposed model scenarios. The locations of where the flow measurements were taken are shown in **Figure 5**. The results are summarised in **Table 11** and **Table 12**. Locations 2, 3 and 8 are located in the high risk area for surface water flooding. This has also been identified as an area of high ecological value, as identified in the ecology report. There is a small reduction in peak flow across this area with an increase in total volume, owing to the increased runoff from the Proposed Development. These areas show a larger cumulative reduction as the measurement lines pick up a lot of flow paths. Locations 6 & 7 measure one or two flow paths each and show a negligible reduction in peak flow, this is because the SuDS only has a minor impact of the catchment associated with these flow pathways.

In summary, the results show that peak flow rates are slightly reduced with the SuDS operating, while the flow is slowed, that causes an increase in volume in the area identified at high risk of flooding in the NRW'S Flood Risk from Surface Water and Small Watercourses map. This demonstrates that the SuDS strategy is mimicking the natural processes currently operating on site.

Table 11 Peak Flows

Flow measurement location	Baseline Peak Flow intensity (l/s)	Proposed Peak Flow intensity (l/s)	Difference in Max Flow Intensity (l/s)
1	71.57	52.1	-19.47
2	558.15	458.62	-99.53
3	517.64	427.64	-90
4	11.17	6.89	-4.28
5	130.82	121.79	-9.03
6	22.27	21.23	-1.04
7	50.47	49.03	-1.44
8	586.05	423.48	-162.57

Table 12 Total Flow Volumes

Flow measurement location	Baseline Flow Volume (m ³)	Proposed Flow Volume (m ³)	Difference in Flow Volume (m ³)
1	1645.02	1216.08	-428.94
2	15486.94	24092.38	8605.44
3	16632.78	25083.3	8450.52
4	266.24	163.91	-102.33
5	3127.29	2996.25	-131.04
6	456.92	464.63	7.71
7	1169.8	1161.19	-8.61
8	12988.82	21872.26	8883.44

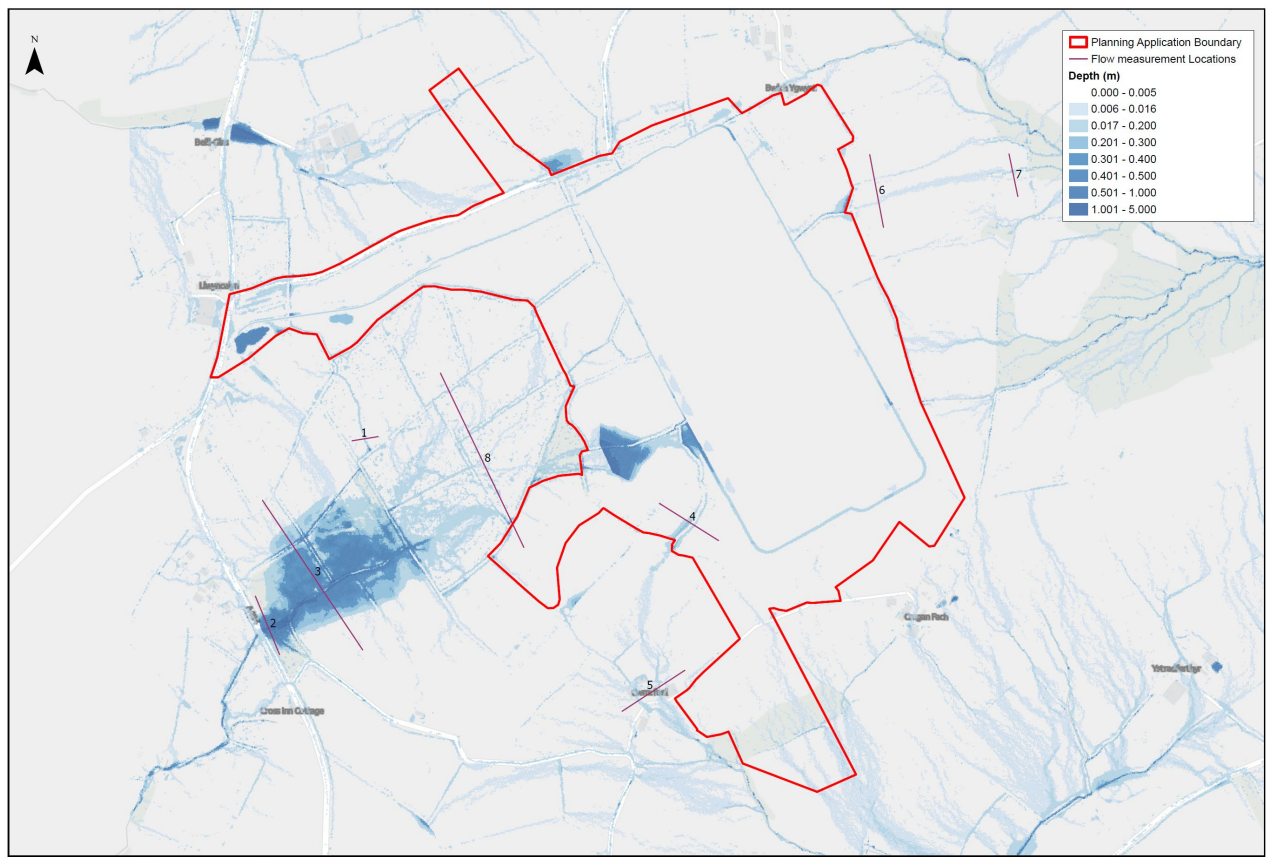


Figure 5 Flow Measurement Locations

6.1.2 Proposed SuDS Strategy: Detailed SuDS Plan

A detailed SuDS plan for the permanent operational phase components of the Proposed Development is included in **Appendix E**.

6.1.3 Proposed SuDS Strategy: Maintenance Plan

The proposed SuDS will be privately managed and maintained by National Grid over the design lifetime of Proposed Development. The CIRIA SuDS manual sets out appropriate maintenance schedules for both swales and basins:

Table 13 Recommended maintenance for Ponds.

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

Table 14 Recommended maintenance for Swales

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

6.1.4 Proposed SuDS Strategy: Water Quality Treatment and Pollution Prevention Plan

The runoff from the operational components of the Proposed Development is expected to be clean (i.e. mainly comprising runoff substation equipment, concrete slabs and roof runoff). The MOT Type 3 crushed stone aggregate that will comprise the main element of SuDS storage will, however, filter out dust and any fine sediment contained within the runoff generated.

National Grid will put in place effective pollution control measures throughout the operational lifetime of the Proposed Development. Such measures will include (but will not be limited to): ensuring that the storage and operational use of oils, fuels and other chemicals within the compounds aligns with best practice and the relevant pollution prevention guidelines, and ensuring that any vehicles that need to visit the compounds are well maintained (i.e. in order to prevent/minimise hydrocarbon leakage), in addition to the use of, for example, light liquid bypass/oil separators in gully pots in the eastern access road, if required as part of the detailed design. In addition, the microbial communities that are known to develop over time within the SuDS sub-grade material are known to be effective at breaking down hydrocarbons¹⁵. This will help to prevent pollution of receiving waterbodies in the event of minor hydrocarbon spills (for example, from leaking maintenance vehicles).

Finally, the operational components of the Proposed Development will occupy land that is currently used for livestock grazing. The implementation of the Proposed Development will, therefore, remove a

¹⁵ See, for example: Newman, A. P., et al., (2002): Oil bio-degradation in permeable pavements by microbial communities. *Water Sci Technol.* 45 (7), pp51-6.

source of diffuse nitrogen and phosphorous pollution over its developed area. This will help to reduce diffuse nitrogen and phosphorous loading within the receiving catchments.

Both the Substation and Access Road SuDS management trains have been assessed against the CIRIA C753 Simple Index Approach using HR Wallingford's Simple Index tool¹⁶, and have been deemed sufficient for their land use type. The results are included in **Appendix I**.

6.1.5 Proposed SuDS Strategy: Biodiversity and Amenity

The substation platform has been designed so that its footprint is as small as possible. The proposed swales and SuDS basin will provide visual amenity using natural construction materials and heterogeneity incorporated into the form of these features will provide habitat for local flora and fauna, both aquatic and terrestrial.

¹⁶ [Water quality assessment for SuDS developments \(SuDS manual\) | UK SuDS](#)

7.0 SUDS PRINCIPLES/STANDARDS REVIEW

7.1 SUDS PRINCIPLES

Applications for SAB approval must demonstrate how they have complied with the principles of the Welsh SuDS Standards or provide justification for any departure. Table 15 below demonstrates how the SuDS Strategy for the Proposed Development complies with these principles and justifies any departures accordingly.

7.2 SUDS STANDARDS

Applications for SAB approval must also demonstrate how they have complied with the Welsh SuDS Standards. Movement to lower levels must demonstrate that exception criteria apply and give appropriate justification. Table 16 below demonstrates how the SuDS Strategy for the Proposed Development complies with these Standards and justifies exception criteria where appropriate.

Table 15 Compliance with SuDS Principles

SuDS Principle	Llandyfaelog Substation
1. Manage water on or close to the surface and as close to the source of the runoff as possible	The SuDS strategy involves the use of source control and infiltration/sub-base storage techniques to manage water directly adjacent to the source of runoff.
2. Treat rainfall as a valuable natural resource	N/A: The permanent above-ground components of the Proposed Development will remain largely unmanned, with no requirement for non-potable water for operational purposes. No welfare/toilet facilities are proposed for the site. Rainwater Harvesting is not proposed for this site as it is a substation that will not be manned frequently. Therefore, the proposals do not include any infrastructure or features that require water use.
3. Ensure pollution is prevented at source, rather than relying on the drainage system to treat or intercept it	Most of the runoff generated by the Proposed Development will be clean (i.e. roof runoff). The source control and infiltration/sub-base storage techniques will help to remove dust and silt from the runoff at source, and the sub-base layer will establish microbial communities that will be able to breakdown hydrocarbons in the event of minor vehicle leaks. National Grid will put in place effective pollution control measures throughout the operational lifetime of the Proposed Development. Such measures will include (but will not be limited to): ensuring that the storage and operational use of oils, fuels and other chemicals within the compounds aligns with best practice and the relevant pollution prevention guidelines, and ensuring that any vehicles that need to visit the compounds are well maintained (i.e. in order to prevent/minimise hydrocarbon leakage)
4. Manage rainfall to help protect people from increased flood risk, and the environment from morphological and associated ecological damage resulting from changes in flow rates, patterns and sediment movement caused by the development	The SuDS Strategy will provide a sufficient volume of attenuation storage (i.e. in the SuDS sub-grade material) to accommodate all runoff generated by the Proposed Development during the design event (whilst taking climate change into account). This means that for most of the year, discharges are likely to remain at - or close to - zero and will provide betterment to existing greenfield 1 in 100-year runoff rates.

Llandyfaelog 400kV Substation – SuDS Strategy

SUDS Principles/Standards review

SuDS Principle	Llandyfaelog Substation
5. Take account of likely future pressures on flood risk, the environment and water resources such as climate change and urban creep	The SuDS Strategy has been designed to incorporate a 40% uplift in the design rainfall depth to account for climate change to the 2115 horizon.
6. Use the SuDS Management Train, using drainage components in series across a site to achieve a robust surface water management system (rather than using a single “end of pipe” feature, such as a pond, to serve the whole development)	The SuDS strategy involves the use of source control and base sump storage techniques to manage water directly adjacent to the source of runoff and will redirect runoff back into the existing drainage ditch network. This is the most appropriate SuDS solution given the scale and nature of the Proposed Development.
7. Maximise the delivery of benefits for amenity and biodiversity	The substation platform has been designed so that its footprint is as small as possible. The compound incorporates measures such as the inclusion of reinforced crushed stone surfacing to minimise the requirement for hard/impermeable surfacing. The proposed swales, basins and wetland will provide visual amenity using natural construction materials and heterogeneity incorporated into the form of these features will provide habitat for local flora and fauna, both aquatic and terrestrial.
8. Seek to make the best use of available land through multifunctional usage of public spaces and the public realm	N/A. The substation platform and surrounding area is not accessible to the general public for reasons of health, safety, and asset security.
9. Perform safely, reliably, and effectively over the design life of the development taking into account the need for reasonable levels of maintenance	The SuDS Strategy has been designed to operate safely and effectively over the design lifetime of the Proposed Development and will be privately managed and maintained by National Grid.
10. Avoid the need for pumping where possible	The SuDS Strategy does not incorporate any features that rely on pumping and will be entirely gravity-drained (with the exception of a small pump that would be required for any rainwater harvesting and re-use system included as part of the detailed design of the toilet facility).

Llandyfaelog 400kV Substation – SuDS Strategy

SUDS Principles/Standards review

SuDS Principle	Llandyfaelog Substation
11.Be affordable, taking into account both construction and long-term maintenance costs and the additional environmental and social benefits afforded by the system	National Grid is satisfied that the construction and maintenance costs associated with the SuDS Strategy are commensurate with the scale and nature of the Proposed Development.

Table 16 Compliance with SuDS Standards

SuDS Standard	Llandyfaelog Substation
Standard S1 – Surface water runoff destination	
<i>Level 1 - Surface water runoff is collected for use.</i> <i>Exceptions:</i> <i>- No foreseeable demand for non-potable water</i> <i>- No foreseeable need to harvest water.</i> <i>- Not a viable/cost effective part of the solution</i>	N/A: The Proposed Development will comprise a 400Kv substation that will remain largely unmanned, with no requirement for non-potable water for operational purposes. Rainwater harvesting and re-use techniques for toilets have not been considered possible for this design as the site will be unmanned.
<i>Level 2 - Surface water runoff is infiltrated to ground.</i> <i>Exceptions:</i> <i>- Not practical due to permeability</i> <i>- Would result in ground instability.</i> <i>- Unacceptable risk of pollution (existing contamination, nearby activities, sensitivity of groundwater or surface waterbody)</i> <i>- Unacceptable risk of flooding from groundwater</i> <i>- Ingress flow to combined sewer leading to increased risk of flooding or pollution</i>	Infiltration testing was carried out as part of a Ground Investigation. The results showed that infiltration potential was poor, as discussed in Section 4.2. Therefore it is concluded that infiltration was not possible at this site. The SuDS strategy involves the use of source control and base sump storage techniques to manage water directly adjacent to the source of runoff.

Llandyfaelog 400kV Substation – SuDS Strategy

SUDS Principles/Standards review

SuDS Standard	Llandyfaelog Substation
<i>Level 3 - Surface water runoff is discharged to surface water body.</i> <i>Exceptions:</i> <i>- Not reasonably practical (distance, inappropriate/inadequate access, H&S risks, risk from land use along the drainage route)</i> <i>- Would require use of pumps</i> <i>- Unacceptable increased risk of flooding</i>	The SuDS Strategy will provide a sufficient volume of attenuation storage (i.e. in the SuDS sub-grade material) to accommodate all of the runoff generated by the Proposed Development during the design event (whilst taking climate change into account). This means that for most of the year, discharges are likely to remain at - or close to - zero and will provide betterment to the existing greenfield 1 in 100-year runoff rates estimated under more extreme events. The proposed interception swales will direct runoff around the site and back into the existing ditch network. Rainfall directly on to the site will be attenuated as long-term storage until the sump level and discharged into the SuDS basin.
<i>Level 4 - Surface water runoff is discharged to surface water sewer, highway drain or another drainage system</i> <i>Exceptions:</i> <i>- Not reasonably practical</i> <i>- Would require use of pumps</i> <i>- Unacceptable increased risk of flooding</i>	The Access Road SuDS will connect into the A484. The discharge rate is 4.7 l/s, which is a betterment to the existing Qbar rate of 6.9 l/s. LiDAR data was used to define which catchment the access road would fall into. To avoid the transfer of runoff across catchments, the A484 surface water drainage network was identified as the most suitable downstream receptor. Moreover, a condition and capacity survey of the drainage network was conducted to determine if it was fit for purpose. ICM modelling has demonstrated that the access road SuDS system doesn't discharge until after a storm event has passed, and does not exceed the current capacity of the surface water drainage network.
<i>Level 5 - Surface water runoff is discharged to combined sewer</i>	N/A
Standard S2 – Surface water runoff hydraulic control	The SuDS Strategy will provide a sufficient volume of attenuation storage (i.e. in the SuDS sub-grade material) to accommodate all of the runoff generated by the Proposed Development during the design event (whilst taking climate change into account). The SuDS have been designed to accommodate the 1 in 100-year, six-hour rainfall event, with a 40% uplift for climate change. For most events, discharges are likely to remain at - or close to - zero and will not exceed and will provide a betterment to existing 1 in 100-year greenfield runoff rates under more extreme events.

Llandyfaelog 400kV Substation – SuDS Strategy

SUDS Principles/Standards review

SuDS Standard	Llandyfaelog Substation
Standard S3 – Water Quality	Most of the runoff generated by the Proposed Development will be clean (i.e. roof runoff). The source control and infiltration/sub-base storage techniques will help to remove dust and silt from the runoff at source, and the sub-base layer will establish microbial communities that will be able to breakdown hydrocarbons in the event of minor vehicle leaks. National Grid will put in place effective pollution control measures throughout the operational lifetime of the Proposed Development. Such measures will include (but will not be limited to): ensuring that the storage and operational use of oils, fuels and other chemicals within the compounds aligns with best practice and the relevant pollution prevention guidelines, and ensuring that any vehicles that need to visit the compounds are well maintained (i.e. in order to prevent/minimise hydrocarbon leakage).
Standard S4 – Amenity, and Standard S5 – Biodiversity	The substation platform has been designed so that its footprint is as small as possible. The Platform incorporates measures such as the inclusion of reinforced grass/crushed stone surfacing to minimise the requirement for hard/impermeable surfacing and welded mesh security fencing to minimise visual impact. The proposed swales and SuDS basin will provide visual amenity using natural construction materials and heterogeneity incorporated into the form of these features will provide habitat for local flora and fauna, both aquatic and terrestrial.
Standard S6 – Design of drainage for construction, operation, and maintenance and structural integrity	The SuDS Strategy has been designed to operate safely and effectively over the design lifetime of the Proposed Development and will be privately managed and maintained by National Grid.

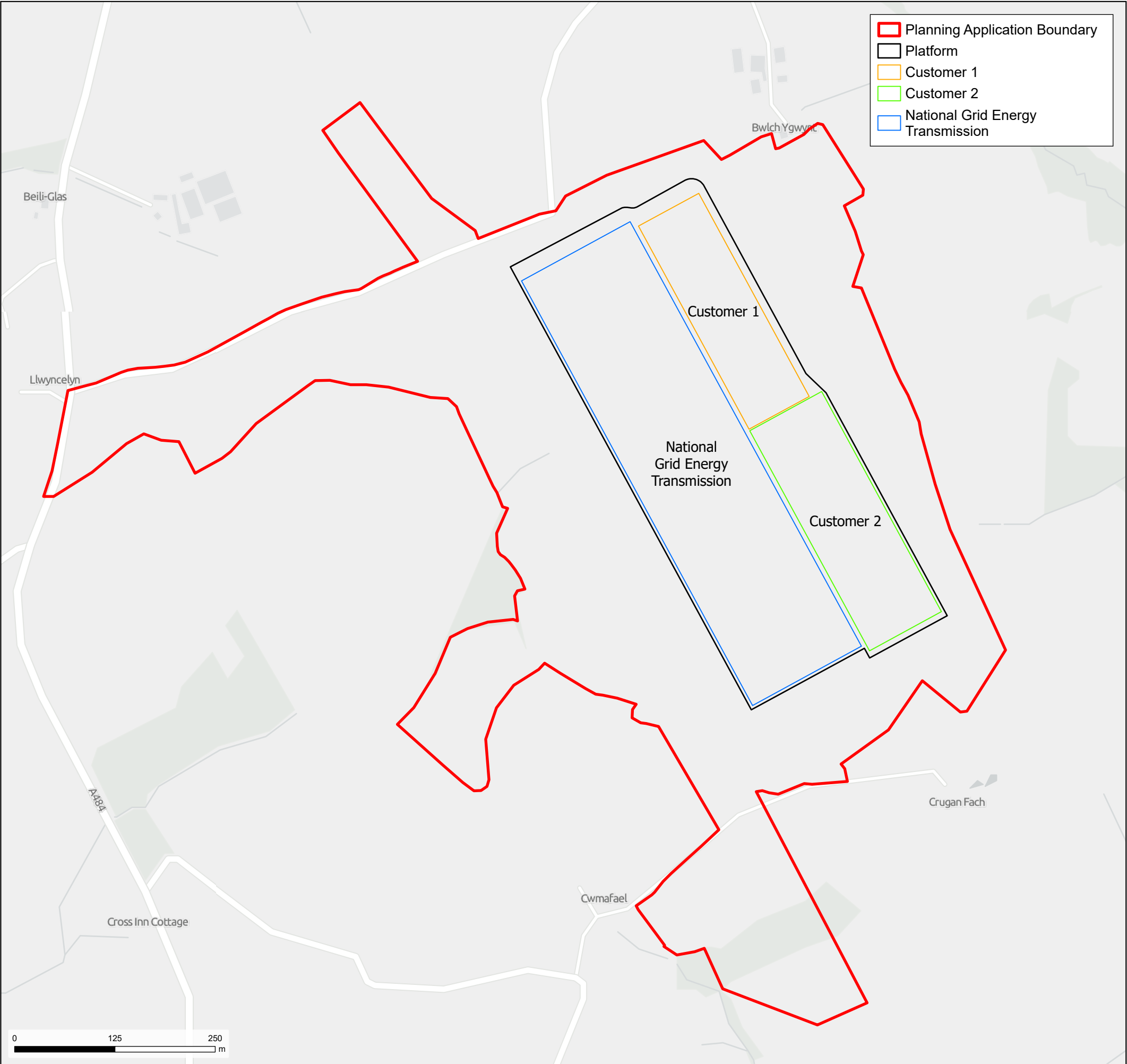
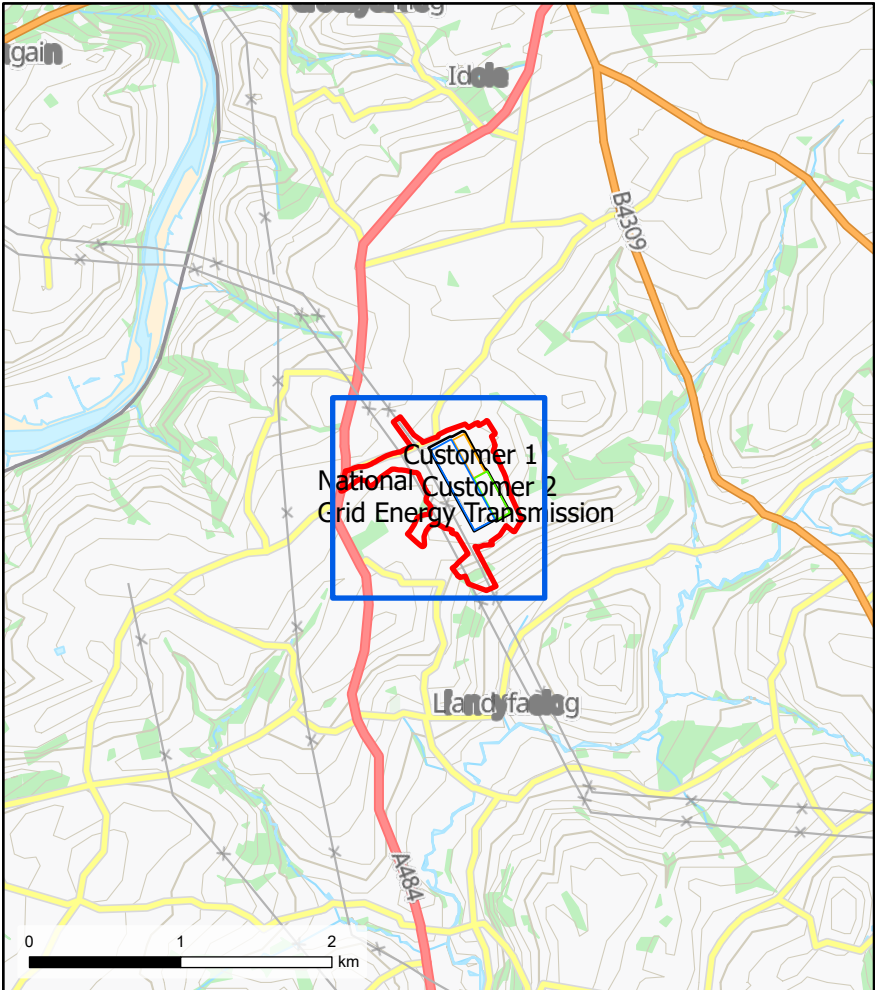
8.0 CONCLUSIONS

This report presents a Sustainable Drainage Systems (SuDS) Strategy for National Grid's Llandyfaelog 400kV Substation Project.

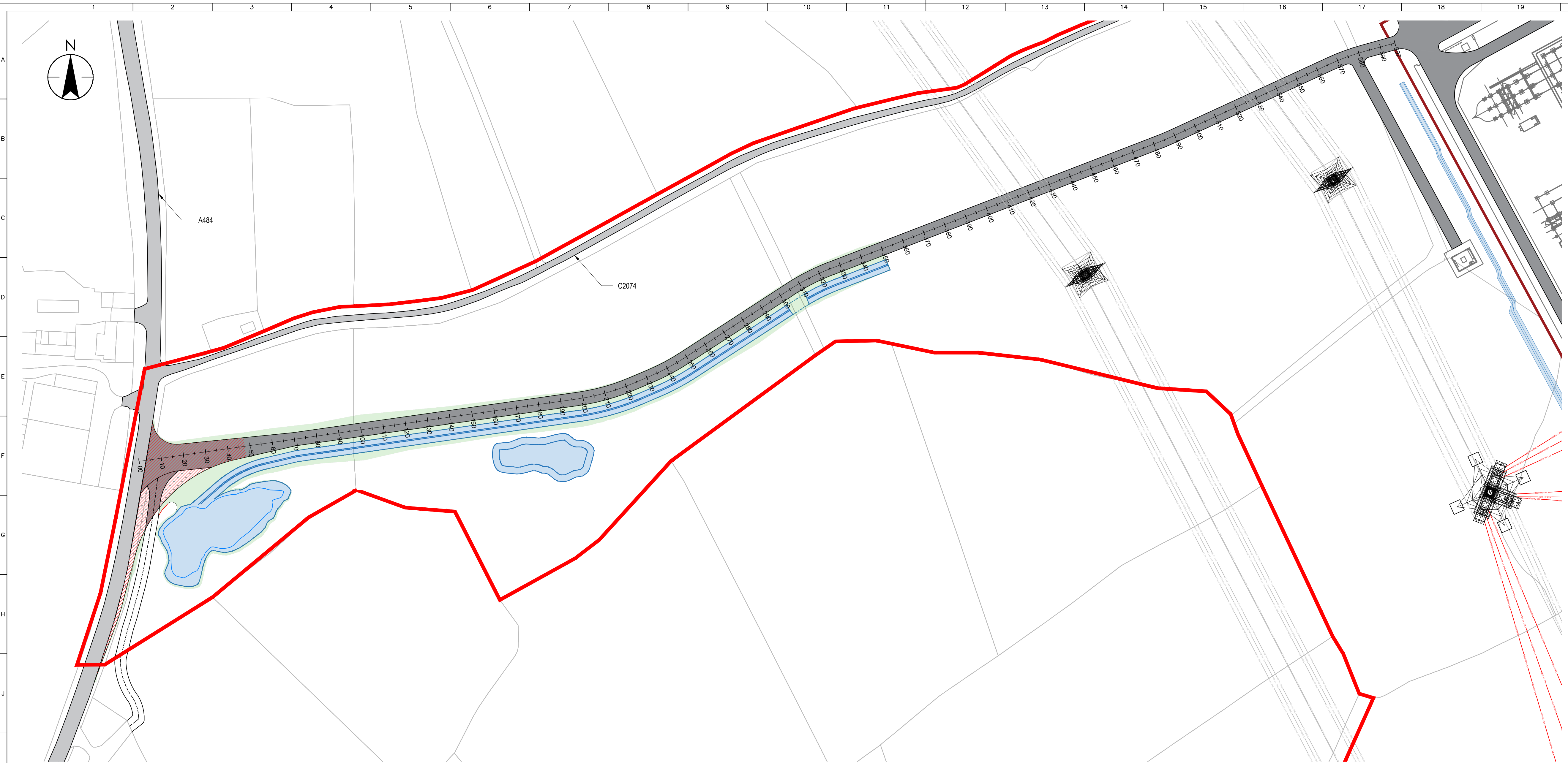
This SuDS strategy involves the use of source control and long-term storage, SuDS basin and swales to manage water on-site and to intercept water likely to enter the site. The SuDS Strategy will provide a sufficient volume of attenuation storage to accommodate all of the runoff generated by the new impermeable areas during the design rainfall event (whilst taking climate change into account). This means that for most events, discharges are likely to remain at - or close to - zero and will provide betterment to the 1 in 100 year greenfield runoff rate. This SuDS Strategy also incorporates elements that will help to clean surface water runoff and prevent pollution incidents which will also provide benefits to biodiversity and amenity.

9.0 APPENDICES

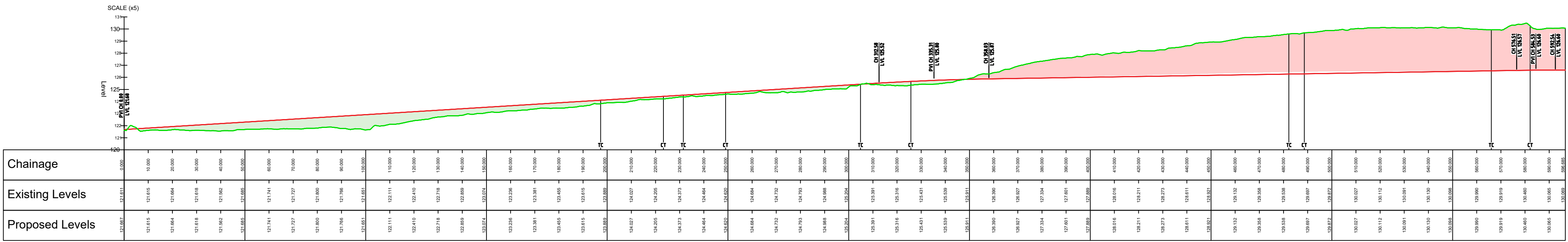
Appendix A Site Location Plan



Appendix B Site Layout Plan



ACCESS ROAD ARRANGEMENT PLAN
1:1000



SECTION ALONG CHAINAGE
NTS

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LEGEND

- SITE BOUNDARY
- PLATFORM BOUNDARY
- NEW HV OHL
- EXISTING HV OHL
- BELLMOUTH EXTENTS FOR CONSTRUCTION DURATION

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DRAWN	LW	Reason for Issue		DRAWN	LW	Reason for Issue	
CHECKED	MK	FIRST ISSUE		CHECKED	MK	UPDATED LAYOUT	
APP'D/DATE	JC	31/10/25		APP'D/DATE	JC	31/11/2025	



Master Scheme No: 101256
Sub-Scheme No: 207820
Site: LLANDYFAELOG SUBSTATION
Scheme Name: NEW LLANDYFAELOG SUBSTATION

Document Title: PROPOSED ACCESS ROAD PLAN

Created by: LW	Date: 31/10/2025	Checked by: MK	Date: 31/10/2025	Approved by: JC	Date: 31/10/2025
Development Eng: D BANHAM	Document Type: DWG	Scale: 1:1000	Format: A1	Sheet(s): 01 OF 01	Rev: B

National Grid Document Number: PDD-101256-LAY-083
FEED Document Number: 331201448-STN-13-XX-LAY-TC-004



LEGEND

EXISTING ROAD

ACCESS ROAD : REFER TO PDD-101256-LAY-053

BELLMOUTH EXTENTS FOR CONSTRUCTION DURATION

EARTHWORK

DRAINAGE

ROAD BELLMOUTH GENERAL ARANGEMENT PLAN
1:500

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APPROVED	JC	31/10/25		APPROVED	JC	31/10/25	

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Sub-Scheme No:
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Site:
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Scheme Name:
NEW LLANDYFAELOG SUBSTATION

Document Title:
PROPOSED BELLMOUTH PLAN

Created by:
LW

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31/10/2025

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31/10/2025

Approved by:
JC

Date:
31/10/2025

Development Eng:
D BANHAM

Document Type:
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Scale:
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Format:
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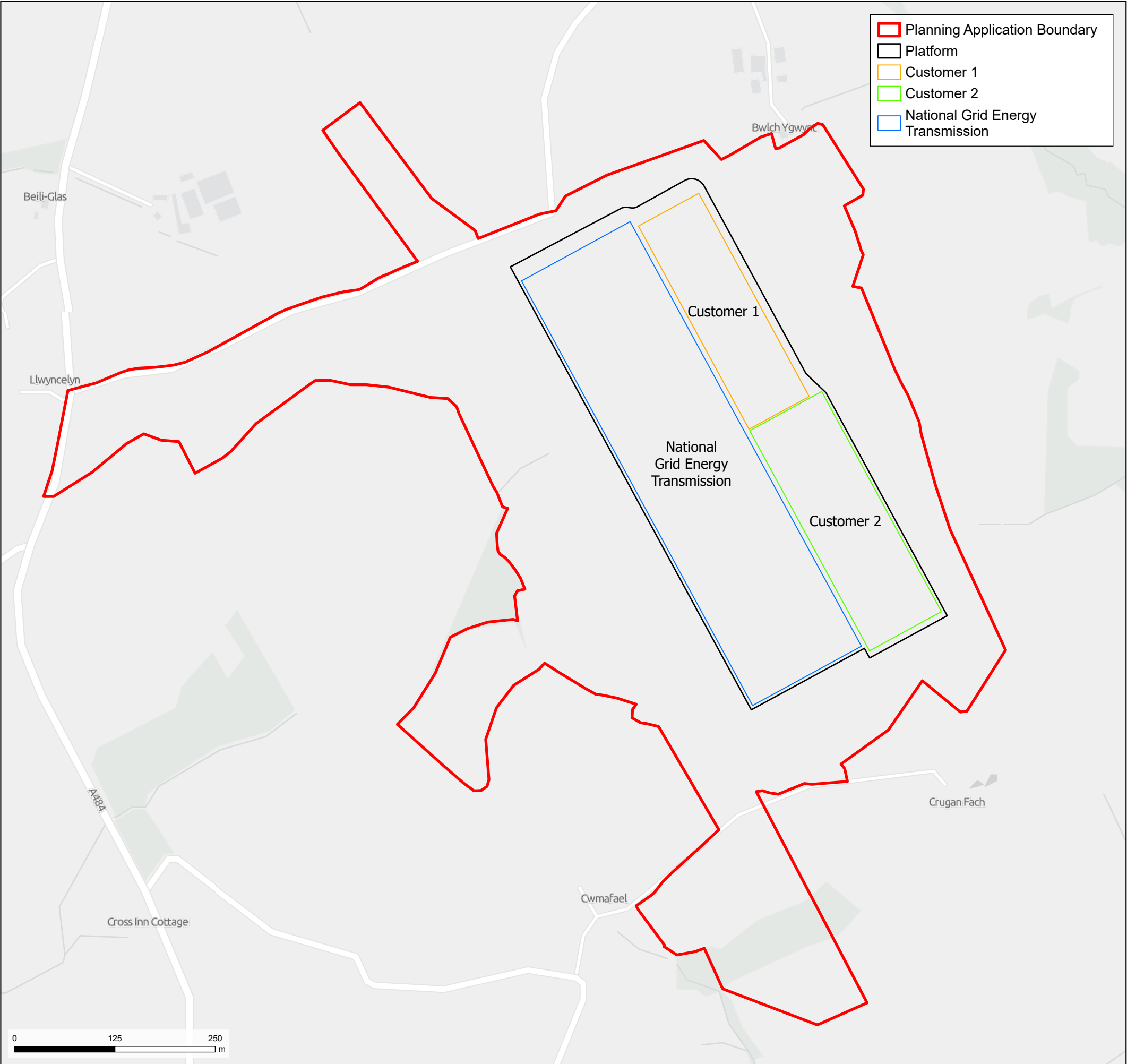
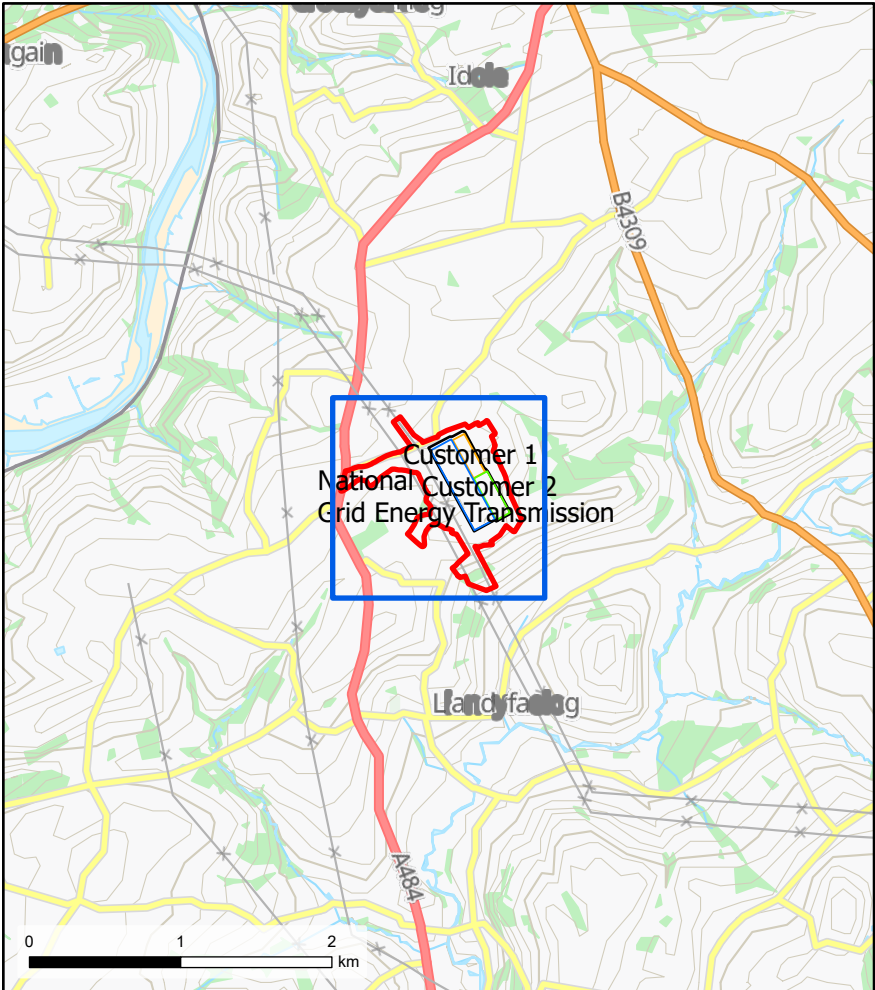
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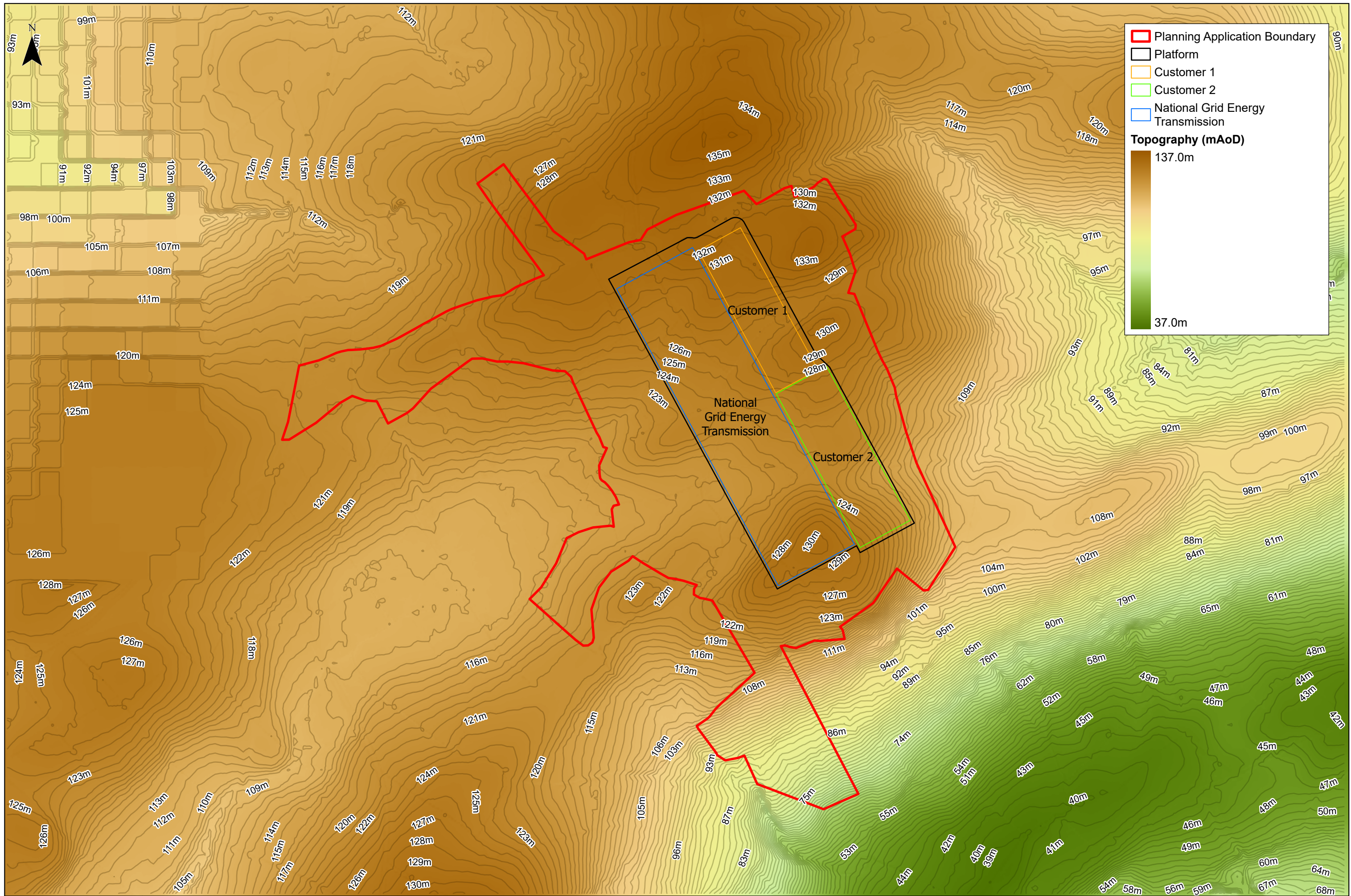
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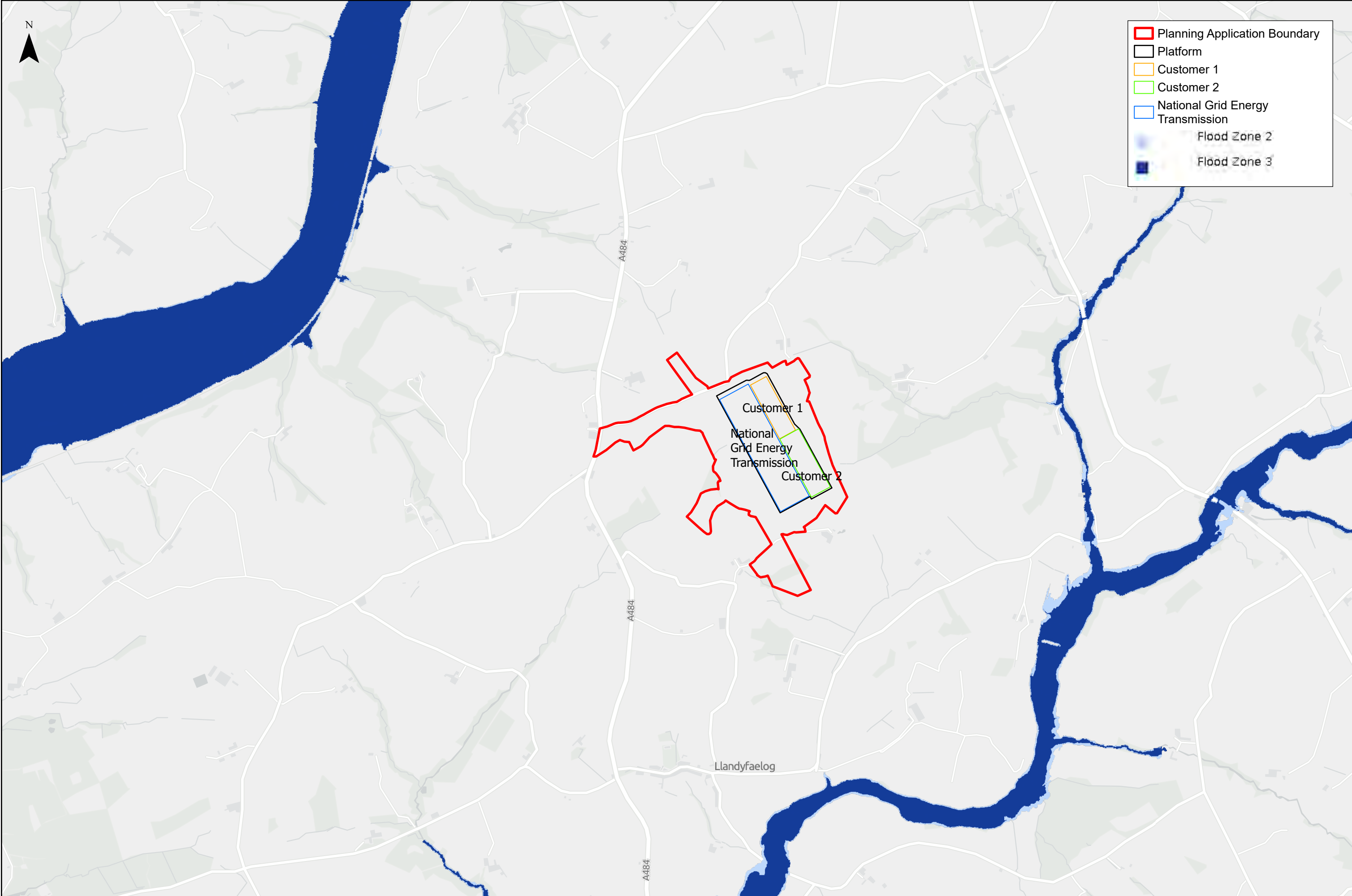
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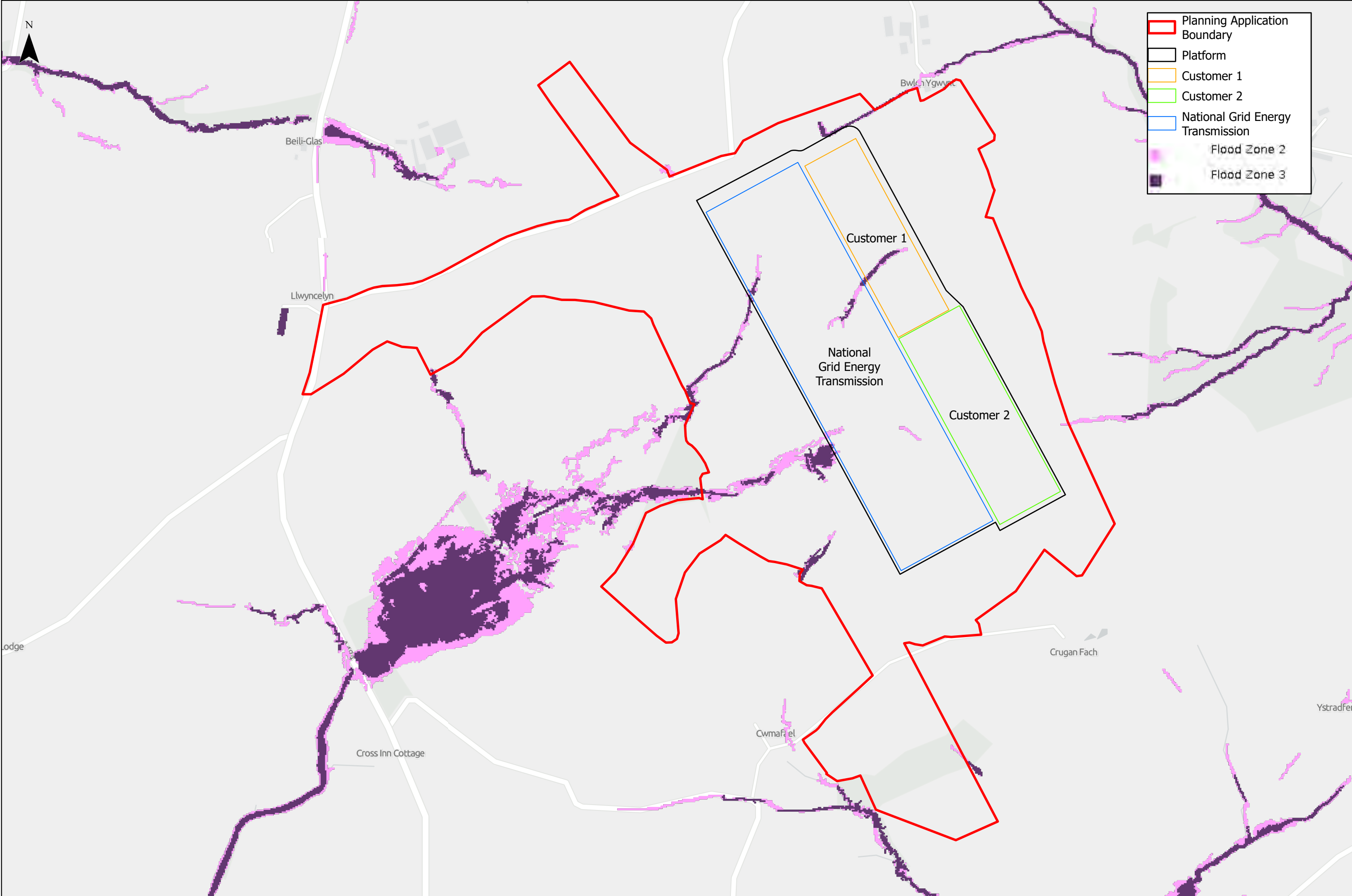
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Appendix C Flood Risk and Topography

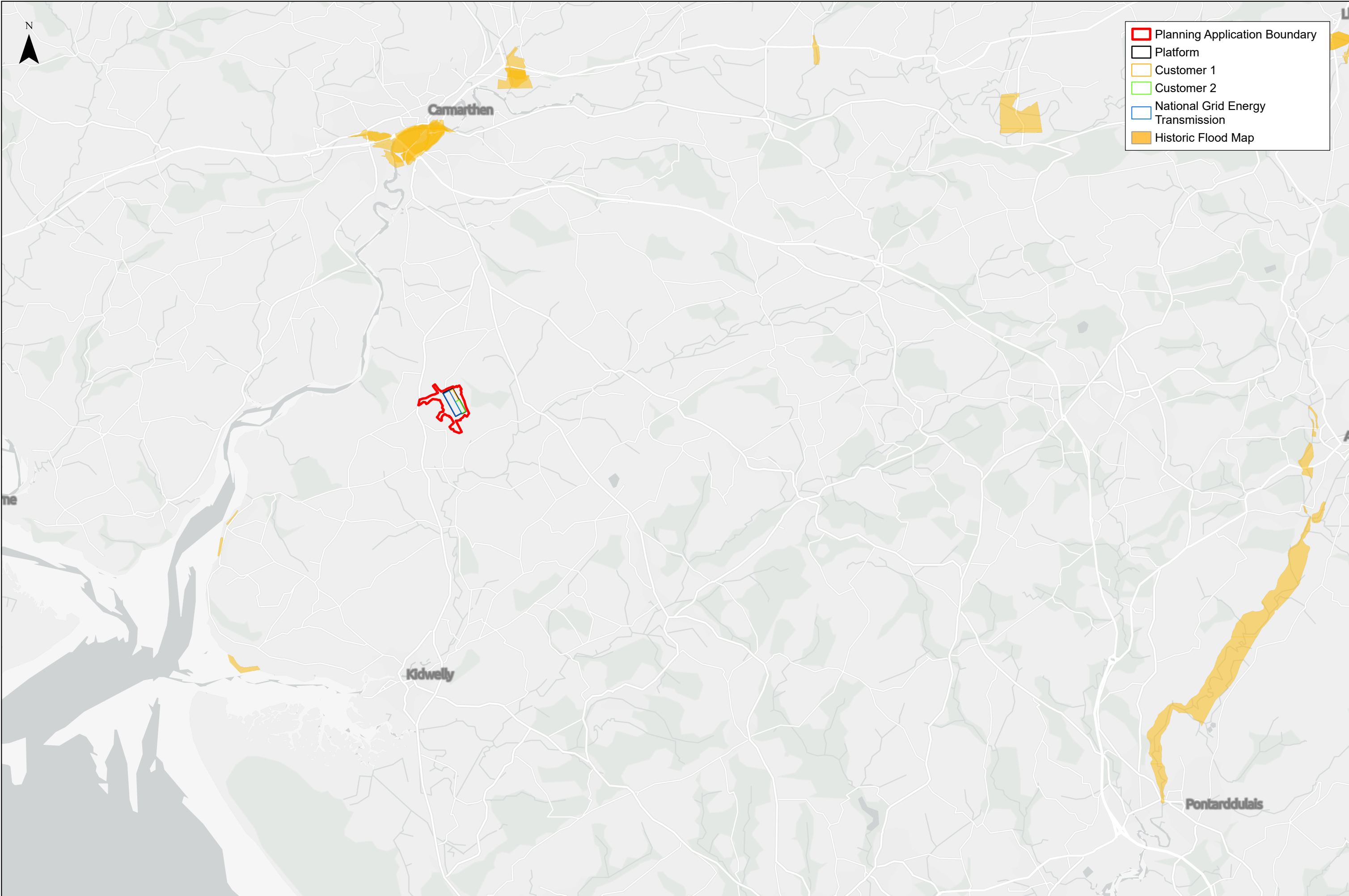




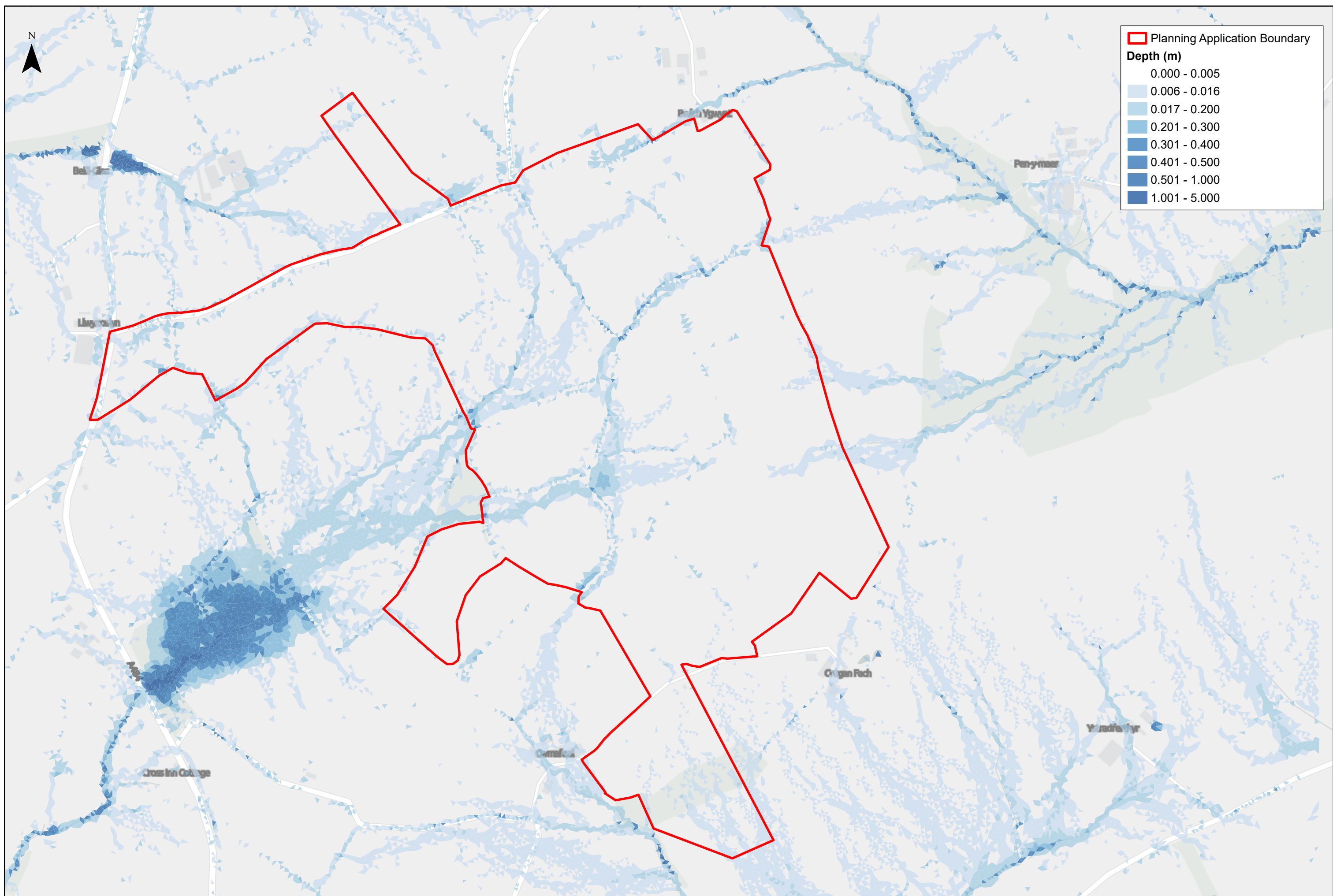


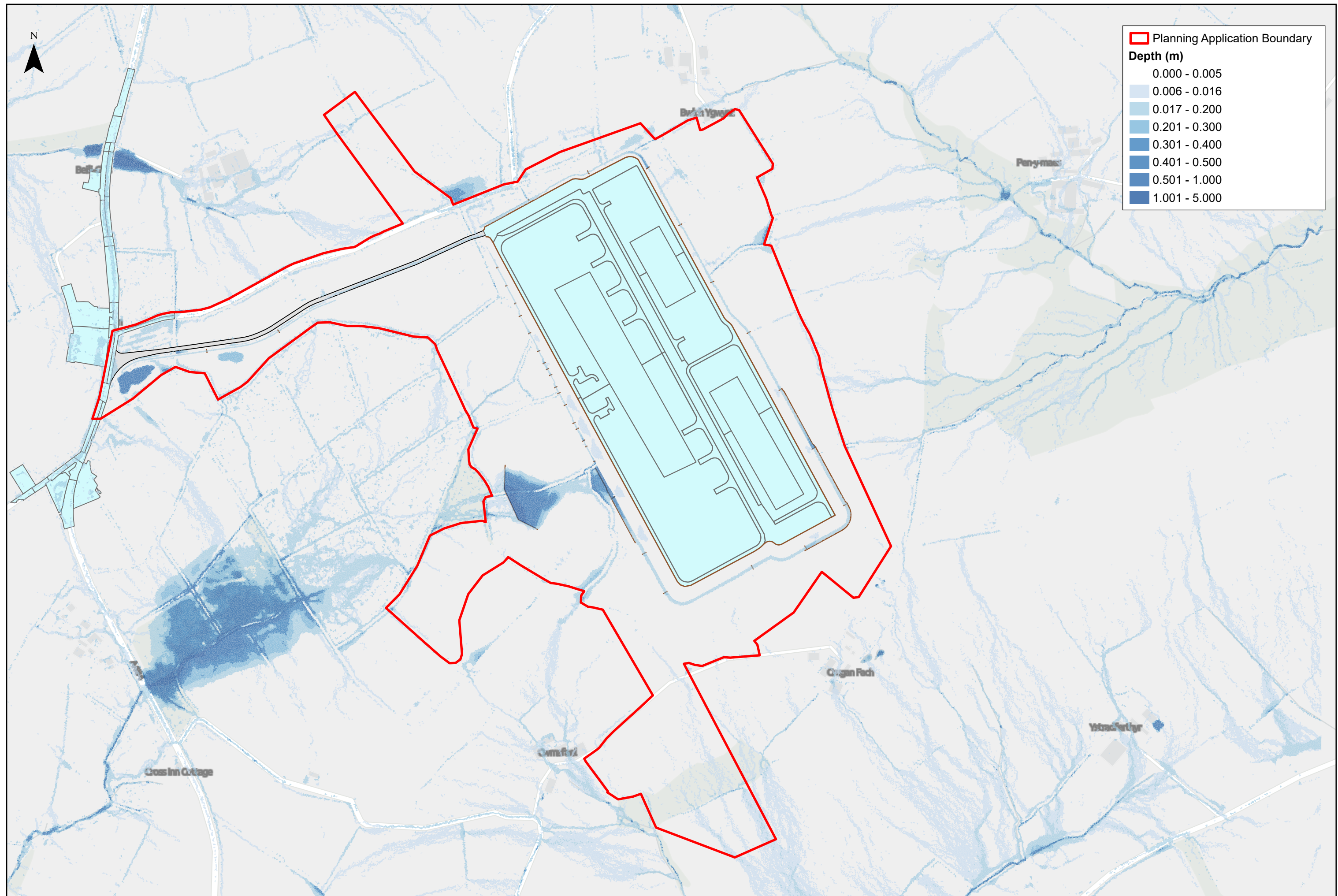


	Planning Application Boundary
	Platform
	Customer 1
	Customer 2
	National Grid Energy Transmission
	Flood Zone 2
	Flood Zone 3

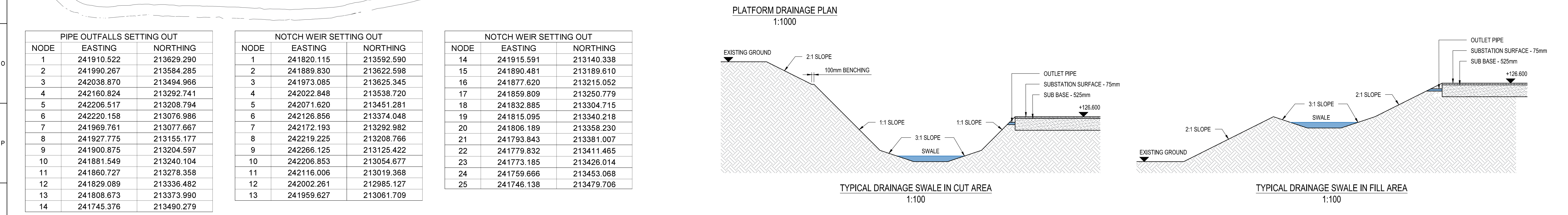
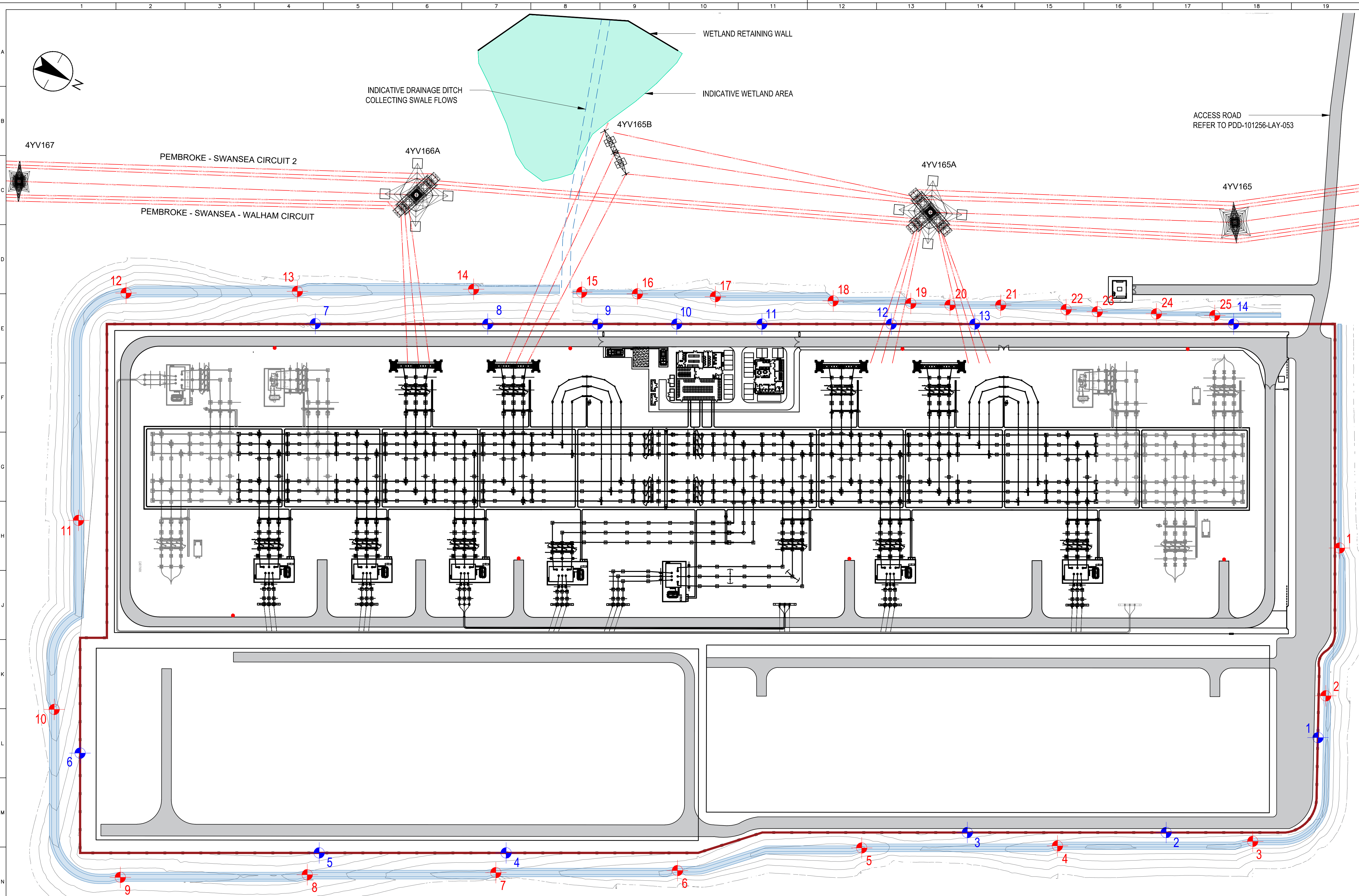


Appendix D ICM Model Results





Appendix E Detailed SuDS Plan



PIPE OUTFALLS SETTING OUT			NOTCH WEIR SETTING OUT			NOTCH WEIR SETTING OUT		
NODE	EASTING	NORTHING	NODE	EASTING	NORTHING	NODE	EASTING	NORTHING
1	241910.522	213629.290	1	241820.115	213592.590	14	241915.591	213140.338
2	241990.267	213584.285	2	241889.830	213622.598	15	241890.481	213189.610
3	242038.870	213494.966	3	241973.085	213625.345	16	241877.620	213215.052
4	242160.824	213292.741	4	242022.848	213538.720	17	241859.809	213250.779
5	242206.517	213208.794	5	242071.620	213451.281	18	241832.885	213304.715
6	242220.158	213076.986	6	242126.856	213374.048	19	241815.095	213340.218
7	241969.761	213077.667	7	242172.193	213292.982	20	241806.189	213358.230
8	241927.775	213155.177	8	242219.225	213208.766	21	241793.843	213381.007
9	241900.875	213204.597	9	242266.125	213125.422	22	241779.832	213411.465
10	241881.549	213240.104	10	242206.853	213054.677	23	241773.185	213426.014
11	241860.727	213278.358	11	242116.006	213019.368	24	241759.666	213453.068
12	241829.089	213336.482	12	242002.261	212985.127	25	241746.138	213479.706
13	241808.673	213373.990	13	241959.627	213061.709			
14	241745.376	213490.279						

SHESQ

- FOR SITE HAZARD PLAN SEE DRAWING - PDD-101256-LAY-054
- RISK ASSESSMENT AND METHOD STATEMENTS TO BE FOLLOWED AT ALL STAGES OF CONSTRUCTION.
- HGV DIMENSIONS USED TO DETERMINE TURNING RADIUS FOR ACCESS ROAD PROVIDED BY NGED. ASSUMED ALSO APPROPRIATE FOR GGC.

GENERAL NOTES

- ALL DIMENSIONS ARE IN MILLIMETRES AND ALL LEVELS ARE IN METRES UNLESS OTHERWISE STATED.
- THIS IS A 4.3 DRAWING AND IS FOR DEVELOPMENT PURPOSES ONLY.
- SUBSTATION LAYOUTS SHOWN INDICATIVELY, AND WILL BE SUBJECT TO CHANGE THROUGH DESIGN DEVELOPMENT.
- ALL WORKS TO BE UNDERTAKEN IN ACCORDANCE WITH NATIONAL
- GRID TECHNICAL SPECIFICATION TS 2.10.08 & TS 3.10.8, AND THE SPECIFICATION FOR HIGHWAY WORKS (SHW).

DRAINAGE NOTES:

- GROUD INFILTRATION RATE TAKEN AS 0. REFER TO GEOTECHNICAL REPORT PDD-101256-REP-004
- ALL DRAINAGE NETWORKS SHOULD BE MAINTAINED REGULARLY BY A COMPETENT PERSON(S) TO ENSURE EFFECTIVE ONGOING OPERATION.
- FLOW TO BE CONTROLLED BY NOTCH WEIRS WITHIN THE SWALE

STN DESIGN ASSUMPTIONS

- STN ASSUME THAT APPROPRIATE SURVEYS FOR TPOs, PROTECTED SPECIES AND OTHER ENVIRONMENTAL CONSTRAINTS HAVE BEEN CARRIED OUT AND DEEMED TO NOT AFFECT THE PROPOSED WORKS.
- ALL WORKS WITHIN THE HIGHWAY WILL REQUIRE APPROVAL FORM THE RELEVANT AUTHORITY PRIOR TO CONSTRUCTION.

LEGEND

ROADWAYS

WETLAND AREA

PLATFORM BOUNDARY

NEW HV OVERHEAD LINE

SWALE

NOTCH WEIR LOCATIONS

PIPE OUTFALLS LOCATIONS

FIRE HYDRANT

REFERENCE DRAWINGS

- 400/132 kV AIS SUBSTATION OVERALL LAYOUT DRAWING: DRAWING No: PDD-101256-LAY-001
- PLATFORM GENERAL ARRANGEMENT: DRAWING No: PDD-101256-LAY-050
- PLATFORM EARTHWORKS: DRAWING No: PDD-101256-LAY-051
- NGET INDICATIVE FOUNDATION PLAN FOR 400KV BAY: DRAWING No: PDD-101256-LAY-052
- ACCESS ROAD GENERAL ARRANGEMENT PLAN: DRAWING No: PDD-101256-LAY-053
- SITE HAZARD PLAN: DRAWING No: PDD-101256-LAY-054
- CDM PLAN: DRAWING No: PDD-101256-LAY-055

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Master Scheme No: 101256

Sub-Scheme No: 207820

Site: LLANDYFAELOG SUBSTATION

Scheme Name: NEW LLANDYFAELOG SUBSTATION

Document Title: PLATFORM DRAINAGE

Created by: GH

Date: 17/07/2025

Checked by: MK

Date: 17/07/2025

Approved by: RA

Date: 17/07/2025

Development Eng: D BANHAM

Document Type: DWG

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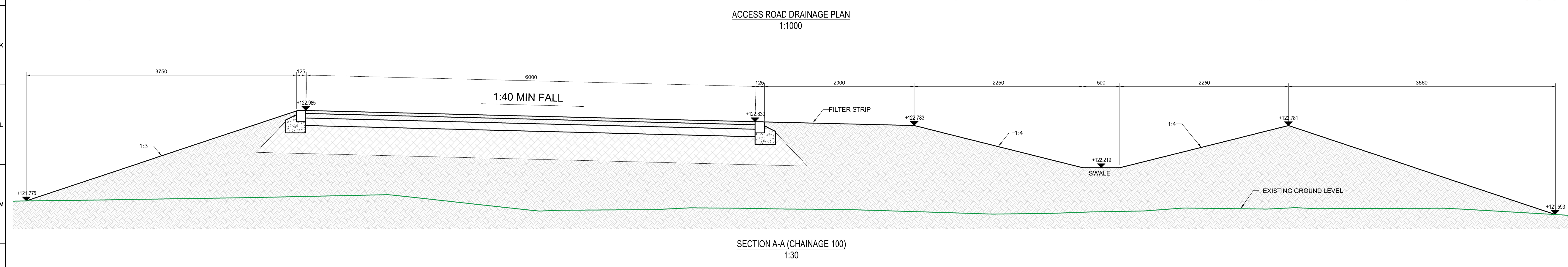
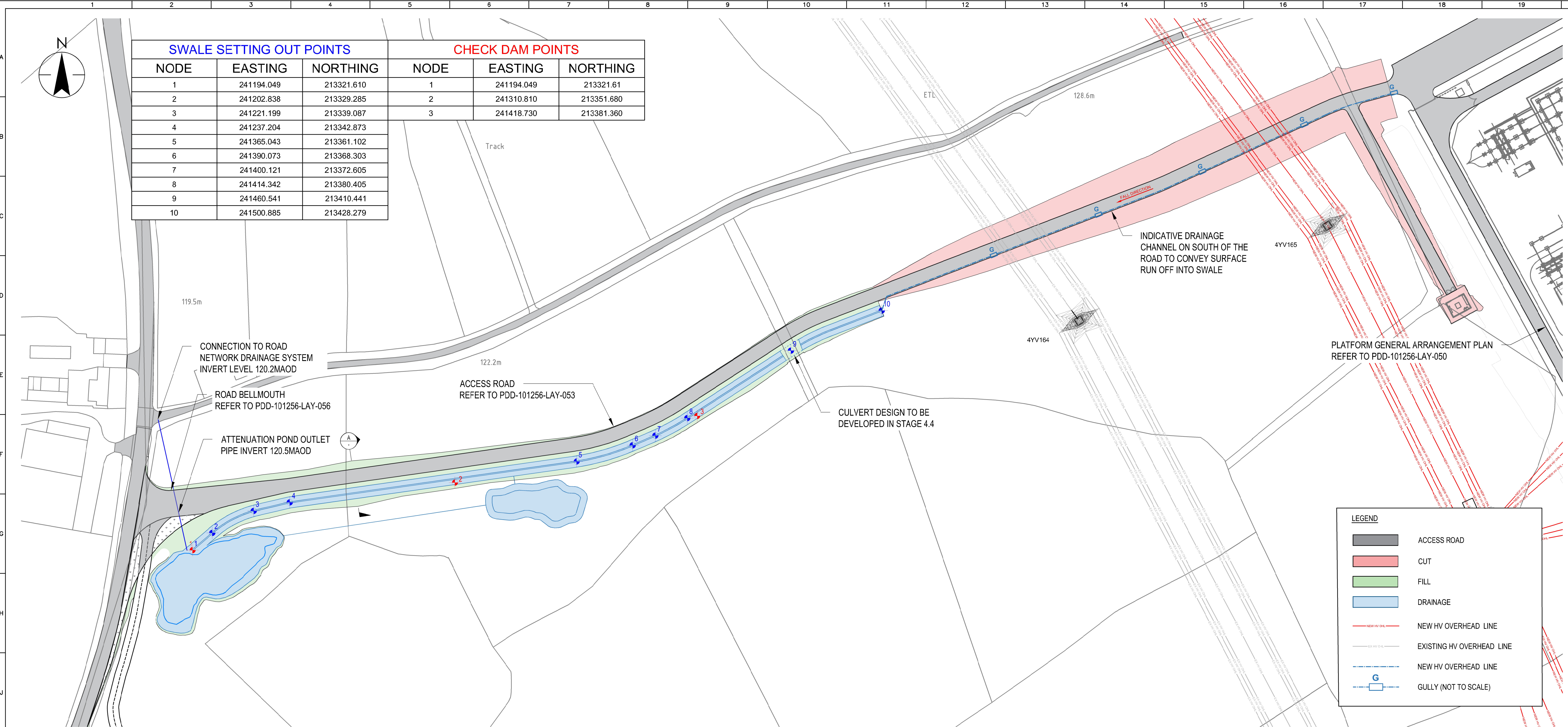
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SHESQ

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- RISK ASSESSMENT AND METHOD STATEMENTS TO BE FOLLOWED AT ALL STAGES OF CONSTRUCTION.
- HGV DIMENSIONS USED TO DETERMINE TURNING RADIUS FOR ACCESS ROAD PROVIDED BY NGED. ASSUMED ALSO APPROPRIATE FOR GGC.

GENERAL NOTES

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- SUBSTATION LAYOUTS SHOWN INDICATIVELY, AND WILL BE SUBJECT TO CHANGE THROUGH DESIGN DEVELOPMENT.

DRAINAGE NOTES:

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- ALL DRAINAGE NETWORKS SHOULD BE MAINTAINED REGULARLY BY A COMPETENT PERSON(S) TO ENSURE EFFECTIVE ONGOING OPERATION.

STN DESIGN ASSUMPTIONS

- STN ASSUME THAT APPROPRIATE SURVEYS FOR TPOs, PROTECTED SPECIES AND OTHER ENVIRONMENTAL CONSTRAINTS HAVE BEEN CARRIED OUT AND DEEMED TO NOT AFFECT THE PROPOSED WORKS.
- ALL WORKS WITHIN THE HIGHWAY WILL REQUIRE APPROVAL FORM THE RELEVANT AUTHORITY PRIOR TO CONSTRUCTION.

REFERENCE DRAWINGS

- PLATFORM GENERAL ARRANGEMENT PLAN:
DRAWING No: PDD-101256-LAY-050
- ACCESS ROAD GENERAL ARRANGEMENT:
DRAWING No: PDD-101256-LAY-053
- SITE HAZARD PLAN:
DRAWING No: PDD-101256-LAY-054
- CDM PLAN:
DRAWING No: PDD-101256-LAY-055
- ROAD BELLMOUTH:
DRAWING No: PDD-101256-LAY-056
- ACCESS ROAD EARTHWORKS:
DRAWING No: PDD-101256-LAY-059

PRELIMINARY

Master Scheme No:
101256

Sub-Scheme No:
207820

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LLANDYFAELOG SUBSTATION

Scheme Name:
NEW LLANDYFAELOG SUBSTATION

Document Title:
ACCESS ROAD DRAINAGE
POST CONSTRUCTION

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GH

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Date:
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PW

Date:
06/11/25

Development Eng:
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Document Type:
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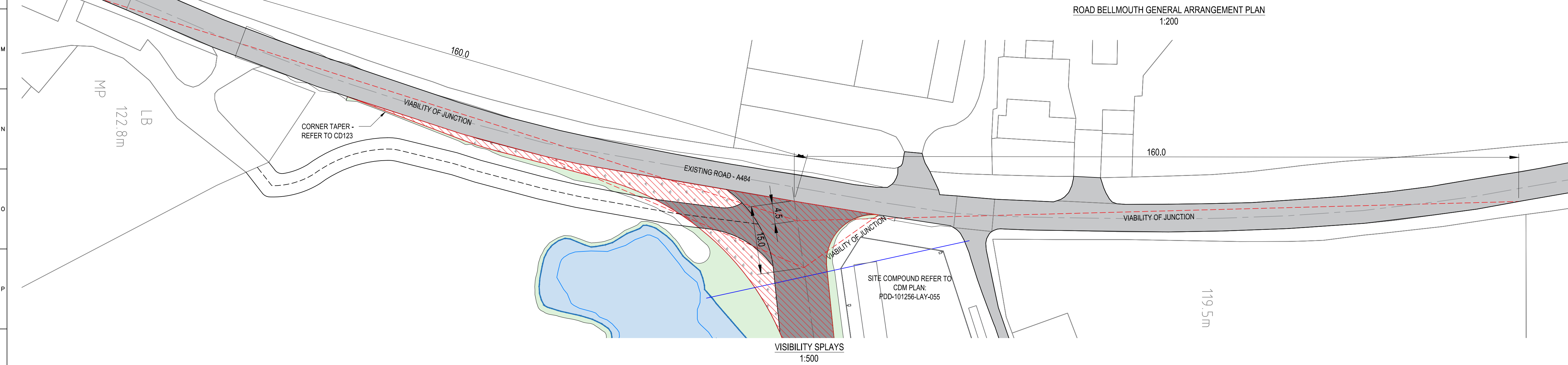
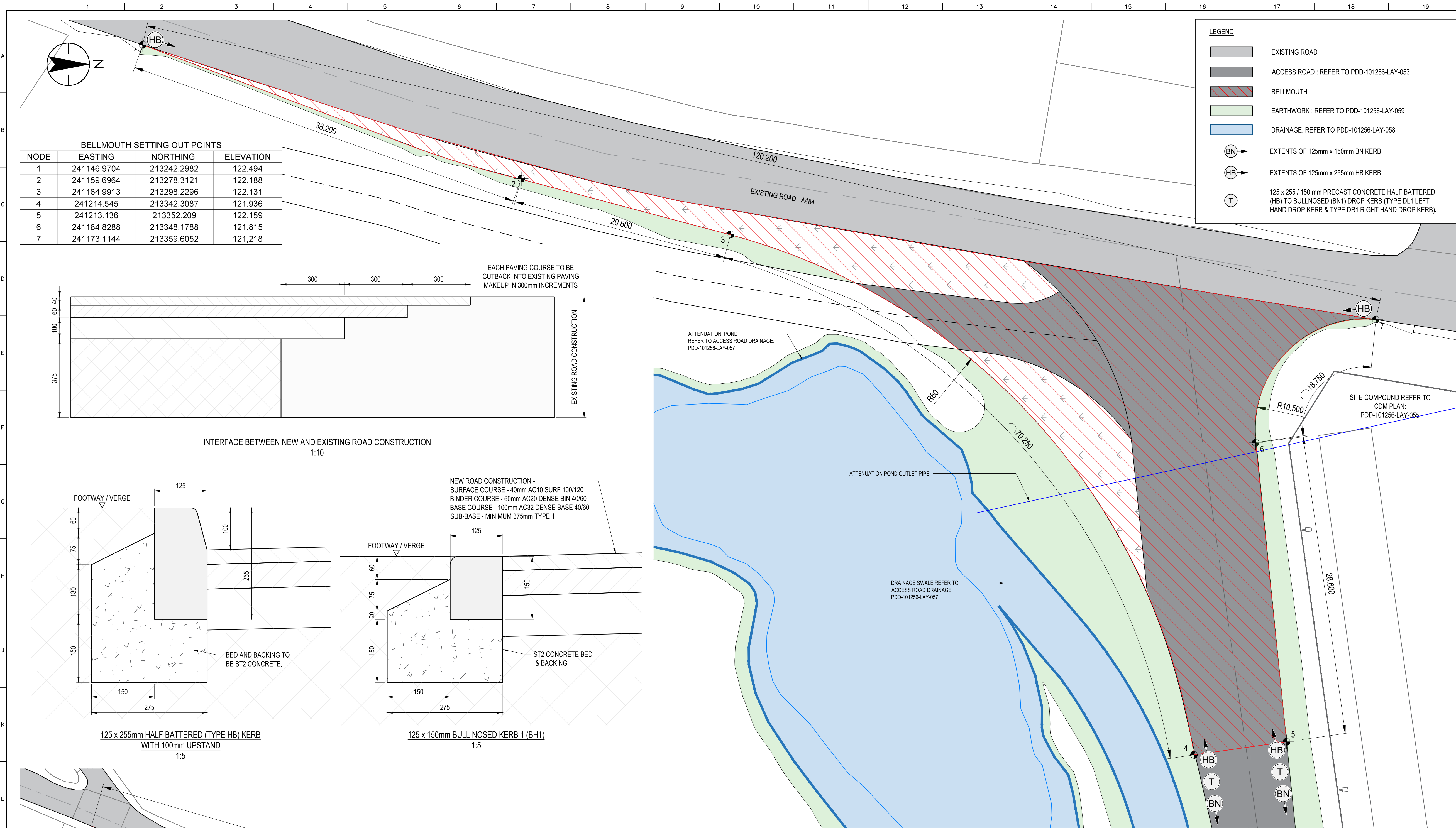
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CHECKED	MK	4.3 STAGE REVIEW		CHECKED	MK	CIVIL ARRANGEMENT UPDATES	
APP'D DATE	RA	17/07/25		APP'D DATE	RA	31/10/25	

SHESQ

- FOR SITE HAZARD PLAN SEE DRAWING - PDD-101256-LAY-054
- RISK ASSESSMENT AND METHOD STATEMENTS TO BE FOLLOWED AT ALL STAGES OF CONSTRUCTION.
- HGV DIMENSIONS USED TO DETERMINE TURNING RADIUS FOR ACCESS ROAD PROVIDED BY NGED. ASSUMED ALSO APPROPRIATE FOR GGC.

GENERAL NOTES

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- THIS IS A 4.3 DRAWING AND IS FOR DEVELOPMENT PURPOSES ONLY.
- SUBSTATION LAYOUTS SHOWN INDICATIVELY, AND WILL BE SUBJECT TO CHANGE THROUGH DESIGN DEVELOPMENT.
- MIN. OFFSET FOR SWALES FROM CARRIAGEWAY TO BE MIN. 5m IN ACCORDANCE WITH BRE365 RECOMMENDATION.
- PAVEMENT CONSTRUCTION NOTES:
- PAVEMENT DESIGN BASED ON SITE TESTING RESULTS - PDD-101256-REP-004.
- ALL BITUMINOUS MATERIALS TO BE IN ACCORDANCE WITH BS 594987.
- ALL PAVING MATERIALS TO BE MANUFACTURED TO BS EN 1338 AND LAID IN ACCORDANCE WITH BS EN 7533.
- ALL SAND LAYING COURSE AND JOINTING MATERIALS TO BE TO BS EN 7533.
- CARRIAGEWAY PAVEMENT JOINTS SHALL BE STEPPED IN HORIZONTALLY TO THE EXISTING CARRIAGEWAY. ALL JOINTS TO BE A MINIMUM 300 mm PER ASPHALT CONCRETE LAYER.
- WHERE ASPHALT CONCRETE MATERIALS ARE LAID OVER EXISTING OR PLANED SURFACES THE SURFACE IS TO BE CLEARED OF DEBRIS, SWEEP AND BITUMINOUS TACK COAT APPLIED PRIOR TO SURFACING BEING LAID. TACK COAT TO BE K1-40 TO BS434, OR SIMILAR APPROVED PRODUCT, LAID AT A SPREAD RATE BETWEEN 0.45L/m² TO 0.55L/m².
- THE LEVELS OF ALL IRONWORK WITHIN THE WORKS AREA TO BE ADJUSTED TO SUIT THE PROPOSED LAYOUT PRIOR TO FINAL SURFACING BEING LAID.
- FLEXIBLE SURFACING MATERIALS MAY ONLY BE LAID WHEN AIR TEMPERATURES ARE 5°C (MIN) AND RISING.
- KERBING NOTES:
- ALL KERBS AND EDGINGS TO BE IN ACCORDANCE WITH BS EN 1340.
- SUBJECT TO THE PRIOR APPROVAL OF THE ENGINEER, THE CONTRACTOR MAY LAY THE KERB AND BACKING IN ONE OPERATION. KERBS SHALL BE BACKED UP AS THE WORKS PROCEED.
- FLEXIBLE CARRIAGEWAYS - KERBS SHALL BE LAID WITH DRY JOINTS AND WITHOUT EXPANSION JOINTS. THE ENDS OF EACH KERB SHALL BE CLOSELY BUTTED UP AGAINST THE ADJACENT KERBS.
- THE SURFACE OF THE BED IS TO BE LEFT ROUGH TO PROVIDE A KEY FOR THE MORTAR AND BACKING. ALL LOOSE DEBRIS IS TO BE REMOVED FROM THE SURFACE OF THE DRIED CONCRETE BEFORE LAYING THE KERB AND BACKING.
- 1000 GAUGE POLYETHYLENE SEPARATION LAYER TO BE LAID BETWEEN KERB / EDGING BACKING AND TOPSOIL IF LANDSCAPE MATERIAL IS OF HIGHLY SHRINKABLE NATURE.

REFERENCE DRAWINGS

- ACCESS ROAD GENERAL ARRANGEMENT PLAN:
DRAWING No: PDD-101256-LAY-053
- SITE HAZARD PLAN:
DRAWING No: PDD-101256-LAY-054
- CDM PLAN:
DRAWING No: PDD-101256-LAY-055
- ACCESS ROAD DRAINAGE:
DRAWING No: PDD-101256-LAY-057
- ACCESS ROAD EARTHWORKS:
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PRELIMINARY

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101256	207820	LLANDYFAELOG SUBSTATION

Scheme Name:
NEW LLANDYFAELOG SUBSTATION

Document Title:
ROAD BELLMOUTH

Created by:	Date:	Checked by:	Date:	Approved by:	Date:
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National Grid Document Number:

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Appendix F Greenfield Runoff Estimates

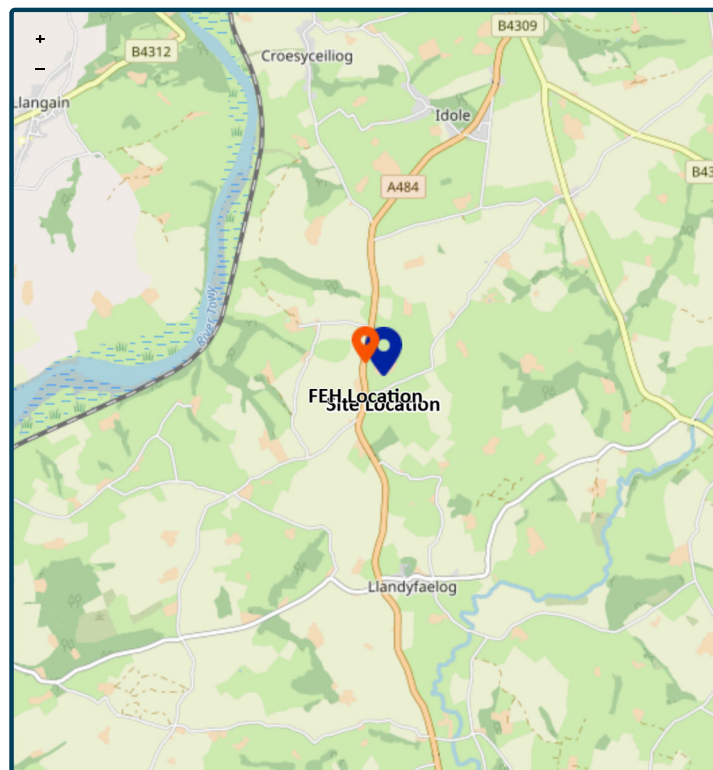
This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance “Rainfall runoff management for developments”, SC030219 (2013), the SuDS Manual C753 (CIRIA, 2015) and the non-statutory standards for SuDS (Defra, 2015). It is recommended that the total storage volume for the site is distributed across the site using multiple SuDS and that hydraulic modelling software is used to undertake and finalise the detailed design of the drainage system.

Project details

Date	25/06/2025
Calculated by	DF
Reference	Llandyfaelog Access Road
Model version	2.0.1

Location

Site name	Llandyfaelog
Site location	



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Site easting	241327
Site northing	213362

Site areas

Total site area (ha)

0.97888

ha

Roof area

Total roof area (ha)

0

ha

Contributing roof area (ha)

0

ha

Non-contributing roof area (ha)

0

ha

Paved area

Total paved area (ha)

0.6024

ha

Contributing paved area (ha)

0.6024

ha

Non-contributing paved area (ha)

0

ha

Grass / vegetated area

Total grass / vegetated area (ha)

00.3764

ha

Contributing grass / vegetated area (ha)

00.3764

ha

Non-contributing grass / vegetated area (ha)

0

ha

Total area

Total contributing area (ha)

0.9788

ha

Contributing areas with urban creep allowance

Urban creep allowance factor

+0% (no creep)

Storage design parameters

Storage base shape

Circular

Storage design depth (mm)

1000

mm

Storage side slope (1 in x)

1 in 3

Storage voids ratio (%)

100% (all voids)

Storage volume design return period (years)

1:100 years

Discharge flow rate from the site

Method

Type of site	Greenfield
Specify the method	IH124

IH124

	<u>My value</u>		<u>Map/default value</u>
SAAR (mm)	1311mm	☐	1311
How should SPR be derived?	Estimate using BFI		
BFIHOST	0.477		
SPR	0.403		
Total area for greenfield runoff calculation (ha)	0.9788ha	☐	0.9788
QBar (l/s)	7.1l/s		
Hydrological region	9	☐	9
Return period (years)	Qbar (1:2.3 years)		
Growth curve factor	1		
Flow rate (IH124) (l/s)	7.1l/s		

Final discharge rate

Runoff calculation method	IH124
Design flow rate (l/s)	7.1l/s

Blockage risk

Specify the method	Flow rate		
Minimum discharge flow rate to prevent blockage	1l/s		
	<u>My value</u>		<u>Calculated value</u>
Design orifice diameter (mm)	58mm	☐	58
Flow rate of orifice (l/s)	6.9l/s		

Rainfall and runoff

Rainfall input type	FEH22 CSV file		
	FEH_Point_Rainfall_FEH22_AM_241170_213372.csv		
Distance from FEH location to site (km)	0.2km		
Climate change allowance factor	140%		
Specify the runoff method from grass / vegetated areas	Fixed percentage - based on rainfall event depth and SPR		
	<u>My value</u>		<u>Map value</u>

How should SPR be derived?

Estimate using BFI

BFIHOST

0.477

SPR

0.403

Model results

- Maximum discharge flow rate: 6.9 (l/s)
- Outflow orifice diameter: 58 (mm)
- Storage base diameter: 28.89 (m)
- Storage base area: 655.36 (m²)
- Storage total volume: 799.8 (m³)
- Storage total water volume: 799.8 (m³)
- Storm return periods run: 1, 2, 10, 30, 100, 200 (years)
- Storm durations run: 15, 30, 60, 120, 180, 240, 360, 540, 720, 900, 1080, 1440, 1800, 2160, 2880 (minutes)

Return Period (years)	Critical Duration (minutes)	Peak Flow Rate (l/s)	Max Depth (m)	Max water volume (m ³)	Max storage volume (m ³)
1	1440	4.3	0.4	286	286
2	1440	4.6	0.46	328.1	328.1
10	1440	5.6	0.67	501.5	501.5
30	1440	6.2	0.81	627.1	627.1
100	1440	6.9	1	799.8	799.8
200	1800	7.4	1.13	923.4	923.4

Disclaimer

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HR Wallingford are not responsible for any rainfall data shared that is subject to licensing terms imposed by UK Centre for Ecology & Hydrology's Flood Estimation Handbook web service (<https://fehweb.ceh.ac.uk/Home/Terms> (<https://fehweb.ceh.ac.uk/Home/Terms>)).

Calculated by:	Dan Fry
Site name:	GGC
Site location:	Llandyfaelog

This is an estimation of the storage volume requirements that are needed 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). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	51.79641° N
Longitude:	4.28988° W
Reference:	2917983123
Date:	Feb 26 2025 16:32

Site characteristics

Total site area (ha):	2.69
Significant public open space (ha):	0
Area positively drained (ha):	2.69
Impermeable area (ha):	2.69
Percentage of drained area that is impermeable (%):	100
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	2.69
Net impermeable area for storage volume design (ha):	2.69
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively

Methodology

esti	IH124
Q _{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
SPR:	0.3	0.3

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	60
Rainfall 100 yrs 12 hrs:	--	86.87
FEH / FSR conversion factor:	1.19	1.19
SAAR (mm):	1324	1324
M5-60 Rainfall Depth (mm):	17	17
'r' Ratio M5-60/M5-2 day:	0.3	0.3
Hydrological region:	9	9
Growth curve factor 1 year:	0.88	0.88
Growth curve factor 10 year:	1.42	1.42

drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor: 1.4

Urban creep allowance factor: 1

Volume control approach: Use long term storage

Interception rainfall depth (mm): 5

Minimum flow rate (l/s): 2

Growth curve factor 30 year:

1.78

1.78

Growth curve factor 100 years:

2.18

2.18

Q_{BAR} for total site area (l/s):

10.33

10.33

Q_{BAR} for net site area (l/s):

10.33

10.33

Site discharge rates

1 in 1 year (l/s):

Default
9.1

Edited
9.1

1 in 30 years (l/s):

18.4

18.4

1 in 100 year (l/s):

22.5

22.5

Estimated storage volumes

Attenuation storage 1/100 years (m³):

Default
2029

Edited
2043

Long term storage 1/100 years (m³):

820

807

Total storage 1/100 years (m³):

2850

2850

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Calculated by:	Dan Fry
Site name:	NGED
Site location:	Llandyfaelog

This is an estimation of the storage volume requirements that are needed 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). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	51.79780° N
Longitude:	4.29115° W
Reference:	3127455832
Date:	Feb 26 2025 16:31

Site characteristics

Total site area (ha):	3.21
Significant public open space (ha):	0
Area positively drained (ha):	3.21
Impermeable area (ha):	3.21
Percentage of drained area that is impermeable (%):	100
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	3.21
Net impermeable area for storage volume design (ha):	3.21
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively

Methodology

esti	IH124
Q _{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
SPR:	0.3	0.3

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	60
Rainfall 100 yrs 12 hrs:	--	86.87
FEH / FSR conversion factor:	1.19	1.19
SAAR (mm):	1324	1324
M5-60 Rainfall Depth (mm):	17	17
'r' Ratio M5-60/M5-2 day:	0.3	0.3
Hydrological region:	9	9
Growth curve factor 1 year:	0.88	0.88
Growth curve factor 10 year:	1.42	1.42

drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor: 1.4

Urban creep allowance factor: 1

Volume control approach Use long term storage

Interception rainfall depth (mm): 5

Minimum flow rate (l/s): 2

Growth curve factor 30 year:

1.78

1.78

Growth curve factor 100 years:

2.18

2.18

Q_{BAR} for total site area (l/s):

12.33

12.33

Q_{BAR} for net site area (l/s):

12.33

12.33

Site discharge rates

1 in 1 year (l/s):

Default
10.9

Edited
10.9

1 in 30 years (l/s):

21.9

21.9

1 in 100 year (l/s):

26.9

26.9

Estimated storage volumes

Attenuation storage 1/100 years (m³):

Default
2422

Edited
2438

Long term storage 1/100 years (m³):

979

963

Total storage 1/100 years (m³):

3401

3401

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Calculated by:	Dan Fry
Site name:	NGET
Site location:	Llandyfaelog

This is an estimation of the storage volume requirements that are needed 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). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	51.79678° N
Longitude:	4.29343° W
Reference:	2431459223
Date:	Feb 26 2025 16:30

Site characteristics

Total site area (ha):	9.49
Significant public open space (ha):	0
Area positively drained (ha):	9.49
Impermeable area (ha):	9.49
Percentage of drained area that is impermeable (%):	100
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	9.49
Net impermeable area for storage volume design (ha):	9.49
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively

Methodology

esti	IH124
Q _{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
SPR:	0.3	0.3

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	60
Rainfall 100 yrs 12 hrs:	--	86.87
FEH / FSR conversion factor:	1.19	1.19
SAAR (mm):	1311	1311
M5-60 Rainfall Depth (mm):	17	17
'r' Ratio M5-60/M5-2 day:	0.3	0.3
Hydrological region:	9	9
Growth curve factor 1 year:	0.88	0.88
Growth curve factor 10 year:	1.42	1.42

drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor: 1.4

Urban creep allowance factor: 1

Volume control approach: Use long term storage

Interception rainfall depth (mm): 5

Minimum flow rate (l/s): 2

Growth curve factor 30 year:

1.78

1.78

Growth curve factor 100 years:

2.18

2.18

Q_{BAR} for total site area (l/s):

36.04

36.04

Q_{BAR} for net site area (l/s):

36.04

36.04

Site discharge rates

1 in 1 year (l/s):

Default
31.7

Edited
31.7

1 in 30 years (l/s):

64.1

64.1

1 in 100 year (l/s):

78.6

78.6

Estimated storage volumes

Attenuation storage 1/100 years (m³):

Default
7202

Edited
7250

Long term storage 1/100 years (m³):

2894

2847

Total storage 1/100 years (m³):

10097

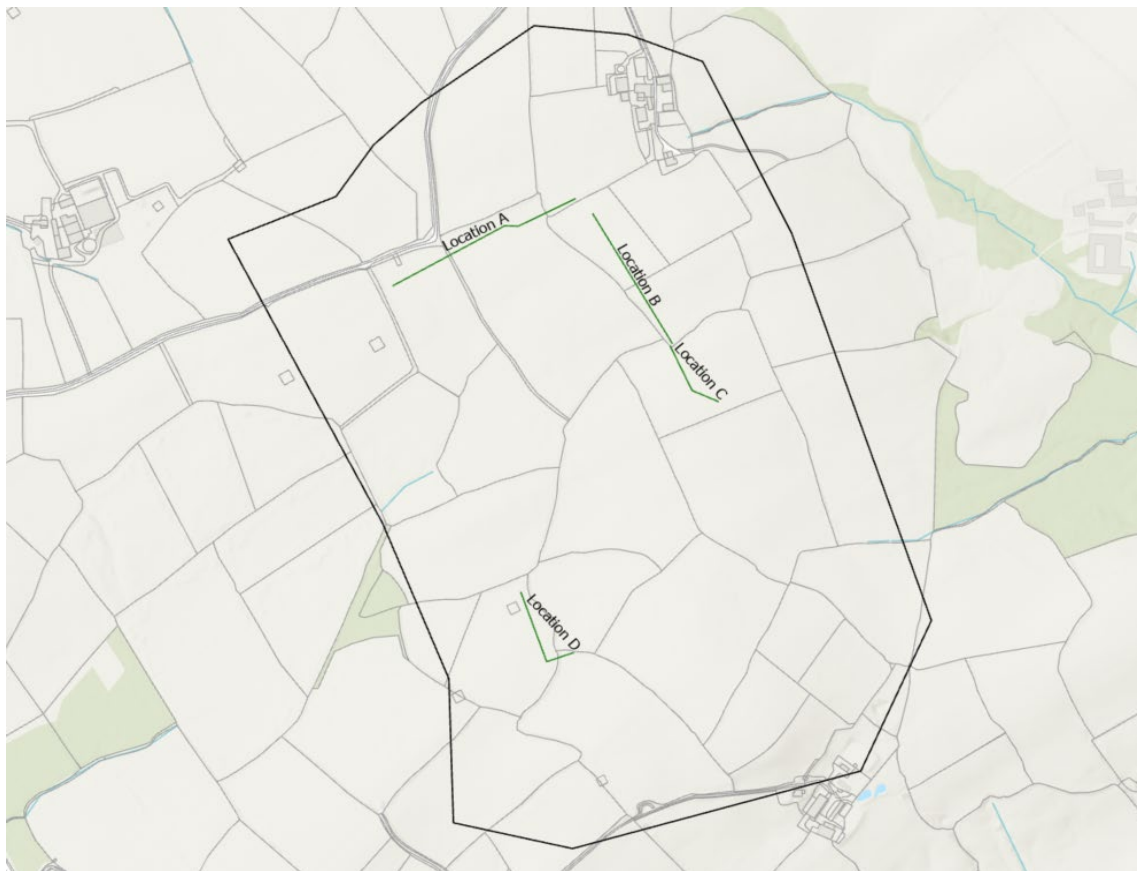
10097

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Sr. No.	PO Location	Q peak (Cumecs)
1	PO Location-A	0.175
2	PO Location-B	0.089
3	PO Location-C	0.009
4	PO Location-D	0.053
Total		0.327

Time (hr)	Q- Location A	Q- Location B	Q- Location C	Q- Location D
0.00	0	0	0	0
0.08	0.0031	0.0069	0.002	0.003
0.17	0.0041	0.0174	0.0039	0.0137
0.25	0.0057	0.0269	0.004	0.0193
0.33	0.0517	0.0548	0.0088	0.0426
0.42	0.1449	0.0838	0.0094	0.0527
0.50	0.1746	0.0894	0.0094	0.0532
0.58	0.1603	0.0633	0.0056	0.0351
0.67	0.1295	0.0519	0.005	0.0279
0.75	0.113	0.0493	0.005	0.0272
0.83	0.0933	0.0333	0.0025	0.017
0.92	0.0639	0.024	0.0019	0.0111
1.00	0.0483	0.0199	0.0017	0.0093
1.08	0.037	0.0128	0.0007	0.0054
1.17	0.0229	0.008	0.0003	0.0029
1.25	0.0136	0.0048	0.0001	0.0016
1.33	0.0086	0.0031	0	0.0009
1.42	0.0057	0.002	0	0.0004
1.50	0.0039	0.0013	0	0.0002
1.58	0.0021	0.001	0	0.0001
1.67	0.0022	0.0008	0	0.0001
1.75	0.0017	0.0006	0	0
1.83	0.0011	0.0005	0	0
1.92	0.0007	0.0004	0	0
2.00	0.0006	0.0003	0	0
2.08	0.0006	0.0003	0	0
2.17	0.0005	0.0003	0	0
2.25	0.0003	0.0002	0	0
2.33	0.0003	0.0002	0	0
2.42	0.0003	0.0002	0	0
2.50	0.0002	0.0001	0	0
2.58	0.0002	0.0001	0	0
2.67	0.0002	0.0001	0	0
2.75	0.0001	0.0001	0	0
2.83	0.0001	0.0001	0	0
2.92	0.0001	0.0001	0	0
3.00	0.0001	0.0001	0	0
3.08	0.0001	0.0001	0	0
3.17	0.0001	0.0001	0	0

3.25	0.0001	0.0001	0	0
3.33	0.0001	0.0001	0	0
3.42	0.0001	0	0	0
3.50	0	0	0	0
3.58	0	0	0	0
3.67	0	0	0	0
3.75	0.0001	0	0	0
3.83	0	0	0	0
3.92	0	0	0	0
4.00	0	0	0	0
4.08	0	0	0	0
4.17	0	0	0	0
4.25	0	0	0	0
4.33	0	0	0	0
4.42	0	0	0	0
4.50	0	0	0	0
4.58	0	0	0	0
4.67	0	0	0	0
4.75	0	0	0	0
4.83	0	0	0	0
4.92	0	0	0	0
5.00	0	0	0	0



Appendix G MicroDrainage Results

Stantec UK

Page 1

Dominion House
Warrington
.



Date 28/10/2025 13:57
File NGET_Platform.SRCX

Designed by DF
Checked by KJL

InnovyzeSource Control 2020.1

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

Half Drain Time : 3161 minutes.

Outflow is too low. Design is unsatisfactory.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	126.106	0.106	0.0	0.0	0.0	2960.3	O K
30 min Summer	126.152	0.152	0.0	0.0	0.0	4219.8	O K
60 min Summer	126.206	0.206	0.0	0.0	0.0	5741.0	O K
120 min Summer	126.247	0.247	0.0	2.4	2.4	6883.3	O K
180 min Summer	126.275	0.275	0.0	6.0	6.0	7664.2	O K
240 min Summer	126.297	0.297	0.0	9.7	9.7	8266.4	O K
360 min Summer	126.329	0.329	0.0	16.7	16.7	9165.1	Flood Risk
480 min Summer	126.352	0.352	0.0	22.5	22.5	9806.1	Flood Risk
600 min Summer	126.370	0.370	0.0	27.3	27.3	10291.5	Flood Risk
720 min Summer	126.383	0.383	0.0	31.2	31.2	10670.6	Flood Risk
960 min Summer	126.403	0.403	0.0	37.1	37.1	11207.6	Flood Risk
1440 min Summer	126.425	0.425	0.0	44.1	44.1	11839.2	Flood Risk
2160 min Summer	126.443	0.443	0.0	49.7	49.7	12326.7	Flood Risk
2880 min Summer	126.459	0.459	0.0	54.8	54.8	12769.4	Flood Risk
4320 min Summer	126.484	0.484	0.0	62.7	62.7	13465.2	Flood Risk
5760 min Summer	126.502	0.502	0.0	68.2	68.2	13980.0	Flood Risk
7200 min Summer	126.517	0.517	0.0	72.3	72.3	14400.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	119.779	0.0	0.0	19
30 min Summer	85.369	0.0	0.0	34
60 min Summer	58.073	0.0	7.2	64
120 min Summer	34.829	0.0	312.4	124
180 min Summer	25.891	0.0	684.9	184
240 min Summer	20.993	0.0	1028.7	244
360 min Summer	15.621	0.0	1612.7	364
480 min Summer	12.644	0.0	2077.3	484
600 min Summer	10.722	0.0	2458.3	602
720 min Summer	9.366	0.0	2777.5	722
960 min Summer	7.556	0.0	3275.5	962
1440 min Summer	5.615	0.0	3970.1	1440
2160 min Summer	4.198	0.0	7026.7	1776
2880 min Summer	3.432	0.0	8005.2	2080
4320 min Summer	2.606	0.0	9250.9	2852
5760 min Summer	2.167	0.0	13428.6	3632
7200 min Summer	1.899	0.0	15098.6	4400

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Stantec UK

Dominion House

Warrington

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Date 28/10/2025 13:57

File NGET_Platform.SRCX

Designed by DF

Checked by KJL

Innovyze

Source Control 2020.1

Page 2



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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	126.530	0.530	0.0	74.3	74.3	14762.3	Flood Risk
10080 min Summer	126.543	0.543	0.0	74.8	74.8	15106.4	Flood Risk
15 min Winter	126.106	0.106	0.0	0.0	0.0	2960.3	O K
30 min Winter	126.152	0.152	0.0	0.0	0.0	4219.8	O K
60 min Winter	126.206	0.206	0.0	0.0	0.0	5741.0	O K
120 min Winter	126.247	0.247	0.0	2.4	2.4	6883.2	O K
180 min Winter	126.275	0.275	0.0	6.0	6.0	7664.3	O K
240 min Winter	126.297	0.297	0.0	9.7	9.7	8267.8	O K
360 min Winter	126.329	0.329	0.0	16.7	16.7	9170.2	Flood Risk
480 min Winter	126.353	0.353	0.0	22.6	22.6	9817.0	Flood Risk
600 min Winter	126.370	0.370	0.0	27.4	27.4	10309.5	Flood Risk
720 min Winter	126.384	0.384	0.0	31.5	31.5	10696.5	Flood Risk
960 min Winter	126.404	0.404	0.0	37.6	37.6	11255.0	Flood Risk
1440 min Winter	126.429	0.429	0.0	45.4	45.4	11949.0	Flood Risk
2160 min Winter	126.447	0.447	0.0	51.0	51.0	12435.6	Flood Risk
2880 min Winter	126.462	0.462	0.0	55.9	55.9	12871.1	Flood Risk
4320 min Winter	126.482	0.482	0.0	62.1	62.1	13413.6	Flood Risk
5760 min Winter	126.493	0.493	0.0	65.4	65.4	13724.8	Flood Risk
7200 min Winter	126.501	0.501	0.0	67.7	67.7	13938.7	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.718	0.0	16611.7	5192
10080 min Summer	1.589	0.0	17891.1	5960
15 min Winter	119.779	0.0	0.0	19
30 min Winter	85.369	0.0	0.0	34
60 min Winter	58.073	0.0	7.2	64
120 min Winter	34.829	0.0	312.5	124
180 min Winter	25.891	0.0	684.8	184
240 min Winter	20.993	0.0	1028.4	242
360 min Winter	15.621	0.0	1611.6	360
480 min Winter	12.644	0.0	2075.2	478
600 min Winter	10.722	0.0	2455.1	596
720 min Winter	9.366	0.0	2773.1	712
960 min Winter	7.556	0.0	3267.9	942
1440 min Winter	5.615	0.0	3954.2	1384
2160 min Winter	4.198	0.0	7017.7	1944
2880 min Winter	3.432	0.0	7990.7	2188
4320 min Winter	2.606	0.0	9220.8	3068
5760 min Winter	2.167	0.0	13423.2	3912
7200 min Winter	1.899	0.0	15093.3	4688

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Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 241170 213372 SN 41170 13372
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	1.000
Cv (Winter)	1.000
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 9.886

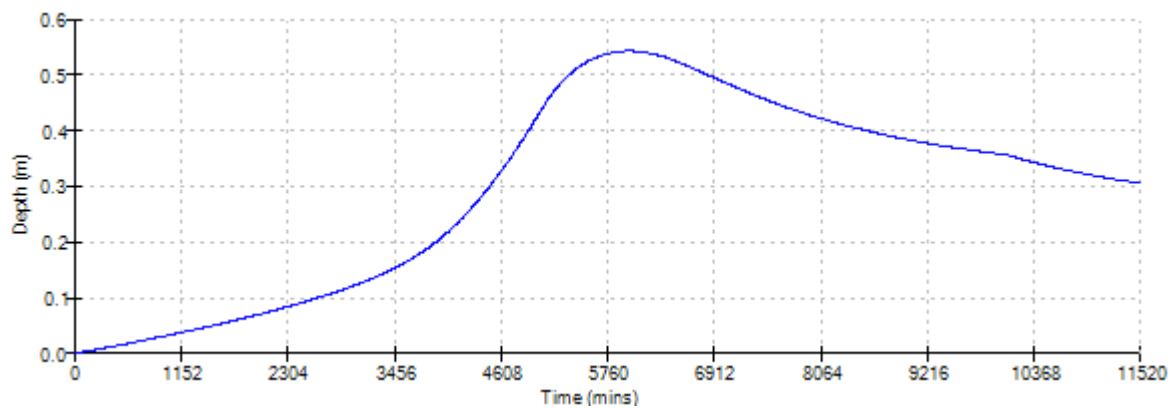
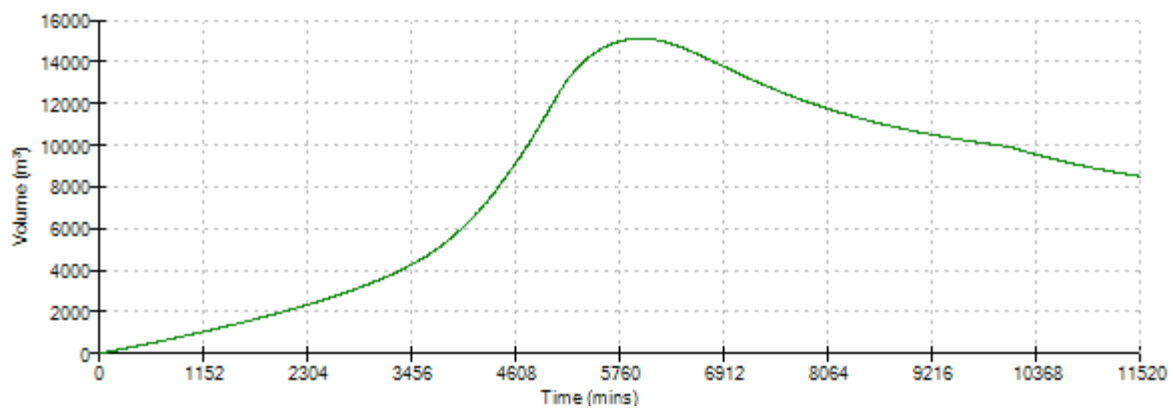
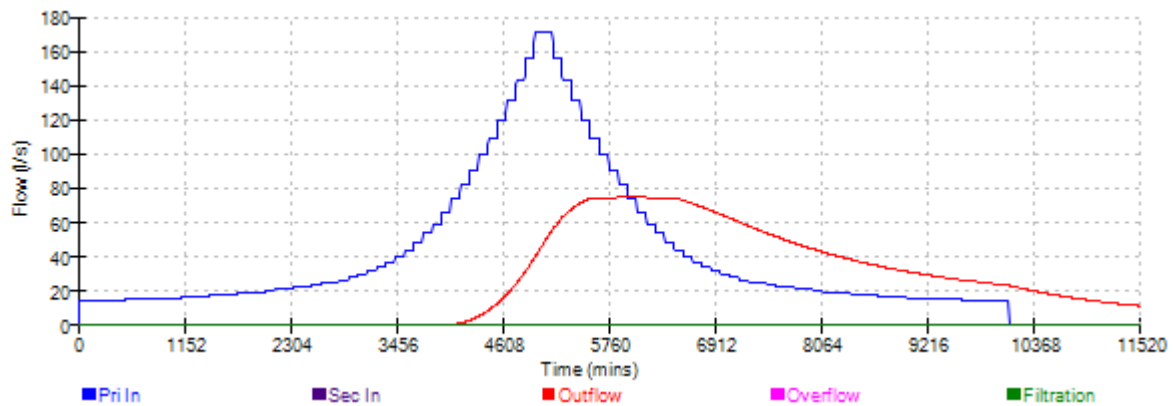
Time (mins)	Area
From:	To: (ha)
0	4 9.886

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Innovyze	Source Control 2020.1																																																																																																							
Model Details Storage is Online Cover Level (m) 126.600 Cellular Storage Structure Invert Level (m) 126.000 Safety Factor 1.0 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.30 Infiltration Coefficient Side (m/hr) 0.00000 <table><tr><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th></tr><tr><td>0.000</td><td>92800.0</td><td>0.0</td><td>0.600</td><td>92800.0</td><td>0.0</td></tr></table> Hydro-Brake® Optimum Outflow Control Unit Reference MD-SHE-0360-7680-0600-7680 Design Head (m) 0.600 Design Flow (l/s) 76.8 Flush-Flo™ Calculated Objective Minimise upstream storage Application Surface Sump Available Yes Diameter (mm) 360 Invert Level (m) 126.200 Minimum Outlet Pipe Diameter (mm) 375 Suggested Manhole Diameter (mm) 1800 <table><tr><th>Control Points</th><th>Head (m)</th><th>Flow (l/s)</th><th>Control Points</th><th>Head (m)</th><th>Flow (l/s)</th></tr><tr><td>Design Point (Calculated)</td><td>0.600</td><td>76.8</td><td>Kick-Flo®</td><td>0.573</td><td>75.1</td></tr><tr><td>Flush-Flo™</td><td>0.459</td><td>76.8</td><td>Mean Flow over Head Range</td><td>-</td><td>50.9</td></tr></table> The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated <table><tr><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th></tr><tr><td>0.100</td><td>10.3</td><td>1.200</td><td>107.5</td><td>3.000</td><td>168.1</td><td>7.000</td><td>251.8</td></tr><tr><td>0.200</td><td>36.2</td><td>1.400</td><td>115.9</td><td>3.500</td><td>181.3</td><td>7.500</td><td>260.9</td></tr><tr><td>0.300</td><td>67.5</td><td>1.600</td><td>123.6</td><td>4.000</td><td>193.5</td><td>8.000</td><td>269.6</td></tr><tr><td>0.400</td><td>76.3</td><td>1.800</td><td>130.9</td><td>4.500</td><td>205.0</td><td>8.500</td><td>278.1</td></tr><tr><td>0.500</td><td>76.5</td><td>2.000</td><td>137.9</td><td>5.000</td><td>215.9</td><td>9.000</td><td>286.3</td></tr><tr><td>0.600</td><td>76.8</td><td>2.200</td><td>144.4</td><td>5.500</td><td>226.2</td><td>9.500</td><td>294.3</td></tr><tr><td>0.800</td><td>88.3</td><td>2.400</td><td>150.7</td><td>6.000</td><td>236.1</td><td></td><td></td></tr><tr><td>1.000</td><td>98.4</td><td>2.600</td><td>156.7</td><td>6.500</td><td>242.4</td><td></td><td></td></tr></table>			Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	0.000	92800.0	0.0	0.600	92800.0	0.0	Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)	Design Point (Calculated)	0.600	76.8	Kick-Flo®	0.573	75.1	Flush-Flo™	0.459	76.8	Mean Flow over Head Range	-	50.9	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	10.3	1.200	107.5	3.000	168.1	7.000	251.8	0.200	36.2	1.400	115.9	3.500	181.3	7.500	260.9	0.300	67.5	1.600	123.6	4.000	193.5	8.000	269.6	0.400	76.3	1.800	130.9	4.500	205.0	8.500	278.1	0.500	76.5	2.000	137.9	5.000	215.9	9.000	286.3	0.600	76.8	2.200	144.4	5.500	226.2	9.500	294.3	0.800	88.3	2.400	150.7	6.000	236.1			1.000	98.4	2.600	156.7	6.500	242.4		
Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)																																																																																																			
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Event: 10080 min Summer



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Customer 1

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Source Control 2020.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
10080 min Summer	126.395	0.395	0.0	22.5	22.5	2915.0	Flood Risk
15 min Winter	126.123	0.123	0.0	10.5	10.5	911.2	O K
30 min Winter	126.175	0.175	0.0	18.1	18.1	1290.5	O K
60 min Winter	126.235	0.235	0.0	22.2	22.2	1735.5	O K
120 min Winter	126.277	0.277	0.0	22.5	22.5	2044.5	O K
180 min Winter	126.304	0.304	0.0	22.5	22.5	2242.8	Flood Risk
240 min Winter	126.324	0.324	0.0	22.5	22.5	2387.5	Flood Risk
360 min Winter	126.351	0.351	0.0	22.5	22.5	2589.3	Flood Risk
480 min Winter	126.369	0.369	0.0	22.5	22.5	2719.9	Flood Risk
600 min Winter	126.381	0.381	0.0	22.5	22.5	2808.3	Flood Risk
720 min Winter	126.389	0.389	0.0	22.5	22.5	2867.4	Flood Risk
960 min Winter	126.397	0.397	0.0	22.5	22.5	2928.9	Flood Risk
1440 min Winter	126.403	0.403	0.0	22.6	22.6	2974.1	Flood Risk
2160 min Winter	126.407	0.407	0.0	22.7	22.7	3002.6	Flood Risk
2880 min Winter	126.403	0.403	0.0	22.6	22.6	2977.5	Flood Risk
4320 min Winter	126.387	0.387	0.0	22.5	22.5	2852.7	Flood Risk
5760 min Winter	126.365	0.365	0.0	22.5	22.5	2691.6	Flood Risk
7200 min Winter	126.344	0.344	0.0	22.5	22.5	2535.5	Flood Risk
8640 min Winter	126.325	0.325	0.0	22.5	22.5	2395.7	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.589	0.0	7794.4	6048
15 min Winter	119.779	0.0	478.5	19
30 min Winter	85.369	0.0	774.1	33
60 min Winter	58.073	0.0	1420.9	62
120 min Winter	34.829	0.0	1739.4	122
180 min Winter	25.891	0.0	1954.5	180
240 min Winter	20.993	0.0	2119.4	238
360 min Winter	15.621	0.0	2364.8	354
480 min Winter	12.644	0.0	2540.0	470
600 min Winter	10.722	0.0	2673.0	584
720 min Winter	9.366	0.0	2777.4	696
960 min Winter	7.556	0.0	2921.9	914
1440 min Winter	5.615	0.0	3041.5	1156
2160 min Winter	4.198	0.0	4271.4	1620
2880 min Winter	3.432	0.0	4614.0	2076
4320 min Winter	2.606	0.0	5069.1	2984
5760 min Winter	2.167	0.0	6194.1	3856
7200 min Winter	1.899	0.0	6768.6	4680
8640 min Winter	1.718	0.0	7313.0	5448

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Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 241170 213372 SN 41170 13372
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	1.000
Cv (Winter)	1.000
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 3.060

Time (mins)	Area
From:	To: (ha)
0	4 3.060

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Dominion House Warrington .	Customer 1	
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Model Details

Storage is Online Cover Level (m) 126.600

Cellular Storage Structure

Invert Level (m) 126.000 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	24600.0	0.0	0.600	24600.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0217-2250-0400-2250
Design Head (m) 0.400
Design Flow (l/s) 22.5
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 217
Invert Level (m) 126.000
Minimum Outlet Pipe Diameter (mm) 300
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	22.5	Kick-Flo®	0.372	21.7
Flush-Flo™	0.282	22.5	Mean Flow over Head Range	-	15.4

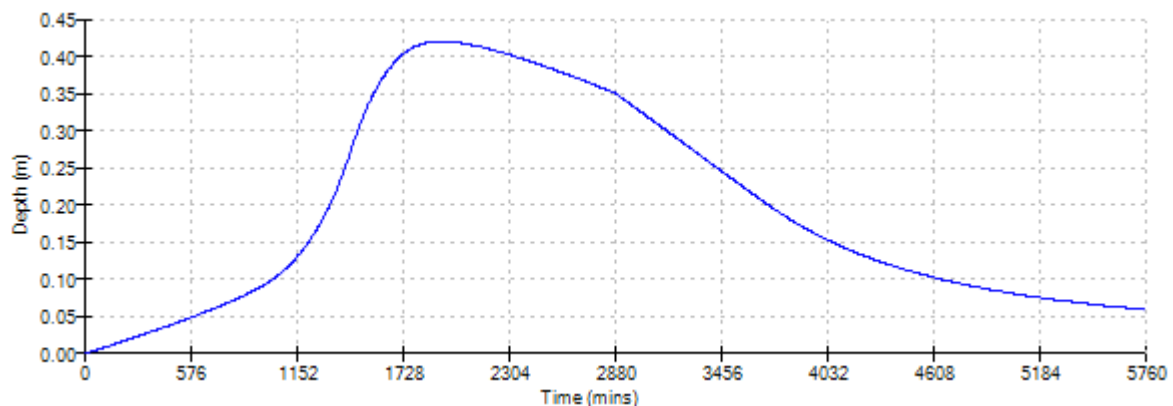
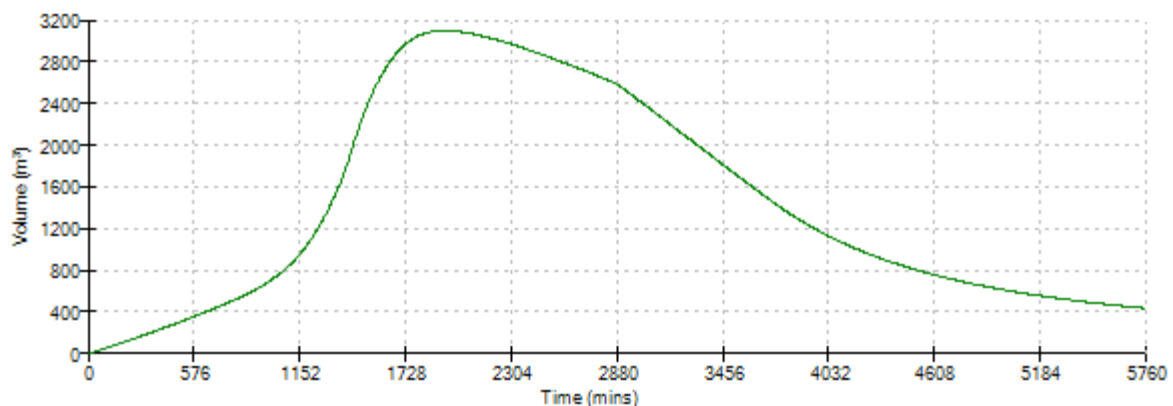
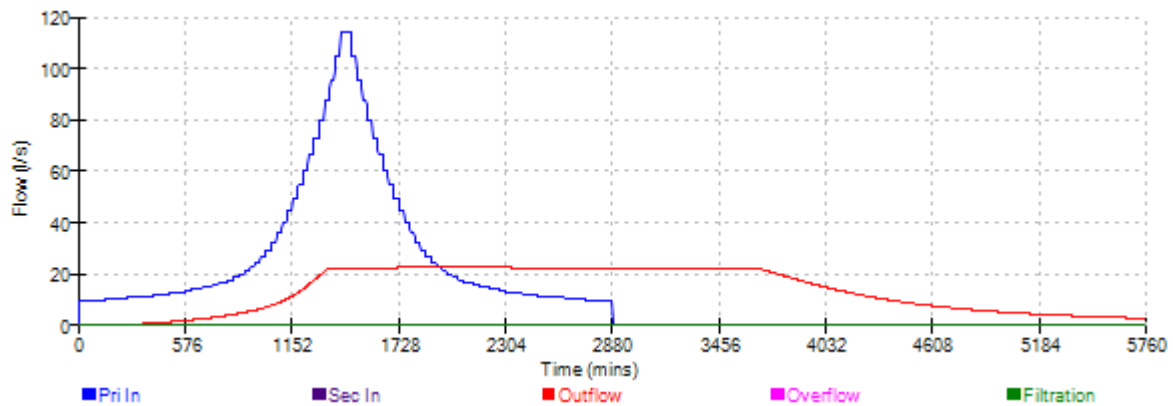
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.3	1.200	38.1	3.000	59.3	7.000	89.6
0.200	21.3	1.400	41.0	3.500	63.9	7.500	92.7
0.300	22.5	1.600	43.7	4.000	68.2	8.000	95.8
0.400	22.5	1.800	46.3	4.500	71.5	8.500	98.8
0.500	25.0	2.000	48.7	5.000	75.5	9.000	101.7
0.600	27.3	2.200	51.0	5.500	79.2	9.500	104.5
0.800	31.3	2.400	53.2	6.000	82.8		
1.000	34.9	2.600	55.3	6.500	86.2		

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Event: 2880 min Summer



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Customer 2 Platform

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	126.424	0.424	0.0	24.2	24.2	4082.8	Flood Risk
10080 min Summer	126.432	0.432	0.0	24.3	24.3	4156.5	Flood Risk
15 min Winter	126.099	0.099	0.0	0.0	0.0	950.8	O K
30 min Winter	126.141	0.141	0.0	0.0	0.0	1355.3	O K
60 min Winter	126.191	0.191	0.0	0.0	0.0	1843.9	O K
120 min Winter	126.230	0.230	0.0	0.8	0.8	2211.0	O K
180 min Winter	126.256	0.256	0.0	2.7	2.7	2460.7	O K
240 min Winter	126.275	0.275	0.0	4.7	4.7	2651.5	O K
360 min Winter	126.304	0.304	0.0	8.3	8.3	2930.2	Flood Risk
480 min Winter	126.324	0.324	0.0	11.2	11.2	3122.4	Flood Risk
600 min Winter	126.339	0.339	0.0	13.4	13.4	3262.3	Flood Risk
720 min Winter	126.350	0.350	0.0	15.1	15.1	3367.6	Flood Risk
960 min Winter	126.364	0.364	0.0	17.2	17.2	3508.9	Flood Risk
1440 min Winter	126.381	0.381	0.0	19.4	19.4	3664.9	Flood Risk
2160 min Winter	126.397	0.397	0.0	21.3	21.3	3818.8	Flood Risk
2880 min Winter	126.408	0.408	0.0	22.6	22.6	3932.6	Flood Risk
4320 min Winter	126.421	0.421	0.0	23.9	23.9	4050.9	Flood Risk
5760 min Winter	126.426	0.426	0.0	24.3	24.3	4104.5	Flood Risk
7200 min Winter	126.430	0.430	0.0	24.3	24.3	4136.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.718	0.0	4719.0	5104
10080 min Summer	1.589	0.0	5143.4	5856
15 min Winter	119.779	0.0	0.0	19
30 min Winter	85.369	0.0	0.0	34
60 min Winter	58.073	0.0	0.0	64
120 min Winter	34.829	0.0	90.4	124
180 min Winter	25.891	0.0	246.5	182
240 min Winter	20.993	0.0	389.2	242
360 min Winter	15.621	0.0	626.1	360
480 min Winter	12.644	0.0	811.1	476
600 min Winter	10.722	0.0	961.7	592
720 min Winter	9.366	0.0	1087.8	706
960 min Winter	7.556	0.0	1285.8	932
1440 min Winter	5.615	0.0	1568.8	1352
2160 min Winter	4.198	0.0	2465.9	1644
2880 min Winter	3.432	0.0	2826.2	2100
4320 min Winter	2.606	0.0	3330.4	2944
5760 min Winter	2.167	0.0	4430.7	3800
7200 min Winter	1.899	0.0	5008.9	4608

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Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 241170 213372 SN 41170 13372
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 3.780

	Time (mins)	Area
From:	To:	(ha)
	0	4 3.780

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Model Details

Storage is Online Cover Level (m) 126.600

Cellular Storage Structure

Invert Level (m) 126.000 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	32100.0	0.0	0.600	32100.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SCU-0205-2690-0400-2690
Design Head (m) 0.400
Design Flow (l/s) 26.9
Flush-Flo™ Calculated
Objective Linear discharge profile
Application Surface
Sump Available Yes
Diameter (mm) 205
Invert Level (m) 126.200
Minimum Outlet Pipe Diameter (mm) 225
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	26.9	Kick-Flo®	0.307	23.7
Flush-Flo™	0.242	24.3	Mean Flow over Head Range	-	16.7

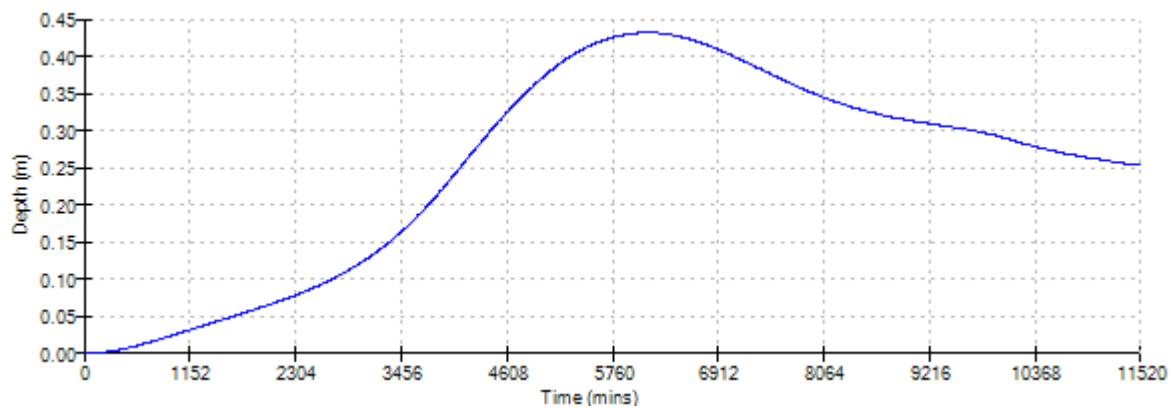
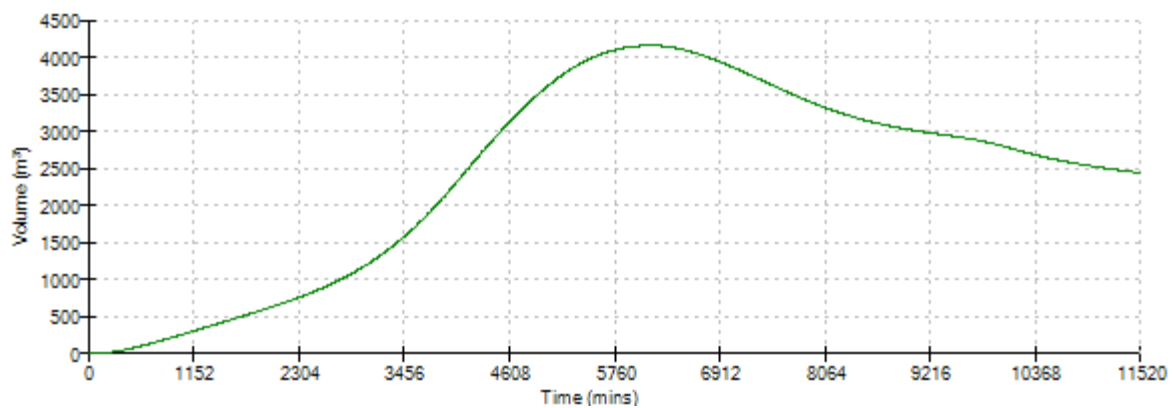
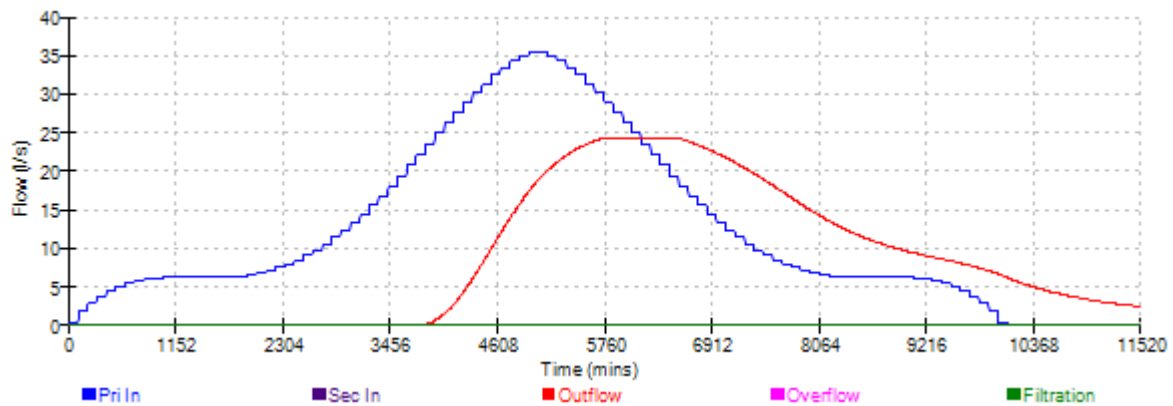
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.8	1.200	45.5	3.000	70.9	7.000	107.2
0.200	21.7	1.400	49.0	3.500	76.5	7.500	111.0
0.300	23.8	1.600	52.3	4.000	81.6	8.000	114.7
0.400	26.9	1.800	55.4	4.500	85.6	8.500	118.3
0.500	29.9	2.000	58.3	5.000	90.3	9.000	121.7
0.600	32.6	2.200	61.0	5.500	94.8	9.500	125.1
0.800	37.5	2.400	63.7	6.000	99.1		
1.000	41.7	2.600	66.2	6.500	103.2		

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Dominion House Warrington .	Customer 2 Platform	
Date 28/10/2025 13:55 File Customer 2.SRCX	Designed by DF Checked by KJL	
Innovyze	Source Control 2020.1	

Event: 10080 min Winter



Cascade Summary of Results for Swale 1.SRCX

	Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
5760 min	Summer	124.155	0.071	0.0	13.0	13.0	0.5	O K
7200 min	Summer	124.149	0.065	0.0	11.4	11.4	0.4	O K
8640 min	Summer	124.145	0.061	0.0	10.2	10.2	0.3	O K
10080 min	Summer	124.142	0.058	0.0	9.5	9.5	0.3	O K
15 min	Winter	124.604	0.520	0.0	255.7	255.7	54.5	FLOOD
30 min	Winter	124.599	0.515	0.0	251.7	251.7	48.0	FLOOD
60 min	Winter	124.565	0.481	0.0	227.5	227.5	28.6	Flood Risk
120 min	Winter	124.441	0.357	0.0	145.5	145.5	14.4	Flood Risk
180 min	Winter	124.380	0.296	0.0	109.6	109.6	9.5	Flood Risk
240 min	Winter	124.342	0.258	0.0	89.2	89.2	7.0	Flood Risk
360 min	Winter	124.296	0.212	0.0	66.6	66.6	4.6	Flood Risk
480 min	Winter	124.269	0.185	0.0	54.1	54.1	3.4	O K
600 min	Winter	124.249	0.165	0.0	45.8	45.8	2.7	O K
720 min	Winter	124.235	0.151	0.0	40.1	40.1	2.2	O K
960 min	Winter	124.215	0.131	0.0	32.4	32.4	1.6	O K
1440 min	Winter	124.192	0.108	0.0	24.1	24.1	1.1	O K
2160 min	Winter	124.173	0.089	0.0	18.0	18.0	0.7	O K
2880 min	Winter	124.162	0.078	0.0	14.8	14.8	0.5	O K
4320 min	Winter	124.149	0.065	0.0	11.2	11.2	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
5760 min Summer	2.167	0.0	1129.5	2896
7200 min Summer	1.899	0.0	1237.1	3608
8640 min Summer	1.718	0.0	1343.1	4304
10080 min Summer	1.589	0.0	1449.2	4960
15 min Winter	119.779	20.3	182.1	12
30 min Winter	85.369	14.6	259.6	20
60 min Winter	58.073	0.0	353.2	34
120 min Winter	34.829	0.0	423.7	64
180 min Winter	25.891	0.0	472.4	94
240 min Winter	20.993	0.0	510.7	124
360 min Winter	15.621	0.0	570.0	184
480 min Winter	12.644	0.0	615.1	246
600 min Winter	10.722	0.0	652.0	306
720 min Winter	9.366	0.0	683.5	368
960 min Winter	7.556	0.0	735.2	476
1440 min Winter	5.615	0.0	819.6	716
2160 min Winter	4.198	0.0	919.2	1068
2880 min Winter	3.432	0.0	1001.9	1432
4320 min Winter	2.606	0.0	1141.0	2148

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Dominion House Warrington .		
Date 15/10/2025 17:01 File Swales_to_Basin.CASX	Designed by dfry Checked by	
Innovyze Source Control 2020.1		

Cascade Rainfall Details for Swale_1.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 241170 213372 SN 41170 13372
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.724

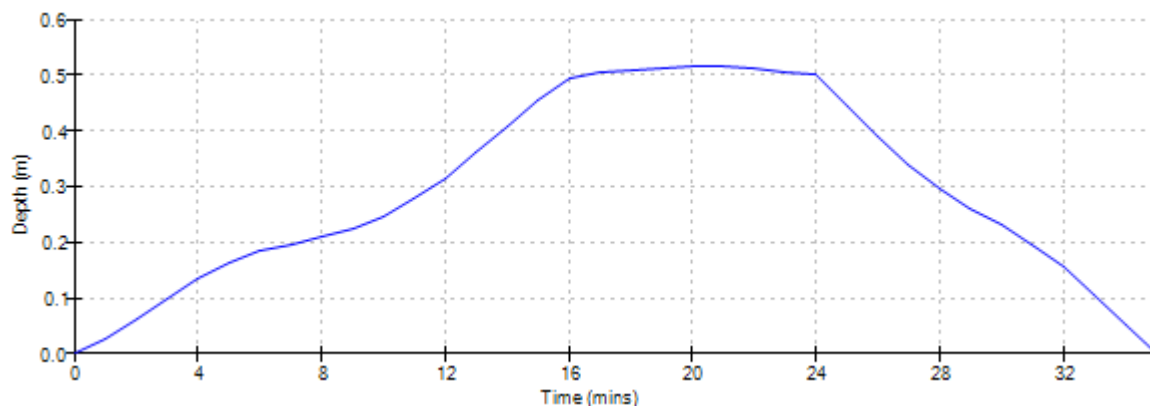
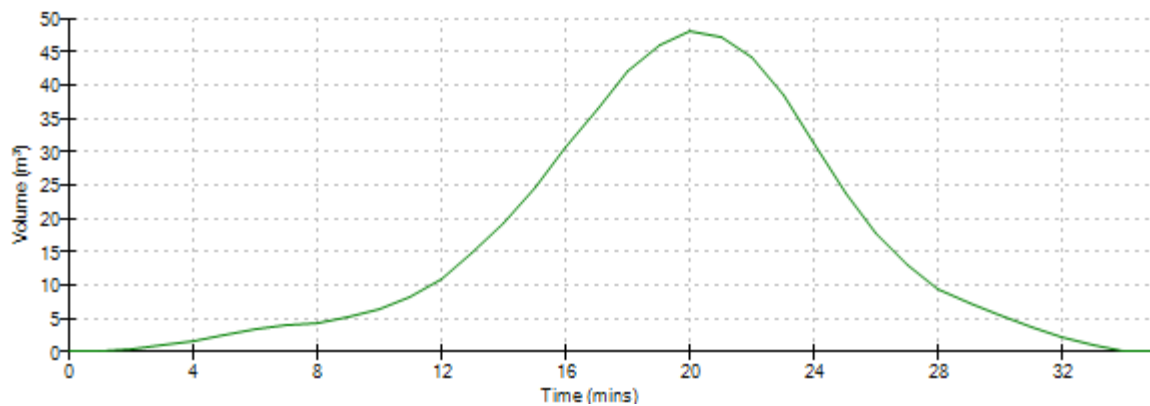
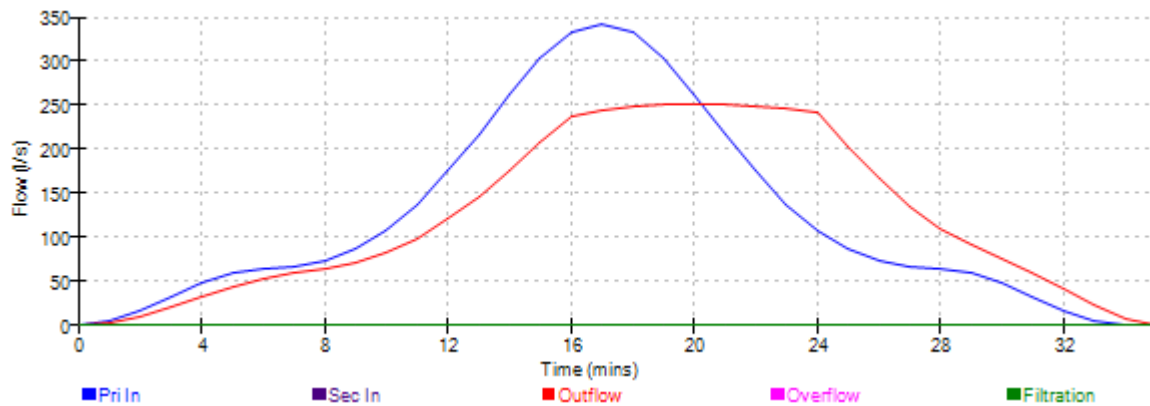
Time (mins)	Area
From:	To: (ha)
0	4 0.724

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Stantec UK		Page 5																								
Dominion House Warrington .																										
Date 15/10/2025 17:01 File Swales_to_Basin.CASX	Designed by dfry Checked by																									
Innovyze	Source Control 2020.1																									
<u>Cascade Model Details for Swale_1.SRCX</u> Storage is Online Cover Level (m) 124.584 <u>Swale Structure</u> <table> <tr> <td>Infiltration Coefficient Base (m/hr)</td> <td>0.00000</td> <td>Length (m)</td> <td>110.0</td> </tr> <tr> <td>Infiltration Coefficient Side (m/hr)</td> <td>0.00000</td> <td>Side Slope (1:X)</td> <td>3.0</td> </tr> <tr> <td>Safety Factor</td> <td>2.0</td> <td>Slope (1:X)</td> <td>83.4</td> </tr> <tr> <td>Porosity</td> <td>1.00</td> <td>Cap Volume Depth (m)</td> <td>0.000</td> </tr> <tr> <td>Invert Level (m)</td> <td>124.084</td> <td>Cap Infiltration Depth (m)</td> <td>0.000</td> </tr> <tr> <td>Base Width (m)</td> <td>2.0</td> <td></td> <td></td> </tr> </table> <u>Weir Outflow Control</u> Discharge Coef 0.544 Width (m) 0.400 Invert Level (m) 124.084			Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	110.0	Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0	Safety Factor	2.0	Slope (1:X)	83.4	Porosity	1.00	Cap Volume Depth (m)	0.000	Invert Level (m)	124.084	Cap Infiltration Depth (m)	0.000	Base Width (m)	2.0		
Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	110.0																							
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0																							
Safety Factor	2.0	Slope (1:X)	83.4																							
Porosity	1.00	Cap Volume Depth (m)	0.000																							
Invert Level (m)	124.084	Cap Infiltration Depth (m)	0.000																							
Base Width (m)	2.0																									
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Innovyze	Source Control 2020.1	

Cascade Event: 30 min Winter for Swale_1.SRCX



Upstream Structures	Outflow To	Overflow To
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Half Drain Time : 2 minutes.

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
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Dominion House
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Cascade Summary of Results for Swale_2.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control E (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
5760 min Summer	122.490	0.081	0.0	15.6	15.6	0.4	O K
7200 min Summer	122.483	0.074	0.0	13.7	13.7	0.3	O K
8640 min Summer	122.478	0.069	0.0	12.4	12.4	0.3	O K
10080 min Summer	122.475	0.066	0.0	11.5	11.5	0.3	O K
15 min Winter	122.925	0.516	0.0	252.8	252.8	40.4	FLOOD
30 min Winter	122.929	0.520	0.0	255.7	255.7	44.5	FLOOD
60 min Winter	122.916	0.507	0.0	246.2	246.2	30.2	FLOOD
120 min Winter	122.811	0.402	0.0	173.6	173.6	13.3	Flood Risk
180 min Winter	122.743	0.334	0.0	131.4	131.4	8.6	Flood Risk
240 min Winter	122.700	0.291	0.0	107.1	107.1	6.3	Flood Risk
360 min Winter	122.649	0.240	0.0	80.3	80.3	4.1	Flood Risk
480 min Winter	122.618	0.209	0.0	65.0	65.0	3.0	Flood Risk
600 min Winter	122.596	0.187	0.0	55.2	55.2	2.4	O K
720 min Winter	122.580	0.171	0.0	48.3	48.3	1.9	O K
960 min Winter	122.557	0.148	0.0	38.9	38.9	1.4	O K
1440 min Winter	122.531	0.122	0.0	29.0	29.0	0.9	O K
2160 min Winter	122.510	0.101	0.0	21.8	21.8	0.6	O K
2880 min Winter	122.497	0.088	0.0	17.9	17.9	0.5	O K
4320 min Winter	122.483	0.074	0.0	13.7	13.7	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	2.167	0.0	1358.8	2912
7200 min Summer	1.899	0.0	1488.3	3544
8640 min Summer	1.718	0.0	1615.7	4312
10080 min Summer	1.589	0.0	1743.5	4968
15 min Winter	119.779	16.4	219.2	15
30 min Winter	85.369	20.0	312.4	24
60 min Winter	58.073	7.1	425.0	38
120 min Winter	34.829	0.0	509.7	66
180 min Winter	25.891	0.0	568.3	96
240 min Winter	20.993	0.0	614.4	124
360 min Winter	15.621	0.0	685.7	184
480 min Winter	12.644	0.0	740.0	244
600 min Winter	10.722	0.0	784.4	302
720 min Winter	9.366	0.0	822.3	364
960 min Winter	7.556	0.0	884.5	484
1440 min Winter	5.615	0.0	986.0	730
2160 min Winter	4.198	0.0	1105.8	1072
2880 min Winter	3.432	0.0	1205.4	1424
4320 min Winter	2.606	0.0	1372.7	2176

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Cascade Rainfall Details for Swale_2.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 241170 213372 SN 41170 13372
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.147

Time (mins)	Area
From:	To: (ha)
0	4 0.147

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Cascade Model Details for Swale_2.SRCX

Storage is Online Cover Level (m) 122.909

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	120.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	71.6
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	122.409	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.5		

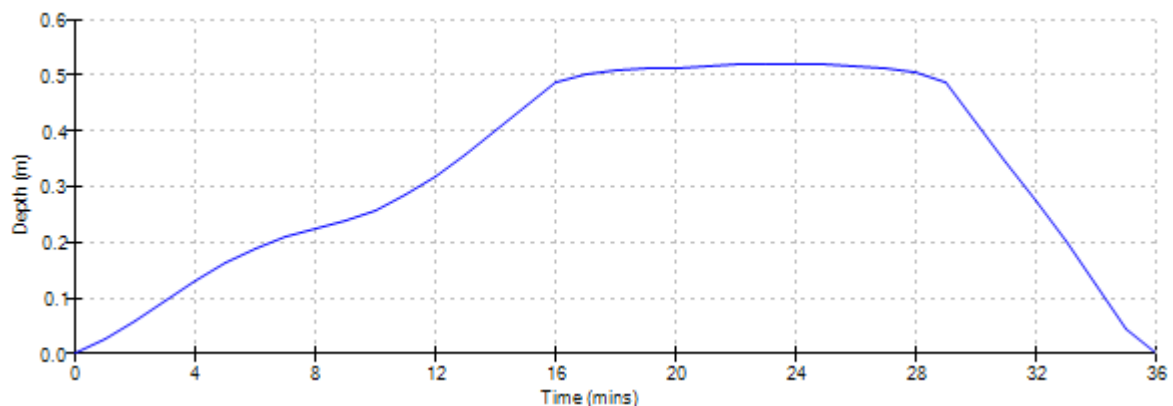
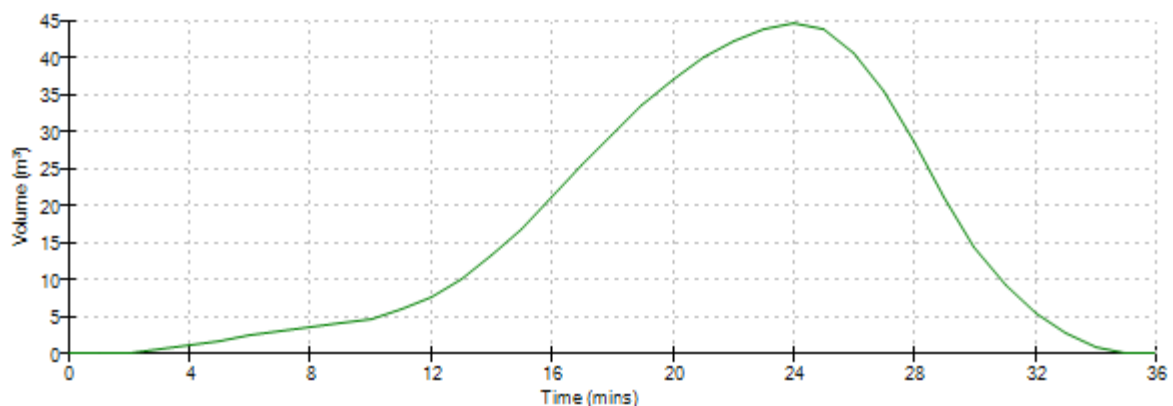
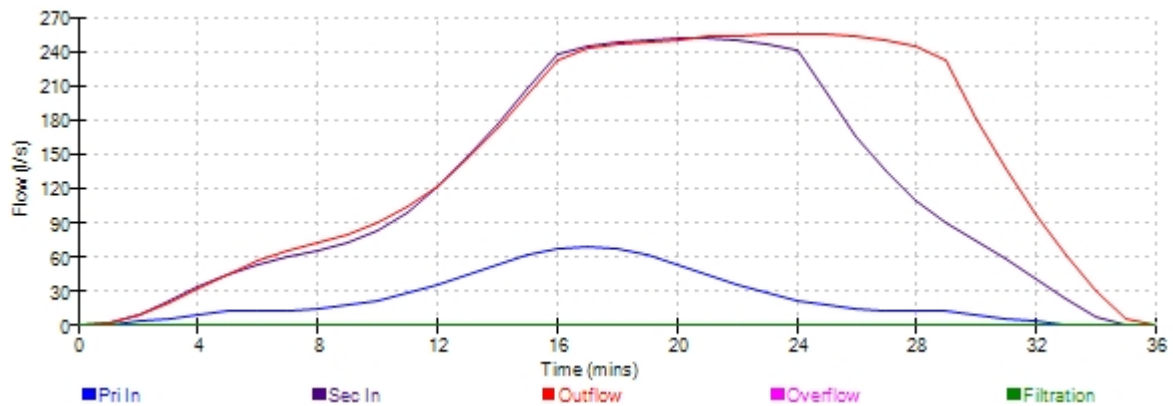
Weir Outflow Control

Discharge Coef 0.544 Width (m) 0.400 Invert Level (m) 122.409

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Dominion House Warrington .		
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Cascade Event: 30 min Winter for Swale_2.SRCX



Stantec UK

Dominion House

Warrington

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Date 15/10/2025 17:02

File Swales_to_Basin.CASX

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Cascade Summary of Results for Swale_3.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
5760 min Summer	121.169	0.087	0.0	17.6	17.6	0.6	O K
7200 min Summer	121.162	0.080	0.0	15.3	15.3	0.5	O K
8640 min Summer	121.157	0.075	0.0	13.9	13.9	0.4	O K
10080 min Summer	121.153	0.071	0.0	12.8	12.8	0.4	O K
15 min Winter	121.591	0.509	0.0	247.7	247.7	38.7	FLOOD
30 min Winter	121.598	0.516	0.0	252.4	252.4	46.1	FLOOD
60 min Winter	121.595	0.513	0.0	250.2	250.2	42.8	FLOOD
120 min Winter	121.511	0.429	0.0	191.7	191.7	19.7	Flood Risk
180 min Winter	121.441	0.359	0.0	146.4	146.4	12.9	Flood Risk
240 min Winter	121.396	0.314	0.0	119.8	119.8	9.5	Flood Risk
360 min Winter	121.341	0.259	0.0	89.7	89.7	6.1	Flood Risk
480 min Winter	121.307	0.225	0.0	72.9	72.9	4.5	Flood Risk
600 min Winter	121.284	0.202	0.0	62.0	62.0	3.5	Flood Risk
720 min Winter	121.267	0.185	0.0	54.1	54.1	2.9	O K
960 min Winter	121.242	0.160	0.0	43.7	43.7	2.1	O K
1440 min Winter	121.214	0.132	0.0	32.6	32.6	1.4	O K
2160 min Winter	121.191	0.109	0.0	24.4	24.4	0.9	O K
2880 min Winter	121.177	0.095	0.0	20.0	20.0	0.7	O K
4320 min Winter	121.161	0.079	0.0	15.2	15.2	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	2.167	0.0	1525.7	2928
7200 min Summer	1.899	0.0	1671.1	3592
8640 min Summer	1.718	0.0	1814.2	4400
10080 min Summer	1.589	0.0	1957.6	5008
15 min Winter	119.779	9.2	246.1	18
30 min Winter	85.369	15.8	350.8	28
60 min Winter	58.073	12.9	477.4	42
120 min Winter	34.829	0.0	572.3	68
180 min Winter	25.891	0.0	638.1	98
240 min Winter	20.993	0.0	689.8	126
360 min Winter	15.621	0.0	770.0	186
480 min Winter	12.644	0.0	831.0	244
600 min Winter	10.722	0.0	880.8	306
720 min Winter	9.366	0.0	923.3	364
960 min Winter	7.556	0.0	993.2	486
1440 min Winter	5.615	0.0	1107.2	730
2160 min Winter	4.198	0.0	1241.7	1100
2880 min Winter	3.432	0.0	1353.4	1452
4320 min Winter	2.606	0.0	1541.3	2164

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Cascade Rainfall Details for Swale_3.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 241170 213372 SN 41170 13372
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.107

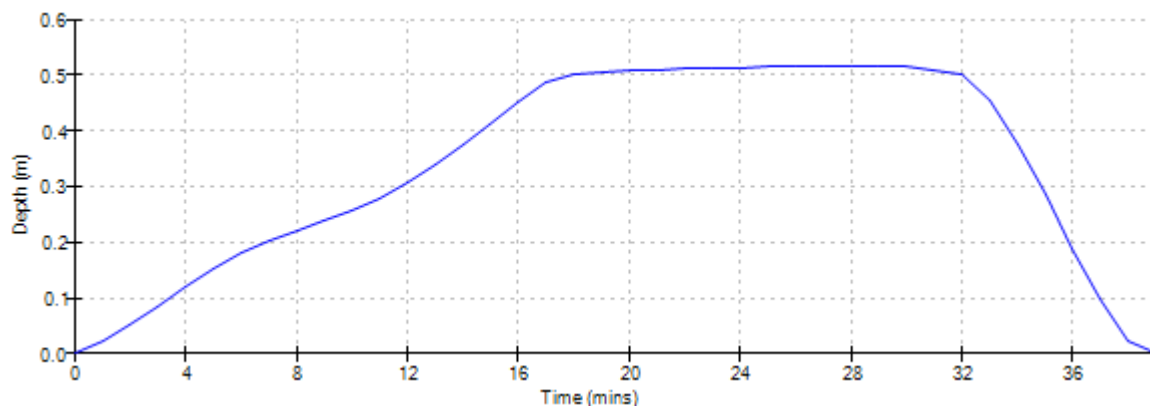
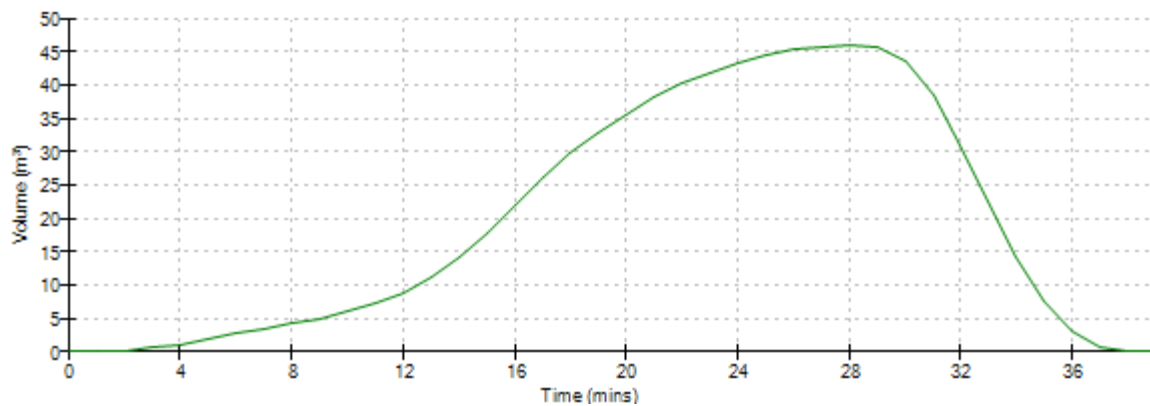
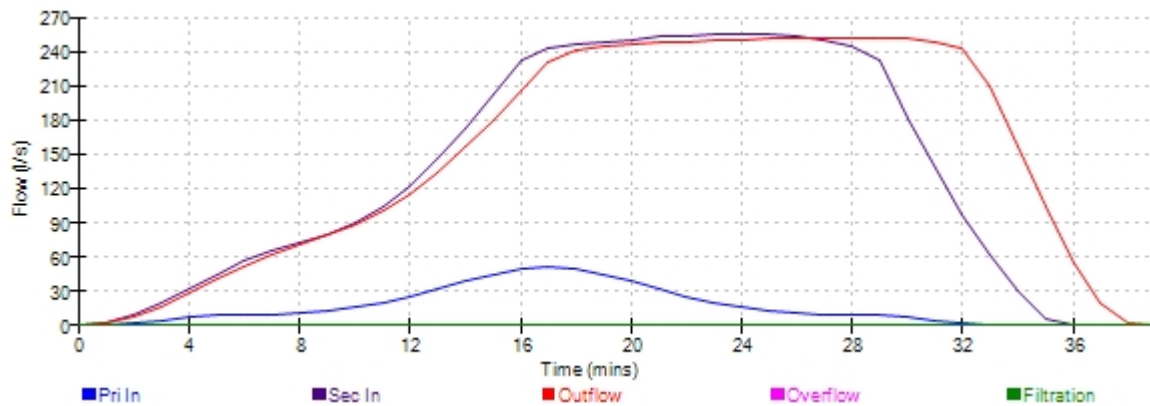
	Time (mins)	Area
From:	To:	(ha)
	0	4 0.107

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Dominion House Warrington .																										
Date 15/10/2025 17:02 File Swales_to_Basin.CASX	Designed by dfry Checked by																									
Innovyze	Source Control 2020.1																									
<u>Cascade Model Details for Swale_3.SRCX</u> Storage is Online Cover Level (m) 121.582 <u>Swale Structure</u> <table style="width: 100%; border: none;"> <tr> <td style="width: 40%;">Infiltration Coefficient Base (m/hr)</td> <td style="width: 20%;">0.00000</td> <td style="width: 20%;">Length (m)</td> <td style="width: 20%;">120.0</td> </tr> <tr> <td>Infiltration Coefficient Side (m/hr)</td> <td>0.00000</td> <td>Side Slope (1:X)</td> <td>3.0</td> </tr> <tr> <td>Safety Factor</td> <td>2.0</td> <td>Slope (1:X)</td> <td>90.4</td> </tr> <tr> <td>Porosity</td> <td>1.00</td> <td>Cap Volume Depth (m)</td> <td>0.000</td> </tr> <tr> <td>Invert Level (m)</td> <td>121.082</td> <td>Cap Infiltration Depth (m)</td> <td>0.000</td> </tr> <tr> <td>Base Width (m)</td> <td>1.5</td> <td></td> <td></td> </tr> </table> <u>Weir Outflow Control</u> Discharge Coef 0.544 Width (m) 0.400 Invert Level (m) 121.082			Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	120.0	Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0	Safety Factor	2.0	Slope (1:X)	90.4	Porosity	1.00	Cap Volume Depth (m)	0.000	Invert Level (m)	121.082	Cap Infiltration Depth (m)	0.000	Base Width (m)	1.5		
Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	120.0																							
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0																							
Safety Factor	2.0	Slope (1:X)	90.4																							
Porosity	1.00	Cap Volume Depth (m)	0.000																							
Invert Level (m)	121.082	Cap Infiltration Depth (m)	0.000																							
Base Width (m)	1.5																									
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Cascade Event: 30 min Winter for Swale_3.SRCX



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Innovyze	Source Control 2020.1				
<u>Cascade Summary of Results for Storage_Basin.SRCX</u>					
Upstream Outflow To Overflow To Structures Swale_3.SRCX (None) (None) Swale_2.SRCX Swale_1.SRCX					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	120.705	0.205	4.6	216.0	O K
30 min Summer	120.787	0.287	4.6	307.5	O K
60 min Summer	120.882	0.382	4.6	415.1	O K
120 min Summer	120.945	0.445	4.6	488.7	O K
180 min Summer	120.986	0.486	4.6	536.7	O K
240 min Summer	121.015	0.515	4.6	571.7	O K
360 min Summer	121.055	0.555	4.6	619.6	O K
480 min Summer	121.079	0.579	4.6	649.6	O K
600 min Summer	121.095	0.595	4.6	669.4	O K
720 min Summer	121.106	0.606	4.6	682.5	O K
960 min Summer	121.116	0.616	4.6	695.2	O K
1440 min Summer	121.121	0.621	4.6	701.0	O K
2160 min Summer	121.121	0.621	4.6	701.2	O K
2880 min Summer	121.118	0.618	4.6	696.9	O K
4320 min Summer	121.106	0.606	4.6	682.3	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	119.779	0.0	193.3	26	
30 min Summer	85.369	0.0	276.1	37	
60 min Summer	58.073	0.0	409.5	66	
120 min Summer	34.829	0.0	490.2	126	
180 min Summer	25.891	0.0	544.5	184	
240 min Summer	20.993	0.0	585.6	244	
360 min Summer	15.621	0.0	644.4	364	
480 min Summer	12.644	0.0	680.7	484	
600 min Summer	10.722	0.0	698.1	602	
720 min Summer	9.366	0.0	698.7	722	
960 min Summer	7.556	0.0	683.5	962	
1440 min Summer	5.615	0.0	652.1	1280	
2160 min Summer	4.198	0.0	1089.0	1660	
2880 min Summer	3.432	0.0	1178.0	2048	
4320 min Summer	2.606	0.0	1217.5	2900	
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Dominion House Warrington .					
Date 15/10/2025 17:03 File Swales_to_Basin.CASX		Designed by dfry Checked by			
Innovyze		Source Control 2020.1			
Cascade Summary of Results for Storage_Basin.SRCX					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
5760 min Summer	121.095	0.595	4.6	668.5	O K
7200 min Summer	121.087	0.587	4.6	659.5	O K
8640 min Summer	121.083	0.583	4.6	653.8	O K
10080 min Summer	121.081	0.581	4.6	651.4	O K
15 min Winter	120.728	0.228	4.6	242.0	O K
30 min Winter	120.820	0.320	4.6	344.6	O K
60 min Winter	120.926	0.426	4.6	465.9	O K
120 min Winter	120.997	0.497	4.6	550.0	O K
180 min Winter	121.042	0.542	4.6	604.3	O K
240 min Winter	121.075	0.575	4.6	643.9	O K
360 min Winter	121.119	0.619	4.6	699.2	O K
480 min Winter	121.148	0.648	4.6	734.9	O K
600 min Winter	121.167	0.667	4.6	759.3	O K
720 min Winter	121.181	0.681	4.6	776.2	O K
960 min Winter	121.196	0.696	4.6	795.2	O K
1440 min Winter	121.206	0.706	4.6	808.5	Flood Risk
2160 min Winter	121.202	0.702	4.6	803.1	Flood Risk
2880 min Winter	121.196	0.696	4.6	795.2	O K
4320 min Winter	121.172	0.672	4.6	765.6	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
5760 min Summer	2.167	0.0	1519.3	3752	
7200 min Summer	1.899	0.0	1663.0	4608	
8640 min Summer	1.718	0.0	1803.1	5448	
10080 min Summer	1.589	0.0	1939.9	6256	
15 min Winter	119.779	0.0	217.3	27	
30 min Winter	85.369	0.0	306.8	38	
60 min Winter	58.073	0.0	458.4	66	
120 min Winter	34.829	0.0	547.0	124	
180 min Winter	25.891	0.0	605.4	182	
240 min Winter	20.993	0.0	648.0	240	
360 min Winter	15.621	0.0	700.8	358	
480 min Winter	12.644	0.0	716.5	474	
600 min Winter	10.722	0.0	711.5	590	
720 min Winter	9.366	0.0	704.9	704	
960 min Winter	7.556	0.0	692.0	932	
1440 min Winter	5.615	0.0	670.4	1368	
2160 min Winter	4.198	0.0	1215.3	1732	
2880 min Winter	3.432	0.0	1304.4	2192	
4320 min Winter	2.606	0.0	1269.4	3116	
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Dominion House Warrington .					
Date 15/10/2025 17:03 File Swales_to_Basin.CASX	Designed by dfry Checked by				
Innovyze	Source Control 2020.1				
<u>Cascade Summary of Results for Storage_Basin.SRCX</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
5760 min Winter	121.147	0.647	4.6	733.8	O K
7200 min Winter	121.126	0.626	4.6	707.2	O K
8640 min Winter	121.108	0.608	4.6	684.7	O K
10080 min Winter	121.093	0.593	4.6	666.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
5760 min Winter	2.167	0.0	1701.8	4040	
7200 min Winter	1.899	0.0	1862.4	4976	
8640 min Winter	1.718	0.0	2018.3	5872	
10080 min Winter	1.589	0.0	2168.0	6752	
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Designed by dfry Checked by		
Innovyze		Source Control 2020.1

Cascade Model Details for Storage_Basin.SRCX

Storage is Online Cover Level (m) 121.500

Tank or Pond Structure

Invert Level (m) 120.500

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1020.0	0.700	1271.6	1.000	1387.9

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0106-4600-0700-4600
Design Head (m)	0.700
Design Flow (l/s)	4.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	106
Invert Level (m)	120.500
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.700	4.6	Kick-Flo®	0.477	3.9
Flush-Flo™	0.213	4.6	Mean Flow over Head Range	-	3.9

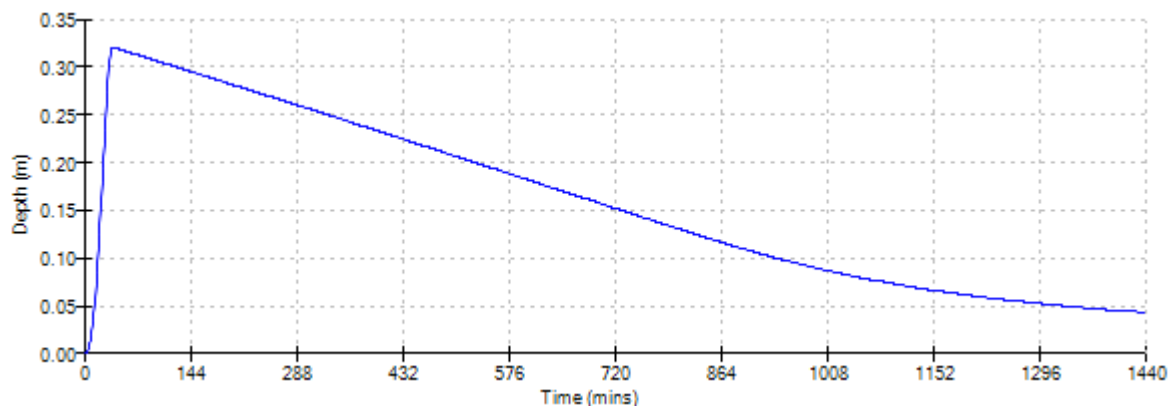
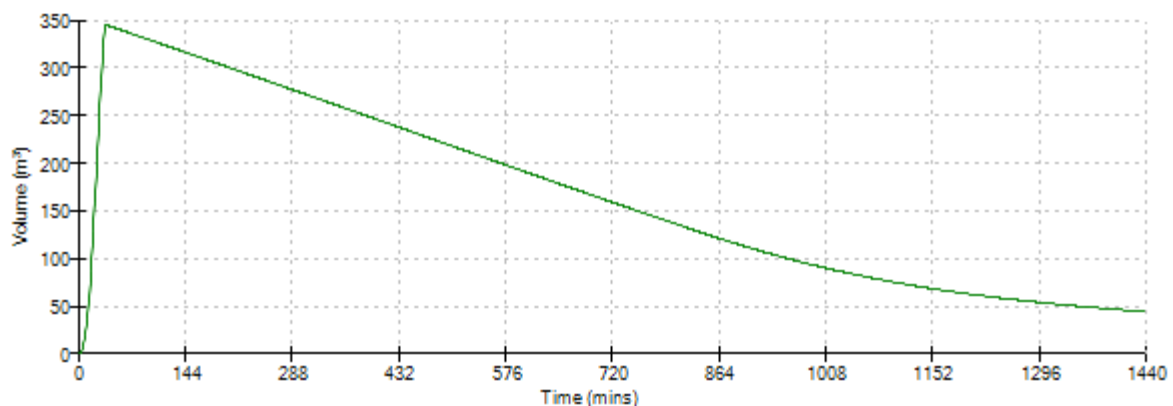
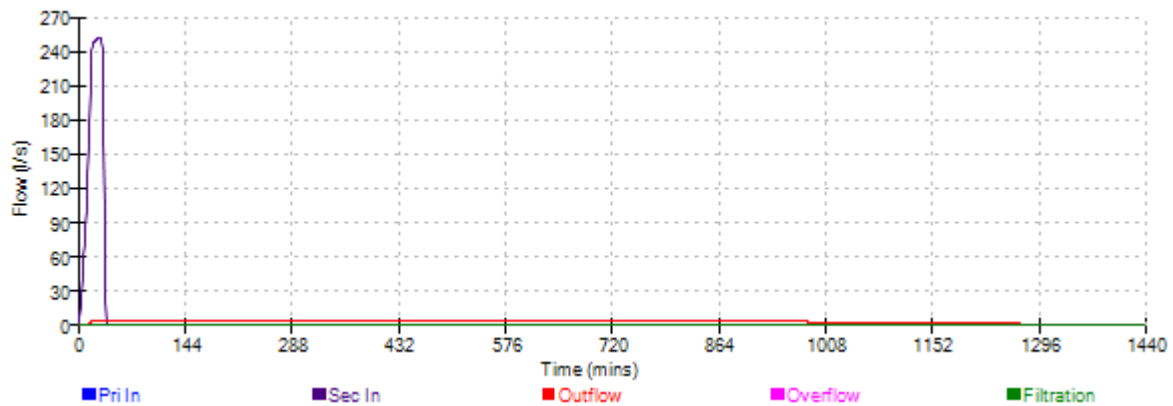
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	1.200	5.9	3.000	9.1	7.000	13.6
0.200	4.6	1.400	6.3	3.500	9.8	7.500	14.0
0.300	4.5	1.600	6.8	4.000	10.4	8.000	14.5
0.400	4.3	1.800	7.1	4.500	11.0	8.500	14.9
0.500	3.9	2.000	7.5	5.000	11.6	9.000	15.4
0.600	4.3	2.200	7.8	5.500	12.1	9.500	15.8
0.800	4.9	2.400	8.2	6.000	12.6		
1.000	5.4	2.600	8.5	6.500	13.1		

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Date 15/10/2025 17:03	Designed by dfry	
File Swales_to_Basin.CASX	Checked by	
Innovyze	Source Control 2020.1	

Cascade Event: 30 min Winter for Storage_Basin.SRCX



Appendix H A484 Connection results

Stantec

REPORT OF SURVEY

Project: 24ST032430_A484 Highway Drainage Survey

Watercourses: Unknown Watercourse

Type of Survey: Drainage Survey

Drawing Number: 24ST032430/01 to 03 = Drainage and Cross Section Survey

Storm Geomatics Job No: 24ST032430

Client Name Job No: -

Date of Survey: January 2025

To: Stantec
Rotterdam House (1st Floor)
116 Quayside
Newcastle Upon Tyne
NE1 3DY

From: Storm Geomatics Head Office
Storm Geomatics Limited
Unit 11 Shipston Business Village
Tilemans Lane
Shipston-on-Stour
Warwickshire
CV36 4FF

Date of Survey: January 2025

Contents

1.0 Scope

2.0 Survey Control

3.0 Topography

4.0 Presentation

5.0 Health & Safety

6.0 Comments

Appendix I Control Processing Information

Appendix II Self Certification Forms

Appendix III Proposal

Report of Survey

1.0 Scope

The scope was taken from the document "A484_Survey_Proposal_Storm_V2" which can be found in Appendix III.

2.0 Survey Control

2.1 Survey control has been established using dual frequency Global Navigation Satellite System (GNSS) survey grade equipment to Environment Agency (EA) specification 5.01. All processing has been undertaken using the OSTN15 and OSGM15 transformation and geoid models. Processing details of all control data can be found in Appendix I of this report.

2.2 1x new E6 Grade control station, E6-1, has been installed for future reference.

The coordinates for the new station can be found in the following table.

2.2.1 *Table showing the names and coordinates of the newly installed control stations:*

Point ID	Eastings	Northings	Height
E6-1 (Final Value)	241169.541	212954.950	114.444

3.0 Topography

3.1 All files relating to detail survey observations and computations are held on Storm Geomatics server in Trimble Business Centre format.

3.2 Each individual cross section has been positioned using RTK GNSS

3.3 The survey was accomplished using a Trimble S5 Total Station, resected from GNSS Network RTK configuration.

3.4 The detail has been surveyed using a Trimble R10/R12 receiver and S5 Total Station. The following self checks were made:

- Daily Checks of the Measurement Pole
- Checks to known control as detailed in the table below:

Date	Eastings	Northings	Height
CHK 28.01PM	241169.554	212954.955	114.468
CHK 29.01 AM	241169.557	212954.970	114.437
Mean	241169.556	212954.963	114.453
Standard Deviation	0.002	0.011	0.022
Difference to Levelled Control	0.015	0.012	0.009

4.0 Presentation

- 4.1 Files relating to survey deliverables are submitted within the folders of the digital data.
- 4.2 All manhole description sheets can be found within the Drainage Data folder and photos of these manholes can be found within each individual manhole description sheet.
- 4.3 The Wincan project produced as part of the CCTV survey can be viewed via the '3786C1 A484 CCTV report' document and the links within.

5.0 Health and Safety

- 5.1 There were no incidents to report. All members of the site team were briefed at each location by the senior surveyor as to the hazards on site and the method of work.

6.0 Comments

- 6.1 The survey was completed without incident.
- 6.2 No Non-Native Invasive Species (NNIS) were identified on site.
- 6.3 We were unable to lift the following manholes and gulleys:

GU8, GU11, GU13, GU102, MH101, MH102.

Two extra chambers were also traced that couldn't be lifted / found. One was tarmacked over (GU14.2) and the other was on private land which couldn't be accessed. (12.1).

For the unliftable covers, cover levels and the outline of the covers have been plotted. In some cases, we were able to find connections to the unliftable chambers from other manholes/gulleys. This is all plotted in the CAD drawing.
- 6.4 Assumed routes can be found within the CAD drawing and CCTV report in purple.
- 6.6 Levels have been taken periodically on the verge and the ditch that was found has been surveyed with tops and bottoms of banks.
- 6.7 All other information regarding the CCTV survey can be found within the drainage data folder.
- 6.8 Please note there are some naming and pipe size errors within the Wincan CCTV video footage. We are unable to amend this once processed so please only use the information provided within the drawings.

Signed:

Date: 18/02/2024

Name: Tom Atkinson

Position in Company: Senior Surveyor

Appendix I
Control Processing Summary

Appendix II
Self-Certification Forms

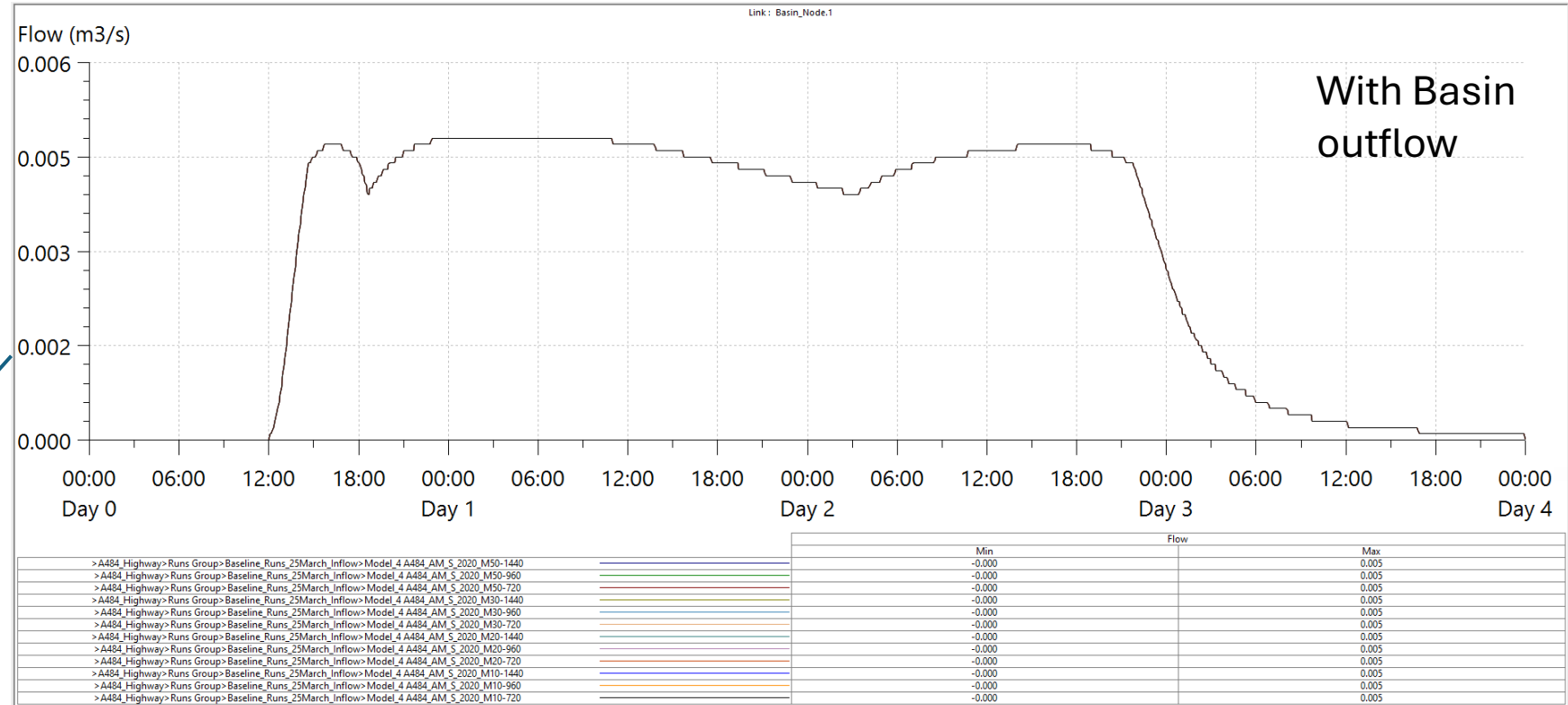
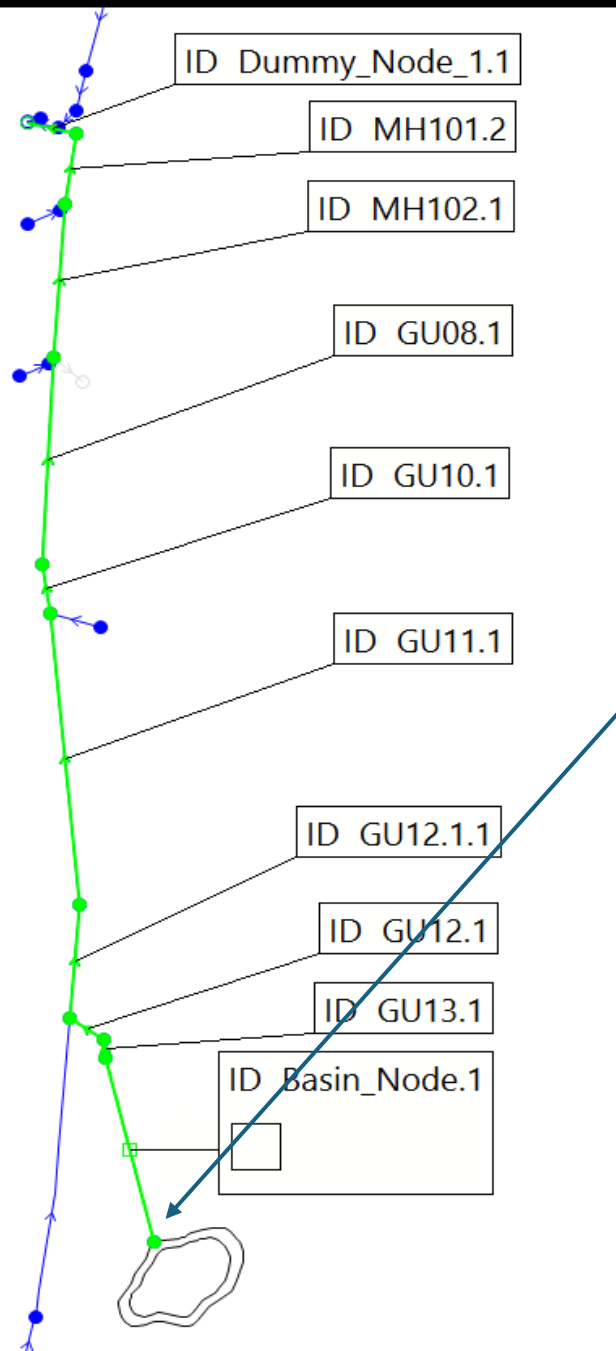
Appendix III Specification

Appendix IIII
CCTV Report

Flood Flow analysis

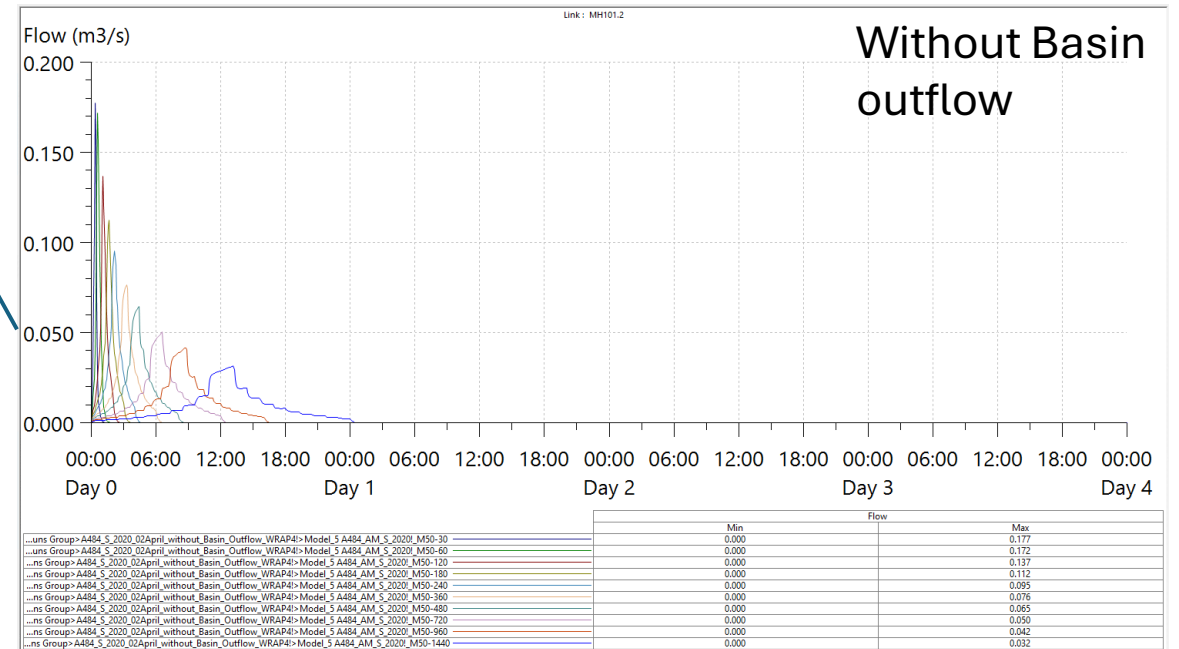
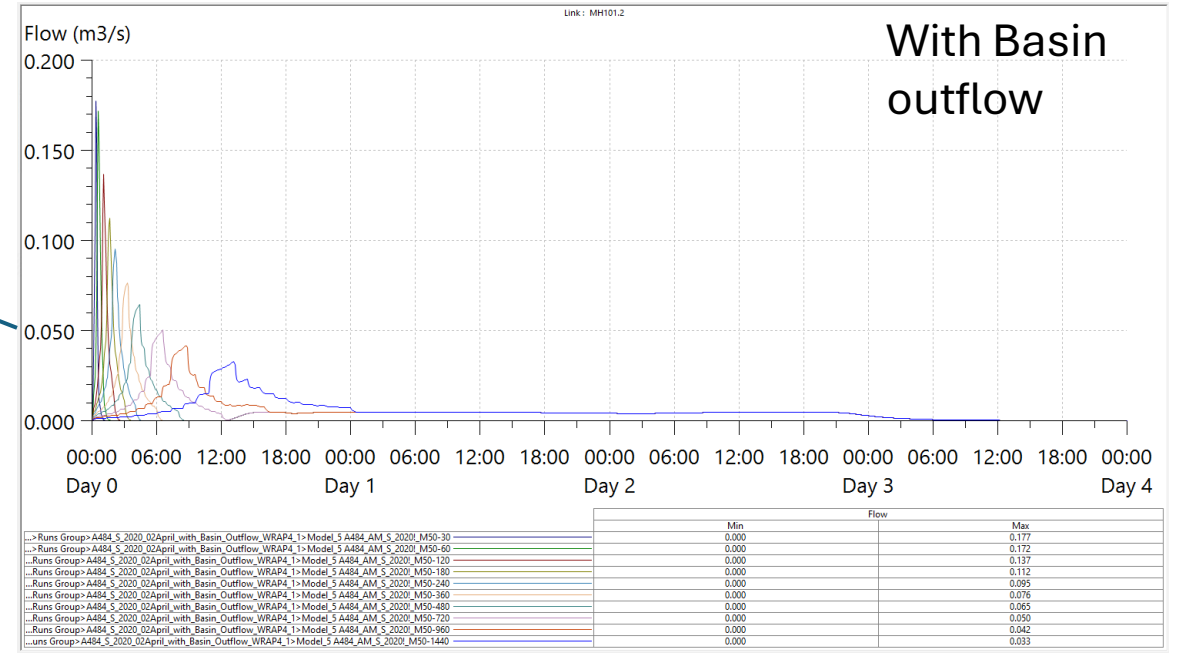
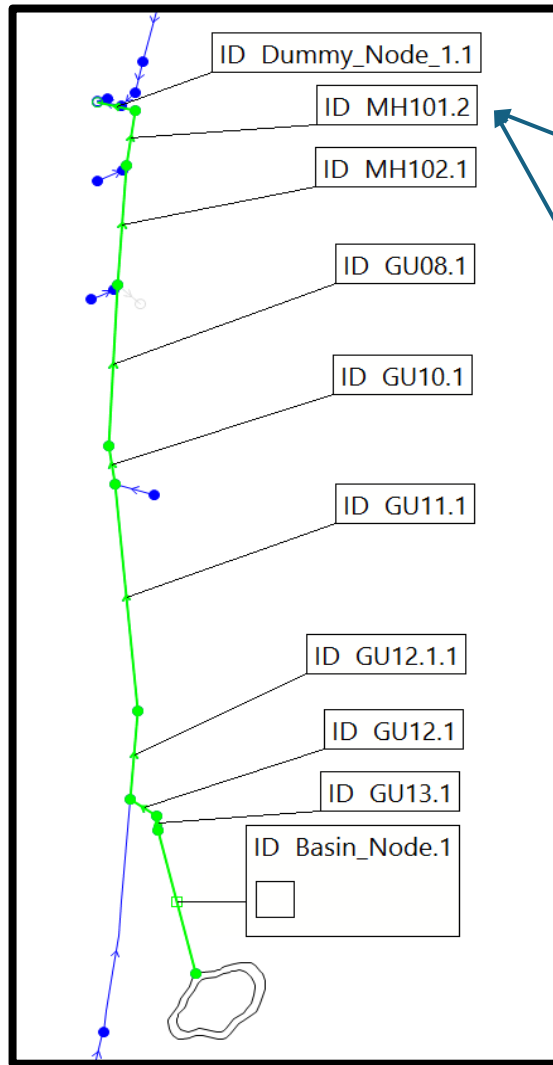
- The model for A484 was checked for design events for 5, 10, 20-, 30-, 50- and 100-year return period and 30, 60, 120, 180, 240, 360, 480, 720, 960 and 1440min durations.
- The model predicts flooding for design events 20 years and higher return periods
- The model was simulated for two scenarios - with basin outflow and without basin outflow
- The results indicate that the most of the design events' peak flow rates are passed through the network and do not coincide with the basin outflow except for 720, 960 and 1440.
- Design event results predict that the network has capacity to convey basin outflows.
- During higher return period events (>20 year) the area is likely to receive overland flows which may have an impact on the network and will need to be investigated further.

Basin_Node.1



As seen in the graph, the basin outflow triggers after 12-hours.

MH101.2

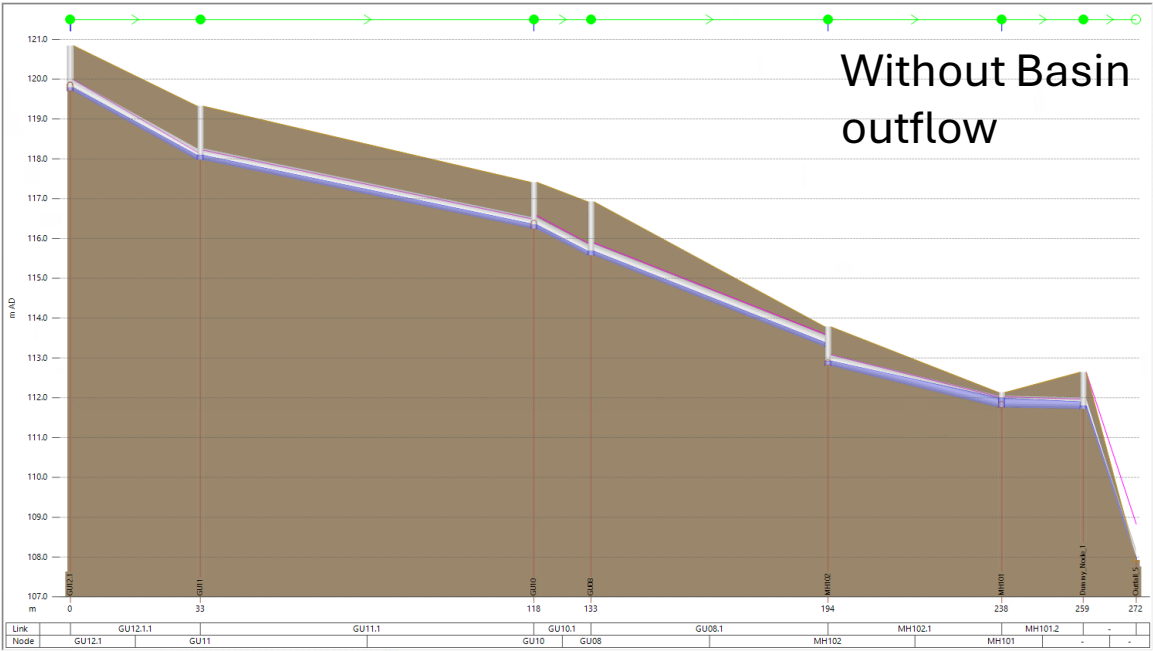
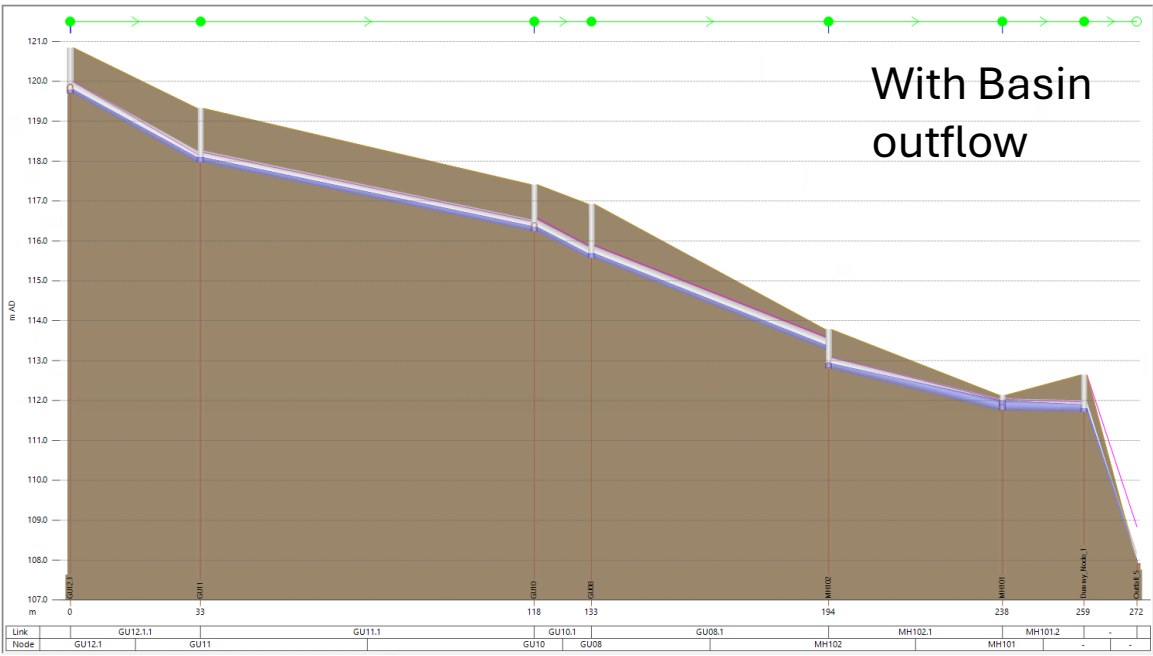
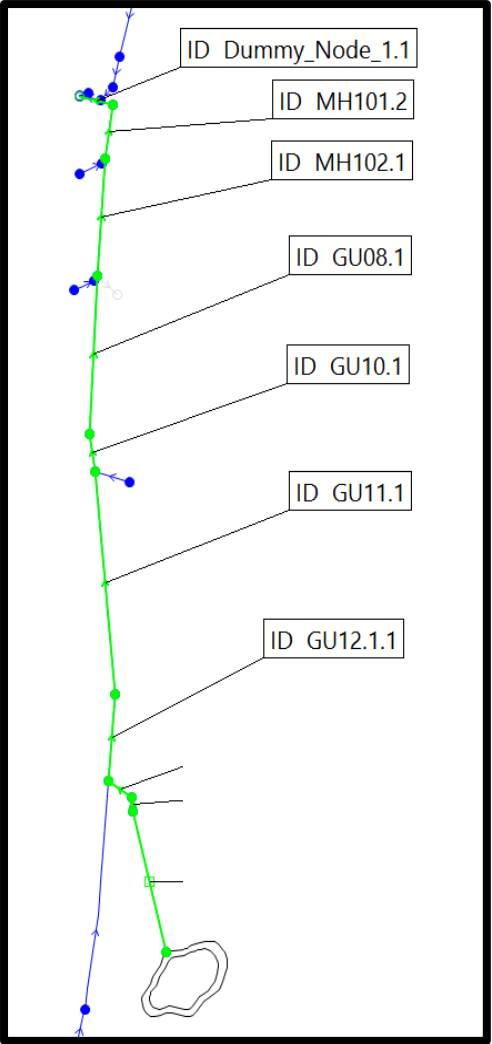


As seen in the graph, the simulation events which are longer than 720 min only affecting the basin outflow, and it doesn't affect in peak flooding.

M50-720 Scenario

L-section for main line
GU12.1.1 to Outfall

As seen in the graph pipe doesn't show any flood increase due to basin outflow.



Appendix I Simple Index Approach tool results

SUMMARY TABLE		DESIGN CONDITIONS			
		1	2	3	4
Land Use Type Pollution Hazard Level Pollution Hazard Indices TSS Metals Hydrocarbons	Other industrial site area High 0.8 0.8 0.9	These indices should only be used if considered appropriate by the required risk assessment and where approved by the regulator. If they are not considered appropriate, the risk assessment should use alternative measures of pollution hazard for the site.	In Scotland and Northern Ireland, the environmental regulator should be consulted as part of the licensing process required for High Risk sites. In England and Wales, the environmental regulator should be consulted prior to design (for pre-permitting advice) to determine the most appropriate design approach and requirements for risk assessment.		
SuDS components proposed					
Component 1	Pervious pavement (where the pavement is not designed as an infiltration component)	SuDS components can only be assumed to deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters of the SuDS Manual. See also checklists in Appendix B			
Component 2	Swale				
Component 3	Pond or wetland				
SuDS Pollution Mitigation Indices TSS Metals Hydrocarbons	>0.95 >0.95 >0.95				
Groundwater protection type Groundwater protection Pollution Mitigation Indices TSS Metals Hydrocarbons	None 0 0 0				
Combined Pollution Mitigation Indices TSS Metals Hydrocarbons Acceptability of Pollution Mitigation TSS Metals Hydrocarbons	>0.95 >0.95 >0.95 Sufficient Sufficient Sufficient	Reference to local planning documents should also be made to identify any additional protection required for sites due to habitat conservation (see Chapter 7 The SuDS design process). The implications of developments on or within close proximity to an area with an environmental designation, such as a Site of Special Scientific Interest (SSSI), should be considered via consultation with relevant conservation bodies such as Natural England			

SUMMARY TABLE		DESIGN CONDITIONS			
		1	2	3	4
Land Use Type Pollution Hazard Level Pollution Hazard Indices TSS Metals Hydrocarbons	Highly frequented lorry approaches to industrial estates High 0.8 0.8 0.9	These indices should only be used if considered appropriate by the required risk assessment and where approved by the regulator. If they are not considered appropriate, the risk assessment should use alternative measures of pollution hazard for the site.	In Scotland and Northern Ireland, the environmental regulator should be consulted as part of the licensing process required for High Risk sites. In England and Wales, the environmental regulator should be consulted prior to design (for pre-permitting advice) to determine the most appropriate design approach and requirements for risk assessment.		
SuDS components proposed					
Component 1	Filter strip	SuDS components can only be assumed to deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters of the SuDS Manual. See also checklists in Appendix B			
Component 2	Swale				
Component 3	Detention basin				
SuDS Pollution Mitigation Indices TSS Metals Hydrocarbons	 0.9 0.95 >0.95				
Groundwater protection type Groundwater protection Pollution Mitigation Indices TSS Metals Hydrocarbons	None 0 0 0				
Combined Pollution Mitigation Indices TSS Metals Hydrocarbons Acceptability of Pollution Mitigation TSS Metals Hydrocarbons	 >0.95 Sufficient Sufficient Sufficient	0.9 0.95 Reference to local planning documents should also be made to identify any additional protection required for sites due to habitat conservation (see Chapter 7 The SuDS design process). The implications of developments on or within close proximity to an area with an environmental designation, such as a Site of Special Scientific Interest (SSSI), should be considered via consultation with relevant conservation bodies such as Natural England			