Visual Impact Provision: Snowdonia Project – SuDS Strategy

Sustainable Drainage Systems (SuDS) Strategy

Date:

02/06/2020

Prepared for:

National Grid

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Project Name:

Visual Impact Provision: Snowdonia Project

Project No:

41523996

Report Ref:

RPT_41523996_*SuDS Strategy*

Sign-off Sheet

Project Name	Visual Impact Provision: Snowdonia Project
Project No	41523996
Report Reference	RPT_*41523996_SuDS Strategy*

Revision	Date	Description	Author	Check	Review
Draft	09 September 2019	First Draft	Kelvin Limbrick	Janet Langsford	Pauline Barry
Updated to incorporate comments from RSK and National Grid	04 December 2019	Second Draft	Kelvin Limbrick	Janet Langsford	Pauline Barry

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Executive Summary

This report presents a Sustainable Drainage Systems (SuDS) Strategy for National Grid's Visual Impact Provision (VIP) Snowdonia Project, which aims to mitigate the visual impact of existing electricity infrastructure within the Snowdonia National Park near Minffordd and to conserve and enhance the natural beauty, wildlife and environmental heritage of the area.

It is intended that this SuDS Strategy will form the initial basis of discussions to obtain approval from Gwynedd Council (covering the Snowdonia National Park Authority), as Lead Local Flood Authority (LLFA) and SuDS Approval Body (SAB), for the proposed SuDS solutions. As such, this SuDS Strategy has been developed to align with the Welsh Statutory SuDS Standards.

This SuDS strategy involves the use of source control and infiltration/sub-base storage techniques to manage water directly adjacent to the source of runoff. 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 not exceed the minimum recommended rate of 5l/s for single discharge points under more extreme events. This SuDS Strategy also incorporates elements that will help to clean surface water runoff and prevent pollution incidents, and the VIP Snowdonia Project itself will also deliver biodiversity and amenity enhancements. Details of the proposed Water Conservation Statement are also outlined in this report.

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
OHL	Overhead Line
SAB	SuDS Approval Body
SEC	Sealing End Compound
SuDS	Sustainable Drainage Systems
TAN	Technical Advice Note
VIP	Visual Impact Provision

Glossary

Sealing End Compound	Required where a high-voltage underground cable transitions to an overhead line. The overhead line finishes on a terminal tower. Downleads bring the conductors down to join onto where the ends of the underground cables come out of the ground.
Tunnel Head House	Required to allow access into the shafts, provide ventilation and to locate plant and equipment.

1.0 INTRODUCTION

1.1 SCOPE

National Grid is currently undertaking the Visual Impact Provision (VIP) Snowdonia Project, (here on referred to as the Proposed Project), which aims to mitigate the visual impact of existing electricity infrastructure within the Snowdonia National Park near Minffordd and to conserve and enhance the natural beauty, wildlife and environmental heritage of the area.

The Proposed Project comprises undergrounding a 3.5km section of existing overhead line (OHL) (here on referred to as the VIP subsection) using a tunnel from a location close to National Grid's existing Garth Sealing End Compound (SEC) on the western side of the Dwyryd Estuary to Cilfor on the eastern side of the Dwyryd Estuary, and to remove the existing VIP subsection (pylons and conductors).

Some components of the operational phase of the Proposed Project will introduce permanent new impermeable hardstanding areas. New areas of permanent impermeable hardstanding on the western side of the Dwyryd Estuary, within the planning jurisdiction of Gwynedd Council, include:

- Reconfiguration of equipment at the existing Garth SEC;
- A tunnel head house close to National Grid's existing Garth SEC; and
- A short access road to the tunnel head house.

New areas of permanent impermeable hardstanding on the eastern side of the Dwyryd Estuary, within the planning jurisdiction Snowdonia National Park, include:

- A new SEC near Cilfor (required to connect the new underground conductor to the remaining existing OHL);
- A tunnel head house located in the same compound as the new SEC; and
- An access road to the new SEC and tunnel head house.

A site location plan is included in Appendix A. Site layout plans are included in Appendices B and C for the western and eastern components respectively.

Stantec UK Ltd has been commissioned by National Grid to undertake an appraisal of options and establish a Sustainable Drainage Systems (SuDS) Strategy for the Proposed Project. This document sets out the proposed scope and methodology for this SuDS Strategy. This SuDS strategy only considers the new permanent areas of impermeable hardstanding associated with the Proposed Project listed above (i.e. the above-ground operational phase components). The sustainable management of surface water during the construction phase will be covered by the contractor's Construction Environmental Management Plan (CEMP) and the construction phase embedded mitigation measures presented in the accompanying Environmental Appraisal (see Chapter 9 Water Resources). Details of the proposed Water Conservation Statement are also outlined in this report.

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 2010 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 100m^2 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). Gwynedd Council (covering the Snowdonia National Park Authority) will be the SAB for the Proposed Project;
- 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);
- Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems (Welsh Government, October 2018);
- Implementation of Schedule 3 to 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).

Therefore, the Proposed Project 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. 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:
  - Level 1: Surface water runoff is collected for use, e.g. rainwater harvesting systems;
  - Level 2: Surface water runoff is infiltrated to ground;
  - Level 3: Surface water runoff is discharged to surface water body;
  - Level 4: Surface water runoff is discharged to surface water sewer, highway drain or another drainage system; and
  - Level 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 – Surface water runoff hydraulic control:
  - Managed to prevent any discharge from site for the majority of rainfall events of <5mm (i.e. for 80% of events in summer and 50% in winter);
  - 1 in 1-year runoff rate controlled to mitigate for impacts from erosion on morphology and the ecology of receiving surface water bodies (i.e. replication of greenfield runoff rates);

  - 1 in 100-year runoff rate and volume controlled to mitigate the impact on flood risk on the receiving watercourse/drainage receptor (i.e. aim for replication of greenfield runoff rates/volumes; betterment of rates of at least 30% for previously developed sites; use of the 1 in 100-year, 6-hour rainfall event is sufficient for design purposes; and if greenfield rates are unachievable use 2 l/s/ha); and
  - 1 in 100-year runoff managed to protect people and property on or adjacent to the site (1 in 30-year standard for roads and access areas; 1 in 100-year standard for property, critical infrastructure and roads; and the inclusion of freeboard).
- Standard S3 – Water Quality:
  - To prevent negative impacts on receiving water quality and/or protect downstream drainage systems (including sewers – with specific regard to oils and sediments).
- Standard S4 – Amenity:
  - Contribution to the development design through high quality visual impact for surface SuDS.
- Standard S5 – Biodiversity:
  - Maximisation of biodiversity benefits.
- Standard S6 – Design of drainage for construction, operation, and maintenance and structural integrity:
  - Designed for easy, safe and cost-effective construction, maintenance and operation and structural integrity (minimum design life equivalent to the design life of the development).

2.2 NATIONAL POLICY

2.2.1 Planning Policy Wales (Edition 10, December 2018)

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 Wales Spatial Plan (2008)

Chapter 12 (Valuing our Environment) recognises the importance of climate change and the impact on communities, working environments, way of life, and health and wellbeing through flood risk issues, with consequences for land use, water resources, biodiversity and wildlife.

2.2.3 TAN 15: Development and Flood Risk (2004)

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 is currently being updated although, at the time of writing, it is not known when the updated document will be made publicly available.

2.3 LOCAL PLANNING POLICY

2.3.1 Anglesey and Gwynedd Joint Local Development Plan

The Anglesey and Gwynedd Joint Local Development Plan was adopted on 31 July 2017.

Strategic Policy PS 5: Sustainable Development relates to reducing the amount of water used and wasted; reducing the effect on water resources and quality; managing flood risk and maximizing use of sustainable drainage schemes; and progressing the objectives of the Western Wales River Basin Water Management Plan.

Strategic Policy PS 6: Alleviating and adapting to the effects of climate change relates to:

- Implementing sustainable water management measures in line with the objectives in the Western Wales River Basin Management Plan;
- Locating development away from flood risk areas, and aiming to reduce the overall risk of flooding within the Plan area and areas outside it, taking account of a 100 years and 75 years of flood risk in terms of the lifetime of residential and non-residential development, respectively, unless it can be clearly demonstrated that there is no risk or that the risk can be managed;
- Being able to withstand the effects of climate change as much as possible because of a development's high standards of sustainable design, location, layout and sustainable building methods (in line with Policy PCYFF 3); and
- Aiming for the highest possible standard in terms of water efficiency and implement other measures to withstand drought, maintain the flow of water and maintain or improve the quality of water, including using sustainable drainage systems (in line with Policy PCYFF 6).

Policy PCYFF 3: Design and Place Shaping, states that for new development drainage systems are to be designed to limit surface water runoff and flood risk and prevent pollution.

Policy PCYFF 6: Water Conservation states that the proposals should incorporate water conservation measures where practicable, including SuDS. All proposals should implement flood minimisation or mitigation measures where possible, to reduce surface water runoff and minimise its contribution to flood risk elsewhere. Proposals greater than 1,000m^2 or 10 dwellings should be accompanied by a Water Conservation Statement. Details of the proposed Water Conservation Statement are outlined in this report.

Policy AMG 4: Coastal Protection states that the development should not cause unacceptable harm to water quality.

2.3.2 Local Flood Risk Management Strategy

The Local Flood Risk Management Strategy was published by Gwynedd Council in February 2013.

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.

Gwynedd Council (covering the Snowdonia National Park Authority) will be the SAB for any SuDS applications associated with the Proposed Project. Gwynedd Council advises the Snowdonia National Park Authority on the likely impact of new development on flood risk.

2.3.3 Eryri Local Development Plan 2016-2031

The revised Eryri Local Development Plan (2016-2031) was adopted by the Snowdonia National Park Authority on the 06 February 2019.

Strategic Policy A: National Park Purposes and Sustainable Development, seeks to ensure that new development promotes the principles of sustainable development in ways which further National Park purposes and duty whilst conserving and enhancing the National Park's 'Special Qualities'. This includes conserving the quality and quantity of natural resources such as water and preventing inappropriate development in areas which are at risk from flooding or which contribute to the risk of flooding.

Development Policy 6: Sustainable Design and Materials, requires all forms of new build development to attain at least the national sustainable building requirements, and to take into consideration biodiversity protection and enhancement and environmental sustainability.

Strategic Policy Dd: Climate Change, relates to ensuring that any flood protection works have no adverse environmental impacts or that they can be satisfactorily mitigated; and conserving and enhancing areas of peatland to assist in carbon retention, water storage and flood prevention.

2.4 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.

2.5 SUDS ASSESSMENT APPROACH

SuDS aim to mimic the natural drainage of a site prior to development, allowing as much water as possible to evaporate, or infiltrate into the ground, close to where it fell, then attenuating and conveying the rest to the nearest watercourse or sewer system to be released at the same rate as (or less than) the runoff from the existing site, thereby preventing any increase in flood risk downstream.

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 Project 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 Project. Reference has been made to the following guidance, where appropriate, to help develop the SuDS Strategy:

- Sustainable Drainage (SuDS) Statutory Guidance (Welsh Government, January 2019);
- Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems (Welsh Government, October 2018);
- Implementation of Schedule 3 to 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);
- Sewers for Adoption – 6th Edition (WRc plc, 2006) and 7th Edition (WRc plc, 2012);

- Relevant Pollution Prevention Guidance notes, including the relevant replacement guidance series: Guidance for Pollution Prevention; and
- DEFRA/Environment Agency Guidance: Rainfall runoff management for developments (Report reference: SC030219, October 2013).

3.0 THE VIP SNOWDONIA PROJECT

3.1 DEVELOPMENT PROPOSALS

3.1.1 Permanent Operational Phase Components (western side of the Dwyryd Estuary)

On the western side of the Dwyryd Estuary, the operational phase of the Proposed Project will introduce the following new areas of permanent impermeable hardstanding:

- Reconfiguration of equipment at the existing Garth SEC;
- A tunnel head house close to National Grid's existing Garth SEC; and
- A short access road to the tunnel head house.

The total area of this new impermeable hardstanding (i.e. roof area, road/parking areas and reconfigured equipment concrete slab areas) is shown in Table 1 below.

Operational Phase Component	Total Impermeable Area (m^2)
Reconfiguration of equipment at the existing Garth SEC	0[1]
Western tunnel head house and car parking	329
Access road to western tunnel head house	198

Table 1. New impermeable areas associated with the permanent operational phase components of the Proposed Project (western side of the Dwyryd Estuary).

3.1.2 Permanent Operational Phase Components (eastern side of the Dwyryd Estuary)

On the eastern side of the Dwyryd Estuary, the operational phase of the Proposed Project will introduce the following new areas of permanent impermeable hardstanding:

- A new SEC near Cilfor (required to connect the new conductor to the replacement terminal tower and onto the existing OHL);
- A tunnel head house located in the same compound as the new SEC; and
- An access road to the new SEC and tunnel head house.

The total area of this new impermeable hardstanding (i.e. roof area, road/parking areas and new SEC equipment concrete slab areas) is shown in Table 2 below.

[1] Whilst the reconfiguration of the existing Garth SEC is a component of the operational phase of the Proposed Project, it is not expected to result in the creation of additional impermeable area.

Operational Phase Component	Total Impermeable Area (m^2)
New SEC near Cilfor, Eastern tunnel head house, and SEC pads	982
Access road to the new SEC and eastern tunnel head house	1369

Table 2. New impermeable areas associated with the permanent operational phase components of the Proposed Project (eastern side of the Dwyryd Estuary).

4.0 BASELINE CONDITIONS

4.1 TOPOGRAPHY

4.1.1 Permanent Operational Phase Components (western side of the Dwyryd Estuary)

Existing ground levels in the area of the western tunnel head house and access road are at ca. 1.89m AOD. Ground levels throughout the existing Garth SEC are at ca. 3.7m AOD.

4.1.2 Permanent Operational Phase Components (eastern side of the Dwyryd Estuary)

Existing ground levels in the area of the new SEC near Cilfor (including the eastern tunnel head house) are at ca. 4.2m AOD. Ground levels along the route of the new access road range between ca. 2.8m to ca. 3.6m AOD.

4.2 GROUND CONDITIONS

4.2.1 Permanent Operational Phase Components (western side of the Dwyryd Estuary)

Cranfield University's Soilscapes website[2] provides high-level information on soil characteristics across the UK and classifies the soil types for these operational phase components as: *"Freely draining acid loamy soils over rock, and Saltmarsh soils (naturally wet)".*

The British Geological Survey's Geology Viewer website[3] describes the bedrock geology and superficial deposits beneath these locations as:

- Bedrock geology: Maentwrog Formation - Mudstone, siltstone and sandstone. Sedimentary bedrock formed between 508 and 485.4 million years ago during the Cambrian period; and
- Superficial deposits: Tidal Flat Deposits - Clay, silt and sand. Sedimentary superficial deposit formed between 11.8 thousand years ago and the present during the Quaternary period.

4.2.2 Permanent Operational Phase Components (eastern side of the Dwyryd Estuary)

Cranfield University's Soilscapes website classifies the soil types for these operational phase components as: *"Freely draining acid loamy soils over rock".*

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

- Bedrock geology: Dol-cyn-afon Formation - Mudstone and siltstone. Sedimentary bedrock formed between 485.4 and 477.7 million years ago during the Ordovician period; and

[2] http://www.landis.org.uk/soilscapes/
[3] https://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html

- Superficial deposits: Alluvium - Clay, silt, sand and gravel. Sedimentary superficial deposit formed between 11.8 thousand years ago and the present during the Quaternary period.

The eastern operational components of the Proposed Project will be constructed in an area where there are widespread active peat deposits. A Peat Depth Survey report is provided in the CEMP in Appendix 2A of the accompanying Environmental Appraisal.

4.3 FLOOD RISK

Some of the operational phase components of the Proposed Project are located in areas of high flood risk. Further details can be found in the Flood Consequences Assessment (FCA) contained within Appendix 9A of the Environmental Appraisal.

4.4 EXISTING DRAINAGE

Ordinary watercourses are located to the north of the existing Garth SEC and to the south of the location of the western tunnel head house and access road, respectively (Appendix A). These watercourses flow east to west into the Afon Glaslyn estuary. On the eastern side of the estuary, the Nant Yr Efail stream flows from northeast to southwest from the Llyn Tecwyn Uchaf reservoir across the location of the proposed SEC near Cilfor and eastern tunnel head house, with numerous drains and issues connecting into the stream across the area and from the north northeast (Appendix A). These are also ordinary watercourses and join the Dwyryd estuary further to the west.

No sewers are present in the vicinity of the existing Garth SEC and western tunnel head house, the nearest being located at Syenite Terrace (foul) and at Osmond (surface water and combined). No sewers are present in the vicinity of the proposed SEC near Cilfor and eastern tunnel head house.

5.0 WATER CONSERVATION STATEMENT

As required by policy PCYFF 6 detailed in Section 2.3.1, a Water Conservation Statement is required to support a planning application for a development over 1,000m^2.

From the onset, the Proposed Project incorporated water conservation measures. These measures include the adoption of SuDS features to manage surface water runoff, rainwater harvesting to re-use rainwater 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 Project. SuDS are adopted in order to manage surface water runoff and as a mean to minimise flood risk by increasing permeable surfaces and storage capacity thus reducing the risk of surface water flood risk. This is presented in further details in Sections 6 and 7.

5.2 RAINWATER HARVESTING

It is intended that a rainwater harvesting tank will be included within the Eastern Tunnel Head House Compound. This rainwater would be used for flushing the WC within the Eastern Tunnel Head House Compound, thus reducing the overall demand for potable water.

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.

These water saving devices will be installed at the Eastern Head House. No washing facilities are currently foreseen at the Western Tunnel Head House however, the above water saving devices could be installed 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 Project. The aim of the appraisal is to assist with discussions to obtain approval from Gwynedd Council (covering the Snowdonia National Park Authority), as Lead Local Flood Authority (LLFA) and 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 3 below.

Table 3. 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 S3 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: Permanent Operational Phase Components (western side of the Dwyryd Estuary)

The permanent operational phase components of the Proposed Project on the western side of the Dwyryd Estuary will be served by a sustainable drainage system that comprises source control and sub-surface storage techniques. The finished surface of the western tunnel head house compound will comprise reinforced grass (Appendix B). This surfacing will be permeable and is required in order to support maintenance vehicle weights of up to five tonnes. Layers of MOT Type 1 and 2 crushed stone aggregate will be incorporated beneath the reinforced grass layer and these layers will be used to create the raised developed platform of the head house compound. The void space contained within these crushed stone layers will also serve to provide the necessary storage for the runoff that infiltrates through the reinforced grass surface layer.

In order to create the developed platform level within the head house compound of 3.0 to 3.2m AOD, the layer of Type 1 and 2 crushed stone aggregate will need to be 1.75m thick. Runoff from the roof of the tunnel head house building and car parking areas will drain to the reinforced grass surface layer and subsequently into the layers of Type 1 and 2 crushed stone aggregate.

To provide additional SuDS measures, the ramped access road into the western compound will be surfaced with reinforced grass/permeable tarmac with a typical ca. 0.5m thick layer of MOT Type 1 and 2 crushed stone aggregate underneath. The void space contained within these crushed stone layers will serve to provide the necessary storage for the runoff that infiltrates through the permeable surface of the access road.

The Flood Estimation Handbook (FEH) Depth-Duration-Frequency (DDF) model was used to determine the design rainfall depth for the Proposed Project. The 1 in 100 year, six-hour duration rainfall depth is 74.50mm. This was uplifted by 40% to allow for climate change over the lifetime of the Proposed Project to create a design rainfall depth of 104.30mm. This rainfall depth was used to calculate the attenuation storage requirement for these elements of the Proposed Project. Table 4 below provides an overview of these calculations, with the full calculations provided in Appendices D and E.

Project Component	Total Impermeable Area (m^2)	1 in 100-year +40% for Climate Change Design Rainfall Depth (mm)	Total Runoff Volume (m^3)	Area of Reinforced Grass/Permeable Road Surface (m^2)	Depth of Type 1 and 2 Crushed Aggregate Layer (m)	Aggregate Layer Assumed Typical Porosity[4]	Total Available Attenuation Storage Volume (m^3)
Western tunnel head house and parking areas	329	104.30	34.31	367	1.75	0.3	193
Access road to western tunnel head house	198	104.30	20.65	198	0.5	0.3	29.7

Table 4. Total runoff and available SuDS storage volumes for the permanent operational phase components of the Proposed Project on the western side of the Dwyryd Estuary – 1 in 100 year + 40% for climate change design event.

[4] Note that Appendices D and E also provide values for 'worst-case' porosity.

Table 4 above demonstrates that the SuDS storage volume available within the crushed aggregate layers is considerably greater than the total runoff generated by these components of the Proposed Project under the design 1 in 100-year (+40% for climate change) event. These calculations are conservative, given that they assume that the discharge rate from the proposed SuDS features will be zero.

It is anticipated that drainage outfalls from the crushed aggregate layers beneath the western tunnel head house compound and access road will be required and that these will discharge to the existing field drainage channel shown in Appendix B. Given that the storage volume available within the crushed aggregate layers will be sufficient to store all runoff generated from these components of the Proposed Project during the design rainfall event, the maximum rate of discharge through these outfalls would not exceed the minimum recommended outflow rate of 5l/s for single points of discharge. Indeed, for most events, it is expected that the rate of discharge would be at – or close to – zero.

The detailed design of the final SuDS scheme and outfall arrangement will be undertaken by the Contractor, although it is recommended that the crushed aggregate layers are lined with an impermeable geomembrane and that the outfalls are fitted with non-return valves to prevent the local water table from occupying the available storage space within the aggregate layers under wet weather conditions.

6.1.2 Proposed SuDS Strategy: Detailed SuDS Plan (West)

A detailed SuDS plan for the permanent operational phase components of the Proposed Project on the western side of the Dwyryd Estuary is included in Appendix H.

6.1.3 Proposed SuDS Strategy: Permanent Operational Phase Components (eastern side of the Dwyryd Estuary)

The permanent operational phase components of the Proposed Project on the eastern side of the Dwyryd Estuary will be served by a sustainable drainage system that comprises source control and sub-surface storage techniques. The finished surface of the new SEC and eastern tunnel head house compound will comprise reinforced grass (this will also apply to the parking spaces within the compound) and crushed stone (Appendix C). This surfacing will be permeable and is required in order to support maintenance vehicle weights of up to five tonnes. Layers of MOT Type 1 and 2 crushed stone aggregate will be incorporated beneath the reinforced grass and crushed stone layer and these layers will be used to create the raised developed platform of the new SEC and head house compound. The void space contained within these crushed stone layers will also serve to provide the necessary storage for the runoff that infiltrates through the reinforced grass and crushed stone surface layers.

In order to create the developed platform level within the new SEC and head house compound of 6.0m AOD, the layer of Type 1 and 2 crushed stone aggregate will need to be up to 4m thick in places (although a thickness of 2m has been assumed here for the purposes of the below calculations). Runoff from the roof of the tunnel head house building, and SEC foundation pads will drain to the reinforced grass and crushed stone surface layers and subsequently into the layers of Type 1 and 2 crushed stone aggregate.

The permanent access road to the new SEC and eastern tunnel head house compound will be a ‘floating-road’ design in order to minimise the impact of its construction on the surrounding peat layers. This new access road will be flanked on either side (or on one side, depending on the crossfall of the final design) by a linear filter drain arrangement comprising crushed stone. The crushed stone within these linear filter drains will provide the necessary attenuation storage to accommodate the runoff from the new road. Discharge from the filter drains will be encouraged to enter the surrounding peat layers in order to help to ensure that these peat layers continue to remain active. The contractor will also ensure that appropriate pollution control measures are incorporated into the detailed design of this new access road (for example light liquid bypass/oil separators in gully pots) in order to capture any

hydrocarbon leaks from vehicles and/or dust/silt from the road surface before it can enter the filter drain system. These interception systems will need to be appropriately maintained over the design lifetime of this new access road.

The Flood Estimation Handbook (FEH) Depth-Duration-Frequency (DDF) model was used to determine the design rainfall depth for the Proposed Project. The 1 in 100 year, six-hour duration rainfall depth is 74.50mm. This was uplifted by 40% to allow for climate change over the lifetime of the Proposed Project to create a design rainfall depth of 104.30mm. This rainfall depth was used to calculate the attenuation storage requirement for these elements of the Proposed Project. Table 5 below provides an overview of these calculations, with the full calculations provided in Appendices F and G.

Project Component	Total Impermeable Area (m^2)	1 in 100-year +40% for Climate Change Design Rainfall Depth (mm)	Total Runoff Volume (m^3)	Area of Reinforced Grass/Crushed Stone/Filter Drain (m^2)[6]	Depth of Type 1 and 2 Crushed Aggregate Layer (m)	Aggregate Layer Typical Assumed Porosity[5]	Total Available Attenuation Storage Volume (m^3)
New SEC near Cilfor/ Eastern tunnel head house/SEC pad foundations	982	104.30	102.42	2839	2	0.3	1703
Access road to the new SEC and eastern tunnel head house	1369	104.30	142.79	600	1	0.3	180[6]

Table 5. Total runoff and available SuDS storage volumes for the permanent operational phase components of the Proposed Project on the eastern side of the Dwyryd Estuary – 1 in 100 year + 40% for climate change design event.

[5] Note that Appendices F and G also provide values for 'worst-case' porosity
[6] Two lateral Filter Drains (one either side of the access road) each with length = 200m, width = 1.5, depth = 1, porosity = 0.3

Table 5 above demonstrates that the SuDS storage volume available within the crushed aggregate layers is considerably greater than the total runoff generated by these components of the Proposed Project under the design 1 in 100-year (+40% for climate change) event. These calculations are conservative, given that they assume that the discharge rate from the proposed SuDS features will be zero.

It is anticipated that drainage outfalls from the crushed aggregate layers beneath the new SEC and eastern tunnel head house compound and access road will be required. The new SEC and eastern tunnel head house compound will discharge to one of the existing (or diverted and reinstated) land drains in the area. Discharge from the filter drains serving the new access road will be encouraged to enter the surrounding peat layers in order to help to ensure that these peat layers continue to remain active. Given that the storage volume available within the crushed aggregate layers will be sufficient to store all runoff generated from these components of the Proposed Project during the design rainfall event, the maximum rate of discharge through these outfalls would not exceed the minimum recommended outflow rate of 5l/s for single points of discharge. Indeed, for most events, it is expected that the rate of discharge would be at – or close to – zero.

The detailed design of the final SuDS scheme and outfall arrangement will be undertaken by the Contractor, although it is recommended that the crushed aggregate layers are lined with an impermeable geomembrane and that the outfalls are fitted with non-return valves to prevent the local water table from occupying the available storage space within the aggregate layers under wet weather conditions.

6.1.4 Proposed SuDS Strategy: Detailed SuDS Plan (East)

A detailed SuDS plan for the permanent operational phase components of the Proposed Project on the eastern side of the Dwyryd Estuary is included in Appendix I.

6.1.5 Proposed SuDS Strategy: Maintenance Plan

The proposed SuDS will be privately managed and maintained by National Grid over the design lifetime of Proposed Project.

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

The runoff from the operational components of the Proposed Project is expected to be clean (i.e. mainly comprising roof runoff). The MOT Type 1 and 2 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 Project. 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 hydrocarbons[7]. This will help to prevent pollution of receiving waterbodies in the event of minor hydrocarbon spills (for example, from leaking maintenance vehicles).

[7] 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.*

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

6.1.7 Proposed SuDS Strategy: Biodiversity and Amenity

The compounds have been designed so that their footprints are as small as possible. Both compounds incorporate 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 landscape around the perimeters of the compounds has been designed to integrate the compounds into the landscape as much as possible and will include new landscaping around their respective perimeters. These landscaped areas will be planted with a mix of native tree, shrub and hedgerow species that will complement the existing environment and provide opportunities for increased biodiversity. The Proposed Project will provide visual amenity enhancements through the removal of existing overhead lines and pylons throughout the in a popular tourist area that lies within Snowdonia National Park and its immediate landscape setting.

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 6 below demonstrates how the SuDS Strategy for the Proposed Project 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 7 below demonstrates how the SuDS Strategy for the Proposed Project complies with these Standards and justifies exception criteria where appropriate.

Table 6 Compliance with SuDS Principles

SuDS Principle	Permanent Operational Phase Components (western side of the Dwyryd Estuary)	Permanent Operational Phase Components (eastern side of the Dwyryd Estuary)
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 Project will comprise tunnel head house and Sealing End compounds, which will remain largely unmanned, with no requirement for non-potable water for operational purposes. No welfare/toilet facilities are proposed for the western head house compound. A small mess room with a sink and flushing toilet will be provided at the eastern head house compound. Rainwater harvesting and re-use techniques for the toilet will be considered as part of the detailed design.	
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 Project 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 Project. 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. Finally, the operational components of the Proposed Project will occupy land that is currently used for livestock grazing. The implementation of the Proposed Project will, therefore, remove a 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.	
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	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 Project during the design 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 not exceed the minimum recommended rate of 5l/s for single discharge points under more extreme events.	

SUDS Principles/Standards review

SuDS Principle	Permanent Operational Phase Components (western side of the Dwyryd Estuary)	Permanent Operational Phase Components (eastern side of the Dwyryd Estuary)
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	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 infiltration/sub-base storage techniques to manage water directly adjacent to the source of runoff. This is the most appropriate SuDS solution given the scale and nature of the Proposed Project.	
7. Maximise the delivery of benefits for amenity and biodiversity	The compounds have been designed so that their footprints are as small as possible. Both compounds incorporate 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 landscape around the perimeters of the compounds has been designed to integrate the compounds into the landscape as much as possible and will include new landscaping around their respective perimeters. These landscaped areas will be planted with a mix of native tree, shrub and hedgerow species that will complement the existing environment and provide opportunities for increased biodiversity. The Proposed Project will provide visual amenity enhancements through the removal of existing overhead lines and pylons throughout the in a popular tourist area that lies within Snowdonia National Park and its immediate landscape setting.	
8. Seek to make the best use of available land through multifunctional usage of public spaces and the public realm	N/A. The permanent above-ground components of the Proposed Project will comprise tunnel head house and Sealing End compounds, which will be operational, electricity assets, that will not be 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	The SuDS Strategy has been designed to operate safely and effectively over the design lifetime of the Proposed Project and will be privately managed and maintained by National Grid.	

SUDS Principles/Standards review

SuDS Principle	Permanent Operational Phase Components (western side of the Dwyryd Estuary)	Permanent Operational Phase Components (eastern side of the Dwyryd Estuary)
taking into account the need for reasonable levels of maintenance		
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 for the eastern head house compound).	
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 Project.	

Table 7 Compliance with SuDS Standards

SuDS Standard	Permanent Operational Phase Components (western side of the Dwyryd Estuary)	Permanent Operational Phase Components (eastern side of the Dwyryd Estuary)
Standard S1 – Surface water runoff destination		
Level 1 - Surface water runoff is collected for use *Exceptions:* – *No foreseeable demand for non-potable water* – *No foreseeable need to harvest water* – *Not a viable/cost effective part of the solution*	N/A: The permanent above-ground components of the Proposed Project will comprise tunnel head house and Sealing End compounds, which will remain largely unmanned, with no requirement for non-potable water for operational purposes. No welfare/toilet facilities are proposed for the western head house compound. A small mess room with a sink and flushing toilet will be provided at the eastern head house compound. Rainwater harvesting and re-use techniques for the toilet will be considered as part of the detailed design.	
Level 2 - Surface water runoff is infiltrated to ground *Exceptions:* – *Not practical due to permeability* – *Would result in ground instability* – *Unacceptable risk of pollution (existing contamination, nearby activities, sensitivity of groundwater or surface waterbody)* – *Unacceptable risk of flooding from groundwater* – *Ingress flow to combined sewer leading to increased risk of flooding or pollution*	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. It is recommended that the MOT Type 1 and 2 crushed stone aggregate sub-base layers are lined with an impermeable geomembrane to prevent the local water table from entering these storage areas during wet weather events. This means that infiltration to ground below these sub-base layers is unlikely to be practicable.	

SUDS Principles/Standards review

SuDS Standard	Permanent Operational Phase Components (western side of the Dwyryd Estuary)	Permanent Operational Phase Components (eastern side of the Dwyryd Estuary)
Level 3 - Surface water runoff is discharged to surface water body *Exceptions:* – *Not reasonably practical (distance, inappropriate/inadequate access, H&S risks, risk from land use along the drainage route)* – *Would require use of pumps* – *Unacceptable increased risk of flooding*	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 Project during the design 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 not exceed the minimum recommended rate of 5l/s for single discharge points under more extreme events. These discharge points are, however, likely to drain to the surface watercourses adjacent to both compounds.	
Level 4 - Surface water runoff is discharged to surface water sewer, highway drain or another drainage system *Exceptions:* – *Not reasonably practical* – *Would require use of pumps* – *Unacceptable increased risk of flooding*	N/A	
Level 5 - Surface water runoff is discharged to combined sewer	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 Project 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 the minimum recommended rate of 5l/s for single discharge points under more extreme events. These discharge points are, however, likely to drain to the surface watercourses adjacent to both compounds.	

SUDS Principles/Standards review

SuDS Standard	Permanent Operational Phase Components (western side of the Dwyryd Estuary)	Permanent Operational Phase Components (eastern side of the Dwyryd Estuary)
Standard S3 – Water Quality	Most of the runoff generated by the Proposed Project 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 Project. 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. Finally, the operational components of the Proposed Project will occupy land that is currently used for livestock grazing. The implementation of the Proposed Project will, therefore, remove a 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.	
Standard S4 – Amenity, and Standard S5 – Biodiversity	The compounds have been designed so that their footprints are as small as possible. Both compounds incorporate 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 landscape around the perimeters of the compounds has been designed to integrate the compounds into the landscape as much as possible and will include new landscaping around their respective perimeters. These landscaped areas will be planted with a mix of native tree, shrub and hedgerow species that will complement the existing environment and provide opportunities for increased biodiversity. The Proposed Project will provide visual amenity enhancements through the removal of existing overhead lines and pylons throughout the in a popular tourist area that lies within Snowdonia National Park and its immediate landscape setting.	
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 Project and will be privately managed and maintained by National Grid.	

8.0 CONCLUSIONS

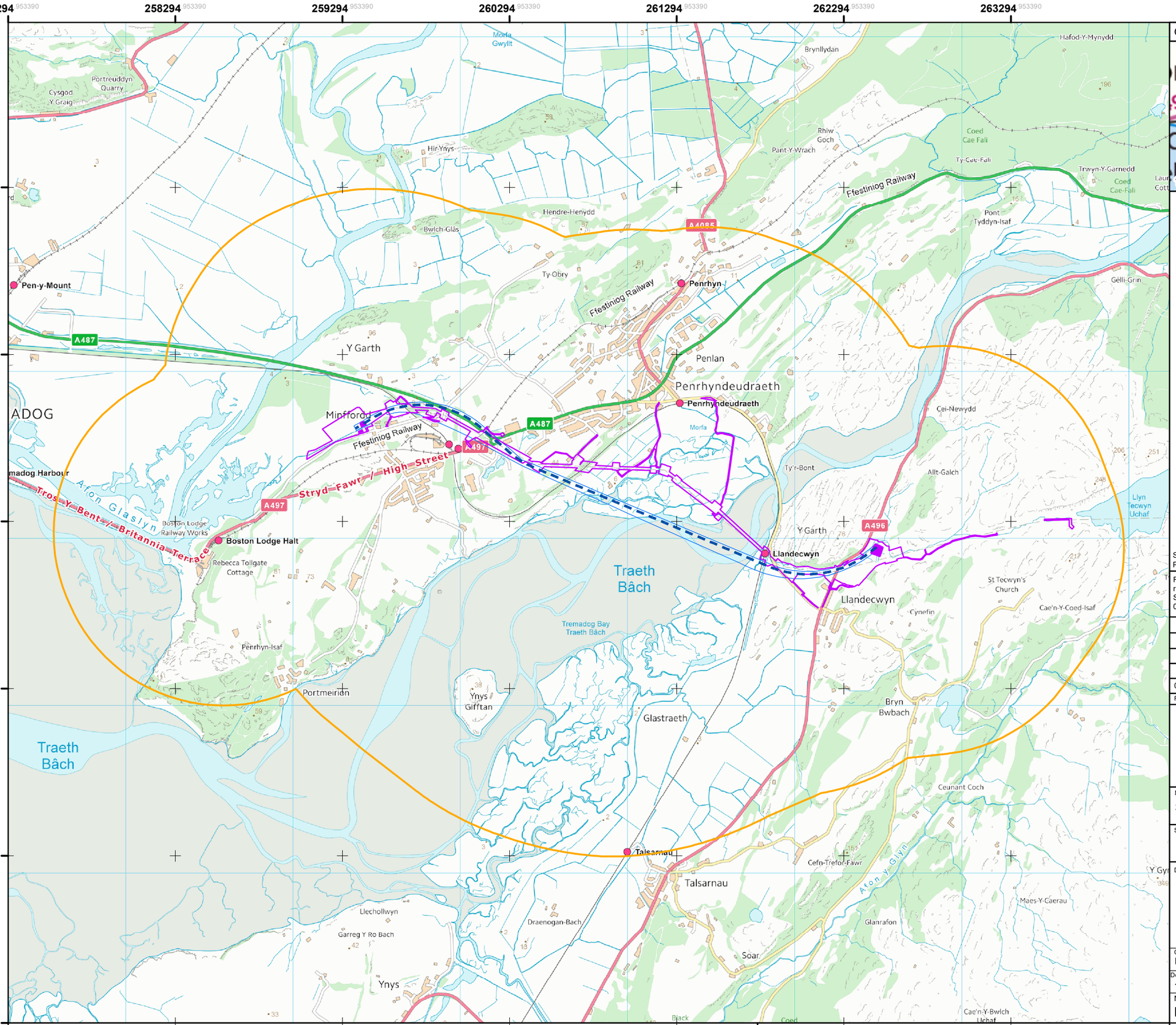
This report presents a Sustainable Drainage Systems (SuDS) Strategy for National Grid's Visual Impact Provision (VIP) Snowdonia Project, which aims to mitigate the visual impact of existing electricity infrastructure within the Snowdonia National Park near Minffordd and to conserve and enhance the natural beauty, wildlife and environmental heritage of the area.

It is intended that this SuDS Strategy will form the initial basis of discussions to obtain approval from Gwynedd Council (covering the Snowdonia National Park Authority), as Lead Local Flood Authority (LLFA) and SuDS Approval Body (SAB), for the proposed SuDS solutions. As such, this SuDS Strategy has been developed to align with the Welsh Statutory SuDS Standards.

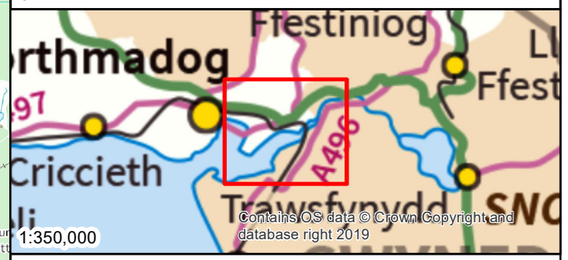
This SuDS strategy involves the use of source control and infiltration/sub-base storage techniques to manage water directly adjacent to the source of runoff. The SuDS Strategy will provide a sufficient volume of attenuation storage to accommodate all of the runoff generated by the new impermeable areas 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 not exceed the minimum recommended rate of 5l/s for single discharge points under more extreme events. This SuDS Strategy also incorporates elements that will help to clean surface water runoff and prevent pollution incidents, and the VIP Snowdonia Project itself will also deliver biodiversity and amenity enhancements.

APPENDICES

Appendix A Site Location Plan



Overview



Proposed Development

- Proposed Tunnel Alignment
- Proposed Tunnel Alignment (inc Limit of Deviation)
- Above Ground Permanent Works
- Site Boundary
- Study Area

Source:
Proposed Development: National Grid November 2019.

Rev	Description	Cre'd	Chk'd	App'd	Date
009	Revised site boundary	LA	JL	KL	03/02/2020

nationalgrid

Master Scheme No:	Sub-Scheme No:	Site:
33495	33495	Snowdonia

Scheme Name:
Visual Impact Provision (VIP) Snowdonia Project

Document Title:

Appendix A: SUDS Strategy Site Location Plan

Created by:	Date:	Checked by:	Date:	Approved by:	Date:
LA	03/02/2020	JL	03/02/2020	KL	03/02/2020

Development Eng:	Document Type:	Scale:	Format:	Sheet(s):	Rev:
-	GIS	1:22,500	A3	1 of 1	001

National Grid Document Number:
PDD-33494-GIS-?

FEED Document Number:
-

Stantec UK

The plan / drawing is for the purpose of the Environmental Impacts Assessment (EIA) and represents the proposed project. The design, scale and layout shown on this plan / drawing are indicative.

0 0.1250.25 0.5 0.75 1 Kilometer

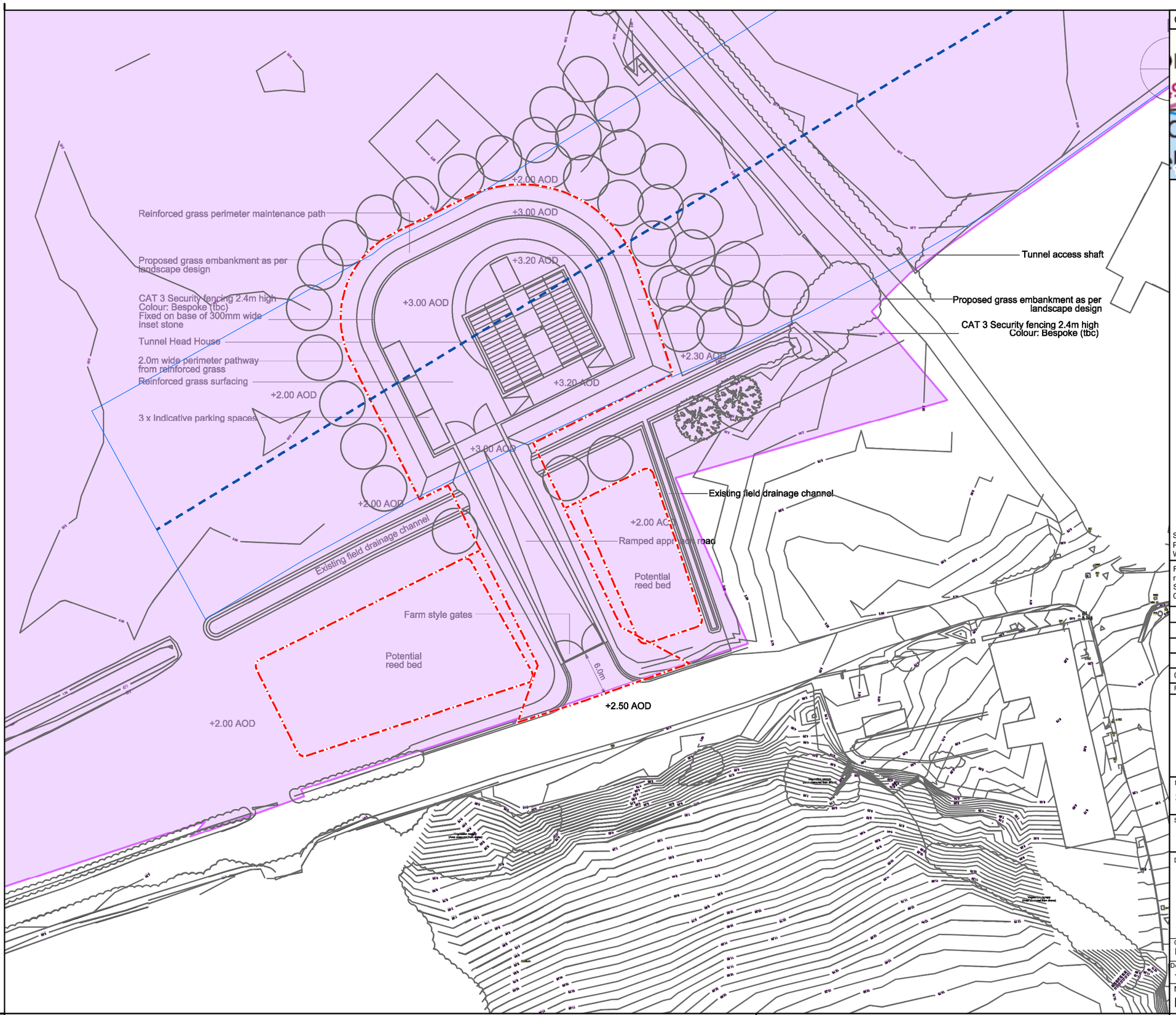
Coordinate System: British National Grid

\\UKRED1S01\Data\Projects\41523774 - National Grid VIP Hydrology\Technical (T)\T5- GIS\Snowdonia\Maps\SuDs\Appendix A - Site Location Plan Feb 2020.mxd

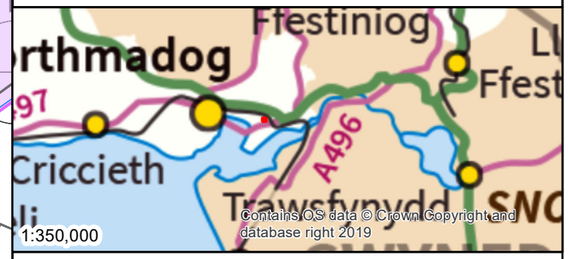
Appendix B Site Layout Plan - West

259352.691661

338594.283820



Overview



Proposed Development

- Proposed Tunnel Alignment
- Proposed Tunnel Alignment (inc Limit of Deviation)
- Site Boundary
- National Grid Ownership Boundary
- West Proposed Site Plan - taken from PDD-33494-ARC-206

Source:
Proposed Development: National Grid November 2019.
West Proposed Site Plan: Taken from PDD-33494-ARC-206.

Rev	Description	Cre'd	Chk'd	App'd	Date
009	Revised site boundary	LA	JL	KL	03/02/2020

nationalgrid

Master Scheme No:	Sub-Scheme No:	Site:
33495	33495	Snowdonia

Scheme Name:
Visual Impact Provision (VIP) Snowdonia Project

Document Title:

Appendix B: SUDS Strategy
Site Layout Plan for Western Head House Compound and Access Road

Created by:	Date:	Checked by:	Date:	Approved by:	Date:
LA	03/02/2020	JL	03/02/2020	KL	03/02/2020

Development Eng:	Document Type:	Scale:	Format:	Sheet(s):	Rev:
-	GIS	1:500	A3	1 of 1	001

National Grid Document Number:
PDD-33494-GIS-?

FEED Document Number:
-

Stantec UK

The plan / drawing is for the purpose of the Environmental Impacts Assessment (EIA) and represents the proposed project. The design, scale and layout shown on this plan / drawing are indicative.

0 5 10 20 Meters

Coordinate System: British National Grid

\\UKRED1S01\Data\Projects\41523774 - National Grid VIP Hydrology\Technical (T)\T5- GIS\Snowdonia\Maps\SuDs\Appendix B - Site Layout Western Head House Compound Feb 2020.mxd

Appendix C Site Layout Plan - East

262433.886176

CAT 3 Security fencing 2.4m high
CAT 2 Security Fence 2.4m high With Additional 1m Electrical Fencing Above
DNO Transformer Compound
CAT 2 Security Fence 2.4m high With Additional 1m Electrical Fencing Above
Retaining Wall
Inset Stone
Reinforced Grass
3.00 AOD +
6 x Indicative parking spaces
Head House
Shaft
+ 6.00 AOD
Proposed Landscaping Banking
Reinforced Grass
Inset stone strip
2.0m wide perimeter pathway from reinforced grass
Existing Wall
+ 6.00 AOD
+ 5.00 AOD
Substation Compound
132kV cable trough
Crushed Stone Surface
Inset stone strip
Section of s
(position no
Existing pyt
(to be remo
CAT 3 Security fencing 2.4m high
Extent of fencing and gates to be removable
CAT 2 Security Fence 2.4m high With Additional 1m Electrical Fencing Above
Proposed Landscaped Banking
Reinforced Grass
Stone Edging
Existing stream (Position not survey
Existing Wall
Existing Public Footpath
Mark Cretan (Stream)
5.8m
10.3m
7.5m
5.0m
8.9m
14.1m
5.4m
18.5m
29.5m
2.0m

Overview

Proposed Development

- Proposed Tunnel Alignment
- Proposed Tunnel Alignment (inc Limit of Deviation)
- Site Boundary
- National Grid Ownership Boundary
- East Proposed Site Plan - taken from PDD-33494-TUN-004E

Source:
Proposed Development:National Grid November 2019.
East Proposed Site Plan: Taken from PDD-33494-TUN-004E.

Rev	Description	Cre'd	Chk'd	App'd	Date
008	Revised site boundary	LA	JL	KL	03/02/2020

nationalgrid

Master Scheme No:	Sub-Scheme No:	Site:
33495	33495	Snowdonia

Scheme Name:
Visual Impact Provision (VIP) Snowdonia Project

Document Title:
Appendix C: SUDS Strategy
Site Layout Plan for Eastern Head House Compound and Access Road

Created by:	Date:	Checked by:	Date:	Approved by:	Date:
LA	03/02/2020	JL	03/02/2020	KL	03/02/2020

Development Eng:	Document Type:	Scale:	Format:	Sheet(s):	Rev:
-	GIS	1:500	A3	1 of 1	001

National Grid Document Number:
PDD-33494-GIS-?

FEED Document Number:
-

337857.675892

Stantec UK

The plan / drawing is for the purpose of the Environmental Impacts Assessment (EIA) and represents the proposed project. The design, scale and layout shown on this plan / drawing are indicative.

0 5 10 20 Meters

Coordinate System:
British National Grid

\\UKRED1S01\Data\Projects\41523774 - National Grid VIP Hydrology\Technical (T)\T5- GIS\Snowdonia\Maps\SuDs\Appendix C - Site Layout East Feb 2020.mxd

Appendix D SuDS Calculations – Western Head house

Snowdonia VIP SuDS Strategy - Appendix D

Date: 04/12/2019
Author: Kelvin Limbrick
Reviewer: Janet Langsford
Location: Western Head House

Rainfall

100-year Return Period, 6-hour duration hyetograph	Obtained from FEH DDF data
Total rainfall depth (mm)	74.5
Total rainfall depth + CC (40%) (mm)	104.30
Total rainfall depth + CC (40%) (m)	0.10

Hardstanding (m^2)

Western Head House and parking areas	329
Total of hardstanding area (m^2)	329

Attenuation volume

Volume to attenuate (m^3)	34.31

MOT Type 1 and 2 granular base dimensions (with reinforced grass surfacing)

Area (m^2)	367
Depth (m)	1.75
Porosity (typical)	0.3
Porosity (worst-case)	0.06

Available volume in sub-base

Available volume in sub-base (typical) (m^3)	193
Available volume in sub-base (worst-case) (m^3)	39

Summary

The available volume in the sub-base is higher than the volume of surface water runoff to attenuate.

Appendix E SuDS Calculations – Western Head house Access Road

Snowdonia VIP SuDS Strategy - Appendix E

Date: 04/12/2019
Author: Kelvin Limbrick
Reviewer: Janet Langsford
Location: Western Head House Access Road

Rainfall

100-year Return Period, 6-hour duration hyetograph	Obtained from FEH DDF data
Total rainfall depth (mm)	74.5
Total rainfall depth + CC (40%) (mm)	104.30
Total rainfall depth + CC (40%) (m)	0.10

Hardstanding (m^2)

Western Head House Access Road	198
Total of hardstanding area (m^2)	198

Attenuation volume

Volume to attenuate (m^3)	20.65

MOT Type 1 and 2 granular base dimensions (with permeable road surfacing)

Area (m^2)	198
Depth (m)	0.5
Porosity	0.3

Available volume in sub-base

Available volume in sub-base (m^3)	29.7

Summary

The available volume in the sub-base is higher than the volume of surface water runoff to attenuate.

Appendix F SuDS Calculations – Cilfor SEC/Eastern Head house

Snowdonia VIP SuDS Strategy - Appendix F

Date: 04/12/2019
Author: Kelvin Limbrick
Reviewer: Janet Langsford
Location: New SEC near Cilfor and Eastern Tunnel Head House

Rainfall

100-year Return Period, 6-hour duration hyetograph	Obtained from FEH DDF data
Total rainfall depth (mm)	74.5
Total rainfall depth + CC (40%) (mm)	104.30
Total rainfall depth + CC (40%) (mm)	0.10

Hardstanding (m^2)

SEC, headhouse and equipment pads	982
Total of hardstanding area (m^2)	982

Attenuation volume

Volume to attenuate (m^3)	102.42

MOT Type 1 and 2 granular base dimensions (with reinforced grass and crushed stone surfacing)

Area (m^2)	2839
Depth (m)	2
Porosity (typical)	0.3
Porosity (worst-case)	0.03

Available volume in sub-base

Available volume in sub-base (typical) (m^3)	1703.4
Available volume in sub-base (worst-case) (m^3)	170.34

Summary

The available volume in the sub-base is higher than the volume of surface water runoff to attenuate.

Appendix G SuDS Calculations – Access Road to Cilfor SEC/Eastern Head house

Snowdonia VIP SuDS Strategy - Appendix G

Date: 04/12/2019
Author: Kelvin Limbrick
Reviewer: Janet Langsford
Location: Permanent Access Road to New SEC near Cilfor and Eastern Tunnel Head House

Rainfall

100-year Return Period, 6-hour duration hyetograph	Obtained from FEH DDF data
Total rainfall depth (mm)	74.5
Total rainfall depth + CC (40%) (mm)	104.30
Total rainfall depth + CC (40%) (m)	0.10

Hardstanding (m^2)

Area of road	1369
Total of hardstanding area (m^2)	1369

Attenuation volume

Volume to attenuate (m^3)	142.79

Lateral Filter Drains

Length	200
Width	1.5
Depth	1
Porosity	0.3

Available volume in sub-base

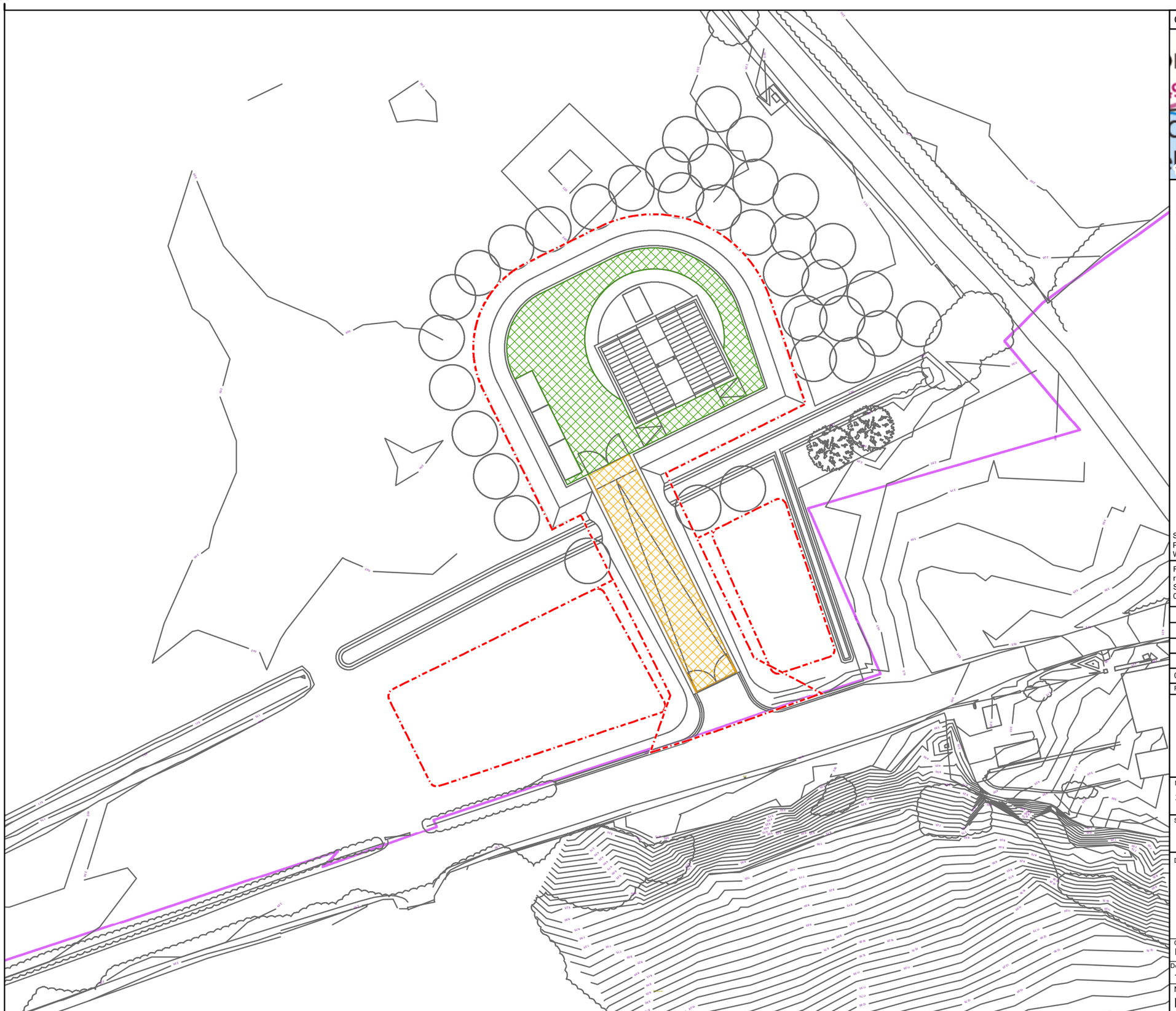
Available volume in sub-base (m^3)	180

Summary

The available volume in the sub-base is higher than the volume of surface water runoff to attenuate.

Appendix H SuDS Plan (West)

259335 120275



Overview

Proposed Development

- Site Boundary
- National Grid Ownership Boundary
- West Proposed Site Plan - taken from PDD-33494-ARC-206

Proposed Surface

- Ramped Approach Road (198.00m^2)
- Reinforced Grass Surfacing (367.00m^2)

Source:
Proposed Development: National Grid November 2019.
West Proposed Site Plan: Taken from PDD-33494-ARC-206.

Rev	Description	Cre'd	Chk'd	App'd	Date
010	Revised site boundary	LA	JL	KL	03/02/2020

nationalgrid

Master Scheme No:	Sub-Scheme No:	Site:
33495	33495	Snowdonia

Scheme Name:
Visual Impact Provision (VIP) Snowdonia Project

Document Title:
Appendix H: SUDS Strategy
SuDS Plan Western Head House Compound and Access Road

Created by:	Date:	Checked by:	Date:	Approved by:	Date:
LA	03/02/2020	JL	03/02/2020	KL	03/02/2020

Development Eng:	Document Type:	Scale:	Format:	Sheet(s):	Rev:
-	GIS	1:500	A3	1 of 1	001

National Grid Document Number:
PDD-33494-GIS-?

FEED Document Number:
-

338598 2339662

Stantec UK

The plan / drawing is for the purpose of the Environmental Impacts Assessment (EIA) and represents the proposed project. The design, scale and layout shown on this plan / drawing are indicative.

0 5 10 20 Meters

Coordinate System:
British National Grid

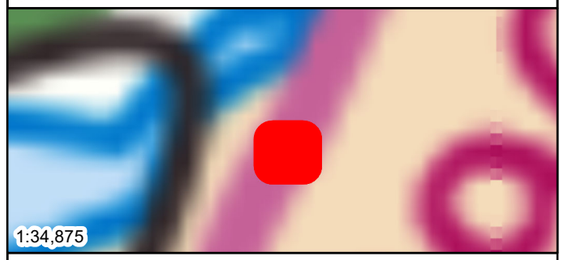
\\UKRED1S01\Data\Projects\41523774 - National Grid VIP Hydrology\Technical (T)\T5- GIS\Snowdonia\Maps\SuDs\Appendix H - SuDS Plan West Feb 2020.mxd

Appendix I SuDS Plan (East)

262417.535842

337859.541116

Overview



Proposed Development

- Proposed Tunnel Alignment (inc Limit of
- Site Boundary
- National Grid Ownership Boundary
- East Proposed Site Plan - taken from PDD-33494-TUN-004E

Proposed Surface

- SEC Infrastructure Concrete Pads (Total Area = 96m^2
- Area of crushed stone and reinforced grass(2839m^2)

Source:
Proposed Development: National Grid November 2019.
East Proposed Site Plan: Taken from PDD-33494-TUN-004E.

Rev	Description	Cre'd	Chk'd	App'd	Date
009	Revised site boundary	LA	JL	KL	03/02/2020

nationalgrid

Master Scheme No:	Sub-Scheme No:	Site:
33495	33495	Snowdonia

Scheme Name:
Visual Impact Provision (VIP) Snowdonia Project

Document Title:

Appendix I: SUDS Strategy
SuDS Plan for Eastern Head House Compound and Access Road

Created by:	Date:	Checked by:	Date:	Approved by:	Date:
LA	03/02/2020	JL	03/02/2020	KL	03/02/2020

Development Eng:	Document Type:	Scale:	Format:	Sheet(s):	Rev:
-	GIS	1:564	A3	1 of 1	001

National Grid Document Number:
PDD-33494-GIS-?

FEED Document Number:
-

Stantec UK

The plan / drawing is for the purpose of the Environmental Impacts Assessment (EIA) and represents the proposed project. The design, scale and layout shown on this plan / drawing are indicative.

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Coordinate System:
British National Grid

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