HORIZON NUCLEAR POWER

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1 Introduction

1.1 Overview

1.1.1 This report provides additional information on the assessment of the operational effects of the A5025 Off-line Highway Improvements on water quality within the receiving water environment, as reported in chapter G8 (surface water and groundwater) (Application Reference Number: 6.7.8).

1.1.2 The assessments of the effects of routine road runoff and accidental spillage risk to receiving watercourses has been undertaken using Highways England's (formally Highways Agency) Water Risk Assessment Tool (HAWRAT). These assessments are as outlined within DMRB Volume 11, Section 3, Part 10, HD 45/09 Road Drainage and the Water Environment [RD1], hereafter referred to as HD 45/09. This guidance is highlighted in chapter B8 (surface water and groundwater) (Application Reference Number: 6.2.8).

1.1.3 The following procedures are discussed within this report:

- Method A – Effects of Routine Runoff on Surface Waters (Simple Assessment);
- Method C – Effects of Routine Runoff on Groundwater; and
- Method D – Pollution Impacts from Accidental Spillages.

1.1.4 Method B (Effects of Routine Runoff on Surface Waters – Detailed Assessment) has not been applied to this assessment. The 'simple' assessment is considered to be of sufficient level of detail to identify the potential impact of routine runoff on surface waters [RD1]. Method B need only be used if Method A indicates high risk.

1.1.5 This report is set out as follows:

- an overview of the proposed sustainable drainage system (SuDS) features is provided in section 2;
- the assessment methodologies and inputs are provided in Section 3;
- the results of the assessments are provided in Section 4; and
- a discussion of the results is provided in Section 5.

2 SuDS for water quality

2.1.1 SuDS are a requirement under Planning Policy Wales (Edition 9) [RD2]. In addition, SuDs and a suitable SuDS 'treatment train' (a logical sequence of SuDS features) are also recommended under the guidance of The SuDS Manual [RD3]. Therefore SuDS have been included within the DMRB Stage 3 process. Three SuDS components are included as part of the proposed scheme: filter drains, land drainage ditches (swales), and retention ponds (wet). These components are proposed in differing combinations, or 'treatment trains', dependent on the varying treatment efficiencies required or site constraints associated with each proposed outfall location. The location of each SuDS features is provided in table G8-2-1-1 below and indicatively shown in figures G8-2-1 to G8-2-4.

Table G8-2-1 Type and location of SuDS features within each section

Section	Catchment	SuDS feature(s)	New outfall	Approximate NGR
1	1	Ditch	Cleifiog Fawr	229748, 379186
1	2	Ditch	Cleifiog Fawr	229750, 379146
1	3	None (over the edge into existing field)	None (unrestricted)	229759, 379210
1	4	Filter drain and swale	Cleifiog Fawr	229758, 379224
1	5	Ditch	Cleifiog Fawr	229752, 379193
1	6	Ditch	Cleifiog Isaf	230145, 379803
3	1	Ditch	Tributary of Afon Llywenan	231793, 381592
3	2	Filter drain and retention pond (Pond A)	Tributary of Afon Llywenan	231789, 381754
3	3	Filter drain and retention pond (Pond B)	Afon Alaw	231806, 382243
3	4	Ditch	Afon Alaw	231765, 382541
3	5	Filter drain and retention pond (Pond C)	Tributary of Tan R'Allt	231550, 383060
3	6	None (over the edge into existing field)	None (unrestricted)	231590, 383401
5	1	None (over the edge into existing field)	None (unrestricted)	231895, 386364
5	2	Filter drain and retention pond (Pond A)	Tributary of Afon Llanrhyddlad	232064, 386838
5	3	Filter drain and	Tributary of	232064, 386838

Section	Catchment	SuDS feature(s)	New outfall	Approximate NGR
		retention pond (Pond A)	Afon Llanrhyddlad	
5	4	Filter drain and retention pond (Pond B)	Tan-y-bryn	231640, 386544
5	5	None (over the edge into new ditch)	Tan-y-bryn outside study area)	231611, 386821
5	6	Filter drain and retention pond (Pond C)	East Drain	231839, 387168
5	7	None (over the edge into existing road drainage)	None	231608, 387197
7	1	Retention pond (Pond A)	Afon Cafnan	233936, 390053
7	2	None (over the edge into new ditch)	Nant Llygeirian	233871, 389795
7	3	Retention pond (Pond B)	Afon Cafnan	234103, 390394
7	4	Retention pond (Pond C)	Afon Cafnan	234090, 390634

2.1.2 The treatment performances of these features, as detailed in Section 3 'Treatment Efficiency Calculations', will be dependent on their correct design and maintenance, as detailed below.

2.1 Filter drains

2.1.1 Filter drains are trenches alongside the carriageway that are filled with a permeable material or media that are designed to filter, temporarily detain, and then convey runoff or allow infiltration. At the base of the trench there is a perforated pipe, which conveys runoff downstream. Filter drains can remove pollutants by:

- directly filtering out sediments, hydrocarbons and heavy metals;
- encouraging adsorption (adhesion of pollutants to the surface of the filter media);
- biodegradation (biological breakdown of pollutants by organisms that develop within the filter media); and
- volatilisation (conversion of pollutants to a gas (predominantly hydrocarbons)).

2.1.2 The filter drains would be lined to prevent infiltration due to the need to contain pollutants in the event of an accidental spillage, therefore reduction in pollutant concentrations will be achieved through filtration, adsorption,

biodegradation and volatilisation processes within the filter media only. The minimum depth of the filter media to ensure reasonable treatment is 500mm.

2.1.3 Filter drains should not be used for drainage during the construction phase as untreated runoff is likely to contain large amounts of fine sediment, debris and other pollutants. This would cause rapid clogging and sub-optimal treatment during the operational phase.

2.1.4 The filter drains would require regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities. Treatment performance is detailed in Section 3 and is dependent on correct design, maintenance, and commitment to a management programme.

2.1.5 Further detail on the maintenance of filter drains can be found in The SuDS Manual C753 [RD3].

2.2 Land drainage ditches (swales)

2.2.1 Swales are shallow, flat-bottomed, vegetated open channels designed to convey, treat and attenuate surface water runoff. Swales can often replace conventional drainage by providing the following benefits:

- facilitate sedimentation;
- facilitate filtration through the root zone and soil matrix;
- facilitate infiltration into the underlying soil;
- facilitate evapotranspiration;
- provide aesthetic and biodiversity benefits; and
- allow ease of maintenance and visibility of blockages etc.

2.2.2 Swales can be enhanced to provide additional treatment through a filter bed of prepared soil overlying an underdrain system or inclusion of wetland planting at the base. The proposed design of the swale within Section 1 of the A5025 Off-line highway improvements is to be confirmed at the detailed design stage.

2.3 Retention ponds (wet)

2.3.1 Retention ponds (wet) are depressions that include a permanent volume of water and are designed to temporarily attenuate and treat runoff. The permanent volume of water enables:

- the establishment of aquatic vegetation;
- settlement of suspended sediments and other pollutants;
- filtration through aquatic vegetation;
- adsorption (adhesion of pollutants to sediment within the pond);

- biodegradation (biological breakdown of pollutants by organisms that develop within the permanent pool, within and around aquatic vegetation, biofilms and within sediments);
- precipitation (condensation of dissolved pollutants into solids);
- uptake of pollutants by plants and biofilms; and
- nitrification (biological oxidation, particularly of ammonia, by bacteria).

2.3.2 To maximise treatment efficiency, retention ponds (wet) should include a forebay, occupying a minimum of 10% of the total pond area, separated by a permeable berm to allow for trapping of sediment within a more manageable area and reducing sedimentation within the remainder of the pond.

2.3.3 Planting aquatic vegetation within and across the retention pond is required to enhance treatment and ensure polluted runoff does not bypass treatment areas. Planting vegetation zones increases filtration, biodegradation and uptake of pollutants by plants. Planting can also be used to create separate treatment areas and to encourage the development of biofilms (algae, bacteria and other microorganisms) that further enhance treatment.

2.3.4 The retention ponds (wet) should be designed to enable inflows to distribute across the width of the pond, with inlets and outlets placed to maximise flow path length. The retention pond should also increase in depth to avoid remobilisation of sediments close to the outlet during high flow events.

2.3.5 The retention ponds (wet) will require maintenance to ensure continuing operation to design performance standards. All designers should provide detailed specifications and frequencies for the required maintenance activities.

3 Methodology

3.1 HAWRAT routine runoff assessment on surface waters

3.1.1 Method A of DMRB HD 45/09 [RD1], developed using HAWRAT, is a desktop exercise to assess the magnitude of potential short-term impacts of routine runoff on surface waters and the long term annual average concentrations. Method B of DMRB HD 45/09 [RD1], is a more detailed approach to assess the risk of pollution to surface waters. It builds on Method A by using information collected from site surveys. Method B need only be used if Method A indicates high risk.

3.1.2 Runoff Specific Thresholds (RSTs) have been devised by the Highways England and the Environment Agency (NRW has not separately developed any thresholds). Two thresholds have been developed to protect aquatic ecology in watercourses, which relate to the intermittent nature of road runoff (i.e. contaminants washed off the road surface in a rainfall event):

- a typical exposure period of six hours (RSTs 6 hour); and
- a worst-case scenario of 24 hours (RSTs 24 hour).

3.1.3 Dissolved copper (Cu) and dissolved zinc (Zn) are used as indicators of the level of impact, as they can result in particularly acute toxic effects to aquatic life at certain concentrations. Table G8-2-2 summarises the RSTs for dissolved Cu and dissolved Zn used within HAWRAT [RD1].

Table G8-2-2 RSTs for short-term exposure

		Zn (µg/l) Hardness		
Threshold	**Cu (µg/l)**	**Low (<50mg CaCO3/l)**	**Medium (50 – 200mg CaCO3/l)**	**High (>200mg CaCO3/l)**
RSTs 24 hour	21	60	92	385
RSTs 6 hour	42	120	182	770

3.1.4 RSTs are short-term only and are designed to be used alongside Environmental Quality Standards (EQS), adopted as part of the Water Framework Directive, that represent ecological thresholds for long-term water quality. A HAWRAT ‘pass’ or ‘fail’ for RSTs is determined through a calculation of the number of exceedances per year. Table G8-2-3 shows the number of exceedances used to determine a HAWRAT ‘pass’ [RD1].

Table G8-2-3 Number of exceedances per year required to achieve a HAWRAT 'pass'

	Not within 1km of protected site		Within 1km of protected site	
Metal	**RST 24**	**RST 6**	**RST 24**	**RST 6**
Dissolved Cu	<2	<1	<1	<0.5
Dissolved Zn	<2	<1	<1	<0.5

3.1.5 HAWRAT estimates in-river annual average concentrations for dissolved Cu and dissolved Zn that can be compared to adopted EQS as detailed in The SuDS Manual [RD3] and shown in table G8-2-4.

Table G8-2-4 EQS for dissolved Cu and Zn in surface water

Metal	Annual mean bioavailable concentration (µg/l)
Cu	6 (50 – 100 mg/l $CaCO_3$)
Zn	50 (50 – 100 mg/l $CaCO_3$)

3.1.6 HAWRAT calculates concentrations for total dissolved Cu and Zn, and in the absence of long-term water quality data, a comparison is made for exceedance against EQS for bioavailable Cu and Zn.

3.1.7 HAWRAT uses a three step approach to assessing the impacts of both soluble and sediment-bound pollutants and determines whether the drainage system would 'pass' or 'fail' (or 'alert') in terms of water quality in the receiving water features during operation. The three step approach is as follows:

- Step 1: calculate pollutant concentrations in highway runoff (before mixing in SuDS feature).
- Step 2: calculate pollutant concentrations in SuDS feature after mixing has taken place (accounts for pollutant dilution and dispersal capacity in water feature).
- Step 3: consider the effectiveness of the proposed treatment systems at mitigating pollutant concentrations.

3.1.8 Step 2 and Step 3 are only applied if Step 1 results in a fail.

3.1.9 Steps 2 and 3 contain two tiers of assessment for sediment accumulation: Tier 1 is a simple assessment requiring only an estimate of the river width, whilst Tier 2 is a more detailed assessment which requires further watercourse parameters including roughness, bed gradient, side slopes and channel width. Tier 2 assessments are only undertaken where outfalls fail for sediment impacts under Tier 1.

3.1.10 Where outfalls are located along the same watercourse and within 100m (for dissolved/soluble pollutants only and sediment-bound pollutants) or 1km (dissolved/soluble pollutants only) of one another, a cumulative assessment is undertaken.

3.1.11 An alert is given for outfalls that would otherwise pass the assessment for sediment-bound pollutants, were it not for the following features being present downstream:

- a protected site within 1km of the point of discharge; or
- a structure, lake or pond within 100m of the point of discharge.

3.1.12 In both cases, the alert indicates the need for further consideration of the proposed outfall and the agreement of appropriate settlement measures with the 'Overseeing Organisation'.

Treatment efficiency calculations

3.1.13 The proposed drainage strategy includes two variants of SuDS treatment train, comprising:

- Treatment train 1: filter drain and swale; and
- Treatment train 2: filter drain and retention pond (wet).

3.1.14 The selection of specific SuDS components has been undertaken based on the primary functions and capabilities of those components (e.g. pre-treatment, conveyance, source control, site control and regional control). The treatment efficiencies discussed below are indicative and subject to the correct design and maintenance of each component (refer to Section 2).

3.1.15 Values for the indicative treatment performance data of various SuDS components are provided in table 26.13 of The SuDS Manual [RD3]. This table includes a range of average pollutant inflow concentrations from urban surfaces and average outflow concentrations after treatment by various SuDS components.

3.1.16 The adopted pollutant removal values for the removal of total suspended solids (TSS) by swales and retention ponds (wet) are based on the average percentage removal derived from the inflow and outflow concentrations provided in table 26.13 of the SuDS Manual [RD3]. Table G8-2-5 shows how the treatment efficiency has been derived from table 26.13.

Table G8-2-5 Derivation of treatment efficiency for TSS

	Concentration range TSS (25%ile – 75%ile) (mg/l)	Mean value TSS (mg/l)
Inflow from urban surface	20 - 114	67
Swale*	10 - 43	27
Outflow from retention pond (wet)**	4 - 28	16

* % of mean inflow concentration remaining after treatment by swale = 27 / 67 x 100 = 40%, thus removal efficiency = 100% - 40% = 60%

** % of mean inflow concentration remaining after treatment by retention pond (wet) = 16 / 67 x 100 = 24%, thus removal efficiency = 100% - 24% = 76%

3.1.17 Table 26.13 of The SuDS Manual [RD3] also gives values for total Cu and total Zn; however, these values are not appropriate to use for soluble removal efficiencies. Instead, the removal efficiencies for dissolved Cu and Zn have been based on pre-defined removal rates quoted in the DMRB Volume 4, Section 2, Part 3 Design of Highway Drainage Systems HD 33/16 [RD4], hereafter referred to as HD 33/16.

3.1.18 The SuDS Manual [RD3] does not include performance values for filter drains or ditches; consequently, the DMRB HD 33/16 [RD4] values have also been used for filter drains and ditches for TSS, dissolved Cu and dissolved Zn.

3.1.19 The SuDS Manual [RD3] does include performance values for oil separators; however, the DMRB HD 33/16 [RD4] states that oil separators can only be chosen for treating oils and must not be relied upon to treat suspended solids or dissolved metals. Oil separators have therefore not been included in the SuDS treatment trains for the purpose of this HAWRAT assessment.

3.1.20 The subsequent removal efficiencies derived for each individual SuDS component are provided in table G8-2-6.

Table G8-2-6 Removal efficiencies of individual SuDS components

Treatment system type	Removal efficiency (%)		
	Dissolved Cu	Dissolved Zn	TSS
Filter drain	0	45	60
Ditch	15	15	25
Swale	50	50	60
Retention pond (wet)	40	30	76

3.1.21 The overall treatment efficiencies of the two treatment train components are shown in the following section. The SuDS Manual [RD3] guidance advises that a factor of 0.5 is applied to the treatment efficiency of a secondary treatment component, as the treatment performance of a secondary level of treatment is reduced due to already reduced pollutant concentrations in the inflow. This has been accounted for in all treatment efficiency calculations and is presented below. This reduction factor is only applied where the primary level of treatment has a treatment efficiency. For instance, filter drains have 0% treatment efficiency for dissolved Cu, therefore a 0.5 reduction factor would not be applied to the secondary level of treatment.

3.1.22 The values shown in bold text have been used in the Step 3 routine runoff assessments.

Treatment of copper

- Treatment train 1: 100% x (1 – 0.5) = 50% of dissolved Cu remaining, therefore the treatment efficiency is **50%**.

- Treatment train 2: 100% x (1 – 0.4) = 60% of dissolved Cu remaining, therefore the treatment efficiency is **40%**.

Treatment of zinc

- Treatment train 1: 100% x (1 – 0.45) x (1 – 0.25) = 41% of dissolved Zn remaining, therefore the treatment efficiency is **59%**.
- Treatment train 2: 100% x (1 – 0.45) x (1 – 0.15) = 47% of dissolved Zn remaining, therefore the treatment efficiency is **53%**.

3.1.23 As the treatment removal rates for dissolved Cu and Zn are different, Step 3 of the HAWRAT assessment has been performed twice. In the first instance, to reflect the varying removal of dissolved Cu, a soluble removal rate of 50% for treatment train 1 and 20% for treatment train 2 has been applied. In the second instance, to reflect the varying removal of dissolved Zn, a soluble removal rate of 59% for treatment train 1 and 53% for treatment train 2 has been applied.

Calculation for settlement of total suspended solids

- Treatment train 1: 100% x (1 – 0.6) x (1 – 0.3) = 28% of sediment remaining, therefore the treatment efficiency is **72%**.
- Treatment train 2: 100% x (1 – 0.6) x (1 – 0.38) = 25% of sediment remaining, therefore the treatment efficiency is **75%**.

3.1.24 Table G8-2-7 shows the different pollutant removal efficiencies for TSS, dissolved Cu and dissolved Zn for treatment trains 1 and 2.

Table G8-2-7 Treatment trains 1 and 2 – summary of pollutant removal efficiencies

Drainage system	Treatment efficiency (%)		
	Dissolved Cu	Dissolved Zn	TSS
Treatment train 1			
Filter drain	0	45	60
Swale	50	25*	30*
Total system	*50*	*59*	*72*
Treatment train 2			
Filter drain	0	45	60
Retention pond (wet)	40	15*	38*
Total system	*40*	*53*	*75*

*0.5 x treatment performance as indicated in The SuDS Manual (C753)

3.1.25 Input parameters (both generic to all outfalls and specific to individual outfalls) and data sources used within the assessments are presented in tables G8-2-8 and G8-2-9.

Table G8-2-8 Generic user parameters applied to all outfalls

Parameter	Units	Default value	Value used	Notes/sources
Annual Average Daily Traffic (AADT)	Vehicles per day (vpd)	>10,000 and <50,000	>10,000 and <50,000	Source: Jacobs' traffic modelling team. Note: Design year 2033
Climatic region	-	Warm dry	Colder wet	Source: HAWRAT Help v1.0
Rainfall site	-	Ashford (SAAR 710mm)	Colwyn Bay (SAAR 788.1mm)	Source: HAWRAT Help v1.0
Hardness	$CaCO_3$ mg/l	Low = <50mg $CaCO_3$/l	Medium = 50 - 200mg $CaCO_3$/l	Worst-case Dŵr Cymru Welsh Water online water quality data

Table G8-2-9 Information sources

Parameter	Notes/sources
95%ile River flow (m^3/s)	Source: National River Flow Archive gauge data for the nearest gauged catchment (102001 Cefni at Bodffordd). This catchment has similar topographical and geological characteristics to scheme catchments so the Q95%ile for Cefni was pro-rated to approximate the Q95%ile for scheme catchments.
Baseflow Index (BFI)	Source: Used the same BFI as the Cefni catchment.
Impermeable road area drained (ha)	Source: AECOM Design Fix 5
Permeable area draining to outfall (ha)	Source: AECOM Design Fix 5
Within 1km upstream of a protected site?	Source: Project Mapper (GIS of route)
Is there a structure <100m downstream that reduces the velocity?	Source: topographical surveys
Estimated river width at Q95 (m)	Source: topographical surveys
Tier 2 Bed width (m)	Not applicable
Tier 2 Side slope (m/m)	Not applicable
Tier 2 Long slope (m/m)	Not applicable
Tier 2 Manning's n	Not applicable
Existing treatment of soluble substances (%)	Precautionary approach to assume no existing treatment.
Existing attenuation – restricted discharge rate (%)	
Existing settlement of sediments (%)	
Proposed treatment of soluble substances	Sources: The SuDS Manual (C753) table 26.13 – Performance of SuDS

Parameter	Notes/sources
(%)	components in reducing urban runoff contamination [RD3] and DMRB HD 33/16 table 8.1 – Indicative Treatment Efficiencies of Drainage Systems [RD4]
Proposed attenuation – restricted discharge rate (l/s) to QBAR	Source: AECOM Design Fix 5
Proposed settlement of sediments (%)	Sources: The SuDS Manual (C753) table 26.13 – Performance of SuDS components in reducing urban runoff contamination [RD3] and DMRB HD 33/16 table 8.1 – Indicative Treatment Efficiencies of Drainage Systems [RD4]

3.1.26 Details of the proposed outfalls, assessment point locations, proposed treatment trains and input parameters used in the HAWRAT routine runoff assessment are presented in appendix G8-2-1. Where cumulative assessments have been undertaken, the most downstream outfall location has been selected.

Limitations

3.1.27 HAWRAT is primarily designed for the assessment of major trunk roads and motorways with relatively high traffic levels, such that the minimum traffic banding available within HAWRAT is '>10,000 and <50,000' vehicles per day (vpd). Calculations by the Jacobs traffic modelling team have predicted traffic flows of <10,000vpd, which is below the lower end of the HAWRAT traffic banding. Therefore, pollution loading calculated by the HAWRAT tool is likely to be higher than the actual pollution loading generated by the proposed scheme. This makes the assessment very conservative.

3.1.28 Where the Q95%ile is less than 0.002m^3/s, HAWRAT considers the watercourse to be a soakaway as the flow is too low to allow sufficient conveyance as a watercourse. The tool recommends that Method C is instead applied. The Q95%ile values used in this assessment have been pro-rated from the neatest gauged catchment and, whilst considered to be appropriate for this assessment, they are not accurate representations of the actual Q95%ile of each individual catchment. Method A has been applied as a sense check, as well as application of Method C.

3.1.29 Downstream structures have not been independently surveyed on site, therefore a worst case scenario has been assumed for all structures, whereby they are assumed to reduce the velocity of the watercourse.

3.1.30 The drainage proposals include silt traps prior to some outfalls. Silt traps are not considered to be a SuDS feature and any treatment efficiency could not be accounted for within the HAWRAT. Therefore the HAWRAT results assume the absence of silt traps. This makes the assessment very conservative for locations where silt traps are used.

3.1.31 HAWRAT is an indicative assessment tool only, and a HAWRAT 'pass' or 'fail' is not intended to be rigid. Further water quality assessments may need

to be undertaken during the detailed design stage, in consultation with NRW, to ensure adequate protection of the water environment.

3.2 Routine runoff assessment on groundwater

3.2.1 Method C of DMRB HD 45/09 [RD1] is a matrix assessment tool used to assess the risk of routine runoff to groundwater. The assessment is based on an examination of the 'Source-Pathway-Receptor protocol' (S-P-R) used in risk assessment procedures developed and supported by the Environment Agency's tool for contaminated land evaluation. This principle may be readily applied to the disposal of road drainage whereby the:

- source comprises road drainage;
- pathway is represented by the drainage system; and
- receptor is the groundwater.

3.2.2 There are a number of input components that relate to site-specific road and drainage conditions, as summarised in tables G8-2-10 and G8-2-11.

Table G8-2-10 Generic user parameters applied to all outfalls

Source parameter	Units	Value used	Notes/data sources
AADT	vpd	>10,000 and <50,000	Source: Jacobs' traffic modelling team.
Rainfall volume	mm	788.1	Source: Colwyn Bay SAAR in HAWRAT Help v1.0
Rainfall intensity (1 hr)	mm/hr	62.7	Source: AECOM Design Fix 5
Soakaway geometry	-	Continuous linear ditch	Source: AECOM Design Fix 5

Table G8-2-11 Information sources

Pathway parameter	Notes/data sources
Unsaturated zone	Source: Ground Investigation data [RD5, RD6, RD7 and RD8]
Flow type	
Effective grain size	
Lithology	

3.2.3 Each component is given a risk rating (1 for low, 2 for medium or 3 for high) based on a defined range of values. The matrix acknowledges that individual components may have a greater or lesser influence on the magnitude of the risk to groundwater. To recognise this, weighting factors have been applied to each component. The matrix is shown below in table G8-2-12.

Table G8-2-12 Method C groundwater matrix risk assessment tool

Property or parameter	Low risk (Score 1)	Medium risk (Score 2)	High risk (Score 3)	Weighting factor
AADT	<50,000vpd	>50,000 to <100,000vpd	>100,000vpd	15
Rainfall volume	<740mm	740 - 1060	>1060	15
Rainfall intensity	Even (<35 mm FEH one hour rainfall)	Uneven (35-47 mm FEH one hour rainfall)	Concentrated (>47 mm FEH one hour rainfall)	
Soakaway geometry	Continuous linear (e.g. ditch, grassed channel)	Single point, or shallow soakaway (e.g. (lagoon) serving low road area	Single point, deep serving high road area (>5,000 m2)	15
Unsaturated zone	Depth to water table >15 m and unproductive strata	Depth to water table <15 to >5m	Depth to water table <5m	20
Flow type	Unconsolidated or non-fractured consolidated deposits (i.e. dominantly intergranular flow)	Consolidated deposits (i.e. mixed fracture and intergranular flow)	Heavily consolidated sedimentary deposits, igneous and metamorphic rocks (dominated by fracture porosity)	20
Effective grain size	Fine sand and below	Coarse sand	Very coarse sand and above	7.5
Lithology	>15% clay minerals	<5% to >1% clay minerals	<1% clay minerals	7.5

3.2.4 For each site, the risk rating is multiplied by the weighting factor to provide an overall risk score. The lowest possible score is 100 whilst the highest possible score is 300. Higher scores indicate a greater risk to groundwater and should be used to determine whether or not a direct discharge is appropriate or some form of attenuation mechanism should be provided to either break the S-P-R linkage or control the pollutant loading being discharged to ground.

3.2.5 The overall risk scores and associated magnitude of impact are summarised in table G8-2-13.

Table G8-2-13 Method C groundwater risk assessment matrix scores

Overall risk score	Risk of impact
<150	Low
150 - 250	Medium
>250	High

3.2.6 Details of the proposed outfalls, assessment point locations and input parameters used in the groundwater risk assessment matrix are presented in appendix G8-2-1. Where cumulative assessments have been undertaken, the most downstream outfall location has been.

Limitations

3.2.7 The risk assessment matrix has been developed using professional judgement and provides an indicative assessment of the risk to groundwater. Further water quality assessments may need to be undertaken during the detailed design stage, in consultation with NRW, to ensure adequate protection of the water environment.

3.3 Accidental spillage assessment

3.3.1 Method D of DMRB HD 45/09 [RD1] has been designed to calculate spillage risk during operation of the road and the associated probability of a serious pollution incident. The risk is calculated assuming that an accident involving spillage of pollutants onto the carriageway would occur at an assumed frequency (expressed as annual probabilities) based on calculated traffic volumes; the percentage of that traffic volume that is considered a Heavy Goods Vehicle (HGV); and the type of road/junction. The annual probability of a serious accidental spillage leading to a serious pollution incident is also dependent upon the response time of the emergency services. A risk factor is applied depending on the location and likely response time, and the type and sensitivity of the receiving water feature.

3.3.2 The risk factors applicable to the A5025 Off-line Highway Improvements are provided in table G8-2-14. As the A5025 is classified as a rural trunk road with a response time of >20minutes and <one hour, the probability factor for a serious accidental spillage leading to a serious pollution incident of surface waters was taken as 0.6 from table D1.1 of DMRB HD 45/09 [RD4].

Table G8-2-14 Risk factors for serious accidental spillages per billion HGV (km/year)

Junction type	Rural trunk road
No junction	0.29
Side road	0.93
Roundabout	3.09

Note: Risk factor applies to all road lengths within 100m of these junction types.

3.3.3 The probability of a serious accidental spillage was calculated as follows:

PSPL= RL x SS x (AADT x 365 x 10-9) x (%HGV ÷ 100)

Where:

- PSPL = probability of a serious accidental spillage in one year over a given road length;
- RL = road length in km;
- SS = risk factors serious spillage rates from table G8-2-13;
- AADT = Annual Average Daily Traffic; and
- %HGV = percentage of Heavy Goods Vehicles.

3.3.4 The probability that a spillage will cause a pollution incident is calculated thus:

PINC = PSPL x PPOL

Where:

- PINC = the probability that a spillage will cause a pollution incident; and
- PPOL = the risk reduction factor, dependent upon emergency services response times, which determines the probability of a serious spillage leading to a serious pollution incident of surface waters (factor of 0.6 applied to the A5025 Off-line Highway Improvements).

3.3.5 In line with DMRB HD 45/09 [RD1], where a serious pollution incident is calculated as less than the 1% Annual Exceedance Probability (AEP) (i.e. less frequent than one in 100 years), the spillage falls within acceptable limits and no further spillage prevention measures are required. Where assessed to be greater than the 1% AEP (i.e. more frequent than one in 100 years), the risk is unacceptable and mitigation will be required to reduce the risk of an impact occurring.

3.3.6 Higher levels of protection are afforded where road runoff discharges within close proximity (i.e. within 1km) to designated wetlands or designated conservation sites protected by EU or UK legislation, including Special Areas of Conservation or Sites of Special Scientific Interest (SSSI); or could affect public or private water supplies (or other important abstractions). In these cases, it is more appropriate to achieve a spillage risk of less than the 0.5% AEP (i.e. less frequent than one in 200 years). Where assessed to be greater than the 0.5% AEP (i.e. more frequent than one in 200 years), the risk is unacceptable and mitigation will be required to reduce the risk of an impact occurring.

4 Results

4.1 HAWRAT routine runoff assessment on surface waters

4.1.1 The results of the routine runoff assessment on surface waters are contained in appendix G8-2-2. Within these tables, a traffic light system has been used to aid interpretation: green shading indicates a HAWRAT 'pass', orange shading indicates HAWRAT 'alert', and red shading indicates HAWRAT 'fail'.

Section 1 - Valley

4.1.2 All outfalls fail at Step 1 (in highway runoff prior to mixing in the SuDS features).

4.1.3 At Step 2 (in river, pre-mitigation), all five independently assessed outfalls passed the HAWRAT routine runoff assessment with respect to dissolved/soluble pollutants. Four of the outfalls registered an alert for sediment-bound pollutants due to the presence of downstream structures within 100m of the outfall. These structures are culverts conveying the watercourse beneath field access tracks. One outfall (S1 C5) failed sediment-bound pollutants.

4.1.4 At Step 3 (in river, post-mitigation), all five outfalls passed the routine runoff assessment with respect to dissolved/soluble pollutants. One of the outfalls (S1 C6) passed the routine runoff assessment with respect to sediment-bound pollutants, with four registering an alert. There were no exceedances of the EQS for dissolved Cu and dissolved Zn for individual outfalls.

4.1.5 Two cumulative assessments have been undertaken. At Step 2, one cumulative assessment (including sediments) passed for dissolved/soluble pollutants but failed for sediment-bound pollutants due to the presence of a downstream structure within 100m of the outfall. At Step 3, the sediment-bound pollutants register an alert. There were no exceedances of the EQS for dissolved Cu and dissolved Zn for this combined outfall.

4.1.6 The second cumulative assessment (for dissolved/soluble pollutants only) passed at both Step 2 and Step 3. At Step 2, there were no exceedances of the EQS for dissolved Cu or dissolved Zn.

Section 3 - Llanfachraeth

4.1.7 All outfalls fail at Step 1 (in highway runoff prior to mixing in the SuDS features).

4.1.8 At Step 2 (in river, pre-mitigation), all three independently assessed outfalls passed the routine runoff assessment with respect to dissolved/soluble pollutants and sediment-bound pollutants. All three outfalls registered an alert for sediment-bound pollutants due the proximity to the Alaw SSSI and downstream culvert structures.

4.1.9 At Step 3 (in river, post-mitigation), all three outfalls passed the routine runoff assessment with respect to both dissolved/soluble pollutants. All three outfalls registered an alert for sediment-bound pollutants. There were no exceedances of the EQS for dissolved Cu and dissolved Zn.

4.1.10 The cumulative assessment (for dissolved/soluble pollutants only) passed both Step 2 and Step 3. There were no exceedances of the EQS for dissolved Cu and dissolved Zn.

Section 5 - Llanfaethlu

4.1.11 All outfalls fail at Step 1 (in highway runoff prior to mixing in the SuDS features).

4.1.12 At Step 2 (in river, pre-mitigation), all three independently assessed outfalls passed the routine runoff assessment with respect to dissolved/soluble pollutants. The results of the sediment-bound pollutants registered two passes (S5 C3 and S5 C4) and one fail (S5 C6).

4.1.13 At Step 3 (in river, post-mitigation), all three outfalls passed both the routine runoff assessment with respect to both dissolved/soluble pollutants and sediment-bound pollutants. There were no exceedances of the EQS for dissolved Cu and dissolved Zn.

4.1.14 The cumulative assessment (for dissolved/soluble pollutants only) passed both Step 2 and Step 3. There were no exceedances of the EQS for dissolved Cu and dissolved Zn.

Section 7 - Cefn Coch

4.1.15 All outfalls fail at Step 1 (in highway runoff prior to mixing in the SuDS features).

4.1.16 At Step 2 (in river, pre-mitigation), all three independently assessed outfalls pass the HAWRAT routine runoff assessment with respect to dissolved/soluble pollutants. Two of the outfalls passed sediment-bound pollutants whilst one outfall failed (S7 C3).

4.1.17 At Step 3 (in river, post-mitigation), all three outfalls passed the routine runoff assessment with respect to both dissolved/soluble pollutants and sediment-bound pollutants. There were no exceedances of the EQS for dissolved Cu and dissolved Zn.

4.1.18 The cumulative assessment (for dissolved/soluble pollutants only) passed both Step 2 and Step 3. There were no exceedances of the EQS for dissolved Cu and dissolved Zn.

4.2 Routine runoff assessment on groundwater

4.2.1 The results of the routine runoff assessment on groundwater are contained in appendix G8-2-3. Within these tables, a traffic light system has been used to aid interpretation: green shading indicates a ‘low risk of impact’; orange

shading indicates a 'medium risk of impact'; and red shading indicates a 'high risk of impact'.

Section 1 - Valley

4.2.2 The three outfalls assessed as soakaways have a weighted score of 170, which translates to a medium risk of impact. This is mainly due to the shallow depth to groundwater and heavily consolidated deposits, which have been given a risk score of three and have the largest weighting factor. Heavily consolidated deposits limit interaction between migrating fluids and the soil and rock materials, encourages bypass flows (which offer more direct pathways to underlying groundwater) and increase the rate of advance of pollutants. However, as stated in chapter G7 (soils and geology) (Application Reference Number: 6.7.7) groundwater was not considered a sensitive receptor within the Section 1 risk assessment.

4.2.3 A sensitivity analysis of each outfall was undertaken, whereby the parameters outlined in table G8-2-11 were given a high risk score. This resulted in an increased weighted score for each outfall; however, the score remained within the medium risk banding.

Section 3 - Llanfachraeth

4.2.4 None of the outfalls have been assessed as soakaways as watercourse flow is sufficient.

Section 5 - Llanfaethlu

4.2.5 The three outfalls assessed as soakaways have a weighted score of between 170 and 225, all of which translate to a medium risk of impact. This is due mainly to the shallow depth to groundwater. However, as stated in chapter G7 (Application Reference Number: 6.7.7), the site investigation did not identify significant linkages to groundwater based on the site being underlain by predominantly unproductive strata (glacial till) and a Secondary B aquifer (bedrock).

4.2.6 A sensitivity analysis of each outfall was undertaken, whereby the parameters outlined in table G8-2-10 were a given high risk score. This resulted in an increased weighted score for each outfall; however, the score remained within the medium risk banding.

Section 7 - Cefn Coch

4.2.7 None of the outfalls have been assessed as soakaways as watercourse flow is sufficient.

4.3 Accidental spillage assessment

4.3.1 The results of the accidental spillage assessment for individual outfalls and for outfalls discharging to the same watercourse are contained in appendix G8-2-4. Within these tables, a simple colour coded system has been used to aid interpretation. Green shading indicates that the probability of a

spillage is below the 0.5% AEP, whilst red shading indicates that the probability of a spillage is above 0.5% AEP.

Section 1 - Valley

4.3.2 The annual probability of a serious pollution incident occurring within each highway catchment draining to an individual outfall, and cumulatively draining to Cleifiog Fawr, has been estimated to be far below 0.5% AEP. The magnitude of impact is therefore negligible.

4.3.3 A sensitivity analysis of each outfall was undertaken, whereby the highest risk factor in table G8-2-13 (a roundabout) was applied. This resulted in an increased probability of a serious pollution incident occurring at each outfall; however, the score remained well below 0.5% AEP so indicated no change in risk category for the worst case scenario.

Section 3 - Llanfachraeth

4.3.4 The annual probability of a serious pollution incident occurring within each highway catchment draining to an individual outfall, and cumulatively draining to the Afon Alaw has been estimated to be far below 0.5% AEP. The magnitude of impact is therefore negligible.

4.3.5 There are no roundabouts in Section 5; however, the sensitivity analysis applied the risk factor from a roundabout in order to assess the worst case. This resulted in an increased probability of a serious pollution incident occurring at each outfall; however, the score remained well below 0.5% AEP and so indicated no change in risk category for the worst case scenario.

Section 5 - Llanfaethlu

4.3.6 The annual probability of a serious pollution incident occurring within each highway catchment draining to an individual outfall, and cumulatively draining to Hen-shop Drain has been estimated to be far below 0.5% AEP. The magnitude of impact is therefore negligible.

4.3.7 There are no roundabouts in Section 5; however, the sensitivity analysis applied the risk factor from a roundabout in order to assess the worst case. This resulted in an increased probability of a serious pollution incident occurring at each outfall; however, the score remained well below 0.5% AEP and so indicated no change in risk category for the worst case scenario.

Section 7 - Cefn Coch

4.3.8 The annual probability of a serious pollution incident occurring within each highway catchment draining to an individual outfall, and cumulatively draining to the Afon Cafnan has been estimated to be far below 0.5% AEP. The magnitude of impact is therefore negligible.

4.3.9 There are no roundabouts in Section 5; however, the sensitivity analysis applied the risk factor from a roundabout in order to assess the worst case. This resulted in an increased probability of a serious pollution incident

occurring at each outfall; however, the score remained well below 0.5% AEP and so indicated no change in risk category for the worst case scenario.

5 Summary

5.1 HAWRAT routine runoff assessment

Section 1 - Valley

5.1.2 At Step 3 (in river, post-mitigation), the cumulative assessment registered an alert mainly due to a downstream culvert, which could restrict conveyance of sediments. However, the drainage proposals include a silt trap prior to the outfall to Cleifiog Fawr. The silt trap has not been accounted for in the HAWRAT. Subject to detailed design, inclusion of the silt trap will therefore reduce the amount of sediment and its potential risk to surface waters. In addition, the drainage design indicates that a 100m section of the existing ditch to which the three drainage outfalls are to be cleaned and re-profiled. On this basis the magnitude of impact is considered to be small. There are no exceedances of EQS.

Section 3 - Llanfachraeth

5.1.3 At Step 3 (in river, post-mitigation) all three outfalls registered a pass for dissolved/soluble pollutants but registered an alert for sediment-bound pollutants when assessed independently. This is due to the presence of the Alaw transitional water body and SSSI downstream of the outfalls. When assessed cumulatively, all outfalls passed. There are no exceedances of EQS. Overall, the magnitude of impact is considered to be negligible.

Section 5 - Llanfaethlu and Section 7 - Cefn Coch

5.1.4 At Step 3 (in river, post-mitigation) the three outfalls in each section registered a pass for dissolved/soluble pollutants and sediment-bound pollutants when assessed independently and cumulatively. There are no exceedances of EQS. Overall, the magnitude of impact is considered to be negligible.

5.2 Routine runoff assessment on groundwater

Section 1 - Valley and Section 5 - Llanfaethlu

5.2.2 The three outfalls in each section assessed as soakaways were estimated to have a medium risk of impact on groundwater. This is due mainly to the shallow depth to groundwater and heavily consolidated deposits. However, as stated in chapter G7 (Application Reference Number: 6.7.7) the site investigation did not identify significant linkages to groundwater, therefore the magnitude of impact is instead considered to be small.

Section 3 – Llanfachraeth and Section 7 - Cefn Coch

5.2.3 None of the outfalls have been assessed as soakaways as watercourse flow is sufficient, therefore the magnitude of impact is negligible.

5.3 Accidental spillage assessment

5.3.1 The annual probability of a serious pollution incident occurring on all four sections of road has been estimated to be far below the 0.5% AEP event. The magnitude of impact on receiving surface waters for all four sections is therefore negligible.

6 References

Table G8-2-15 Schedule of references

ID	Reference
RD1	Highways Agency, Scottish Government, Welsh Assembly Government and The Department for Regional Development Northern Ireland, 2009. *Design Manual for Roads and Bridges, Volume 11, Section 3, Part 10, HD 45/09 Road Drainage and the Water Environment.* [pdf] [Accessed May 2017]. Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol11/section3/hd4509.pdf.
RD2	Welsh Government, 2016. *Planning Policy Wales (Edition 9).* [pdf] [Accessed May 2017]. Available at: http://gov.wales/docs/desh/publications/161117planning-policy-wales-edition-9-en.pdf
RD3	Construction Industry Research and Information Association (CIRIA), 2015. *C753 The SuDS Manual*. London.
RD4	Highways England, Transport Scotland, Welsh Government and Department for Infrastructure, 2016. *Design Manual for Roads and Bridges, Volume 4, Section 2, Part 3*, HD 33/16 Design of Highway Drainage Systems. [pdf] [Accessed May 2017]. Available at: http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol4/section2/hd3316.pdf.
RD5	Structural Soils, 2016. *Factual Report on Ground Investigation, Site 1 – Junction 3 A55 Valley Improvements*, 730168 Site 1.
RD6	Structural Soils, 2016. *Factual Report on Ground Investigation, Site 2 – Llanfachraeth Improvements*, 730168 Site 2.
RD7	Structural Soils, 2016. *Factual Report on Ground Investigation, Site 3 – Llanfaethlu Improvements*, 730168 Site 3.
RD8	Structural Soils, 2016. *Factual Report on Ground Investigation, Site 4 – Cefn Coch Bend Improvements*, 730168 Site 4.

Figures

FIGURE G8-02-1

Cleifiog Fawr

Catchment 01 to kerb drains and into new ditches at the top of the embankment

Catchment 03 to drain over the edge into an existing ditch

None (over the edge into existing field)

Filter drain and swale

Ditch

Ditch

Ditch

Catchment 04 to drain into a filter drain and discharge into a swale that outfalls into an existing ditch

Catchment 06 to drain the carriageway run-off over the edge and into a new ditch that also drains the existing surface water run-off from the surrounding area into an existing ditch via a culvert beneth the highway

Ditch

Catchment 05 to drain the carriageway run-off over the edge and into a new ditch that also drains the existing surface water run-off from the surrounding area into an existing ditch via a culvert beneth the highway

Catchment 02 to drain part of the roundabout and the existing surface water run-off from the surrounding area into an existing ditch via a culvert benethe the highway

Cleifiog Fawr

Legend

- A5025 Off-line Highway Improvements (Section 1)
- Catchment 1
- Catchment 2
- Catchment 3
- Catchment 4
- Catchment 5
- Catchment 6
- Catchment 7
- Watercources
- Road drainage
- SuDS and outfall

Note: the catchments relate to sections of the road that drain through various SuDS features to the road drainage outfall

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	AUG 17	Initial Issue	RM	RA	SH	RB

Client: HORIZON NUCLEAR POWER

Project: WYLFA NEWYDD PROJECT
ENVIRONMENTAL STATEMENT

Drawing Title: DRAINAGE FEATURES IN SECTION 1

Scale @ A3	1:3,000	DO NOT SCALE
Jacobs No.	60PO8077	
Client No.		

Drawing No. 60PO8077_DCO_G_APP_08_02_01

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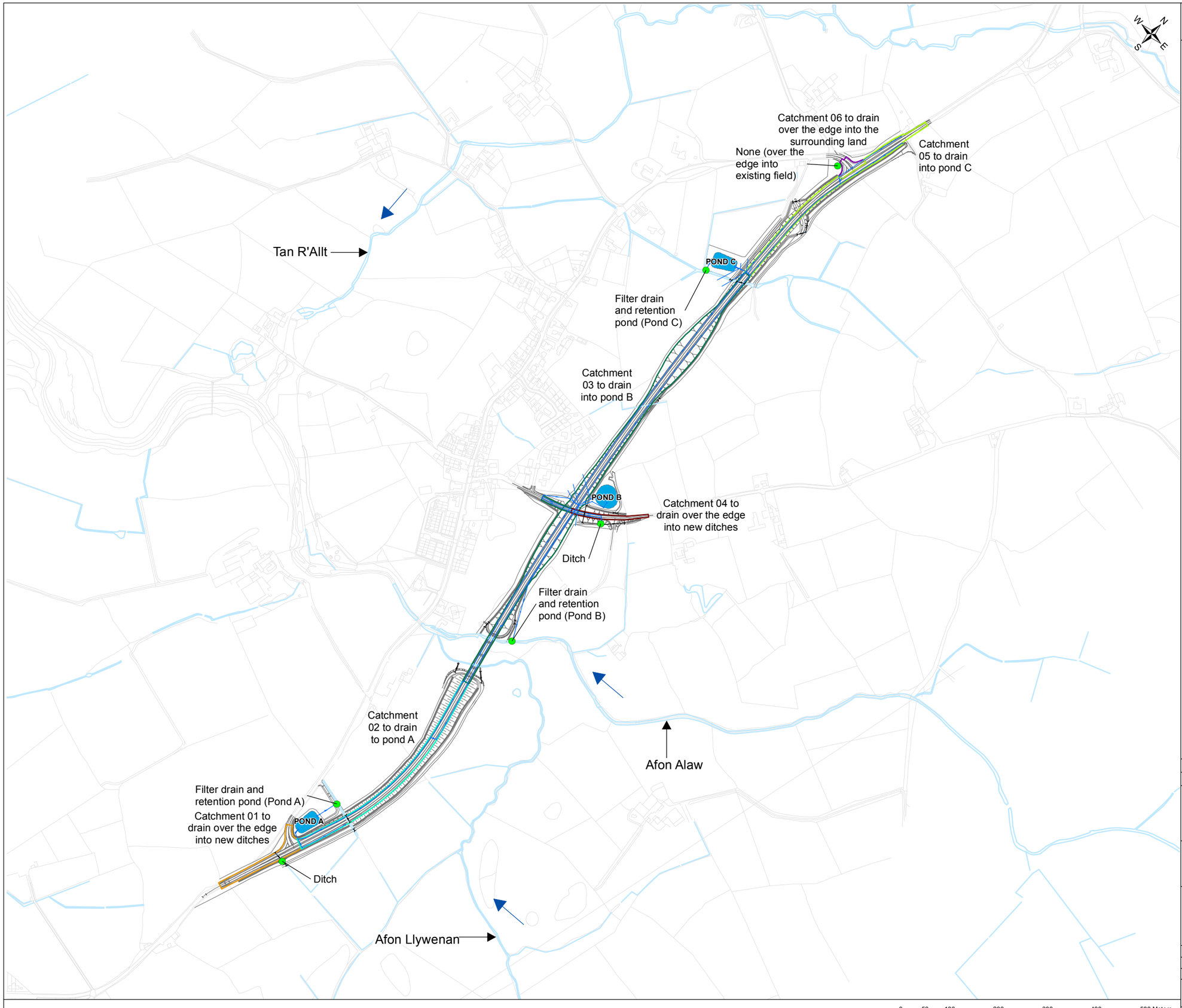
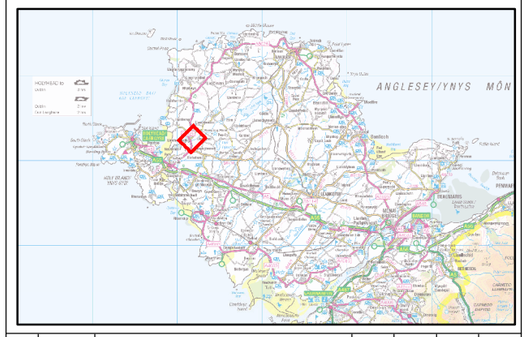
FIGURE G8-02-2



Legend

- A5025 Off-line Highway Improvements (Section 3)
- Catchment 1
- Catchment 2
- Catchment 3
- Catchment 4
- Catchment 5
- Catchment 6
- Catchment 7
- Culverts
- Watercourses
- Road drainage
- Ponds
- SuDS and outfall

Note: the catchments relate to sections of the road that drain through various SuDS features to the road drainage outfall



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	AUG 17	Initial Issue	RM	RA	SH	RB

Client: HORIZON NUCLEAR POWER

Project: WYLFA NEWYDD PROJECT
ENVIRONMENTAL STATEMENT

Drawing Title: DRAINAGE FEATURES IN SECTION 3

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Client No.		

Drawing No. 60PO8077_DCO_G_APP_08_02_02

FIGURE G8-02-3

None (over the edge into existing road drainage)

Catchment 07 to drain over the edge into existing A5025 drainage where possible

East Drain

Catchment 06 to drain into pond C - some new field drainage ditches to be drained into pond C

Catchment 05 to drain pver the edge into new ditches

Hen-shop ar drain tion pond (Pond C)

POND C

None (over the edge into new ditch)

Afon Llanrhyddlad

Filter drain and retention pond (Pond B)

Catchment 04 to drain into pond B

POND B

Catchment 02 to drain into pond A

POND A

Catchment 03 to drain into pond A

None (over the edge into existing field)

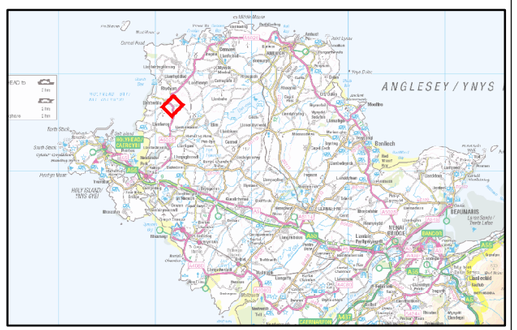
Filter drain and retention pond (Pond A)

Catchment 01 to drain over the edge into new ditches

Legend

- A5025 Off-line Highway Improvements (Section 5)
- Catchment 1
- Catchment 2
- Catchment 3
- Catchment 4
- Catchment 5
- Catchment 6
- Catchment 7
- Culverts
- Watercourses
- Road drainage
- Ponds
- SuDS and outfall

Note: the catchments relate to sections of the road that drain through various SuDS features to the road drainage outfall



0 50 100 200 300 400 500 Metres

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	AUG 17	Initial Issue	RM	RA	SH	RB

Client: HORIZON NUCLEAR POWER

Project: WYLFA NEWYDD PROJECT
ENVIRONMENTAL STATEMENT

Drawing Title: DRAINAGE FEATURES IN SECTION 5

Scale @ A3	1:5,000	DO NOT SCALE
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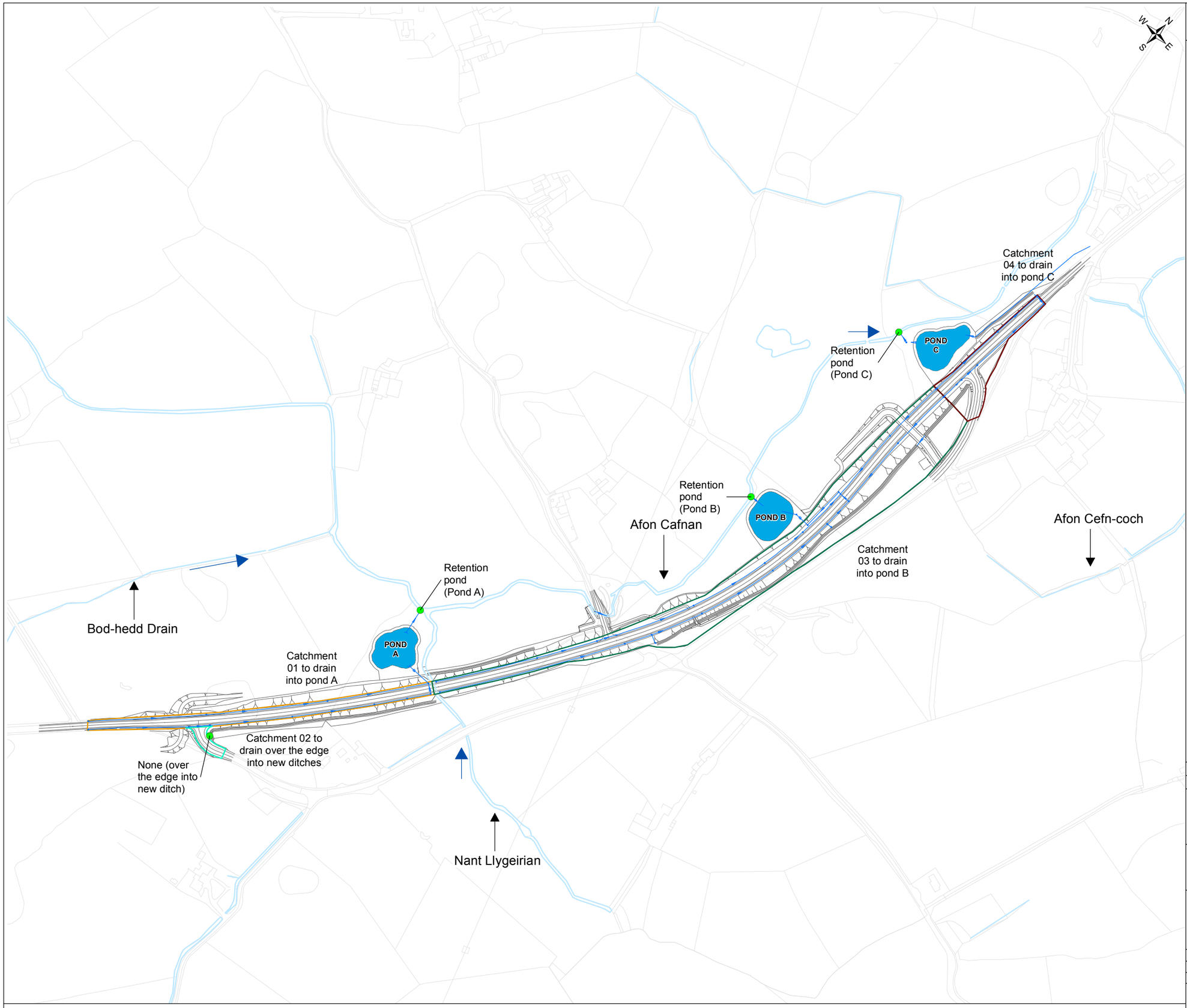
Client No.		

Drawing No. 60PO8077_DCO_G_APP_08_02_03

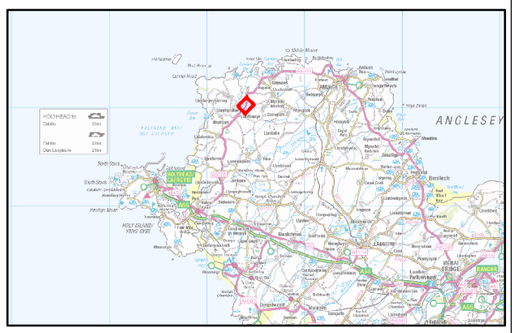
FIGURE G8-02-4



Legend

- A5025 Off-line Highway Improvements (Section 7)
- Catchment 1
- Catchment 2
- Catchment 3
- Catchment 4
- Catchment 5
- Catchment 6
- Catchment 7
- Watercourses
- Road drainage
- Ponds
- SuDS and outfall

Note: the catchments relate to sections of the road that drain through various SuDS features to the road drainage outfall



0 25 50 100 150 200 250 Metres

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	AUG 17	Initial Issue	RM	RA	SH	RB

Client: HORIZON NUCLEAR POWER

Project: WYLFA NEWYDD PROJECT
ENVIRONMENTAL STATEMENT

Drawing Title: DRAINAGE FEATURES IN SECTION 7

Scale @ A3	1:4,000	DO NOT SCALE
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Client No.		

Drawing No. 60PO8077_DCO_G_APP_08_02_04

Appendix G8-2-1 A5025 Off-line highway improvements – HAWRAT input parameters

Appendix G8-2.1 – A5025 Off-line Highway Improvements – HAWRAT input parameters

Parameter	Default Value	Section 1					Section 3			Section 5			Section 7		
		Catchment 1	Catchment 2	Catchment 4	Catchment 5	Catchment 6	Catchment 2	Catchment 3	Catchment 5	Catchment 3	Catchment 4	Catchment 6	Catchment 1	Catchment 3	Catchment 4
		Ditch	Ditch	Filter Drain + Swale	Ditch	Ditch	Filter Drain + Pond A	Filter Drain + Pond B	Filter Drain + Pond C	Filter Drain + Pond A	Filter Drain + Pond B	Filter Drain + Pond C	Pond A	Pond B	Pond C
Easting of outfall	-	229748	229752	229760	229915	230145	231787	231805	231549	232060	231640	231837	233936	234101	234091
Northing of outfall	-	379185	379194	379224	379577	379803	381754	382244	383061	386837	386544	387167	390053	390394	390634
Receiving watercourse		Cleifiog Fawr	Cleifiog Fawr	Cleifiog Fawr	Cleifiog Fawr	Cleifiog Isaf	Afon Llywenan	Afon Alaw	Tan R'Alt tributary	Afon Llanrhyddlad	Tan-y-bryn	Afon Llanrhyddlad	Afon Cafnan	Afon Cafnan	Afon Cafnan
Step 1: Runoff Quality															
Two Way AADT broad group	-	>10000 to <50000	>10000 to <50000	>10000 to <50000	>10000 to <50000	>10000 to <50000	>10000 to <50000	>10000 to <50000	>10000 to <50000	>10000 to <50000	>10000 to <50000	>10000 to <50000	>10000 to <50000	>10000 to <50000	>10000 to <50000
Climatic Region	-	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay
Rainfall Site	-	Colder wet	Colder wet	Colder wet	Colder wet	Colder wet	Colder wet	Colder wet	Colder wet	Colder wet	Colder wet	Colder wet	Colder wet	Colder wet	Colder wet
Step 2: In-River Impacts (Tier 1)															
95%ile River Flow (m^3/s)	0	0.001	0.001	0.001	0.002	0.002	0.008	0.052	0.019	0.001	0.000	0.001	0.003	0.003	0.003
Baseflow Index (BFI)	0.5	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Impermeable road area drained (ha)	1	0.1719	0.03255	0.4553	0.6576	0.3067	0.4557	1.0438	0.1930	0.2223	0.1907	0.5949	0.3862	0.8346	0.2954
Permeable area draining to outfall (ha)	1	0.0143	0.0088	0.0525	3.944	0.7125	0.2450	0.2538	0.1038	0.1199	0.1434	0.3462	0.1500	0.6874	0.2026
Water Hardness	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Within 1km upstream of a protected site?	No	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No	No	No
Downstream structure that reduces the velocity <100m?	No	Yes	Yes	Yes	Yes	No	Yes	No	No	No	Yes	No	No	No	No
Use Tier 1	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Use Tier 2	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Estimated river width at Q95 (m)	5	1.5	1.5	3	2.5	1	2.5	4.0	2.5	1.0	1.0	1.0	2.5	1.0	3.0
Step 3: Mitigation															
Tier 2 Bed width (m)	3														
Tier 2 Side slope (m/m)	0.5														
Tier 2 Long slope (m/m)	0.0001														
Tier 2 Manning's n	0.07														
Existing treatment of solubles (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Existing attenuation – restricted discharge rate (%)	Unlimited (U/L)	U/L	U/L	U/L	U/L	U/L	U/L	U/L	U/L	U/L	U/L	U/L	U/L	U/L	U/L
Existing settlement of sediments (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Proposed treatment of Copper (%)	0	15	15	50	15	15	40	40	40	40	40	40	40	40	40
Proposed treatment of Zinc (%)	0	15	15	59	15	15	53	53	53	53	53	53	30	30	30
Proposed attenuation – restricted discharge rate (l/s)	0	0	0	1.6	0	0	3.5	13	3.4	1.7	4.8	4.2	2.7	7.6	2.5
Proposed settlement of sediments (%)	Unlimited	25	25	72	25	25	75	75	75	75	75	75	76	76	76

Parameter	Section 1		Section 3	Section 5	Section 7
	C1 + C2 + C3 + C4 (inc sediments)	C1 + C2 + C3 + C4 + C5 (exc sediments)	C2 + C3 (exc sediments)	C3 + C6 (exc sediments)	C3 + C4 (exc sediments)
Easting of outfall	229760	229760	231805	232060	234091
Northing of outfall	379224	379224	382244	386837	390634
Receiving watercourse	Cleifiog Fawr	Cleifiog Fawr	Afon Alaw	Afon Llanrhyddlad	Afon Cafnan
Step 1: Runoff Quality					
Two Way AADT broad group	>10000 to <50000	>10000 to <50001	>10000 to <50001	>10000 to <50001	>10000 to <50001
Climatic Region	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay	Colywn Bay
Rainfall Site	Colder wet	Colder wet	Colder wet	Colder wet	Colder wet
Step 2: In-River Impacts (Tier 1)					
95%ile River Flow (m^3/s)	0.001	0.001	0.052	0.001	0.003
Baseflow Index (BFI)	0.45	0.45	0.45	0.45	0.45
Impermeable road area drained (ha)	0.8548	1.5124	1.4995	0.8172	1.1300
Permeable area draining to outfall (ha)	1.6656	5.6096	0.3576	0.4661	0.8900
Water Hardness	Medium	Medium	Medium	Medium	Medium
Within 1km upstream of a protected site?	No	No	Yes	No	No
Downstream structure that reduces the velocity <100m?	Yes	N/A	N/A	N/A	N/A
Use Tier 1	TRUE	N/A	N/A	N/A	N/A
Use Tier 2	FALSE	N/A	N/A	N/A	N/A
Estimated river width at Q95 (m)	3.0	N/A	N/A	N/A	N/A
Step 3: Mitigation					
Tier 2 Bed width (m)					
Tier 2 Side slope (m/m)					
Tier 2 Long slope (m/m)					
Tier 2 Manning's n					
Existing treatment of solubles (%)	0	0	0	0	0
Existing attenuation – restricted discharge rate (%)	U/L	U/L	U/L	U/L	U/L
Existing settlement of sediments (%)	0	0	0	0	0
Proposed treatment of Copper (%)	50	50	40	40	40
Proposed treatment of Zinc (%)	59	59	53	53	30
Proposed attenuation – restricted discharge rate (l/s)	1.6	1.6	13	1.7	2.5
Proposed settlement of sediments (%)	72	72	75	75	76

Treatment efficiencies of SuDS components

Drainage System	Treatment Efficiencies (%)		
	Dissolved Cu	Dissolved Zn	TSS
Filter Drain	0	45	60
Ditch	15	15	25
Swale	50	50	60
Retention Pond (wet)	40	30	76

Q95

NRFA Gauage: 102001 Cefni at Bodffordd		
Area	21.7	km2
Q95	0.02	m3/s
	0.000921659	m3/s/km2

Treatment train	Dissolved Cu remaining	Treatment efficiency	Dissolved Zn remaining	Treatment efficiency	Sediment remaining	Treatment efficiency
Treatment Train 1: Filter Drain + Swale	50	**50**	41	**58.75**	28.00	**72.00**
Treatment Train 2: Filter Drain + Retention Pond (wet)	60	**40**	47	**53.25**	24.80	**75.20**

Appendix G8-2-2 A5025 Off-line highway improvements – HAWRAT results

Appendix G8-2.2 – A5025 Off-line Highway Improvements – HAWRAT results

DMRB HD 45/09 Method A non-cumulative routine runoff assessment for surface waters

Outfall	Step 2 – In-River Impacts								Step 3 – Post-mitigation							
	Soluble Pollutants						Sediment-bound pollutants		Soluble Pollutants						Sediment-bound pollutants	
	RST 24 (exc./year)		RST6 (exc./year)		AA-EQS (µg/l)		Low-flow velocity (m/s)	DI value	RST 24 (exc./year)		RST 6 (exc./year)		AA-EQS (µg/l)		Low-flow velocity (m/s)	DI Value
	Cu	Zn	Cu	Zn	Cu	Zn			Cu	Zn	Cu	Zn	Cu	Zn		
S1 C1	0.00	0.20	0.00	0.00	0.25	0.81	0.00	49.88	0.00	0.10	0.00	0.00	0.21	0.69	-	37.41
S1 C2	0.00	0.00	0.00	0.00	0.00	0.17	0.00	9.44	0.00	0.00	0.00	0.00	0.04	0.15	-	7.08
S1 C4	0.60	0.50	0.00	0.00	0.55	1.78	0.00	69.32	0.00	0.00	0.00	0.00	0.28	0.74	-	19.41
S1 C5	0.10	0.10	0.00	0.00	0.38	1.25	0.00	116.42	0.00	0.00	0.00	0.00	0.33	1.06	-	87.32
S1 C6	0.00	0.10	0.00	0.00	0.22	0.71	0.02	91.82	0.00	0.10	0.00	0.00	0.19	0.61	-	68.87
S3 C2	0.00	0.00	0.00	0.00	0.09	0.30	0.01	58.80	0.00	0.00	0.00	0.00	0.05	0.14	-	14.52
S3 C3	0.00	0.00	0.00	0.00	0.03	0.11	0.04	40.21	0.00	0.00	0.00	0.00	0.02	0.05	-	10.05
S3 C5	0.00	0.00	0.00	0.00	0.02	0.06	0.04	14.77	0.00	0.00	0.00	0.00	0.01	0.03	-	3.69
S5 C3	0.00	0.20	0.00	0.00	0.31	1.00	0.01	85.58	0.00	0.00	0.00	0.00	0.18	0.47	-	21.40
S5 C4	0.00	0.20	0.00	0.00	0.27	0.88	0.01	73.42	0.00	0.00	0.00	0.00	0.16	0.41	-	18.35
S5 C6	0.60	1.00	0.00	0.00	0.66	2.14	0.01	229.03	0.10	0.00	0.00	0.00	0.40	1.01	-	57.26
S7 C1	0.00	0.20	0.00	0.00	0.19	0.63	0.01	64.71	0.00	0.00	0.00	0.00	0.11	0.44	-	15.53
S7 C3	0.10	0.20	0.00	0.00	0.37	1.20	0.03	213.74	0.00	0.00	0.00	0.00	0.22	0.84	-	51.30
S7 C4	0.00	0.10	0.00	0.00	0.15	0.49	0.00	43.05	0.00	0.00	0.00	0.00	0.09	0.35	-	10.33

DMRB HD 45/09 Method C cumulative routine runoff assessment for surface waters

Outfall	Step 2 – In-River Impacts								Step 3 – Post-mitigation							
	Soluble Pollutants						Sediment-bound pollutants		Soluble Pollutants						Sediment-bound pollutants	
	RST 24 (exc./year)		RST6 (exc./year)		AA-EQS (µg/l)		Low-flow velocity (m/s)	DI value	RST 24 (exc./year)		RST 6 (exc./year)		AA-EQS (µg/l)		Low-flow velocity (m/s)	DI Value
	Cu	Zn	Cu	Zn	Cu	Zn			Cu	Zn	Cu	Zn	Cu	Zn		
S1 C1 + C2 + C3 + C4	1	1.1	0.1	0.2	0.86	2.64	0	130.14	0.1	0	0	0	0.43	1.18	-	36.44
S1 C1 + C2 + C3 + C4 + C5	1.8	1.8	0.1	0.3	1.36	3.48	N/A	N/A	0	0.2	0	0	0.68	1.89	N/A	N/A
S3 C2 + C3	0	0	0	0	0.05	0.16	N/A	N/A	0	0	0	0	0.03	0.07	N/A	N/A
S5 C3 + C6	1.3	1.2	0.1	0.2	0.85	2.67	N/A	N/A	0.1	0.2	0	0	0.51	1.69	N/A	N/A
S7 C3 + C4	0.2	0.5	0	0	0.48	1.52	N/A	N/A	0	0	0	0	0.29	1.11	N/A	N/A

Legend	
RST	Runoff Specific Threshold
DI	Deposition Index
AA-EQS	Annual Average Environmental Quality Standard
S	Section
C	Catchment
Green	Pass
Amber	Alert
Red	Fail

Appendix G8-2-3 A5025 Off-line highway improvements – Groundwater assessment

Appendix G8-2.3 – A5025 Off-line Highway Improvements – Groundwater assessment

DMRB HD 45/09 Method C routine runoff assessment for groundwater

Parameter	Weighting Factor	Section 1			Section 5			Notes
		Catchment 1	Catchment 2	Catchment 4	Catchment 3	Catchment 4	Catchment 6	
		Ditch	Ditch	Filter Drain + Swale	Filter Drain + Pond A	Filter Drain + Pond B	Filter Drain + Pond C	
Easting of outfall		229748	229752	229760	232060	231640	231837	
Northing of outfall		379185	379194	379224	386837	386544	387167	
Traffic density	15	1	1	1	1	1	1	See Specific User Parameters
Rainfall volume	15	2	2	2	2	2	2	Colwyn Bay SAAR within HAWRAT is 788.1mm
Rainfall intensity		3	3	3	3	3	3	62.7mm/hr as used by AECOM in drainage design
Soakaway geometry	15	1	1	1	1	1	1	Continuous linear ditches
Depth to water	20	3	3	3	3	3	3	Where present throughout the scheme, groundwater was struck at between 0.6 to 4.8m bgl
Flow type	20	3	3	3	2	2	2	Section 1 is underlain by Tidal Flat Deposits. Section 5 Pond A outfall underlain by Glacial Till. Section 5 Ponds B and C underlain only by metamorphic Gwna Group bedrock.
Effective grain size	7.5	1	1	1	1	1	1	Clay and silt tidal flat deposits. Glacial till is mainly fine and coarse grained diamicton, generally stiff and of low permeability but with thin discontinuous sand and gravel lenses and layers.
Lithology	7.5	3	3	3	2	2	2	Linked to above
Overall Weighted Risk Score	-	225	225	225	198	198	198	

Risk score	
1	Low Risk
2	Medium Risk
3	High Risk

Weighting Risk Score	
<150	Low Risk of Impact
150 - 250	Medium Risk of Impact
>250	High Risk of Impact

Appendix G8-2-4 A5025 Off-line highway improvements – Accidental spillage risk assessment

Appendix G8-2.4 – A5025 Off-line Highway Improvements – Accidental spillage risk assessment

DMRB HD 45/09 Method D accidental spillage risk assessment

Receiving water feature	Section	Risk Weighting	Length within catchment (km)	Annual Average Daily Traffic (vpd)	%HGV	Probability Score (P_{POL})	Probability of Spillage (P_{SPL})	Probability of Incident (P_{INC})	Probability of Incident (P_{INC}) %	Return Period (Years)	Acceptable?
Section 1											
Cleifiog Fawr	1 - Ch 0 to Ch 45	0.29	0.045	9132	2.000	0.6	0.0000009	0.000001	0.000	1915797	**Yes**
	1A - Roundabout	3.09	0.040	9132	2.000	0.6	0.0000082	0.000005	0.000	202275	
	2 - Ch 45 to Ch 80	0.29	0.035	9132	2.000	0.6	0.0000007	0.000000	0.000	2463167	
	3 - Roundabout and field runoff	3.09	0.040	9132	2.000	0.6	0.0000082	0.000005	0.000	202275	
	4 - Ch 80 to Ch 290	0.29	0.210	9132	2.000	0.6	0.0000041	0.000002	0.000	410528	
	5 - Ch 290 to Ch 610	0.29	0.320	9132	2.000	0.6	0.0000062	0.000004	0.000	269409	
						Total:	**0.0000283**	**0.0000170**	**0.0016963**	**58951**	
Cleifiog Isaf	6 - Ch 610 to Ch 800	0.29	0.190	9132	2.000	0.6	0.0000037	0.000002	0.000	453741	
						Total:	**0.0000037**	**0.0000022**	**0.0002204**	**453741**	
Section 3											
Afon Alaw	1SB - Ch 20 to Ch 180	0.29	0.160	6264	3.000	0.6	0.0000032	0.000002	0.000	523679	**Yes**
	1NB - Ch 20 to Ch 140	0.29	0.120	6264	3.000	0.6	0.0000024	0.000001	0.000	698238	
	3 - Ch 180 to Ch 670	0.29	0.490	6264	3.000	0.6	0.0000097	0.000006	0.001	170997	
	4 - Ch 670 to Ch 1100	0.29	0.430	6264	3.000	0.6	0.0000086	0.000005	0.001	194857	
	5 - Ch 1100 to Ch 1685	0.29	0.585	6264	3.000	0.6	0.0000116	0.000007	0.001	143228	
						Total:	**0.0000355**	**0.000021**	**0.002130**	**46940**	
Tan R'Alt	6 - Ch 1685 to Ch 2100	0.29	0.415	6264	3.000	0.6	0.0000083	0.000005	0.000	201900	
						Total:	**0.0000793**	**0.000048**	**0.004756**	**21026**	
Section 5											
Hen-shop ditch	1 - Ch 200 to Ch 380	0.29	0.180	6781	3.000	0.6	0.0000039	0.000002	0.000	430002	**Yes**
	1A - Side road	0.93	0.050	6781	3.000	0.6	0.0000035	0.000002	0.000	482712	
	2 - Ch 380 to Ch 520	0.29	0.140	6781	3.000	0.6	0.0000030	0.000002	0.000	552860	
	3 - Ch 520 to Ch 650	0.29	0.130	6781	3.000	0.6	0.0000028	0.000002	0.000	595387	
Tan-y-bryn	4 - Ch 650 to Ch 770	0.29	0.120	6781	3.000	0.6	0.0000026	0.000002	0.000	645003	
	5A - Ch 770 to 900	0.29	0.130	6781	3.000	0.6	0.0000028	0.000002	0.000	595387	
	5B - Side road	0.93	0.080	6781	3.000	0.6	0.0000055	0.000003	0.000	301695	
						Total:	**0.0000241**	**0.000014**	**0.001443**	**69299**	
Hen-shop ditch	6 - Ch 900 to Ch 1150	0.29	0.250	6781	3.000	0.6	0.0000054	0.000003	0.000	309601	
						Total:	**0.0000127**	**0.000008**	**0.000763**	**131110**	
Section 7											
Afon Cafnan	1 - Ch 80 to Ch 390	0.29	0.310	5260	3.000	0.6	0.0000052	0.000003	0.000	321876	**Yes**
	4 - Ch 400 to Ch 900	0.29	0.500	5260	3.000	0.6	0.0000084	0.000005	0.001	199563	
	5 - Ch 900 to Ch 1050	0.29	0.150	5260	3.000	0.6	0.0000025	0.000002	0.000	665211	
	6 - Ch 1050 to Ch 1200	0.29	0.150	5260	3.000	0.6	0.0000025	0.000002	0.000	665211	
						Total:	**0.0000185**	**0.000011**	**0.001**	**89893**	