



Barmouth Viaduct Gardens – Coastal Scheme

Habitats Regulations Assessment (HRA)

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List of Abbreviations

AA	Appropriate Assessment
AIES	Assessment of Implications on European Sites
cSAC	Candidate Special Area of Conservation
EMS	European Marine Site
ES	Environmental Statement
FCS	Favourable conservation status
HRA	Habitats Regulations Assessment
IEEM	Institute of Ecology and Environmental Management
IROPI	Imperative Reasons of Over-riding Public Interest
JNCC	Joint Nature Conservation Committee
LSE	Likely Significant Effect
OMS	Offshore Marine Site
PEU	Plainly Established and Uncontroversial
PPG	Pollution Prevention Guideline
pRamsar	Possible Ramsar Site
pSAC	Possible Special Area of Conservation
pSPA	Potential Special Protection Area
SAC	Special Area of Conservation
SPA	Special Protection Area

Executive Summary

This report comprises a Habitats Regulations Assessment (HRA) for coastal defence improvement works to the Viaduct Gardens frontage wall at Barmouth, Gwynedd. An HRA is an assessment of impacts on European protected sites of importance for nature conservation.

The proposed works consists of improvements to the Viaduct Gardens sea wall. The height of the existing wall will be increased with the installation of a reinforced concrete parapet. The wall will also be strengthened with the installation of sheet piling and reinforced concrete. The proposals also include the placement of rock armour in front of the wall to dissipate wave energy. The length of the frontage wall to be repaired and improved is approximately 60m. A new surface water outfall is being incorporated in to the works, which will extend out from the wall onto the beach for a distance of approx. 22m.

Works will take place partly within and adjacent to a European protected site, and within close proximity to other sites which have mobile species as qualifying features.

Following a Screening Assessment, the first stage of the HRA identified that there would be ‘Likely Significant Effects’ for Pen Llyn a’r Sarnau SAC and Afon Eden – Cors Goch Trawsfynydd SAC. Therefore, the assessment progressed to Stage 2 ‘Appropriate Assessment’ stage, which considered the potential for the works to have an adverse effect on the integrity of the sites, taking proposed mitigation measures into account. It should be noted that the information included in this report

relating to Stage 2 forms a Statement to inform an Appropriate Assessment (SIAA), as the Appropriate Assessment itself will be made by the Competent Authority.

The assessment concluded that without mitigation the two SAC's could be affected, by pollution, habitat degradation, and disturbance of mobile species, but mitigation measures could be implemented that would eliminate the chance of any residual effects on the integrity on the Afon Eden – Cors Goch Trawsfynydd SAC.

For the Pen Llyn a'r Sarnau SAC mitigation measures could not rule out an adverse affect on the integrity of the site, as coastal squeeze habitat losses would occur in the long term from the site due to hold the line policy at this frontage. The assessment therefore continued to consider alternative options, imperative reasons of overriding public interest and compensatory measures.

1.0 INTRODUCTION

YGC have been commissioned to undertake a Habitats Regulations Assessment (HRA) for proposed works to reduce coastal flood risk to the community of Barmouth, Gwynedd. The proposed works are located at the mouth of the Afon Mawddach, at the southern end of Barmouth (NGR: SH 61549 15531). The purpose of this HRA is to assess the impact of the proposals on sites of international importance for biodiversity.

Barmouth (Abermaw), Gwynedd, is located on the northern shore on the mouth of the Mawddach Estuary. The sea front at Barmouth suffers from flooding due to both overtopping of the sea wall and surface run-off from the bluff behind the town (Dinas Oleu). A Project Appraisal Report (PAR) was originally undertaken in 2004. This was updated in 2018 and formed the basis of an Outline Business Case (OBC) approved June 2021. The OBC presented nine options for coastal flood risk management along the sea front. A preferred option of repairing and improving the frontage wall at Viaduct Gardens is now being progressed through Full Business Case (FBC).

The preferred option presented consists of improvements to the Viaduct Gardens sea wall. The height of the existing wall will be increased in this area. The works can be summarised into the following elements:

- The existing filled garden area behind the existing sea wall will be stabilised through the use of sheet piling and/or king post walls. The installation of these will be mainly from the Viaduct Garden side of the wall.
- Existing wall will be demolished in sections, with the existing rock armour at toe of wall moved back from the wall to expose the face (rock armour material to be re-used upon completion of new wall).
- Construction of new wall consist of lower and middle section, with a reinforced concrete parapet on top. A concrete foundation slab is to be cast in situ, with precast L shaped units laid on the foundation base. The lower section will be backfilled with mass concrete. The parapet wall will be installed as an in-situ wall once the lower and mid sections are complete.
- Rock armour is to be installed along the base of the new wall. Previously removed armour will be used, along with some additional armour.
- A new surface water pipe outfall is to be constructed which involves the installation of a 750mm diameter pipe, which will protrude approx. 13m from the new wall face. Beach material will need to be excavated to accommodate the pipe, which will sit on a concrete mattress (2.4m wide) and be encased in 250mm thick concrete. Rock armour will be placed each side of the pipe at the lower section, and an anti-scour basin will be constructed at the outfall, consisting of rock armour. (Scheme drawings are presented in Appendix B)

The length of the frontage wall to be improved as part of the scheme is approximately 60m.

The construction works associated with this project are limited to the viaduct gardens sea wall and the foreshore area where the new pipe outfall is to be constructed. Machinery access to the intertidal area will be required via the main harbour slipway.

The proposed works are located adjacent to and within the Pen Llyn a'r Sarnau SAC, and in close proximity to other European protected sites, as detailed further in this report.

1.2 Authors

This HRA has been prepared by:

- Rhys Meilyr Thomas, PGDip, with 4 years of ecological consultancy experience, including HRA and Environmental Impact Assessment (EIA) of large projects;

- David Harries MSc CIEEM CEnv with over 15 years of ecological consultancy experience, including HRA and Ecological Impact Assessment (EclA) of large projects.
- Owain Griffith, BSc MCIWEM PIEMA, with 20 years of environmental consultancy experience, including HRA and Environmental Impact Assessment (EIA) of large projects.

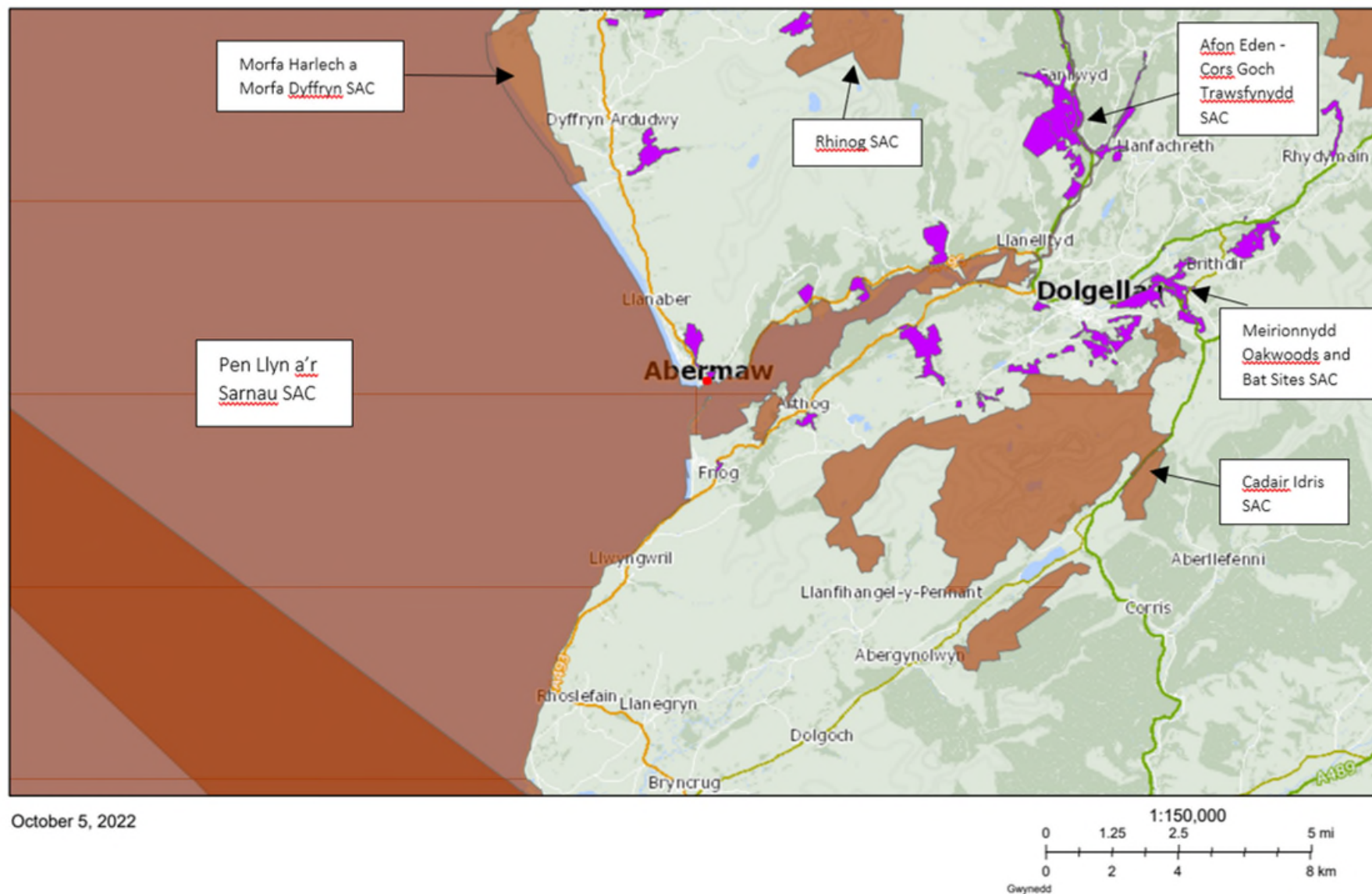


Figure 2: Location of proposed works (red dot) in relation to internationally protected sites (SAC - brown shading. Purple shading denotes Meirionnydd Oakwood and Bat sites SAC locations.)

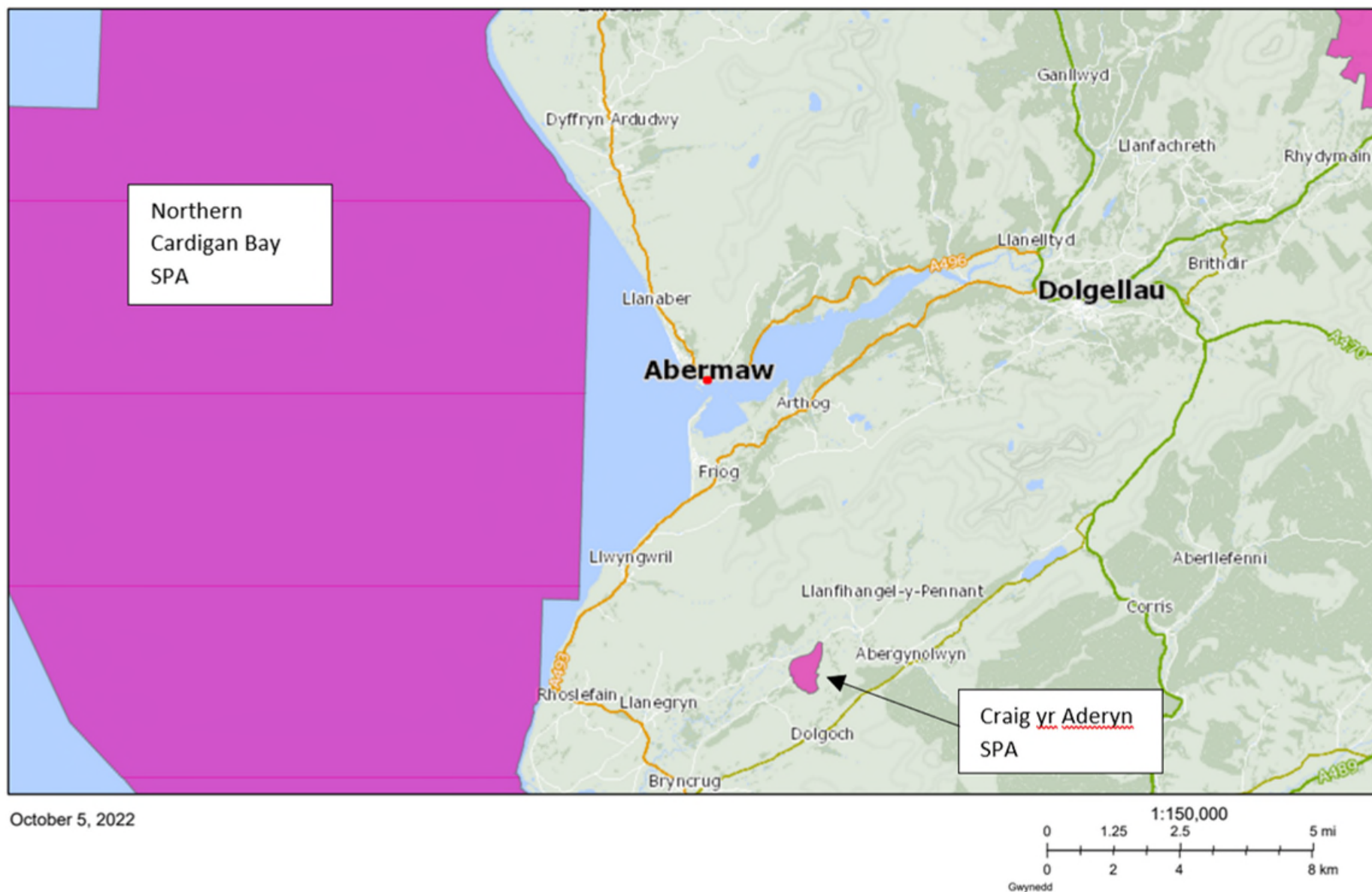


Figure 3: Location of proposed works (red dot) in relation to internationally protected sites (SPA - pink shading)

1.3 European Sites and Ramsars

The EU Habitats Directive requires competent authorities to assess the impacts of plans and projects on the Natura 2000 network of protected sites, including Special Protection Areas (SPAs) and Special Areas of Conservation (SACs). In England and Wales, the Directive is implemented by the Conservation of Habitats and Species and Planning (Various Amendments) (England and Wales) Regulations 2017 (the 'Habitats Regulations'). These set out the requirement for a Habitats Regulations Assessment (HRA) where necessary, comprising a series of mandatory tests.

According to Government policy and advice, 'Wetlands of International Importance' or Ramsar sites, although not subject to the Habitats Regulations, should be treated within the planning system in the same way as SACs and SPAs (or 'European sites'). The same level of protection is also given to potential or proposed sites (i.e. pSPA, pSAC and pRamsar), which have not yet been formally designated.

1.4 The HRA of Projects

HRA asks specific, mandatory questions of development projects. Firstly, a pre-screening process establishes whether a project can be exempted, excluded or eliminated, either because it is directly connected with the conservation management of the protected site, or it doesn't qualify as a 'project' (within the meaning and scope of the Habitats Directive), or because it couldn't conceivably affect any protected sites. If it cannot be discounted for these reasons, it has to undergo a process involving the four stages outlined in Table 1 and Figure 2 below.

The first stage is to screen the project to identify if it may result in a likely significant effect, whether alone or in-combination with other plans or projects. Provided that these significant effects can be ruled out, then no further assessment is needed. Following recent case law (People over Wind, 2017), mitigation cannot be taken into consideration at this stage.

If likely significant effects cannot be ruled out, then the project will proceed to the 'Appropriate Assessment' stage which explores the impacts in terms of the site's conservation objectives. This is to identify whether it can be ascertained that *it will not adversely affect the integrity of the European site*. It is only at this stage that mitigation measures can be considered or imposed (such as changes to design or timing of works). If the Appropriate Assessment can rule out any adverse effects on the integrity of the European site (with or without mitigation), the project may then be consented.

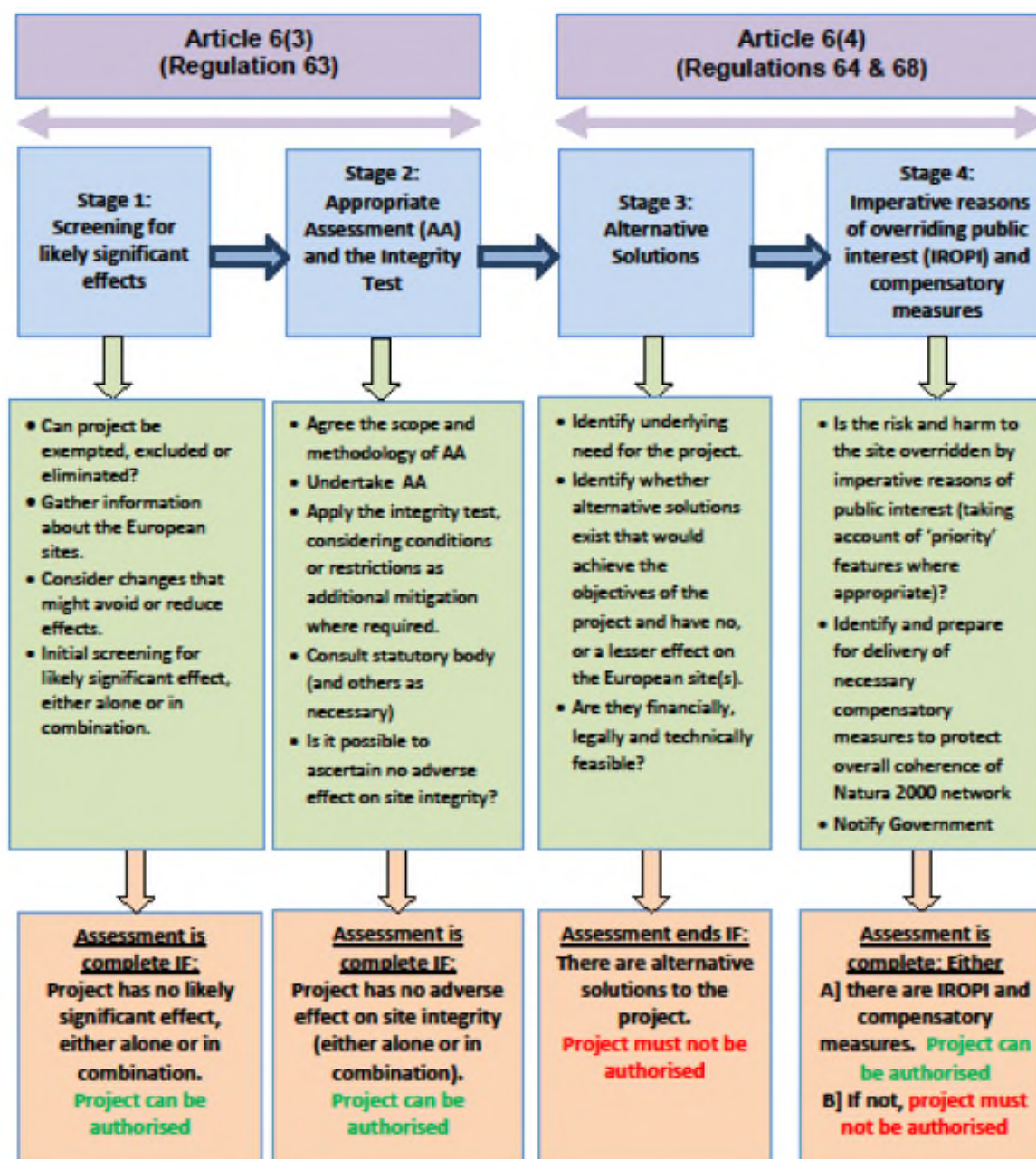
If adverse effects cannot be ruled out, then the assessment progresses to stages three and four and specific derogations may be sought. These determine whether alternative solutions exist and if not, whether imperative reasons of overriding public interest apply and if so, whether compensation is feasible. It should be noted that use of the derogations is regarded as a last resort and should be considered only in exceptional circumstances. The majority of projects are resolved during stages 1 and 2 of the HRA process, as few would manage to pass the strict tests of stages 3 and 4.

Table 1: Summary of the four-stage HRA process

Stage	Test	Task
1	Screening	If the project cannot be excluded from the process (pre-screening), this stage determines if the project will lead to a 'likely significant effect' on a European site alone or in-combination with other plans or projects. This stage uses a very precautionary approach, without consideration of mitigation measures. This stage involves gathering information about the protected sites but is not a detailed analysis of the impacts
2	Appropriate Assessment and Integrity Test	If 'likely significant effects' cannot be ruled out, a more thorough 'appropriate assessment' must be carried out to assess whether it is possible to ascertain whether the project will have an 'adverse effect on the integrity of the site' (AEOI) or not. Mitigation can be considered at this stage but not before
3	Alternative Solutions	If 'AEOI' cannot be ruled out, the HRA must explore whether less damaging 'alternative solutions' could deliver the overall objective of the project
4	Imperative Reasons of Over-riding Public Interest (IROPI) and Compensation	If no alternative solutions exist, the project can only proceed if 'IROPI' apply and 'compensatory measures' must be delivered before consent can be granted

This HRA uses guidance provided by the Habitats Regulations Assessment Handbook (DTA, 2013, February 2019 edition), which draws on best practice and case law from the UK and across the EU to inform best practice. The definitions of HRA terminology used in the assessment can be found in the HRA Handbook. It also draws on recent guidance from NRW, namely - Assessment of Coastal Squeeze Guidance note Reference number: GN 06 ([GN 062 Assessment of coastal squeeze \(naturalresources.wales\)](#))

Extent of knowledge, use of professional judgement and the precautionary principal of professional judgment have been used in the gathering of data and in the interpretation of results gained in relation to the potential impacts, mitigation and significance of any residual impacts, and consideration against conservation objectives. If information is unknown about a potential impact on a species, then the precautionary principal has been used.



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Figure 4: Outline of the four-stage approach to the Habitats Regulations Assessment of projects

1.5 Definitions, Evidence and Case Law

Stage One – Screening

In the context of a likely significant effect, 'likely' means a possible (or the risk of a) significant effect whose occurrence cannot be excluded on the basis of objective information. 'Significant' means if it is likely to undermine the conservation objectives of a European / internationally important site. 'Objective information' can be defined as a clear verifiable fact rather than a subjective opinion and when carrying out a screening assessment, it is not that significant effects are probable, it is that a risk is 'sufficient'. However, there must be credible evidence that there is a 'real', rather than a 'hypothetical' risk.

An ‘in-combination’ assessment is only required when an impact is identified as having an insignificant effect on its own (but residual effects remain) that may become significant when taken into consideration with other plans or projects. This type of assessment is only required during the screening stage, although it can be difficult to distinguish between likely significant effects when considered alone or in-combination. Additionally, the rather coarse nature of the screening stage can sometimes preclude or compromise the necessary analysis and an incorrect choice can sometimes prompt extensive and unnecessary work, which is a limitation of this process. Therefore, unless the issues at the screening stage are clear, this HRA assumes that all likely significant effects apply alone with no residual effects. This will ensure all possible effects are considered and assessed for more thorough analysis in the appropriate assessment if required.

Stage Two – Appropriate Assessment and the Integrity Test

Regulation 63 states that where a plan is ‘likely to have a significant effect’, it can only be consented if the competent authority can ascertain that it ‘will not adversely affect the integrity of the European site.’ An Appropriate Assessment is defined as “the consideration of the impact on the integrity of the Natura 2000 site of the project or plan, either alone or in combination with other projects or plans, with respect to the site’s structure and function and its conservation objectives. Additionally, where there are adverse impacts, an assessment of the potential mitigation of those impacts”.

The ‘integrity’ of a European site is defined as:

‘the coherence of its ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified or listed.’

The European Commission defined it more recently as follows:

‘The integrity of the site involves its constitutive characteristics and ecological functions. The decision as to whether it is adversely affected should focus on and be limited to the habitats and species for which the site has been designated and the site’s conservation objectives.’

As the HRA process is an iterative process, further scrutiny during the Appropriate Assessment will inevitably confirm or challenge the outcomes of the screening exercise. As a result, this may result in changes such as the identification of new or removal of existing effects, or the need for an in-combination screening assessment.

In accordance with the principles of the mitigation hierarchy, if mitigation measures are able to remove an adverse effect, the measure should be adopted regardless of the cost or difficulty.

Favourable Conservation Status

The aim of the Habitats Directive is to maintain or restore the habitats and species (or qualifying features) listed in Annex I and Annex II respectively, to favourable conservation status (FCS) to ensure their long-term survival is secured across their natural range within the EU. This is described in Articles 1(e) and 1 (i) of the Directive as follows:

The conservation status of a natural habitat will be taken as favourable when:

- *Its natural range and areas it covers within that range are stable or increasing;*
- *The specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future; and*
- *The conservation status of its typical species is favourable as defined in (i);*

[and]

The conservation status of a species will be taken as favourable when:

- *Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats;*
- *The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and*
- *There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.*

These targets may apply across several member states but are delivered by site-based conservation objectives. Site-based conservation objectives can be defined as *‘a set of specified objectives to be met in a site in order to make sure that the site contributes in the best possible way to achieving FCS at the appropriate level (taking into account the natural range of the respective species or habitat types)’*.

Priority features

Some of the qualifying features of the Natura 2000 European sites are listed as ‘Priority features’. These are treated in the same way as the other features during Stages 1 and 2 of an HRA, but at Stage 4, Imperative reasons for overriding public interest (IROPI) are restricted to those relating to human health, public safety or beneficial effects on the environment if priority features would or could be adversely affected by a plan or project. In other words, IROPI of a social or economic nature alone cannot be considered sufficient reasons for impacts on ‘priority features’ when assessing the derogations (Stages 3 and 4 of HRA).

Mitigation and case law

The People Over Wind case provided a new interpretation of when and how mitigation measures should be considered in an HRA. In 2017, the European Court of Justice departed from previous decisions, clearly identifying that measures specifically designed to avoid or reduce likely significant effects should not be evaluated at the screening stage, and should be reserved for the Appropriate Assessment stage.

Role of the competent authority

It is the competent authority’s responsibility to decide whether or not to adopt this assessment as part of their duty under the Habitats Regulations.

2.0 THE NEED FOR ASSESSMENT AND IDENTIFYING EUROPEAN SITES AT RISK

2.1 Exclusion, Elimination and Exemption from the Need for Assessment

Prior to the identification of vulnerable European sites, Stage 1 of the HRA process encourages a brief 'pre-screening' exercise to determine whether there is actually a need for an HRA. It decides whether a proposed development can be:

- **Exempted** from the HRA because it is '... directly connected with or necessary for the management of the ... European site';
- **Excluded** from the HRA because 'it is not a project within the meaning and scope of the Habitats Directive'; or
- **Eliminated** from the HRA because it can easily be shown that although 'it is a project ... it could not have any conceivable effect on any European site'.

Following this pre-screening exercise, it is evident that the proposed development does in fact represent a project within the meaning and scope of the Habitats Directive with the potential to cause harm to European sites. As a result, it can neither be excluded nor eliminated from the HRA. Additionally the purpose of the project is not directly connected with or necessary to the management of European sites, and so it cannot be made exempt from the HRA process. Therefore, the first steps of the Stage 1 assessment will need to commence by identifying which European sites (and associated features) may be at risk. The identification of these sites is outlined in the section below.

2.2 Identification of European sites at risk

This HRA has adopted a precautionary 10km radius from the proposed works to search for European protected sites at risk. This distance is considered to be the maximum extent that a project of this nature and scale could reasonably be expected to generate measurable effects. Using the data from 'Map Gwynedd' (the Gwynedd Council GIS database), the sites within this area are listed in Table 2 below and shown in Figure 1 above.

Table 2. European sites within 10km of the proposed works (or further if mobile species features could be affected)

European site	Distance
Pen Llyn a'r Sarnau SAC	Within the footprint of the proposed works.
Meirionnydd Oakwoods and Bat Sites SAC	50m north of the proposed works at its nearest point.
Northern Cardigan Bay SPA	3.5km west of proposed works.
Cadair Idris SAC	4.3km south east of proposed works.
Morfa Harlech a Morfa Dyffryn SAC	7.1km north west of proposed works.
Craig yr Aderyn SPA	8.7km south of proposed works.
Rhinog SAC	9.7km north east of proposed works.
Afon Eden - Cors Goch Trawsfynydd SAC	11km east of proposed works.

In some instances, sites require a larger search radius of up to 30km if they support highly mobile qualifying species such as lesser horseshoe bats or otters that could be affected by the proposed

works. In this instance there are no other sites with lesser horseshoe bats as a qualifying species feature within 30km of the proposals, other than Meirionnydd Oakwoods and Bat Sites SAC. Otters are likely to use the estuary habitat adjacent to the proposals. A buffer zone of 25km is typically applied for assessing impacts on sites with otter as a qualifying mobile species. Other than Pen Llyn a'r Sarnau SAC which is within the footprint of the works, the only other site within 25km which includes otter as a qualifying species is Afon Eden - Cors Goch Trawsfynydd SAC. This site is therefore included in this assessment.

Pen Llyn a'r Sarnau SAC is classified as a 'European Marine Site' (EMS). All EMSs are accompanied by bespoke conservation objectives and supplementary advice. The HRA will initially focus solely on the high-level objectives and then, if necessary, further scrutiny of other objectives will be reserved for the appropriate assessment.

The presence of a site on the list in Table 2 doesn't in itself justify its inclusion in subsequent stages of the HRA process, as this depends on the characteristics of the site and the possible impact pathways between the two. Therefore, to encourage a consistent, reliable and repeatable process, the HRA Handbook identifies 22 generic criteria (including sub-criteria) to focus the assessment on relevant sites only, as shown in full in Appendix A. If no European sites are identified in the final column of this table then none will be considered to be at risk and no further scrutiny is needed. In practice, this process can alter the area of search by expanding it (for instance in the case of riverine sites) or shrinking it where the evidence demands that harmful effects are unlikely.

Importantly, although the outcomes of the site identification task will reflect the type and location of the proposed development, and/or the ecological characteristics of the European sites, it does not represent the test for likely significant effect (which follows later).

Of the 22 criteria listed, five were considered to be a credible threat to European sites in the area and are presented in Table 3 below, with Columns 2 and 3 in Appendix A omitted. The remaining criteria have been removed from any further consideration in this HRA as they are not relevant to the proposed works.

Table 3. Scanning and site selection list for European sites that could potentially be at risk from the proposed works

Types of project (or potential effects)	Sites to scan for and check (and additional context)	List of European sites potentially at risk
(1) All projects (terrestrial, coastal and marine)	Sites within which the project is wholly or partly located. The proposed works will take place partly within the Pen Llyn a'r Sarnau SAC. The frontage wall is located immediately outside the SAC boundary. The installation of sheet piling and associated works to the wall will be taking place outside the SAC. The placement of rock armour in front of the frontage wall will extent out onto the foreshore, however this will not extend out as far as the SAC boundary, therefore there would be no direct loss of SAC habitat as a result of this activity. The installation of a new surface water outfall pipe will extend out from the sea wall, and into the SAC resulting in construction work within the SAC itself, and minor land take of SAC habitat. The proposed works will be taking place within and adjacent to a mosaic of intertidal habitats, and machinery and equipment access to the frontage will be required along the foreshore (through the SAC), therefore the risk of habitat loss or degradation as a result of construction activity cannot be ruled out. Works will be taking place within the intertidal SAC habitat, and on land directly adjacent to the SAC, therefore there is a risk of contamination of SAC habitats should there be an unmitigated pollution event during the construction period. There is also a risk of habitat loss due to land required to accommodate the new surface water outfall within the SAC. Therefore, at this stage the potential for harmful effects on the Pen Llyn a'r Sarnau SAC and its features cannot be ruled out and further consideration is required.	Pen Llyn a'r Sarnau SAC
(2) Projects that could affect wetland features	Effects considered are those associated with the physical presence of built development and the localised effects on surface/groundwater resources and quality, resulting from changes in run-off, sedimentation, erosion, etc. The proposed works are partly located within Pen Llyn a'r Sarnau SAC, a marine site (see Criterion (3) below). Morfa Harlech a Morfa Dyffryn SAC and Northern Cardigan Bay SPA are hydrologically connected.	see Criterion (3) below

Types of project (or potential effects)	Sites to scan for and check (and additional context)	List of European sites potentially at risk
	(see Criterion (3) below) The Meirionnydd Oakwoods and Bat Sites is located 50m north of the site at it's nearest point and could be susceptible to settlement of suspended dust particles during construction, however it is considered highly unlikely that this will impact upon the site's wetland features. There are no direct hydrological connections between the proposed works and the SAC. Effects on the wetland features of this site have been scoped out. Effects Can be ruled out for Cadair Idris SAC, Craig yr Aderyn SPA and Rhinog SAC given the distance of these sites from the scheme, the size and nature of the proposed works, and the lack of hydrological connectivity. Afon Eden-Cors Goch Trawsfynydd is connected by the Mawddach Estuary, located where the Afon Mawddach enters the estuary, c.11km upstream at its closest point. However, due to the distance of this site and its location upstream of the proposed works, effects on the wetland features of this site have been scoped out.	
(3) Projects that could affect the marine environment (Criterion (2): 'Projects that could affect wetland features' is also covered here as the wetland features in this case are all marine)	Effects considered are those associated with the physical presence of built development and the localised effects on surface/groundwater resources and quality, resulting from changes in run-off, sedimentation, erosion, etc. The proposed works will be taking place within and directly adjacent to the Mawddach Estuary, which forms part of the Pen Llyn a'r Sarnau SAC. There is some potential for the proposed works to cause adverse pollution impacts on the immediate and surrounding Pen Llyn a'r Sarnau SAC habitats during construction. Coastal defence developments have the potential to affect the hydraulic conditions of the surrounding coastal environment, which could lead to long term impacts upon nearby habitats. In this case, there is no change in the footprint of the wall itself, and the placement of rock armour in front of the wall is replicating the current conditions (apart from a small section on the eastern section where there is currently no rock armour present).	Pen Llyn a'r Sarnau SAC

Types of project (or potential effects)	Sites to scan for and check (and additional context)	List of European sites potentially at risk
	The proposals include the installation of a new surface water outfall pipe, which will extend out from the sea wall into the intertidal area of the SAC. This has the potential to result in loss of overall area of SAC habitat due to the land required to accommodate the surface water pipe, however this is expected to be very minor given the footprint of the new pipe. The new outfall will discharge surface water, as is currently the case with the outfall that is being replaced. Northern Cardigan Bay SPA is hydrologically connected to the proposed works (3.5km west) and could potentially be affected by adverse pollution impacts during construction. Given the nature and scale of the works proposed, the distance of the works from the SAC, and the high dilution factor associated with the marine environment, it is not likely that this site would suffer significant effects from pollution during construction. However, there is potential for effects on the habitats of the red-throated diver outside of the SAC, which is considered under criteria 5 below. Morfa Harlech a Morfa Dyffryn SAC is hydrologically connected to the proposed works via the coast (7.1km north). However, given the nature and scale of the works proposed, the distance of the works from the SAC, and the high dilution factor associated with the marine environment, it is not likely that this site would suffer significant effects from pollution during construction. Potential effects on the features of this site have therefore been scoped out. Therefore, at this stage the potential for harmful effects on the Pen Llyn a'r Sarnau SAC and its features cannot be ruled out and further consideration is required.	
(5) Projects that could affect mobile species	Criterion 5 includes sites whose qualifying features include mobile species which may be affected by the project irrespective of the location of the project or whether the species would be in or out of the site when they might be affected. Mobile species are those considered to spend part of their life-cycle on land, in water or air beyond the designated site boundary. Typically, it focuses on potential impacts on functionally-linked land and water utilised by the birds, mammals and migratory fish associated with the European sites	Pen Llyn a'r Sarnau SAC Afon Eden – Cors Goch Trawsfynydd SAC. Meirionnydd Oakwoods and

Types of project (or potential effects)	Sites to scan for and check (and additional context)	List of European sites potentially at risk
	listed. Pen Llyn a'r Sarnau SAC has mobile species features that include otter, grey seal and bottlenose dolphin. The proposed works has the potential to effect the mobile species features of the site through disturbance or through water pollution and habitat degradation during construction. Otter and Atlantic Salmon are mobile species features of the Afon Eden – Cors Goch Trawsfynydd SAC, and the populations could utilise land/waters in the Mawddach Estuary, adjacent to the proposed works. Lesser horseshoe bat is a mobile species feature of the Meirionnydd Oakwoods and Bat Sites SAC. This species could utilise land within or adjacent to the area of proposed works for foraging. There is also potential for effect on the habitats of the red-throated diver feature of the Northern Cardigan Bay SPA. While the Craig yr Aderyn SPA has mobile species features, given the distance of this site from the works and lack of hydrological connectivity, the likelihood of significant harmful effects can be ruled out. Note that 'indirect' effects on mobile species on functionally – linked land or water beyond the development site, are considered under other criteria 14 and 15 below. Therefore, at this stage the potential for harmful effects on Pen Llyn a'r Sarnau SAC, Afon Eden – Cors Goch Trawsfynydd SAC, the Meirionnydd Oakwoods and Bat Sites SAC, and the Northern Cardigan Bay SPA and their features cannot be ruled out and further consideration is required. <i>Note: There is a close link between criterion 5 and criteria 14 and 15 below.</i>	Bats Sites SAC Northern Cardigan Bay SPA
(14) Projects which	Criterion 14 refers to sites whose qualifying features are considered to be potentially sensitive to	Pen Llyn a'r Sarnau SAC

Types of project (or potential effects)	Sites to scan for and check (and additional context)	List of European sites potentially at risk
could introduce or increase, or alter the timing, nature or location of disturbance to species	disturbance, for example as a result of noise, activity or movement or the presence of disturbing features that could be brought about by the project. There is a risk of disturbance to otters, a qualifying feature of the Pen Llyn a'r Sarnau SAC and Afon Eden – Cors Goch Trawsfynydd SAC, during construction. However, this would be minimal as the location is already subject to high levels of disturbance, and for this reason is considered unlikely to support otter resting sites. Furthermore, the works would be undertaken during daylight hours when otter activity is minimal. Lesser Horseshoe Bats is a mobile species feature of Meirionnydd Oakwoods and Bat sites SAC. There may be a small risk of temporary disturbance during construction phase. There are no cofnod records of Lesser Horseshoe Bat roosts within 1km of the proposed works. Therefore, effects that include potential disturbance of otters cannot be ruled out for the Pen Llyn a'r sarnau SAC and Afon Eden – Cors Goch Trawsfynydd, along with effects that include potential disturbance of lesser horseshoe bats for the Meirionnydd Oakwoods and Bat Sites SAC, and further consideration is required. <i>Note: There is a close link between criterion 14 and criteria 5 and 15.</i>	Afon Eden – Cors Goch Trawsfynydd SAC. Meirionnydd Oakwoods and Bats Sites SAC
(15) Projects which could introduce or increase or change the timing, nature of location of light or noise pollution	Criterion 15 includes sites whose qualifying features are considered to be potentially sensitive to the effects of changes in light or noise that could be brought about by the project. There is likely to be a temporary increase in noise pollution during the construction period through construction machinery and sheet piling activities. This could potentially cause a low level of disturbance to the otter, grey seal and bottlenose dolphin features of the Pen Llyn a'r Sarnau SAC, along with the otter feature of Afon Eden – Cors Goch Trawsfynydd SAC. However, there is already a high degree of disturbance in the vicinity of the proposals. Works would also be undertaken during daylight hours when otter activity is minimal. There would be no additional artificial lighting of the site.	Pen Llyn a'r Sarnau SAC Afon Eden – Cors Goch Trawsfynydd SAC. Meirionnydd Oakwoods and Bats Sites SAC

Types of project (or potential effects)	Sites to scan for and check (and additional context)	List of European sites potentially at risk
	As above, the proposed works are likely to create a temporary increase in noise levels during the course of the works, potentially impacting lesser horseshoe bats. Cofnod records do not indicate the presence of a lesser horseshoe bat roost within 1km of the proposed works. Effects on foraging bats would be minimal as works will be undertaken during daylight hours and there would be no artificial lighting of the site. Therefore, effects on otters from noise pollution on the Pen Llyn a'r Sarnau SAC and Afon Eden – Cors Goch Trawsfynydd SAC cannot be ruled out. Likewise, effects on lesser horseshoe bats from noise pollution on Meirionnydd Oakwoods and Bat Sites SAC also cannot be ruled out. <i>Note: There is a close link between criterion 15 and criteria 5 and 14 above.</i>	
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2.3 Initial outcome of site identification exercise

Following the initial high-level preliminary screening exercise provided by Table 3 above and Appendix A (full version including criteria screened out as well as those screened in), the number of potential threats and sites affected is reduced. Despite this, the nature of the criteria results in considerable overlap in some instances, such as in criteria 5, 14, and 15 which can all effectively be represented by 'disturbance / displacement of mobile species'. Criterion 1 and 3 effectively represent the threats caused by 'pollution' and 'habitat degradation'. These terms will therefore be used in any subsequent assessment, in place of the criteria in Table 3 above.

The outcomes of the site identification exercise are therefore shown in Table 4 below.

Table 4. Summary of potential threat mechanisms and European sites at risk

Potential threat	Relevant Criteria from Table 3	European sites
Pollution of marine environment (including foraging habitat for mobile species features)	(1) (3) and (5)	Pen Llyn a'r Sarnau SAC Afon Eden – Cors Goch Trawsfynydd SAC. Northern Cardigan Bay SPA
Habitat loss / degradation	(1) (3) and (5)	Pen Llyn a'r Sarnau SAC
Disturbance / displacement of mobile species feature	(5), (14) and (15)	Pen Llyn a'r Sarnau SAC Afon Eden – Cors Goch Trawsfynydd SAC. Meirionnydd Oakwoods and Bats Sites SAC

Table 4 above demonstrates that potential impacts on three European sites remain, and a formal screening assessment is therefore required.

3.0 SCREENING

3.1 Purpose

The purpose of the screening exercise determines whether or not a plan or project will lead to a 'likely significant effect' or, in other words, whether there is a risk that the proposed works will lead to effects that would 'undermine the conservation objectives' of the site and cannot be 'excluded on the basis of objective information'. An Appropriate Assessment is required when likely significant effects (that are credible and not hypothetical) are identified (or cannot be ruled out).

3.2 Approach

In order to complete the screening stage and identify any likely significant effects on site features, additional information is needed for each site at risk. The screening tables (Table 5 - 8) below therefore collate additional information for each site, including a site description and list of qualifying features, and use this to identify any likely significant effects from the proposed works (based on the threats listed in Table 4 above) and the site features potentially affected. The site-specific information provided in these tables has been collated from the Natural Resources Wales and JNCC websites. If necessary more detailed descriptions of the sites will be provided at the Appropriate Assessment stage, including the conservation objectives, but the information in Tables 5 - 6 below is sufficient for the screening stage.

In-depth analysis is not required at the screening stage as it should only operate as a 'trigger' to determine if an Appropriate Assessment is needed. Therefore, detailed examination of each of the conservation objectives of each of the features of the sites will not be undertaken at this stage, and is reserved for the Appropriate Assessment stage. Instead, this section only broadly explores whether it is possible that conservation objectives could be undermined and takes into account the risk of a potential significant effect.

As a result of the 'People Over Wind' decision, the screening stage is able to consider the essential features and characteristics of a project but is not able to take bespoke mitigation measures into account. The consideration of all mitigation for this project is therefore reserved for the Appropriate Assessment stage.

Table 5. Screening Assessment for the Pen Llyn a'r Sarnau SAC

Pen Llyn a'r Sarnau SAC (146,010.52 ha)	UK0013117
<u>Qualifying features</u> 1110 Sandbanks which are slightly covered by seawater all the time 1130 Estuaries 1150 Coastal Lagoons *Priority Feature 1160 Large shallow inlets and bays 1170 Reefs 1140 Mudflats and sandflats not covered by sea water at low tide 1310 Salicornia and other annuals colonizing mud and sand 1330 Atlantic salt meadows (<i>Glauco-Puccinellietalia maritima</i>) 8330 Submerged or partially submerged sea caves 1349 Bottlenose dolphin <i>Tursiops truncatus</i> 1355 Otter <i>Lutra lutra</i> 1364 Grey seal <i>Halichoerus grypus</i>	
<u>Description</u> The Pen Llyn a'r Sarnau SAC encompasses areas of sea, coast and estuary that support a wide range of different marine habitats and wildlife. The nature of the seabed and coast and the range of	

environmental conditions present vary throughout the SAC. Differences in rock and sediment type, aspect, sediment movement, exposure to tidal currents and wave action, water clarity and salinity together with biological and food chain interactions have created a wide range of habitats and associated communities of marine plant and animal species, some of which are unique in Wales.

Potential Threats / Vulnerabilities

1) Pollution of habitat features and foraging habitat for mobile species:

It is possible that machinery and materials used for works on site could be a source of pollution, which could directly affect the adjacent intertidal mudflats and sandflats feature of the SAC and other marine / estuary habitats nearby. Construction activities could also result in increased sedimentation working within and around the water environment. The works are located immediately adjacent to and within the intertidal 'mudflats and sandflats' feature of the European site creating a potential direct pollution risk. The area is also part of the 'Estuaries' feature of the SAC. Due to the high dilution factor associated with a marine environment and the scale and nature of the proposed works, it is considered unlikely that any habitat further than c.500m away from the proposed works would suffer significant effects from pollution during construction. Therefore, effects on other SAC habitat features are scoped out.

It is considered highly likely that the estuary habitat adjacent to the proposed works is used occasionally for foraging by members of the otter population of the SAC. Cofnod records include foraging otters approx. 300m south of the proposals (2018). Deterioration in water quality and degradation of habitat could potentially impact on otters and could result in reduction of prey availability (fish). Although this poses a fairly low risk of having a significant effect on the conservation objectives of this feature due to the abundance of suitable foraging habitat elsewhere in the local area and the large range of the otter, it is included here as a likely significant effect on a precautionary basis.

Bottlenose dolphin and grey seal are likely to use the Mawddach Estuary entrance as foraging habitat, however both these species will forage widely and any decline in prey species in one area may not immediately impact the populations. As mentioned above, due to the scale and nature of the works proposed and the high dilution factor associated with the marine environment, any pollution impacts are likely to be local. It is therefore not considered likely that there will be significant effect on bottlenose dolphin and grey seal from pollution impacts.

Outcome: It is considered that the threat from pollution during construction could potentially undermine the conservation objectives of the site for intertidal mudflats and sandflats, estuaries, and otter features of the SAC and is therefore included as a likely significant effect.

2) Habitat Loss / degradation

The proposed works require the construction of a 750mm diameter surface water outfall pipe that will extend approximately 13m from the sea wall, into the SAC habitat. This will result in loss of SAC habitat for the footprint of the pipe, outfall, and protective rock armour (approx. 67m²) and could lead to temporary degradation of immediate adjacent habitat during the construction phase.

As the proposed works require vehicle and machinery access through the SAC, the nature of the works could result in physical disturbance of intertidal habitats by construction vehicles. There is therefore a risk that this could lead to degradation and loss of SAC habitat adjacent to the sea wall that is being repaired and for the construction of the new surface water outfall pipe. There is a mosaic of intertidal habitat present within the harbour area where works are proposed, between the south facing sea wall and the north facing slipway. (See Appendix C which includes phase 1 habitat plan). The habitat in this area forms part of the SAC's 'mudflats & sandflats not covered by

seawater at low tide' habitat feature along with the overriding 'Estuaries' feature.

Although the scale of the proposed works is considered small at first instance in relation to the abundance of intertidal mudflats / sandflats and estuaries habitat in the area, further consideration of the impacts upon the conservation objectives are required.

The proposed works are within a 'hold the line' policy unit (PU 11.14) of the SMP and are not classified as maintenance works. In line with NRW guidelines (GN 062) the work must be assessed for potential coastal squeeze affects. .

The SMP2 HRA does not identify PU 11.14 as having coastal squeeze losses. However the SMP HRA paragraph 5.5.53 states that *"Managed Realignment (PUs 11.2, 11.5, 11.6, 11.9, 11.10, 11.12, 11.13 and 11.14) in the long term would ensure that coastal squeeze would not be an issue, as no alteration to the physical or chemical processes would be expected other than that resulting from natural variation in response to sea level rise."* However, PU 11.14 is HTL and therefore we consider the SMP HRA to be incorrect and, are proceeding on the basis that coastal squeeze losses should have been identified. This potential impact will be assessed as part of the costal process assessment for the project.

Outcome: It is considered that the threat from habitat degradation during construction, direct loss of habitat, and indirect loss of habitat through coastal squeeze during operation, could potentially undermine the conservation objectives of the site for intertidal mudflats and sandflats, and estuaries, features of the SAC and is therefore included as a likely significant effect.

3) *Disturbance / displacement of mobile species features:*

There are no Cofnod records of otter resting sites or holts within or in the vicinity of the proposed works area and none were recorded during the site survey undertaken February 2022 (Refer to Barmouth Viaduct Gardens Preliminary Ecological Appraisal, ARUP - May 2022). Due to the exposed nature of the site within a populated area of town and the high level of disturbance already experienced within this area, the presence of artificial lighting, and the tidal inundation of the beachfront, it is considered highly unlikely that the proposed works area would support potential holt opportunities or resting sites. However, otters are very likely to be present, at times, on the Mawddach Estuary habitat nearby whilst foraging and commuting.

There is likely to be some temporary noise pollution during the works, above current levels, which could potentially cause a low level of disturbance to foraging otters. This could cause a reduction in foraging opportunities for otter, thus potentially reducing access to food sources. However, such disturbance would be temporary and the works would be undertaken during daylight hours when otter activity is minimal. There would be no additional artificial lighting of the site.

As this risk is so minimal, no resting sites would be disturbed and even if an otter foraging during daylight hours was to be temporarily disturbed within the construction period, it is not considered realistic to imagine that this could have a significant adverse effect on the conservation objectives of the otter feature of the SAC, given the availability of suitable foraging habitat elsewhere in the locality. This impact on otters is therefore scoped out of any further assessment.

The proposed works are likely to involve sheet piling activity, which is likely to cause increased disturbance as a result of noise, to the bottlenose dolphin and grey seal features of the SAC, if they are found to be present in the vicinity of the proposed works during construction. Artificially introduced hazards and reductions in the natural quality and suitability of bottlenose dolphin and grey seal habitat in the SAC can occur through noise and visual disturbance.

Due to no proposed works being carried out in the water column (avoiding tidal inundation to the work area), it is not considered likely that the proposal will have a likely significant effect. However, grey seals and bottlenose dolphin presence cannot be ruled out at this stage due to potential pathways. For this reason, at this current stage likely significant effect of the disturbance of grey seal and bottlenose dolphin associated with the SAC cannot be ruled out and are carried forward for appropriate assessment.

Outcome:

It is considered that the threat from disturbance during construction could potentially undermine the conservation objectives of the site for grey seal and bottlenose dolphin features of the SAC and is therefore included as a likely significant

Summary of Likely Significant Effects and Features requiring Appropriate Assessment

- Pollution of adjacent estuary and intertidal mudflats and sandflats habitat, including otter foraging habitat, during construction.
- Habitat loss / degradation as a result of physical disturbance of intertidal habitat.
- Disturbance of grey seals and bottlenose dolphins associated with the SAC during the construction phase of the works.
- Potential coastal squeeze leading to indirect losses of mudflats and sandflats features of the SAC.

Table 6. Screening Assessment for the Meirionnydd Oakwoods and Bat Sites SAC

Meirionnydd Oakwoods and Bat Sites SAC (2812.79 ha)	UK0014789
<u>Qualifying features</u> 91A0 Old sessile oak woods with <i>Ilex</i> and <i>Blechnum</i> in the British Isles 91E0 Alluvial forests with <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i> (<i>Alno-Padion</i>, <i>Alnion incanae</i>, <i>Salicion albae</i>) *Priority Feature 3260 Water courses of plain to montane levels with the <i>Ranunculion fluitantis</i> and <i>Callitriche-Batrachion</i> vegetation 4010 Northern Atlantic wet heaths with <i>Erica tetralix</i> 4030 European dry heaths 9180 <i>Tilio-Acerion</i> forests of slopes, screes and ravines *Priority Feature 91D0 Bog woodland *Priority Feature 1303 Lesser horseshoe bat <i>Rhinolophus hipposideros</i> <u>Description</u> The Meirionnydd Oakwoods and Bat Sites SAC is made up of a series of woodlands, stretching from Dolgellau in the south to Eryri in the north. The majority of the SAC is classified as the woodland type known as “Old sessile oak woods with <i>Ilex</i> and <i>Blechnum</i> in the British Isles”, which covers approximately 84% of the SAC and is the dominant woodland type at most of the sites. A key feature of European importance is the rich Atlantic bryophyte communities that are often well developed within this Annex I type. These include numerous rare species, such as <i>Campylopus setifolius</i>, <i>Sematophyllum demissum</i>, <i>Adelanthus decipiens</i>, <i>Leptocyphus cuneifolius</i> and <i>Plagiochila atlantica</i>. Another key feature of the Meirionnydd Oakwoods and Bat Sites SAC is the lichen flora which is exceptionally rich and includes numerous rare species such as, <i>Micarea xanthonica</i>, <i>Parmelinopsis horrescens</i>, <i>Phyllopsora rosei</i>, <i>Micarea stipitata</i> and <i>Tyothallia biformigera</i>. Frequently the oak woodland occurs as part of a mosaic of woodland types including other Annex I Habitats, “Bog woodland”, “Alluvial forests with <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i>” and “<i>Tilio-</i>	

Acerion forests of slopes, screes and ravines” which occur in small areas and are only significant at a few of the component SSSI/units. The transitions between these different woodland types are important in terms of maintaining the structure and function of the habitat type and vary across the U.K.

The heath is characterised by abundant *Calluna vulgaris*, *Ulex gallii* and *Erica cinerea* growing on thin, poor acidic soils. There are many small areas of dry heath interspersed amongst the woodland, which have not been measured, but the three largest areas of dry heath, together comprise 1% of the area of the SAC.

The feature “Water courses of plain to montane levels with the *Ranunculon fluitantis* and *Callitricho-Batrachion* vegetation” occurs within the Afon Glaslyn, within the Glaslyn SSSI and currently outside the SAC but within a proposed extension to the SAC.

Lesser horseshoe bats have over 20 known roosts within the SAC and forage widely within the SAC’s woodlands, associated habitats and the surrounding countryside. The SAC includes maternity roost sites in various types of buildings and structures, and winter hibernation sites, especially in mines. There are other types of roost such as night, transitional, leks and swarming sites, about which very little is known.

Potential Threats / Vulnerabilities

1) Disturbance of mobile species feature: lesser horseshoe bat.

The works will take place approximately 50m from the nearest SAC component. The proposed works are likely to create a temporary increase in noise levels during the course of the works. There are no Cofnod records of any lesser horseshoe bat roosts within 1km of the proposed works area. The proposed works to repair and strengthen the sea wall will not directly impact any potential lesser horseshoe bat roost features, as the species tend to roost in caves, or old buildings, churches, stables or barns. No potential roost features are present within the sea wall itself, and no trees with bat roost potential will be removed as part of the proposals. Therefore, there will be no loss of potential roosting habitat.

The area in the vicinity of the proposed works contain buildings and features that could potentially support roosting bats. However, the area is subject to an existing level of daily noise pollution with the presence of road traffic, railway, and boat/power craft activities. The proposed works are likely to cause a temporary increase in noise pollution levels during construction phase, although this is not considered likely to cause a significant effect. The presence of existing artificial lighting within and adjacent to the proposed works area will act as a deterrent to lesser horseshoe bats. Furthermore, as the works will be taking place during daylight hours, there is not likely to be any effect on foraging bats. The potential for the proposed works to disturb lesser horseshoe bats is therefore scoped out and not considered a likely significant effect.

Outcome: No likely significant effect

Summary of Likely Significant Effects and Features requiring Appropriate Assessment

- None

Table 7. Screening Assessment for the Afon Eden – Cors Goch Trawsfynydd SAC

Afon Eden – Cors Goch Trawsfynydd SAC (284.29 ha)	UK0030075
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Qualifying features

7110 Active raised bogs ***Priority Feature**

1029 Freshwater pearl mussel *Margaritifera margaritifera*

1831 Floating water-plantain *Luronium natans*

1106 Atlantic Salmon *Salmo salar*

1355 Otter *Lutra lutra*

Description

The Afon Eden/River Eden is a relatively unmodified river, mainly upland in character, of approximately 10km length. The watershed begins just south of Llyn Trawsfynydd, within an area of gently sloping and poorly drained land. The upper section of the catchment is slow-flowing with a number of deep pools along its length. In the lower two-thirds of the catchment the river flows more steeply into a narrow rocky gorge, with an adjacent area of forestry plantation, known as Coed y Brenin. The Afon Eden joins with the Afon Mawddach, just above the village of Ganllwyd, but the SAC boundary continues downstream to the tidal limit of the Mawddach at Llanelltyd. The Afon Eden is fed by a number of base-poor upland streams, which flow from the eastern flanks of the Rhinog mountains. The Ardudwy leat takes the most acidic waters from the eastern tributaries to Llyn Trawsfynydd. This water is used to maximise the water available for HEP generation by the Maentwrog Power Station.

The area receives high average rainfall, which has contributed to the development of raised bogs, blanket bog, and transition mires and quaking bogs. Two areas of raised bog occur at the top end of the catchment, close to the watershed, where they were once part of a much larger extent of bog, much of which is now flooded by Llyn Trawsfynydd. Transition mires and quaking bogs occur in waterlogged situations where they receive nutrients from the surrounding catchment as well as from rainfall. They are located within the wetlands surrounding the areas of raised bog.

The ecological structure and functions of the site are dependent on hydrological and geomorphological processes (often referred to as hydromorphological processes), the quality of riparian habitats and connectivity of habitats. Animals that are highly mobile such as migratory fish and otters, are also affected by factors operating outside the site.

The river contains the last known population of freshwater pearl mussels surviving in Wales, they are almost entirely confined to one section of the river. Historically the mussels were more widespread in the catchment. The mussels rely on salmonid parr hosting, for a short period of time, the glochidial larvae of the mussels on their gills, so the success of migratory and spawning fish in the catchment is crucial to their long-term survival. Atlantic salmon is also an important fish species that breeds in the Mawddach catchment.

In the slow-moving waters just upstream from Pont y Gribble is a population of floating water plantain.

Potential Threats / Vulnerabilities

1) *Pollution of supporting habitat outside SAC, impacting Atlantic Salmon and otter:*

The Afon Eden – Cors Goch Trawsfynydd SAC is located approximately 11km to the east of proposals. The SAC is connected fluviially to the proposed works via the Afon Mawddach, however the SAC is located upstream of proposals. The tidal reach of the estuary reaches as far as 500m upstream of the Mawddach / Wnion confluence, therefore does not reach as far as the Afon Eden – Cors Goch Trawsfynydd SAC boundary. For this reason, and considering the scale and nature of the proposals, it is not likely that any pollution impacts from the proposed works would directly affect habitat within the SAC.

Otters are known to be widely distributed in the Mawddach catchment, and given that the species can have a range of between 20 – 30km it is highly likely that otters using habitat within the SAC would also be present in the vicinity of the proposed works at Barmouth. There is potential for the works to lead to temporary deterioration in water quality through increase in suspended solids from works next to the water environment, or from pollution through accidental spill from construction machinery. There is therefore the possibility of contamination of otter foraging habitat outside of the protected site, and a reduction in abundance and availability of prey for otters (fish).

Similarly, Atlantic Salmon is a feature of the Afon Eden – Cors Goch Trawsfynydd SAC and would be vulnerable to deterioration in water quality in the Afon Mawddach caused by any potential pollution event during the course of construction. Significant pollution to the Afon Mawddach could lead to mortality of Atlantic Salmon within the affected area, but could also act as a barrier to migrating Salmon moving up the catchment during spawning season. However, due to the high dilution factor associated with a marine environment and the scale and nature of the works proposed, it is considered highly unlikely that there would be significant effects from pollution within the estuary that would impact the Atlantic Salmon population. The threat of pollution and habitat degradation upon the Atlantic Salmon feature is therefore not considered a likely significant effect.

Outcome: It is considered that the threat from pollution during construction could potentially undermine the conservation objectives of the site for otter and is therefore a likely significant effect for this feature only.

2) Disturbance of mobile species features – Otter:

The Afon Eden – Cors Goch Trawsfynydd SAC supports a population of otters which will range within and beyond the boundaries of the SAC to feed and commute using the waterways and riparian land to feed, rest and breed. Otters are known to be widely present in the Mawddach catchment.

There are no Cofnod records of otter resting sites or holts within or in the vicinity of the proposed works area. Due to the exposed nature of the site within a populated area of town and the high level of disturbance already experienced within this area, the presence of artificial lighting, and the tidal inundation of the beachfront, it is considered highly unlikely that the proposed works area would support potential holt opportunities or resting sites. However, otters are very likely to be present, at times, on the Mawddach Estuary habitat nearby, whilst foraging and commuting.

There would be some localised temporary noise pollution during the works, above current levels, which could potentially cause a low level of disturbance to foraging otters. However, this would be minimal and the works would be undertaken during daylight hours when otter activity is minimal. There would be no additional artificial lighting of the site.

As this risk is so minimal, no resting sites would be disturbed and even if an otter foraging during daylight hours was to be temporarily disturbed within the construction period, it is not considered realistic to imagine that this could have a significant adverse effect on the conservation objectives of the otter feature of the SAC. This impact on otters is therefore scoped out of any further assessment.

Outcome: No likely significant effect

Summary of Likely Significant Effects and Features requiring Appropriate Assessment

- Pollution of supporting habitat outside SAC: Otter.

Table 8. Screening Assessment for Northern Cardigan Bay SPA

Northern Cardigan Bay SPA (82312 ha)	UK9020327
<u>Qualifying features</u> Red Throated Diver <i>Gavia stellata</i> <u>Description</u> Northern Cardigan Bay / Gogledd Bae Ceredigion SPA, as the name suggests occupies the northern half of Cardigan Bay on the west coast of Wales. Several rivers flow into the northern part of Cardigan Bay including the Dwyfach, Glaslyn/Dwryd, Wnion, Dysynni, Leri, Mawddach and Dyfi. The coastline is dominated by rocky cliffs and shores with occasional sandy beaches and estuaries. Where estuaries flow into northern Cardigan Bay, the sea quickly becomes more than 20 metres deep, but elsewhere remains shallow (less than 10 m deep) for up to 20 km offshore. These shallow areas are sub-tidal shingle reefs, known as the sarnau. All three of the sarnau lie roughly north-east to south-west and are presumed to be formed from glacial deposits left at the end of the last ice age. Sarn Badrig is the largest and most northerly sarn, running parallel with the Llŷn Peninsula from Harlech up to 24 km offshore. Sarn y Bwlch is the smallest sarn, starting from near Tywyn. Sarn Cynfelyn, the most southerly sarn, starts from north of Aberystwyth. These shallow reefs are important ecological habitats within the Northern Cardigan Bay / Gogledd Bae Ceredigion SPA and are important features of the Pen Llŷn a'r Sarnau Special Area of Conservation (SAC), designated under the EC Habitats and Species Directive. The two tidal streams that enter the Irish Sea, from the north near the Isle of Man and the south through the St George's Channel, meet in the vicinity of Cardigan Bay resulting in weak tidal currents in the area. The tidal range in the bay is up to 4m at a spring tide. <u>Potential Threats / Vulnerabilities</u> 1) <i>Pollution of marine environment outside SPA (including foraging habitat for mobile species features)</i> The SPA is located 3.5km west of the proposals. Although the site is hydrologically connected to the proposed works, given the nature and scale of the proposals and the dilution factor associated with the marine environment, it is considered highly unlikely that a pollution event during construction could impact the SPA itself. However, any localised pollution contamination could potentially impact upon the SPA's mobile species feature, the red throated diver, which could potentially be present the marine environment in the vicinity of the proposals for foraging. It is considered unlikely that any habitat further than c.500m away from the proposed works would suffer significant effects from pollution during construction, therefore any such contamination would be localised in nature. This could potentially effect upon feeding grounds and prey availability of the red throated diver, however, given the availability of suitable habitat elsewhere and the large range of this species, it is not considered likely that this poses a significant threat to the conservation objective of this feature. Outcome: No likely significant effect <u>Summary of Likely Significant Effects and Features requiring Appropriate Assessment</u>	

- None

Evidence provided in Tables 5 – 8 above allows the likely significant effects to European sites to be broken down into threats to specific features of the sites identified, with some features being screened out of any further assessment. Therefore, Table 9 below summarises the results of this screening exercise, listing the European sites identified as being at risk from the proposed works, the likely significant effects and the features of each of the sites that could be affected.

Table 9. Summary of Screening Exercise

European Site	Likely Significant Effects and Features at Risk Likely			
	<i>Pollution of habitat features and foraging habitat</i>	<i>Habitat loss / degradation through construction works</i>	<i>Disturbance / displacement of mobile species</i>	<i>Direct and Indirect loss of habitat through Coastal squeeze</i>
Pen Llyn a'r Sarnau SAC	• Intertidal Mudflats and Sandflats • Estuaries • Otter	• Intertidal Mudflats and Sandflats • Estuaries •	• Grey seal • Bottlenose dolphin	• Intertidal Mudflats and Sandflats
Afon Eden – Cors Goch Trawfynydd SAC	• Otter			

4.0 FORMAL SCREENING OPINION

The proposed improvement has been screened according to the statutory procedures laid out in the Habitats Regulations 2017 (as amended) using the methodology outlined in the Habitats Regulations Assessment Handbook.

The screening exercise concluded that likely significant effects (LSE) could not be ruled out for the Pen Llyn a'r Sarnau SAC and Afon Eden – Cors Goch Trawsfynydd SAC due to the reasons outlined in Tables 5 and 7 above and summarised in Table 9 above. Therefore, an appropriate assessment is required for these likely significant effects.

5.0 APPROPRIATE ASSESSMENT

5.1 Purpose

Where a project is likely to have a significant effect, the precautionary principle emphasises that consent can only be granted if the competent authority can ascertain that the proposed improvement will not adversely affect the integrity of the European site, following an appropriate assessment. This is the purpose of the appropriate assessment stage.

In accordance with the 'People Over Wind' ruling, the appropriate assessment takes any incorporated mitigation measures into account that are sufficient to remove the likely significant effect. Conversely, if mitigation measures are not proposed, or prove to be inadequate, they can be imposed by the competent authority via conditions or other planning tools.

The role of mitigation is different to that of compensation. Mitigation measures aim to avoid, remove or reduce significant effects on European sites, whereas compensation is only considered under the derogations at the later stages of the HRA if required.

The HRA Handbook outlines the definition of integrity in contemporary planning policy and states that for a consent-making body to conclude the absence of an adverse effect, then it should be 'convinced' that no reasonable scientific doubt remains. As defined by the CJEU (Sweetman) and European Commission, the integrity of the site is 'the lasting preservation of the constitutive characteristics of the site'. For further definitions see Section 1.5 above.

5.2 Approach

The screening assessment found that likely significant effects could not be ruled out for three features of the Pen Llyn a'r Sarnau SAC and the otter feature of the Afon Eden – Cors Goch Trawsfynydd SAC.

These issues are individually subject to further scrutiny through an appropriate assessment (Table 10, 11 and 12 below), which considers the site's conservation objectives for the features that have been screened into the assessment (see Table 9 above). Individual effects are assessed with and without mitigation, concluding with an individual Integrity Test including an assessment of whether any residual effects remain with mitigation in place. A list of the mitigation measures proposed is included in Table 13. If no adverse effect on integrity is recorded but residual effects do remain, an in-combination assessment is likely to be required. If an adverse effect on the integrity of the site remains, the assessment would have to proceed to the derogations, or stages 3 and 4 of HRA (see Table 1 and Figure 4 in Section 1 above).

Following an in-combination assessment of any residual effects (if required), an overall Formal Integrity Test for the proposed works will be reported.

Information about the qualifying features of the sites has been obtained from the JNCC and NRW web-sites.

Table 10. Appropriate Assessment for Pollution Impacts

Pen Llyn a'r Sarnau SAC (146,010.52 ha)	<u>Features at risk</u> Estuaries Intertidal Mudflats and Sandflats Otter (<i>Lutra lutra</i>)
Afon Eden – Cors Goch Trawsfynydd SAC (284.29ha)	<u>Features at risk:</u> Otter (<i>Lutra lutra</i>)
Assessment without mitigation	
The Pen Llyn a'r Sarnau SAC supports a number of estuarine and marine habitats and species, and the proposed works will take place directly within and adjacent to the SAC, with machinery access through the SAC required. Much of the SAC is marine but extensive intertidal areas are also included. Of the nine habitats for which the site is designated, those in closest proximity to the proposals include 'mudflats and sandflats not covered by seawater at low tide' which is present within and adjacent to the proposed works area, and the broader 'estuaries' habitat which covers the whole of the Mawddach Estuary area. The Pen Llyn a'r Sarnau SAC is also designated for a number of qualifying species, including its population of otters, which are known to range far and wide within and beyond the boundaries of the SAC to forage, breed, rest and commute. Whilst predominantly aquatic, they will use riparian land for foraging and resting and are susceptible to disturbance or changes in prey availability. Consequently, the presence and availability of resting places, food and freshwater, are key factors in the maintenance of the overall population. The Afon Eden – Cors Goch Trawsfynydd SAC is designated for its raised bog and blanket bog habitats along with the Afon Eden which is a relatively unmodified river, mainly upland in character. The Afon Eden, approximately 10km, flows from just south of Llyn Trawsfynydd, down toward the village of Ganllwyd where it joins with the Afon Mawddach. The SAC boundary continues downstream to the tidal limit of the Mawddach at Llanelltyd, where the Mawddach flows into the Pen Llyn a'r Sarnau SAC boundary, approx. 11km upstream (east) of the proposals. The ecological structure and functions of the site are dependent on hydrological and geomorphological processes, the quality of riparian habitats and connectivity of habitats. Species that are highly mobile, such as migratory fish and otters, are also affected by factors operating outside the site. Like the Pen Llyn a'r Sarnau SAC, Otter is also a qualifying species for the Afon Eden - Cors Goch Trawsfynydd SAC. It can be presumed, given the distances involved and the wide-ranging behaviour of the species, and the fact that the site is within the same catchment as the proposals, that otters in the vicinity of the proposals will form part of the Afon Eden – Cors Goch Trawsfynydd SAC population. As reported in the screening stage (Section 3) of this HRA, it is possible that the machinery and materials used for the proposed works on site could be a source of pollution, which could directly affect the habitat and species features discussed above. Such pollution incidents would cause localised pollution of the immediate habitat and water environment, and depending on the scale, flows and tides at the time, could spread both upstream and downstream. There is a risk therefore of pollution causing degradation of habitat features within and adjacent to the works. Likewise, it is possible that any contamination of the intertidal habitat could lead to a reduction in prey availability for the local otter population. Unmitigated, any pollution release to the environment could potentially undermine conservation objectives of the habitats and otter features of Pen Llyn a'r Sarnau SAC, along with the otter feature	

of the Afon Eden-Cors Goch Trawsfynydd SAC. However, due to the small scale and temporary nature of the work, any pollution incident is likely to be relatively small in scale and there would be a high degree of dilution and dispersion within the marine water environment of the estuary, particularly during tidal cycles. With this in mind, any effects are likely to be short-term. The likelihood of significant effects on these habitat and species features through contamination is low, however, without mitigation, residual effects could be considered to remain.

Conclusion

Without any mitigation measures in place, there is some risk to the intertidal mudflats and sandflats, estuaries, and other features of the identified sites from pollution contamination. Conservation objectives (i)(ii)(iii) (as listed in the table below) of Pen Llyn a'r Sarnau SAC's habitat features could potentially be compromised. Conservation Objective (iii) of Pen Llyn a'r Sarnau SAC's other feature, along with Conservation Objective (i) of Afon Eden – Cors Goch Trawsfynydd's other feature could also be compromised. Therefore, an adverse effect on the integrity of these sites due to pollution cannot be ruled out without mitigation in place.

Assessment with Mitigation

Given that adverse effects have been identified, this assessment must consider if mitigation measures incorporated within the scheme can provide the competent authority with 'certainty' that no reasonable scientific doubt remains as to the absence of an effect upon the integrity of the European site.

Each of the mitigation measures is considered to cover the criteria identified in the DTA HRA Handbook, namely effectiveness, reliability, timeliness, deliverability, enforcibility and likelihood they will be maintained and persist for however long is necessary. This HRA does not make any distinction between embedded elements of the design that may provide ecological benefits that are secondary to their primary purpose and the bespoke measures specifically designed to avoid, cancel or reduce the impact of the development on site features.

The control of pollution and similar incidents forms a frequent component of most large-scale developments. Consequently, a range of tried and trusted techniques can be adopted to reduce the risk of such events to an acceptably low level or remove them entirely even where sensitive European sites are concerned. This provides a high degree of confidence that they will be successful.

Application of mitigation measures:

Mitigation measures are included in full in Table 10 below, but those involved with reducing or avoiding the potential impact from pollution and habitat degradation can be summarised as follows:

- Contractor to prepare and adhere to a Construction Environment Management Plan (CEMP) which will detail what measures will be in place to protect the surrounding environment. Location of adjacent protected sites shall be clearly highlighted.
- Materials stored on site shall be located more than 10m away from watercourses or estuary habitat at all times.
- Pollution spill kits to be readily available on site and in plant/machinery at all times, with staff suitably trained in how to deploy.
- Contractor to have emergency incident response procedure in place in the case of a spillage.
- Contractor to adhere to pollution prevention best practice guidelines, including;
 - PPG1: Understanding your environmental responsibilities.

- GGP5: Works and maintenance in or near water.
 - PPG6: Working at construction and demolition sites.
 - GPP21: Pollution response planning.
 - GPP22: Dealing with spills.
- Biodegradable lubricant and hydraulic oil to be used in plant machinery where possible. Biodegradable oils are less toxic than most synthetic oil but should still be stored to the same standards as other oils and prevented from entering the water environment.
 - Works to take place at low tide conditions only. No works to be completed within the intertidal area when the adjacent mudflat and sandflats are inundated with seawater.
 - Any excess concrete material or wash-water shall be fully and securely contained and disposed of appropriately off site
 - All concreting works to take place at low tide conditions, allowing sufficient time for concrete to set prior to any potential tidal inundation. Curing accelerators to be used where necessary.
 - Contractor to monitor tidal and weather conditions / forecasts and plan work accordingly

Conclusion

With these mitigation measures in place it is considered that the risk is reduced to the extent that there would be no adverse effect on the integrity of the Pen Llyn a'r Sarnau SAC and Afon Eden Cors Goch Trawsfynydd SAC, with no residual effects on any of the Conservation Objectives of the features of these sites.

Table 11. Appropriate Assessment for habitat degradation and loss through construction works.

Pen Llyn a'r Sarnau SAC (146,010.52 ha)	<u>Features at risk</u> Estuaries Intertidal Mudflats and Sandflats
Assessment without mitigation The proposed improvement works to the sea wall and new surface water outlet installation will take place within and directly adjacent to the SAC. Due to the location of the works, machinery access will be required along the foreshore from the north facing slipway located approx. 40m south west of the Viaduct Gardens sea wall. Excavation works for the sea wall and placement of rock armour will take place within the intertidal area, directly adjacent to the SAC. Excavation works and construction associated with the installation of the surface water outfall will take place within the SAC. Of the nine habitats for which the site is designated, those in closest proximity to the proposals include 'mudflats and sandflats not covered by seawater at low tide' which is present within and adjacent to the proposed works area, and the broader 'estuaries' habitat which covers the whole of the Mawddach Estuary area. An intertidal biotope survey was undertaken in the area during March 2022. (Refer to <i>Barmouth</i>	

Viaduct Gardens Intertidal Biotope Report, ARUP, 2022). The report summarises the intertidal habitat in front of the Viaduct Gardens frontage wall as follows:

The characteristics of the habitat here resemble predominant areas of intertidal bare sand with patchy areas of shingle and cobbles. The rock armour and viaduct pillars have been colonised by sparse lichen and patches of green alga. Lower down on the shore, small intertidal rocks and boulders are present, colonised by brown and green algae

A relatively broad range of commonly occurring species were observed; including the following, SACFOR abundance denoted as [#]:

- Algae - Chlorophyta (green seaweeds): *Ulva enteromorpha* [O] (gutweed).
- Algae - Ochrophyta: Phaeophyceae (brown seaweeds): *Fucus spiralis* [C] (spiral wrack), *Pelvetia canaliculata* [C] (channelled wrack), *Fucus vesiculosus* (bladderwrack) [C], *Fucus ceranoides* (horned wrack) [O], *Ascophyllum nodosum* [O] (knotted wrack).
- Crustacea - *Semibalanus balanus* [A] (acorn barnacle), *Austrominius modestus* [R] (Darwin's barnacle – Invasive Non-Native Species).
- Chordata: Pisces: Osteichthyes (fish) – *Lipophrys pholis* [P] (shanny), *Pholis gunnellus* [P] (butterfish).
- Mollusca - *Littorina littorea* [C] (common periwinkle).

Due to the requirements for machinery access and construction activities within the intertidal mudflats and sandflats / estuary habitat during the proposed works there is a threat of habitat degradation and loss. In order to access the intertidal area in front of the sea wall, construction plant and machinery will need to track across the harbour foreshore from the main harbour slipway. This could cause rutting and compaction of the intertidal mudflat and sandflat habitat in this area, which could harm invertebrates within the habitat. However, it is recognised that areas of the harbour will already be subject to such disturbance, as vessels are regularly launched or recovered via the slipway. Similarly, excavating areas of this intertidal habitat in order to undertake the works could lead to habitat degradation, particularly if the areas are not restored appropriately. Any such degradation is only likely to have minimal impact on the habitat features of the SAC due to the small scale and temporary nature of the works and the abundance of these habitat features in the surrounding area.

The installation of the new surface water outfall pipe, which will extend out into SAC habitat, will result in permanent loss of habitat for the footprint of the pipe structure (approx. 67m²). This will result in loss of (0.006ha) of the SAC's intertidal mudflat and sandflat habitat which constitutes part of the 'mudflats and sandflats not covered by seawater at low tide' feature of the Pen Llyn a'r Sarnau SAC and also represents a sub-feature of the 'estuary' feature of the same SAC. Given that the total area of intertidal mudflat and sandflat habitat in the SAC is in the region of 3358ha, the loss of 0.006ha (representing less than 0.0002%) is not considered to be significant, and would not have an adverse effect on the integrity of the Pen Llyn a'r Sarnau SAC. However, as the impact from permanent loss of habitat cannot be mitigated, residual effects would remain.

A coastal process assessment has been carried out to quantify any direct and indirect impacts on coastal processes occurring as a result of the project. The assessment considered both construction and operational impact, including direct loss from the foreshore, release of sediments, changes in flow condition, potential for scour and the effects of climate change (see Appendix G).

The assessment concludes that there will be very limited changes in coastal processes as a result of upgrading the sea wall and installation of the outfall. The direct loss of mapped intertidal habitat is predicted to be *circa* 67m² as a result of the footprint of the new outfall. Where changes may occur due to blockage effects of the outfall they will be very minor due to its sheltered location and position in the tidal frame. As a result the assessment expects that the direct and indirect effects on coastal processes (and therefore Annex 1 habitats) will be negligible.

The Coastal Processes Assessment also undertook an assessment of potential coastal squeeze losses in line with NRW Guidance GN062 (see Appendix G). Potential for coastal squeeze losses to occur from the SAC has already been identified. Further detailed analysis is provided in Appendix G of this document. In summary, for the worst case UKCP18 RCP8.5 95th %ile scenario, a total of 1.37ha of coastal squeeze losses were calculated at the is frontage for the life time of the project.

These losses are further defined is the assessment as follows:

- 0.75 ha of coastal squeeze; and
- 0.62 ha of natural squeeze.

Natural squeeze is defined as the loss of habitat against any natural feature that restricts the rollback of intertidal habitats, in this case high ground limiting the accommodation space available.

Therefore 0.75ha of coastal squeeze losses are attributed to the project.

Conclusion

Without any mitigation measures in place, there is some risk to the intertidal mudflats and sandflats, and estuaries features of the Pen Llyn a'r Sarnau SAC from habitat degradation, coastal squeeze and loss through construction activities. Conservation objectives (i)(ii)(iii) (as listed in the table below) of Pen Llyn a'r Sarnau SAC's habitat features could potentially be compromised. Therefore, an adverse effect on the integrity of these sites cannot be ruled out without mitigation in place.

Assessment with Mitigation

Given that adverse effects have been identified, this assessment must consider if mitigation measures incorporated within the scheme can provide the competent authority with 'certainty' that no reasonable scientific doubt remains as to the absence of an effect upon the integrity of the European site.

Each of the mitigation measures is considered to cover the criteria identified in the DTA HRA Handbook, namely effectiveness, reliability, timeliness, deliverability, enforcibility and likelihood they will be maintained and persist for however long is necessary. This HRA does not make any distinction between embedded elements of the design that may provide ecological benefits that are secondary to their primary purpose and the bespoke measures specifically designed to avoid, cancel or reduce the impact of the development on site features.

Application of mitigation measures:

Mitigation measures are included in full in Table 10 below, but those involved with reducing or avoiding the potential impact of habitat degradation from construction activites can be summarised as follows:

- Materials stored on site shall be located more than 10m away from watercourses or estuary habitat at all times.
- Works to take place at low tide conditions only. No works to be completed within the intertidal area when the adjacent mudflat and sandflats are inundated with seawater.
- Access to and along the intertidal area to be via the main harbour slipway and along a designated pathway to keep potential habitat disturbance to a minimum.

- Bog mats to be used under plant/machinery in any soft parts of the intertidal areas to reduce potential compaction impacts.
- There shall be no access to mid – to lower shore where trafficking of vehicles may directly impact sensitive marine habitats.
- Excavations to be backfilled in same layers as they were removed, so that the top 1m layer of sediment removed goes back in at this level, and anoxic materials lower down is returned to the bottom of the excavations. This will aid recovery of the habitat following excavation works.
- Beach material excavated for the pipe is to be placed within the surrounding intertidal area and not taken from site.
- Beach levels to be restored around the new pipe once construction work is complete, using existing excavated beach material.

The loss of 0.75ha as a result of coastal squeeze cannot be mitigated, therefore a conclusion of adverse effect on the integrity of the Pen Llyn ar Sarnau must be drawn.

Conclusion

The described measures are considered to reduce with risk of construction activity to the extent that there would be no adverse effect on the integrity of the Pen Llyn a'r Sarnau SAC. However, residual effects do remain due to the loss of habitat attributed to coastal squeeze and minor direct habitat loss, which cannot be mitigated.

Table 12. Appropriate Assessment for disturbance / displacement of mobile species

Pen Llyn a'r Sarnau SAC (146,010.52 ha)	<u>Features at risk</u> Bottlenose Dolphin <i>Tursiops truncatus</i> Grey Seal <i>Halichoerus grypus</i>
Assessment without mitigation	
The proposed works to the sea wall will be carried out from dry land however aspects of the works will need to be carried out from the foreshore, during low tide conditions. As the construction method of the sea wall is sheet piling, it poses a potential to cause underwater noise, specifically impacting on any grey seals and bottlenose dolphins that could be present in the vicinity of the proposed works from the Pen Llyn a'r Sarnau SAC. The proposed works are likely to involve the installation of sheet piling, which is likely to cause increased disturbance as a result of noise, to the bottlenose dolphin and grey seal features of the SAC, if they are found to be present in the vicinity of the proposed works during construction. Artificially introduced hazards and reductions in the natural quality and suitability of bottlenose dolphin and grey seal habitat in the SAC can occur through noise and visual disturbance. The activity has the potential to increase anthropogenic underwater noise in the marine environment in the vicinity of the proposed works, albeit temporarily during construction. This could potentially alter the behaviour of the bottlenose dolphin and grey seal should they be present in the area. Such occurrence may temporarily displace these species from important feeding habitat whilst pile driving activity is taking place. In a recent study on bottlenose dolphins in the Moray Firth (in relation to the	

construction of the Nigg Energy Park in the Cromarty Firth), small effects of pile driving on dolphin presence have been observed, however, dolphins were not excluded from the vicinity of the piling activities (Graham et al. 2017). The pile driving resulted in a slight reduction of the presence, detection positive hours and the encounter duration for dolphins within the Cromarty Firth, however, this response was only significant for the encounter durations. Encounter durations decreased within the Cromarty Firth (though only by a few minutes) and increased outside of the Cromarty Firth on days of piling activity. These data highlight a small spatial and temporal scale disturbance to bottlenose dolphins as a result of impact piling activities.

Due to the availability of other suitable habitat within the SAC and the temporary nature of the works it is not considered likely that the proposals will have a significant likely effect. However, grey seals and bottlenose dolphin presence cannot be ruled out.

Observations of bottlenose dolphins in the SAC have recorded centres of activity in Tremadog Bay, at the entrances to estuaries and also close to some of the Sarnau reefs, indicating the catchments of the freshwater tributaries entering the site together with the offshore reefs contribute to the overall site integrity for the species (NRW, 2018).

No grey seals have been historically recorded in the vicinity of the works according to a Cofnod search of the site. In areas that have high incidence of human presence through coastal walking, boating, fishing or other activity, the grey seal is generally not seen hauled out. It is therefore not considered likely that the proposals will have a significant effect upon potential grey seal haul-out habitat.

Conclusion

Without any mitigation measures in place, there is some risk to the bottlenose dolphin and grey seal features of the Pen Llyn a'r Sarnau SAC from disturbance and displacement through construction activities and noise. Conservation objectives (i)(ii)(iii) (as listed in the table below) of Pen Llyn a'r Sarnau SAC's species features could potentially be compromised. Therefore, an adverse effect on the integrity of these sites cannot be ruled out without mitigation in place.

Assessment with Mitigation

Given that adverse effects have been identified, this assessment must consider if mitigation measures incorporated within the scheme can provide the competent authority with 'certainty' that no reasonable scientific doubt remains as to the absence of an effect upon the integrity of the European site.

Each of the mitigation measures is considered to cover the criteria identified in the DTA HRA Handbook, namely effectiveness, reliability, timeliness, deliverability, enforcibility and likelihood they will be maintained and persist for however long is necessary. This HRA does not make any distinction between embedded elements of the design that may provide ecological benefits that are secondary to their primary purpose and the bespoke measures specifically designed to avoid, cancel or reduce the impact of the development on site features.

Application of mitigation measures:

Mitigation measures are included in full in Table 10 below, but those involved with reducing or avoiding the potential impact of mobile species disturbance / displacement from construction activities can be summarised as follows:

- Pilling and other related construction works shall occur in dry conditions only;
- Pilling will cease and standing time will be implemented during high tide;

With the implementation of the above mitigation measures in place, no works (including pile driving activity) will take place in the water column. This will reduce the distance in which such anthropogenic noise will carry into the marine environment.

Conclusion

With these mitigation measures in place it is considered that the risk is reduced to the extent that there would be no adverse effect on the integrity of the Pen Llyn a'r Sarnau SAC, with no residual effects on any of the Conservation Objectives of the features of the site.

Conservation objectives

Impact on Conservation Objectives – Pen Llyn a'r Sarnau SAC		
Conservation Objectives for 'Mudflats and Sandflats not covered by seawater at low tide' and Estuaries'.		Outcome
The vision for this feature is for it to be in favourable conservation status, where all the following conditions are satisfied:		
(i)	The overall distribution and extent of the habitat features within the site, and each of their main component parts is stable or increasing. For the intertidal mudflat and sandflat feature these include: - Mya arenaria and polychaetes in muddy gravel - Eel grass Zostera marina beds - Muddy gullies in the Mawddach estuary. For estuaries this includes the stability of sandy sediments in proportion to the muddy sediments. <u>Restoration and recovery</u> As part of this objective it should be noted that; for the estuaries feature additional land which should form an integral part of the estuarine ecosystem should be restored.	Adverse effect on integrity due to coastal squeeze losses
(ii)	The physical, biological and chemical structure and functions necessary for the long-term maintenance and quality of the habitat are not degraded. Important elements include: - geology - sedimentology - geomorphology, - hydrography and meteorology - water and sediment chemistry - biological interactions. This includes a need for nutrient levels in the water column and sediments to be: - at or below existing statutory guideline concentrations	No adverse effect on integrity; No residual effects

- within ranges that are not potentially detrimental to the long-term maintenance of the features species populations, their abundance and range. Contaminant levels in the water column and sediments derived from human activity to be: - at or below existing statutory guideline concentrations - below levels that would potentially result in increase in contaminant concentrations within sediments or biota - below levels potentially detrimental to the long-term maintenance of the feature species populations, their abundance or range taking into account bioaccumulation and biomagnification. <u>Restoration and recovery</u> As part of this objective it should be noted that; for the estuaries feature the structure and functions of the estuaries that have been damaged/degraded by the constraints of artificial structures such as flood banks, are restored.	
(iii) The presence, abundance, condition and diversity of typical species are such that habitat quality is not degraded. Important elements include: - species richness, - population structure and dynamics, - physiological health, - reproductive capacity, - recruitment, - mobility, - range.	No adverse effect on integrity; No residual effects
Conservation Objectives for ‘Otter’, ‘Bottlenose dolphin’ and ‘Grey seal’ To achieve favourable conservation status, all the following, subject to natural processes, need to be fulfilled and maintained in the long-term:	Outcome
(i) The population is maintaining itself on a long-term basis as a viable component of its natural habitat. Important elements include: • population size • structure, production • condition of the species within the site. As part of this objective it should be noted that for bottlenose dolphin and grey seal; • Contaminant burdens derived from human activity are below levels that may cause physiological damage, or immune or reproductive suppression	No adverse effect on integrity; No residual effects

For grey seal populations should not be reduced as a consequence of human activity.	
(ii) The species population within the site is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future. (iii) As part of this objective it should be noted that for bottlenose dolphin and grey seal: • Their range within the SAC and adjacent inter-connected areas is not constrained or hindered • There are appropriate and sufficient food resources within the SAC and beyond • The sites and amount of supporting habitat used by these species are accessible and their extent and quality is stable or increasing	No adverse effect on integrity; No residual effects
(iv) The presence, abundance, condition and diversity of habitats and species required to support this species is such that the distribution, abundance and populations dynamics of the species within the site and population beyond the site is stable or increasing. Important considerations include; • distribution • extent • structure • function and quality of habitat • prey availability and quality. As part of this objective it should be noted that; • The abundance of prey species subject to existing commercial fisheries needs to be equal to or greater than that required to achieve maximum sustainable yield and secure in the long term. • The management and control of activities or operations likely to adversely affect the species feature is appropriate for maintaining it in favourable condition and is secure in the long term. • Contamination of potential prey species should be below concentrations potentially harmful to their physiological health. • Disturbance by human activity is below levels that suppress reproductive success, physiological health or long-term behaviour • There are sufficient sources within the SAC and beyond of high quality freshwater for drinking and bathing.	No adverse effect on integrity; No residual effects
Populations should be increasing.	No adverse effect on integrity; No residual effects

Impact on Conservation Objectives – Afon Eden - Cors Goch Trawsfynydd SAC	
Conservation Objectives for 'Otter'	Outcome
(i) The population of otters in the SAC is stable or increasing over the long term and reflects the natural carrying capacity of the habitat within the SAC, as determined by natural levels of prey abundance and associated territorial behaviour.	No adverse effect on integrity; No residual effects
(ii) The natural range of otters in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches that are potentially suitable to form part of a breeding territory and/or provide routes between breeding territories. A number of potential and breeding sites have been identified (Lyles, 2006) in the upper reaches of the Afon Eden. The size of breeding territories may vary depending on prey abundance.	No adverse effect on integrity; No residual effects
(iii) The population size should not be limited by the availability of suitable undisturbed breeding sites. Where these are insufficient they should be created through habitat enhancement and where necessary the provision of artificial holts. No otter breeding site is subject to a level of disturbance that could have an adverse effect on breeding success. Where necessary, potentially harmful levels of disturbance are managed. Survey information shows that otters are widely distributed in the Mawddach catchment.	No adverse effect on integrity; No residual effects
(iv) The safe movement and dispersal of individuals around the SAC is facilitated by the provision, where necessary, of suitable riparian habitat, and underpasses, ledges, fencing etc at road bridges and other artificial barriers.	No adverse effect on integrity; No residual effects
(v) All factors affecting the achievement of these conditions are under control.	No adverse effect on integrity; No residual effects

Integrity Test

Integrity test:	Pollution Impacts: Without mitigation there is a low risk of pollution leading to degradation of habitats and species adjacent to the proposed works area. This could potentially undermine Conservation Objectives of two habitat features and one species feature of the Pen Llyn a'r Sarnau SAC and one species feature of Afon Eden – Cors Goch Trawsfynydd SAC. However, when the proposed mitigation measures are taken into account, it is considered that the risk would be reduced sufficiently to consider that there would be no adverse effect on the integrity of these protected sites, with no residual effects. Habitat loss/degradation impacts: Permanent loss of approx. 0.006ha of habitat from the 'Intertidal mudflats and sandflats' and 'Estuary' features of the Pen Llyn a'r Sarnau SAC does contravene the conservation objectives of the site but it is not considered to represent an adverse effect on the integrity of the site. As no mitigation is possible residual effects remain.
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	Without mitigation there is a risk of construction activities such as plant/vehicle movement and excavation activities leading to habitat degradation within the intertidal area adjacent to the proposed works (away from the footprint of the works itself). This could potentially undermine Conservation Objectives for two habitat features of the Pen Llyn a'r Sarnau SAC. However, when the proposed mitigation measures are taken into account, it is considered that the risk would be reduced sufficiently to consider that there would be no adverse effect on the integrity of the protected site, with no residual effect. Disturbance impacts: Without mitigation there is a risk of construction activities, such as pile driving, leading to disturbance and displacement of mobile species that may be present in the marine environment in the vicinity of the proposed works. This could potentially undermine Conservation Objectives for two species features of the Pen Llyn a'r Sarnau SAC. However, when the proposed mitigation measures are taken into account, it is considered that the risk would be reduced sufficiently to consider that there would be no adverse effect on the integrity of the protected site, with no residual effect. Coastal Squeeze The loss of 0.75ha of habitat as a result of coastal squeeze cannot be mitigated, therefore a conclusion of adverse effect on the integrity of the Pen Llyn ar Sarnau must be drawn.
Residual effects / In combination:	Residual effects remain due to the small-scale loss from two features of the Pen Llyn a'r Sarnau SAC, which cannot be mitigated. Therefore, the residual effects will need to be assessed in-combination with other relevant projects.

Table 13. Mitigation Measures Proposed to Reduce or Avoid Impacts on European Sites

Mitigation Proposed	Impact Reduced/Avoided	European Site Affected	Site Features Affected
• Contractor to prepare and adhere to a Construction Environment Management Plan (CEMP) which will detail what measures will be in place to protect the surrounding environment. Location of adjacent protected sites shall be clearly highlighted. • Materials stored on site shall be located more than 10m away from watercourses or estuary habitat at all times. • Pollution spill kits to be readily available on site and in plant/machinery at all times, with staff suitably trained in how to deploy. • Contractor to have emergency incident response procedure in place in the case of a spillage. • Contractor to adhere to pollution prevention best practice guidelines, including; - PPG1: Understanding your environmental responsibilities. - GGP5: Works and maintenance in or near water. - PPG6: Working at construction and demolition sites. - GPP21: Pollution response planning. - GPP22: Dealing with spills. • Biodegradable lubricant and hydraulic oil to be used in plant machinery where possible. Biodegradable oils are less toxic than most synthetic oil but should still be stored to the same standards as other oils and prevented from entering the water environment. • Works to take place at low tide conditions only. No works to be completed within the intertidal area when the adjacent mudflat and sandflats are inundated with seawater. • Any excess concrete material or wash-water shall be fully and securely contained and disposed of appropriately off site • All concreting works to take place at low tide conditions, allowing sufficient time for concrete to set prior to any potential tidal inundation. Curing accelerators to be used where necessary. • Contractor to monitor tidal and weather conditions / forecasts and plan work accordingly	Pollution of marine environment and otter foraging habitat.	Pen Llyn a'r Sarnau SAC Afon Eden – Cors Goch Trawfynydd SAC.	Estuaries Intertidal Mudflats and Sandflats Otter Otter

- Materials stored on site shall be located more than 10m away from watercourses or estuary habitat at all times. - Works to take place at low tide conditions only. No works to be completed within the intertidal area when the adjacent mudflat and sandflats are inundated with seawater. - Access to and along the intertidal area to be via the main harbour slipway and along a designated pathway to keep potential habitat disturbance to a minimum. - Bog mats to be used under plant/machinery in any soft parts of the intertidal areas to reduce potential compaction impacts. - There shall be no access to mid – to lower shore where trafficking of vehicles may directly impact sensitive marine habitats. - Excavations to be backfilled in same layers as they were removed, so that the top 1m layer of sediment removed goes back in at this level, and anoxic materials lower down is returned to the bottom of the excavations. This will aid recovery of the habitat following excavation works. - Beach material excavated for the pipe is to be placed within the surrounding intertidal area and not taken from site. - Beach levels to be restored around the new pipe once construction work is complete, using existing excavated beach material.	Habitat degradation through construction activities.	Pen Llyn a'r Sarnau SAC	Estuaries Intertidal Mudflats and Sandflats
- Pilling and other related construction works shall occur in dry conditions only. - Pilling will cease and standing time will be implemented during high tide. - All relevant persons on site to be made aware of the mitigation and obligations in place, and to be briefed with a toolbox talk on the relevant ecological issues prior to commencement of the work. - Works shall be confined to daylight hours and no additional artificial lighting shall be used.		Pen Llyn a'r Sarnau SAC	Bottlenose dolphin Grey seal

6.0 IN-COMBINATION ASSESSMENT

6.1 Purpose

The test for likely significant effect in Regulation 63(1) of the Habitats Regulations is that effects should be assessed 'either alone *or* in combination with other plans or projects'.

For the avoidance of doubt, the Regulations identify that an in-combination assessment is required only during the screening stage and only where an impact is identified which would have an insignificant effect on its own (a 'residual' effect) but where likely significant effect may arise cumulatively with other plans or projects.

Cumulative effects are those which make the effect more likely or more significant. Thus, where likely significant effects can be ruled out alone, there is no need for an assessment in combination because if there is no effect, it cannot add anything to an in-combination or cumulative assessment.

At the screening stage of the assessment, however, it can be difficult to distinguish between likely significant and insignificant effects where the exercise is meant to be brief. This HRA therefore assumes that any credible effect identified is assessed *alone with no residual effects*. This allows all possible effects to be captured for more detailed scrutiny in the appropriate assessment.

Despite this, further scrutiny may modify this opinion and the need for an in-combination assessment may subsequently be required as described in the Handbook:

'...at a later stage when the appropriate assessment concludes that a plan or project screened as having a likely significant effect alone will not, upon further investigation, be likely to have such an effect alone, but could have such an effect in combination. In (this) situation, the appropriate assessment will need to be extended, in order to address in combination effects to inform the integrity test bearing in mind the potential for cumulative effects.'

As a result, in-combination effects are therefore considered in the appropriate assessment, which has two functions. The first function is to consider whether further scrutiny of the appropriate assessment can identify that an effect, previously identified as significant alone, was not of sufficient magnitude to justify this outcome and should have been identified as a residual effect and considered in-combination.

Secondly, it explores if possible residual adverse effects on the integrity of the site that were ruled out alone could lead to a significant adverse effect when considered in-combination. This employs best practice by considering cumulative effects at all stages of the HRA.

6.2 Approach

In the appropriate assessment stage of this HRA (see Section 5 above), adverse effects on the integrity of the European sites were ruled out for all impacts when considered alone but residual effects remained for one impact, namely habitat loss. This can be shown clearly in another version of Table 9 (Summary of Screening Exercise) above, except with only the residual effects remaining after the appropriate assessment stage with mitigation taken into account, presented as Table 14 below.

This shows that all impacts on Afon Eden – Cors Goch Trawsfynydd SAC can be ruled out from any in-combination assessment, as well as any impacts relating to pollution and disturbance of mobile species, as there were no residual effects relating to these. The in-combination assessment needs to

consider other plans and projects that could have similar effects on the features included in Table 14 below.

Table 14. Summay of Residual Effects to be Assessed In-combination with other plans and projects.

European Site	Residual Effects and Features at Risk Likely
	<i>Habitat loss / degradation through construction works</i>
Pen Llyn a'r Sarnau SAC	• Intertidal Mudflats and Sandflats • Estuaries

6.3 Assessment

Numerous sources of information have been reviewed in order to identify plans and projects that could potentially act in-combination with the proposed works. To keep the assessment relevant, the review of plans and projects has focussed on those that have potential to impact upon the marine / intertidal environment within the Pen Llyn and Sarnau SAC, with particular focus on areas identified as containing 'intertidal mudflat and sandflat' habitat feature along with those areas that contain 'estuaries' feature.

Data on the Wales Marine Planning Portal has been reviewed, which provides details of projects which are subject to Marine Licencing within the Pen Llyn a'r Sarnau SAC Area. Natural Resources Wales and Gwynedd Council have been consulted and plans/projects identified as being relevant are detailed below.

Nationally Significant Infrastructure Projects (NSIPs), currently identified on the Planning Inspectorate (PINS) website have been reviewed for their potential to interact with the proposed works, based on their relevance (located within Pen Llyn a' Sarnau SAC). No relevant projects were identified.

National Grid, Snowdonia Visual Improvement Provision - Afon Dwyrdd Estuary

The Visual Impact Provision (VIP) Snowdonia Project is a stakeholder driven project to mitigate the visual impact of existing electricity infrastructure in nationally protected landscapes in Great Britain. The aim of the VIP Snowdonia Project is to relocate a section of overhead line underground within, and adjacent to, Snowdonia National Park. The VIP subsection is approximately 3km in length and runs from National Grid's existing Garth Sealing End Compound (SEC) near Minffordd (to the east of Porthmadog) across the Dwyrdd Estuary where it enters the western edge of the Snowdonia National Park. It then continues past the small settlement of Cilfor. The Proposed Project will include the construction of a new underground cable connection (constructed within a tunnel); a new SEC and associated terminal pylon; reconfiguration of the existing Garth SEC; two new tunnel head houses and associated accesses; and removal of the existing VIP subsection (pylons and conductors).

The HRA for this scheme (Visual Impact Provision Snowdonia, Marine Habitats Regulations Assessment: Stage 1 Screening and Stage 2 Information to Inform Appropriate Assessment) identified potential impacts on the 'Atlantic Salt Meadows' feature of the Pen Llyn a'r Sarnau SAC, which also forms part of the 'Estuaries' feature of the SAC. The use of temporary access tracks and working areas has the potential to reduce the range of the Qualifying Feature. However, with the implementation of mitigation measures which include restoring habitat and establishing location of rare species in order to avoid disturbance, it is concluded that the scheme will not have an adverse effect on the integrity

of the SAC either alone or in combination with other plans or projects. No other impact on this site are included. As no residual effects from this project remain, in relation to the European sites included in Table 14 above, there is no potential for this project to act in-combination with the proposed works.

Barmouth Beach Management

Proposed small scale movement of wind blown sand from main promenade area in Barmouth. Scheme involves moving sand from promenade area, back onto beach, to a designated deposition area within the sand dunes on Barmouth Beach.

The activity will be taking place outside the Pen Llyn a'r Sarnau SAC, and the HRA (Barmouth Beach Management Habitat Regulations Assessment, YGC, December 2022) concluded that there would be no significant effect on the SAC with no residual effects. There is therefore no potential for this project to act in-combination with the proposed works.

Hafan y Mor – Construction of rock armour breakwaters

The key components of the proposed development includes changing 120m of existing linear coastal rock revetment to groynes with sand/gravel, introducing a further 210m of coastal protection made up of rock armour breakwaters with intervening areas of beach (sand/gravel) recharge, and importation of around 18,000m³ of sand, gravel and rock armour.

The HRA for this scheme (Hafan y Mor Holiday park 2030 vision masterplan – Environmental Statement, Habitat Regulations Appraisal – Volume 2:Appendix K, December 2019) concluded that there would be likely significant effect on the Pen Llyn a'r Sarnau SAC with the main effect being that part of the footprint of the coastal defences necessarily intrudes into the boundary of the SAC and will cover an area of sandflat that is an interest feature of the SAC. The area of direct sandflat loss is 0.15 ha (1,542 m²). In the event of a negative assessment of the implications for a European site, under Regulation 68 of the Conservation of Habitats and Species Regulations 2017 the appropriate competent authority must secure that any necessary compensatory measures. For this project compensation measures have been developed, to address the loss of SAC intertidal habitat under the footprint of the coastal defence works. It has been agreed with NRW that compensation for the loss of SAC habitat beneath the footprint of the works would therefore involve removal of rubble (imported material which provides rudimentary coastal protection at the top of the shore) within the shingle to enhance the quality of this habitat. This shingle restoration area will cover a 2,493 m² area of shingle to the east of the defences.

As the loss of habitat is suitably compensated for within the scope of the project, it is concluded that there is no potential for this project to act in-combination with the proposed works.

Welsh National Marine Plan (WNMP)

The HRA for this plan (Welsh National Marine Plan Habitat Regulations Assessment, August 2019), in relation to in-combination effects of other plans and projects, concludes that the wide range of external plans and programmes, and their varied approaches to HRA, ensures that attempting to define and assess specific effects at a strategic scale is not practicable to any meaningful extent. The review of plans and projects for 'in combination' effects was necessarily high level due to the strategic nature of the marine plan and the uncertainties inherent with it. 'In combination' effects will therefore need to be revisited and addressed in a more comprehensive manner at the project – level when more detailed information is available. However, the WNMP includes appropriate plan-level mitigating provisions within it that will minimise the risk of 'in combination' effects as a result of activities within the WNMP area.

No further plans or projects have been identified that could act in-combination with the residual effects of the proposed works.

6.4 Conclusion

No information was obtained that was able to suggest that there could be other plans or projects acting in-combination with the residual effects of the proposed works to create an adverse impact on the integrity of any European sites. The individual Integrity Tests for each issue evaluated in the appropriate assessment therefore stand with no need for further scrutiny and can be carried forward into the Formal Integrity Test in Section 7.

7.0 FORMAL INTEGRITY TEST / CONCLUSION

This HRA subjected the potential effects of the proposed works to an appropriate assessment and integrity test in accordance with the statutory procedures laid out in the Habitats Regulations 2017 (as amended) using methodology described in the Habitats Regulations Assessment Handbook (Tyldsley and Chapman, 2018 edition). As a result of this assessment, it can be ascertained that:

In terms of potential **pollution** of the adjacent estuary habitat during construction leading to degradation of habitat features and of the prey population of the otter feature of the Pen Llyn a'r Sarnau SAC and Afon Eden – Cors Goch Trawsfynydd SAC, it was considered that with mitigation in place, there would be no adverse effect on the integrity of these sites, with no residual effects.

In terms of **degradation** of intertidal habitat through construction activities leading to loss of intertidal habitat of the Pen Llyn a'r Sarnau SAC, it was considered that with mitigation in place, there would be no adverse effect on the integrity of the site, with no residual effects.

In terms of **disturbance** of mobile species during the proposed works, the assessment found that although there would be temporary increases in noise pollution during construction works, due to existing high levels of disturbance in the area and with the implementation of mitigation measures, any effects would be minimal, and there would be no adverse effects on the integrity of the sites, with no residual effects.

In terms of **habitat loss** as a result of coastal squeeze, these impacts cannot be mitigated. Therefore, a conclusion of adverse effect on the integrity of the Pen Llyn a 'r Sarnau must be drawn. The assessment must then proceed to discuss alternative options, IROPI and compensatory measures.

8.0 STAGE 4 – ALTERNATIVE SOLUTIONS

As an adverse effect on the integrity of the Pen Llyn a'r Sarnau SAC due to coastal squeeze losses has been concluded, the Habitats Regulation Assessment must consider alternative solutions. If alternative solutions that would have a lesser effect or avoid an adverse effect on the integrity of the site are available, then the current proposal should not be approved. If there are no alternative solutions available, then the HRA proceeds to consider, IROPI and compensatory measures.

Whilst the principle of the hold the line policy for this frontage has been established through the SMP and SMP HRA processes, the method of delivering the hold the line policy must be considered at project level.

NRW Guidance GN062 clarifies this position through the following statement:

'If the proposed project is within a 'hold the line' policy unit, then the SMP can be used to support the consideration of alternative solutions in terms of policy. For example, it can show that alternative policies had been considered and tested, and that a conclusion had been reached that the 'hold the line' policy was preferred and could be justified. This means more detailed consideration of alternative solutions at the project level can focus on whether there are alternative ways to deliver the 'hold the line' policy which would have a lesser effect or avoid adverse effect on site integrity. For example, consideration could be given to localised set back of the defence structure which would reduce the squeeze effect by creating space. If such measures are not possible whilst still delivering the project objectives, then it can be concluded that there are no alternative solutions.'

Roll Back Options

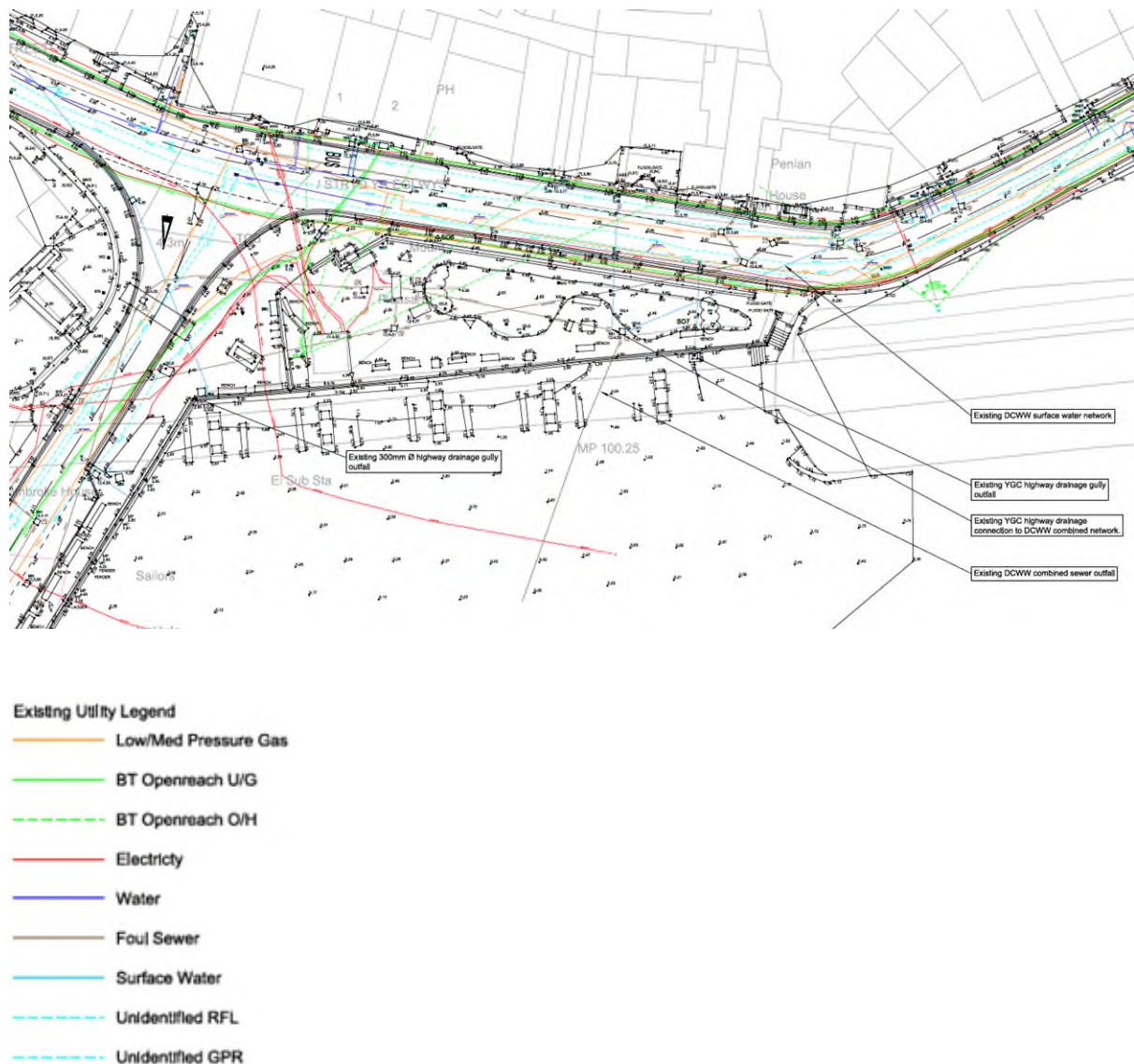
For an option to have less coastal squeeze losses, the line of the existing sea wall would need to move landward to allow further intertidal habitat to be created. The full extent of potential roll back is shown in the coastal squeeze assessment (Appendix G). And repeated below:



Figure 13. Area behind the sea wall with a topography of HAT +1 in 2124 (pink area RCP8.5 70%ile and pink plus green area RCP8.5 95%ile)

Whilst this area of land could theoretically be changed into intertidal habitat through moving the existing line of defence, there would be significant social, economic and environmental impact of doing so.

As is demonstrated in the following image, there are several key services located directly behind the sea wall. This area of the Town represents a very narrow corridor between the harbour and steep rocky slopes of Dinas Oleu to the North. Therefore, a significant number of the towns key services run through this area, serving the wider town.



These include an electricity sub-station, low and high voltage electricity supplies; an existing combined foul water pumping station with associated connections and overflows, telecoms connections to several properties and business and a low and high pressure gas main. With the exception of the telecoms cables all the other key services are located below ground, meaning they are all reliant of the harbour wall providing protection from coastal erosion and flooding.

The A497 country road represents the only transport link from Barmouth to Dolgellau to the east, and is a key road for residents, emergency services and business. For the full extent of theoretical roll back to be achieved, it would mean the loss of this road, the key services described above and adjacent residential properties and businesses.

Relocating and diverting all the key services and closure of the road would need to be undertaken for any significant roll back to be achieved. However, due the steep sloping nature of the land to the north, there is no available space for the diversion of services and road, meaning that delivering such an option would be impossible to achieve.

Due to the presence of key services, transport links and properties behind the wall, and the lack of available space to move/divert these services, maintaining the line of the existing wall is considered to be the only possible way of implementing the 'hold the line policy' at this frontage. Further option assessment and refinement therefore continued on this basis.

Direct Impacts

The project forms part of Welsh Government's Coastal Risk Management Programme, and as such, needs to follow Welsh Government's flood risk appraisal process to determine a preferred option – prior to detailed design and consenting. A total of 11 options were identified and assessed for as part of the long list appraisal process. The options considered are summarised below:

Option 1- Do Nothing - This option would undertake no improvement or maintenance works in the area. This would likely increase both the frequency and the severity of flooding to all assets at risk (structures, road and infrastructure as previously described). The sea wall acting as both coast protection and flood defence was underpinned in 1996. Finally, climate change would further increase the risk and consequences of flooding.

Do Nothing option is contrary to the SMP policy for this coastline – as it would not hold the line over 3 epochs. Whilst this is not grounds for discounting the option it is disadvantageous.

Option 2-Do Minimum - This option is the approach being currently undertaken by the council.

The do minimum approach consists of maintaining infrastructure and supplying sandbags to residents. The expenditure on maintenance will increase in response to climate change. In addition, the Do-minimum approach includes for repairs to damaged sections of the sea wall.

This approach will eventually become contrary to the SMP policy for this coastline, which is to hold the line across all epochs; meaning that the defences must eventually be brought up to standard against the impacts of climate change. Although eventually being contrary to the SMP is not grounds for discounting this option it is disadvantageous.

Option 3 - Raise Sea Wall & Improve Existing Drainage Network

This option is summarised below. The major work items that form this option are:

- Strengthen the existing masonry sea wall by underpinning approximately 30 m.
- Locally raise crest level of sea wall by a 1m.
- Repair of damaged sections of sea wall between Viaduct Gardens and Bath House.
- 5 additional gullies with pipework connecting to public sewer in Church Street.
- 2 additional gullies connected to the surface water sewer outside Linda's shop.

Option 4 – Armour stone Revetment & New Drainage Network

The major work items that form this option are:

- Local armour stone revetment against the sea wall with increased crest level, reducing overtopping.
- Repair of damaged sections of sea wall between Viaduct Gardens and Bath House.
- Upsize the existing drainage network with a new flapped outfall through the revetment.
- Construct approximately 70 m of 450 mm diameter drainage network along the A496 to the new outfall.
- Replace and increase the number of gullies connecting to new drainage system.

Option 5 - Near-Shore Breakwater & New Drainage Network with Pumped Outfall

The major work items that form this option are:

- A new breakwater seaward of the viaduct
- Repair of damaged sections of sea wall between Viaduct Gardens and Bath House
- A new surface water culvert system with gullies along Church Street (50 m)
- Upgrade the existing culvert in Church Street and connect to new pumping station.
- Replace existing and add new gullies connecting to new surface water system.
- A new surface water pumping station and outfall.

Option 6 - Raised Beach & New Drainage Network with Pumped Outfall

The major work items that form this option are:

- A revetment seaward of the viaduct some 75 m in length with crest of 2 m AOD
- A raised beach between the proposed revetment and existing seawall
- Repair of damaged sections of sea wall between Viaduct Gardens and Bath House
- A new drainage network with gullies along Church Street (50 m)
- Replace and increase the number of gullies connecting to new drainage system.
- Upgrade the existing culvert in church street and connect to new pumping station.
- A new surface water pumping station and outfall.

Option 7- Near-Shore Breakwater & New Drainage Network with Storage

The major work items that form this option are:

- A near-shore breakwater seaward of the viaduct
- Repair of damaged sections of sea wall between Viaduct Gardens and Bath House
- A new drainage network of 450 mm diameter pipes in the A496 (70m) connected to the new outfall.
- Upgrade the existing culvert in Church Street include storage and connect to new outfall.
- Replace and increase the number of gullies connecting to new drainage system.
- A new surface water pumping station and outfall.

Option 8 - Raised Beach & Sea Wall with New Drainage Network with Pumped Outfall

The major work items that form this option are:

- Repair of damaged sections of sea wall between Viaduct Gardens and Bath House.
- A raised seawall at least 5.33m AOD plus allowance for wave action approx. 325 m in length with 3 gates for access. The sea wall has been set at 5.85 m AOD (1 m above existing).
- A new drainage network with gullies along Church Street (50 m).
- Replace and increase the number of gullies connecting to new drainage system.
- Upgrade the existing culvert in church street an connect to new pumping station.
- A new surface water pumping station and outfall.

Option 9 - New Impounded Marina

The major work items that form this option are:

- A new harbour wall from Trwyn Y Gwaith to headland near Glanaber Terrace at least 5.33 m AOD approx. 430 m in length, including lock access on existing channel.
- Upgrade the existing culvert on Church St and connect to new outfall.
- Replace and increase the number of gullies connecting to new drainage system.
- A new surface water pumping station and outfall.

Option 10 – Raise A496

This option is summarised here, the major work items that form this option are:

- Raising the A496 such that it is at a level above which the flood risk to it is acceptable i.e., above 5.33 m AOD with an allowance for wave action which means raising by at least 1.4 m at its lowest. The raising should be such that it allows water to pass underneath the road essentially creating a bridge. This option would involve significant utilities infrastructure loss and diversions.

This option would only protect the A496 road, not the adjacent properties or services. The substantial construction costs, lack of residential protection and impact on utility infrastructure of this option means it wouldn't be an economically feasible project, nor would it achieve the scheme objectives – therefore would never be funded and built.

Option 11 – Property Level Protection

This option is summarised here, the major work items that form this option are:

- Provision of individual property protection for the residential properties commercial properties.

Whilst property level protection is considered to be an effective way of addressing residual flood risk, as a standalone option without upgrading existing defences it would not achieve the hold the line policy in the medium or long term.

All options were assessed against the scheme objectives, to ensure that the preferred option was feasible and acceptable. The option assessment against the scheme objectives is summarised below.

	Objective1	Objective2	Objective3	Objective 4	Objective5
Description	Reduce risk of coastal flooding to properties at Viaduct Gardens	Maintain the landscape character whilst enhancing sea defences	Reduce flood risk to the A496 county road	Enhance sea defences without damage/harm to the environment.	Maintain the Cambrian coast railway line
Option 1	X	X	X	X	X
Option 2	X	X	X	X	X
Option 3	✓	✓	✓	✓	X
Option 4	✓	✓	✓	✓	X
Option 5	✓	✓	✓	?	✓
Option 6	✓	✓	✓	✓	✓
Option 7	✓	✓	✓	?	✓
Option 8	✓	✓	✓	✓	✓
Option 9	✓	✓	✓	?	✓
Option 10	X	X	✓	X	X
Option 11	✓	X	X	X	X

Options 1 through to 8 inclusive were moved on to the 'shortlist assessment' for further detailed consideration.

Option 8 represented the clear preferred option by virtue of a significantly better cost benefit ratio, allowing for the betterment of defences without significant damage/harm to the environment, and is the only option that meets the objectives of the scheme and achieves a full 200-year (tidal) with 50 years of climate change allowance. The surface water system (including the pumping station) provides a 1 in 100 year +30% allowance for climate change SoP.

Further refinement of option 8 during the detailed design stage led to the removal of the raised beach element, as part of this measure would be located within the SAC and would occur direct habitat loss. The only remaining element of the scheme which would directly impact the SAC would be part of the surface water outfall pipe. This outfall is essential to achieve the surface water flooding objectives and needs to outfall into the harbour. Through consultation with NRW's marine advisory team, the length of the piped outfall was reduced to keep the direct land take from the SAC to the minimum at 67m².

Conclusion.

The SMP conclusion of 'hold the line' for this frontage is confirmed by a project level assessment confirming that maintaining the existing line of defence is the only possible option.

The options appraisal process has then followed a comprehensive and robust option selection assessment to ensure any direct impacts on the SAC where kept to a minimum.

As no feasible alternative options have been identified, imperative reasons of overriding public interest will need to be demonstrated.

9.0 STAGE 5 – IMPERATIVE REASONS OF OVERRIDING PUBLIC INTEREST (IROPI)

The NRW GN062 Guidance states that:

“In the event where no alternative solutions are feasible, a project may still go ahead if it can be demonstrated that there are imperative reasons of overriding public interest. Overriding public interest means that the public interest of carrying out the purpose of the project is considered to override the importance of maintaining the site features at that location.”

The proposed Viaduct Gardens Flood Alleviation Scheme, in line with the SMP is within a ‘Hold The Line’ policy unit for all three epochs. Due to this reason, the SMP2 is used to support the findings in line with the Welsh Government Policy clarification note, paragraph 3.4.

‘Provided that an individual project/plan is demonstrably consistent with the relevant Shoreline Management Plan policy, the statutory notice to WG from NRW shall include a short confirmation of the fact and therefore the plan/project is justified on grounds of no alternative solutions and the existing Shoreline Management Plan IROPI’ (NRW, 2022).

Following the test for alternatives concluding no alternative solutions, the proposed project has been screened against the Stage 5 flowchart within the NRW GN062 guidance.

Are the proposed works in a ‘hold the line; policy unit	YES
Option 1 – works are within a ‘hold the line’ policy unit. The SMP can be used to support the IROPI test.	
Are there imperative reasons for overriding public interest of a social or economic nature sufficient to override the harm to the site?	YES Justification: In line with the SMP IROPI part of the justification for the HTL policy at PDZ 11.14 was as follows: <i>The scale of the importance is clear; given the social, economic and transport infrastructure, HTL is necessary along some frontages to protect access within and amongst surrounding communities, or to maintain the economic function of specific locations that support surrounding communities.</i> The proposed option moving forward for the Viaduct Gardens FAS gives is therefore considered in line with the SMP HRA for the ‘Hold the Line’ policy.
Proceed to Stage 6: Compensatory Measures.	

10.0 STAGE 6: COMPENSATORY MEASURES

The Coastal Squeeze Assessment carried out for the site of proposed works identified a potential habitat loss of 0.75ha.

In line the Welsh Government policy clarification note for the use of National Habitat Creation Programme in delivering FCERM projects, section 3.6 states:

“The compensatory measures necessary to offset those losses can be delivered as part of a strategic approach to address the adverse effects of implementing SMP policies, through the National Habitats Creation Programme (NHCP).”

In any of the above examples, if an appropriate assessment identifies that an FCERM intervention will adversely affect the integrity of a national site network, and proceeds on the basis of IROPI, then necessary compensatory measures must be secured. The most effective way to do this would be through the NHCP.

There is also a minor direct habitat loss of 67m² of the mudflat and sandflat feature identified during the Appropriate Assessment Stage. Whilst this loss was not considered to cause an adverse effect on integrity in its own right, it is recommended that this loss is also compensated for through the NHCP.

This allows work to proceed without the individual Risk Management Authority needing to source compensatory measures. However, the provision of land, qualitative habitat improvements or support to NHCP would strengthen their business case and may provide wider biodiversity and amenity benefits.

As the scheme promoter Gwynedd Council has identified the likely requirements as part of the appropriate assessment. The responsibility for monitoring loss and managing an adequate and timely supply of land through NHCP remains with NRW.

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APPENDICES

Appendix A: European sites potentially at risk (full table)

Types of project (or potential effect)	Sites to scan for and check	Initial list of potentially affected sites	Additional context	Final list of European sites potentially at risk
(1) All projects (terrestrial, marine, coastal)	Sites within which the project is wholly or partially located	Pen Llyn a'r Sarnau SAC	This criterion identifies all the European sites within the footprint of the scheme. The proposed works are within, and directly adjacent to Pen Llyn a'r Sarnau SAC	Pen Llyn a'r Sarnau SAC.
(2) Projects that could affect wetland features	(a) Sites upstream or downstream of the project location in the case of river or estuary sites	Pen Llyn a'r Sarnau SAC Meirionnydd oakwoods and Bat Sites SAC.	Effects considered are those associated with the physical presence of built development and the localised effects on surface/groundwater resources and quality, resulting from changes in run-off, sedimentation, erosion, etc.	See Criterion (3) below
	(b) Open water, peatland, fen, marsh and other wetland sites with relevant hydrological links to the project, irrespective of distance from the project location	Northern Cardigan Bay SPA Morfa Harlech and Morfa Dyffryn SAC Afon Eden – Cors Goch Trawsfynydd SAC	The proposed works lie within Pen Llyn a'r Sarnau SAC, a marine site (see Criterion (3) below). Morfa Harlech a Morfa Dyffryn SAC and Northern Cardigan Bay SPA are hydrologically connected. (see Criterion (3) below) The Meirionnydd Oakwoods and Bat Sites is located 12m north of the site at it's nearest point and could be susceptible to settlement of suspended dust particles during construction, however it is considered highly unlikely that this will impact upon the site's wetland features. There are no direct hydrological connections between the proposed works and the SAC. Effects on the wetland features of this site have been scoped out. Afon Eden-Cors Goch Trawsfynydd is connected by the Mawddach Estuary, located where the Afon Mawddach	

Types of project (or potential effect)	Sites to scan for and check	Initial list of potentially affected sites	Additional context	Final list of European sites potentially at risk
			enters the estuary, c.11km upstream at its closest point. However, due to the distance of this site and its location upstream of the proposed works, effects on the wetland features of this site have been scoped out.	
(3) Projects that could affect the marine environment	Sites that could be affected by changes in water quality, currents or flows; or effects on the intertidal or sub-tidal areas, or the seabed, or marine species	Pen Llyn a'r Sarnau SAC Northern Cardigan Bay SPA Morfa Harlech and Morfa Dyffryn SAC	Effects considered are those of a wider, more strategic scale than (2) above. There is some potential for the proposed works to cause adverse pollution impacts on the immediate and surrounding Pen Llyn a'r Sarnau SAC habitats during construction. Any potential for changes in hydraulic conditions is unlikely as there is minimal change from current footprint. Morfa Harlech a Morfa Dyffryn SAC and Northern Cardigan Bay SPA are hydrologically connected, however due to the scale and nature of the works proposed and the distnaces of these sites from the proposals, any pollution impacts are unlikely.	Pen Llyn a'r Sarnau SAC
(4) Projects that could affect the coast	Sites in the same coastal 'cell', or part of the same coastal ecosystem, or where there are interrelationships with or between different physical coastal processes	See (3) above.	Effects considered are those of a wider, more strategic scale than (2) above. See (3) above.	See (3) above.
(5) Projects that could affect	Sites whose qualifying features include mobile species which	Pen Llyn a'r Sarnau SAC	This considers direct impacts of the scheme on mobile species within or outside the designated sites. Mobile	Pen Llyn a'r Sarnau SAC

Types of project (or potential effect)	Sites to scan for and check	Initial list of potentially affected sites	Additional context	Final list of European sites potentially at risk
mobile species	may be affected by the project irrespective of the location of the location of the project or whether the species would be in or out of the site when they might be affected	Meirionnydd Oakwoods and Bat Sites SAC Afon Eden – Cors Goch Trawsfynydd SAC Northern Cardigan Bay SAC	species are those considered to spend part of their life-cycle on land, in water or air beyond the designated site boundary. Typically, it focuses on potential impacts on functionally-linked land and water utilised by bird, mammals or fish associated with European sites. Note that ‘indirect’ effects on mobile species on functionally – linked land or water beyond the development site, is considered under other criteria below, such as ‘6. Recreational pressure’, and ‘14. Disturbance’. Otter is a mobile species feature of the Pen Llyn a’r Sarnau SAC and the Afon Eden – Cors Goch Trawsfynydd SAC. Lesser horseshoe bat is a mobile species feature of the Meirionnydd Oakwoods and Bat Sites SAC. Both of these species could utilise land within or adjacent to the area of proposed works for foraging. Grey seal and bottle nose dolphin are features of the Pen Llyn a’r Sarnau SAC, which could be affected by habitat degradation and/or disturbance during construction. There is also potential for effect on the habitats of the red-throated diver feature of the Northern Cardigan Bay SAC.	Meirionnydd Oakwoods and Bat Sites SAC Afon Eden – Cors Goch Trawsfynydd SAC Northern Cardigan Bay SAC
(6) Projects that could increase recreational pressure on European sites where	(a)European sites within which the project would be wholly or partly located (b)Such European sites within an agreed zone of influence or	None	The project is not considered to increase recreational pressure on European sites. Therefore, direct effects on European sites from increased recreational pressure can be ruled out of any further consideration.	None

Types of project (or potential effect)	Sites to scan for and check	Initial list of potentially affected sites	Additional context	Final list of European sites potentially at risk
qualifying features are sensitive to such pressures	other reasonable and evidence-based travel distance of the project location that may be affected by local recreational or other visitor pressure generated by the project (c) Such European sites within an agreed zone of influence or other evidence-based longer travel distance of the project, which are major (regional or national) visitor attractions such as European sites which are National Nature Reserves where public visiting is promoted, sites in National Parks, coastal sites and sites in other major tourist or visitor destinations			
(7) Projects which could increase the amount of	(a) Sites that are used for, or could be affected by, water abstraction irrespective of distance from the project	None	The proposed works would not comprise of any such activities. Therefore, direct effects on European sites from increased development can be ruled out of any further consideration.	None

Types of project (or potential effect)	Sites to scan for and check	Initial list of potentially affected sites	Additional context	Final list of European sites potentially at risk
development	(b) Sites used for, or could be affected by, discharge of effluent from wastewater treatment works or other waste management streams serving the project, irrespective of distance from the project			
	(c) Sites that could be affected by the provision of new or extended transport or other infrastructure			
	(d) Sites that could be affected by increased deposition of air pollution arising from the proposals, including emissions from significant increases in traffic			
(8) Projects comprising linear developments or infrastructure	Sites within a specified distance from the centre line of the proposed route (or alternative routes), the distance may be varied for differing types of site/qualifying features and in the absence of established good practice standards, distances(s) to be agreed by the statutory conservation body	None	This HRA has adopted a 10km radius in which to evaluate the potential impacts of the proposed works. Individual effects are identified in other criteria. This criterion does not identify the types of potential impacts which are, instead, more closely defined by other criteria as listed above or below. Therefore, column 5 has been left blank as attention is drawn to more specific criteria.	See other criteria
(9) Projects that	Sites considered to have	None	The project is not considered to introduce new activities or	None

Types of project (or potential effect)	Sites to scan for and check	Initial list of potentially affected sites	Additional context	Final list of European sites potentially at risk
introduce new activities or new uses into the marine, coastal or terrestrial environment	qualifying features potentially vulnerable or sensitive to the effects of the new activities proposed by the project		uses into the environment.	
(10) Projects that could change the nature, area, extent, intensity, density, timing or scale of existing activities or uses	Sites considered to have qualifying features potentially vulnerable or sensitive to the effects of the changes to existing activities proposed by the project	None	The project is not considered to change the nature, area, extent, intensity, density, timing or scale of existing activities or uses in a way that would pose a threat to any habitat or species features of the protected sites.	None
(11) Projects that could change the quantity, quality, timing, treatment or mitigation of emissions or discharges to air, water or soil harvested, extracted or consumed	Sites considered to have qualifying features potentially vulnerable or sensitive to the changes in emissions or discharges that could arise as a result of the project, over and above those already identified	None	The project is not considered to change the the quantity, quality, timing, treatment or mitigation of any emissions or discharges to air, water or soil harvested, extracted or consumed.	None
(12) Projects	Sites whose qualifying features	None	No such activities are proposed and changes to biological	None

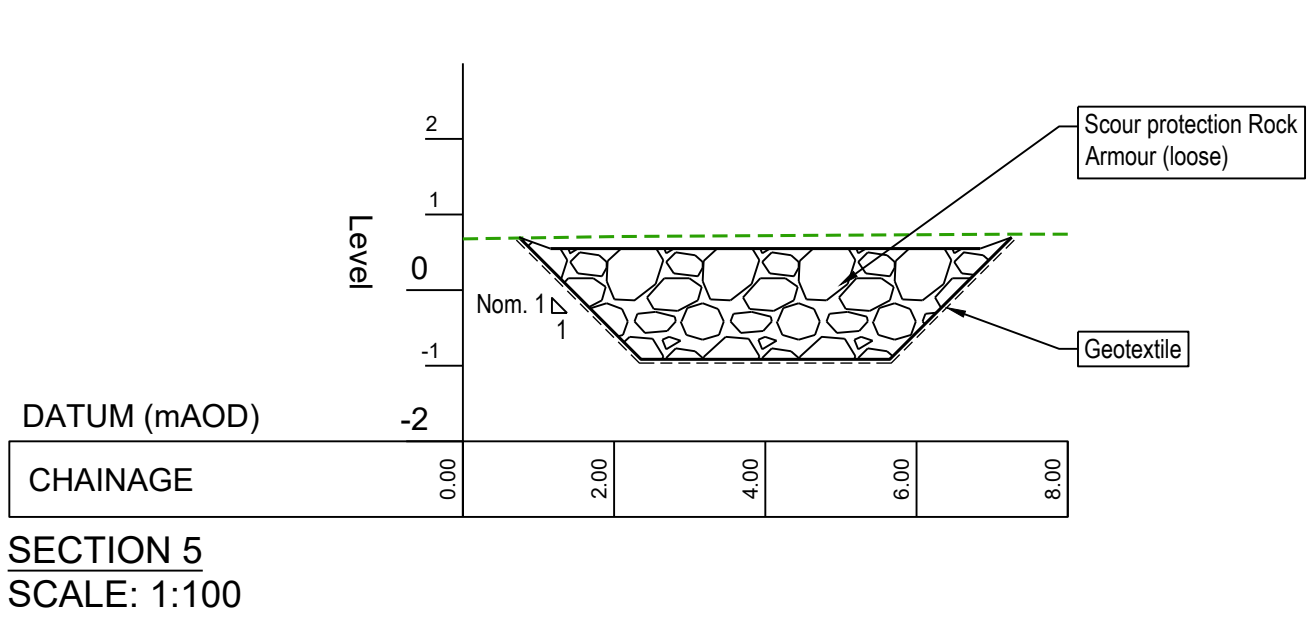
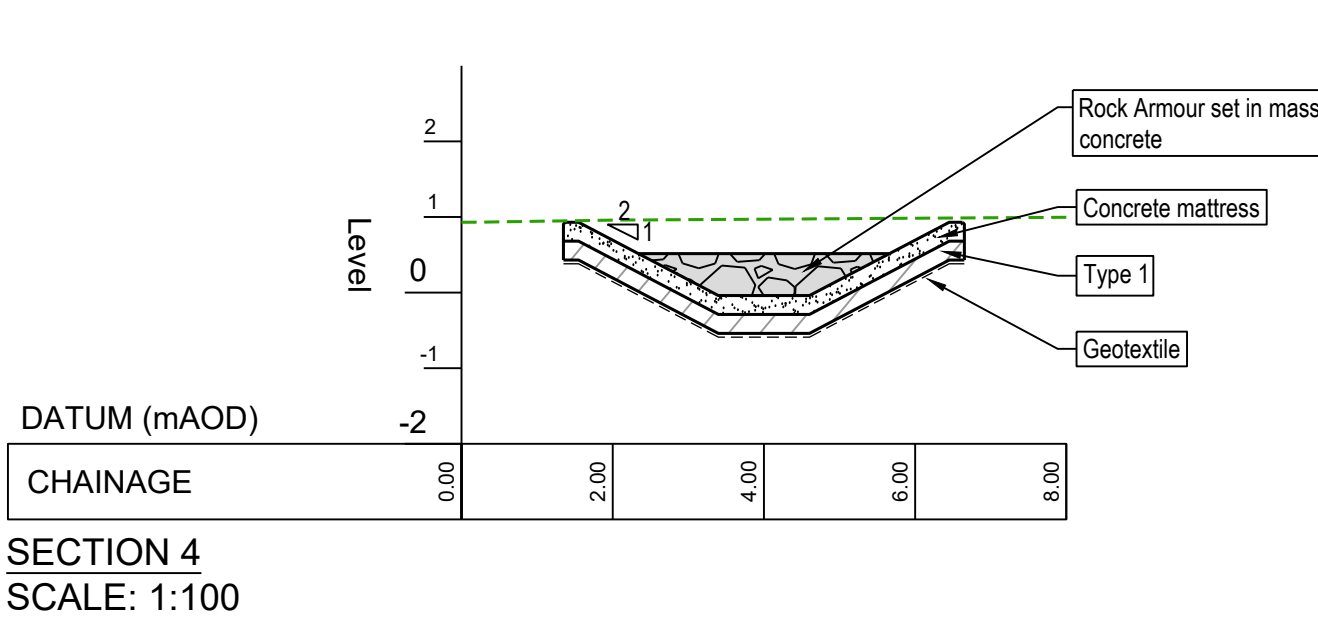
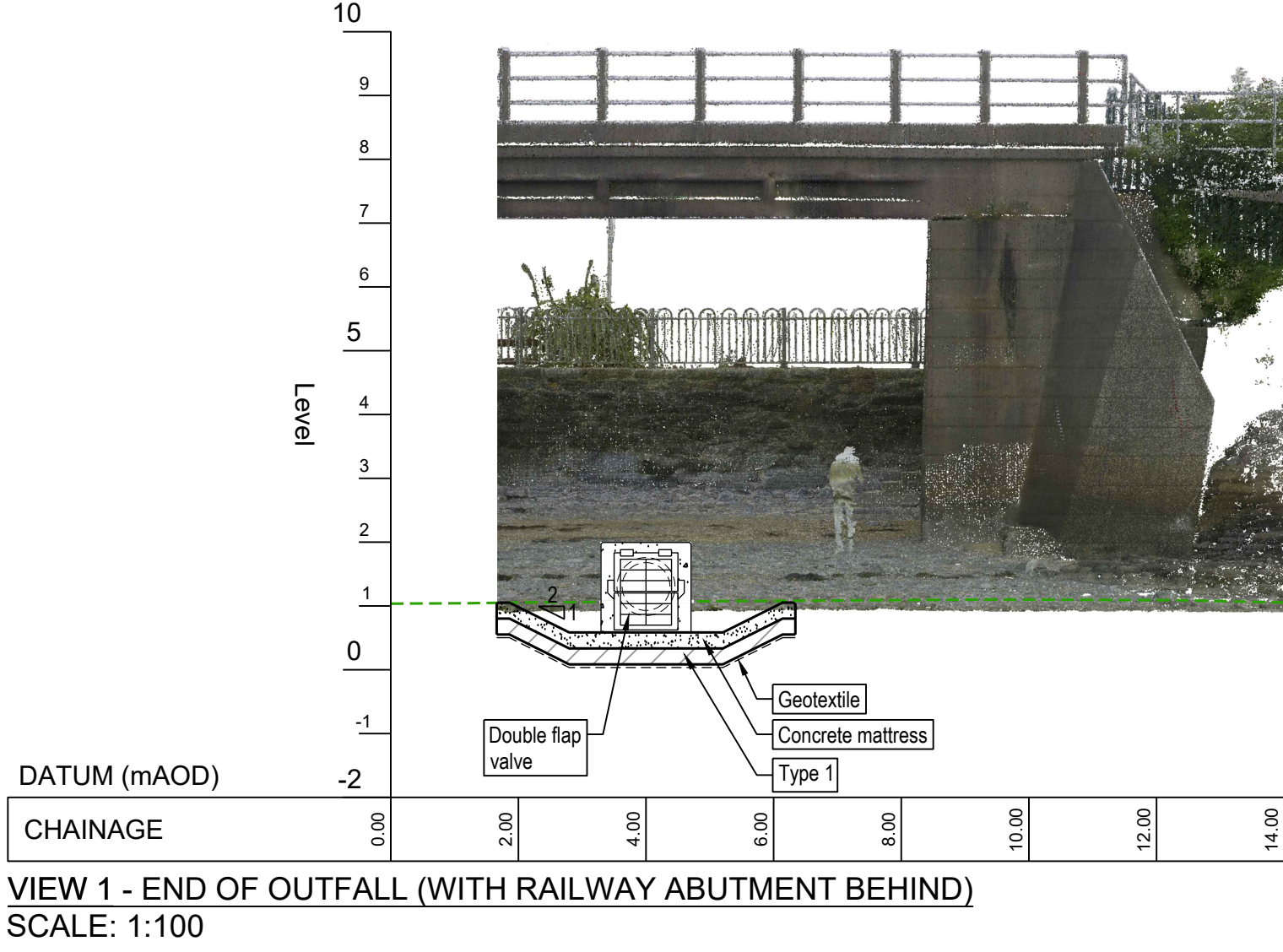
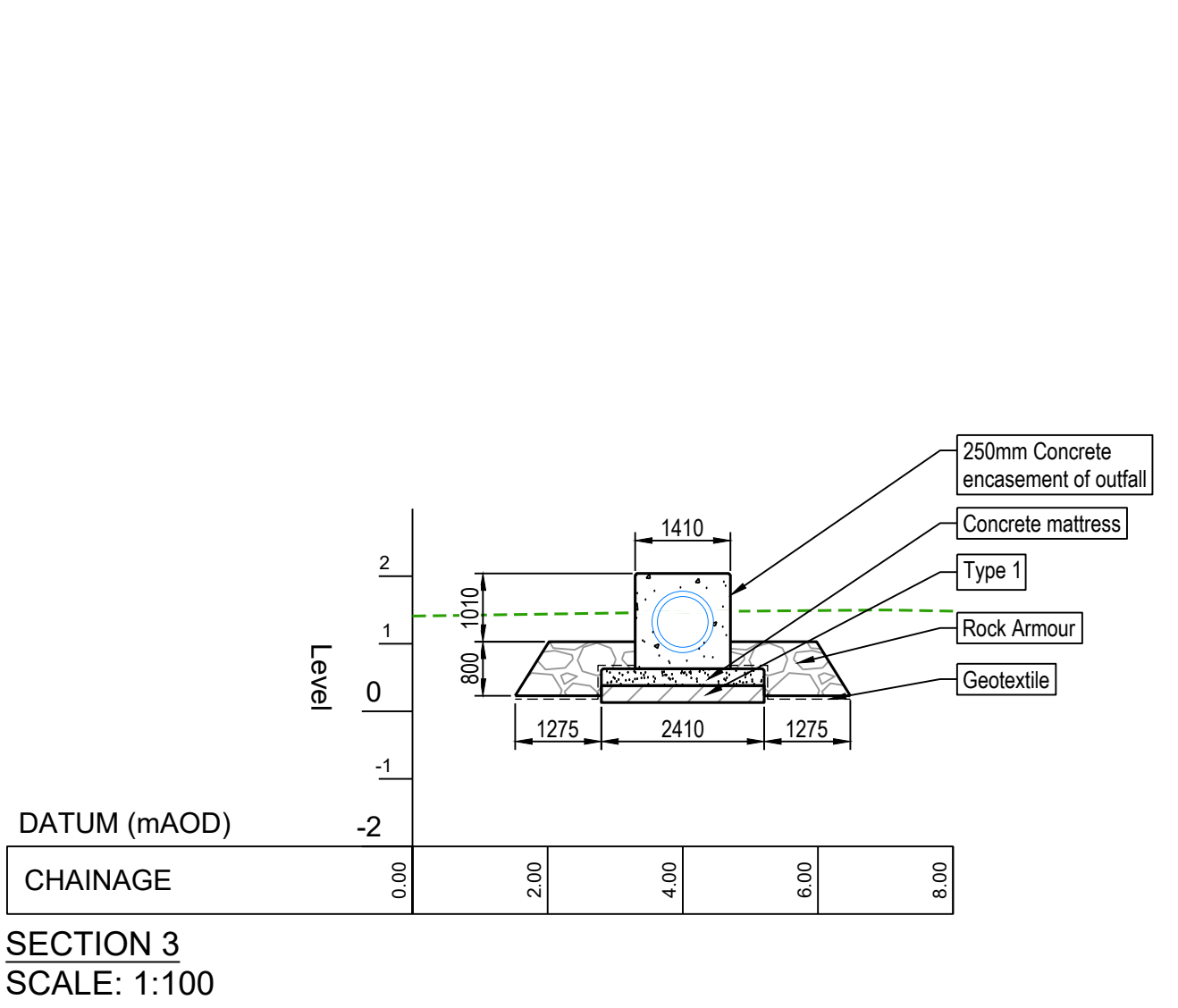
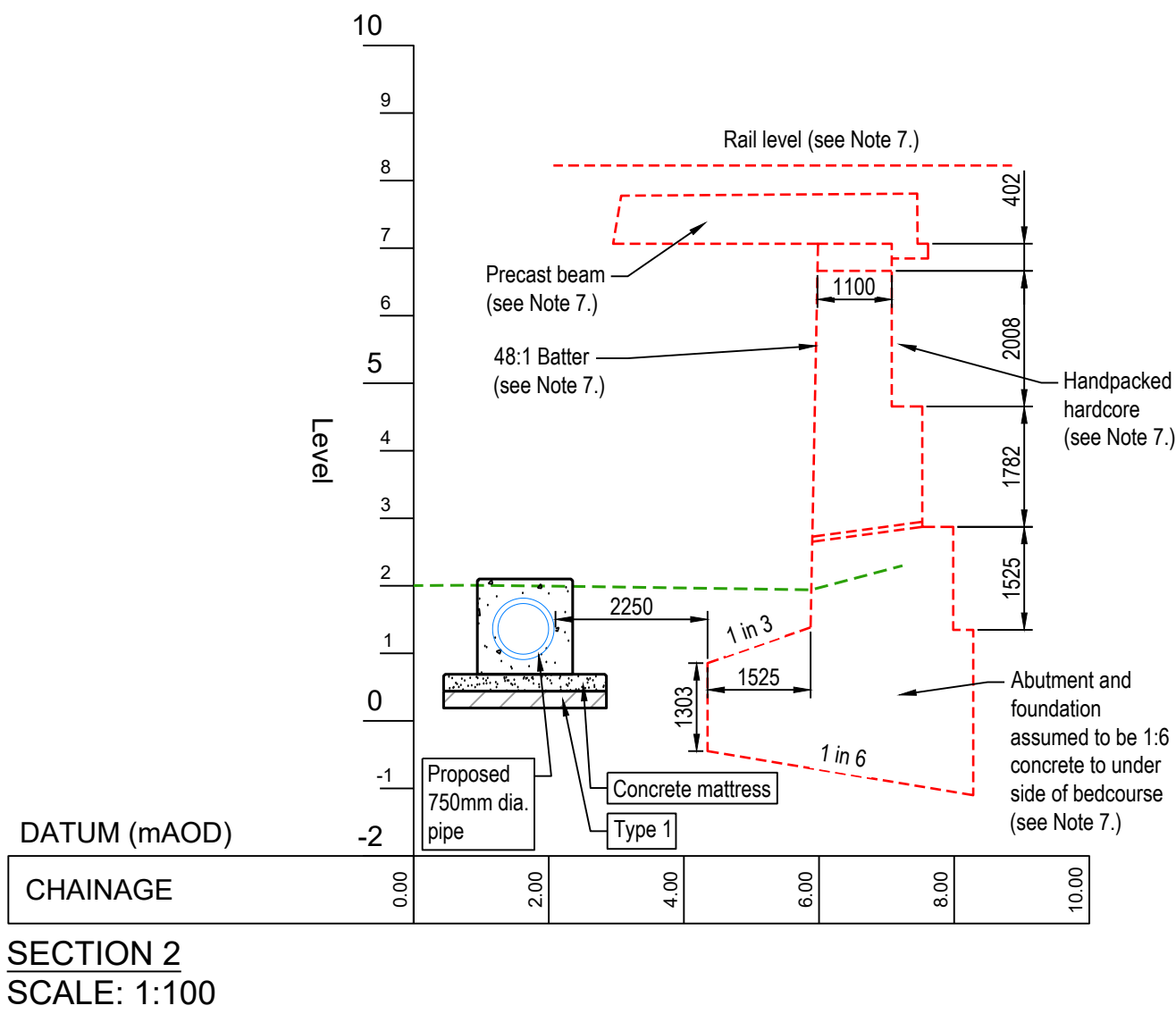
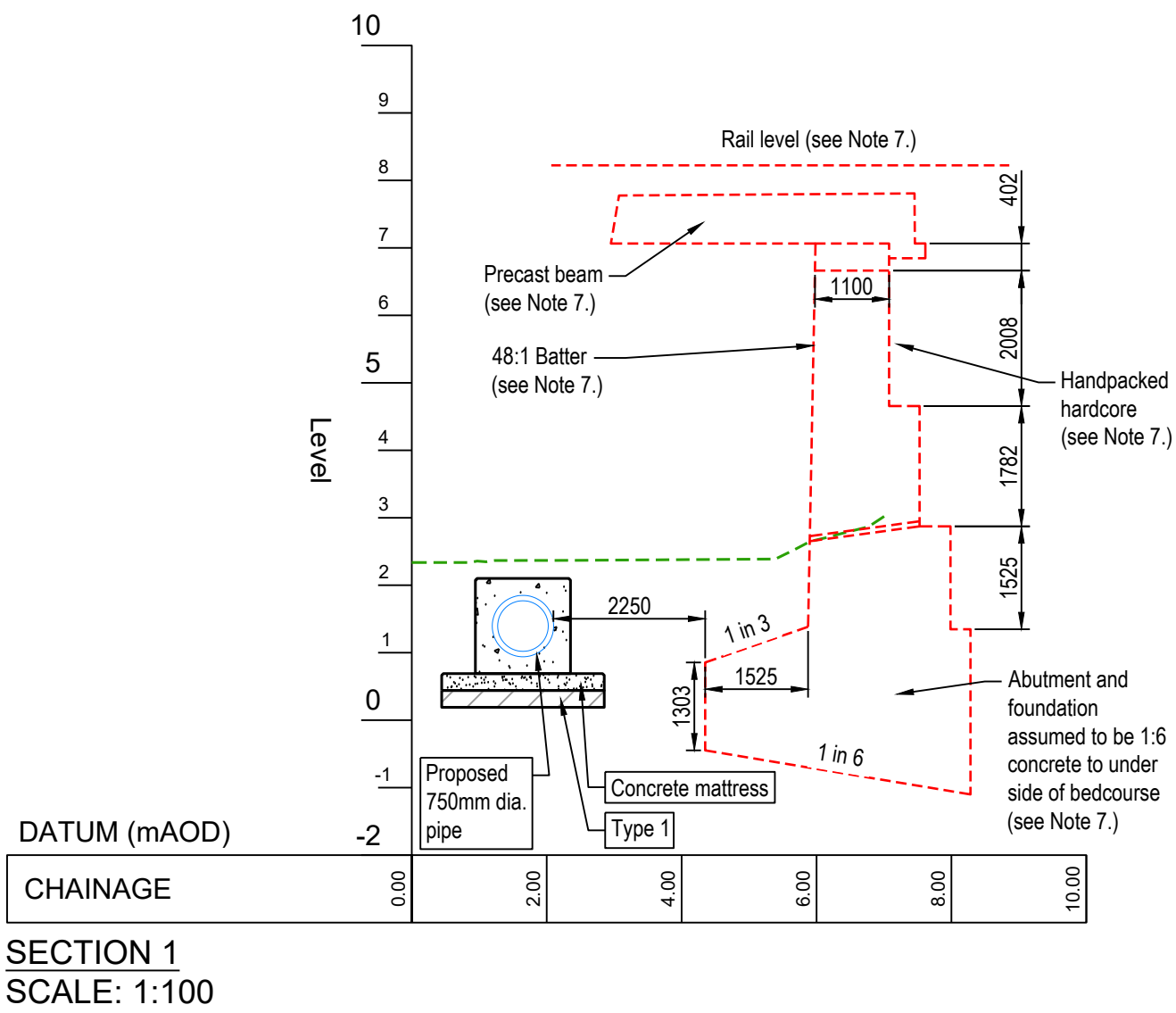
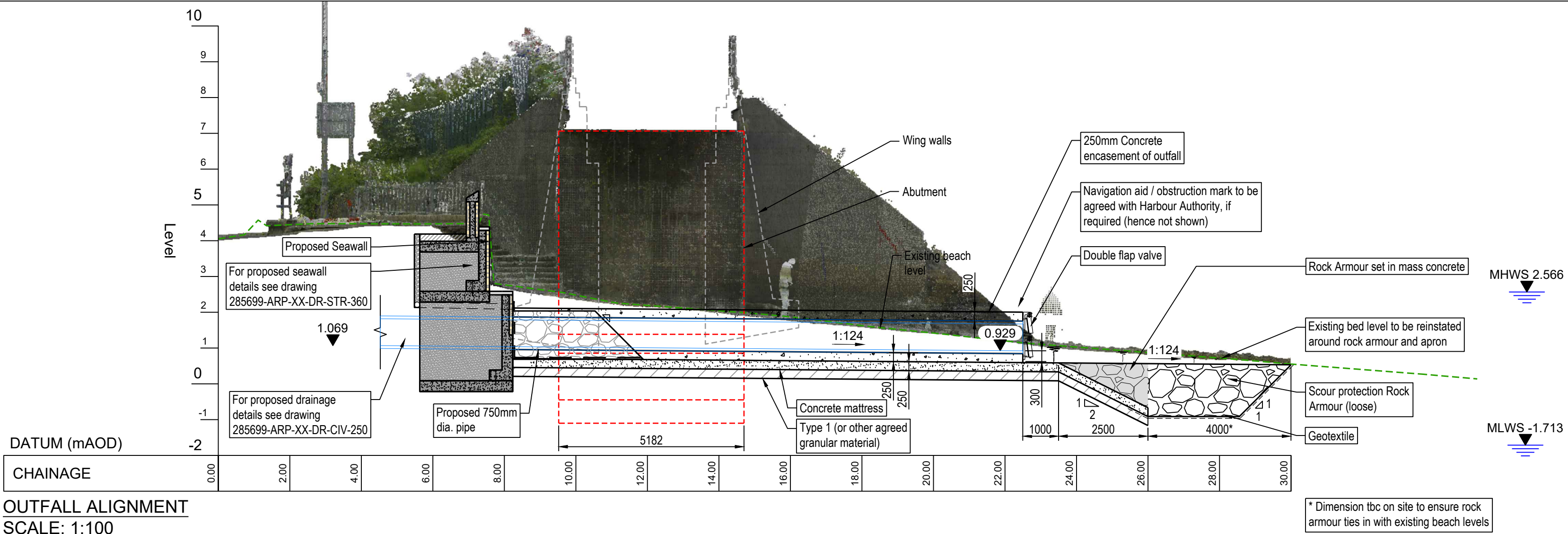
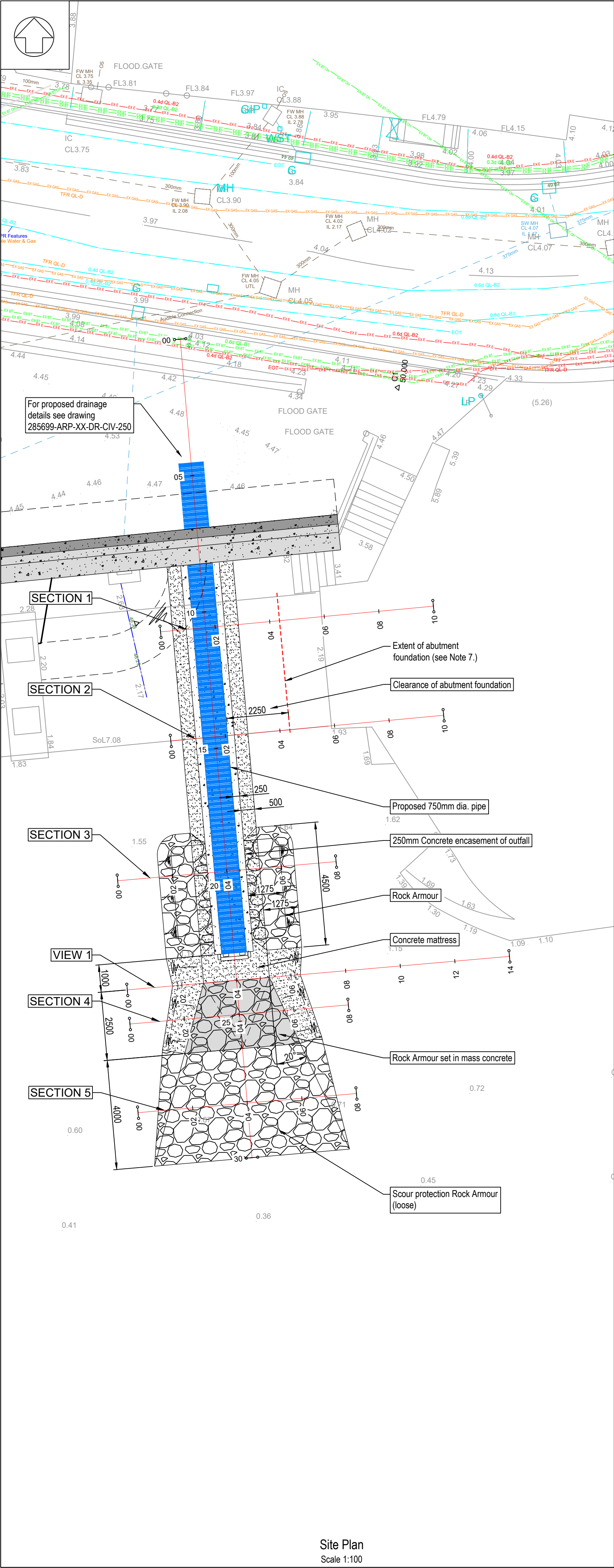
Types of project (or potential effect)	Sites to scan for and check	Initial list of potentially affected sites	Additional context	Final list of European sites potentially at risk
that could change the quantity, volume, timing, rate or other characteristics of biological resources harvested, extracted or consumed	include the biological resources which the project may affect, or whose qualifying features depend on the biological resources which the project may affect, for example prey species or supporting habitat which may be disturbed by the harvesting, extraction or consumption		resources that might affect qualifying features on all European sites listed can be ruled out of any further consideration.	
(13) Projects that could change the quantity, volume, timing, rate, or other characteristics of physical resources extracted or consumed	Sites whose qualifying features rely on the physical resources which the project may affect, for example, as habitat or a physical environment on which habitat may develop or which may be disturbed by the extraction or consumption	None	The proposed works would not cause changes to any physical resources extracted or consumed.	None
(14) Projects which could introduce or increase, or alter the timing, nature or location of disturbance to species	Sites whose qualifying features are considered to be potentially sensitive to disturbance, for example as a result of noise, activity or movement or the presence of disturbing features that could be brought about by the project	Pen Llyn a'r Sarnau SAC Meirionnydd Oakwoods and Bat Sites SAC Afon Eden – Cors Goch Trawsfynydd SAC	There is a small risk of disturbance to otters, a qualifying feature of the Pen Llyn a'r Sarnau SAC and Afon Eden – Cors Goch Trawsfynydd SAC, during construction. Similarly, the proposed works could lead to disturbance of grey seal and bottlenose dolphin feature of the Pen Llyn a'r Sarnau SAC. Lesser Horseshoe Bats is a mobile species feature of Meirionnydd Oakwoods and Bat sites SAC. There may be a small risk of temporary disturbance during construction	Pen Llyn a'r Sarnau SAC Afon Eden – Cors Goch Trawsfynydd SAC Meirionnydd Oakwoods and Bat Sites SAC

Types of project (or potential effect)	Sites to scan for and check	Initial list of potentially affected sites	Additional context	Final list of European sites potentially at risk
			phase. There are no cofnod records of Lesser Horseshoe Bat roosts within 1km of the proposed works.	
(15) Projects which could introduce or increase or change the timing, nature or location of light or noise pollution	Sites whose qualifying features are considered to be potentially sensitive to the effects of changes in light or noise that could be brought about by the project	Pen Llyn a'r Sarnau SAC Afon Eden – Cors Goch Trawsfynydd SAC Meirionnydd Oakwoods and Bat Sites SAC	There would be some localised temporary noise pollution during the construction period, which could potentially cause a low level of disturbance to otters, grey seal and bottlenose dolphin features of the Pen Llyn a'r Sarnau SAC. However, this would be minimal as there is already a degree of disturbance in the vicinity of the proposals. Works would also be undertaken during daylight hours when otter activity is minimal. There would be no additional artificial lighting of the site. As above, the proposed works are likely to create a temporary increase in noise levels during the course of the works, potentially impacting lesser horseshoe bats. Cofnod records do not indicate the presence of a lesser horseshoe bat roost within 1km of the proposed works. Effects on foraging bats would be minimal as works will be undertaken during daylight hours and there would be no artificial lighting of the site.	Pen Llyn a'r Sarnau SAC Afon Eden – Cors Goch Trawsfynydd SAC Meirionnydd Oakwoods and Bat Sites SAC
(16) Projects which could introduce or increase a potential cause of mortality of species	Sites whose qualifying features are considered to be potentially sensitive to the source of new or increased mortality that could be brought about by the project	None	The project would not introduce or increase a potential cause of mortality of species.	None

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- A1**
- Nodiadur / Notes
1. All dimensions are in millimetres unless noted otherwise.
 2. All levels are in metres relative to ordnance datum Newlyn (mAOD) unless noted otherwise.
 3. All coordinates are in metres relative to ordnance survey national grid.
 4. Do not scale from this drawing. All dimensions must be checked / verified on site.
 5. Refer to PN22427 Barmouth Viaduct Gardens Factual Report on Ground Investigation, Geotechnics (February 2023).
 6. Outfall to extend on the foreshore until invert level is 300mm above bed level (minimum).
 7. Abutment shown as derived from historical drawing of Barmouth Reconstruction of Old Chapel Viaduct Substructure.

- Legend**
- Information derived from historical drawings (see Note 7.)
 - Existing beach level
 - Mean high water springs
 - Mean low water springs
- Legend - Existing Utilities**
- EX GAS EX GAS Low Pressure Gas
 - EX BT EX BT BT / Openreach
 - EX BT OH EX BT OH BT / Openreach (overhead)
 - EX E EX E Electricity
 - EX W EX W Water
 - Foul Sewer
 - Surface Water
 - Unidentified RFL
 - Unidentified GPR

Tide Levels	
Datum	mAOD
HAT	3.26
MHWS	2.56
MHWN	1.26
MSL	0.26
MLWN	-0.54
MLWS	-1.74
LAT	-2.14

Hanes Fersiwn / Version History				
P03	06.10.23	CF	JB	BM
AMENDMENTS TO SHORTEN OUTFALL				
P02	08.06.23	CF	DO	BM
DRAFT FOR COMMENT				
P01	31.05.23	CF	DO	BM
DRAFT FOR COMMENT				
Rev	Date	By	Chkd	Appd

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YGC

Llywodraeth Cymru
Welsh Government

Enw a Rhif y Proiect Cynyr Gwynedd / Gwynedd Council Project Name and Number

Cynllun arfordirol Gerddi Traphont

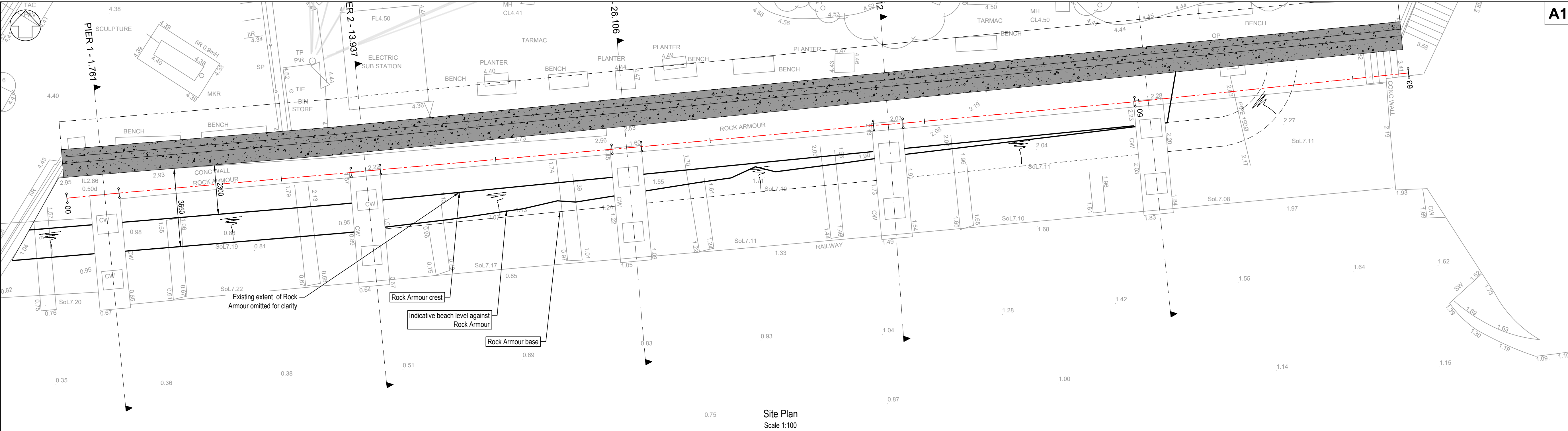
Viaduct Gardens Coastal Scheme

Tell Luniad / Drawing Title

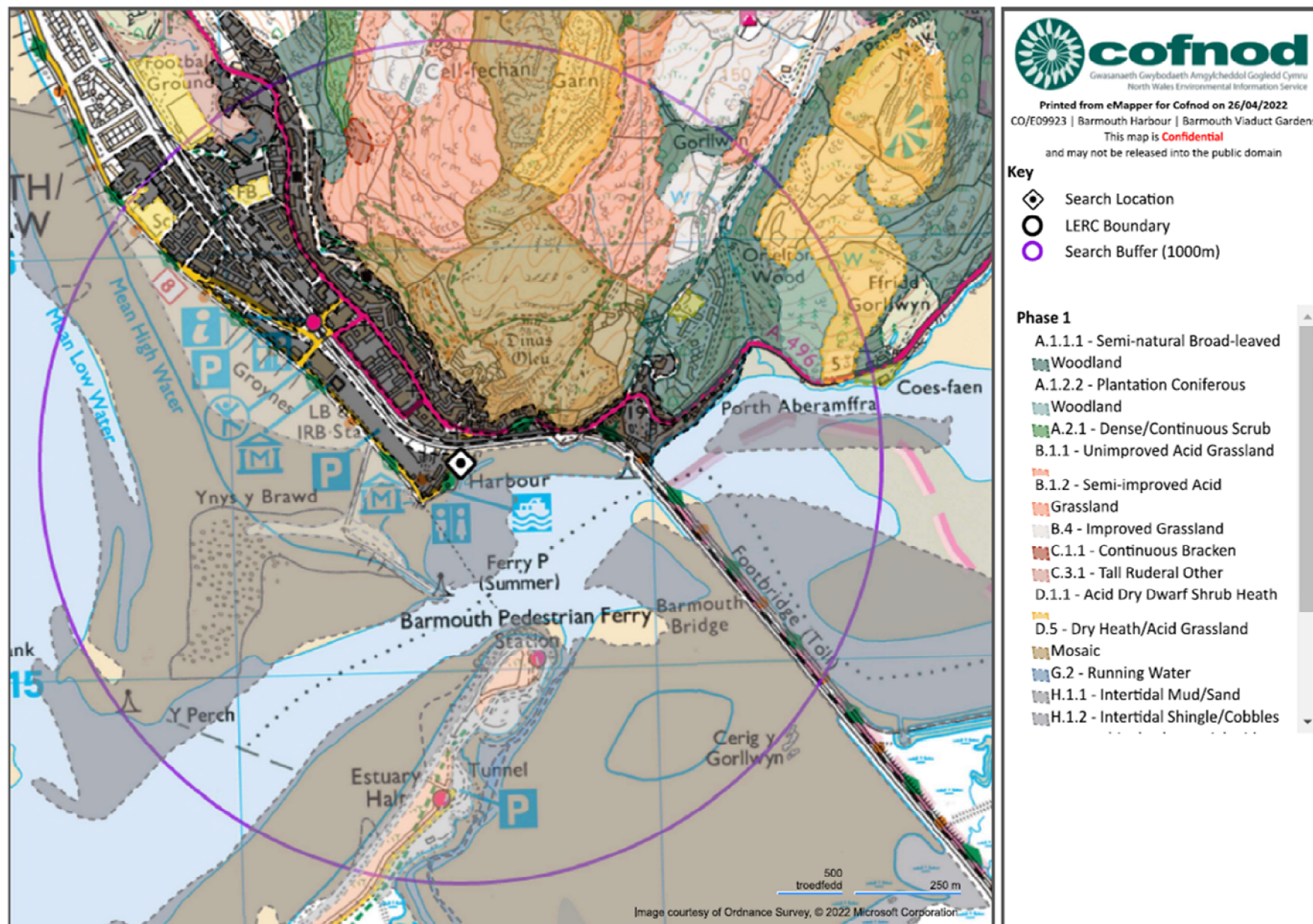
Proposed Drainage Sections - New Outfall

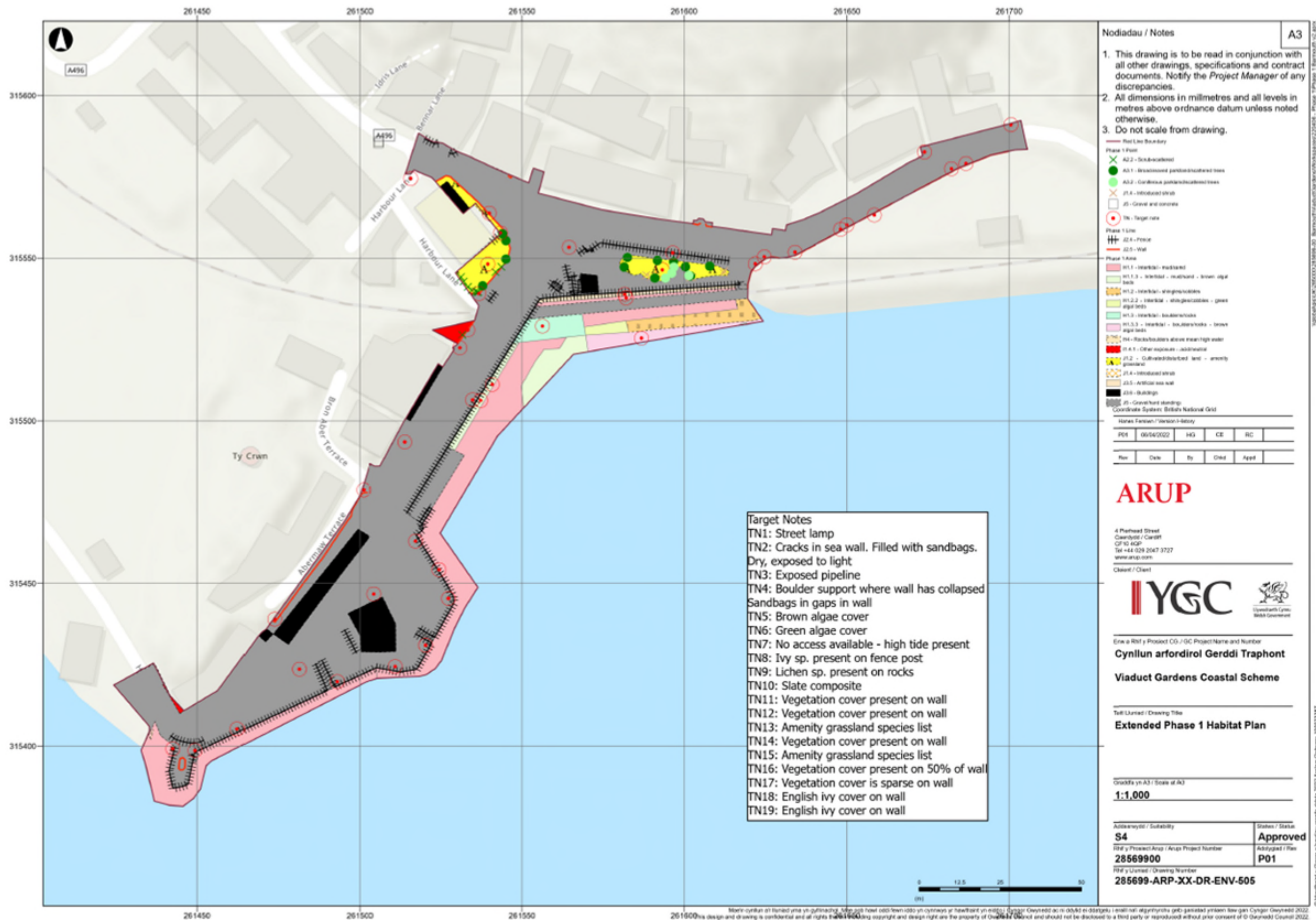
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Rhan / Role	
Civil Engineer	
Addasrwydd / Suitability	
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Rhif y Luniad / Drawing Number	Adolygiad / Rev
	P03

285699-ARP-XX-DR-CIV-290

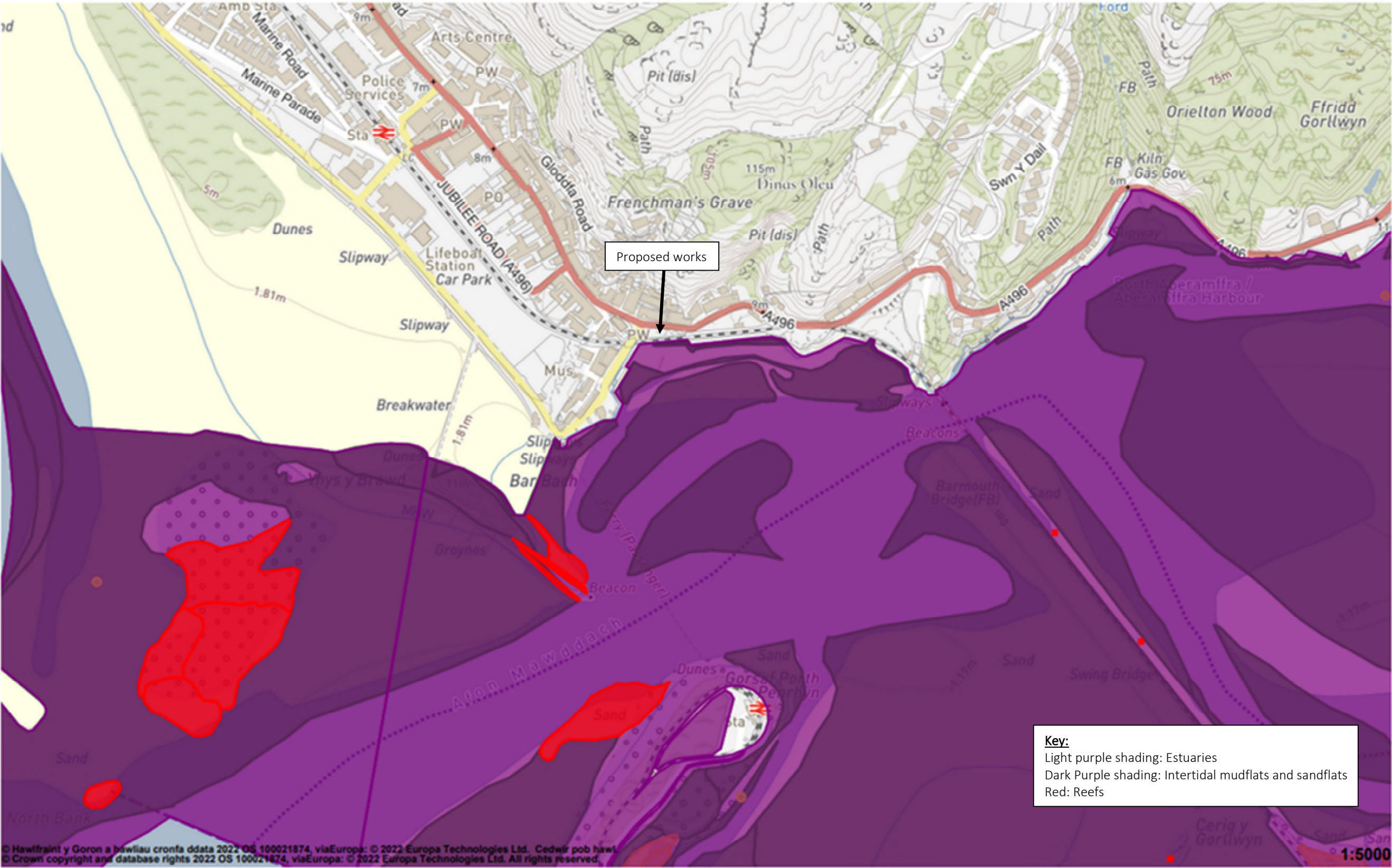


Appendix C – Phase 1 Habitat plans





Marine SAC features

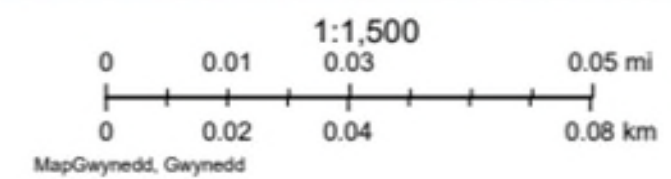


Marine SAC habitat features of Pen Llyn a'r Sarnau SAC. (Source: Data Map Wales).

Appendix D: Aerial plan



October 3, 2022



Appendix E: Site Photographs



1. Viaduct Gardens frontage wall, looking west across the proposed works area.



2. Looking west across the proposed works area.



3. Looking towards the western extent of the works area.



4. Viaduct Gardens area, north of the frontage wall.



5. Western extent of frontage wall.



6. Central section of frontage wall



7. Central section of frontage wall



8. Eastern extent of frontage wall



9. Looking east along frontage wall



10. Western extent



11. Eastern extent

Appendix F – Construction Methodology

Viaduct Gardens Construction methodology (Limited to works on wall and Outfall)

Sequence of Works

Wall Works

a) Access to the wall at beach level

- Access to the seaward side of the wall will be via an existing ramp approx. 50m away from the wall.
- Access is shared with current harbour activities.



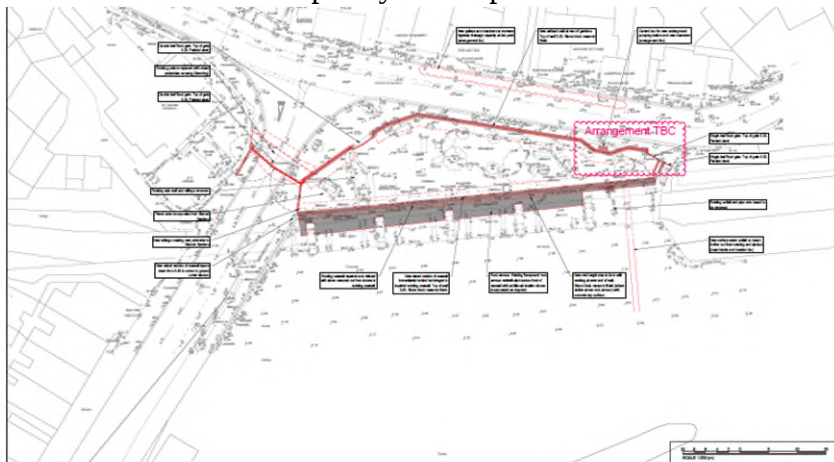
- c. Plant using this access rout will return to the top of the ram storage area at the end of each shift.
- d. Typical plant that will use this route will be tracked excavator and tracked dumper. Wheeled duper may be used if beach condition allows.
- e. Majority of the works will be caried out from the viaduct garden side of the wall to avoid marine working.

b) Temporary works

- a. Prior to dismantling the existing wall , some temporary support works will be required to stabilize the structure and existing filled garden areas.
- b. Sheet piling or king post walls will be used to support the embankment .
- c. Installation of these will be mainly from the Viaduct Garden side of the wall , with possible assistance from the back with an excavator.
- d. Current wall and beach rock armour will remain in place during installation of temporary works.
- e. Scaffolding may be required at the end of the works to construct the wall parapet . Scaffold poles may need to extend to beach level.
- f. Existing surface water drainage outfalls will be maintained as active throughout the works until it is swapped over to the permanent works. Some minor over pumping may need to be carried out during wall construction with water pumped from the nearest upstream manhole from the outfall. Water will be pumped onto rock armour to prevent scour.

c) Existing wall demolition / Removal

- a. Exiting wall will be demolished in sections with exposed wall dependant of extent of temporary works protection to the embankment.



- b. Existing rock armour at the toe of the wall will be moved back from the wall to expose the face - this material along with some additional armour as required will be re used as armour on completion of the new wall.
- c. Upper part of stone wall will be removed and take into the gardens side of the wall for re use in the parapet.
- d. Lower part of wall will be excavated down to the beach and loaded away for disposal or re-used as armour if suitable.
- e. Excavation from behind the stone facing, to the temporary support will be loaded onto dumper and taken away for disposal. This material is expected to be sand & gravel and only small amount to be retained as backfill if necessary to the gardens side.
- f. Existing piped outfalls will have temporary supports as necessary.

- a. Top and middle sections will be PCC L shaped units as shown in the drawing above .
- b. PCC units will be laid directly on the base in situ slab once cured. With the PCC unit anchored into the base slab using grouted in dowels.
- c. PCC unit will be craned in by an excavator , either from the top of the embankment or from the bottom , dependant on working space around existing structures.
- d. Once the lower unit is in place and anchored then joints will be sealed ready for the in-situ concrete backfill.
- e. Temporary end shutters will be placed at the sections to be poured.
- f. Concrete will be placed using pump or skip for the top of the wall.
- g. Once the base unit is in place and backfilled the wall will then no longer be tidal condition susceptible.

- h. Middle wall (PCC) will be installed in same manner.
- i. Backfill for middle wall will be done from the gardens side of the wall with placement and compaction carried out in thin layers.
- j. Upper part of wall and where new and existing outfalls will be cast in situ.

f) Cast in situ sections

- a. Areas where existing and new pipework / cabling protrude the wall will be cast in situ in lieu of using PCC units , this is to ensure flexibility in locating the pipe/ cable around the new wall.
- b. One whole section of PCC unit will be left out and a shutter placed either side of the PCC unit – in situ sections will be 1.0 - 1.5m long.
- c. In situ section will have reinforcement and will tie into the PCC units with dwells or similar.
- d. In situ sections will be stone faced to match surrounding precast units with facing tied in with anchors to the concrete
- e. Concrete pours for the wall will be done using pump or skip for the top of the wall.
- f. There are approx. 2-3 areas where this method will be used. If pipe is only in lower section, then middle section can return to the PCC wall method and vice versa. This will minimise in situ concrete works.

g) In situ parapet wall

- a. The parapet wall will be installed as an in-situ wall once the lower and mid sections are complete.
- b. Base slab will be poured from the gardens side of wall , and rebar installed as starter bars.
- c. Two stone walls facing will be built , with the middle of the wall being infilled with concrete .
- d. Coping will be in situ concrete as shown on previous drawing. Access to the parapet will be mainly from the garden , with scaffold used on the seaward side.

h) Rock Armour

- a. On completion of the lower and middle wall , access from the beach side will no longer be required , therefore the permanent rock armour can be installed.
- b. Previously removed armour stored at beach level will be placed by excavator on the geotextile laid against the new wall .
- c. Additional armour will be delivered to the harbour side by road wagon and transferred to temporary stockpile.
- d. Additional armour as required , will be brought to the wall using a dumper , with

- e. Armour will be placed to profile as shown in the drawing above with care undertaken during placement around the viaduct foundations.
- f. Beach will be reinstated around the viaduct and any waste/undersized armour removed or used as rip rap within the armour section.

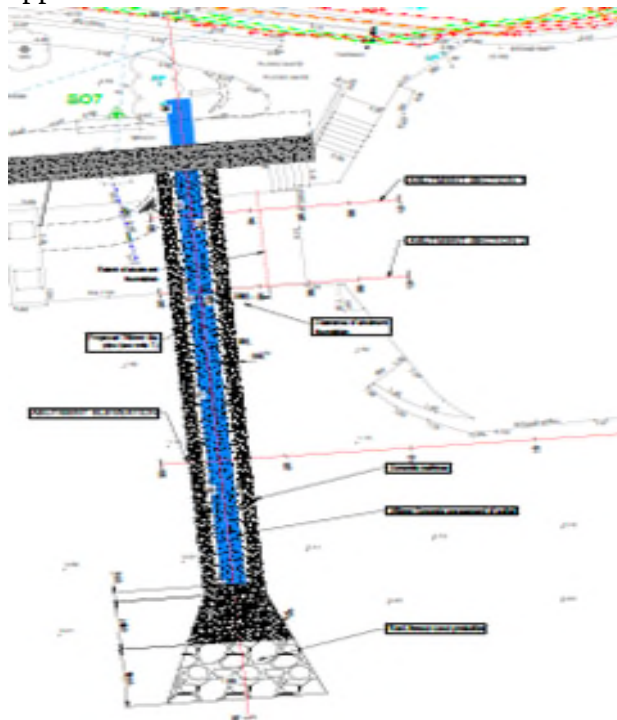
Pipe outfall works

a) Temp works

- a. Existing piped outfall will remain operational until new system is complete.
- b. Rock armour excavated from the wall works may be used to protect the new piped outfall area during excavation and concrete works as a temporary measure. This bund may also be reinforced using excavated beach materials from the pipe works.

b) Pipe work installation

- a. The new outfall pipe will be a 750mm diameter pipe and will protrude approx. 22m from the new wall face.



- b. Timing of the works will be to coincide with good weather and low tides as excavation work vary but go as low as approx.. -0.5 Aod.
- c. Pipework protruding through the new wall will have been previously installed with coupler inserted into the new wall
- d. The beach material for the bed will be excavated out and new granular layer placed to provide a firm profile for the pipework, with material brought in by dumper across the beach.
- e. Placement of the concrete mattress will be done when tides and weather conditions are favourable, with accelerators considered to be used to ensure the concrete cures before next tide.

- ### c) Concrete surround

- [illegible]

- #### d) Outfall detail

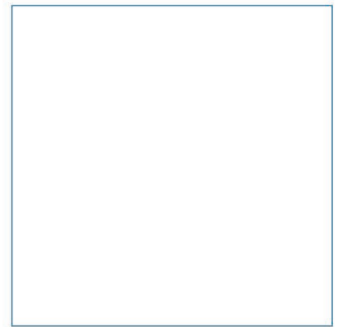
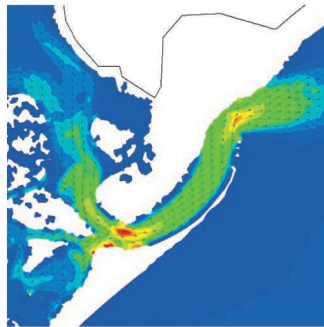
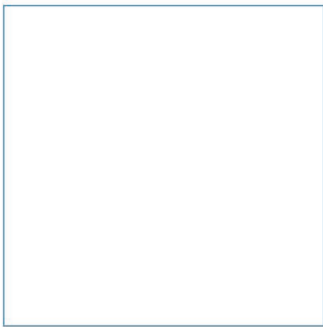
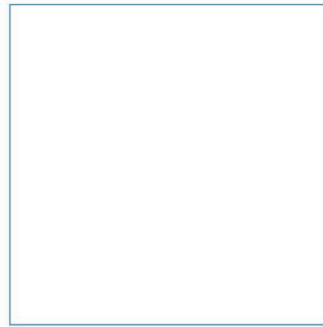
- The anti-scour basin will be constructed once the pipe is fully surrounded in concrete.
- Rock armour will be paced in the end by excavator with material brought in by dumper along the beach.
- A bolt on flap valve or tide valve will be installed at the end of the pipework
- Once complete any rock armour used as temporary protection will be removed and taken back to the wall as permanent works.
- Beach levels will be restored round the new pipe and any debris from the works cleared away.

Ymgynghoriaeth Gwynedd Consultancy (YGC)

Viaduct Gardens, Barmouth

Coastal Processes Assessment

November 2023



Innovative Thinking - Sustainable Solutions

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Viaduct Gardens, Barmouth

Coastal Processes Assessment

November 2023



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1 Introduction

A Marine Licence is being sought by Cygnor Gwynedd Council (CGC) for the construction of the Viaduct Gardens Flood Alleviation Scheme (FAS), Barmouth. Following a submission of Marine Licence CML2332 for the construction of flood defence works at Viaduct Gardens, Natural Resources Wales (NRW) concluded that without a coastal squeeze assessment and physical processes impact assessment it was unable to ascertain the extent of the direct and indirect loss of the Annexe 1 feature of the Pen Llŷn a'r Sarnau Special Area of Conservation (SAC). Therefore, potential impacts to the SAC are unable to be ruled out.

ABPmer has been commissioned by Ymgynghoriaeth Gwynedd Consultancy (YGC) to review coastal processes along the Viaduct Gardens frontage and produce a coastal squeeze assessment to support the Marine Licence. This coastal process assessment has sought to identify the direct and indirect impacts of the seawall and outfall structure on the intertidal mudflats and sandflats during construction and operation of the FAS along with any secondary effects due to the pipe and outfall structure extending above the current foreshore level.

The study has been completed following the guidance set out by NRW in Evidence Report 624 Advice on Physical Processes for Small-scale Marine and Coastal Projects. Consideration of the potential for coastal squeeze is also included making reference to NRW Guidance Note 062 Assessment of Coastal Squeeze. The results have been taken forward for consideration in the project's Habitat Regulations Assessment (HRA).

The assessment has followed a desk-based approach using expert geomorphological analysis and baseline understanding to identify potential direct and indirect effects of the FAS on coastal processes. The following datasets have been utilised along with a number of associated project reports:

- Digital Terrain Model (DTM) consisting of a range of topographic and bathymetric datasets assembled by ABPmer for NRW as part of NRW project '*Understanding the likely scale of deterioration of Marine Protected Area features due to coastal squeeze*' (underway);
- Geological data from the British Geological Survey (BGS); and
- Designated habitat mapping layers available from DataMapWales¹

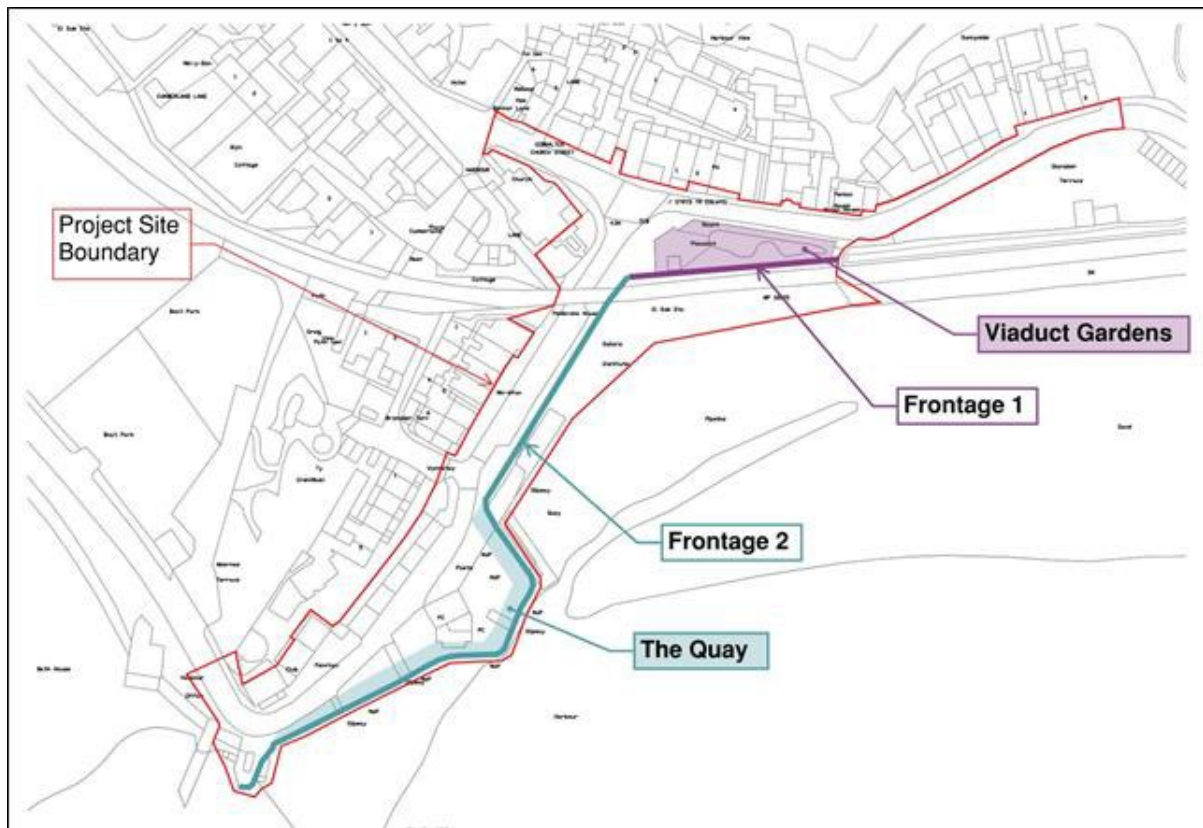
1.1 The Scheme

1.1.1 Introduction

Barmouth is located in Cardigan Bay, between Llanaber in the north and River Mawddach to the south. Viaduct Gardens is located on the north shore of the Mawddach Estuary (Figure 1).

Viaduct Gardens is a public open space to the south of the A496 Church Street. The existing sea wall is vertical blockwork with a parapet wall. Emergency rock protection was placed at the base of the wall following failure of the structure. The Cambrian Railway passes over Viaduct Gardens on a short viaduct in front of the sea wall with five support piers on the foreshore.

¹ <https://datamap.gov.wales/>



Source: Arup, 2022a

Figure 1. Location of Frontage 1 Viaduct Gardens

1.1.2 Scheme design and construction methodology

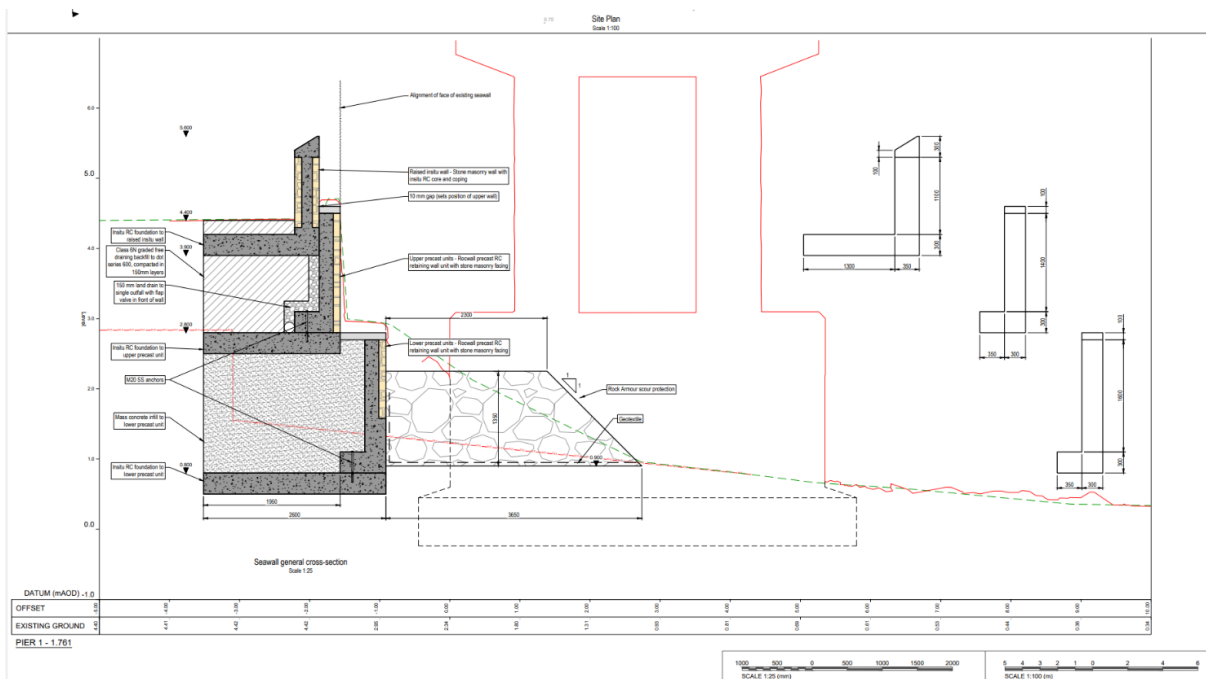
The FAS for Viaduct Gardens has been developed to address both surface water and coastal flooding of Church Street and the Barmouth seafront. The scheme protects two frontages; Viaduct Gardens (Frontage 1) and The Quay (Frontage 2) as shown in Figure 1. The Quay frontage will be upgraded using property level flood protection.

This coastal process assessment considers only those elements which could influence local coastal processes; these are the upgrade of the sea wall and installation of an outfall at Viaduct Gardens (frontage 1). The scheme is summarised as follows (YGC, 2023):

- Repairs to the existing sea wall;
- A new 450 mm culvert in Church Street with gullies;
- A new pumping station and outfall to update the existing network with additional gullies; and
- Formalisation of the rock armour placed during emergency works following a failure of the existing sea wall.

The existing wall will be carefully demolished in sections. Temporary support structures, including sheet piling and scaffolding, will be installed to stabilise the existing wall during demolition. The upper part of the existing stone wall will be removed and taken into the gardens side of the wall for re-use in the parapet. The lower part of the wall will be excavated down to the beach and loaded away for disposal or re-used as rock armour. The foundation for the replacement wall will be cast *in situ*, and the wall itself will feature a combination of precast and *in situ* sections for optimal construction flexibility. The existing rock armour will be moved back from the wall to expose the face and will be re-used as armour upon completion.

The height of the wall will be increased by ~0.9 m with the installation of a reinforced concrete parapet. (YGC, 2023). The sea wall design is shown as Figure 2 below which shows the design lies within the footprint of the existing wall and rock revetment.



Source: reproduced from scheme design drawings (Arup, 2023a)

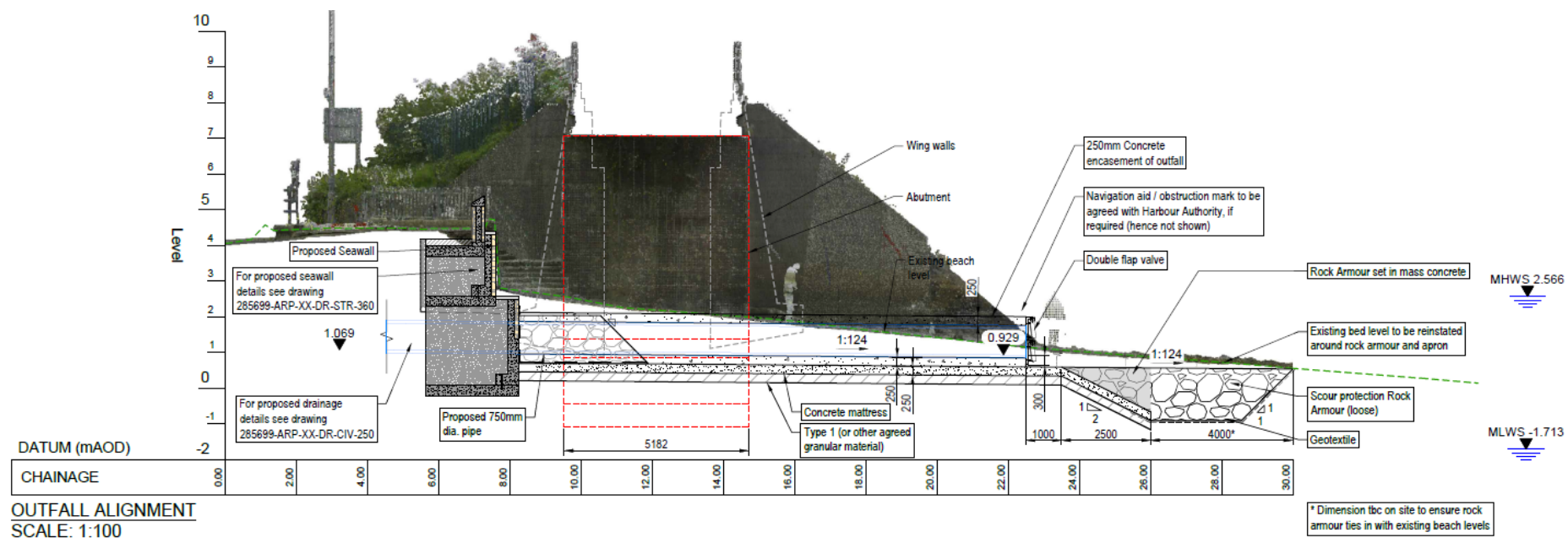
Figure 2. Sea wall improvements

In parallel with the wall renovation, the project involves the installation of a new gravity fed outfall pipe system. The 750 mm diameter pipe will extend approximately 13 m from the new wall face (Figure 3). This requires the excavation of beach material for the pipe bed, the placement of a concrete mattress for support, and laying of the pipe. Temporary anchors will ensure correct pipe positioning until the concrete surround is in place. Rock armour will be placed each side of the pipe at the lower section to prevent scour. The system will also incorporate an anti-scour basin constructed at the outfall and the installation of a one-way valve at the end of the pipe. Beach restoration and debris removal conclude the construction activities (YGC, 2023).

The peak flows from the outfall are presented below which include a 40% allowance for climate change as per design requirements so the actual present-day flows will be lower. These are peak flows which will only occur for short periods. The critical storm duration for the proposed system is predominantly the 240 minute (4 hour) storm event therefore the peaks flow will occur for an approximate 1.5 hr window during the peak period of the event (Arup 2023).

Table 1. Design flow conditions

Return Period	Free Outfall Peak Flow (l/s) including 40% allowance for climate change
1	348
5	532
30	858
100	1182



Source: reproduced from scheme design drawings (Arup, 2023b)

Figure 3. New surface water outfall

2 Baseline Understanding

2.1 Overview

The Mawddach Estuary is situated towards the northern part of Cardigan Bay at Barmouth, it is orientated along a west to east axis. The estuary has formed from a river valley that has subsequently flooded as a result of sea level rise since the last glaciation. Sand spits are present on both sides of the estuary mouth indicating that sediment can be transported along the open coast from both the north and the south, although the northern spit has been built upon and is now immobile. The shoreline adjacent to the estuary mouth is wide and sandy showing the potential for significant interaction between the estuary and the open coast (ABPmer, 2011). Barmouth estuary was heavily modified in the 19th and 20th centuries with the railway viaduct, the Ynys y Brawd causeway which closed the Bar Bach Channel and gradual harbour encroachment and hardening of the sea defences around the estuary. The coastal processes operating at the mouth of the estuary are illustrated as Figure 4 below. The Mawddach Estuary has a small ebb tidal delta formed by interactions between tidal flows in and out of the estuary and littoral drift. Most of the estuary is flood dominant and has acted as a sink for marine and fluvial sediments throughout the later Holocene (ABPmer, 2011).

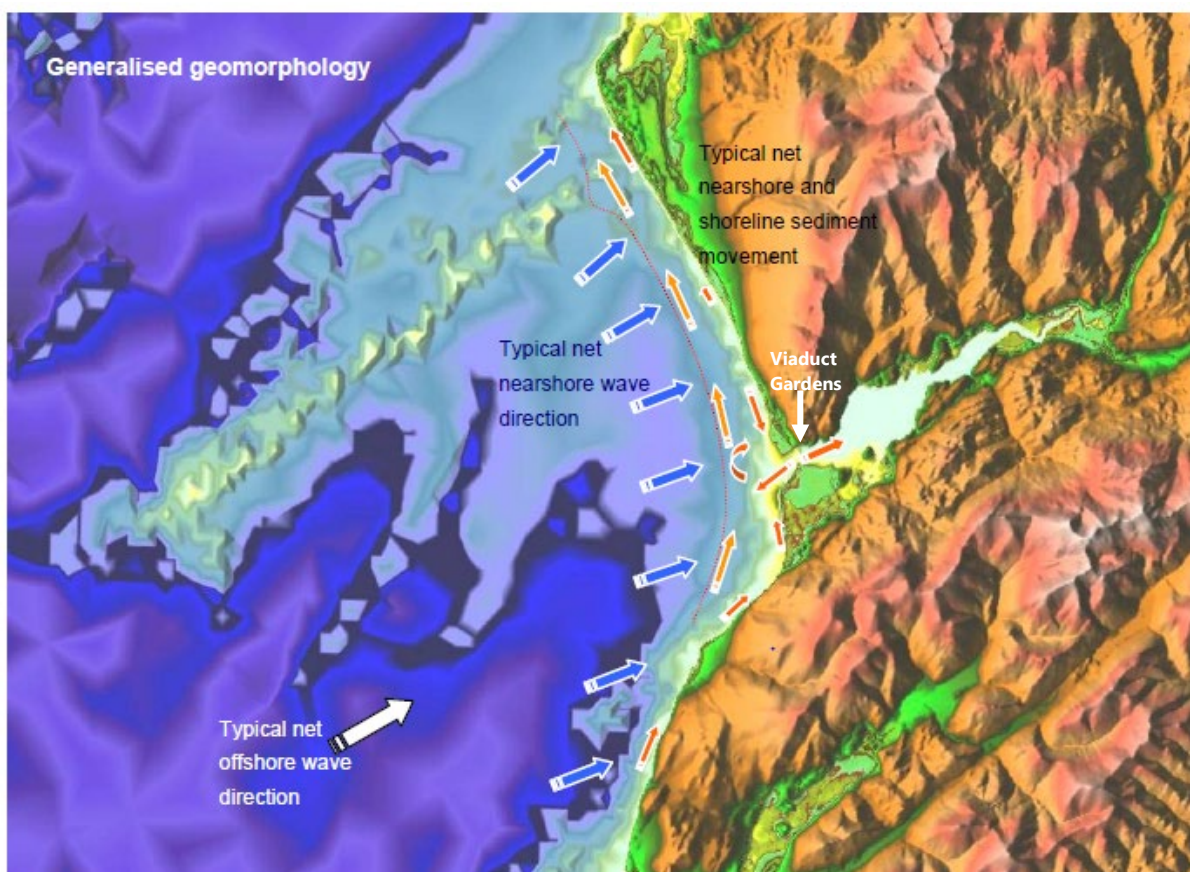


Image source: ABPmer, 2011

Figure 4. Conceptual Understanding of coastal processes at the mouth of the Mawddach Estuary.

Viaduct Gardens lie within Sub Cell 9, Policy Unit (PU) 11.14 of the current Shoreline Management Plan (SMP2) (ABPmer, 2011). The extent of the policy unit and the adjacent policy units further north are shown in Figure 5. The policy for PU 11.14 is Hold the Line (HTL) by maintaining the existing coastal defences for all three epochs: short term (up to 2025), medium term (2025 to 2055) and long term (2055 to 2105).



Source: ABPmer, 2019²

Figure 5. SMP policy units including Barmouth South (11.14)

² Shapefile data from lle.gov.wales now datamap.gov.wales

2.1.1 Nature conservation designations

Viaduct Gardens is situated on the northern bank of the Mawddach Estuary which is designated as a Site of Special Scientific Interest (SSSI). The Mawddach Estuary SSSI is designated for its biological features, including the estuary itself, a large shallow estuary which drains south-west into Cardigan Bay, and a series of adjacent habitats. It also supports other notable invertebrates and is of local importance for its breeding birds and wintering wildfowl.

The estuary also lies within the Llŷn Peninsula and Sarnau SAC. The following are the SAC designated features relevant to the coastal process assessment (Arup 2022a):

- Sandbanks which are slightly covered by sea water all the time;
- Estuaries, including the Glaslyn/Dwyrdd, Mawddach and Dyfi estuaries. The intertidal sandflats support communities of burrowing invertebrates, including dense populations of polychaete worms (such as *Levinisensis gracilis*), crustaceans (such as *Eudorella truncata*), bivalve molluscs (such as *Mysella bidentata*) and gastropod molluscs (such as *Otina ovata*);
- Saltmarsh fringing the shores of the estuaries, and the saltmarsh creeks and pools, are important habitat features for juvenile fish;
- Large shallow inlets and bays, such as the seabed of Tremadog Bay on the south side of the Llyn Peninsula, consisting of a mosaic of different sediment types. Algal species (*Naccaria wiggii* and *Scinaia spp.*) are present. Burrowing animals, including bivalves, crabs, brittlestars, urchins and worms, dominate the muddier sediments. Beds of eelgrass (*Zostera angustifolia*) and muddy gravel shores. Gravelly beach supports a nationally rare amphipod (*Pectenogammarus planicrurus*). Several unusual species include bearded red seaweed (*Anotrichium barbatum*) and a mantis shrimp (*Rissoides desmaresti*);
- Reefs encompassing a varied range of reef habitats, including submerged and intertidal glacial moraines. There are distinctive communities on bedrock and boulders, ranging from sites exposed to very strong wave action and/or tidal streams to sites sheltered from strong water movement. Algal communities are dominant over much of the reefs, with growths of foliose red and brown algae forming very dense beds in many places, in the absence of shading from kelp. Two brown algae species (*Chorda filum* and *Laminaria saccharina*) and red algae flourish on or near the reef crest, the number of algae species on pebbles increases with depth. In certain areas there are extensive forests of sea-oak (*Halidrys siliquosa*). Rich animal-dominated biotopes are found in the deeper parts of the reefs, including crustaceans, cnidarians, sponges, hydroids and encrusting bryozoans; and
- Glasswort (*Salicornia sp.*) and other annuals colonising mud and sand.

The designated mapped habitats taken from DataMap Wales are illustrated in Figure 6 below and show both intertidal reef and sandflat and mudflat. From review of the site photographs and Google Earth imagery, it is considered that the foreshore in front of Viaduct Gardens frontage has sandflat and mudflat habitat.



Figure 6. Designated habitats around the Viaduct Gardens frontage

2.2 Geology and geomorphology

2.2.1 Geology and sediments

The bedrock at Viaduct Gardens is coarse grained graywacke that formed during the Cambrian period. It is a sedimentary rock abundant in Wales which scores a 6-7 (hard) on the Moh's hardness scale. It is composed of grains of quartz, feldspar, and small lithic fragments set in a compact, clay-fine matrix (Dott, 1964). The shore consists of mixed surface sediments and the following information has been summarised from the results of trial pits undertaken to support the design (Geotechnics Ltd, 2022).

Viaduct Gardens lies on made ground, composed of very gravelly fine to coarse sand with a medium angular cobble content of slate and slag. The gravel is angular to subangular fine to coarse comprising slate, slag, clinker, tarmacadam, concrete and brick fragments.

On the basis of trial pit surveys (Geotechnics Ltd, 2022), at the proposed outfall at the MHWS mark there is a surface layer (0.05 m) of cobbles on top of *circa* 0.70 m of silty fine to coarse sand with a high subrounded cobble content of siltstone with shell fragments. From *circa* 0.75 m to 2.30 m depth, silty fine to medium-sized sand is present with a low subrounded cobble content of siltstone and slate. Trial pit sides below approximately 0.6 m depth became unstable due to groundwater inflow and the pit was terminated at 2.30 m due to inflow and associated instability.

About 20 m west of the proposed outfall and 0.2 m lower than the MHWS mark trial pits revealed slightly fine to medium sand with high subangular cobble content of siltstone and slate in the top 0.20 m. From approximately 0.20 m to 2.10 m depth, slightly silty fine to medium sand with some shell fragments were observed. Pit sides below 0.60 m depth became unstable due to groundwater inflow and the pit was terminated at 2.10 m due to inflow and associated instability.

2.2.2 Geomorphology and sediment transport

The conceptual understanding of the sediment transport processes is illustrated as Figure 4. This shows the predominant south to north alongshore sediment transport pathway with a smaller north-south return along the Barmouth frontage with significant accumulation on the northern shore of the entrance. The Mawddach Estuary has a relatively large intertidal area relative to its total size and is a sink for sediment (ABPmer, 2011).

As noted in Section 2.1 sediment transport is both from the north and south with the entrance to the estuary is dominated by the sand spits and significant transport between the coast and estuary.

The morphology of the estuary mouth has changed significantly since records began as summarised below (ABPmer 2022):

- On the basis of 18th and 19th century records there were two entrance channels into the estuary, the southern channel that lay south of Ynys y Brawd and the Bar Bach Channel to the north;
- The Mawddach railway viaduct (constructed in 1866-7) appears to have fixed the main low water channel of the estuary close to the northern edge of the estuary and the Quay;
- This is likely to have made it more difficult for ebb tidal flows to turn sharply to the northwest into the northern channel, encouraging increased flow through the southern channel to the south of Ynys y Brawd, potentially triggering the shoaling of the Bar Bach Channel in the later 19th and early 20th centuries;

- The Ynys y Brawd causeway was then constructed in 1970-1975, fully blocking the northern Bar Back channels and fixing the single entrance channel in the present-day alignment; and
- This will also have fixed the general ebb flow tidal pattern within the estuary mouth, i.e. between the Trwyn y Gwaith breakwater and the railway Viaduct.

The flood/ebb flow regime in the entrance is now much more fixed than in the historical past, and it appears that this results in the ebb flow being forced closer to the northern edge of the entrance and the quay walls. A clear secondary channel is observed along the northern extent of the harbour and along the quay wall in all recent imagery. It is expected that the realigned flow regime in combination with wave reflection from the vertical structures within the harbour have been the main contributory factors to the bed lowering observed over the past two centuries (ABPmer, 2011).

The historic bed lowering is ongoing. Arup (2022b) identified an extract from the Network Rail archive showing drawings including the beach level in 1951, this level is shown on the present day image as Figure 7. All historic photos before 1972 show the beach level at the location of the railway viaduct to be around 0.3 m below the top of the pier pedestals which is also consistent with the MHWS shoreline shown on the historic maps at this time. By 2004 the beach level has reduced by 0.5 m and during a site walkover in January 2022, beach levels had reduced by well over 1 m at the railway viaduct near the corner of Frontage 1 and Frontage 2 (Arup, 2022b).



Photograph from: YGC, 2023 – Appendix E

Figure 7. Image showing western extent of frontage and historic beach level

Beach lowering is further evidenced by the exposure of the bases of the old timber trestles, found adjacent to the concrete pier pedestals. Figure 7 shows the extent of beach lowering increases moving east to west towards the corner between Viaduct Gardens and The Quay.

The present day elevations are illustrated in Figure 8 which shows the smaller ebb flow channel close to the frontage. Analysis of tidal water level data for Barmouth (Table 2) alongside present day topographic data (Figure 8) shows that the frontage is completely inundated from approximately MHWN.

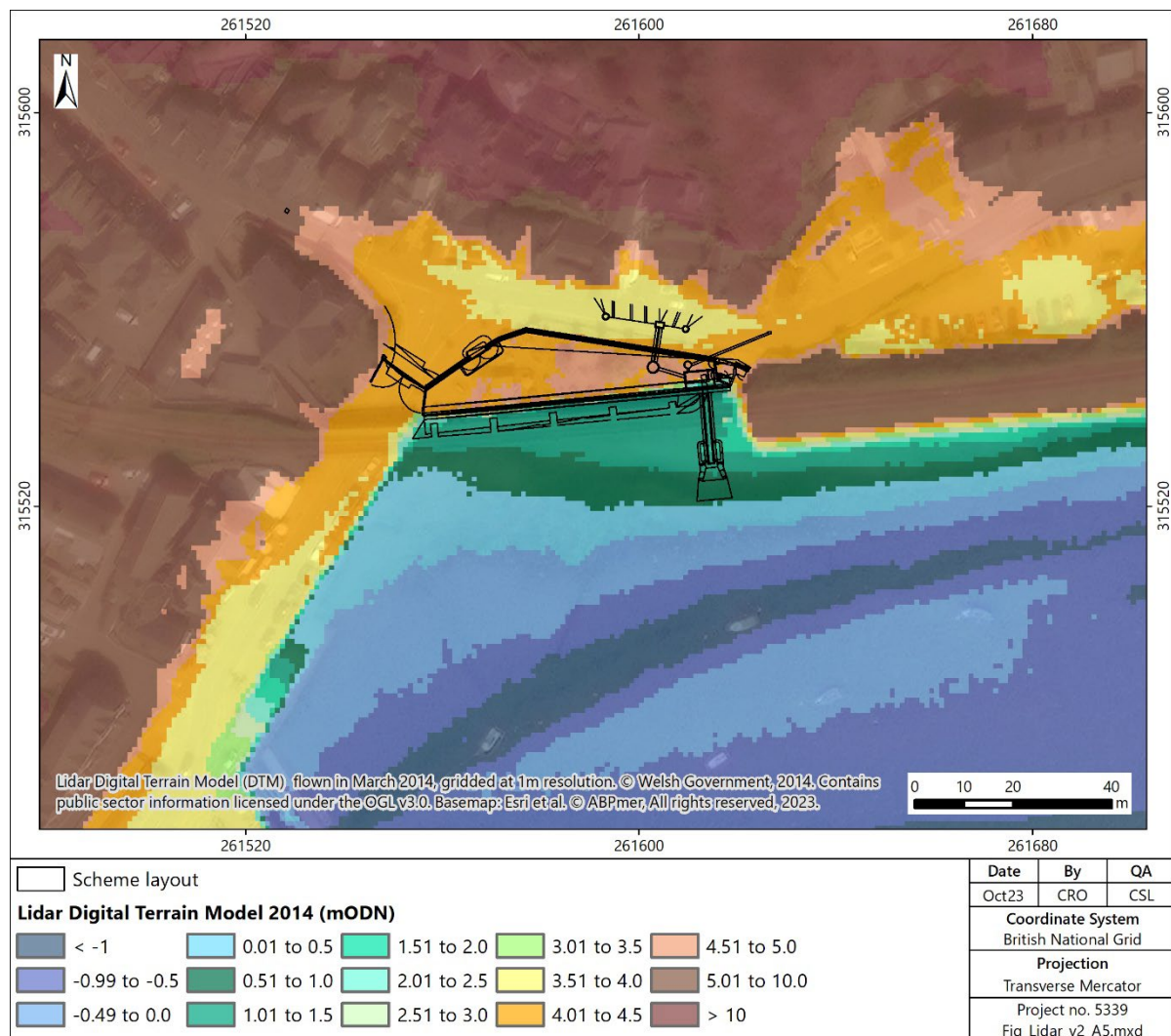


Figure 8. Present day bathymetry

Table 2. Tidal characteristics at Barmouth

Reference Still Water Level	Present day (mCD)	Present day (mODN)
Highest Astronomical Tide (HAT)*	5.69	3.25
Mean high water springs (MHWS)	5.00	2.56
Mean high water neaps (MHWN)	3.50	1.06
Mean sea level (MSL)	2.64	0.2
Mean low water neaps (MLWN)	1.80	-0.64
Mean low water springs (MLWS)	0.70	-1.74
Lowest Astronomical Tide (LAT)*	0.32	-2.12
Mean Spring Range	4.30	
Mean Neap Range	1.70	

* - Data not available from Admiralty tide tables. Extracted from NTLSF Barmouth gauge (NTLSF, 2023)

Source: Admiralty Tide Tables (Admiralty 2023)

2.3 Water levels

Barmouth lies within Cardigan Bay, where the tide is macrotidal, with a diurnal spring tidal range of 4.30 m. Water levels from Mean High-Water Springs (MHWS) to Mean Low Water Springs have been taken from the 2023 Admiralty Tide Tables. Highest Astronomical Tide (HAT) and Lowest Astronomical Tide (LAT) values are not included in the 2023 Admiralty tide tables and have been taken from the National Tide Level Sensor Facility (NTLSF) gauge at Barmouth. It is worth noting that MHWS was found to be in close agreement between the Admiralty data and the NTLSF gauge data, with the NTLSF data being only slightly higher by +0.05 m. The conversion from chart datum (mCD) to Ordnance Datum Newlyn (mODN) for Barmouth is -2.44 m (Admiralty Tide Tables 2023).

2.3.1 Future water levels

Climate change will affect conditions at the site through both sea level rise and storm surges. The magnitude of change is expected to increase throughout the lifetime of the development.

The associated water levels in 2124 at Barmouth are provided as Table 3 below which have been derived using UKCP18 sea level rise estimates for the higher central allowance (70th percentile) and upper end allowance (95th percentile) of Representative Concentration Pathway (RCP) 8.5. The extension of the period beyond 2100 has been applied using NRW Climate Change Guidance (Welsh Government, 2021) and sea level rise estimates have been applied from 2001 following guidance by NRW (R. Park, *pers. comm.*, September 11, 2023).

Table 3. Predicted water levels in 2124

Water Level	Present day (mCD)	Present day (mODN)	2124 RCP8.5 70th %ile (mODN)	2124 RCP8.5 95th %ile (mODN)
HAT	5.69	3.25	4.34	4.74
MHWS	5.00	2.56	3.65	4.05
MHWN	3.50	1.06	2.15	2.55
MSL	2.64	0.20	1.29	1.69
MLWN	1.80	-0.64	0.45	0.85
MLWS	0.70	-1.74	-0.65	-0.25
LAT	0.32	-2.12	-1.03	-0.63

2.3.2 Extreme water levels

Extreme water levels were derived as part of the scheme design and outlined in ABPmer (2022). These are provided in Table 4. The water levels have used the Environment Agency's Coastal Flood Boundary Database 2017 baseline extreme levels³ (using location 832) and predicted climate change projections from the UK Climate Impact Programme UKCP18⁴.

³ <https://www.data.gov.uk/dataset/73834283-7dc4-488a-9583-a920072d9a9d/coastal-design-sea-levels-coastal-flood-boundary-extreme-sea-levels-2018>

⁴ <https://ukclimateprojections-ui.metoffice.gov.uk/ui/home>

Table 4. Extreme water level projections

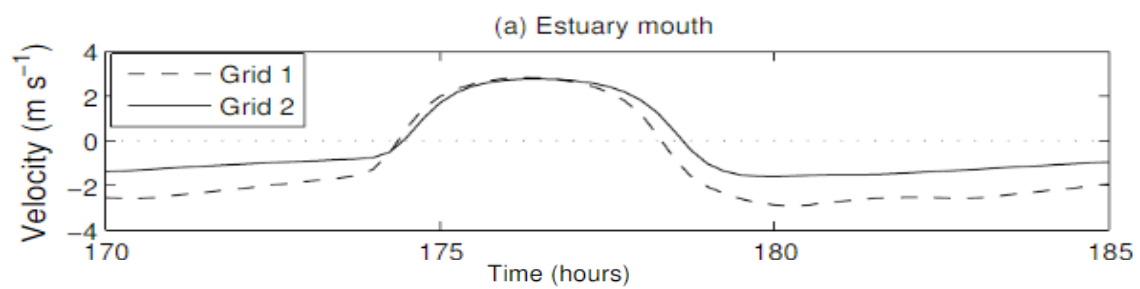
Years from present day	n/a	0		20		50		100	
Epoch	2017 ^{*1}	2022		2042		2072		2122	
%ile	n/a	70	95	70	95	70	95	70	95
SLR from 2017 (m)	n/a	0.02	0.03	0.14	0.18	0.41	0.53	0.93	1.27
Return Period	Extreme water levels (mODN)								
t1	3.46	3.48	3.49	3.60	3.64	3.87	3.99	4.39	4.73
t2	3.59	3.61	3.62	3.73	3.77	4.00	4.12	4.52	4.86
t5	3.75	3.77	3.78	3.89	3.93	4.16	4.28	4.68	5.02
t10	3.87	3.89	3.90	4.01	4.05	4.28	4.40	4.80	5.14
t20	3.99	4.01	4.02	4.13	4.17	4.40	4.52	4.92	5.26
t25	4.03	4.05	4.06	4.17	4.21	4.44	4.56	4.96	5.30
t50	4.14	4.16	4.17	4.28	4.32	4.55	4.67	5.07	5.41
t75	4.21	4.23	4.24	4.35	4.39	4.62	4.74	5.14	5.48
t100	4.26	4.28	4.29	4.40	4.44	4.67	4.79	5.19	5.53
t150	4.33	4.35	4.36	4.47	4.51	4.74	4.86	5.26	5.60
t200	4.38	4.40	4.41	4.52	4.56	4.79	4.91	5.31	5.65
^{*1} CFBD base year									

The scheme has used a 1:200 year design still water level in 2122 of 5.31 m ODN in accordance with the latest Welsh Government Guidance for Flood and Coastal Erosion Risk Management Authorities which recommends RCP8.5 70% as design allowance and the 95%ile as a sensitivity test (Welsh Government, 2021).

2.4 Flow regime

There is little information on the flow regime in the estuary and no survey data has been identified. Notwithstanding this, the estuary is considered to be ebb dominant (ABPmer 2011). A modelling study commissioned by the Countryside Council for Wales (CCW) undertook hydrodynamic simulations of the Mawddach Estuary and investigated the response of the estuary to future tidal and atmospheric changes (Robins, 2011). Under annual-mean river flow rate conditions, peak velocities occurred during spring tides through the estuary mouth and exceeded 2 m s⁻¹. Peak velocities in the main estuary were small on the tidal flats and up to 1 m s⁻¹ in the channels, reducing to 0.5 m s⁻¹ up-stream. The addition of a 1 in 100-year fluvial event causes little change to the velocities in the main estuary, whilst a 1 in 100 year storm surge of 2 m increased peak velocities at the mouth by 15% and increased the tidal prism two-fold.

Depth averaged velocity at the estuary mouth during a spring tidal cycle under mean river flow conditions is shown in Figure 9 for two model grids: Grid 1 (<10 m resolution mesh in the main estuary) and Grid 2 (same as Grid 1 but with all anthropogenic features removed e.g. rail line embankments, flood defence embankments etc.). Generally, depth-averaged flows for the flood tide exceed 2 m/s with the structures in place but are generally weaker during the ebb phase (reaching 2.5 m/s for Grid 1) (Robins, 2011).

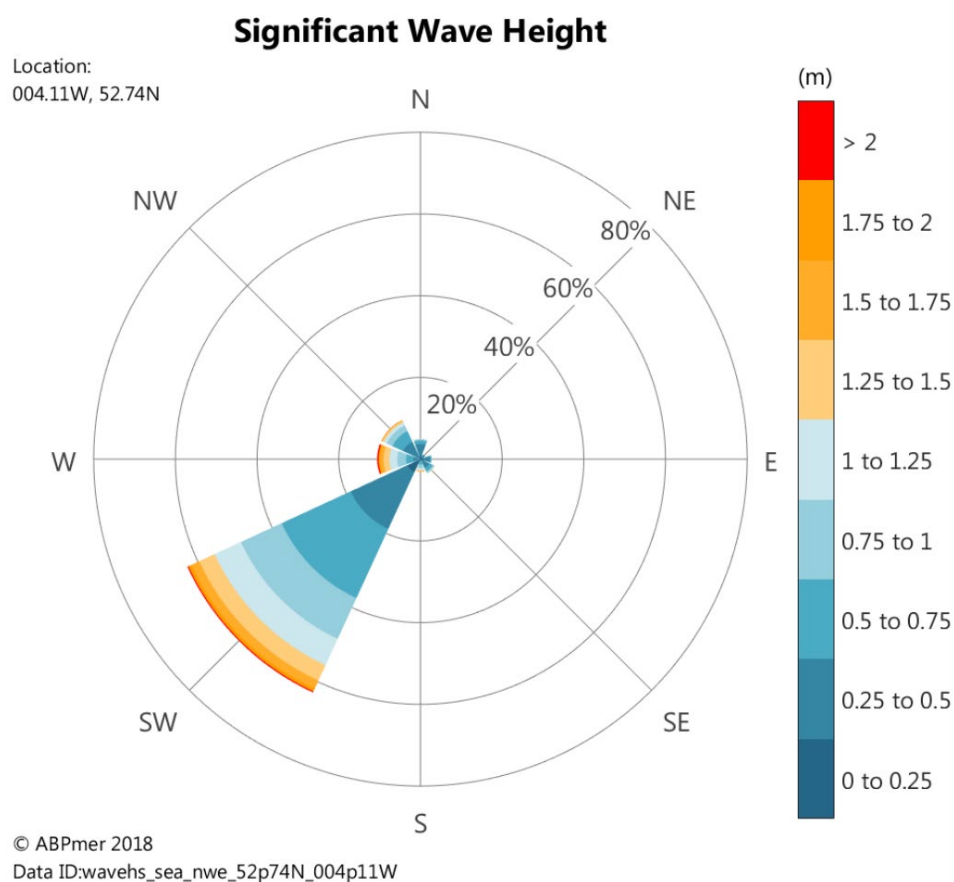


Source: Robins, 2011

Figure 9. Depth averaged velocities at the mouth of the estuary.

2.5 Wave regime

The long-term wave climate just offshore of the Mawddach Estuary is illustrated in Figure 10 below. The coast is affected by a mixture of swell waves originating in the Atlantic and Wind waves from the Irish Sea and Cardigan Bay, with a mean wave height of 0.7 m. The dominant wave direction is from the southwest, accounting for over 60% of waves, due to the offshore prevailing wind conditions. The offshore reef feature of Sarn Badrig, which extends 11 km offshore from Barmouth North beach (Figure 5), also inhibits wave energy reaching the site from more north westerly directional sectors.



Source: ABPmer SEASTATES Hindcast Data (ABPmer, 2013)

Figure 10. Wave conditions offshore of the Mawddach Estuary

As Viaduct Gardens is largely sheltered from waves propagating eastward from Cardigan Bay, wave diffraction is the primary mechanism by which waves enter the harbour. ABPmer (2022) provided an overview of the key wave transformation processes that occur at the site as the waves propagate inshore and through the mouth of the estuary. This is illustrated as Figure 11 and shows:

- Complex wave refraction as the wave travels through the entrance with waves refracting from the edge of the channel;
- Wave diffraction as the waves pass Trywn y Gwaith breakwater;
- Wave reflection off the defences to the south of the channel;
- Wave overtopping of the Trywn y Gwaith breakwater; and
- Possible wave amplification / overtopping as waves run along the quay wall.



Adapted from ABPmer, 2022

Figure 11. Wave transformation into the estuary

2.6 Future morphological change

The future evolution of the estuary is discussed in ABPmer (2011). Although there is uncertainty associated with regard to the estuary's future evolution, due to its geomorphological form and the fact that the sediment supply from offshore and the adjacent coast is plentiful, it is considered likely that the estuary will continue to accrete with sea level rise.

More locally to the frontage, higher water levels and potentially greater wave energy is likely. Accordingly, the reflection of wave energy off the seawalls is likely to increase. Over time this could lead to gradual local scouring adjacent to the seawalls until a new 'equilibrium' bed level is achieved.

3 Assessment

3.1 Introduction

The potential changes to coastal processes and direct construction effects arising from the new sea wall and outfall have been considered with respect to:

- Construction:
 - Direct loss of foreshore; and
 - Release of sediment during construction.
- Operation:
 - Changes in flow conditions through the presence of the sea wall and operation of the outfall (blockage);
 - Potential for scour; and
 - Effects from climate change

3.2 Construction effects

3.2.1 Direct loss of foreshore

The western section of the new sea wall follows the existing alignment, with the eastern section extending approximately 0.6 m seaward. The design includes for formalisation of the existing rock armour and there is no change in the overall footprint associated with the sea wall and no direct loss of foreshore as a result.

There will be *circa* 85 m² loss as a result of the footprint of the new outfall (including scour protection to the side and fronting the outfall). The length of the outfall has been minimised as far as practically possible and would result in a loss of only *circa* 67 m² of mapped mudflat and sandflat habitat. Assessment of the implications of this loss of habitat is provided in the Habitats Regulations Appraisal currently being produced by YGC.

3.2.2 Release of sediments during construction

The excavations and plant movements on the foreshore has the potential to both compact material and release sediments into the water column. The construction activities will be undertaken during low tide conditions and the potential for sediment suspension would occur on the subsequent tide rather than any direct release into the water column. The foreshore consists of a mixture of cobbles, sand and mud and the potential for the release of significant amounts of fines above background levels causing a sediment plume would be unlikely. Where material has been disturbed, due to the low flow conditions transport and deposition is expected to be localised and aligned to the direction of flow.

3.3 Operational effects

3.3.1 Changes in flow conditions through blockage effects

There is the potential for blockage effects from the infrastructure changing flow and wave conditions and hence sediment transport. The frontage is already heavily influenced by the existing viaduct piers and existing sea walls. Raising the existing sea wall will not affect the hydrodynamic regime and

formalisation of the rock scour protection will reduce wave energy and the effects of toe erosion at the sea wall.

There is the potential for blockage effects from the new outfall. However, the outfall is aligned with the adjacent Network Rail embankment and will not be extending out into the main flow path. Evidence Report 624 suggests that the maximum change to any coastal processes would be *circa* ten times the maximum dimensions of the structure: as the outfall only extends *circa* 13 m from the seawall, this would conservatively mean a maximum extent of approximately 130 m. However, the outfall is small and located in a sheltered corner of the estuary mouth high in the tidal frame above the main channel and surrounded by vertical walls. Peak velocities are thought to be low reducing the period at which sediment would be mobilised [noting the study by Robins (2011) stated 'peak velocities in the main estuary were small on the tidal flats and up to 1 m s^{-1} in the channels].

The structure will only be interacting with the flow regime when tidal conditions are above *circa* MHWN. Therefore, the percentage of time sediment would be both mobilised and the outfall structure is interacting with the flow regime is relatively small and the extent of the blockage effect on the structure on the sediment transport system is, therefore, judged to be small in this location.

3.3.2 Potential for scour

The potential for scour from the outfall has been mitigated through the use of rock scour protection reducing the risk of scour in the immediate vicinity of the outfall. Beach levels will be reinstated. In addition, the outfall is surrounded by the sea walls, viaduct piers and rail embankment which have a much greater effect on the local flow and wave regime. Therefore, the additional interaction with the outfall is considered to have only a minor effect on the local flow regime.

NRW has identified the potential for the flow from the outfall (operational only during flooding events) to affect the foreshore during lower states of the tide, potentially causing a local drainage channel across the foreshore. The design flow conditions are provided in Table 1. Due to the intermittent nature of the outfall (storm events) the number of events and volume of water being released across the foreshore will be highly variable and also be dependent upon the state of the tide during the storm duration. The scour effect of the discharge has been mitigated through the provision of the rock apron and it is considered that any local scour arising from a single event (or series of events) will be further mitigated by the natural sediment transport across the frontage during each subsequent tidal cycle.

3.3.3 Effects from climate change

The effects of sea level rise over the design life of the structure will mean that mean sea level will increase in front of the sea wall and there will be greater tide locking of the outfall (requiring more frequent pumping).

The estuary will continue to be a net sink of sediment although if the ongoing rate of sedimentation does not keep pace with sea level rise, the tidal prism will increase. Bed level lowering at the frontage is anticipated to continue but the rock protection will provide some localised reduction in scour at the base of the wall and the outfall.

The increase in tidal prism will affect the alignment of the ebb channel in front of Viaduct Gardens which is influenced by the hard structures of the Quay, Viaduct Gardens and the railway embankment. Its future alignment is uncertain but raising the wall and the new outfall structure is unlikely to noticeably influence the location of the ebb channel in the context of the surrounding vertical structures.

3.4 Conclusion

The assessment concludes that there will be very limited changes in coastal processes as a result of upgrading the sea wall and installation of the outfall. The direct loss of mapped intertidal habitat is predicted to be *circa* 67 m² as a result of the footprint of the new outfall. Where changes may occur due to blockage effects of the outfall they will be very minor due to its sheltered location and position in the tidal frame. As a result the assessment expects that the direct and indirect effects on coastal processes (and therefore Annex 1 habitats) will be negligible.

4 Coastal Squeeze Assessment

4.1 Screening for potential coastal squeeze

The FAS is being implemented as part of the HTL SMP 2 policy for PU 11.14 Barmouth South. The Viaduct Gardens frontage is *circa* 70 m long as shown in Figure 1. Located within the Pen Llŷn a'r Sarnau SAC the scheme requires consideration of coastal squeeze. Coastal squeeze is defined as the loss of natural habitats or deterioration of their quality arising from anthropogenic structures, or actions, preventing the landward transgression of those habitats that would otherwise naturally occur in response to sea level rise in conjunction with other coastal processes. Coastal squeeze affects habitat on the seaward side of existing structures (NRW 2022).

NRW Guidance Document GN062 also states that '*maintaining a particular coastal alignment whilst sea-levels continue to rise will lead to narrowing of the intertidal/coastal zone, and loss of habitat. The Habitats Regulations requires that the extent of designated Annex 1 habitats is stable or increasing. Therefore, projects or activities which prevent the natural ability of habitats to migrate landwards in response to sea-level rise are likely to lead to adverse effects or deterioration of the National Site Network*'.

NRW Guidance Document GN062 sets out a step-by-step approach to considering coastal squeeze. Screening Step 1 sets out four questions to identify the potential for coastal squeeze. These are listed below, with the corresponding answers for this FAS.

- Is there a plan or project to undertake works to a structure or an activity occurring which implements hold the line and/or maintains the current shoreline position (this can include works to the landward side of a defence)? Note that maintenance activities are considered at screening step 2.
 - **Answer: YES**
- Would the habitats be able to migrate landwards in response to sea level rise if there was no coastal structure or the management activity was stopped (i.e., the land behind the defence would be susceptible to flooding if the defence failed or would be expected to erode rapidly)? This includes land which is currently developed as explained in section 1.2 above).
 - **Answer: YES**
- Is there a National Site Network designated site with Annex 1 habitats present in the area seaward of the defence? Note that the designated site does not need to be immediately adjacent to the proposed works or structure, and the site boundary could be nearby or lower down the shore.
 - **Answer: YES**
- If the proposed works are in a 'Hold the line' policy unit, does the SMP HRA identify coastal squeeze losses? If the proposed works are in a 'No active intervention' or 'Managed Realignment' policy unit then this question does not apply as coastal squeeze will not have been assessed for these policy types. The preferred policy may change over time. Consideration should be given to the policy periods (SMP epochs) relevant to the proposed lifespan of the works. For works which overlap or cross 2 policy units or more than one epoch you would need to consider the policies for all
 - **Answer: NO**

The SMP2 HRA does not identify PU 11.14 as having coastal squeeze losses. However, the SMP HRA paragraph 5.5.53 states that "*Managed Realignment (PUs 11.2, 11.5, 11.6, 11.9, 11.10, 11.12, 11.13, and 11.14) in the long term would ensure that coastal squeeze would not be an issue, as no alteration to the physical or chemical processes would be expected other than that resulting from natural variation in*

response to sea level rise.” However, PU11.14 is HTL and therefore we consider the SMP HRA to be incorrect and are proceeding on the basis that coastal squeeze losses should have been identified.

The assessment therefore proceeds to Screening Step 2:

- Does the proposed project or activity fall within the definition of maintenance?
 - **Answer: NO**, although the works are to an existing structure, it is considered that the works are upgrading and raising the defences rather than maintaining the existing structure.

The Stage 2 Test of Likely Significant Effect. This stage gives four options. Based upon concerns relating to the validity of the SMP2 HRA it is considered that the FAS falls within Option 3:

- Proposed works could lead to coastal squeeze, are not maintenance, and are in a HTL policy unit.

The guidance states that if the SMP2 HRA identifies coastal squeeze impacts, record these and proceed to stage 3 Appropriate Assessment. Due to the error in the SMP2 HRA the following section completes the coastal squeeze assessment for the frontage following guidance in Section 4 of GN062.

For reference Welsh Government (WG) policy clarification note paragraph 3.4 states: *‘Provided that an individual project/plan is demonstrably consistent with the relevant Shoreline Management Plan policy, the statutory notice to WG from NRW shall include a short confirmation of the fact and therefore the plan/project is justified on grounds of no alternative solutions and the existing Shoreline Management Plan IROPI’* (NRW, 2022).

4.2 Coastal squeeze assessment

4.2.1 Methodology

The following section sets out the technical assessment requirements of the coastal squeeze assessment. It broadly follows Section 4 of GN62 along with FRS17187 *‘What is Coastal Squeeze?’* (Environment Agency, 2021).

The quantification of losses in front of the Viaduct Gardens frontage is based on a hypsometry analysis, whereby the extent of available habitat space in front of the present sea wall is determined from the tidal frame and the present-day topography. The present day topography uses the 2014 LiDAR data of the estuary as illustrated in Figure 8. This LiDAR data set includes some false readings, where levels relate to the water level surface in the main channels rather than the seabed. For the analysis, these false readings were therefore removed and the depth along the centre line of the channels was assumed to be MLWS, and the dataset was interpolated. The resultant DTM, therefore covers the entire intertidal frame, extending from the centre of the main channel (to represent present day MLWS) to the sea wall. The area of assessment is shown Figure 12

The water levels and sea level rise scenarios are as follows:

- Present day assumed to be 2024 using water levels provided in Table 2;
- 2124 using sea level rise estimates following UKCP18 RCP 8.5 70th and 95thile and using 2001 water levels as the starting year to align with UKCP18 base year⁵ as shown in Table 3.

⁵ As advised by NRW



Figure 12. Area subject to the coastal squeeze assessment

Using the DTM data, the hypsometry analysis calculates the extent of potential intertidal habitat that lies in the intertidal frame for each epoch as follows with the associated water levels provided in Table 5:

- **Supralittoral** (MHWS to HAT +1 m)
- **Upper Intertidal** (MHWN to MHWS)
- **Lower to Mid Intertidal** (MLWS to MHWN)

Table 5. Water levels and associated habitat groupings

Habitat	Water Level	Present day (mODN)	2124 RCP8.5 70th %ile (mODN)	2124 RCP8.5 95th %ile (mODN)
Supralittoral	HAT +1	4.25	5.34	5.74
	MHWS	2.56	3.65	4.05
Upper Intertidal	MHWS	2.56	3.65	4.05
	MHWN	1.06	2.15	2.55
Lower-mid Intertidal	MHWN	1.06	2.15	2.55
	MLWS	-1.74	-0.65	-0.25

The change in potential intertidal habitat extent as a result of sea level rise therefore captures the maximum loss (or gain) in potential habitat extent fronting Viaduct Gardens as a result of maintaining the sea wall. The outfall is not considered to result in coastal squeeze.

The coastal squeeze assessment does not consider changing morphology as a result of sea level rise or the potential for roll-back should the defences not be maintained. However, this is considered using expert geomorphological judgement using the baseline understanding provided in the Section 2 as per the requirement of guidance document '*What is Coastal Squeeze?*' (Environment Agency, 2021).

4.2.2 Results

The outputs of the hypsometric analysis is presented in Table 6 and Table 7 below using the RCP8.5 70th %ile and 95%ile respectively. It can be seen that the predicted losses are largely associated with the lower to mid intertidal. However, it should be noted that this will be significantly influenced by the movement of the nearshore channel which is included in the area for assessment.

Table 6. Quantification of potential habitat loss using hypsometric analysis and UKCP18 RCP8.5 70th %ile

Year	Lower to mid intertidal area (ha)	Upper intertidal area (ha)	Supra tidal area (ha)
Present day	1.51	0.07	0.00
2124	0.38	0.00	0.00
Coastal Squeeze	1.13	0.07	0.00

Table 7 Quantification of potential habitat loss using hypsometric analysis and UKCP18 RCP8.5 95th %ile

Year	Lower to mid intertidal area (ha)	Upper intertidal area (ha)	Supra tidal area (ha)
Present day	1.51	0.07	0.00
2124	0.21	0.00	0.00
Coastal Squeeze	1.30	0.07	0.00

It is considered that the quantification of (up to) *circa* 1.37 ha loss (under the RCP 8.5 95th %ile scenario in Table 7) is a significant overestimation of the losses which would occur due to the presence of the sea wall. This is because the conceptual understanding has identified that the estuary is a net sediment sink and likely to continue to accrete with sea level rise. Although it is not possible to determine whether the rate of sedimentation will keep pace with future sea level rise, continued sedimentation has the potential to reduce the amount of future inter-tidal habitat loss.

The area of potential 'accommodation space', i.e. the area which habitat could roll back into based solely on its topography, is shown as Figure 13. This shows a total area of 0.75 ha under the RCP8.5 95%ile scenario (pink plus green on the figure).

Assuming the worse-case scenario using the RCP8.5 95%ile sea level rise scenario and no morphological change, the assessment predicts *circa* 1.37 ha habitat loss in front of the sea wall. The maximum potential accommodation space (roll back area) is 0.75 ha.

Therefore it is concluded that there is the potential for the following losses over the lifetime of the project:

- 0.75 ha of coastal squeeze; and
- 0.62 ha of natural squeeze. Natural squeeze is defined as the loss of habitat against any natural feature that restricts the rollback of intertidal habitats, in this case high ground limiting the accommodation space available.



Figure 13. Area behind the sea wall with a topography of HAT +1 in 2124 (pink area RCP8.5 70%ile and pink plus green area RCP8.5 95%ile)

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6 Abbreviations/Acronyms

HAT	Highest Astronomical Tide
HRA	Habitat Regulations Assessment
HTL	Hold the Line
IROPI	Imperative Reasons of Overriding Public Interest
LAT	Lowest Astronomical Tide
LiDAR	Light Detection and Ranging
mCD	Metres Relative to Chart Datum
MHWN	Mean High Water Neap
MHWS	Mean High Water Spring
MLWN	Mean Low Water Neap
MLWS	Mean Low Water Spring
mODN	Metres Relative to Ordnance Datum Newlyn
MSL	Mean Sea Level
NRW	Natural Resources Wales
NTLSF	National Tidal and Sea Level Facility
OD	Ordnance Datum
PU	Policy Unit
RCP	Representative Concentration Pathway
SAC	Special Area of Conservation
SLR	Sea Level Rise
SMP	Shoreline Management Plan
SSSI	Site of Special Scientific Interest
UK	United Kingdom
UKCP	UK Climate Projections
WG	Welsh Government
YGC	Ymgynghoriaeth Gwynedd Consultancy

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

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