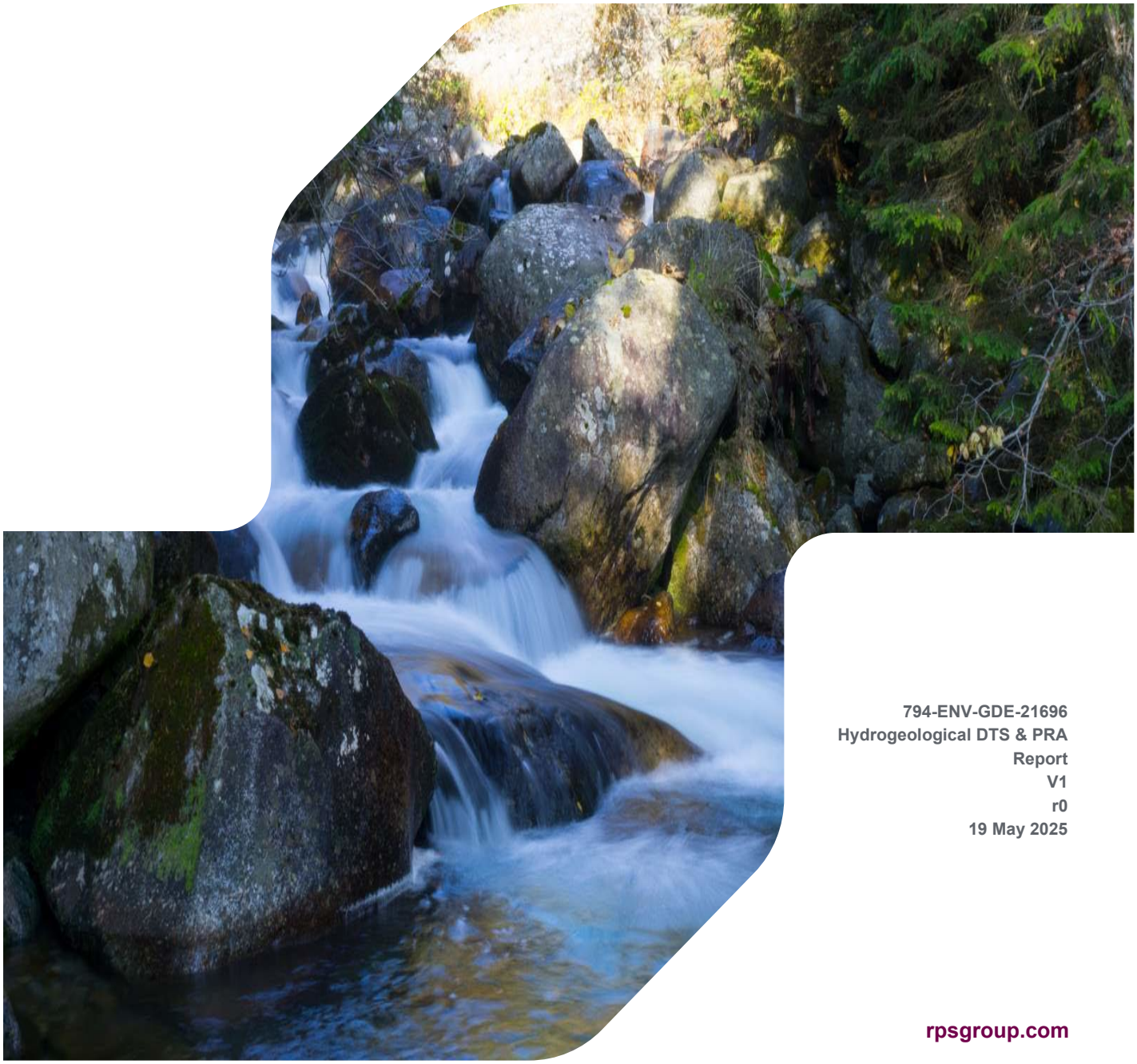
HYDROGEOLOGICAL DESKTOP STUDY AND PRELIMINARY RISK ASSESSMENT

Penrhos 132kV Cable Replacement

Morgan Sindall



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EXECUTIVE SUMMARY

This report presents the findings of a Preliminary Hydrogeological Risk Assessment (HRA) for the Penrhos 132 kV Cable Replacement Project, conducted as part of a desktop study to evaluate potential impacts on groundwater resources and environmental receptors. The project involves the construction of a new substation at Penrhos and the replacement of a buried electrical cable along a 3 km route in Anglesey, North Wales.

The assessment identifies several key receptors that require further consideration and management due to their qualitative risk rankings:

1. **Private Water Supply on Lon Towyn Capel Road**: Located approximately 1 km southwest of the substation, this receptor has been assigned a moderate risk ranking due to uncertainties regarding its infrastructure and potential hydraulic connectivity to the groundwater body. Further investigation is needed to assess potential impacts from construction activities.
2. **Ynys Mon Secondary Groundwater Body**: This groundwater body underlies the cable corridor and substation, with a moderate risk ranking attributed to the likelihood of hydraulic continuity with construction activities. While impacts on groundwater levels are expected to be minimal, monitoring for potential water quality impacts is essential.
3. **Beddmanarch-Cymyran SSSI, Beddmanarch Bay Shellfish Water Protected Area, and Ynys Mon/Anglesey AONB**: These sensitive ecological receptors, located within or adjacent to the proposed cable corridor, have been assessed with a low to moderate risk ranking. Effective management measures are necessary to prevent adverse effects from project-related discharges.

The HRA is based on existing data sources and a desktop study, which present certain assumptions and limitations. Notably, the absence of site-specific geological and hydrogeological survey data may limit the accuracy of the conceptual model. The bedrock terrain consists of fractured crystalline metapelites, an aquifer type which is known to exhibit highly variable and anisotropic characteristics. This variability introduces a higher degree of uncertainty regarding the potential impacts on groundwater resources.

To address these uncertainties, a full Hydrogeological Impact Assessment (HIA) will be developed following the consolidation of the Hydrogeological Conceptual Site Model (HCSM) using results from the Stage 1 & 2 Ground Investigation. This will ensure that the ground model is accurately constrained by site-specific geotechnical data, which is crucial given the highly variable nature of the bedrock as an aquifer.

In turn, this HIA shall be used to inform the management practices for the Groundwater and Surface Water Management Plan section of the Construction Environmental Management Plan.

In summary, while the preliminary risk assessment indicates that the project can proceed with manageable risks, further delineation of risks to the identified receptors is required. Implementing robust mitigation strategies through a Ground and Surface Water Management Plan will be essential to ensure compliance with environmental regulations and protect the integrity of local groundwater resources and ecological sites throughout the duration of the Penrhos 132 kV Cable Replacement Project.

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1 INTRODUCTION

1.1 Scope of works & Project Overview

1.1.1 The project, which is being executed by the Client, Morgan Sindall, on behalf of National Grid, involves the construction of a new substation at Penrhos and the replacement of a buried electrical cable along a 3km route from Penrhos substation, Holyhead (E:226890, N:380639) to Tower EV86 (E:229387, N:379839) in Anglesey, North Wales.

1.1.2 This Desk Top Study and preliminary Hydrogeological Risk Assessment presents the preliminary environmental information for the Penrhos 132 kV Cable Replacement Project and qualitatively presents the Hydrogeological Conceptual Site Model (HCSM) and the associated qualitative preliminary HRA.

1.1.3 The HCSM and HRA laid out in this report shall inform the management practices for the Groundwater and Surface Water Management Plan (GSWMP) section of the Construction Environmental Management Plan (CEMP).

1.1.4 The Stage 1 & 2 Ground Investigation for the Project is currently ongoing. Results of the ground investigation, upon reporting, shall be used to inform a full Hydrogeological Impact Assessment (HIA). Results of the HIA will be fed back into the GSWMP to further mitigate and control any risks that persist following the quantitative risk assessment of the HIA.

1.2 Objectives

1.2.1 The objectives of this DTS and preliminary HRA are to support the abstraction licence and discharge consent applications submitted to NRW on the 8th and 9th of May respectively and to provide the foundations of the quantitative Hydrogeological Impact Assessment (HIA).

1.2.2 Following completion of the Stage 1 & 2 Ground Investigation, geotechnical data will be used to consolidate the HCSM and present a full HIA of the proposed engineering works and their associated groundwater abstractions and effluent discharges.

1.2.3 In particular, this DTS & preliminary HRA aims to:

- Present the existing environmental baseline established from desk studies, and consultation.
- Identify any assumptions and limitations encountered in compiling the environmental information as well as further consultation requirements.
- Present the potential environmental effects on geology, hydrogeology and ground conditions arising from the Penrhos 132 kV Cable Replacement Project, based on the information gathered and the analysis and assessments undertaken to date.

1.3 Assessment area

1.3.1 The Penrhos 132 kV Cable Replacement Project area, hereafter referred to as the Study Area includes:

- The area of land to be temporarily or permanently occupied during the construction, operations and maintenance and decommissioning of the project.
- Geological and hydrogeological receptors within 1km of the red line boundary for the Penrhos 132 kV Cable Replacement Project. The 1km buffer was selected for the Study Area as potential impacts on hydrogeological receptors are likely to occur within this distance. Potential impacts on geological receptors may occur within a shorter distance, however a conservative approach has been followed and a consistent buffer has been applied for all receptors.

1.3.2 The Study Area is shown in Figure 1-1. This area will be reviewed and modified in response to any alterations made to the cable corridor during the detailed design process. The red line boundary for the Penrhos 132 kV Cable Replacement Project encompasses two distinct areas;

- The Penrhos Substation which occupies part of the former Anglesey Aluminium Metals (AAM) Works at Penrhos, on Holyhead Island. The substation is a site of historic groundwater contamination following a transformer fire in 2008. Post remediation groundwater monitoring performed by LK Consult Ltd in 2021 exhibited a 100% reduction of the contaminants of concern and concluded the remedial aims had been met. The post remediation monitoring report is provided in Appendix G.
- The cable corridor, measuring approximately 5m wide running from the Penrhos Substation, across Stanley Embankment to the point of grid connection at Tower EV86. The alignment of the corridor follows the trajectory of the exisiting buried cables that require replacement.

1.4 Proposed Construction Activities

1.4.1 Proposed construction activities to be undertaken by the scheme are summarised as follows:

- Construction a new substation compound occupying an area of approximately 4360m^2 upon the site of the old rectifier yard at Penrhos. Installation of foundations will entail excavation to depths of 1.5mbgl in this area. The footprint of the new substation compound is shown in Figure 1-1.
- Construction of two transmission circuits to connect the new substation at Penrhos to the grid at Tower EV86 on Anglesey Island. This will entail open trenching to a depth of 1.5 mbgl on landwards sections of the proposed cable corridor, in lengths not exceeding 20m, to facilitate the following:
  - Removal of exisiting oil-filled cables that connect present along proposed cable corridor alignment
  - Installation of two 132kV transmission circuits at a depth of approximately 1 mbgl.
- Replacement of exisiting cables along Stanley Embankment which exist in pre-cast concrete troughs measuring approximately 0.6m wide by 0.4m deep.

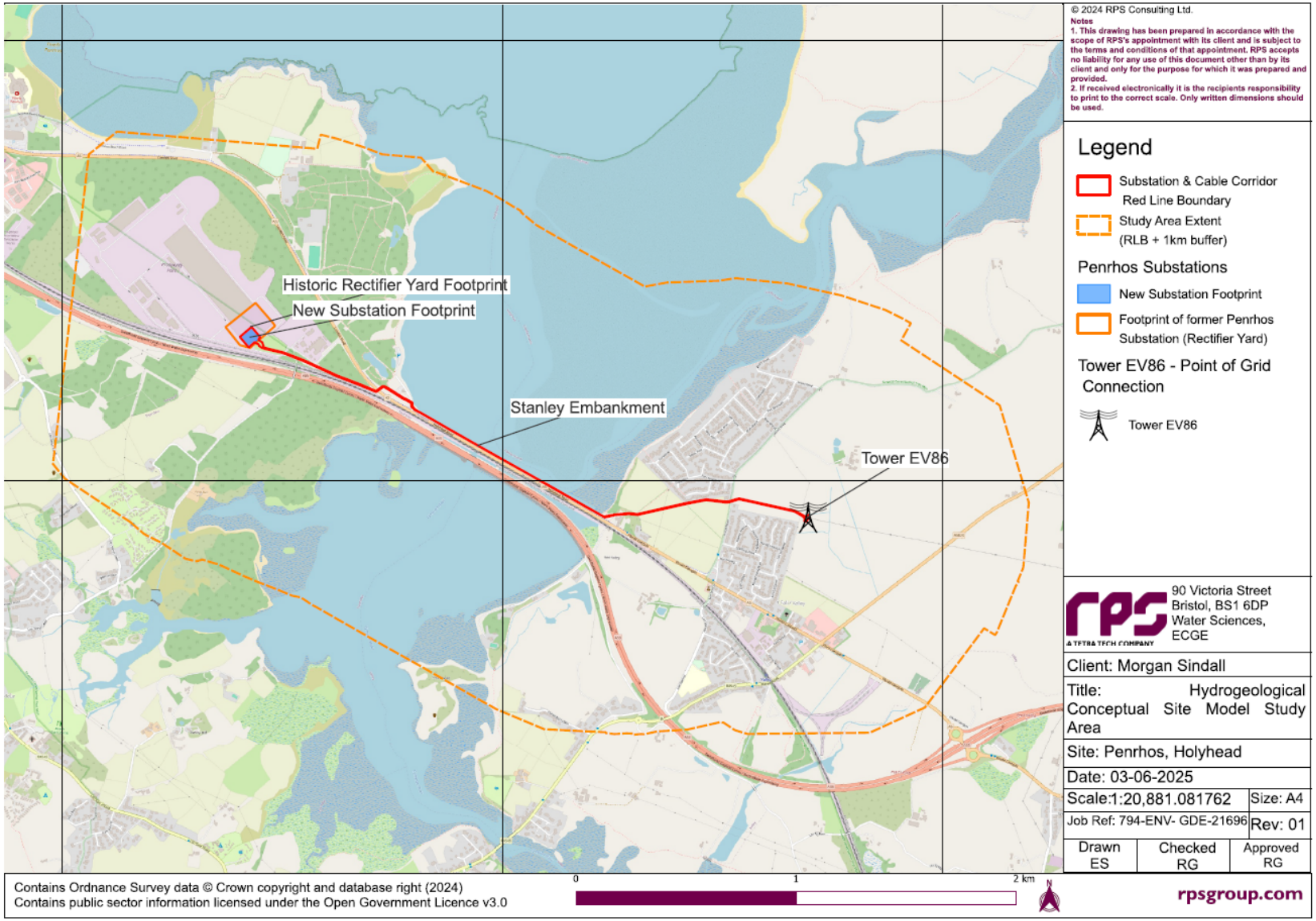

Figure 1-1 – The project Study Area indicating the relative locations of Penrhos substation and the red line boundary of the cable corridor to the proposed point of grid connection. The Study Area extent has been determined by generation of a 1km buffer.

1.5 Assessment approach

1.5.1 Data sources

1.5.1 The baseline environment for the HCSM has been principally defined through a desktop study that reviewed the following:

- Publicly available data sources available from the following organisations:
  - British Geological Survey (BGS)
  - Natural Resources Wales (NRW)
  - Isle of Anglesey County Council (IACC)
- Information contained in a Groundsure Enviro-Geo Insights report for the Study Area. That report includes:
  - General information regarding geological, hydrogeological and hydrological setting
  - Groundwater abstraction licences
  - Current and historical landfill sites
  - Current and historical waste sites
  - Pollution incidents
  - Discharge consents
  - Current and historical land-use
  - Mining and ground working areas (coal and non-mining)
  - Geotechnical constraints
- Historical Ordnance Survey mapping and some aerial photography.

1.5.2 Information on geology, hydrogeology and ground conditions within the Study Area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 16.6 below.

Table 1-1 Summary of key desktop reports

Title	Source	Year	Author
Geoindex (Onshore)	BGS Map Viewers	-	British Geological Survey
Sheet SH28SE, (Valley), Bedrock, 1:10 000	BGS Maps Portal	2020	British Geological Survey, (British Geological Survey , 2020)
Sheet SH27NE, (Four Mile Bridge), Bedrock, 1:10 000	BGS Maps Portal	2020	British Geological Survey, (British Geological Survey, 2020)
Sheet SH28SE, (Penrhos), Superficials, 1:10 000	BGS Maps Portal	2014	British Geological Survey, (British Geological Survey, 2014)
Sheet SH27NE, (Rhoscolyn), Superficials, 1:10 000	BGS Maps Portal	2014	British Geological Survey, (British Geological Survey, 2014)
Aquifer designation – bedrock	NRW interactive map of data about the natural environment	-	National Resources Wales
Aquifer designation – superficial deposits	NRW interactive map of data about the natural environment	-	Natural Resources Wales

The physical properties of minor aquifers in England and Wales	NERC Open Research Archive (NORA)	2000	British Geological Survey (Jones, H K, Morris, B L, Cheney, C S, Brewerton, L J, Merrin, P D, Lewis, M A, MacDonald, A M, Coleby, L M, Talbot, J C, McKenzie, A A, Bird, M J, Cunningham, J, and Robinson, V K.)
Groundwater vulnerability	NRW interactive map of data about the natural environment and GeoIndex Onshore	-	Natural Resources Wales and BGS
Groundwater safeguard zones	NRW interactive map of data about the natural environment	-	Natural Resources Wales
WFD groundwater bodies (Cycle 2)	Lle Geo-Portal for Wales. Spatial Dataset	-	Partnership between Welsh Government and Natural Resources Wales
WFD river water bodies (Cycle 2)	Lle Geo-Portal for Wales. Spatial Dataset	-	Partnership between Welsh Government and Natural Resources Wales
Geological Conservation Review (GCR) sites	Lle Geo-Portal for Wales. Spatial Dataset	-	Partnership between Welsh Government and Natural Resources Wales
Regionally Important Geological and Geomorpholgical Sites (RIGS)	Lle Geo-Portal for Wales. Spatial Dataset	-	Partnership between Welsh Government and Natural Resources Wales
Protected Sites (Sites of Scientific Interest, Special Areas of Conservation)	Lle Geo-Portal for Wales. Spatial Dataset; NRW interactive map of data about the natural environment and Groundsure Enviro-Geo Insights Report	-	Partnership between Welsh Government and Natural Resources Wales
Main Rivers in Wales	Lle Geo-Portal for Wales. Spatial Dataset	-	Partnership between Welsh Government and Natural Resources Wales
Groundsure Enviro-Insights Report for the Penrhos Substation Area	Groundsure	2021	Produced by Groundsure for WSP for the 1.25 ha area occupied by the substation at Penrhos.
Orthios, Former Anglesey Aluminium, Penrhos – Post Remediation Monitoring Report (Escrow Site 1 – Rectifier Yard Area)	Appendix G	2021	LK Consult Ltd (LKC)
Remediation Validation Report, Escrow Site 1 (Rectifier Yard)	Appendix H	2020	LK Consult Ltd (LKC)

1.5.2 Consultation

1.5.1 A summary of the key consultation activities undertaken to date to inform the HCSM and HRA is presented in Table 1-2 below, together with how the information gained from these consultation activities has been considered in the production of this report.

Table 1-2 Summary of consultation activities undertaken for the Penrhos Cable replacement project relevant to the hydrogeological conceptual model

Date	Consultee and type of response	Issues Raised	Response to issue raised and how it has been considered in this report

31/03/2025	Isle of Anglesey County Council (IOACC)	Potential presence of private water supplies within the Study Area.	The location of one PWS has been identified by IOACC. The email response is given in Appendix D. This PWS has been integrated into the HCSM and preliminary risk assessment as a sensitive receptor.

1.6 Limitations of assessment

1.6.1 The assessments presented in this report are largely based on the results of a desktop study of baseline conditions. At this stage no site-specific geological, hydrogeological or ground condition survey data has been gathered asides from the information gathered within the site walkover which was executed on the 1st and 2nd of April 2025 and is reported in Appendix B. The use of publicly available data sources at this stage is considered sufficient, given the conservative nature of the risk assessment undertaken. Following the completion of the scheduled intrusive ground investigation works by WSP and the reporting of subsequent findings, this report will be revised to further consolidate the HCSM.

2 ENVIRONMENTAL SETTING

2.1 Hydrology & topology

2.1.1 The hydrological and topographical setting of the Study Area is captured in Figure 2-1. The Study Area is situated in the surface water catchment of one NRW Main River Catchment:

- Cleifiog (Valley) WFD river waterbody catchment, that occupies the eastern end of the Study Area up to its confluence with the Holy Island Straits 0.4km south of the Study Area.

2.1.2 All other catchment area occupied by the Study Area are small, undesignated coastal catchments. The hydrological area in question falls under the WFD defined Crigyll Caradog Operational Management Catchment.

2.1.3 There are also several small watercourses within the Study Area, many of which discharge either to the Cleifiog Main River and its tributaries or into transitional and coastal water bodies. Ordnance Survey mapping also identifies many small ponds and water bodies, most notably at low elevations along the coastlines on either side of the Holy Island Strait. These hydraulically isolated ponds are likely situated upon low permeability glacial till or tidal flat deposits.

2.1.4 Topography within the Study Area is also depicted in Figure 2-1. Elevation across the Study Area varies between -2 mAOD within the estuary channel to 20m AOD on the headland which comprises the most north easterly section of the Study Area on Holy Island.

2.1.5 Topography along the proposed alignment of the cable corridor on Holy Island from the substation to Stanley Embankment is relatively flat and gently undulating with elevation decreasing from 10 m AOD to 5 m AOD.

2.1.6 The proposed alignment then crosses the Cymyran Strait along Stanley Embankment at an elevation of 5 m AOD. At the point of landfall on Anglesey Island, the alignment of the cable corridor veers northwards, reaching a high of 17 m AOD just after crossing Gorad Road. There is then another decline in elevation to 2 m AOD at the point of grid connection at Tower EV86.

2.1.7 The gently rolling landforms across the landward sections of the Study indicate a landscape shaped by underlying superficial glacial deposits which cap a basement of ancient, eroded bedrock.

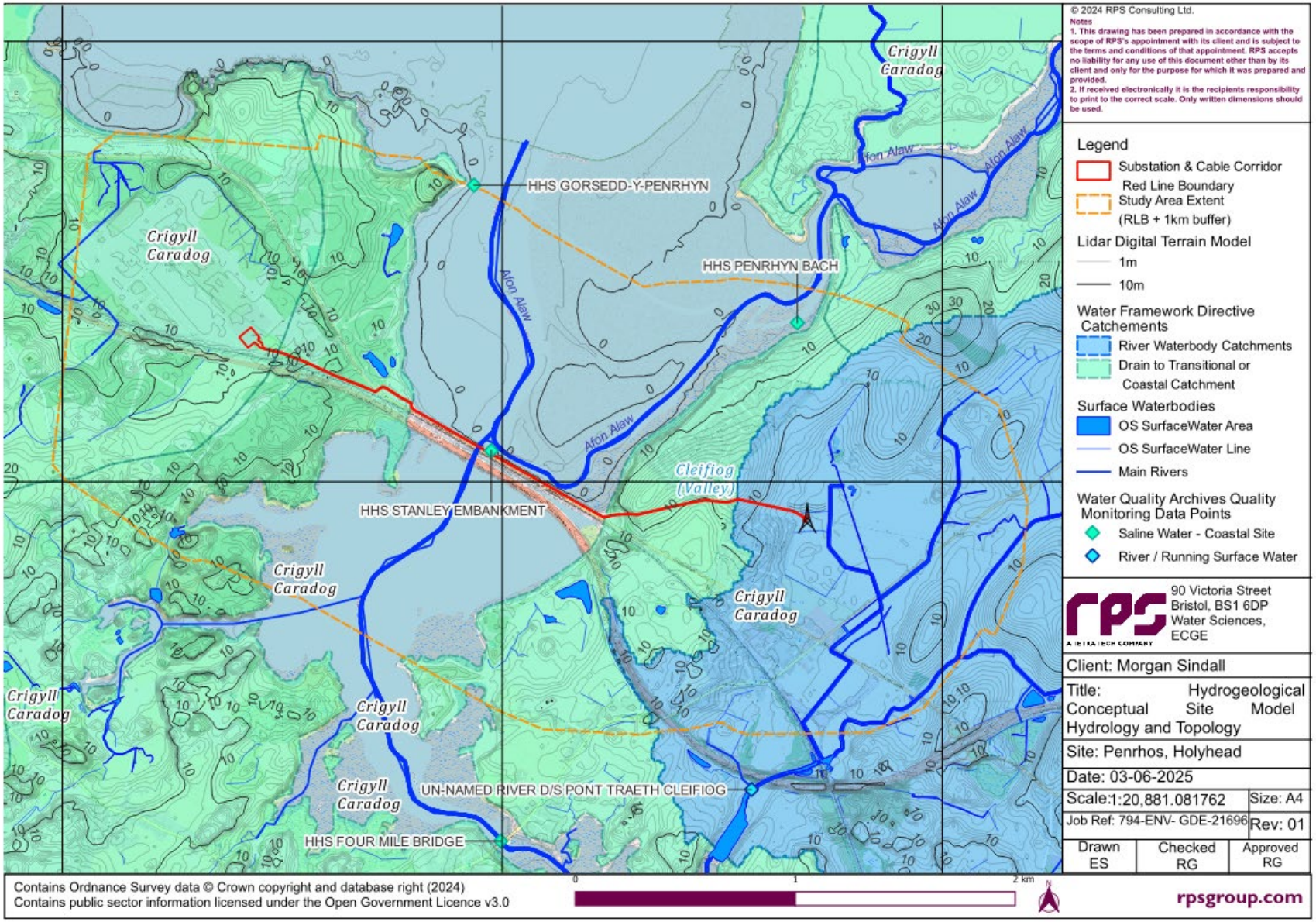

Figure 2-1 Hydrology and Topology of the Study Area

2.2 Geology and superficials

2.2.1 A summary of the regional geological sequence is provided in Table 2-1 and presented in Figure 2-2 and Figure 2-4.

2.2.2 Bedrock

2.2.1 The regional bedrock terrain in the Anglesey area of North Wales is highly structurally deformed but generally gets progressively older from the northwest to the southeast. The oldest bedrock in the region comprises a thick sequence of Neoproterozoic mica schists which form the core of the Central Anglesey Shear Zone. The bedrock of the Study Area is composed of a complex orogenic sequence of Cambrian schists and psammites of the New Harbour Formation. Metamafic amphibolite intrusions are present within the sequence and are generally observed to strike in a SW-NE direction.

2.2.2 As shown in Figure 2-2 and Figure 2-3, a small outcrop of the Clwyd Limestone Group is also shown on Holy Island, just north of the cable corridor. Geological base mapping for Figure 2-3 is composed of 1:50 000 (BGS, 2020) and more recent 1:10 000 scale geological mapping of the area has removed this unit (British Geological Survey , 2020). Therefore, the Clwyd Limestone has been omitted form the conceptual geological model and the interpreted stratigraphic sequence presented in Table 2-1.

2.2.3 Geology in the Study Area is structurally complex, and the bedrock has been subject to multiple phases of deformation. The first of these being repeated intrusions by mafic bodies during a period of island arc volcanism in the Cambrian period. Pervasive chlorotic foliation within the pelitic New Harbour Formation was secondary to the volcanism and resulted in the alteration of the mafic intrusives to amphibolites, serpentinites and metagabbros (Phillips, 1991). Following this, a period of ductile deformation resulted in the formation of major regional folding which resulted in further deformation to the rock fabric in the form of recumbent folding and crenulation cleavage.

Picture 2-1 Bedrock of the of the New Harbour Formation depicting distinctive 2-phase deformation fabric SH 2755781401.

2.2.4 Picture 2-1, taken from the Site Walkover Report in Appendix B, depicts the mesoscale ductile deformation that has postdated the period of mineral foliation. The resulting folding is disharmonic due to alternating degrees of competency in the foliated minerals. The picture was taken at the Penrhos Drumlin Regionally Important Geodiversity Site (see Figure 2-8) on the northern edge of the headland at the northern end of Penrhos Coastal Park.

Table 2-1 Stratigraphy of the Study Area and associated aquifer designation.

Era	Group	Formation	Description*	Thickness*	Aquifer designation (NRW)	BGS hydrogeological description
Superficial geology						
Quaternary	Tidal Flat Deposits		Tidal flat deposits, including mud flat and sand flat deposits. They consist of unconsolidated sediment, mainly mud and/or sand	-	Secondary Undifferentiated	Not described
	Coastal Zone Deposits (Undifferentiated)		Shingle, sand, silt and clay; may be bedded or chaotic.	-	Secondary Undifferentiated	Not described
	Blown Sand		A low rounded ridge of course materials (gravels, cobbles and boulders) piled up by very powerful storm waves at the inland margin of a beach, above the level reached by normal spring tides.	-	Secondary A	Not described
	Glacial Till (Devensian)		Unconsolidated mixed deposit consisting of a heterogenous mixture of clay, sand, gravel, and boulders varying widely in size and shape	-	Secondary Undifferentiated	Not described
	Glaciofluvial Deposits (Devensian)		Unconsolidated material by glacial river waters and consisting of boulders, gravel, sand, silt and clay from ice sheets or glaciers.	-	Secondary A	Not described
	Alluvium		Sorted/Semi-sorted clay, silt, sand and gravel deposited by a river, stream or other body of running water.	-	Secondary Undifferentiated	Not described
Bedrock geology						
Late Cambrian –	Holy Island Group	New Harbour Formation	Chlorite-muscovite schist and phyllite, semipelite	Up to 2km	Secondary Aquifer	Low productivity aquifer. Highly indurated pelitic

Early Ordovician			predominates with subsidiary psammite. Metabasaltic rock and calcsilicate rock locally. Abundant sheet-like units of metamafic rock (amphibolite) occur locally. (BGS, 2025)			rocks with limited groundwater in the near surface weathered zone and secondary fracture systems.

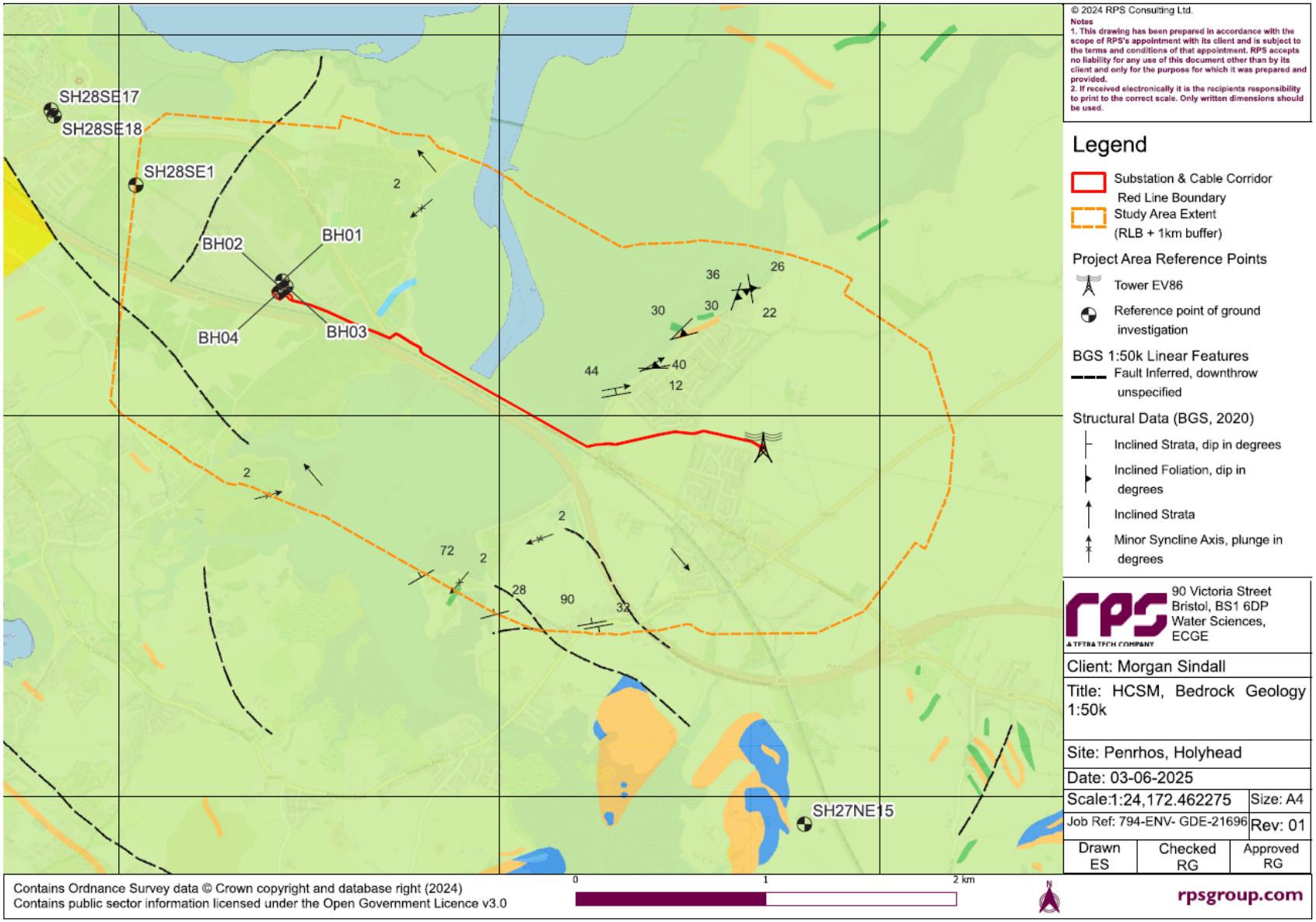

Figure 2-2 1:50k Mapped Bedrock Geology of the Study Area

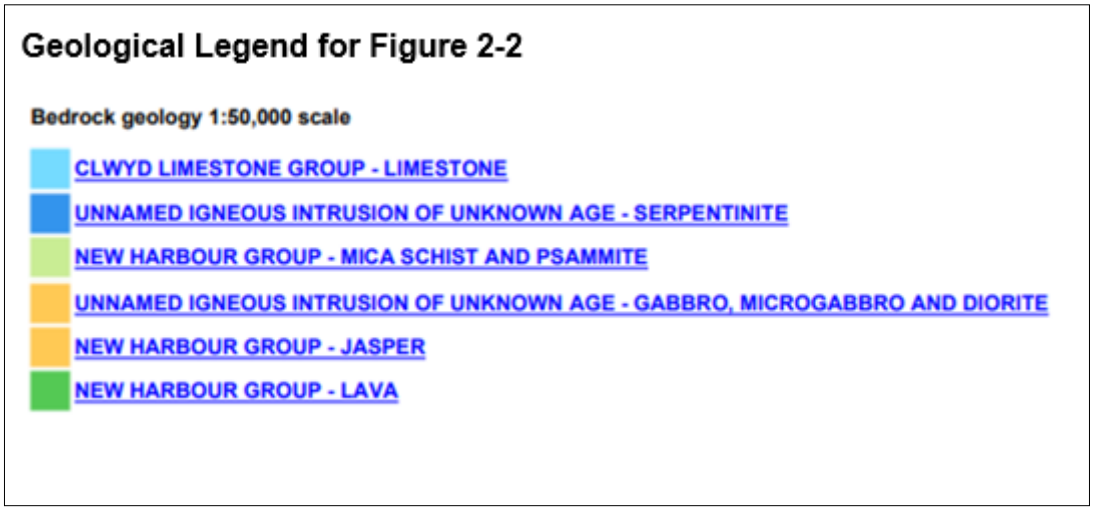

Figure 2-3 Geological Legend for Figure 2-2. (BGS, 2020)

2.2.3 Superficial Deposits

2.2.1 The superficial geology within landwards sections of the Study Area is dominated by diamicton glacial till and tidal flat deposits. Glacial till deposits in the Anglesey area are described as being dense and overconsolidated composing of a heterogenous mixture of clay, sand gravel and boulders (BGS, 2025). A BGS report on the physical properties of till deposits in Anglesey also provides evidence to suggest diamicton tills in the area around Penrhos have a higher proportion of fines and are generally present in thicknesses of 4-6m in coastal areas (Boon, et al., 2014). Three drumlins and other associated glacial structures are also mapped within the study area. Drumlins are low, oval or elongated mounds or small hills consisting of compacted till that were formed by the movement of glacial ice. The drumlin at Penrhos measures approximately 15m in height and is recognised as a Regionally Important Geodiversity Site (RIGS).

2.2.2 Tidal flat deposits dominate on the eastern end of the Study Area, in the flood plain of the Cleifiog River where the cable corridor joins the grid at Tower EV86. These deposits are described as being composed of unconsolidated deposits of mud and sand of variable thickness (BGS, 2025).

2.2.3 Figure 2-5 presents the distribution of the different mapped superficial deposits across the Study Area and a descriptive summary of each deposit type is given in Table 2-1. It can be seen that glacial till and tidal flat deposits dominate the superficials in landwards sections of the Study Area but glaciofluvial deposits are also present. Undifferentiated coastal zone deposits are the only mapped deposit below mean high water springs and the distribution of the mapped unit covers the majority of the area occupied by the Cymyran Strait and its tributaries.

2.2.4 All superficial deposits within the area are designated as Secondary (undifferentiated) aquifer units with the exception of the blown sand and glaciofluvial deposits with are designated as Secondary A aquifers and are only found in restricted areas in the vicinity of Penrhos on Holy Island.

2.2.4 Local geological records

2.2.1 The expected geological sequence within the Study Area has been corroborated using borehole records from the BGS GeoIndex Onshore platform as well as historic ground investigation records from Penrhos substation. The geological logs for the five boreholes identified within the Study Area and a further 3 boreholes present in the same stratigraphy but up to 1km away from the Study Area are provided in Appendix A, wherein their location is shown in Figure 2-3 and Figure 2-5. These logs demonstrate:

- There are no publicly available borehole records indicating subsurface stratigraphy within the Study Area. SH28SE1, installed in 1903, only records rest water levels and well construction details.
- There are records of some 20 further installations on GeoIndex but the records are confidential.
- SH27NE15, 1km south of the study area, demonstrates the presence of the New Harbour Formation to depths of 102mbgl.
- SH28SE17 & SH28SE18 record deposits of ‘mixed clay, sand & stone fill’ (TILL) over ‘very hard green schist’ (NEW HARBOUR FORMATION).
- BH01 to BH04 demonstrate a sequence of made ground over 1 to 3 m of glacial till covering a bedrock of competent schist (NEW HARBOUR FORMATION)
- BH01 to BH04 record rest water levels of 1.47 to 1.84 mbgl.

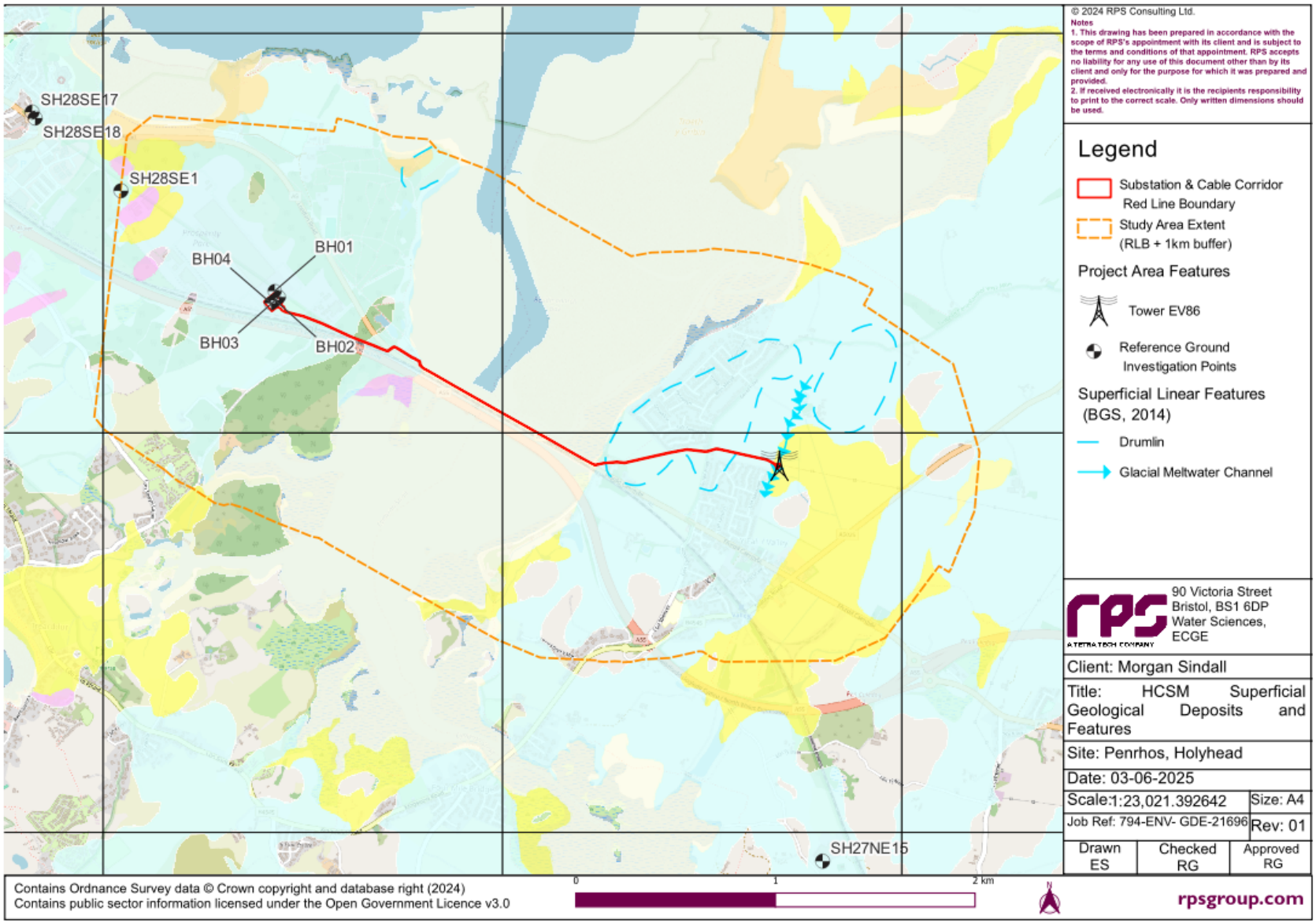

Figure 2-4 Superficial deposits and features of the Study Area. Extracted from 1:50k BGS Mapping

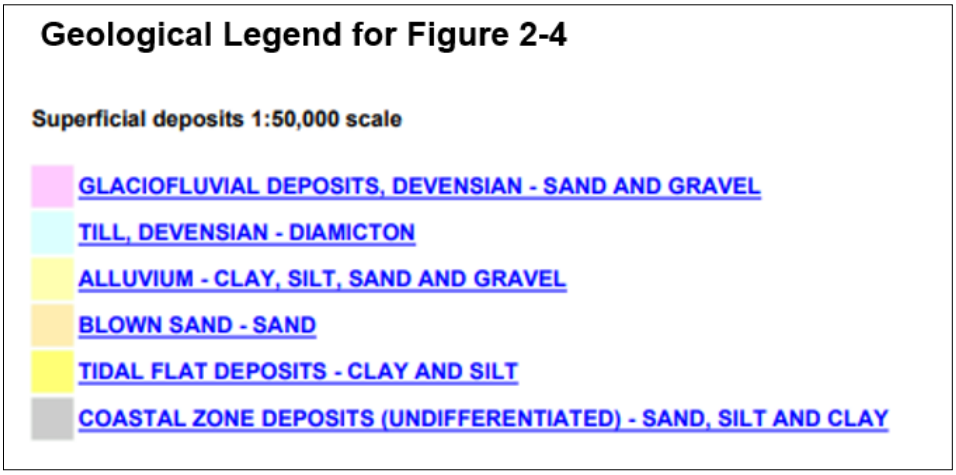

Figure 2-5 Geological Legend for Figure 2-4 (BGS, 2020)

2.3 Hydrogeology

2.3.1 Aquifer units

2.3.1 Aquifers in Wales are classified by NRW and the BGS (British Geological Survey, 2022) on the following basis:

- Principal aquifer – the geological unit that provides significant quantities of water and can support water supply and/or baseflow to rivers, lakes and wetlands on a strategic scale. They typically have a high intergranular and/or fracture permeability meaning they usually provide a high level of water storage
- Secondary A aquifer – the geological unit that provides modest amounts of water, but the nature of the rock or the aquifer's structure limits their use. They support water supplies at a local rather than strategic scale (such as for private supplies) and remain important for rivers, wetlands and lakes
- Secondary B aquifer – Dominated by lower permeability layers that may store and yield limited amounts of groundwater
- Secondary (undifferentiated) aquifer - Where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type, but generally have only a minor resource value
- Unproductive strata - These rocks have negligible significance for water supply or baseflow to rivers, lakes and wetlands. They consist of bedrock or superficial deposits with a low permeability that naturally offer protection to any aquifers that may be present beneath.

2.3.2 Aquifer classifications for bedrock and superficial geology within the Study Area are summarised in Table 2-1. Bedrock aquifer classification status and vulnerability status is mapped in Figure 2-7. Table 16.7 also provides the BGS hydrogeological description for the New Harbour Formation as it is the only bedrock unit present in the Study Area.

2.3.3 With regards to superficial geology, the majority of the Study Area is underlain by glacial till, coastal zone deposits and tidal flat deposits which are classified as Secondary (Undifferentiated) aquifer units. Given the clay-rich nature and low permeability of these strata, groundwater will be restricted to localised granular lenses or layers which do not typically form significant groundwater bodies. As their aquifer classification suggests, localised groundwater within these superficial units is not considered to be of significant resource value.

2.3.4 Granular glaciofluvial deposits, and blown sand deposits, found in the north westerly sections of the Study Area, can form locally important groundwater bodies and are classified as Secondary A

aquifer units. The importance of these aquifers is, dependent on their thickness and their lateral extent. As the extent of these deposits in the Study Area is limited, it is unlikely that they constitute a locally important groundwater resource.

2.3.5 The Cambro-Ordivician bedrock of the New Harbour Formation is composed of metapelites and psammites which have little to no intergranular porosity or permeability. Groundwater in this formation is restricted to fractures and faults or associated with zones of weathering, typically at shallow depths. The presence of groundwater in shallow weathered regions of the New Harbour Formation has been observed at the Penrhos substation area where rest water levels have been recorded at depths of 1.47 to 1.84 mbgl. The New Harbour Formation is classified a Secondary B aquifer unit reflecting its low permeability and the fact groundwater is typically of little resource importance.

2.3.6 The vulnerability of groundwater present in both bedrock and superficial deposits is also shown in Figure 2-7. Vulnerability status for each aquifer type is determined by the BGS as follows:

- High: areas that can easily transmit pollution to groundwater. They are characterised by high-leaching soils and the absence of low-permeability superficial deposits.
- Medium: areas that offer some groundwater protection. Intermediate between high and low vulnerability.
- Low: areas that provide the greatest protection to groundwater from pollution. They are likely to be characterised by low-leaching soils and/or the presence of low-permeability superficial deposits.

2.3.7 Vulnerability status varies from high to low across the Study Area with all groundwater at the western end of the Study Area being classified as ‘high vulnerability’ and groundwater vulnerability status varying from high to low at the eastern end of the Study Area on Anglesey Island.

2.3.8 BGS borehole records and ground investigation records local to the Penrhos substation site, provided in Appendix A, confirm the following:

- The New Harbour Formation can exhibit artesian groundwater pressures at depth with water rising to 30mbgl from screened depths of 80-100mbgl.
- Shallow ground installations (<10m) frequently report the absence of groundwater, indicating its occurrence is spatially variable across the site.
- Rest water levels recorded at Penrhos substation vary between 1.47 and 1.84 mbgl and indicate the presence of groundwater in both the glacial till and the fractured surficial schists.
- The absence of borehole records for the New Harbour Formation in the area suggests the unit is not important with respect to water resources. This also reflects its designation as a Secondary B aquifer.

2.3.2 Water Framework Directive groundwater bodies

2.3.1 The Study Area crosses only one groundwater body as defined by the Water Framework Directive (WFD) (Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy). This groundwater body and its status is summarised in Table 2-2 and shown within Figure 2-7.

Table 2-2 Summary of WFD groundwater bodies within the Study Area

Reference	Name	Position in Study Area	Overall status	Quantitative status	Chemical status
GB41002G204400	Ynys Mon Secondary	Defined in all landward sections of the Study Area.	Poor	Good	Poor

2.3.2 The Ynys Mon Secondary groundwater body currently has poor status which relates to the assessment of its chemical status.

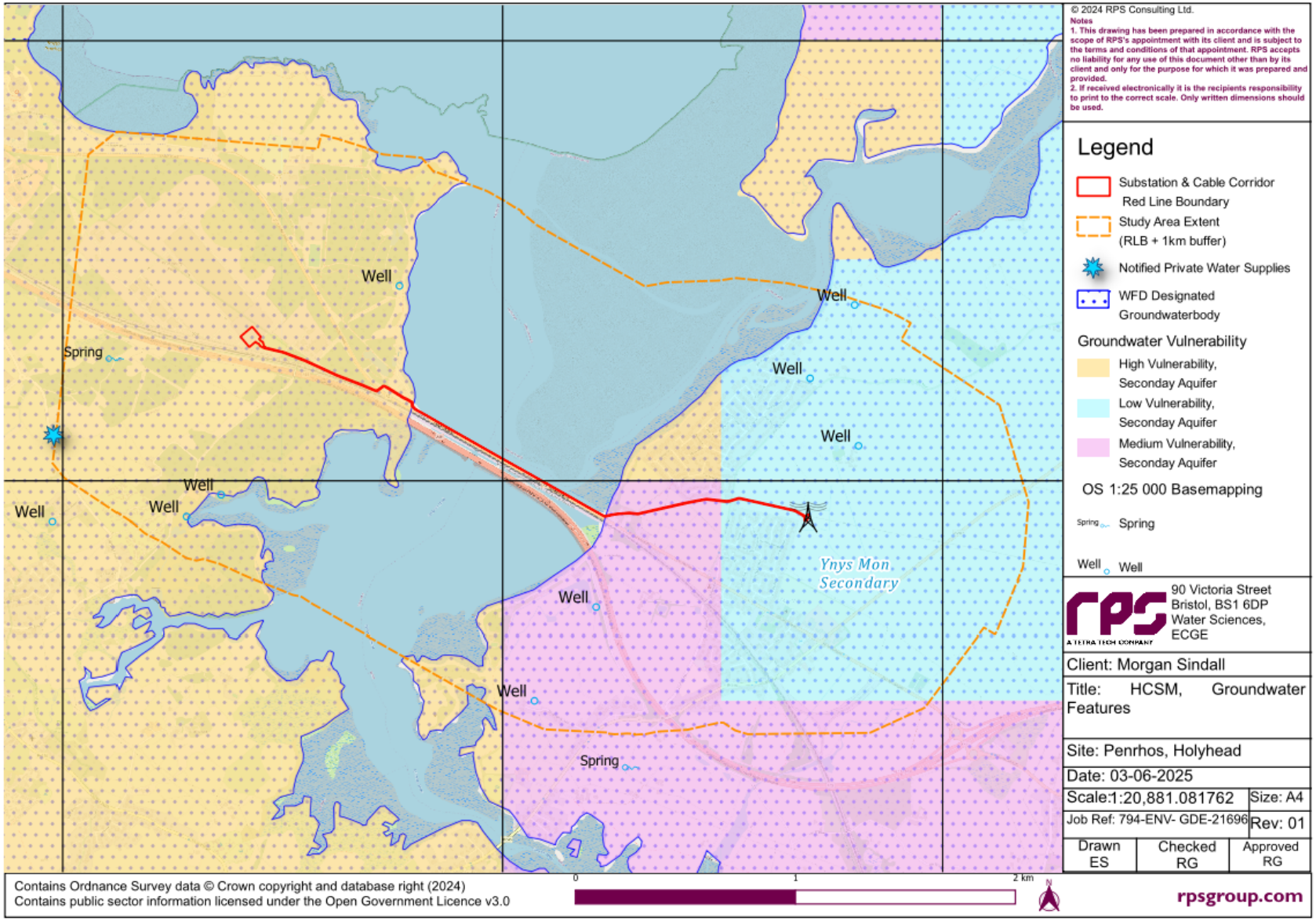

Figure 2-6 Groundwater features of the Study Area 'Contains British Geological Survey materials © UKRI [2025]'

2.3.3 Licensed and private groundwater abstractions

2.3.1 Ordnance Survey mapping (1:25,000 scale) identifies eight ‘wells’ and one ‘spring’ across the Study Area, most notably around the edges of areas that are overlain by glacial till. Although there are no licensed abstractions in the low permeability Silurian bedrock, the presence of these wells suggest small private abstractions may be relatively common and the water is accessible.

2.3.2 Consultation with Anglesey County Council on the potential presence of private groundwater supplies has revealed one registered supply. The approximate location of said supply is shown in Figure 2-7. No further information on the supply type or infrastructure was given. The consultation response is provided in Appendix C.

2.3.3 The survey of potential licensed groundwater abstractions within the Study Area is yet to be undertaken. A request for further information on licensed abstractions was sent to NRW on the 20th of March 2025, see Appendix C. A response regarding the presence of licensed abstractions in the Study Area is yet to be received, however. Following receipt of information regarding potential licensed groundwater abstractions in the area, any necessary associated abstraction source risk assessments shall be completed.

2.3.4 Groundwater source protection zones

2.3.1 NRW do not report any groundwater SPZs within the Study Area or on the Island of Anglesey in its entirety as of May 2025. (NRW, 2025)

2.3.5 Summary of groundwater receptors

2.3.1 The identified private water supply, despite being at the very edge of the Study Area, represents an important and sensitive groundwater receptor. In addition to this supply, the Ynys Mon Secondary groundwater body constitutes another high vulnerability groundwater receptor.

2.3.2 The surface watercourses that cross Study Area and in particular the proposed cable corridor, also constitute potential groundwater receptors, where they are in hydraulic continuity with aquifers in the underlying bedrock and/or superficial deposits. Groundwater within these aquifer units will tend to flow towards, and discharge to, these watercourses. However, the discontinuous nature of groundwater in the glacial till and tidal flat deposits and its limited resource potential suggests that the groundwater contribution to these small watercourses will be of limited importance to their flow regime.

2.3.3 The desktop study has not identified any groundwater dependent protected sites within the Study Area.

2.3.4 The ultimate receptor of groundwater in aquifers underlying the Study Area is the coastline of the Cymyran Strait and the Irish Sea to which all local watercourses ultimately flow and groundwater is discharged.

2.4 Environmental sensitivity

2.4.1 All protected and/or sites within the Study Area that could be affected by the construction, of the Penrhos 132 kV Cable Replacement Project were identified using the following sources:

- Lle Geo-Portal for Wales - Spatial Dataset;
- NRW interactive map of data about the natural environment and;
- Groundsure Enviro-Geo Insights Report previously obtained for the Penrhos Substation, provided in Appendix D.

2.4.2 Figure 2-8 depicts the spatial distribution of protected sites that were identified within the DTS indicating that the Study Area is situated in an area of exceptionally high environmental sensitivity, particularly the section of the cable corridor that crosses the Cymyran Strait via Stanley Embankment.

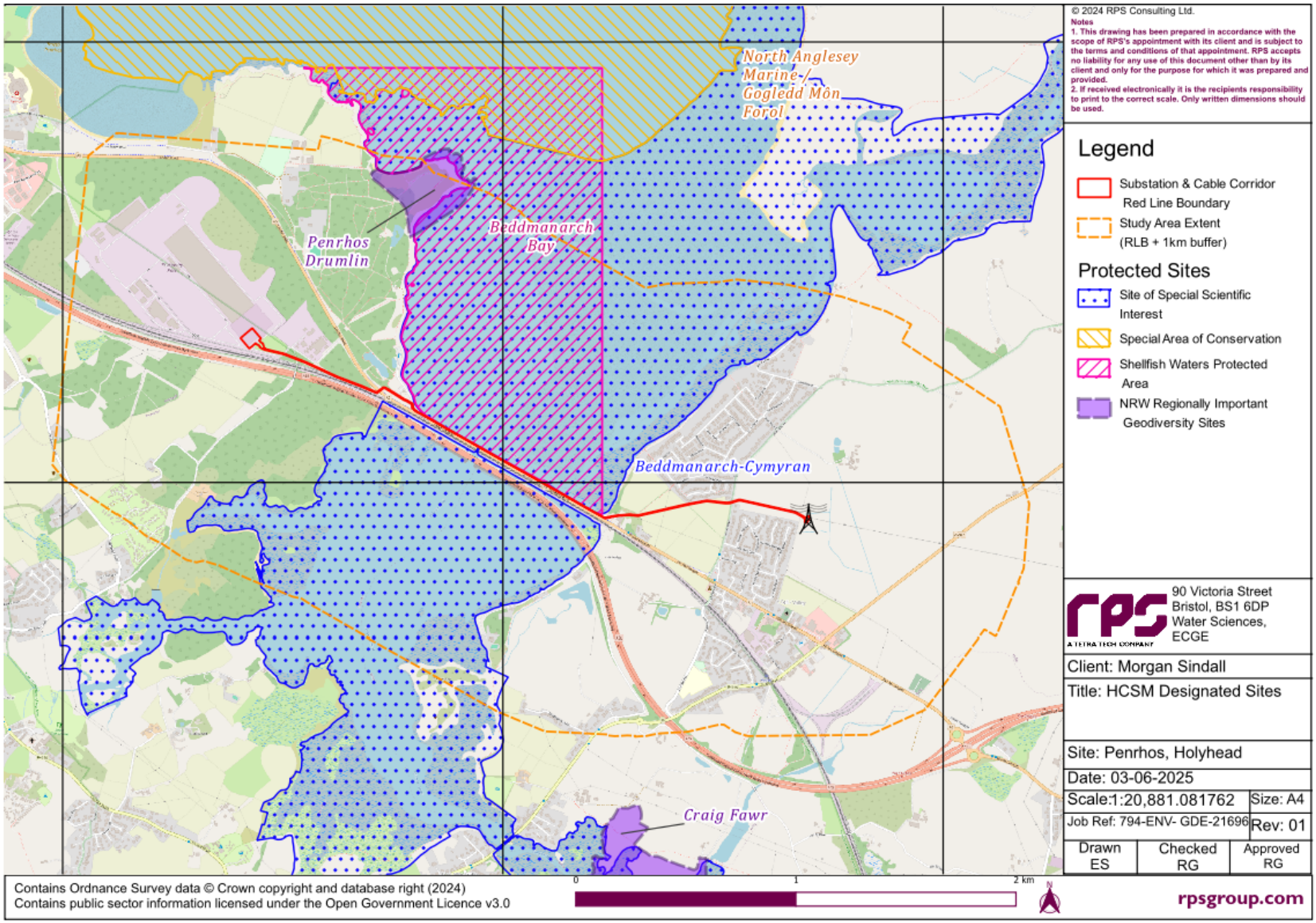

Figure 2-7 Protected Sites of the Study Area.

2.5 Site specific surveys

2.5.1 No site-specific intrusive surveys have been undertaken to inform the baseline hydrogeological conceptual model presented in this report.

2.6 Summary of controlled water and environmental receptors

Geology

2.6.1 No GCR sites are present in the study area.

2.6.2 One RIG has been identified in the study area and is summarised in Table 2-3.

Table 2-3 Summary of RIGS in the study area

Site Name	Distance from the proposed cable corridor	Notes
Penrhos Drumlin	Within 700m of the proposed cable corridor.	Quaternary glacial landform.

Hydrogeology

2.6.3 All PWS identified through consultation with local councils are summarised in Table 2-4.

Table 2-4 Summary of notified PWS in the study area

Reference	Site Name	Distance from the proposed cable corridor	Notes
PWS	Lon Towyn Capel Rd. PWS	Within 1km of the proposed cable corridor.	Active PWS registered at private property address. Notification of supply through Anglesey County Council. No further details known.

2.6.4 Groundwater bodies defined within the study area are summarised in Table 2-5.

Table 2-5 Summary of groundwater bodies in the study area

Name	Distance from the proposed cable corridor	Notes
Ynys Mon Secondary	Within cable corridor.	WFD defined groundwater body. Overall status defined as poor.

Geological and Groundwater Dependent Protected Sites

2.6.5 Protected sites identified within the study area are shown in Figure 2-7 and summarised in Table 2-6.

Table 2-6 Summary of designated sites in the study area

Site Name	Distance from the proposed cable corridor	Site Type	Notes
Beddmanarch-Cymyran	Within proposed cable corridor.	SSSI	Spatial extent defined by coastline of the Cymyran Strait.
Beddmanarch Bay	0 m from proposed cable corridor.	Shellfish Waters Protected Area	Adjacent to the proposed cable corridor, north of Stanley Embankment.
Ynys Mon / Anglesey	Within cable corridor	AONB	Designated in 1967. Covers all landwards sections of the Study Area to the west of the village of Valley.

3 LAND USES

3.1 Landfill sites

3.1.1 As shown in Figure 3-1, one historical landfill has been identified within the Study Area. Cae Glas Road Landfill is situated 100m to the south of the proposed cable route alignment and covers an area of approximately 0.1 km^2. Closed in 1980, records show the site received a mixture of industrial, commercial and household waste and was likely situated on the site of Tre-Gof quarry (NRW, 2025).

3.1.2 The landfill site is located on the opposite side of the A5 and the North Wales Expressway within a window in the glacial till, on top of the schistose bedrock of the New Harbour Formation. Given this setting it is considered to represent a low soil and groundwater contamination risk with regards to the Penrhos Cable Replacement Project.

3.1.3 No active landfill sites have been identified within the Study Area (NRW, 2025).

3.2 Other recent and historical land-uses

3.2.1 Two active petrol stations have been identified within the Study Area, both located on the Holyhead Road within Valley. Both fuel stations are located approximately 500m away from the route of the proposed cable, down topographic gradient. Given these factors, it is not thought to represent a possible soil or groundwater contamination risk.

3.2.2 Derwyn Garage, also situated on Holyhead Road at the southeastern end of Stanley Embankment (see Figure 3-1), is situated on top of the proposed cable route alignment. The business consists of a workshop building, tarmacked parking area and small vehicular yard at the rear. At present, the cable route is proposed to run under the parking area and vehicular yard at the back of the building before traversing up the embankment to the northeast, onto agricultural land. Observations made during the site walkover revealed two spoil heaps situated in the parking area but no visible or olfactory evidence of fuel related spills.

3.2.3 Additional historical land uses identified within the Study Area include four small unspecified quarries. These historical features were identified from GeoIndex and all registered as having ceased activities. The closest site of historic quarrying is Tre-gof on Holy Island, approximately 200m to the south of the proposed cable route. As discussed in Section 3.1, this area of surficial ground workings has likely been filled in by the Cae Glas Road Landfill.

3.3 Pollution incidents

3.3.1 Data on Category 1 & 2 Environmental Pollution Incidents sourced from NRW shows that there are no registered environmental pollution incidents identified within the Study Area (NRW, 2025).

3.3.2 However, the rectifier yard at Penrhos Substation is a known site of historical contamination following a transformer fire in 2008. As discussed in section 1.3.2, post remediation groundwater monitoring of the site concluded in 2021 and reported results concluded the agreed remedial aims of removal of free products and betterment of groundwater quality had been met. See Appendix G and Appendix H for further details.

3.4 Licensed discharges to groundwater

3.4.1 No licensed discharges to groundwater have been identified within the study area (NRW, 2025)

3.5 Summary of Potential Contamination Sources

3.5.1 A summary of all identified potential sources of contamination is given below in Table 3-1 to Table 3-3. Derwyn Garage is the only current or historical land use that is thought to pose a significant

degree of risk to controlled waters and environmental receptors through the construction of the Penrhos 132 kV Cable Replacement project.

Landfill sites

3.5.2 Details of the current and historical landfill sites presented in those figures are summarised in Figure 3-1.

Table 3-1: Landfill sites (current & historical)

Site Name	Distance from the proposed cable corridor	Waste Type	Landfill Status	Notes	Qualitative Risk Ranking	Justification
Cae Glas Road	110m southwards from proposed cable corridor.	Inert, Industrial, Commercial, Household, Special.	Ceased operation 1980.	Contains potentially biodegradable 'household' waste. No known active monitoring. Registered with Isle of Anglesey Borough Council.	Low to moderate	Possible biodegradable or contaminated waste mass, but situated on the 110m southwards and downgradient of cable corridor.

Fuel stations

3.5.3 Fuel stations represent a particular risk to land and groundwater quality. The details of three current garages identified in the study area are summarised in Table 3-2.

Table 3-2 Summary of fuel stations within the study area

Name	Distance from the proposed cable corridor	Address	Status	Qualitative Risk Ranking	Justification
Derwyn Garage	Within proposed cable corridor.	Derwyn Garage, Holyhead Road, Valley, Isle of Anglesey, Wales, LL65 3AF	Open	Moderate	On alignment of proposed cable corridor, currently active.
Dyffryn Service Station	440m from proposed cable corridor.	Dyffryn Service Station, Holyhead Road, Valley, Isle of Anglesey, Wales, LL65 3DP	Open	Low	Located 440m away, down topographic gradient from proposed cable corridor.
Essar Service Station	550m from proposed cable corridor.	Gwalia Service Station, Fford Caergybi, Valley, Isle of Anglesey, Wales, LL65 3DR	Open	Low	Located 550m away, down topographic gradient from proposed cable corridor.

Historical mining operations

3.5.4 Several historical mines have been identified from BGS reporting (BGS, 2020). These features are listed in Table 3-3 and shown in Figure 3-1.

Table 3-3 Historical mines reported by the British Geological Survey

Name	Position relative to search corridor	Status	Notes	Qualitative Risk Ranking	Justification
Tre-gof	Within 250m of cable corridor	Closed	Type unknown. Likely been infilled by Cae Glas Road landfill.	Low to Moderate	Within 250m of proposed cable corridor, extent of historical ground workings unknown.
Penrhos	Within 850m of cable corridor	Closed	Type unknown.	Low	Within 850m of proposed cable corridor. Raised from negligible to low as extent of historical ground workings unknown.
Glan-morfa	Within 830m of cable corridor	Closed	Type unknown.	Low	Within 830m of proposed cable corridor. Raised from negligible to low as extent of historical ground workings unknown.
Valley Quarry	Within 820m of cable corridor	Closed	Quarry	Low	Within 820m of proposed cable corridor. Raised from negligible to low as extent of historical ground workings unknown.

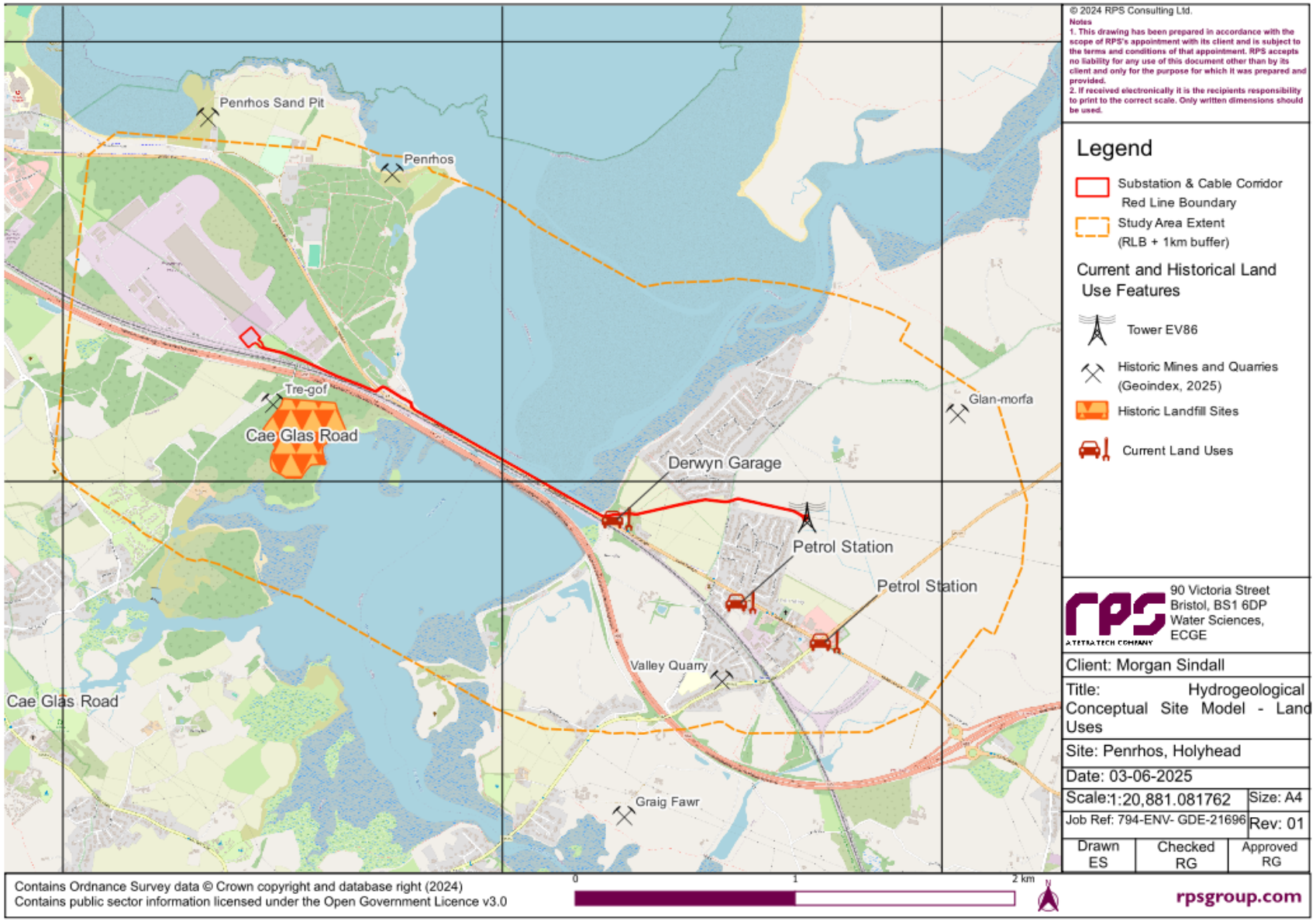

Figure 3-1 Historical and current land uses of the Penrhos site

4 REGULATORY INFORMATION

4.1 Land Report

4.1.1 A Groundsure report on Penrhos Substation was commissioned in 2021 by WSP to support interpretative ground investigation reporting on the Penrhos Substation site with the aim of assessing the extent of any residual contamination following previous remedial works and to develop a ground model to support future construction works aiming to reestablish the substation site.

4.1.2 The Groundsure report is provided in Appendix D and has been used to inform this HCSM.

4.2 Environmental Permitting

4.2.1 Submission for an application for a groundwater abstraction licence to support the cable replacement works was made on the 8th of May 2025 to Natural Resources Wales. An associated application for a discharge consent was made on the 9th of May.

4.2.2 The purpose of these permit applications was to maintain excavations into the underlying aquifers during the installation of the new 132 kV transmission cables and lawfully discharge any abstracted groundwater and rainwater runoff back into the environment.

4.3 Regulatory Communications

4.3.1 Preliminary consultation with NRW regarding advice on the submission of environmental permit applications was initiated on the 22nd of April 2025. No response was received however ahead of the initial groundwater abstraction license and associated discharge consent permit applications. It is expected that further consultation with NRW will be required in order for the permits to be duly made.

5 PRELIMINARY RISK ASSESSMENT

5.1 Methodology

5.1.1 Approach

5.1.1 The risk to identified controlled waters and environmental receptors is dependent on the probability that a hydrogeological pathway exists between the source and the proposed cable corridor or substation and the severity of the consequence (as a result of the construction activity) if the pathway exists. A qualitive risk ranking is assigned to each level of outcome using the risk matrix presented in Table 5-1.

Table 5-1: Qualitative risk matrix for sensitive groundwater receptors. Criteria used to quantify the magnitude and probability are laid out in Appendix E.

QUALITATIVE RISK MATRIX		Magnitude of consequence if pathway exists			
		High	Medium	Low	Negligible
Probability that a hydrogeological pathway exists	Highly Likely	Very High Risk	High Risk	Moderate Risk	Low to Moderate Risk
	Likely	High Risk	Moderate Risk	Low to Moderate Risk	Low Risk
	Low Likelihood	Moderate Risk	Low to Moderate Risk	Low Risk	No Risk
	Unlikely	Low to Moderate Risk	Low Risk	No Risk	No Risk

5.1.2 Probability that a hydrogeological pathway exists

5.1.1 The probability that a hydrogeological pathway exists is based on the following criteria:

- **Highly Likely** – The groundwater receptor is known to be in same groundwater catchment and in a down hydraulic gradient position relative to the activity; and/or the groundwater flow path short; and/or the geological system is simple (e.g. shallow, sand and gravel aquifer in valley bottom); and/or the pathway proven in a more complex system.
- **Likely** – The groundwater receptor is expected to be in the same groundwater catchment and down-gradient to the construction activity; and/or it is a relatively simple geological / hydrogeological system / pathway; and/or it is a complex fractured system with known points of spring flow / discharge given position of source; and/or medium or short flow path.
- **Low Likelihood** – The groundwater receptor is unlikely to be situated in same groundwater catchment or is in an up hydraulic gradient or lateral position to the activity; and/or the geological / hydrogeological system / pathway is complex and tortuous (e.g. thick multi-layered aquifer; low and high permeability beds interbedded; fracture pathways etc); and/or simple geological system but supply source is known to be up hydraulic gradient or lateral position; and/or long flow path.
- **Unlikely** – The groundwater receptor is situated in a different groundwater catchment or up hydraulic gradient from construction activity; and/or pathway dominated by low permeability geological, units (mudstones / clays etc); and/or very long flow path.

5.1.3 Magnitude of consequence if pathway exists

5.1.1 The magnitude of a potential consequence from an activity should a pathway be thought to exist shall be related to the following:

- Characteristics of the pathway in terms of,
  - pathway length & flow mechanisms.
  - complexity / tortuosity of pathway & hydraulic continuity.
  - potential for attenuation.
  - the relative position of the receptor to the activity in the flow field.
  - possible travel time.
- Nature of the impact in terms of,
  - the magnitude / scale of effect (e.g. on flow, levels or water quality)
  - the duration of effect (permanent vs short term)

5.1.2 The magnitude of consequence is defined on the basis of the criteria laid out in Appendix E.

5.1.4 Certainty

5.1.1 The assessment also considers certainty in terms of the probability the pathway exists and the severity of outcome. This will be defined either low, medium or high.

5.1.2 The method has been designed to ensure the assessment is conservative and precautionary in nature. If the uncertainty is medium or high, it will be necessary to raise the risk ranking by a level of two (e.g. from ‘Low Risk’ to ‘Low to Moderate Risk’ or ‘Moderate Risk’).

5.2 Results

5.2.1 A summary of the risk assessment for the environmental receptors identified in Section 2.3.5 and is provided in Table 5-2.

Table 5-2 Preliminary hydrogeological risk assessment for environmental groundwater receptors within the Study Area

Receptor Name	Receptor Description	Horizontal Separation (Source to CRC at closest point)	Hydrogeology & Potential Pathway	Qualitative Risk Ranking					Justification / Note
				Pathway Probability	*Confidence*	Consequence Magnitude	*Confidence*	Risk Class	
Penrhos Drumlin	RIGS	Receptor c. 700m N of cable route.	• The receptor is situated above the bedrock of the New Harbour Formation. • The receptor is located a significant distance from the cable corridor and Substation site. • The receptor is located hydraulic gradient from the cable corridor and Substation site.	Unlikely	*High*	Negligible	*High*	No Risk	The receptor is a RIGS site designated due to the presence of certain geological features. It has not been designated on the basis of groundwater. Additionally, the RIGS is located a significant distance from the cable corridor, up hydraulic gradient from the elevation of the scheme.
Private Water Supply on Lon Towyn Capel Road	PWS registered at address on Lon Towyn Capel Road	Source c. 1km SW of substation location.	• It is not known if the supply source receptor is situated above or below the topographic elevation of the cable route corridor and substation. Only the location of the registered address is known. • The hydrogeological system is likely complex and tortuous due to fractured nature of the bedrock aquifer and heterogeneous nature of glacial till.	Low Likelihood	*Low*	High	*High*	Moderate Risk raised high due to lack of confidence	Further information on the supply source need to be acquired in order to accurately determine the degree of risk. Hydraulic continuity between the substation site and the groundwater body feeding the supply cannot be discounted without further evidence.
Ynys Mon Secondary Groundwater Body	WFD defined groundwater body.	Receptor directly underlies all landward sections of the cable corridor and substation.	• The receptor situated directly below the cable route corridor and substation. • The construction activities, as described in section 1.4, will be situated directly above the groundwater body (same groundwater catchment). Relative to the proposed construction activities the groundwater body is considered to be situated down hydraulic gradient with very short flow pathways.	Highly Likely	*High*	Low	*Low*	Moderate Risk – raised to moderate to high due to low confidence	Hydraulic continuity between the cable trench dewatering activities and the groundwater body is likely. However, the magnitude of any impacts on the groundwater body are expected to be low due to low volumes of potential effluent. Additionally, the risk is considered more likely to relate to water quality through accidental emission than impacts on levels or flow, given the small drawdown that would be caused by cable trench dewatering and its temporary nature.

			• Confining layers of impermeable clay dominated till may be present but this is yet to be confirmed by site specific investigation.						Confidence at present is low due to the lack of site specific ground investigation data.
Beddmanarch-Cymyran SSSI	Site of Special Scientific Interest	Within the proposed cable corridor.	• The receptor is known to be in the same groundwater catchment and received discharges from highways drains along Stanley Embankment	Highly Likely	*High*	Negligible	*High*	Low to Moderate Risk	It is anticipated that all effluent generated from the scheme will be composed of rainfall run off and abstracted groundwater. However, there is the potential for contaminated water to be present in the troughs containing the pre-existing cables along Stanley Embankment. No unpermitted discharges will be permitted. Risk management will include mandatory testing for all water prior to discharge into the SSSI. Risk shall be appropriately managed through application of a Ground and Surface Water Management Plan.
Beddmanacrh Bay Shellfish Water Protected Area	Shellfish Waters Protected Area	Adjacent to (0m) from the proposed cable corridor.		Highly Likely	*High*	Negligible	*High*	Low to Moderate Risk	

6 CONCLUSION

6.1.1 The Preliminary Hydrogeological Risk Assessment (HRA) for the Penrhos 132 kV Cable Replacement Project has identified several receptors warranting further consideration and management. The assessment indicates that while the overall risk to groundwater resources is moderate to low, certain receptors warrant further consideration due to their qualitative risk rankings.

6.1.2 The identified receptors include:

- **Private Water Supply on Lon Towyn Capel Road**: This receptor is located approximately 1 km southwest of the substation. Due to uncertainties regarding its infrastructure and subsequently its potential hydraulic connectivity to the groundwater body and underlying geology, it has been assigned a moderate risk ranking. Further investigation is necessary to determine the degree of risk associated with potential impacts from construction activities.
- **Ynys Mon Secondary Groundwater Body**: This groundwater body directly underlies the cable corridor and substation. The assessment indicates a moderate risk due to the likelihood of hydraulic continuity between construction activities and the groundwater body. While impacts on groundwater levels are expected to be minimal, the potential for water quality impacts necessitates careful monitoring and management.
- **Beddmanarch-Cymyran SSSI, and Beddmanarch Bay Shellfish Water Protected Area**: both of these receptors are located within or adjacent to the proposed cable corridor. They have been assessed as having a low to moderate risk ranking. It is crucial to implement appropriate management measures to ensure that any discharges from the project do not adversely affect these sensitive ecological areas.

6.1.3 At present, the hydrogeological risk assessment is based on the findings of the desktop study and existing data sources, which inherently involve certain assumptions and limitations. Notably, the absence of site-specific geological and hydrogeological survey data at this stage may limit the accuracy of the conceptual model. Additionally, the assessment relies on publicly available data, which may not capture all local variations or recent changes in land use. These factors contribute to uncertainties in the risk assessment, particularly regarding the private water supply and the complexity of the groundwater system.

6.1.4 The bedrock terrain is concluded to consist of fractured crystalline metapelites. Reporting guidance developed by the Environment Agency highlights the variable and anisotropic nature of such aquifers and states: *'observations suggest that any results or prognoses will be associated with a greater degree of uncertainty (for example, regarding the shape and size of any cone of depression and the magnitude of any impact)'* (Boak, et al., 2007). In order to minimise uncertainties involved in the results of a quantitative risk assessment, a full HIA will be issued to the regulator following the reporting of the Stage 1 & 2 Ground Investigation for the Project.

6.1.5 Any licensed groundwater abstractions present within the study area have not been identified as a response from NRW regarding the potential presence of these receptors is outstanding.

6.1.6 Further delineation of the risk to the identified receptors is necessary through the application of a robust hydrogeological conceptual site model that is evidenced by site specific penetrative ground investigation data. Robust mitigation strategies must be implemented for the identified sensitive receptors through the application of the Ground and Surface Water Management Plan. This approach will ensure compliance with environmental regulations and protect the integrity of local groundwater resources and ecological sites throughout the duration of the Project.

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APPENDICES

Appendix A

Geotechnical Logs

Appendix B

Site Walkover Report

Appendix C
Isle of Anglesey Consultation Response on PWS local to the Study Area

Appendix D

Penrhos Substation, Holyhead - Groundsure Report

Appendix E
Criteria used to define the terms relating to receptor sensitivity and impact magnitude.

Appendix F

Pre Application Advice Submission

Appendix G

LK Consult Ltd – Post Remediation Monitoring Report, 2021

Appendix H

LK Consult Ltd – Remediation Validation Report, 2020