

ENVIRONMENT

Lightsource BP
Prosiect Maen Hir - North
Anglesey
Phase 1 Geo-Environmental Assessment

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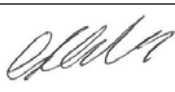
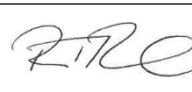
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EXECUTIVE SUMMARY

Executive Summary	
Proposed Development	The proposed development is anticipated to comprise solar, battery storage, possibly green hydrogen, and some other alternative technologies.
Current Site Setting	The site largely comprises agricultural land utilised for grazing animals and crops. A former oil storage depot remains in the centre of the site although the majority of the infrastructure has been removed. Numerous water courses are present on site and in the immediate surrounding area, most of which feed into Afon Wygyr, which flows east to west through the site.
Site History	<p>Rhosgosh oil storage depot was constructed in the 1970s centrally on site, with associated tanks, infrastructure, electricity substations and earthworks. Prior to this the site remained largely undeveloped over the historical mapping period, predominantly utilised for agricultural purposes, with limited farm buildings present. Several small old quarries and ponds have been identified across the site, with some having possibly been infilled.</p> <p>The surrounding land uses are broadly similar, comprising agricultural land with associated farm buildings. A railway line and station were present along the eastern boundary with a railway siding entering the site during 1970s. Small quarries and ponds are mapped in the surrounding area, with some possibly now infilled.</p>
Ground Conditions	<p>Ground conditions are anticipated to comprise localised Alluvium and Devensian Till overlying bedrock of the New Harbour Group, South Stack Formation and Ordovician Rocks. Till is locally absent across the site, with areas of rock outcrops present at ground level. Numerous igneous intrusions are mapped across the site. Made Ground is present at the former oil storage depot and expected in the vicinity of infilled ponds and quarries.</p> <p>The Till is categorised as an undifferentiated Secondary Aquifer, whilst the Alluvium is categorised as a Secondary A Aquifer. All bedrock geologies mapped underlying the site are categorised as Secondary B Aquifers.</p>
Geotechnical Review	<p>Shallow spread foundations are likely to be viable across the majority of the site; however, shallow bedrock may need breaking out to facilitate this locally.</p> <p>Earthworks are likely to be required within the former oil storage depot and possibly where steep gradients are present.</p>
Environmental Review	<p>Within the former oil storage depot, contaminant linkages have been identified through third party investigations and the risk to human health and controlled water receptors is increased to moderate/low. Limited sources of contamination have been identified across the remainder of the site given the lack of historic development. The risk to human health and controlled water receptors in these areas is considered to be low.</p>
Recommendations	<p>Once the development masterplan is defined, it is recommended that ground investigation is undertaken to quantify the contaminant linkages identified within conceptual site model.</p> <p>It is recommended that reliance is sought on the third party ground investigation in order to inform a supplementary round of ground investigation within the former oil storage depot area sufficient enough to inform an updated risk assessment and detailed quantitative risk assessment, where required.</p> <p>It is recommended that intrusive ground investigation is undertaken in areas where Alluvium and bedrock outcrops are known/suspected to be present in order to inform foundation design.</p>

This summary should be read in conjunction with BWB's full report (ref. MSF-BWB-ZZ-XX-RP-YE-0001_Ph1-North) and reflects an assessment of the site based on information received by BWB at the time of production.

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1. INTRODUCTION

Instruction

- 1.1 BWB Consulting (BWB) was instructed by Lightsource BP (the Client) to carry out a Phase 1 Geo-Environmental Assessment for the site at Prosiect Maen Hir - North, Anglesey. Details of the project brief are included in BWB proposal reference 20230130/2/232062/MB/MB, dated 30th January 2023.
- 1.2 The proposed development is anticipated to comprise solar, battery storage (BESS), possibly green hydrogen, and some other alternative technologies.

Objectives

- 1.3 This report has been completed to present pertinent information into the environmental risks and liabilities associated with the site. It has been completed to fulfil the requirements of a preliminary risk assessment in accordance with BS 10175:2011+A2:2017 '*Investigation of potentially contaminated sites, code of practice*' and EA Guidance on Risk Management of Land Contamination <https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm>.
- 1.4 The report has also been prepared with reference to land contamination technical guidance available through <https://www.gov.uk/government/collections/land-contamination-technical-guidance>.
- 1.5 The objectives of this report are to:
 - Assess historical activities at the site with respect to their potential impact on the site environment;
 - Characterise the environmental setting of the site, identify migration pathways and vulnerable receptors for contamination originating at the site, focusing on potential soil and groundwater liabilities;
 - Assess historical and current surrounding land use in relation to known or potential off-site contamination issues that may impact the site;
 - Review existing site investigation and remediation information for the site, where available;
 - Develop a preliminary Conceptual Site Model (CSM); and
 - Assess potential environmental liabilities associated with the site.

Scope of Work

- 1.6 The scope of work included:
 - A site visit to inspect the current site and immediate surroundings, identify potential hazards associated with ground conditions or contamination and to determine potential constraints with regards to ground investigation (photographs presented as Appendix 1);

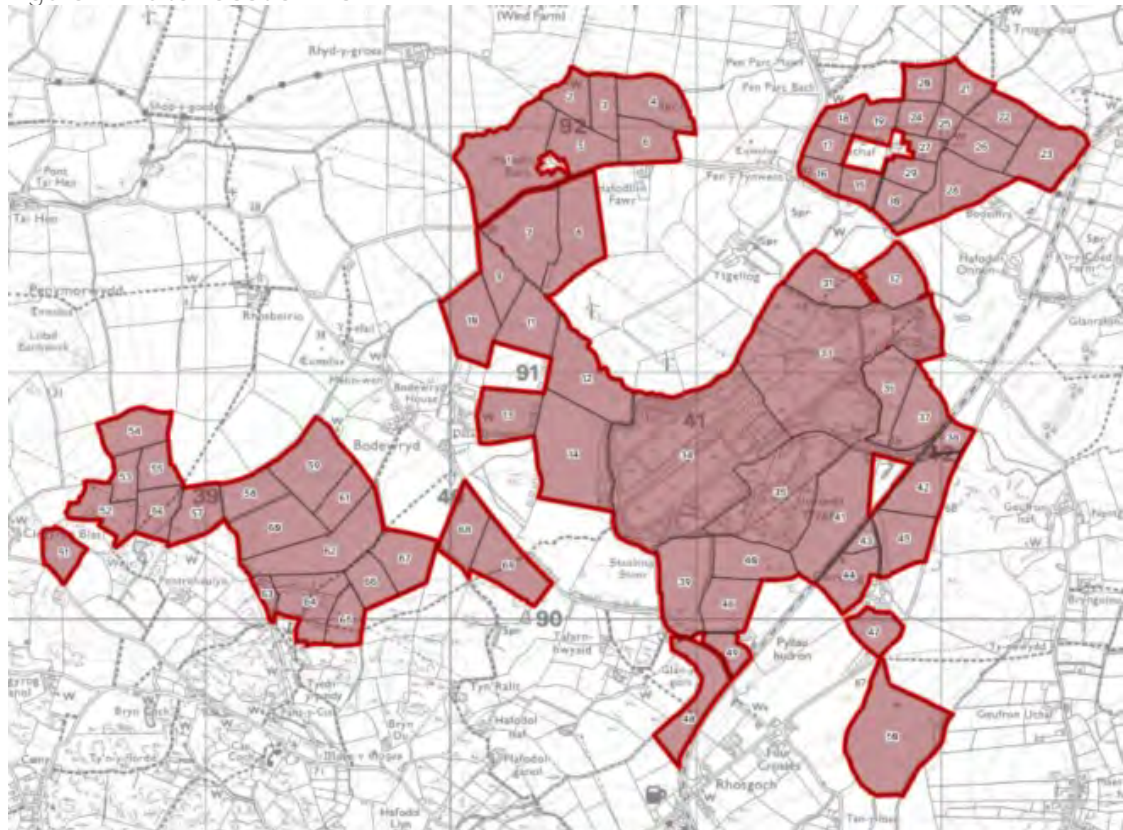
- A review of the following Groundsure Reports (Appendix 2);
 - GSIP-2023-13916-14900_A
 - GSIP-2023-13916-14900_B
 - GSIP-2023-13916-14900_C
 - GSIP-2023-13916-14900_D
 - GSIP-2023-13916-14900_E
- A review of the following information:
 - Historical Ordnance Survey Mapping (Appendix 3);
 - Historical aerial photographs (Google Earth) and other imagery (Groundsure Report);
 - British Geological Survey (BGS) 1:50 000 Scale, 'Anglesey', (Sheets 92, 92, 94, 105 & 106), Drift, (1974);
 - British Geological Survey (BGS) 1:50 000 Scale, 'Anglesey', (Sheets 92, 92, 94, 105 & 106), Solid, (1980);
 - BGS online geological maps and exploratory hole records (www.bgs.ac.uk);
 - MAGIC website (www.natureonthemap.naturalengland.org.uk/magicmap); and
 - Coal Authority Interactive Map Viewer (<http://mapapps2.bgs.ac.uk/coalauthority/home.html>);
- A summary of the key hazards or uncertainties that require additional investigation in order to further characterise the associated risks; and
- Production of a Geo-Environmental Assessment (this report), concluding in a qualitative assessment of the risks from contamination and ground-related constraints which may impact on the site.

2. THE SITE

Site Location

- 2.1 The site is located at Prosiect Maen Hir - North, in Anglesey, centred at approximate National Grid Reference 239893, 391137. The approximate location of the site is shown below in Figure 2:1.

Figure 2:1: Site Location Plan



Site Description

- 2.2 The site comprises an irregular shaped parcel of land covering an area of approximately 416 hectares, centred around the former Rhosgoch oil storage facility. BWB undertook a site walkover on 16th August 2023, selected photographs are presented in Appendix 1. A site layout plan is presented within Drawing 1.
- 2.3 The site is occupied by two distinct land uses, agricultural fields, and the former Rhosgoch oil storage depot.

Former Rhosgoch Oil Storage Depot

- 2.4 The former Rhosgoch oil storage depot is located centrally within the northern land parcel and comprised a decommissioned site with the majority of infrastructure removed, as presented in Figure 2:2. The site was accessed from the north east, along

one of the former access roads, with the north eastern area of the site largely overgrown with dense vegetation.

Figure 2:2: Aerial Photograph of Former Oil Storage Depot



- 2.5 All the former infrastructure had been removed from site with the exception of some relic foundations/stilts, and the bulk heads for the oil pipelines which are understood to remain in-situ and are connected to Amlwch. At the time of the site visit, works to decommission the former oil pipelines were in the initial stages, with site compounds being established.
- 2.6 The former storage tanks had been removed, with slightly raised granular banks demarking the locations. A pond was present in the north west of the site, with a lined attenuation pond in the south with an inoperable sluice gate remaining in-situ. No visual evidence of contamination was observed.
- 2.7 The site was evidently accessed by the public and appeared to have been used for quad biking.
- 2.8 Topographically the site reduces in elevation from south east (c.80m above Ordnance Datum (AOD)) to north west (c. 30m AOD). A small hill is present in the south east of the site, with a series of terraces created in the south western half of the site to accommodate the former storage tanks and infrastructure.

- 2.9 Small watercourses are present along the north, north west and south western boundaries.

Agricultural Land

- 2.10 The rest of the site areas comprised agricultural fields which were undulating in nature and utilised either for growing crops or grazing cattle/sheep.
- 2.11 Overhead services were present crossing numerous fields. Rock outcrops were identified within fields to the north and south of the former oil storage depot, and in the south west of site.
- 2.12 Possible asbestos containing materials were observed along a field boundary within the north of the site, located near to farm buildings. The location of this is indicated on Drawing 1.

Surrounding Land

- 2.13 The surrounding areas predominantly comprised agricultural land, similar to those present on site, with farm buildings located adjacent to some of the fields across site. Wind turbines were sporadically located in neighbouring fields, with a relatively new solar farm located to north of site. A small former quarry was observed to the south east of site.

3. ANTICIPATED GROUND CONDITIONS

- 3.1 The anticipated ground conditions for the site and controlled waters vulnerability is discussed within this Section.

Geology

Made Ground

- 3.2 Made Ground is not mapped on site, however, there are expected to be localised areas of Made Ground around buildings, particularly within the vicinity of the former oil refinery. The oil refinery site was benched at varying elevations, so earthworks have been undertaken historically at the site.

Superficial Geology

- 3.3 Information published by the BGS indicates that a large proportion of the site is underlain by Devensian Till superficial deposits, indicated by the pale blue areas on Figure 3:1 below. Localised pockets of Alluvium (clay, silt, sand and gravel) are mapped in the north west of the site (yellow areas).

Figure 3:1: Superficial Geology



- 3.4 Superficial deposits are locally absent in the central and southern areas of the site, particularly surrounding the former oil storage depot, with smaller areas mapped in the north of the site.

Bedrock Geology

- 3.5 The underlying bedrock comprises the New Harbour Group (Mica, schist and psammite) in the northern half of the site (green areas on Figure 3:2), the South Stack Formation (psammite and pelite) in the south west of site (yellow areas) and Ordovician Rocks (interbedded mudstone and sandstone) in the south east.

Figure 3:2: Bedrock Geology



- 3.6 Igneous intrusions of felsite are mapped to the north, north west and south west of the former oil refinery (dark orange linear feature on Figure 3:2). Igneous intrusions of gabbro, microgabbro and diorite are mapped to the south and west of the former oil refinery (pale orange linear features on Figure 3:2).
- 3.7 The Central Anglesey Shear Zone and Berw Shear Zone (limestone and graphitic shist) is mapped north east of site (cyan area), with the New Harbour Group - Lava (green area) and New Harbour Group - Jasper (pale orange) mapped in the west.

Site Specific Ground Investigation Data

- 3.8 There is no publicly available BGS boreholes located within the site boundary. Boreholes are mapped along the corridor of the overhead power cables which cross the south west of the site, however these are privately owned.
- 3.9 Ground investigation within the former oil storage depot identified ground conditions in the west of the site (previously developed areas) comprising Made Ground over

bedrock of the New Harbour Group (schist), with localised pockets of Glacial Till. In the east, ground conditions comprised topsoil over Glacial Till, over localised Head Deposits, over the New Harbour Group bedrock, with localised pockets of Made Ground.

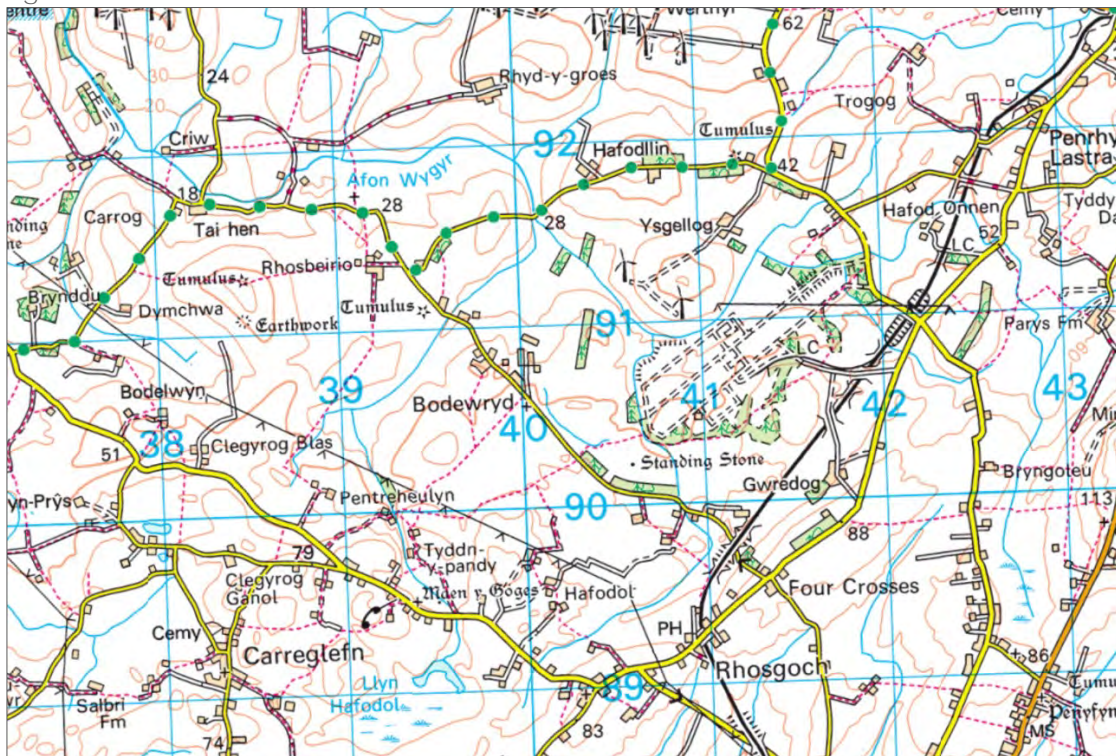
Hydrogeology

- 3.10 The Till is categorised as an undifferentiated Secondary Aquifer, whilst the Alluvium is categorised as a Secondary A Aquifer. All bedrock geologies mapped underlying the site are categorised as Secondary B Aquifers.
- 3.11 Third party ground investigation identified a groundwater body in the west of the site at depths of between 51m and 32m AOD, broadly between 2m and 6m below ground level, indicated to flow to the north west. A separate groundwater body was also identified in the east of the site within the Glacial Till and Head deposits. Groundwater was considered to be in continuity with the adjacent water course.
- 3.12 The site is not indicated to be within, or within close proximity to a groundwater Source Protection Zone, as designated by Natural Resources Wales (NRW).
- 3.13 There are no current or historical abstraction licences relating to groundwater on site or within 500m.
- 3.14 There are no current discharge consents relating to groundwater on site, with the closest being recorded 220m southwest of the site, relating to sewage discharges via an infiltration system.

Surface Waters

- 3.15 Numerous water courses are present within the site and immediate surrounding area. Most are small tributaries which feed into Afon Wygyr which flows east to west, around the northern edge of the former oil refinery before flowing north west towards Cemaes Bay (see Figure 3:3 overleaf). Small streams are present in the south of the site which flow broadly north towards Afon Wygyr.

Figure 3.3: Surface Water Features



- 3.16 Three springs are mapped on site to the east of the former oil storage depot, with two further springs mapped off site to the north of the depot and one along the northern site boundary.
- 3.17 Two small ponds are mapped in the south of the site. Two balancing ponds are present within the former oil storage depot site. Llyn Alaw is mapped 1.6km south of the site.
- 3.18 There are no abstractions relating to surface waters recorded on site or within 500m of the site.
- 3.19 Two historical discharge consents are recorded on site located within the former Rhosgoch oil storage facility to receiving waters of Afon Wygyr. Licences were revoked in 1993 and 1994. Three current discharge consents are recorded within 500m of the site, with the closest recorded 231m south relating to sewage discharges into an unnamed water course.
- 3.20 Three Water Framework Directive (WFD) surface water body catchments are mapped on site;
- Goch Amlwch, which covers the majority of the site area: which had an overall rating of moderate with a 'fail' chemical rating and a 'moderate' ecological rating in 2016.
 - Alaw – upstream Llyn Alaw, covering the south eastern-most field parcel: which had an overall rating of moderate with a 'good' chemical rating and a 'good' ecological rating in 2016; and

- Wygyr, covering partial areas within east and north east of the site: which had an overall rating of moderate with a 'good' chemical rating and a 'moderate' ecological rating in 2016.

Ground Gas and Radon

- 3.21 Localised Alluvium is present on site which represents a potential source of elevated ground gasses. Made Ground and localised contamination within the former oil storage depot also represent a potential source of hazardous ground gasses.
- 3.22 Ground gas monitoring undertaken within the former oil storage depot recorded elevated carbon dioxide (max 14.0% v/v) and methane (max 0.9% v/v), which indicated that the majority of the site should be considered as Characteristic Situation 2 whereby ground gas protection measures would be required.
- 3.23 Radon levels across the majority of the site are indicated to be low (<1% - 3%) whereby radon protection measures would not be required within buildings. However, there are localised areas where the radon level is indicated to be between 3-5% within the far south west and south of the site, and also to the north and north west of the former oil depot. The specific locations are presented within the Groundsure Report (Appendix 2), and commonly correlate with areas where superficial deposits are absent.

Mining and Mineral Extraction

- 3.24 There are no records of significant mining or mineral extraction reported on site. However, the majority of the site is indicated to be located in an area where sporadic or localised underground mining of restricted extent is possible.
- 3.25 Several small quarries are reported both on and near to the site within the Groundsure Report. These correlate to the historical mapping as discussed in Section 4, with most dating back to pre-1880s. In the majority of instances, the Groundsure Report identifies the quarried material to be igneous and metamorphic rock, with the activities reported as having ceased. Sandstone is also indicated to have been historically quarried to the south and east of site.
- 3.26 The far eastern edge of the site is indicated to be in an area where underground mining is known to be within very close proximity to the site, as it lies within 250m of Mynydd Parys and Anglesey Mining. Anglesey Mining operates a shaft which extends 300m below ground level, which is not considered to represent a constraint to the current proposed development.
- 3.27 Mynydd Parys, located 1km east of site, has historically been open-cast mined for ochre and copper. Whilst currently a dormant mine, recent investigations have identified resources which could be mined in the future.

Environmental Sensitivity

- 3.28 The entire island of Anglesey is part of Geomon Global Geopark as designated by UNESCO.

- 3.29 A small area of woodland in the west of the site is recorded as an Ancient Semi Natural Woodland.
- 3.30 Agricultural land classification on site ranges from grade 5 (very poor quality) to Grade 2 (good quality).

4. SITE HISTORY

4.1 Historical Ordnance Survey (OS) mapping for the site area has been reviewed. These maps and plans date from 1887 to 2023. The historical plans reviewed are provided in Appendix 3. The key points of the historical development of the site and surrounding area are summarised below.

On site

4.2 The site has remained relatively undeveloped throughout mapped history and has been utilised predominantly for agricultural purposes. The following site features have been identified on the historical mapping.

- Rhosgoch oil storage depot – first mapped centrally on site from 1979, with storage tanks present in the south west, infrastructure and a tank farm in the central area, and undeveloped land in the north east. Five Electricity substations are mapped in the south west and slopes are reported across the site indicating the earthworks required to plateau the site. A railway siding adjoins the site to the rail line running along the eastern boundary.
- Old Quarries – A small old quarry is mapped in the north east of site from the earliest mapping which is potentially infilled by the 1970s. A small old quarry is mapped immediately south east of Rhosgoch oil storage depot from the earliest mapping. A small old quarry is mapped in the north of the site from the earliest mapping. A linear feature, reported to be a quarry in the Groundsure Report, is mapped in the south east of site from the oldest mapping.
- Farm buildings – Most farm buildings are not included within the site boundary, however, a farm building is present in the north east site area from the earliest mapping. Several farm buildings, a pond and a small quarry were present in the north eastern area of Rhosgoch oil storage depot, prior to its construction.
- Overhead cables – overhead cables are shown on mapping crossing the south western, north and north eastern site areas from the 1970s.
- Surface water features – two springs are mapped in in the north east of the site from the earliest mapping, located along a water course which had an associated pond. The area is also indicated to be marshy from the 1990s. Springs are mapped to the east of the oil storage depot area from the earliest mapping also. A small pond is shown in the east of the site which appears to have been infilled to facilitate the construction of the railway siding. Two further small probably infilled ponds are mapped in the north west of site.

Off-site

4.3 The surrounding land areas have seen similar historical land usages, predominantly being utilised for agricultural purposes with associated farm buildings. The following site features have been identified on the historical mapping.

- Railway Line – A railway line has been present throughout historical mapping, predominantly running along the eastern boundary before crossing the south east corner of the site. The railway line is no longer active. Rhosgoch Station with associated cattle pens, goods sheds and railway sidings was located adjacent to the south eastern corner of the site from the earliest mapping.

- Farm Buildings – farm buildings are mapped adjacent to the south eastern and northern boundary, with a (likely water) tank mapped 20m east.
- Small quarries/pits – A small quarry is mapped 20m south, 100m west and 70m south east of site from the earliest mapping.
- Wind turbines – turbines are mapped 250m north of site from the 1990s.
- Surface water features – numerous small ponds and springs are mapped across the site.
- **St Mary's** Church – a small graveyard is mapped 40m from the southern site boundary from the earliest mapping.

Operational / Company Records

- 4.4 No operational records have been made available for review as part of this assessment.

Summary of Site History

- 4.5 The site has remained largely undeveloped over the historical mapping period, predominantly utilised for agricultural purposes, with limited farm buildings present. Several small old quarries and ponds have been identified across the site, with some having possibly been infilled. Rhosgosh oil storage depot was constructed in the 1970s centrally on site, with associated tanks, infrastructure, electricity substations and earthworks.
- 4.6 The surrounding land uses are broadly similar, comprising agricultural land with associated farm buildings. A railway line and station was present along the eastern boundary with a railway siding entering the site during 1970s. Small quarries and ponds are mapped in the surrounding area, with some possibly now infilled.

5. PREVIOUS INVESTIGATIONS

- 5.1 BWB have been provided with a third-party Ground Investigation Report for the former Shell Oil Depot, which is summarised below.

Ground Investigation Report for Land at the Former Shell Oil Depot, Rhosgoch; by Tier Environmental for The Conygar Investment Company PLC, ref. T/16/1763/GIR, dated October 2016

- 5.2 The assessment comprised a desk-based review, supplemented by intrusive investigations and risk assessments for the former oil storage depot, considering a potential residential development.
- 5.3 The desk study review largely covered the same subject matter as within this report, which is not repeated here.
- 5.4 Ground investigation works comprised 77 window sampler boreholes to a maximum depth of 5.45m below ground level (bgl), 13 cable percussive boreholes to a maximum depth of 12.40 bgl, 15 rotary boreholes to a maximum depth of 16.00m bgl, 184 trial pits to a maximum depth of 6.10m bgl, 6 trial trenches, 8 soakaway tests, 51 dynamic cone penetrometer tests, 22 permeability tests and chemical and geotechnical laboratory analysis.
- 5.5 Ground conditions in the west of the site (previously developed areas) comprised Made Ground over bedrock of the New Harbour Group (schist), with localised pockets of Glacial Till. In the east, ground conditions comprised topsoil over Glacial Till, over localised Head Deposits, over the New Harbour Group bedrock, with localised pockets of Made Ground. An infilled pond was investigated for, but not identified during the works.
- 5.6 A groundwater body was identified in the west of the site at an elevation of between 51m and 32m AOD, broadly between 2m and 6m below ground level, indicated to flow to the north west. A separate groundwater body was also identified in the east of the site within the Glacial Till and Head deposits. Groundwater was considered to be in continuity with the adjacent water course.
- 5.7 Visual/olfactory evidence of hydrocarbon contamination was identified within the area of the former oil storage tanks in the south west of site. The laboratory analysis and risk assessment identified a risk to human health in south west of the site associated with the hydrocarbon impact, and a hotspot of arsenic within the south eastern undeveloped area of site.
- 5.8 Within the groundwater, dissolved concentrations of benzo(a)pyrene, benzo(ghi)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, cadmium, chromium, copper, mercury, nickel, selenium and zinc were recorded at concentrations, which represent a potential risk to controlled waters.
- 5.9 Ground gas monitoring was completed on 6 occasions and recorded ground gas concentrations which were largely considered to be Characteristic Situation 2, whereby

gas protection measured would be required in enclosed spaces. The report states that basic radon protection measures would be required within buildings across the site. However, BWB note that a site-specific radon search was not referenced, with a more up to date assessment included within Section 3.

- 5.10 The waste assessment considered that the majority of soils would be considered as non-hazardous/inert for off-site disposal (if required). However, this is likely outdated, as hydrocarbon impacted soils are likely to be classified as hazardous waste.
- 5.11 The report concluded that despite the previous land use, significant and widespread contamination was not identified within the Made Ground soils or groundwater. A low to moderate risk was identified in relation to human health and controlled waters receptors. The report recommended that a detailed quantitative risk assessment (DORA) be undertaken to assess the risk to both human health and controlled water receptors.

BWB Comment

- 5.12 The ground investigation was comprehensive in terms of site coverage and included a reasonable amount of laboratory testing for a site of this size and history. The findings give confidence that significant contamination is not present at the site, and the risk assessment was based on a more sensitive end use than is currently being considered, so could be considered slightly over conservative with respect to human health receptors from the perspective of the current Proposed Development.
- 5.13 Significant VOC/SVOC contamination was not encountered. However, localised concentrations were identified in the laboratory analysis which were not considered within the risk assessment. The VOC/SVOCs were generally benzene derivatives but warrant consideration within the conceptual model.
- 5.14 It is noted that very limited testing was undertaken within the underlying natural soils, though no visual or olfactory observations of contamination were recorded in the natural strata.

6. REGULATORY SETTING

Permits Consents and Authorisations

- 6.1 A full listing of permits, consents and authorisations including discharge consents, pollution incidences and other environmental information, is included in the Groundsure report, presented in Appendix 3.
- 6.2 No significant features have been identified which are considered likely to have had a detrimental impact on the site.

Landfilling and Waste Management

- 6.3 A full listing of EA, BGS and Local Authority recorded landfills are provided in the Groundsure report presented in Appendix 3.
- 6.4 There are no historical landfill sites identified within 500m of the site,
- 6.5 There are no waste exemption permits listed on site, however, there are numerous exemptions identified in the surrounding area. They relate to various small-scale **agricultural processes including; deposits of dredging's from water courses, spreading waste on agricultural land to confer benefit, use of waste for a specified purposes, burning waste in the open, use of waste in construction, storage of waste in a secure place/containers, use of mulch, cleaning/washing/spraying or coating relevant waste, aerobic composting** all listed within 100m of the site.

7. GEOTECHNICAL APPRAISAL

7.1 The Groundsure report, site history, current site setting and geology setting have all been considered in order to provide an indication of the potential ground related constraints and opportunities in the context of the proposed development as set out in Table 7:1.

Table 7:1: Ground Related Constraints & Opportunities

Potential Constraint / Opportunity	Explanation	Potential Mitigation Options
Preliminary Foundation Solution	Shallow spread foundations are likely to be viable across the majority of the site, bearing onto the till or bedrock. Where Alluvium is present, foundations may need to be locally deepened to found upon more competent strata.	Ground investigation should be undertaken to confirm ground conditions at the site and allow for in-situ and laboratory testing to inform foundation design.
Rock Outcrops	There are areas of the site where visible rock outcrops are present. Additionally, in areas where superficial deposits are absent or thin, hard bedrock deposits may be present at shallow depth.	Shallow hard bedrock may need to be broken out to facilitate the construction of foundations. It is recommended that ground investigation is undertaken in areas where superficial deposits are not mapped to see how deep the competent bedrock is, if considered for development.
Earthworks	Localised earthworks may be required in areas where increased gradients are present, especially within the oil storage depot, where steep banks are present across the site.	Investigation will be required in areas of steep gradients and Made Ground to assess the viability of earthworks. Investigation information within the oil storage depot site indicated Made Ground to predominantly be classified as Earthworks Class 1b and 2c material.
Topsoil / Made Ground	Topsoil is expected to be present across the majority of the site. Limited Made Ground is expected to be present across much of the site, with increased quantities around the oil storage depot.	There is likely to be a surplus of Topsoil which could be retained on site or potentially re-used on third party sites as a commodity. Made Ground could potentially be reused on site, subject to investigation and chemical analysis.
Ground Subsidence Risks	The Groundsure Report indicates a low to negligible risk on site associated with shrink/swell clays, running sands, collapsible deposits, landslides, compressible deposits and dissolution of soluble rocks across most of the site. A moderate compressibility risk is reported where Alluvium is mapped.	This area was not investigated as part of the third party investigation. Intrusive investigation is recommended to inform the potential landslide risk.

Potential Constraint / Opportunity	Explanation	Potential Mitigation Options
	A very small area is indicated to have a moderate landslide risk associated with the elevated ground to the east of Rhosgoch Oil Storage Depot, adjacent to a stream.	
Mineral Extraction	Several former small quarries are present on site, some of which may have been infilled. This represents a risk of Made Ground being present in these areas, or shallow bedrock.	Ground investigation should be undertaken to confirm the ground conditions in these areas.
Drainage Soakaways and	Soils on site are likely to have low permeability and soakaway drainage is unlikely to be viable. Infiltration testing within the former oil depot was indicated to be in the range of 4.7×10^{-6} m/s and 7.79×10^{-8} m/s.	Should soakaways be considered as part of the drainage strategy, it is recommended that infiltration testing in accordance with current guidance is undertaken.
UXO	Review of the unexploded ordnance risk maps available online indicates the site to be in an area of low risk from UXO.	No further assessment required.

8. PRELIMINARY ENVIRONMENTAL RISK ASSESSMENT

Introduction

- 8.1 The risk posed by any contaminants in soil or groundwater will depend on the nature of the hazard, the probability of exposure, the pathway by which exposure occurs, and the likely effects on the receptors. A contaminant is defined as a substance that has the potential to cause harm, while a risk is considered to exist if such a substance is present in sufficient concentration to cause harm and a pathway exists for a receptor to be exposed to the substance.
- 8.2 Three impact potentials exist for any given site, all of which need to be considered in a risk assessment, which are:
- The site impacting upon itself;
 - The site impacting on its surroundings; and
 - The surroundings impacting on the site.
- 8.3 The following sections discuss all the identified potential on and off-site sources, pathways and receptors in the context of the proposed development and plausible contaminant linkages which may represent a risk to identified receptors such as human health and/or controlled waters from the data gained from the desk study.
- 8.4 The assessment is qualitative and aimed to determine all likely contaminant linkages, with consideration of significance and allowing for uncertainties.
- 8.5 Sources (S): These are potential or known sources of contamination that may relate to a former land use or present site feature or process (e.g. fuel storage tanks).
- 8.6 Pathways (P): A pathway is defined as a mechanism or route by which a contaminant comes into contact with, or otherwise affects a receptor. Pathways by which the identified receptors may be impacted upon in the context of the proposed development.
- 8.7 Receptors (R): Receptors are defined as people, living organisms, ecological systems, controlled waters, atmosphere, structures and utilities that could be adversely affected by contaminant(s).

Conceptual Site Model

- 8.8 Consideration has been given to the likely sources, pathways and receptors which may be present, based on the information in the previous sections. These are presented in Table 8:1 and Table 8:2 and further information about the risk classification scheme is included within Appendix 4, with reference to CIRIA C552 '*Contaminated land risk assessment - a guide to good practice*'.
- 8.9 A tabulated version of the Preliminary CSM based on the desk study and site observations is presented in Table 8:3.

Table 8:1: Potential Sources of Contamination

Location	Potential Source	Contaminants of Potential Concern (CoPC)
On-site	Made Ground associated with form oil storage depot.	<ul style="list-style-type: none"> • Heavy metals • Inorganics, such as cyanides, sulphates and nitrates • pH • Volatile organic compounds (VOCs) • Semi-volatile organic compounds (SVOCs) including phenols and • Polycyclic aromatic hydrocarbons (PAHs) • Petroleum hydrocarbons • Methane, carbon dioxide
	Possible localised Made Ground associated within infilled ponds or quarries.	<ul style="list-style-type: none"> • Heavy metals • Inorganics, such as cyanides, sulphates and nitrates • pH • Asbestos Containing Materials (ACMs) • PAH • Petroleum hydrocarbons • Methane, carbon dioxide
	Elevated Radon levels	<ul style="list-style-type: none"> • Radon
	Possible elevated ground gasses associated with potentially organic rich Alluvium.	<ul style="list-style-type: none"> • Methane, carbon dioxide
Off-site	Possible elevated ground gasses associated with potentially organic rich Alluvium.	<ul style="list-style-type: none"> • Methane, carbon dioxide
	Made Ground and potential contamination associated with neighbouring farm activities, infilled small ponds/quarries and railway infrastructure.	<ul style="list-style-type: none"> • Heavy metals • Inorganics, such as cyanides, sulphates and nitrates • PAHs • Petroleum hydrocarbons • Methane, carbon dioxide
	Small Graveyard near to south of site.	<ul style="list-style-type: none"> • Water quality indicators, ammonium, total oxidised nitrogen (nitrate and nitrite), chlorine, total organic carbon, biological oxygen demand, chemical oxygen demand, alkalinity, sodium, potassium, calcium, magnesium, iron, manganese, cadmium, chromium, copper, nickel, lead, zinc, phosphorus, formaldehyde, mercury

8.10 Based on the PCB testing undertaken as part of the third-party investigation, PCB impact associated with the electricity substations has not been included as a potential contaminant of concern.

Table 8:2: Relevant Potential Pathways and Receptors

Receptors	Pathways
Human Health: <ul style="list-style-type: none"> • Future site users • Intrusive maintenance workers 	<ul style="list-style-type: none"> • Dermal contact with soil or dust • Incidental ingestion of soil and/or dust • Inhalation of dust and/or fibres • Inhalation of vapours • Inhalation of radioactive particles • Migration and accumulation of ground gas in enclosed spaces leading to inhalation or explosion
Controlled Waters: <ul style="list-style-type: none"> • Groundwater (Secondary Aquifers) • Surface water features across site. 	<ul style="list-style-type: none"> • Leaching of soil contaminants • Vertical and lateral migration • Surface run-off
Property: <ul style="list-style-type: none"> • Underground utilities • Building structures 	<ul style="list-style-type: none"> • Direct Contact • Accumulation and explosion of gas

Table 8:3: Preliminary Conceptual Site Model

Source	Pathway	Receptor	Con	Prob	Risk	Potential Mitigation/Investigation Requirements
On-site sources as detailed in Table 8:1.	Dermal contact with, and incidental ingestion of soil and/or dust. Inhalation of dust and/or fibres.	Future site users	Md	UI	L	<p>The potential for encountering Made Ground or contaminated soils is restricted to the former oil storage depot, adjacent to railway lines and possibly localised areas of infilled ponds/quarries.</p> <p>As part of the proposed development, it is anticipated that limited human interaction with the soils is likely to happen, based on the end use.</p> <p>Where a viable contaminant pathway exists, the provision of a clean capping layer would restrict direct access to potentially contaminated soils.</p> <p>It is recommended that an intrusive ground investigation be completed in order to assess the extent of any potential contamination at the site.</p>
		Intrusive maintenance workers	Md	Lw	M/L	<p>The exposure of intrusive maintenance workers can be mitigated by the adoption of suitable working methods, utilising appropriate personal protective equipment (PPE) and maintaining good hygiene. If significant asbestos is recorded, the requirements of the Control of Asbestos Regulations (CAR) 2012 should be complied with.</p>
	Inhalation of vapours.	Future site users	Md	UI	L	<p>Significant VOC impact has not been identified on site, however localised concentrations are present within the former oil storage depot. It is considered unlikely that inhalation of vapours would represent a risk to future site users, however, appropriate risk assessment is required to demonstrate this.</p> <p>In the event that elevated concentrations of volatile contaminants are identified on site, potential sources of vapours such as Made Ground and contaminated soils/groundwater could potentially be mitigated through removal or treatment prior to construction or the installation of protection measures may be required during construction to mitigate the potential risk to future site users from vapours.</p>

Source	Pathway	Receptor	Con	Prob	Risk	Potential Mitigation/Investigation Requirements
		Intrusive maintenance workers	Md	Lw	M/L	<p>In the event that elevated concentrations of volatile contaminants are identified during ground investigation works and where entry into confined spaces/excavations is required by intrusive maintenance workers, it is recommended that a combination of the following may be required to mitigate the potential risk of exposure to vapours:</p> <ul style="list-style-type: none"> • appropriate PPE and/or Respiratory Protective Equipment (RPE); • monitoring equipment (such as explosive level meters); and • safe entry procedures.
	Inhalation of radioactive particles	Future site users	Md	Lw	M/L	Radon protection measures are required within buildings/enclosed spaces where naturally elevated radon levels are present.
	Migration and accumulation of ground gases in enclosed spaces leading to asphyxiation (carbon dioxide) or explosion (methane).	Future site users	Md	Lw	M/L	<p>Localised Alluvium is reported to be present in the centre of the site, which may contain organic material, and could represent a source of ground gas.</p> <p>Ground gas monitoring within the former oil storage depot indicated that the site should be categorised as Characteristic Situation 2.</p> <p>The proposed development is likely to have limited enclosed spaces that would warrant ground gas protection measures. However, where enclosed spaces are located in the vicinity of Made Ground, ground gas monitoring is recommended to inform the level of mitigation required.</p>
	Leaching and permeation through soil profile.	Groundwater: Underlying Secondary Aquifer	Md	Lw	M/L	<p>The majority of the site does not have a significant source of contamination that would represent a risk to controlled water receptors.</p> <p>The investigation works at the former oil terminal has identified a potential risk to controlled waters and has recommended</p>
	Vertical and lateral migration of contaminants.		Md	Lw	M/L	
	Lateral migration of contaminated groundwater.	On site water courses	Md	Lw	M/L	

Source	Pathway	Receptor	Con	Prob	Risk	Potential Mitigation/Investigation Requirements
	Surface run-off.		Md	Lw	M/L	that a detailed quantitative risk assessment be undertaken to quantify the risk and inform any remediation requirements.
	Direct contact.	Water utility pipes	Md	Lw	M/L	Contaminants within the former oil storage depot could represent a risk to water supply pipes. An investigation and risk assessment should be undertaken to assess the level of protection required to pipework.
		Buried structures/foundations.	Md	UI	L	Sulphates and low pH in the ground could accelerate the degradation of buried concrete structures (e.g. foundations). Ground investigation should include an assessment of the concrete design class. Conditions within the oil storage depot were reported to be DS1 AC1.
Off-site sources as detailed in Table 8:1.	Migration and accumulation of ground gases in enclosed spaces leading to asphyxiation (carbon dioxide) or explosion (methane).	Future site users	Md	UI	L	A significant source of off site ground gas has not been identified, and limited enclosed spaces are anticipated to form part of the proposed development. Where enclosed spaced are located near to off site sources of Made Ground/Alluvium.
	Lateral migration of contaminated groundwater.	Groundwater: Underlying Secondary Aquifers	Mi	UI	VL	A significant off site source of contamination has not been identified which is likely to result in a risk to the aquifer quality under the site. Ground investigation is recommended in areas adjacent to possible contamination sources (former railway station and graveyard) to quantify this.

VH = Very High, H = High, M = Moderate, M/L = Moderate/Low, L = Low, VL = Very Low

KEY: Sv = Severe, Md = Medium, Mi = Mild, Mr = Minor, Hi = High, Li = Likely, Lw = Low Likelihood, UI = Unlikely

Contaminant Linkage Assessment Summary

When considered in the context of the conceptual site model and the historical activities that have taken place (former oil storage depot), the proposed development is considered to pose a MODERATE/LOW risk to human health. It is considered that the main driver for the risk rating for human health is the presence of contaminants within the soils related to the former depot. However, limited potential sources of contamination are expected outside the former oil storage depot, and the risk to human health is considered to be LOW.

The risk posed to controlled waters is predominantly considered to be MODERATE/LOW due to presence of contaminants within the former oil storage depot and the reported linkage to the nearby surface water receptors.

It is recommended that a ground investigation be undertaken to quantify the identified contaminant linkages and assess likely mitigation measures.

9. CONCLUSION AND RECOMMENDATIONS

Conclusions

- 9.1 The site largely comprises agricultural land utilised for grazing animals and crops. A former oil storage depot remains in the centre of the site. However, the majority of the infrastructure has been removed. Numerous water courses are present within the site and immediate surrounding area, most of which feed into Afon Wygyr, which flow east to west through the site.
- 9.2 The site has remained largely undeveloped over the historical mapping period, predominantly utilised for agricultural purposes, with limited farm buildings present. Several small, old quarries and ponds have been identified across the site, with some having possibly been infilled. Rhosgosh oil storage depot was constructed in the 1970s centrally on site, with associated tanks, infrastructure, electricity substations and earthworks. The surrounding land uses are broadly similar, comprising agricultural land with associated farm buildings. A railway line and station was present along the eastern boundary with a railway siding entering the site during 1970s. Small quarries and ponds are mapped in the surrounding area, with some possibly now infilled.
- 9.3 Ground conditions are anticipated to comprise Devensian Till and localised Alluvium overlying bedrock of the New Harbour Group, South Stack Formation and Ordovician Rocks. Till is locally absent across the site, with areas of rock outcrops present at ground level. Numerous igneous intrusions are mapped across the site. Made Ground is present at the former oil storage depot and expected in the vicinity of infilled ponds and quarries.
- 9.4 The Till is categorised as an undifferentiated Secondary Aquifer, whilst the Alluvium is categorised as Secondary A Aquifers. All bedrock geologies mapped underlying the site are categorised as Secondary B Aquifers.
- 9.5 Limited sources of contamination have been identified across the majority of the site given the lack of historic development. The risk to human health and controlled water receptors in these areas is considered to be low. However, the risk to human health and controlled water receptors increased to moderate/low within the former oil storage depot where contaminant linkages have been identified through third-party investigations.
- 9.6 Shallow spread foundations are likely to be viable across most of the site. However, shallow bedrock may need breaking out to facilitate this locally. Earthworks are likely to be required within the former oil storage depot and possibly where steep gradients are present.

Recommendations

- 9.7 Once the development masterplan is defined, it is recommended that ground investigation is undertaken to quantify the contaminant linkages identified within conceptual site model.

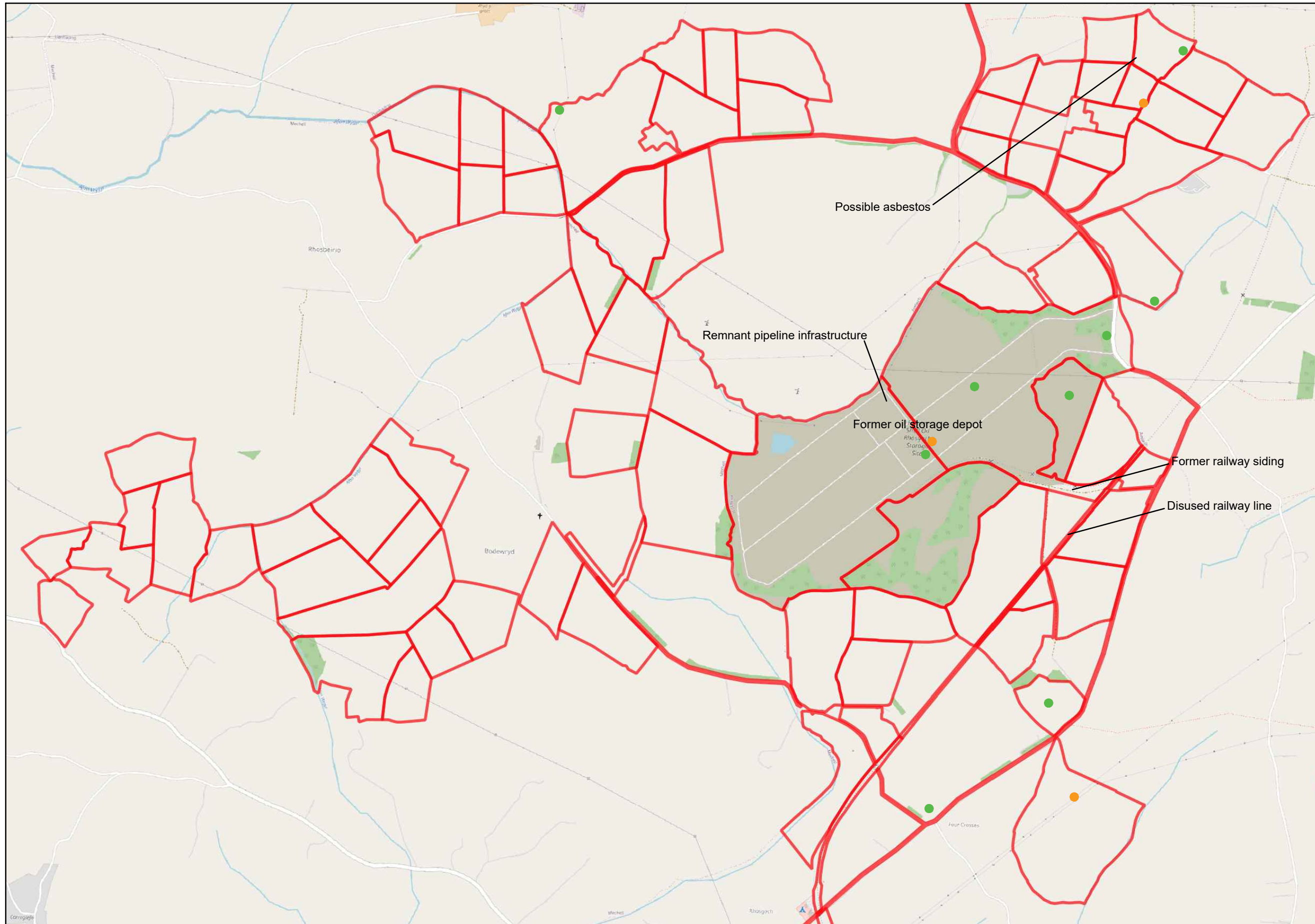
- 9.8 It is recommended that reliance is sought on the third party ground investigation in order to inform a supplementary round of ground investigation within the former oil storage depot area sufficient enough to inform an update risk assessment and detailed quantitative risk assessment, where required.
- 9.9 It is recommended that intrusive ground investigation is undertaken in areas where Alluvium and bedrock outcrops are known/suspected to be present in order to inform foundation design.

10. REFERENCES

- 10.1 BS 10175:2011+A2:2017 Investigation of potentially contaminated sites. Code of practice. British Standards Institute, 2017.
- 10.2 CIRIA C552 *Contaminated land risk assessment. A guide to good practice*. Rudland, D J, Lancefield, R M, Mayell, P N, 2001.
- 10.3 Environmental Protection Act 1990: Part 2A, Contaminated Land Statutory Guidance. Department for Environment Food and Rural Affairs (DEFRA), 2012.
- 10.4 Land Contamination Risk Management. Environment Agency, 2020.
<https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm>
- 10.5 <https://www.gov.uk/government/collections/land-contamination-technical-guidance>.
- 10.6 The Control of Asbestos Regulations. Health and Safety Executive, 2012.

DRAWINGS

Drawing 1: Site Layout Plan



- Notes**
1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
 2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
 3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
 4. Any discrepancies noted on site are to be reported to the engineer immediately.

Key Plan

- Legend**
- Potentially Infilled Pond
 - Former Quarry

Rev	Date	Details of issue / revision	Dwn	Rev

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Client
Lightsource BP

Project Title
Prosiect Maen Hir - Rhosgoch

Drawing Title
Site Layout

Drawn:	CR	Reviewed:	RR
BWB Ref:	232062	Date:	Sept 23
Scale:	A3	NTS	
Drawing Status			
Final			
Project - Originator - Zone - Level - Type - Role - Number	Status	Rev	
MSF-BWB-ZZ-XX-DR-YE-0001_SLS2	V1		

APPENDICES

Appendix 1: Site Photographs

Project Number: 232062
Project Name: Prosiect Maen Hir - Rhosgoch
Site Photographs

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Photo 1—Typical field.



Photo 2—Typical field for grazing.

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Photo 3—Localised rock outcrop with dense vegetation surrounding it.



Photo 4—Possible asbestos identified along boundary near to farm buildings within north east of area.

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Photo 5—Fields with wind turbines off site in adjacent fields.



Photo 6—Access track onto the former oil storage terminal.

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Photo 7—Remnant infrastructure within former oil storage terminal.



Photo 8—Remnant pipework remaining on site.

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Photo 9—Remnants of storage containers with raised embanked areas around outer edges.



Photo 10—pond in north west corner of former oil storage terminal.

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Photo 11—Drainage infrastructure within south west of site.



Photo 12—Off site solar farm to north of site.

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Photo 13—Rock outcrops, steep slope and dense vegetation towards the west of site.



Photo 14—Off site quarry to the south east of site.

Appendix 2: Groundsure Report (Available on Request)

Appendix 3: Historical Mapping (Available on Request)

Appendix 4: Classification of Risk

BWB RISK ASSESSMENT CLASSIFICATION (REFERENCE CIRIA C552, CONTAMINATED LAND RISK ASSESSMENT: A GUIDE TO GOOD PRACTICE, 2001)

CIRIA C552, *Contaminated Land Risk Assessment A Guide to Good Practice*, 2001 sets out a methodology for estimating risk. The methodology for risk evaluation is a qualitative method for interpreting the output for the risk estimation stage of the assessment. It involves the classification of the:

- Magnitude of the potential consequence (severity) of risk occurring; and
- Magnitude of the probability (likelihood) of the risk occurring.

The classification of consequence and probability are replicated in **Table 1** and **Table 2**, respectively.

Table 1: Classification of Consequence

Classification	Definition	Examples
Severe (Sv)	Short term (acute) risk to human health likely to result in "significant harm" as defined by the Environment Protection Act 1990, Part IIA. Short term risk of pollution of sensitive water resource. Catastrophic damage to buildings/property. A short-term risk to a particular ecosystem, or organism forming part of such ecosystem.	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied).
Medium (Md)	Chronic damage to Human Health ("significant harm"). Pollution of sensitive water resources. A significant change in a particular ecosystem, or organism forming part of such ecosystem.	Concentrations of a contaminant from site exceeding the generic or site-specific assessment criteria. Leaching of contaminants from a site to a major or minor aquifer. Death of species within a designated nature reserve.
Mild (Mi)	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services. Damage to sensitive buildings/structures/services or the environment.	Pollution of non-classified groundwater. Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor (Mr)	Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by measures such as protective clothing etc.). Easily repairable effects of damage to buildings, structures and services.	The presence of contaminants at such concentration that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discolouration of concrete.

The classification of consequence does not take into account the probability of the consequence being realised. Therefore, there may be more than one consequence for a particular pollutant linkage. Both a severe and medium classification can result in death.

Severe relates to short term (acute) risk while medium relates to long term (chronic) risk. Mild relates to significant harm but to less sensitive receptors. Minor classification relates to harm which is not significant but could have a financial cost.

Table 2: Classification of Probability

Classification	Definition
High likelihood (Hi)	There is a pollutant linkage and an event that either appears very likely in the short term and almost inevitable in the long term, or there is evidence at the receptor of harm or pollution.
Likely (Li)	There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low likelihood (Lw)	There is a pollutant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely (Ui)	There is a pollutant linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

The classification gives a guide as to the severity and consequence of identified risk when compared with other risk presented on the site. It should be noted that if a risk is identified it cannot be classified as “no risk” but as “very low risk”. Differing stakeholders may have a different view on the acceptability of a risk.

Once the consequence and probability have been classified these can be compared using a matrix to identify an overall risk category, as shown in **Table 3**. These categories and the actions required are categorised in **Table 4**.

Table 3: Risk Evaluation Matrix

Consequence		Severe (Sv)	Medium (Md)	Mild (Mi)	Minor (Mr)
Probability	High likelihood (Hi)	Very High Risk (VH)	High Risk (H)	Moderate Risk (M)	Mod/Low Risk (M/L)
	Likely (Li)	High Risk (H)	Moderate Risk (M)	Mod/Low Risk (M/L)	Low Risk (L)
	Low likelihood (Lw)	Moderate Risk (M)	Mod/Low Risk (M/L)	Low Risk (L)	Very Low Risk (VL)
	Unlikely (Ui)	Mod/Low Risk (M/L)	Low Risk (L)	Very Low Risk (VL)	Very Low Risk (VL)

Table 4: Risk Categorisations

Very High Risk (VH)	<p>There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening.</p> <p>This risk, if realised, is likely to result in a substantial liability.</p> <p>Urgent investigation (if not undertaken already) and remediation are likely to be required.</p>
High Risk (H)	<p>Harm is likely to arise to a designated receptor from an identified hazard.</p> <p>Realisation of the risk is likely to present a substantial liability.</p> <p>Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short-term and are likely over the longer-term.</p>
Moderate Risk (M)	<p>It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.</p> <p>Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer-term.</p>
Low Risk (L)	<p>It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.</p>
Very Low Risk (VL)	<p>There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.</p>

Reference:

CIRIA C552 *Contaminated land risk assessment. A guide to good practice*. Rudland, D J, Lancefield, R M, Mayell, P N, 2001.

