TIDAL LAGOON SWANSEA BAY

Environmental Statement
Chapter 18. Land Quality and Hydrogeology

www.tidallagoonswanseabay.com

Contents

18.0 Land Quality and Hydrogeology

18.1 Introduction

18.1.0.1 This chapter presents an assessment of the potential land quality and hydrogeological impacts of the Project in Swansea Bay, both within onshore elements of the Project and in relation to the immediate surrounding area. It should be noted that some of the impacts relating to the hydrogeology underlying the Onshore Works are also assessed within Chapter 17: Hydrology and Flood Risk of this ES. This is due to the close interrelationship between the two technical disciplines, particularly with respect to groundwater flood risks.

18.1.0.2 This chapter identifies key land contamination receptors and their sensitivities, including the principal water resources, and addresses the direct and indirect impacts of the Project on these receptors. The assessment of impacts is made in the context of the existing conditions within the Project area (baseline conditions), the predicted conditions during site preparation and construction works, and those expected once the Project is operational. Potential mitigation measures are also addressed and residual impacts are identified.

18.1.0.3 The assessment of the potential for land contamination within the Project area is based on previous land use history, and it identifies sensitive receptors within the vicinity of the Project. The chapter includes a Preliminary Risk Assessment (PRA), which establishes relevant source – pathway – receptor pollutant linkages for the potential land contamination issues identified.

18.1.0.4 Consultation in relation to Land Quality has been being undertaken, where required, as part of the Environmental Impact Assessment (EIA) process. In the preparation of this chapter, Natural Resources Wales (NRW) and St Modwen Properties were consulted in respect of baseline land quality conditions and ongoing land remediation activities. In addition, a variety of data sources have been consulted, including published maps, commercially available environmental database records and available third party technical reports. Where used, each data source is referenced as appropriate.

18.2 Legislative and policy context

18.2.1 Introduction

18.2.1.1 Potential redevelopment of areas of brownfield land needs to take into account the regulatory context of the work, the developer needs to provide information that it is fit for purpose, and the development itself should be carried out in accordance with good practice guidance. An environmental assessment of the condition of the Project area must consider the potential receptors of human health and controlled waters, and also include a review of the relevant legislation and planning policy that applies to the Project area and its immediate environs.

18.2.2 National legislation

18.2.2.1 There are three key Acts, which provide the regulatory framework in relation to the risks to human health and the environment from historical land contamination, namely:

I. Part 2A of the Environment Protection Act 1990 (EPA 1990) (the Contaminated Land Regime);

II. Water Resources Act 1991 (WRA 1991); and

III. Town and Country Planning Act 1990 (TCPA 1990).

18.2.2.2 Part 2A EPA 1990 was introduced by an amendment in 2000. The intention was that it addressed the legacy of land affected by contamination associated with historic land uses. The Contaminated Land Regime requires that a risk-based approach is used for the inspection of potentially contaminated sites and to the identification of unacceptable risks to human health and environmental receptors. Unacceptable risks are assessed in the context of the land being "suitable for use", where that land use is the established current use. Where unacceptable risks are identified they must be addressed through appropriate remediation.

18.2.2.3 Under Part 2A EPA 1990, sites are identified as "contaminated land" if they are causing significant harm, if there is a significant possibility of significant harm or if the site is causing, or could cause, significant pollution of controlled waters. The definition of harm relevant to the Project relates to human health and statutorily designated ecological sites, such as the Crymlyn Burrows Site of Special Scientific Interest (SSSI), which lies immediately to the east of the Project area.

18.2.2.4 If a site is assessed as being contaminated land, then remediation is required to render significant contaminant linkages (i.e. the source-pathway-receptor relationships that are associated with significant harm and/or significant pollution of controlled waters) insignificant, subject to a test of reasonableness.

18.2.2.5 The Contaminated Land Regime is considered unlikely to apply directly to the Project, as it is drafted to achieve the identification and remediation of land contamination associated with historic activities. Part 2A EPA 1990 is considered to be the "regime of last resort" (Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance (Defra, 2012)) for the regulation of risks associated with land contamination. The preferred approach is to deal with land contamination through the planning and development control process, Building Regulations, voluntary action by site owners or under the Environmental Damage (Prevention and Remediation) Regulations 2009 (EDR 2009). However, there are three respects by which the Contaminated Land Regime is relevant to the Project:

i. the voluntary inspection and remediation of land within the area of the Project;

ii. the application of the risk-based approach introduced by the Contaminated Land Regime is widely applied to the management of land contamination under other regimes; and

iii. the requirement contained within Part 2A EPA 1990 that any remediation of land contamination undertaken under the development control process achieves a standard such that the Project area could not subsequently be determined as statutory contaminated land under the Contaminated Land Regime.

18.2.2.6 Consultation (pers comm, followed by FOI request, 07/02/2013) with Environment Agency Wales (EAW) (now Natural Resources Wales (NRW)) indicated that elements of the onshore land within the Project area have been the subject of voluntary inspection and remediation action undertaken by the relevant landowner. It is understood that this

voluntary action was undertaken to address the historic legacy of land contamination associated with previous oil and chemical industry land use. Voluntary action by a landowner is undertaken to avoid regulatory action under the Contaminated Land Regime and is required to follow the same risk-based approach and achieve the same regulatory standards as the investigation, assessment and remediation of land.

18.2.2.7 The Contaminated Land Regime principles of risk-based assessment and suitability for use have been widely adopted for the management of land contamination under other UK regulatory regimes. This approach has been codified by:

I. Environment Agency (EA) / Defra Contaminated Land Report 11, Model Procedures for the Management of Land Contamination, 2004 (CLR11);

II. the Environment Agency's Guiding Principles for Land Contamination (GPLC, 2010); and

III. the joint NHBC / Environment Agency / CIEH Guidance for the safe development of housing on land affected by contamination (R&D 66:2008).

18.2.2.8 The principles and guidance related to the Contaminated Land Regime have been used to assess the potential requirement for remediation as part of the Project, in order to ensure that the Project area is not considered to be contaminated land under the EPA 1990 during operation and/or after decommissioning

18.2.2.9 The WRA 1991 sets out the relevant regulatory controls that provide protection to water bodies and water resources. The WRA 1991 has been amended by later legislation, including the Water Act 2003 and the Environmental Permitting (England and Wales) Regulations 2010. The WRA 1991 controls water abstraction, discharge to water bodies, water impoundment, conservation and drought provision. In Wales, the WRA 1991 gives NRW the power to issue anti-pollution works notices under Section 161A or to undertake the works themselves under Section 161, to prevent or remedy the pollution of surface waters or groundwater. These powers are granted to prevent entry of noxious or polluting matter to controlled waters, or to remove, remedy / mitigate or restore the waters to a pre-existing state. Detailed requirements for anti-pollution works notices are set out in the Anti-Pollution Works Regulations 1999.

18.2.2.10 The TCPA 1990, along with National and Local Planning Policy and Guidance, allows local authorities to apply legally binding conditions to any planning consents that are granted. Planning permission can be withheld if risks from contamination cannot be adequately addressed through remediation or other mitigation, or development, can be halted if planning conditions are not appropriately discharged. Section 70(2) TCPA 1990, states that "*In dealing with such an application the authority shall have regard to the provisions of the development plan, so far as material to the application, and to any other material considerations*". Sites for redevelopment must be in a condition that is "suitable for use" and risks need to be assessed for the intended use of the site. Guidance on assessing land contamination risks under the TCPA 1990 is contained within relevant National planning policy, requiring that risk assessment for planning purposes is consistent with the requirements under Contaminated Land Regime. This approach is also consistent with the practical requirements that a site assessed under planning law for its intended or proposed use, should not fail the requirements of Part 2A EPA 1990 when the site is occupied and in use.

18.2.2.11 The Building Act 1984 and the Building Regulations 2000 are the key legislation in relation to the consideration of structural and design aspects of a development in terms

of geotechnical properties of the ground. The Building Regulations 2000 require that buildings are constructed so that ground movement caused by swelling, shrinkage, freezing, landslip or subsidence of the sub-soils will not impair the stability of any part of the building.

18.2.2.12 Within the Building Act regime, there are specific regulations that apply to the regulation and assessment of land contamination related issues. These regulations include:

i. the Contaminated Land (Wales) Regulations 2006 (the CL(W) Regulations 2006);

ii. the Contaminated Land (Wales) (Amendment) Regulations 2012;

iii. the Environmental Damage (Prevention and Remediation) Regulations 2009 (the ED Regulations 2009);

iv. the Environmental Permitting (England and Wales) Regulations 2010 (EP Regulations 2010);

v. the Anti-Pollution Works Regulations 1999; and

vi. the Water Resources Act (Amendment) (England and Wales) Regulations 2009.

18.2.2.13 The CL(W) Regulations 2006 set out the requirements for designation of "special sites" under the Contaminated Land Regime, based on the nature and complexity of the candidate site and the likelihood of significant pollution of controlled waters. The CL(W) Regulations 2006 define specific categories of sites that qualify as special sites, and provide the specific descriptions and qualifying conditions that apply to each category listed. Where a site is designated as a special site, lead regulator responsibility passes from the Local Authority to NRW.

18.2.2.14 The ED Regulations 2009 implement the Environmental Liability Directive 2004/35/EC. The ED Regulations 2009 are intended to apply to the most serious cases of environmental damage and are based on the “polluter pays principle”. The ED Regulations 2009 are not retrospective – pollution / damage caused before 2009 cannot be regulated under the ED Regulations 2009, and would most likely fall under the Contaminated Land Regime. The ED Regulations 2009 provide specific definitions of environmental damage (which are broadly consistent with the Contaminated Land Regime), namely: adverse effects on the integrity of a SSSI, or conservation status of a species and habitats protected by EU legislation outside SSSI designations; adverse effects on surface water or groundwater consistent with a deterioration in the water’s status (i.e. Water Framework Directive (WFD) status) or contamination of land that results in a significant risk of adverse effects on human health.

18.2.2.15 The appropriate enforcing authority has a duty to establish whether damage fits the legal definition of “environmental damage”. It must then identify the responsible operator and serve a remediation notice. The enforcing authority can also take steps to prevent (where an imminent threat is identified) or remedy environmental damage and to require information or action from an operator. Operators have to take steps to prevent environmental damage / further damage, provide information to the enforcing authority and undertake preventative / remedial measures required by the regulator, submit remedial proposals and to pay costs claimed by the regulator for environmental damage. Remediation is required to restore the environmental damage in such a manner that there is no deterioration and to compensate for major harm. Remediation can consist of primary remediation to restore the damage; complementary remediation such as the release of alternative sites to compensate where primary remediation does not fully

restore damage and compensatory remediation to compensate for losses of natural resources whilst damage is being restored.

18.2.2.16 The EP Regulations 2010 amended sections of the WRA 1991 in relation to the pollution of controlled waters and the regulatory regime for granting consents to discharge substances to surface waters and groundwater. Section 12 of EP Regulations 2010 requires that "*A person must not, except under and to the extent authorised by an environmental permit; operate a regulated facility; or cause or knowingly permit a water discharge activity or groundwater activity*". This has become the principal offence relating to the pollution of controlled water in Wales.

Water Framework Directive (Directive 2000/60/EC)

18.2.2.17 The WFD is implemented within the UK under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003.

18.2.2.18 The WFD establishes a framework for a European wide approach to action in the field of water policy. The aim of the WFD is to ensure no deterioration from current status for all inland and near shore watercourses and water bodies (including groundwater). The target contained within the WFD is the attainment of 'Good' status or better, in terms of ecological, but also chemical, biological and physical parameters, by the year 2015. Therefore, any activities or developments that could cause detriment to a nearby water resource, or prevent the future ability of a water resource to reach its target status, must be mitigated so as to reduce the potential for harm and allow the aims of the WFD to be realised.

National Planning Policy

18.2.2.19 Planning Policy Wales Edition 5, 2012 (PPW 5) sets out the land use planning policies of the Welsh Government (WG). In respect of risks from land contamination, PPW 5 advises Welsh local authorities that:

18.2.2.20 *"the planning system should guide development to lessen the risk from natural or human-made hazards, including risk from land instability and land contamination. The aim is not to prevent the development of such land, though in some cases that may be the appropriate response. Rather it is to ensure that development is suitable and that the physical constraints on the land, including the anticipated impacts of climate change, are taken into account at all stages of the planning process."*

18.2.2.21 PPW 5 states that:

"local planning authorities should take into account the nature, scale and extent of contamination which may pose risks to health. Land contamination must be considered in the preparation of development plans to ensure that:

i. new development is not undertaken without an understanding of the risks, including those associated with the previous land use, mine and landfill gas emissions, and rising groundwater from abandoned mines;

ii. development does not take place without appropriate remediation;

iii. *consideration is given to the potential impacts which remediation of land contamination might have upon the natural and historic environments."*

18.2.2.22 Planning decisions need to take into account:

i. *"the potential hazard that contamination presents to the development itself, its occupants and the local environment; and*

ii. *the results of a specialist investigation and assessment by the developer to determine the contamination of the ground and to identify any remedial measures required to deal with any contamination."*

18.2.2.23 PPW 5 advises that:

"where significant contamination issues arise, the local planning authority will require evidence of a detailed investigation and risk assessment prior to the determination of the application to enable beneficial use of land. Where acceptable remedial measures can overcome such contamination, planning permission may be granted subject to conditions specifying the necessary measures. If contamination cannot be overcome satisfactorily, the authority may refuse planning permission."

18.2.2.24 PPW 5 acknowledges the need to address the potential for contaminated land in the Unitary Development Planning process. It goes on to state that:

"*Undertaking development on land designated as contaminated land for the purposes of Part 2A may provide a net cost benefit, by way of taking land from a perceived negative value to a positive value, necessary to fund the required remediation of contaminated land. If remediation required under Part IIA is to commence via the planning process it will be the responsibility of the local planning authority to ensure that the land is suitable for its proposed use. The developer will need to provide sufficient information to both the local planning authority and the enforcing authority under Part 2A. In such cases remediation will be enforced through planning permission. However, in the absence of a definite timetable for implementing planning permission the option should remain for the enforcing authority under Part 2A to require the necessary remediation and to do so under the 'polluter pays' principle".* The preference for development on Brownfield sites is also highlighted "*because their re-use will promote sustainability objectives*".

18.2.2.25 PPW 5 also outlines the approach that should be adopted when development is planned on unstable land. It advises that the approach should focus on understanding the risks and restoration to safeguard investment.

18.2.3 Local Planning Policy – Unitary Development Plans (UDP)

The City and County of Swansea UDP (2008)

18.2.3.1 The City and County of Swansea Council's (CCSC) UDP sets out policies and proposals for future development, use of land and environmental conservation within the area up to 2016. The main intentions of the UDP are to promote sustainable development, protect the environment, facilitate regeneration and to support community planning.

18.2.3.2 The UDP emphasises that the revitalisation of significant brownfield sites in and around the Swansea Dock area should be delivered with the benefit of a waterfront regeneration masterplan. The Swansea Dock / Swansea Bay area is identified as a key area for future development, with the aim of promoting sustainable growth of the local and regional economy, and thereby revitalising the economy in South West Wales. .

18.2.3.3 Within general policies, the UDP states:

i. *"the Council must also take into account the nature, scale and extent of contamination which may pose risks to health and guide developments to lessen the risk from land instability and land contamination. A new regime for contaminated land has been introduced under the provisions of Part IIA of the Environmental Protection Act 1990 and The Contaminated Land (Wales) Regulations 2001. The Council must have regard to the requirements of the Act when considering planning applications.*

ii. *Much work has already been undertaken within the County in dealing with the legacy of dereliction, contamination, pollution and land instability, arising from past industrial activity. This has led to a substantial improvement in the quality of the County's physical environment. This process must continue when assessing new development proposals and the Council will seek to guard against the possibility of new problems being introduced."*

18.2.3.4 Policy EV2, on siting and location, includes:

"*Siting of new development should give preference to the use of previously developed land over greenfield sites, and must have regard to the physical character and topography of the site and its surroundings by:*

1. *Having full regard to existing adjacent developments and the possible impact of environmental pollution from those developments, as well as the creation of any environmental pollution to the detriment of neighbouring occupiers (including light, air and noise),*
2. *Identifying and fully addressing issues of contamination and land instability."*

18.2.3.5 The UDP policy on Health and Environment specifies the following objectives:

I. *To bring forward proposals for the remediation of dereliction and pollution*

II. *To avoid any developments in the vicinity of existing hazard*

III. *To avoid significant adverse environmental impacts from new development*

IV. *To protect undeveloped and functional floodplains*

V. *To safeguard and improve the quality and quantity of controlled waters*

18.2.3.6 Policy EV34, on the Protection of Controlled Waters, states:

"Development proposals that may impact upon the water environment will only be permitted where it can be demonstrated that they would not pose a significant risk to the quality and or quantity of controlled waters. Initiatives that lead to improvements in the quality of surface water will be approved subject to satisfactory ecological and visual safeguards…

…Water is an essential resource and its presence and purity is paramount for the sustainability of life. Over-abstraction can have a detrimental impact on existing users and the environment, whilst pollution of surface and ground waters can render the resource unsuitable for use by man and damage the environment. Maintaining or enhancing the water quality of coastal waters, rivers, canals, lakes, ponds and other water bodies is important for a wide range of uses.

Activities such as the disposal of effluent in soakaways, landfilling or ineffective storage of chemicals can result in the pollution of groundwater. Contaminated sites should be adequately sealed against the leakage of polluted matter and surface drainage should be directed away from the source of contamination and any contaminated water (ground or surface water) must be adequately treated prior to discharge. Planning permission will not be granted where in the opinion of the Council and the EA if the disturbance of contaminated land will significantly affect the quality of surface and groundwaters. Similarly, abstraction and dewatering can affect quantities available. As the clean up of contaminated groundwater or the restoration of quantities or flow is difficult and very expensive, the Council, in co-operation with the EA, will seek to prevent or reduce the risk of groundwater pollution by restricting development that threatens controlled water quality. Guidance on considerations affecting the acceptability of development from a groundwater protection viewpoint has been published by the EA as its "Policy and Practice for the Protection of Groundwater" (GP3)."

18.2.3.7 Policy EV38, Contaminated Land, states:

"Development proposals on land where there is a risk from contamination or landfill gas will not be permitted unless it can be demonstrated to the satisfaction of the Council, that measures can be taken to satisfactorily overcome any danger to life, health, property, controlled waters, or the natural and historic environment…

1. *…Failure to identify and accurately assess any risk to development arising from contamination or landfill gas generation may pose a threat to the health and safety of future occupiers or neighbouring occupiers, as well as the natural and historic environments and controlled waters. Consultations will be undertaken with the EA and / or with the Council's Pollution Control section to ensure that any development proposed does not pose a risk to controlled waters. The EA will also be consulted in respect of development proposals located within 250 metres of landfill sites.*
2. *Planning applications on sites that the Council has reason to believe are contaminated must be accompanied by a site investigation report containing a risk assessment and proposed remedial measures. Consideration of the acceptability of remedial measures will include the impact they have on controlled waters and the natural and historic environment. The Council, in consultation with the EA, will need to be satisfied that actual or potential contamination can be overcome before planning permission can be granted."*

Neath and Port Talbot Unitary Development Plan, 2008

18.2.3.8 The Neath Port Talbot Unitary Development Plan (UDP) was adopted on 26 March 2008 and replaces the West Glamorgan Structure Plan, Minerals Local Plan, and the local plans that previously covered the area. The UDP seeks to encourage any development that reduces the amount of contaminated land across the borough.

18.2.3.9 Policy ENV16 states that:

"Proposals that would tackle contaminated areas will be welcomed provided they would address the contamination without causing unacceptable impact.

Where land is or may be contaminated, development should not take place without an understanding and assessment of the risks including those associated with existing and previous land uses, mine and landfill gas emissions and rising groundwater from

abandoned mines. Any potential impacts which remediation measures would have on the natural and historic environments should be fully considered.

Where there is a significant risk of land being contaminated, a developer will be required to prepare a specialist investigation and assessment of the contamination (including the source of the contamination, the route or pathway by which the contamination is or could result, and the receptor or persons, land, water, or habitats affected), and to identify any appropriate remedial measures.

Where remediation is required under Part 2A of the Environment Protection Act 1990 the developer will be required to convince the Local Planning Authority that the land is suitable for its proposed use. The remediation would be enforced through the planning permission. It should be noted that in the absence of a definite timetable for implementing the planning permission, the option would remain for enforcement action by the appropriate enforcing authority."

18.2.4 Local Planning Policy – Local Development Plans (LDP)

18.2.4.1 UDPs are to be replaced within the next few years by a new form of Development Plan known as a LDP. LDPs are intended to provide a new approach to promoting and controlling change across the CCSC and Neath Port Talbot County Borough Council (NPTCBC) areas. One of the stated aims of the proposed CCSC LDP is to promote sustainable development in Swansea through the use of land and control of development.

The City and County of Swansea Contaminated Land Inspection Strategy

18.2.4.2 CCSC published a 'Contaminated Land Inspection Strategy' in October 2005. The strategy outlines the proposed method for implementing the CCSC's statutory duties under the Contaminated Land Regime.

Neath Port Talbot Contaminated Land Strategy

18.2.4.3 NPTCBC also published a 'Contaminated Land Strategy' in October 2005. The strategy outlines the particular aims of NPTCBC in relation to identifying and remediating contaminated land as identified through Part 2A of the EPA 1990.

18.2.4.4 The overall aims of the strategy are to:

i. *"Identify, remove and prevent significant harm occurring from contaminated land to people, property, animals and the environment;*
ii. *Promote re-development of Brownfield sites;*
iii. *Ensure development control procedures are in place to deal with contaminated land effectively through the planning process; and*
iv. *Manage and/or reduce the council's liabilities as a landowner or occupier with regards contaminated land issues."*

18.2.5 Other relevant policy

River Basin Management Plan (RBMP)

18.2.5.1 A RBMP was prepared in 2009, for the Western Water River Basin District which includes Swansea and the surrounding area. The RBMP focuses on the protection, improvement and sustainable use of the water environment. River basin management is a continuous process of planning and delivery.

18.2.5.2 For groundwater, the RBMP states:

"*For groundwater, good status has a quantitative and a chemical component. Together these provide a single final classification: good or poor status. Poor quantitative status occurs if there could be adverse impacts on rivers and wetlands. Poor chemical status occurs if there is widespread diffuse pollution within the groundwater body, the quality of the groundwater is having an adverse impact on wetlands or surface waters, or the quality of water used for potable supply is deteriorating significantly. There are other objectives for groundwater quality in addition to meeting good status. These are the requirements to prevent or limit the input of pollutants to groundwater and to implement measures to reverse significant and sustained rising trends in pollutants in groundwater*."

18.2.5.3 The Project area falls within the Ogmore - Tawe catchment. According to the RBMP 37% of rivers and lakes have a good ecological status (or potential) compared to 30% of coastal waters and estuaries. With regards to the coastal areas, the main pressures include morphological alterations, nutrient and microbiological contamination from runoff and sewage, chemical contamination.

18.2.5.4 Management schemes proposed to address the issues discussed above include managed realignment schemes and pollution prevention campaigns to protect coastal areas.

Model Procedures for the Management of Land Contamination

18.2.5.5 The Model Procedures for the Management of Land Contamination (CLR11, 2004) provide a road map / flowcharts for structured decision making required for the management of land affected by contamination. CLR11 codifies the general approach for the assessment of land contamination that was introduced with the Contaminated Land Regime in 2000. CLR11 is based on a phased, risk-based approach using the source / contaminant - pathway – receptor concept as the key part of a conceptual site model (CSM). CLR11 uses tiered risk assessment, from qualitative risk screening through to detailed quantitative risk assessment, followed by remedial options appraisal and implementation of the agreed remediation strategy. CLR11 forms the core reference guidance across the range of land contamination-related regulatory regimes in the UK and is integral to most projects dealing with land contamination. Environment Agency Technical Guidance was previously adopted for use in Wales by Environment Agency Wales, and is still applicable as best practice guidance.

Guiding Principles for Land Contamination (Environment Agency 2010)

18.2.5.6 The Environment Agency's Guiding Principles for Land Contamination (the Guiding Principles) comprise a set of three reports (GPLC1, GPLC2 and GPLC3) that provide general guidance for site / problem holders and their professional advisors / consultants. The Guiding Principles provide a simplified overview of the approach laid out in CLR11. The aim of the Guiding Principles is to clarify roles and responsibilities, encourage good

practice and comply with or avoid the need for regulation and to provide a link to relevant advice in other guidance documents.

Groundwater Protection: **Principles and Practice (GP3)**

18.2.5.7 The Environment Agency's GP3 guidance sets out their proposed approach for implementing legislation and policy relevant for the protection of groundwater resources. The document is organised in three sections, presenting the principles of groundwater protection, Environment Agency position statements and relevant legislation and supporting technical information.

A Framework for Assessing the Sustainability of Soil and Groundwater Remediation SuRF-UK 2010

18.2.5.8 The Sustainable Remediation Forum (SuRF-UK) aims to increase understanding of sustainable remediation. The 'Framework for Assessing the Sustainability of Soil and Groundwater Remediation' helps assessors to identify the optimum land and/or groundwater remediation strategy and/or technique.

18.2.5.9 The process of assessing sustainable remediation is defined by SuRF-UK as:

"…the practice of demonstrating, in terms of environmental, economic and social indicators, that the benefit of undertaking remediation is greater than its impact, and that the optimum remediation solution is selected through the use of a balanced decision-making process".

Relevant Pollution Prevention Guidelines (Environment Agency Pollution Prevention Guidance Notes)

18.2.5.10 Pollution Prevention Guidelines Note 1 (PPG1) – 'General Guide to the Prevention of Pollution' provides an introduction to, and the key principles of, the prevention of pollution from a variety of sources.

18.2.5.11 Pollution Prevention Guidelines Note 2 (PPG2) – 'Above Ground Oil Storage Tanks' offers advice on storage options, equipment and its maintenance and how to deal with spills.

18.2.5.12 Pollution Prevention Guidelines Note 3 (PPG3) – 'Use and Design of Oil Separators in Surface Water Drainage Systems' provides guidance on when oil separators are appropriate and what size and type of separator are required.

18.2.5.13 Pollution Prevention Guidelines Note 4 (PPG4) – 'Disposal of Sewage where no Mains Drainage is available' offers advice if connection to the local sewage network is not possible and offers guidance on alternative means of wastewater disposal.

18.2.5.14 Pollution Prevention Guidelines Note 5 (PPG5) – 'Works in, near or liable to affect watercourses' provides guidance on general precautions to take when working in the vicinity of a watercourse, along with more specific measures to take to prevent contamination and to minimise any impacts.

18.2.5.15 Pollution Prevention Guidelines Note 6 (PPG6) – 'Working at construction or demolition sites' repeats much of what PPG5 presents but concentrates specifically on the situations likely to occur at demolition and construction sites.

18.2.5.16 Pollution Prevention Guidelines Note 7 (PPG7) – 'Refuelling Activities' provides information on the correct delivery, storage and dispensing of fuel to help reduce the risk of pollution.

18.2.5.17 Pollution Prevention Guidelines Note 20 (PPG20) – 'Dewatering underground ducts and chambers'

18.2.5.18 Pollution Prevention Guidelines Note 21 (PPG21) - 'Pollution Incident Response Planning' provides advice for those developing site specific pollution incident response plans to help prevent and mitigate damage to the environment caused by accidents such as spillage and fire.

Construction Industry Research and Information Association (CIRIA) Guidance

18.2.5.19 Guidance C532 'Control of Water Pollution from Construction Sites: Guidance for Consultants and Contractors' compiles the CIRIA Guidance but provides further detail with regard to sources of water on construction sites, pollutants and pathways, and provides guidance on planning for the type and location of suitable control measures.

18.2.5.20 Guidance C665, 'Assessing Risks Posed by Hazardous Ground Gases to Buildings' aims to consolidate good practice in a risk-based approach to gas contaminated land and to ensure a consistent approach to decision making while remaining flexible enough to be relevant to site specific and development variability.

18.2.5.21 Guidance C697 'The SUDS Manual' provides best practice guidance on the planning, design, construction, operation and maintenance of sustainable urban drainage systems (SUDS) to facilitate their effective implementation within developments. This supersedes a number of previously issued guidance notes, including C521.

18.3 Assessment methodology and significance criteria

18.3.1 Approach

18.3.1.1 The assessment of land quality conditions has involved the review and collation of readily available information pertaining to the current condition of the soils and groundwater within the Project area and the potential risks they pose to the environment and future users.

18.3.1.2 This information has been used to characterise baseline conditions for the Project area and to assess the need for mitigation to protect future users or the environment from any significant contaminant sources identified. The information has been used to develop a CSM to assess the magnitude and significance of potential impacts associated with the proposed onshore components of the Project.

18.3.1.3 This assessment has involved a desktop review of the following data sources (full references are provided at the end of this chapter):

i. Landmark Information Group, Envirocheck Report_ 43785108_1_1, including historical topographic mapping and environmental database search information for receptor sensitivity;

ii. Ordnance Survey 1:25,000 Explorer, Sheet 165 Swansea;

iii. British Geological (BGS) Survey. 1:50,000 Geological Map Sheet 247 Swansea. Solid and Drift Editions;

iv. EAW on-line resources (http://www.environment-agency.gov.uk) – subsequently changed to NRW at (http://naturalresourceswales.gov.uk/?lang=en);

v. URS Corporation Ltd Report Ref.: 49311733, The Bay Science and Innovation Campus, Swansea University. Environmental Statement, 2010;

vi. URS Corporation Ltd Report Ref.: 49311733/BRRP003, The Bay Science and Innovation Campus Site Investigation and QRA, BP International Ltd. September 2009; and

vii. URS Corporation Ltd Report Ref.: 49311733, The Bay Science and Innovation Campus, Swansea University. Environmental Statement, 2010.

18.3.1.4 URS completed a walkover survey of the accessible onshore areas of the Project on 8 February 2013. The walkover was undertaken to establish the current Project area conditions with respect to land, and selected photographs are presented within this chapter.

18.3.1.5 This ES proceeds on the basis of the outline construction programme as discussed in Chapter 4, Section 4.5.2, which anticipates construction starting in 2015 and with the main construction lasting for about three years. The assessments contained in this chapter are not materially sensitive to works commencing within the anticipated validity of the DCO, which is five years, or to an extension of (say) a further year-or-so.

18.3.2 Impact assessment methodology

18.3.2.1 A review of baseline conditions within the Project area was undertaken to evaluate the nature of potential impacts associated with the Project. The assessment criteria to determine the magnitude of potential impacts (assessed against baseline conditions, prior to the consideration of mitigation measures) during the operational, construction and decommissioning phases of the Project have been qualitatively described and categorised, as set out in Table 18.1. The significance of residual impacts is assessed in accordance with criteria in Table 18.2, and reflect the incorporation of mitigation methods.

18.3.3 Impact magnitude assessment

18.3.3.1 The magnitude of potential impacts (using worst case scenarios) during the operational and construction phases of the Project has been qualitatively described and categorised based on the terminology in Table 18.1.

Table 18.1 Criteria to determine magnitude of impacts

Impact Magnitude	Criteria	Example / Description
High	Results in loss of attribute and likely to cause exceedances of statutory objectives and/or breaches of legislation	Contamination of a potable source of abstraction
Medium	Results in impact on integrity of attribute or loss of part of attribute possibly with / without exceedances of statutory objectives or with/without breaches in legislation.	Reduction in the value of the feature

Low	Results in minor impact on attribute	Measurable changes in attribute, but of limited size and/or proportion
Negligible	Results in no discernible change or an impact on attribute of insufficient magnitude to affect the use / integrity	Discharges to watercourse but no significant loss in quality of the feature

18.3.4 Significance criteria assessment

18.3.4.1 The prediction of impact significance is based on the magnitude of the impact and the importance or sensitivity of the receptors. The assessment takes account of any mitigation measures to be applied in the implementation of the Project. The assessment of impact significance, for negative impacts, are assessed in the absence of any mitigation measures and then following the application of potential mitigation measures.

18.3.4.2 The criteria for classifying impact significance are summarised in Table 18.2.

Table 18.2 Impact significance criteria

Significance	Description
Major Adverse	Considerable detrimental impact (by extent, duration or magnitude) of more than local significance or in breach of recognised acceptability / legislation / policy standards.
Moderate Adverse	Limited detrimental impact (by extent, duration or magnitude) that may be considered significant.
Minor Adverse	Slight, very short or highly localised detrimental impact.
Negligible	No appreciable impact on the attribute, or the attribute of negligible importance
Minor Beneficial	Minor reduction in risk (slight, very short or highly localised impact)
Moderate Beneficial	Moderate reduction in risk
Major Beneficial	Major reduction in risk

18.3.4.3 Significance is also considered in terms of timescale (short, medium or long term), permanence (reversible or permanent) and the geographic scale of the impact (local, district, national or international). For example, a release of suspended solids could result in the temporary closure of a potable water abstraction (High Magnitude), but the effects would be expected to be short-term and fully reversible (Minor Adverse Significance).

18.3.4.4 These definitions take into account the large body of technical guidance that has been produced in the UK for the assessment of ground conditions and water resources by the Government (Defra and its predecessor departments / devolved equivalent), and agencies such as EAW / NRW.

18.3.4.5 In summary, the guidance provides for staged and risk-based data interpretation. This commences with a Preliminary Risk Assessment (PRA, also known as Stage 1 risk assessment), which is normally a desk based assessment to develop an initial CSM and identify any source-pathway-receptor pollutant linkages that might apply for the site and would be used to define any potential risks. Where potential risks are identified, the PRA would be used to design an intrusive site investigation to acquire additional data on the pollutant linkages it identified.

18.3.4.6 Where site investigation data confirms the presence of contaminants of concern, the laboratory analytical data are screened against generic assessment criteria (GAC) defined through the process of Stage 2 Generic Quantitative Risk Assessment (GQRA). GAC are conservative in nature and are used to screen out risks that are unlikely to represent an "unacceptable risk" to the receptors defined in the CSM – the GAC are set to ensure that, if they are not exceeded, it is extremely unlikely that relevant receptors will be exposed to significant levels of risk.

18.3.4.7 In cases where Stage 2 GQRA GAC are exceeded, it is normally appropriate to proceed to Stage 3 Detailed Quantitative Risk Assessment (DQRA) to define Site Specific Assessment Criteria (SSAC). Stage 3 DQRA will often require that additional site investigation is undertaken to collect specific additional data to refine the risk assessment process and determine the need for further action, such as land and / or groundwater remediation.

18.4 Baseline conditions

18.4.1 Study area

18.4.1.1 The location of the Project is shown in Figure 18.1. The red line boundary shows the overall land take assessed for the onshore areas of the Project.

18.4.1.2 The Lagoon seawalls are located within Swansea Bay. The Lagoon seawall has landfalls, located towards the western and eastern extents of the overall Project area. Much of the Project lies beyond the low tide mark and so is largely outside the scope of this Land Quality and Hydrogeology chapter. The exception is the potential for an impact on groundwater flow and the hydrogeological regime that might arise from the management of the tidal cycle during power generation operations. The assessment of the potential effects of the Offshore Works is covered in the relevant chapters of this ES. In particular, Chapter 6: Coastal Processes, Sediment Transport and Contamination and Chapter 7: Marine Water Quality.

18.4.1.3 The extent of the land that has been considered in relation to the Project onshore - the study area - is much greater than the extent of the proposed Onshore Works themselves. The general land quality conditions expected are described for the areas enclosed within the redline boundary shown on Figure 18.1, with more specific discussion of those areas of affected by the Onshore Works.

18.4.1.4 To assist with identifying the areas under discussion in relation to the baseline conditions, the study area has been sub-divided into three zones. The location of the Project is shown in Figure 18.1, with the Cable and Grid Connection shown in orange and the three Figure 18.1 insets, A, B and C showing the three zones. These areas are shown in detail on the subsequent Figures 18.2 to 18.4.

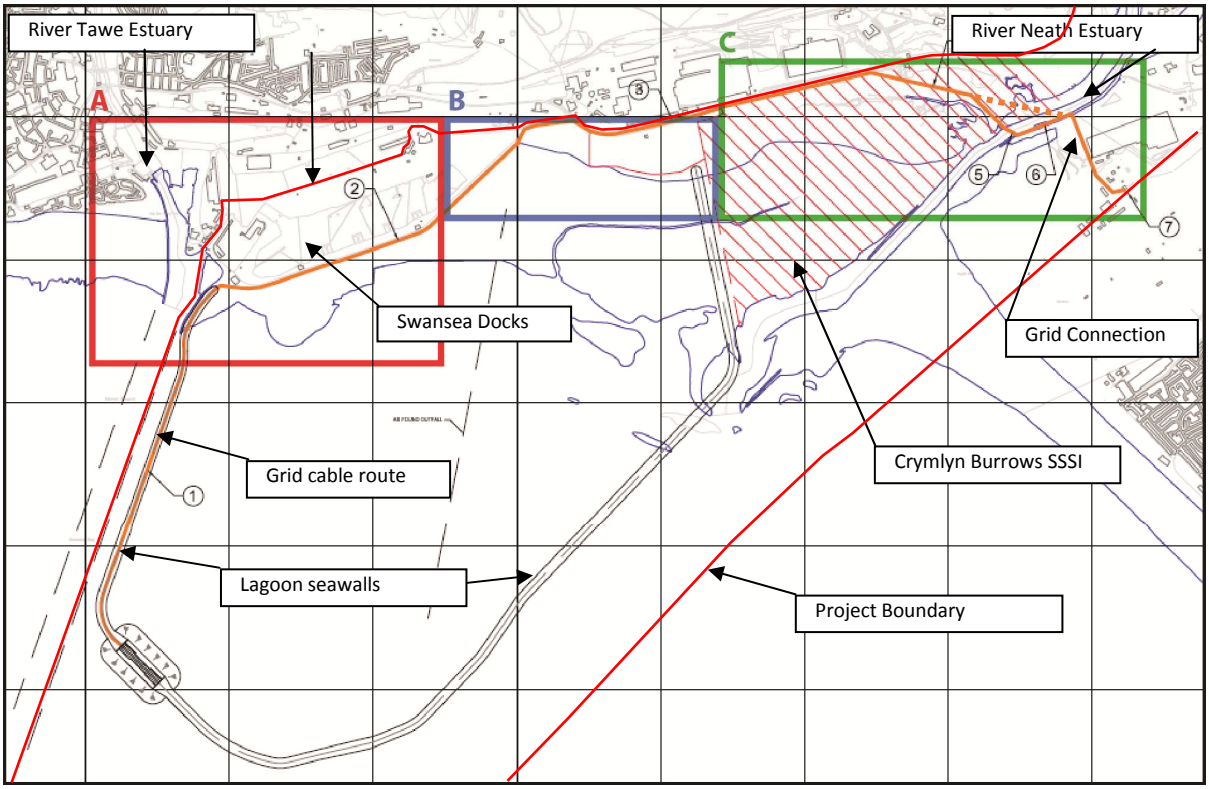

Figure 18.1 Proposed location of Project

18.4.1.5 Figure 18.1 Inset box A is shown as Figure 18.2, depicting the Western Onshore Works Area. This area consists of land within the boundary of Associated British Ports' (ABP) Swansea Docks facility.

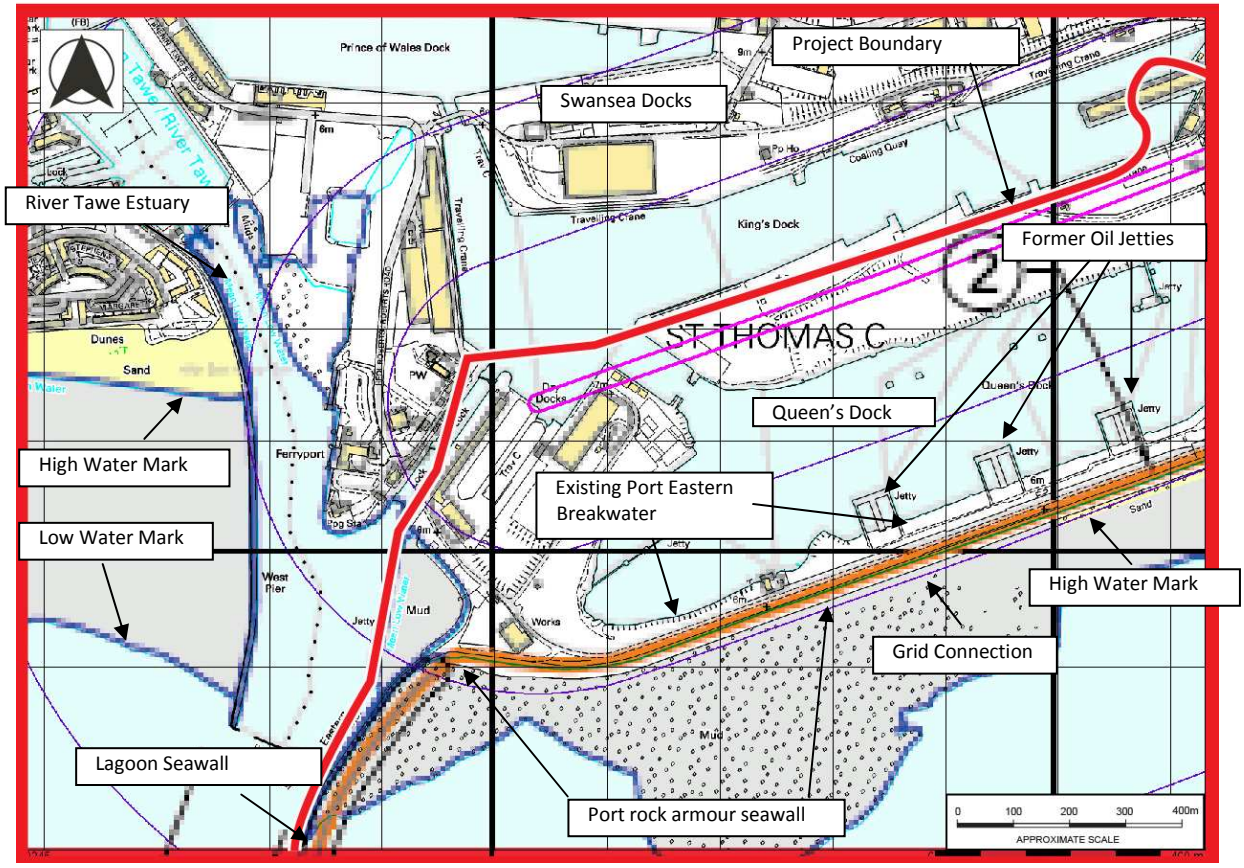

Figure 18.2 Western Onshore Area (Area A), including proposed western Lagoon seawall landfall, Queen's Dock and cable and grid connection route.

18.4.1.6 Figure 18.2 shows Queen's Dock, and the existing Port rock armour seawall (Port Seawall) which forms the seaward boundary of the ABP Swansea Docks complex. The land between the Port Seawall and Queen's Dock is the Eastern Breakwater and this has an access road along the full length, with a strip of currently unused land along either side of the road alignment. Five former oil jetties are present along the southern edge of Queen's Dock. These served the former Queen's Dock oil terminal and are separated from the Port Seawall access road by a security fence.

18.4.1.7 The principal areas of development for Area A are where the Project's western Lagoon seawall makes landfall as shown above. Here, the western landfall facilities would be located which comprise operations & maintenance (O&M), boating and visitor facilities, laboratory and hatchery (further details can be found in Chapter 4: Project Description). The proposed Grid Connection from the Project will be installed alongside the Port road running along the sea front.

18.4.1.8 The area for the western landfall facilities is currently occupied by a cement sheet clad steel framed building (labelled "Works" on Figure 18.2), unused open ground and an empty concrete bund area.

18.4.1.9 Figure 18.1 Inset box B is shown as Figure 18.3, depicting the Central Onshore Works Area (Area B). This area consists of land within the boundary of Associated British Ports' (ABP) Swansea Docks facility, as well as land formerly occupied by an oil storage tank farm (known as the former BP Transit Site). The land within the ABP Swansea Docks complex includes the former Queen's Dock Oil Terminal.

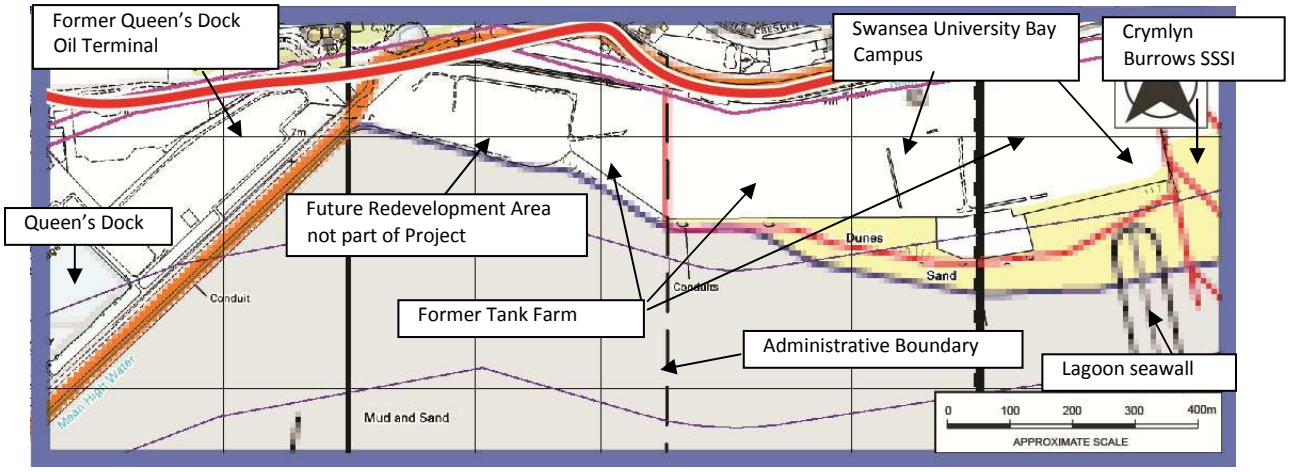

Figure 18.3 Area B, comprising the former Queen's Dock oil terminal, former tank storage areas and eastern Lagoon seawall landfall

18.4.1.10 The former Queen's Dock Oil Terminal is located immediately to the east of the open water of Queen's Dock, and forms a triangular area of land at the eastern end of ABP Swansea Port site. The boundaries of the former Queen's Dock Oil Terminal plot are defined by the eastern end of Queen's Dock, the Port sea front access road and the main west – east docks access road (shown in red along the northern boundary). The plot has been cleared to ground level.

18.4.1.11 Land to the east of the Queen's Dock oil terminal was formerly used for oil / chemical tank storage, for products being transferred between the Queen's Dock Oil Terminal and the former Llandarcy refinery and Baglan Bay chemical works. All former storage tanks and above ground infrastructure has been removed and the site has been subdivided into plots for future redevelopment.

18.4.1.12 The administrative boundary between the CCSC and NPTCBC follows a north – south alignment through the centre of the Area B (Figure 18.3).

18.4.1.13 The former tank farm land to the east of the administrative boundary (i.e. within NPTCBC) has received consent for the development of Swansea University's Bay Campus (SUBC). Construction works commenced on the SUBC in 2012. The proposed eastern Lagoon seawall landfall is adjacent to the eastern boundary of the SUBC.

18.4.1.14 The proposed Grid Connection for the Project continues along the Port sea front access road (from the Area A) to the eastern corner of the ABP Swansea Docks site. It then follows a route parallel to the A483 Fabian Way dual carriageway road, either within the verge of Fabian Way or within Crymlyn Burrows SSSI.

18.4.1.15 Figure 18.1 Inset Box C is shown as Figure 18.4, depicting the Eastern Onshore Works Area (Area C) for the Project which is limited to the cable and grid connection works. The proposed route options will be aligned in the verge alongside the A483 Fabian Way or within the Crymlyn Burrows SSSI, to a point close to the Amazon/Jersey Marine roundabout. The route then continues through Crymlyn Burrows SSSI before crossing the River Neath estuary to the National Grid substation at Baglan Bay Power Station.

18.4.1.16 The Grid Connection will need to pass beneath the River Neath estuary channel. This will be accomplished either by a directional drill beneath the river, or by utilising one of the

existing redundant pipelines that previously connected the Queen's Dock Oil Terminal / Transit Site tank farm with the Baglan Bay chemical works.

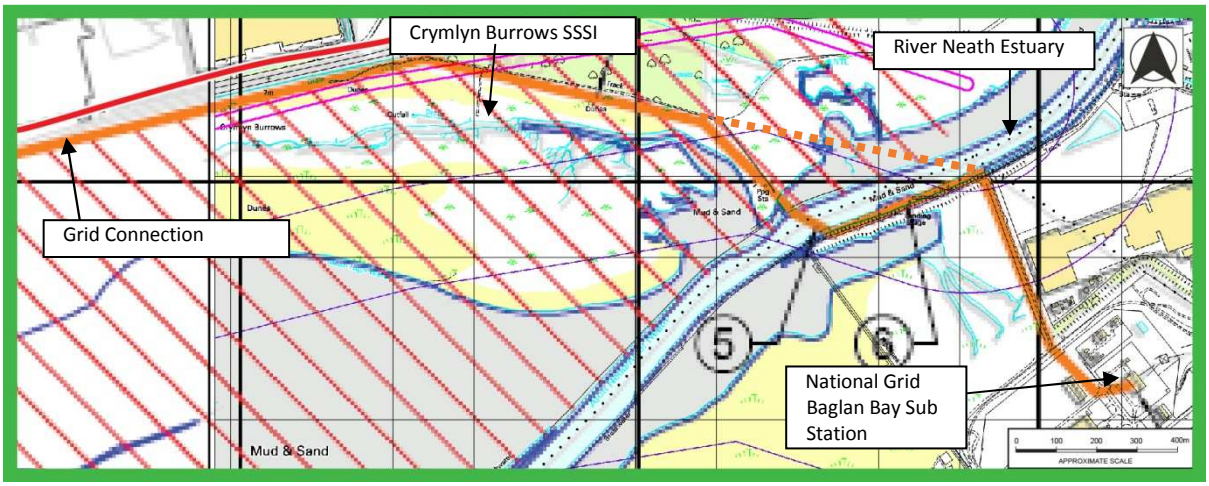

Figure 18.4 Area C, showing the Crymlyn Burrows SSSI (red hatch) and proposed cable and grid connection route to the Baglan Bay substation (orange/dashed section drilled).

Topography

18.4.1.17 A review of the published 1:25,000 Ordnance Survey (OS) mapping for the study area (Explorer Sheet 165, Swansea) indicates that the Onshore Works area of the Project is located along a low elevation coastal margin. The onshore area extends from the intertidal zone, and within the Project area, rises to an elevation of approximately 6-7m Above Ordnance Datum (mAOD).

18.4.1.18 Within the ABP Swansea Docks, ground levels have been raised above the surrounding low-lying coastal margin, both to form the enclosed dock basins and to provide a level development platform for the docks and transport (road and rail) infrastructure. The Port Seawall, which encloses the eastern and southern sections of Queen's Dock, is at an elevation of 6 – 7mAOD. From visual inspection, the Port Seawall appears to be a rock armour protected embankment, approximately 60 - 90m wide, and rising steeply approximately 5-6m from the intertidal beach. Photograph 18.1 shows the beach and seawall topography adjacent to the existing Port Seawall.

Photograph 18.1 Port Seawall, adjacent to the former Queen's Dock Oil Terminal, looking eastwards towards the former tank farm area. Note groundwater seepages from base of Port Seawall. Site Walkover Survey, 7 February 2013.

18.4.1.19 The previously developed areas associated with the Queen's Dock Oil Terminal and Transit Site tank farm are also level, and at an approximate elevation of 7mAOD. The seaward boundaries of these plots are defined by a rock armour / rip-rap seawall for approximately 1,200m of their length, rising steeply from the beach. The easternmost 200m is fronted by sand dunes with no rock armour. Ground levels within the SUBC, at the eastern end of the former tank farm, were raised to mitigate against potential flood risk.

18.4.1.20 To the east of the previously developed areas, the transition between the intertidal sandy beach and intertidal estuary salt marsh areas is more low-lying, gradual and marked by sand dunes. Photograph 18.2 shows the margin beyond the eastern end of the rip-rap rock armour wall.

Photograph 18.2 View eastwards from the eastern end of the sea defences. The topography is low lying, with a gradual transition between the beach and sand dunes. Site Walkover Survey, 7 February 2013.

18.4.1.21 The northern edge of the Project area is defined by the southern edge of the A483 Fabian Way dual carriageway, where ground elevations are between 7 and 9mAOD.

18.4.1.22 To the north of Fabian Way the topography is variable, depending on location. North of Swansea Docks, the land rises steeply to the prominent feature of Kilvey Hill, at 190mAOD.

18.4.1.23 The land to the north of the former Queen's Dock Oil Terminal, Transit Site tank farm and the SUBC is low lying. The northernmost Project area is flanked by a 300-500m wide road, rail and industrial development corridor, at a level elevation of approximately 7mAOD. Further north is the extensive area of low-lying wetland which forms the Crymlyn Bog SSSI.

Site description and surroundings

18.4.1.24 Area A is dominated by the commercial and industrial land use within the ABP Swansea Docks complex. The redline boundary encloses the Queen's Dock, an isthmus of land separating Queen's Dock and King's Dock, and the port entrance and dry docks area.

18.4.1.25 The former oil jetties along the Port Seawall and former chemical jetty on the northern isthmus were associated with the Queen's Dock Oil Terminal and are not currently used.

The dock wall at the north western corner of Queen's Dock is used for mooring ships awaiting ship repair or scrapping.

18.4.1.26 The land surrounding Queen's Dock is largely unused or under-used industrial land. The isthmus of land between Queen's Dock and King's Dock is predominantly occupied by extensive stockpiles of aggregate. The former Queen's Dock Oil Terminal has been demolished and the land area is undergoing remediation for historical land contamination.

18.4.1.27 Land along the Port Seawall on the southern side of Queen's Dock is unused, except for the road access to the dry docks area and a small port stores shed. A second shed is present at the western end of the Port Seawall. At the time of the walkover survey, on 7 February 2013, this building appeared to be disused and in poor condition. Land at the western end of Queen's Dock also includes light industrial buildings associated with the two dry docks and a ship repair business, and a small boatyard, both of which are adjacent to the main port entrance.

18.4.1.28 To the west of the port entrance channel and locks are the port office and RoRo car ferry terminal marshalling area.

18.4.1.29 The Swansea Docks complex continues northwards beyond the redline boundary for the Project, and both King's Dock and Prince of Wales dock are located between the Project area and the A483 Fabian Way. Land between the docks and Fabian Way is undergoing redevelopment for a mixed use of commercial, light industrial and residential land use. North of Fabian Way are the established residential areas of Port Tennant, Dan y Graig and St Thomas.

18.4.1.30 Land within Area B is currently undergoing land contamination remediation, prior to being brought back in to productive commercial, light industrial and residential use.

18.4.1.31 To the north, the study area boundary is defined by the A483 Fabian Way dual carriageway, beyond which are the residential areas of Baldwin's Crescent and Elba Crescent, industrial units (including Gower Chemicals, the former Visteon automotive parts factory, Celtic Mowers, a tool hire yard and car sales areas) and an open area/playing field.

18.4.1.32 Area C is dominated by the scrub woodland, sand dunes and salt marshes of Crymlyn Burrows SSSI, which extends eastwards as far as the River Neath estuary. The SSSI comprises a mix of woodland with 'slacks' (ponds), marshy areas and sand dunes to the south. Beyond the River Neath estuary, the proposed cable and grid connection connects with National Grid's Baglan Bay substation, which is adjacent to the existing Baglan Bay Power Station.

18.4.1.33 Area C is crossed by a number of disused underground pipelines. These are understood to run in a west – east direction, towards the Baglan Bay site. The pipelines cross the River Neath estuary and provide a potential crossing point for the Grid Connection. A redundant valve compound (the foreshore valve compound) is located within the Crymlyn Burrows SSSI, approximately 400m to the east of the former Transit Site tank farm.

18.4.1.34 Land to the south of all areas of the site is occupied by the tidal beach and tidal flats of Swansea Bay and the River Neath Estuary (in the east).

18.4.2 Project area land use history

18.4.2.1 Historical topographic maps from Landmark Information Group Envirocheck Report_ 43785108_1_1 have been reviewed to assess historic land uses. These are summarised for Areas A, B and C, respectively.

18.4.2.2 The land use history of Area A is dominated by the development and operation of Swansea Docks and the associated industrial activities. Table 18.3 provides a summary of the main on-site and off-site land use history in the port area.

Table 18.3 Map summary of historic land uses - Western Onshore Works Area (Area A)

Map Date (scale)	Land Use Summary
1879 (1:2,500)	**The proposed Project area is undeveloped marsh land / intertidal flats**. Port Tennant Copper works and associated gasometer and coal wharfs are in operation within 500m to the north.
1884 (1:10,560)	**No change in the Project area** South Docks located off-site to the west of the River Tawe Estuary and Swansea city to the north west, which appears highly developed with terraced houses, coal works, a timber yard and other buildings likely to be of industrial use. An arsenic works are indicated along the coastline to the north east (approx. current position of Fabian Way)
1899 (1:2,500)	**The Project area still remains undeveloped marsh land.** Port Tennant engine house appears to be upgraded with multiple rail lines and an engine house.
1900 (1:10,560)	**The Project area remains undeveloped marshland.** Prince of Wales Dock has been built just north of Port. Tennant Copper works 500m from the Project area with extensive developments around the docklands including canals, railway networks and loading docks. The Tawe estuary has been canalised over the intertidal flats by construction of a West Pier and East Pier. A tidal basin and locks provide an entrance from the river channel to Prince of Wales Dock.
1918-1919 (1:2,500) 1921 (1:10,560)	**The Project area has been developed into King's Dock and Queen's Docks with associated railway system and coaling quays.** A set of locks provides access from the River Tawe Estuary channel. The Graigola Merthyr Patent Fuel works are recorded on the isthmus of land between King's Dock and Queen's Dock, along with extensive rail sidings and coal loading wharves. The Phoenix Patent Fuel Works are located at the eastern end of Queen's Dock (in the area currently occupied by the ship repair operation). A fish meal factory is located at the south western end of the Port Eastern Breakwater. The Port Eastern Breakwater is occupied by an extensive rail network and a timber yard. A small area of (possibly) open water or un-reclaimed lower elevation land / excavation remains between the Phoenix Patent Fuel Works, a fish meal factory and port access locks. This includes the area currently occupied by the two dry docks adjacent to the port access. Extensive development is also recorded off-site to the north of King's Dock. The Tennant Copper Works has been replaced by an electricity generating station and extensive railway sidings have been developed along the north sides of King's Dock and Prince of Wales Dock and along the River Tawe Estuary Channel (proposed area for the western landfall facility). A new channel provides boat / ship access between Prince of Wales Dock and King's Dock (crossed by a swing bridge that still provides the access to the port offices / ferry port), although the existing tidal basin and locks in to Prince of Wales Dock from the Tawe are also still recorded. A small dry dock, accessed from the tidal basin, is recorded between the original Prince of Wales Dock access locks and King's Dock. Tin plate sheds and a hydraulic power station are also recorded between the tidal basin and King's Dock.
1938 (1:10,560)	**A dry dock is now recorded between the port access locks and Queen's Dock.** Offsite, the original entrance locks from the tidal basin to Prince of Wales Dock have been in-filled.
1948 -1949 (1:2,500)	**Onsite Phoenix Patent Fuel works are no longer shown on the map, just to the east Graigola Merthyr Patent Fuel works are still indicated, with a large goods shed built to the west**. Oil storage tanks are mapped along the Eastern Breakwater. A large goods shed has also been built in Kings Dock with Lamberts Cottages marked to the east and an electricity generating station, medical centre, chapel and large canteen to the north.
1949 (Aerial Photograph	**The photograph is not annotated, but provides evidence of a number of on-site changes compared to the 1938 mapping.** Five jetties extend into Queen's Dock, from the Eastern Breakwater and a single jetty extends in to

Map Date (scale)	Land Use Summary
1:10, 560)	Queen's Dock from the western end of the dock (area of former Phoenix patent fuel works). A series of railway lines are also visible, sweeping around the western edge of Queen's Dock, from the Eastern Breakwater. A building is visible on the site of the fish meal factory. The footprint of this building appears to be similar to the derelict / disused shed observed during the walkover survey. Adjacent to this building is a tetrahedral area with two above ground storage tanks visible (which correlates with the currently empty concrete bunded area)
1951 (1:10,000)	**No significant change onsite.** Features visible on the 1949 aerial photograph are mapped and annotated. Aluminium and Wire factory annotated on the north eastern edge of Kings Dock within 500m of the site.
1964 (1:10,000)	**The jetties on the southern side of Queen's Dock have been remodelled / replaced with the oil terminal jetties that are currently on site** (corresponding with the reported early 1960s development of the Queen's Dock oil terminal / Transit Site tank farm facilities). A series of small oil storage tanks are also associated with the new jetties. The area formerly labelled as a fish meal works is now labelled "works", with the shed believed to be the current derelict shed served by a single railway line. Two circular structures are located to the east of this shed, one of which appears to contain an above ground storage tank. A second dry dock is shown in outline adjacent to the port access locks.
1960 – 1966 (1:2,500)	**Onsite addition of two large warehouses in Queens Dock and Graigola Merthyr Patent Fuel works now marked as disused works**. To the north of the site Lamberts Cottages are no longer shown on the map with a wireless training centre shown in place.
1966 – 1974 (1:2500)	**Onsite no significant change.** The disused Graigola Merthyr Patent Fuel works buildings are no longer shown on map.
1976 (1:10,000 Russian Military Map)	Onsite a briquette fuel factory, a fish powder factory, an oil storage depot, locks and dry docks. A thermo electric power station is shown on the outer eastern edge of Kings Docks along with warehouses, coal chutes and moorage within 250m of the Project area.
1979 (1:10,560)	**No significant change.** Off-site, the former dry dock between King's Dock and the tidal basin is not shown.
1988 - 1981 (1:2500)	Goods shed, remaining area not shown
1989 (1:10,000)	Warehouse on the dockland separating King and Queens Dock is no longer shown.
1992 (1:2500)	No significant change, area not shown.
1994 -1996 (1:2500)	No significant change.
2012 (1:10,000)	**Onsite works are no longer present. Oil tanks adjacent to the Eastern Breakwater oil jetties are no longer present.** The two pairs of tanks in the bunded areas east and west of the fish meal works area / building have been removed. Offsite, part of the former tidal basin appears to have been infilled, although the northern part of the basin and the former dry dock are mapped as open water. The Ordnance Survey mapping is contradicted by online aerial photography, which indicates that the southern part of the tidal basin remains as open mud flat, whereas the northern section and former dry dock appear to be progressively infilled as part of a general area redevelopment. A factory on the eastern edge of South Dock has been redeveloped to residential properties and a Marina. Residential Properties to the north of Kings Dock at approximately 1km.

18.4.2.3 The key land use history observations relating to the Onshore Works in Area A include:

i. Western Landfall Facilities:- The western Lagoon seawall will make landfall onto the existing Swansea Docks Seawall. The building constructed at landfall and the surrounding area will house O&M, boating and visitor facilities, a laboratory/hatchery, and parking. This area has been reclaimed from the intertidal area to form the enclosing structure for Queen's Dock and therefore is formed of made ground. Historical development includes a fish meal plant, dock railway infrastructure and two small tank farms (two tanks each). The historical contents of

the tanks are not known, but mapping / visual inspection indicates that both areas were bunded in case of tank failure. An existing building which corresponds with the footprint of the former fish meal plant is in a disused condition and includes asbestos cement cladding (identified by visual inspection and debris fragment sampling – walkover survey, 7 February 2013).

ii. Access Infrastructure:- Access to the Project will be via the traffic light controlled junction opposite the park and ride on A483 Fabian Way, which leads to an existing roundabout on Langdon Road. A new road will then head east before turning south to run parallel to the existing Port road, which heads towards the DCWW waste water treatment works. At this point, the road will then double back parallel to the existing Port seafront road towards the western landfall. At this turning point minor works will be undertaken to relocated the ABP security gate and provide a bus turning area and some parking.

iii. Grid Connection Works:- The proposed Grid Connection will pass along the existing Port access road adjacent to the southern edge of Queens Dock, including the former oil jetties and oil handling tanks / pipelines to the Queen's Dock Oil Terminal. This area is formed of made ground and has historically been occupied by rail lines and a timber yard.

18.4.2.4 Within Area B, the most important historical land use has been the import, export and storage of liquid oil and chemical products. Table 18.4 provides a summary of the main land use history within, and outside of, the Project area in the area of the Queen's Dock Oil Terminal.

Table 18.4 Map summary of historic land uses - Central Onshore Works Area (Area B)

Map Date (scale)	Land Use Summary
1879 (1:2,500)	**No onsite development. The Project areas are below the high water mark.** Swansea Works (Wagon), Crown Works (Paint) and a gasworks are present within a 500m to the north of the Project area. Port Tennant Canal and an unnamed railway also run in a west-east direction north of the Project area within a 1km radius.
1884 (1:10,560)	**No on-site development** Llansamlet Higher is the main development marked on the western side of the map with the previously unnamed railway now marked as Great Western Railway (GWR). Two unnamed canals also join Port Tennant canal from a north south direction. Burrows Works (Chemical) is north of the proposed Project area within 500m of the site.
1899 (1:2,500)	**No on-site development** Swansea and Crown Works have expanded and another works marked as English Crown Spelter works have developed to the north of the Project area within a 500m radius.
1900 (1:10,000)	**No on-site development** Rhondda & Swansea Bay Railway has been developed and runs in a west east direction parallel with the existing GWR to the north of the Project area. Burrows Chemical works have been expanded and are now marked as Crymlyn Chemical Works. Carriage & Wagon repairing shops are now marked to the north of the proposed Project area. Also, to the north beyond those works are two quarries, an old coal drift and an old coal level marked within a 1km radius of the Project area.
1919 (1:2500)	A major expansion and development of railways throughout the Project area.
1921 (1:10,000)	Most of the Project area remains undeveloped and below the high tide mark. The Eastern Breakwater for Swansea Docks is recorded, although the land enclosed within the breakwater walls is not shown as reclaimed. Some minor infilling of the enclosed area appears to be recorded at the eastern extremity of the area enclosed by the breakwater wall. To the north (north of the current Fabian Way alignment) Kings Dock Works (Tin Plate) are shown with an extension of rail networks around the works and Pritchard Cottages built to the north. Baldwin's Crescent (residential, still present) has also been developed.
1938 -1951	**No changes recorded on site.**

Map Date (scale)	Land Use Summary
(1:10,000)	Kings Dock Works (Tin Plate) developed further with Elba Tin works and sports grounds now shown to the east. A rifle range is mapped to the south of Elba Tin Works and just north of the proposed Project area.
1949 (Aerial Photograph 1:2,500)	The photograph is not annotated, but provides evidence of a number of on-site changes compared to the 1938 mapping. The aerial photographs display some contradictory evidence for the Project area. Two photos are dated 1949, for the same area. One shows no on-site changes, whilst the other shows that 15 large above ground storage tanks have been constructed on the Transit Site tank farm area. The eastern end of Queen's Dock remains largely undeveloped, with only minor infilling / reclamation of the open water area and a row of 8-9 small tanks. The presence of the tank farm without the Queen's Dock Oil Terminal suggests that the southern side of Queen's Dock was used for oil import / export before the development of the most recent Queen's Dock terminal. A large factory is shown to the north west of proposed Project area.
1948 (1:2,500)	United Kingdom Chemical Works marked (as shown in previous aerial photo) with associated tanks, water cooling tower and tar distillery within 500m north west of proposed Project area. Hydraulic Power station and refuse heap also shown further south nearer the Project area. Unmarked buildings previously known as English Crown Spelter Works have been modified and expanded.
1951 (1:10,000)	The 1951 maps appear to have received only limited updates since the 1938 edition. The oil storage tanks shown on the 1947 aerial photograph are not recorded on the published map.
1964 (1:10,000)	The infrastructure associated with the Queen's Dock Oil Terminal is now recorded on the map. Ten of the oil storage tanks within the Transit Site area are mapped, but the eastern part of Transit Site is still recorded as inter tidal beach, although the alignment of the sea defences is shown and one tank is recorded on the beach. Map updates appear to lag significantly behind the developments shown on the aerial photography.
1969 - 1971 (1:2,500)	Ford Works manufacturing car components are found directly north of proposed Project area within 500m.
1976 (1:10,000) Russian Military Map.	The Russian Military Mapping shows the full extent of the Queen's Dock oil terminal and Transit Site Tank Farm. A large warehouse to the north of the proposed Project area is believed to be an automotive factory. Previously King Docks Works previously marked as Kings Dock (Tin Plate) has been modified to a car engine factory. A warehouse to the north west which was previously unmarked "works" is now labelled "thermo electric power station". A conduit (culvert) is also shown along shore line.
1980 - 1989 (1:10,000)	The former GWR railway is now marked as "dismantled". The power station buildings to the north west of the site are no longer shown on the map.
2012 (1:10,000)	The infrastructure associated with the Queen's Dock Oil Terminal and Transit Site tank farm has been removed. A sewage works has been developed on land formerly occupied by railway sidings, north of the site redline boundary. Large area of unlabelled works believed to be car engine / automotive parts factories are still present.

18.4.2.5 The former Queen's Dock Oil Terminal and Transit Site tank farm were used from the 1960s (based on Ordnance Survey mapping – aerial photography suggests that the earliest use could have been earlier) until 2001. The sites were used for bulk storage and transfer of liquid refined petroleum products between ships berthed at the Queen's Dock terminal and the former Llandarcy oil refinery (approximately 1500m northwest), and the former Baglan Bay chemical works (approximately 1500m east). The hydrocarbon and chemical products were conveyed between these sites via a number of underground and over ground pipelines.

18.4.2.6 Historical oil pipelines (the number and construction details are not known) ran parallel to the northern fence line of the former Transit Site tank farm and connected to the Queen's Dock Oil Terminal and to the Llandarcy Refinery. The pipes within the former Transit Site tank farm are understood to have been isolated at the north eastern corner of the tank farm and are believed to have been excavated and removed. The pipelines

between the former Transit Site tank farm and the River Neath / Baglan Bay are believed to remain in-situ.

18.4.2.7 The key land use history observations relating to areas of the Onshore Works in Area B include:

I. Grid Connection Works: The proposed Grid Connection will pass along the Port access road adjacent to the southern edge of the former Queen's Dock Oil terminal. This area is formed of made ground and has historically carried rail lines and oil tanks / pipelines. The Grid Connection then continues eastwards along the northern edge of former Transit Site tank farm, where former underground pipelines were present as part of the oil industry installation.

II. Eastern Landfall: The eastern Lagoon seawall will landfall close to the eastern boundary of the former Transit Site tank farm / SUBC. A temporary access route will be required for the construction phase to access this landfall point. The temporary access will pass over the southern edge of the previously developed area. Following completion of the eastern Onshore Works, the access road would then be modified to form the pedestrian/cycle link from the eastern landfall/SUBC to the western landfall.

18.4.2.8 Area C predominantly comprises undeveloped land of high conservation value. Table 18.5 provides a summary of the main land use history in and around the Crymlyn Burrows SSSI.

Table 18.5 Map Summary of historic land uses - Eastern Onshore Works Area (Area C)

Map Date (scale)	Land Use Summary
1884 (1:10,000)	**Undeveloped intertidal area / beach. Crymlyn Burrows sand dunes and marsh land with the River Neath and associated estuary are present across the proposed Project area.** Brown Ferry Road, the Jersey Marine Hotel and Crymlyn Colliery works are shown within a 500m radius to the north west of the Project area. A railway line is present to the north west, running from west to north east, past the location of the Jersey Marine Hotel. The Tennant Canal is mapped to the north of the railway. Briton Ferry works and some unnamed buildings are present to the north east within a 1km radius of the Project area. An old air shaft is shown approximately 500m to the north.
1890 (1:10,000)	**The Project area remains undeveloped within the exception of a small isolated tank adjacent to the River Neath Estuary channel.** The Rhondda & Swansea Bay railway has been developed to the west running in a northeast-southwest direction. The previously unnamed railway is still present, parallel and to the north of the new line. The older line is labelled "GWR Swansea & Neath Low Level". 1km to the north east the previously unnamed buildings at Briton Ferry are labelled as tin plate, iron and coke works along the banks of the River Neath. Dockland development can also be observed in this area. An old coal drift is marked approximately 500m to the north of the site.
1921 (1:10,000)	**No changes on the Project area.** A golf links is mapped to the north within 250m and Garnet Colliery a quarry and sand pit just beyond this. A wide embanked corridor has been developed along the north edge alignment of the GWR railway line, although the previous line is still mapped. The new embankment is labelled as "course of construction". The developed area associated with River Neath docklands to the north west has become increasingly industrialised with the presence of oil storage tanks. The Cambrian Coke Works (Briton Ferry) are shown as disused.
1938 / 51 (1:10,000)	**No changes on the Project area.**

Map Date (scale)	Land Use Summary
1949 (Aerial Photograph)	The photograph is not annotated, but provides evidence of a number of on-site changes compared to the 1938 mapping. An unmarked road appears to be under construction within 250m to the north running parallel to site in a west to east direction (this is on the alignment of the current A483 Fabian Way dual carriageway). A railway line and marshalling yard are visible on the embankment feature shown on previous maps as "course of construction". Some form of development is visible on the land between Jersey Marine Hotel and the former Garnet Colliery. Railway sidings are visible on previously undeveloped land on the eastern side of the Neath Estuary.
1951 (1:10, 560)	**No changes within the redline boundary.** The road alignment visible in the 1949 aerial photograph is shown as a wide embankment to the north of the Project area. The railway line and marshalling yard visible to the north west on the aerial photograph and the sidings to the east of the River Neath are recorded on the map. The area of development between Jersey Marine Hotel and the former Garnet Colliery, visible on the 1949 aerial photograph, is mapped, along with a second similar development approximately 200m to the south west. These developments are unlabelled, but have the appearance of small military camps.
1964 (1:10, 560)	**No significant changes**. The road alignment visible as a construction feature on previous maps is shown in a complete form, but is not labelled.
1976 (1:10,000) Russian Military Map.	On site (within Crymlyn Burrows) and unlabelled black line corresponds with the route of the Queen's Dock / Transit Site – Baglan pipelines. The previously unnamed road to the north is now labelled "483" (A483). Chemical Works are present within 250 north west of proposed Project area. South eastern section of area unmapped.
1984 (1:10,000)	**On site (within Crymlyn Burrows) the route of the Queen's Dock / Transit Site – Baglan pipelines is mapped. An "outfall" is labelled approximately 70-80m south of the pipeline route.** Development is mapped to the north of the A483, including an industrial building labelled "Works". The south eastern area of map east of the Neath Estuary has become highly industrialised with power station works, tanks and cooling towers (Baglan Bay chemical works).
2012 (1:10,000)	**Onsite changes are limited to the labelling of a "Ppg Sta" where the pipeline route intercepts the Neath Estuary channel.** Offsite, the "works" adjacent to the A483 have been replaced with a larger building (Amazon Distribution Centre). The Baglan Bay Power Station is mapped to the east of the River Neath, and within the former Baglan Bay chemical works area only the road layout and an electrical substation are mapped.

18.4.2.9 The key land use history observations relating to areas of the Onshore Works in the Eastern Onshore area include:

i. Grid Connection Works: Development, operation and decommissioning of the pipeline routes. The proposed cable and gird connection options will follow the established pipeline route and will either seek to utilise one of the established pipeline crossings of the Neath Estuary or pass beneath the estuary by directional drilling.

18.4.3 Walkover survey

18.4.3.1 A walkover survey was undertaken on 7 February 2013 to assess the current condition of the study area and to inspect that adjacent receptors and routes for potential contaminant migration. As the redline boundary encloses a large area of land, the walkover survey was focused on the inspection of accessible areas of Queen's Dock and the adjacent foreshore. The photographs below were taken during this walkover survey.

18.4.3.2 The inspection of the Queen's Dock / Area A was undertaken on foot. No access was available to the former Queen's Dock Oil Terminal. However, a broad assessment of the condition of the Oil Terminal was able to be made through the perimeter fencing. The inspection indicated that while the onsite structures associated with the Oil Terminal have been removed, the in-ground features including pipe tracks, sumps and drains were still present. Contractors equipment was observed within the fenced perimeter, along with infrastructure typically associated with the remediation of land contamination (NRW and the lease holder, St Modwen Properties, confirmed that remediation works are ongoing at the Oil Terminal). Four groundwater remediation wells were observed outside the Oil Terminal perimeter. These were in the southern (seaward) verge of the Port seawall access road, suggesting that investigations by other parties have found that contamination arising from the Queen's Dock terminal is mobile in the groundwater system between the terminal and the adjacent Swansea Bay intertidal zone. Photograph 18.3 (7 February 2013) shows a redundant pipe track within the former Oil Terminal area and a groundwater remediation well on the Port access road.

Photograph 18.3 View westwards across the former Oil Terminal site, and a detail view of a groundwater remediation well located between the Port access road and the Port seawall. The Grid Connection route will pass through this plot. The general view shows a former pipe track (foreground) and contractors' compound (left distance) (7 February 2013).

18.4.3.3 The disused oil jetties were inspected, but like the Oil Terminal, these were fenced off from the Port sea front access road. The jetties will not be within the Project Area. The fencing provides a visible and secure separation between the accessible road / and adjacent area and the inner edge of the seawall that was associated with the previous oil industry infrastructure.

18.4.3.4 Stockpiles of material resembling demolition waste were noted in several areas, including the verges adjacent to the Oil Terminal.

18.4.3.5 On the western point of Queen's Dock, a derelict building and fly tipped / discarded waste materials were observed. This area is within the Project area. The building appeared to be sheeted with asbestos cement cladding and appeared to be in a poor condition, with detached cladding sheets and fragments of damaged cladding visible on the ground surface. One sample of cladding debris was collected for laboratory analysis.

Analysis confirmed that the material contained asbestos fibres. The building and cladding debris are shown in Photograph 18.4 and 18.5.

Photograph 18.4 Derelict building at the western end of Area A. Note the condition of cladding and fly tipped tyres. Fragments of cladding and other burnt and discarded wastes are visible on the ground surface (7 February 2013).

Photograph 18.5 Fragment of cladding debris collected for analysis (7 February 2013).

18.4.3.6 A mound of disused tyres was also noted to have been fly tipped / disposed of beside the derelict building. Other waste materials included fragments of burnt material and melted metal residues (possibly lead). In this area, large circular tank bases were also noted within an empty concrete bund. This feature corresponds with the tetragonal bunded area shown on historical maps.

18.4.3.7 Suspected waste materials were also observed between the derelict building / access road and Queen's Dock. Irregular grassed over mounds suggest that the material has been in-situ for a period of time.

18.4.3.8 A foreshore inspection was conducted at low tide. This allowed any intertidal groundwater seepages / discharge onto the foreshore to be identified. The observations made were considered very useful for assessing the general groundwater discharge regime, which is relevant in the later assessment of how the operation of the Project might impact on the hydrogeological regime.

18.4.3.9 No seepages were observed on the areas of the foreshore adjacent to the open water body of Queen's Dock. This observation suggests that the dock is well sealed as the presence of a fixed higher head of water adjacent to this section of foreshore is not resulting in leakage of water from the dock to the beach. Observation confirmed that the fixed head of water in the dock is also preventing shallow groundwater discharge to the higher parts of the intertidal zone adjacent to the dock. Consequently, groundwater flow from the north is interpreted as finding alternative shallow flow pathways around the docks area, or its movement is restricted to deeper parts of the aquifer, with discharge further down the intertidal zone or below the low tide mark.

18.4.3.10 The onshore boundary between the open water body of Queen's Dock and the made ground of the former Oil Terminal corresponds with the location of a culvert outfall on the seaward side of the Port Seawall (the outfall is 30m east of the eastern edge of Queen's Dock). No intertidal springs were observed to the west of the culvert. Numerous intertidal spring seepages were observed to the east of the culvert (visible on online aerial photography).

18.4.3.11 The springs adjacent to the Oil Terminal and Transit Site tank farm were observed to be discoloured (dark / black coloured). Some were noted to be malodorous and exhibited a surface sheen. Two distinct types of sheen were noted. The most common sheen was a platy sheen that broke up when disturbed. This type of sheen is typically associated with microbiological activity, such as natural breakdown and organic decay processes. The second type of sheen was a more mobile sheen that did not break up when disturbed. This type of sheen is typically associated with hydrocarbon contamination. During the walkover survey this oily type sheen was only observed adjacent to the western part of the Transit Site tank farm.

18.4.3.12 The presence of these seepages adjacent to the Oil Terminal and Transit Site tank farm areas is interpreted as evidence of shallow groundwater discharge across this section of the foreshore. The discoloured appearance suggests that the shallow groundwater is contaminated. The dark discolouration, malodorous nature and platy sheen are interpreted as evidence of potentially reducing / anoxic groundwater conditions, possibly related to the natural biotic breakdown of hydrocarbon contamination and / or associated with artificially enhanced bioremediation of hydrocarbon contaminated soil and groundwater. Photographs 18.6 and 18.7 show the visual evidence of discoloured seepages observed during the walkover survey.

Photograph 18.6 Discoloured seepage to the foreshore, adjacent to the "gap" in the Port Seawall (7 February 2013).

Photograph 18.7 Discoloured seepage, showing visible surface sheen (7 February 2013).

18.4.4 Site sensitivity

18.4.4.1 Area A and Area B do not lie within any designated ecological receptors, as defined under Part 2A of the EPA 1990.

18.4.4.2 Area C corresponds with the onshore (dunes, scrub woodland, saltmarsh) and intertidal areas of the Crymlyn Burrows SSSI. The only construction activity proposed within the SSSI area is the cable and grid connection works between the Project and the Baglan Bay substation. To minimise disruption, existing tracks or pipeline routes through the SSSI will be used wherever possible.

18.4.4.3 Crymlyn Bog Nature Reserve is located to the north of the A483 Fabian Way. Crymlyn Bog is a Special Area of Conservation (SAC), Ramsar designated wetlands site, Natura 2000 site and a Site of Special Scientific Interest (SSSI). No construction activities will be undertaken within 500m of Crymlyn Bog.

18.4.5 Geological conditions

18.4.5.1 The geological conditions for the Onshore Works areas have been reviewed using data provided within Landmark Information Group Envirocheck Report_ 43785108_1_1, British Geological Survey 1:50,000 Sheet 247 and geological investigation data included within the URS Bay SAIC Environmental Statement.

18.4.6 Made ground

18.4.6.1 Areas A and B have been reclaimed from the intertidal flats of Swansea Bay. The shallowest deposits for these areas will therefore comprise of the made ground fill materials used to raise ground levels above the tidal high water mark. These materials might be expected to include a mix of re-deposited natural materials (e.g. dredged sands and gravels) as well as anthropogenic fill materials associated with historic land use and local industry. The historic topographic maps indicate that the Queen's Dock area was reclaimed from the intertidal flats by construction of the Port Seawall, followed by subsequent infilling of the developed areas behind the rock armour seawall.

18.4.6.2 The Onshore Works comprising the western landfall facilities, access works and elements of the Grid Connection works will require construction activities on areas of made ground. The continuation of the Grid Connection route will pass through areas of made ground along the alignment parallel to the A483 Fabian Way, and again on the eastern side of the River Neath Estuary where it runs to the Baglan Bay substation.

18.4.6.3 The British Geological Survey (BGS) records for made ground deposits are shown on Figure 18.5 (included within Volume 2).

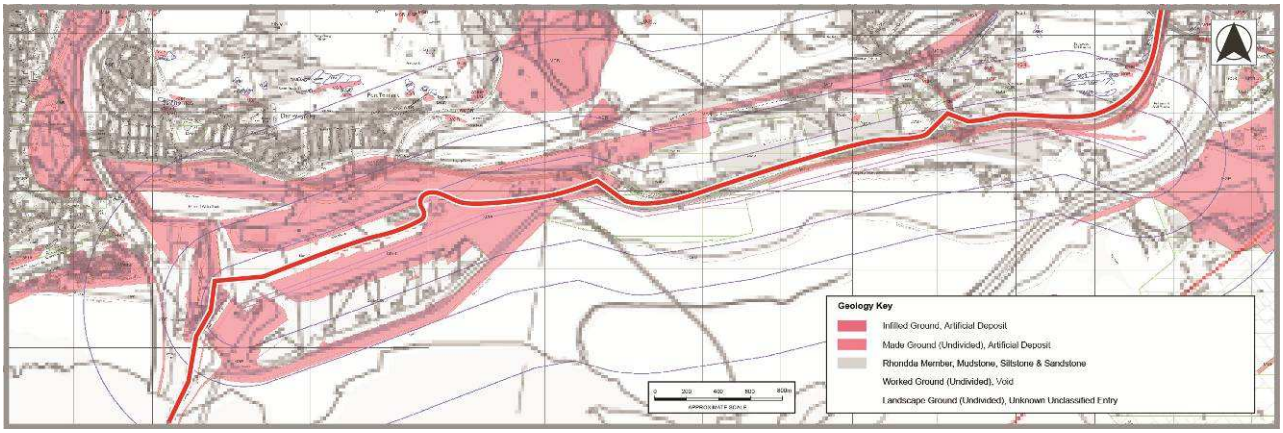

Figure 18.5 Composite figure showing extracts of the BGS Artificial Ground and Landslip mapping, including the northern redline study area limit for the Project[1].

18.4.6.4 The BGS defines in-filled ground as ground which has been excavated and then in-filled with artificial ground (as shown in pink on Figure 18.5). The parts of Area B which were previously occupied by the Transit Site tank farm are mapped as "Landscape Ground (Undivided)". Landscaped ground is defined as areas where the original surface has been extensively remodelled but it is impractical or impossible to separately delineate areas of worked (excavated) ground and made ground. As the historical maps show the construction of the seawall and the development of the Transit Site tank farm on the higher ground level behind the seawall, it is reasonable to interpret the reclaimed area as comprising made ground.

18.4.7 Superficial deposits

18.4.7.1 The made ground associated with the reclaimed land in the docks and former oil industry facilities is underlain by natural superficial deposits. The superficial deposits are predominantly beach deposits in the west and blown sand in the east. To the north west of the Project area (in the vicinity of Prince of Wales Dock and Port Tennant) there are areas of alluvium, with Devensian till deposits further inland. A further area of alluvium is mapped on either side of the River Neath Estuary. Crymlyn Bog, to the north of the Project area, is characterised by peat superficial deposits.

18.4.7.2 The British Geological Survey records for superficial deposits are shown on Figure 18.6 (included within Volume 2).

[1] Sourced from Landmark Information Group Envirocheck Report_ 43785108_1_1

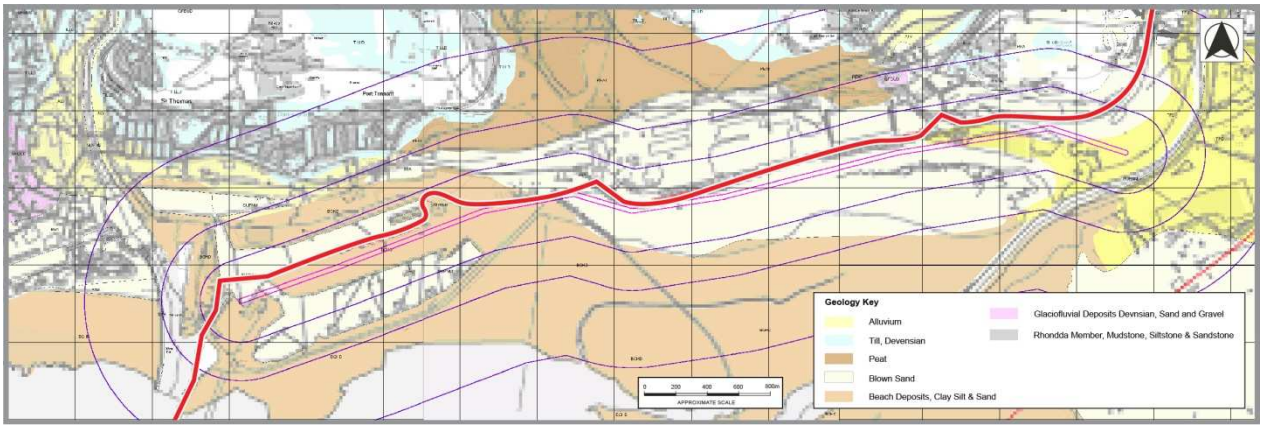

Figure 18.6 Composite figure showing extracts of the BGS Superficial Deposits mapping, including the northern redline study area limit for the Project[2]

18.4.7.3 The Onshore Works relating to the western Lagoon seawall landfall and building, Access Works and Grid Connection works route along the sea front road are underlain by Beach Deposits (beneath the near-surface made ground). The Beach Deposits are a mix of clay, silt and sand.

18.4.7.4 The eastern Lagoon seawall landfall will also be constructed over Beach Deposits, but the furthest onshore elements, including any visitor facility close to the SSSI, are likely to be developed on Blown Sand deposits. The Grid Connection Works are expected to traverse areas of Blown Sand and Alluvium.

18.4.8 Bedrock Geology

18.4.8.1 The Project area is underlain by mudstones, siltstones and sandstones of the Carboniferous South Wales Middle Coal Measures Formation. To the north of the Project area, a thin band of South Wales Upper Coal Measures is recorded on the British Geological Survey mapping, before giving way to harder sandstones of the Llynfi Member Sandstone, that form the higher ground of Kilvey Hill. Small intermittent bands of Rhonda Member Sandstone exist within the Llynfi Member Sandstone.

18.4.8.2 The Project area is traversed by a series of faults that are aligned approximately north – south, and one fault that is aligned north east – south west. The recorded bedrock faults are shown on the BGS bedrock geology map, Figure 18.7 (included within Volume 2).

[2] Sourced from Landmark Information Group Envirocheck Report_ 43785108_1_1

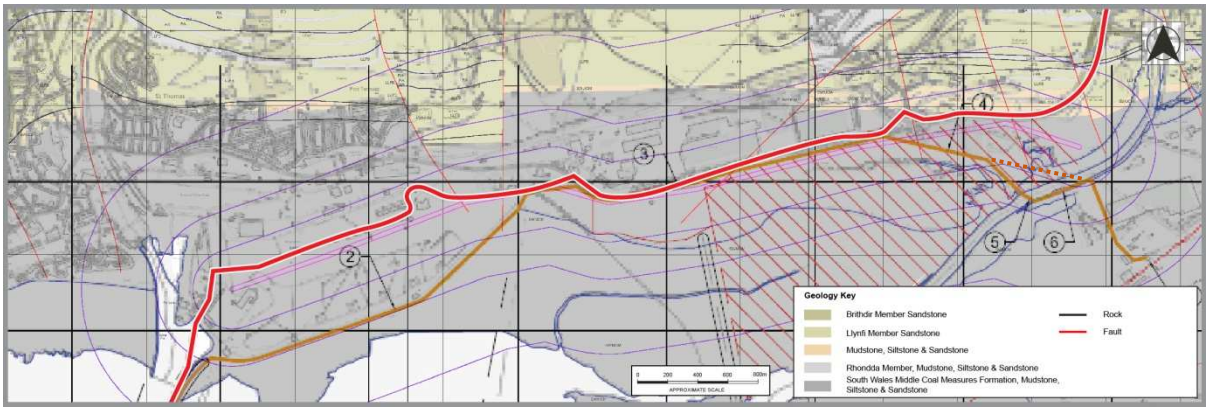

Figure 18.7 Composite figure showing extracts of the BGS Bedrock Geology mapping, including the northern redline boundary for the Project[3].

18.4.8.3 Site specific information is available for the former Transit Site tank farm area, based on previous site investigation works undertaken for the former operator and to support the EIA for the SUBC development. Based on review of the data included within the URS 2010 SAIC ES, including published geological maps (BGS Map 247) for the former Transit Site and data compiled from the detailed site investigation undertaken within the Transit Site tank farm area, the stratigraphic succession directly beneath this area is anticipated to comprise the following strata (listed from ground level downwards):

i. Made Ground – comprising slightly to very gravely sand with occasional concrete rubble, cobbles, rootlets and black staining in sand;

ii. Shallow Sand Unit – comprising slightly gravely, slightly to very silty sand with occasional rootlets, coal fragments and shell fragments, orange/black staining in sand;

iii. Silt/Clay Unit – comprising soft – firm, slightly sandy silt/clay with rare fine gravel and shell fragments. Not uniform, mainly encountered in the northern and central parts of the Project area;

iv. Lower Sand Unit – comprising loose, fine – medium sand with rare gravel;

v. Glacial Deposits – not widely encountered during site investigation. Potential presence of boulder clay inferred below 12.5m in the south eastern part of the former Transit Site tank farm area; and

vi. Sandstone Bedrock – regionally, the Carboniferous Sandstone bedrock underlies the glacial deposits. This unit has not been encountered during site investigations.

18.4.8.4 Neither the Boulder Clay nor Sandstone formations were encountered during the intrusive investigations completed within the former Transit Site tank farm area.

18.4.8.5 Table 18.6 summarises the anticipated geology beneath the former Transit Site tank farm area. The stratigraphic sequence is likely to be similar for other land within the Project's Onshore Works areas, although the thickness of individual units will vary, especially for the thickness of the made ground. Made ground would be expected to be thicker within the docks area, where ground levels have been substantially increased with the formation of the Port Seawall and reclamation of the docks area inside the breakwater seawall.

[3] Sourced from Landmark Information Group Envirocheck Report_ 43785108_1_1.

Table 18.6 Identified and published geological stratigraphy

Strata	Proven Data from Site Investigation	
	Thickness (m)	Approximate depth to top of strata (m bgl)
Made Ground	0.25	0.0
Shallow Sand Unit	0.25 – 10	1.5
Silt/Clay Unit	0 –1.0	10
Lower Sand Unit	>5m	10.5
Glacial Deposits	N/E	-
Carboniferous Sandstone Bedrock	N/E	-
Notes: m = metres, bgl = below ground level, # = estimated values, N/E = not encountered during ground investigation, *= Maximum depth of Phase II Site Investigation.		

18.4.9 Geotechnical considerations

18.4.9.1 Table 18.7 summarises the levels of potential geotechnical hazards identified at the Project, based on available site geological data and Landmark Information Group Envirocheck Report_ 43785108_1_1.

Table 18.7 Potential geotechnical hazards

Hazard Type	Reported Hazard Potential
Shallow Mining	None
Collapsible Ground	Varies: None to Moderate (depending on strata type)
Compressible Ground Stability	Moderate - High (Loose windblown sand and made ground)
Ground Dissolution Stability	None
Landslide Ground Stability	None - Very Low
Running Sand Ground Stability	Low – Moderate (Possibly High for loose windblown sand)
Shrinking or Swelling Clay Ground Stability	None – Very Low
Radon Affected Areas	None, <1% of homes above the action level
Radon Protection Measures	None required

18.4.10 Hydrogeology and hydrology

18.4.10.1 The baseline assessment of the hydrogeological and hydrological conditions is based on review of the information contained within Landmark Information Group Envirocheck Report_ 43785108_1_1, URS walkover survey of 7 February 2013 and selected URS site investigation data from the former Transit Site tank farm area contained within the 2010 URS EIA for the SUBC development. URS additionally completed a separate walkover survey on 20 September 2013, in support of an assessment of the groundwater discharge

to the intertidal zone. The findings of this assessment are reported in Appendix 18.1, Volume 3[4].

Groundwater sensitivity

18.4.10.2 Man-made deposits within and around the Swansea Docks area are designated as an unknown aquifer type due to the material being artificial land.

18.4.10.3 Superficial deposits underlying and surrounding the docks are classified as Secondary A, Secondary Undifferentiated and Unproductive Strata. Further to the east, the superficial Beach Deposits in the vicinity of the former Transit Site tank farm and the Blown Sands of Crymlyn Burrows are classed as a Secondary A aquifer. The beach deposits of the intertidal zone and the alluvium flanking the River Neath estuary (including areas of Crymlyn Burrows) are classified as a Secondary Undifferentiated aquifer. The peat deposits underlying Crymlyn Bog, to the north of the Project area, are classified as Unproductive Strata.

18.4.10.4 The Carboniferous bedrock strata in the Swansea Bay area are designated as a Secondary A Aquifer.

18.4.10.5 New aquifer designations replaced the old system of classifying aquifers as Major, Minor and Non-Aquifer in April 2010. This system is in line with the Groundwater Protection Policy (GP3) and the WFD and is based on BGS mapping.

18.4.10.6 The Environment Agency[5] defines Secondary A Aquifers as:

"*permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers*."

18.4.10.7 Due to their permeability, Secondary A aquifers are considered to be moderately vulnerable to pollutants. Aquifers are classified as Secondary Undifferentiated when it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type. Unproductive Strata are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

18.4.10.8 Under Groundwater Vulnerability classification the entire site is classed as a Minor Aquifer with soils classes of High leaching potential (H) , 1, 2, 3, U. This means infiltration times of contaminants to groundwater have the potential to be short.

18.4.10.9 No source protection zones are identified within 1000m of the Project area. Source Protection Zones (SPZ) have been defined by the Environment Agency, for groundwater sources, to protect public water drinking supplies from pollution. Potentially contaminating activities are subject to higher levels of regulatory control / oversight within the defined SPZ areas.

[4] *URS Report Ref.: 47065127/Supplement to PEIR/ES Chapter 18 "Groundwater-Intertidal Zone Discharge: Conceptual Model", October 2013*

[5] http://www.environment-agency.gov.uk/homeandleisure/117020.aspx

Groundwater quality

18.4.10.10 Previous investigations undertaken by URS in 2005-2006 (URS, 2006), within the former Transit Site tank farm area, established elevated levels of total petroleum hydrocarbons and volatile organic compounds within the groundwater. The findings reported within the URS 2010 SAIC Environmental Statement include:

i. visual and olfactory observations suggestive of soil contamination were made during intrusive investigations in a number of boreholes and trial pits. In general, evidence suggestive of significant contamination was generally observed only within the shallow sand to a depth of approximately 5-6m;

ii. soil headspace readings using a photoionisation detector (PID) detected concentrations from <1 part per million (ppm) to 9,960 ppm. These observations are potentially indicative of the presence of light petroleum hydrocarbons. The most elevated readings were observed in the southwest and northern central areas of the SAIC site. The PID headspace concentrations were observed to decrease with depth;

iii. Total Petroleum Hydrocarbons (TPH) were detected at concentrations above the Minimum Detection Level (MDL) of 5 milligrams per kilogram (mg/kg) in 57 of the 91 soil samples analysed from within the NPTCBC authoritative boundary or 50m thereof. The reported concentrations indicate that, in general, the majority of the TPH is present as carbon chain lengths in the C12 to C40 range. The highest observed concentrations tend to be located in the southwest, northeast and north central areas of the SAIC site. A similar distribution is observed in groundwater. Figures 18.8 and 18.9 show TPH concentrations in soil and in groundwater, respectively;

iv. outside of the former Tank 856 area (a known location of historical release, towards the centre of the SAIC site, and adjacent to the southern fence line of the former operational Transit Site tank farm), benzene has only been detected in 3 of 91 soil samples analysed (see Figure 18.10). Benzene concentrations above the MDL were, however, reported in 46 of the 74 groundwater samples analysed, at concentrations ranging from 1.3 micrograms per litre (µg/l) to 58,900µg/l (see Figure 18.11). The observed elevated concentrations tended to be within the southwest of the SAIC site and around former Tank 856. A similar pattern is observed in soil for toluene, ethylbenzene and xylenes although they were not reported to be present at significant concentrations in the area of the former Tank 856;

v. metals results were not identified at significant concentrations in soil or groundwater. Lead, nickel, chromium and mercury, for example, were not detected above their respective laboratory method detection limits in any of the groundwater samples analysed from the series monitoring wells named 'TSMW'. Only trace concentrations of arsenic and cadmium were reported in samples analysed. Review of borehole and trial pit logs show no evidence of significant infilling of the SAIC site with ash/clinker or other potentially metalliferous materials. Furthermore, the use of the SAIC site for petroleum product storage does not suggest metals are likely to have been a significant ground contamination issue; and

vi. for polycyclic aromatic hydrocarbons (PAHs), given the limited anthropogenic material used as fill, these were considered unlikely to be a significant source of contamination to controlled waters. Some data was previously collected for this contaminant suite. Where PAHs have previously been detected, the total PAH concentration is dominated by naphthalene.

18.4.10.11 The distribution of TPH and benzene contaminant concentrations in groundwater are depicted on Figures 18.8 and 18.9. It should be noted that the areas of the highest reported concentrations are close to the western boundary of the SUBC development (outline shown in red). These concentrations reflect groundwater concentrations prior to commencement of remediation activities at the time of URS investigation and monitoring works (pre-2009). Soil and groundwater remediation activities have been undertaken since 2009 to enable development of the SUBC.

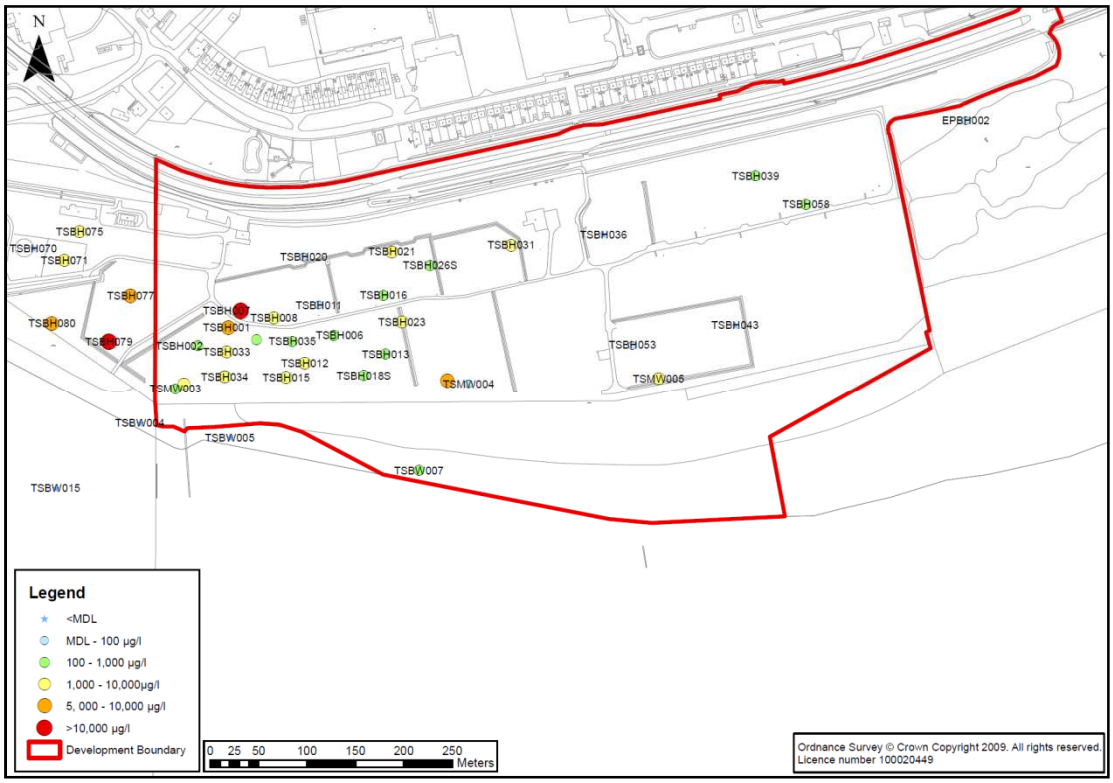

Figure 18.8 Distribution of Total Petroleum Hydrocarbons (TPH) in groundwater, based on URS investigation of the former Transit Site tank farm area.

18.4.10.12 The most significant areas of elevated groundwater TPH concentrations are located towards the western boundary of the SUBC. These areas are not located in the vicinity of any Onshore Works proposed as part of the Project. The eastern Lagoon seawall landfall and visitor facility will be located towards the eastern / south eastern edge of Figure 18.8.

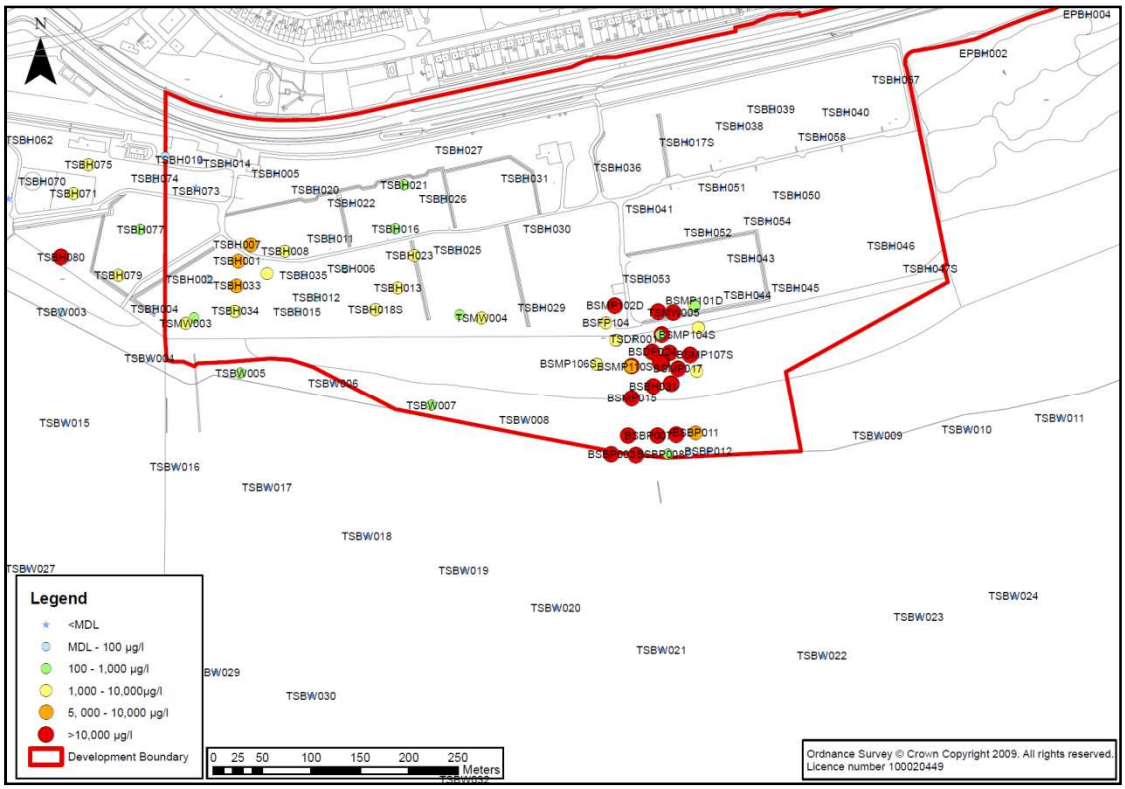

Figure 18.9 Distribution of benzene in groundwater, based on URS investigation of the former Transit Site tank farm area.

18.4.10.13 The most significant area of groundwater benzene contaminated groundwater is located to the west of the eastern landfall, which will be located towards the eastern / south eastern edge of Figure 18.9.

18.4.10.14 It should be noted that, according to the Shoreline Management Plan (Halcrow, 2012) decontamination of the former Transit Site tank farm site has already commenced as part of the SUBC development. Evidence of groundwater remediation infrastructure was also observed within and adjacent to the former Queen's Dock Oil terminal during the walkover survey conducted during February 2013.

18.4.10.15 The legacy of industrial activities in and around the Swansea Docks area means that it is also possible that groundwater quality has been adversely affected as a result of previous land use history. However, the fixed surface water head within the docks and apparently good isolation of the impounded surface water body suggests that any contaminants within the shallow made ground soils may not be mobile to the underlying groundwater regime.

18.4.10.16 The site is located adjacent to the intertidal zone. During falling tides / at low tide, groundwater discharge to the beach can be observed as a series of seepages along the foreshore. Visual observations made during the February 2013 walkover survey noted that these groundwater discharges appear to be discoloured and malodorous along the foreshore areas adjacent to the former Queen's Dock Oil terminal and former Transit Site tank farm areas. No groundwater discharge sampling and analysis has been undertaken in support of this Environmental Statement. An appropriate sampling and analysis programme will be established as part of the ground investigations that will be implemented prior to construction works commencing (see Section 18.5.2).

18.4.10.17 As the groundwater is likely to be in hydraulic continuity with the sea, it is assessed as likely that there has been some localised saline intrusion into the shallow aquifer parallel to the intertidal zone and that the groundwater is slightly saline. This is expected to be particularly relevant in relation to the aquifers supported by the superficial deposits – Beach Deposits and Blown Sand. For the shallow, permeable Beach Deposit and Blown Sand aquifers it would be expected that during the rising and high tide part of the tidal cycle, saline water will recharge into the shallow aquifer, and that during falling and low tide parts of the cycle the saline "bank storage" (i.e. the saline recharge to the aquifer that occurred over the peak of the tidal cycle) component of the aquifer will discharge, along with normal groundwater flux. This cycle can result in the storage of both groundwater and contaminants during high tide, followed by the discharge of groundwater, again along with contaminants as the tide recedes. This interpretation is consistent with the observations made during the February 2013 walkover survey.

18.4.10.18 The proximity to the sea and the possibility of current / future saline intrusion means that the groundwater is unlikely to be utilised as a resource for potable water supply abstraction. The pumping of abstraction boreholes drilled in to aquifers in close proximity to tidal waters, can exacerbate the development of saline intrusion into the aquifer.

18.4.10.19 To help assess the possible environmental impacts of the Project with respect to groundwater – intertidal zone discharge and saline intrusion, URS has completed a supplementary report, Appendix 18.1, Volume 3. The supplementary report concludes that there should be no change to the potential for saline intrusion in the area adjacent to the Queen's Dock. The high impounded water level and depth of the dock construction is assessed as acting as a barrier to groundwater discharge to the intertidal zone, and conversely, is also expected to act as a barrier to saline intrusion from tidal waters to the aquifer.

18.4.10.20 The future potential for saline intrusion along the remainder of the coastal margin enclosed by the Project, unlikely to change significantly under the proposed managed tidal cycle compared to the current natural tidal cycle. The managed high tide levels will be above the elevation of the observed fresh groundwater discharges. These groundwater discharges typically occur at the base of the Port Seawall / SUBC coastal erosion protection rip-rap, or where the sea wall / rip-rap is absent at a position high up on the intertidal zone / beach profile, below the seaward edge of the sand dunes.

18.4.10.21 Therefore, the conditions will be similar to those present under the current natural tidal cycle – the groundwater discharges are submerged by the top of each tide, resulting in a mixing of tidal water and groundwater along a zone defined by the position of the seawall and a strip immediately inland of the seawall, where standing groundwater levels are lower than the natural or managed high tide level.

18.4.10.22 The reduced managed high tide levels (compared to the natural peak high tide level) are expected to reduce the width of the groundwater / tidal water mixing zone and therefore reduce the potential for saline intrusion, especially in the eastern area adjacent to the SUBC. The extent of any existing or future groundwater / tidal water mixing zone in this area is expected to be <200m, approximately half the 400m distance between the high tide mark and the Crymlyn Bog SAC.

18.4.10.23 Slightly lower standing groundwater levels beneath the former Transit Site tank farm to the east of the SUBC might be expected to result in practically a continuation of the

current conditions. Managed tidal levels will be lower than current natural high tides, but will still be higher than groundwater within the adjacent plot of land. No groundwater level data has been reviewed for land to the north of Fabian Way. If groundwater levels north of the road remain low, with respect to the managed tidal elevation, then the potential for saline intrusion towards Crymlyn Bog will be similar to the current natural conditions.

Groundwater flow regime & groundwater flooding

18.4.10.24 In general, groundwater flow is interpreted as being perpendicular to the coastline. Groundwater recharge will occur inland, particularly from the wetland area of the Crymlyn Bog, with a general hydraulic gradient expected to the south towards Swansea Bay. Evidence of this groundwater discharge pathway can be observed as intertidal springs along the Swansea Bay foreshore.

18.4.10.25 In the vicinity of Swansea Docks, the presence of a fixed surface water head within the docks appears to be acting as a barrier to shallow groundwater flow to the intertidal zone. This is interpreted as a function of the 10.7m depth of the docks and performance of the hydraulic seal for the docks.

18.4.10.26 The absence of groundwater seepages within the intertidal foreshore adjacent to Queen's Dock suggests that groundwater flow is either active at a deeper level within the aquifer; and / or within the shallow aquifer, groundwater mounding occurs behind the docks (artificially elevating groundwater levels in the Fabian Way / Port Tenant areas), with the increased groundwater head driving flow pathways further to the east or west. No evidence has been observed for groundwater flows to the west (i.e. to the Tawe estuary), but increased groundwater seepage discharge was observed for the foreshore adjacent to the former Queen's Dock Oil Terminal.

18.4.10.27 Previous URS investigations have established that the groundwater within the former Transit Site tank farm area is typically encountered at a depth of 1 – 1.5m below the established ground level. Beneath the sand dunes, which rise 2 – 4m higher than the level of the former bunded Transit Site tank farm areas, groundwater was observed at depths ranging from 3 – 5m from surface. This is as a result of the change in topography, but also stems from a change in the groundwater gradient as it falls towards and discharges at the beachfront.

18.4.10.28 The URS investigations also concluded that the tidal influence on groundwater levels within the former Transit Site tank farm area is minimal (20-30mm), although it has been observed to be of the order of 400mm on the dunes closer to the sea. These observations of groundwater depth relate to the ground surface as it was for the period when the Transit Site tank farm was operational.

18.4.10.29 The supplementary report on Groundwater-Intertidal Zone Discharge (Appendix 18.1, Volume 3) compares the reported ground elevation and groundwater level data from the SUBC ES with the sea wall and beach topography and the TLSB modelled natural and managed tidal water level data.

18.4.10.30 The Groundwater-Intertidal Zone Discharge: Conceptual Model establishes that for the area fronted by the sand dunes (the eastern part of SUBC), managed high tide levels will be higher than standing groundwater levels for a zone approximately 100-150m wide. Further inland, the standing groundwater levels should remain higher than the managed

high tide level, maintaining a hydraulic head and limiting the width of groundwater / tidal water mixing.

18.4.10.31 For the area adjacent to the sea wall of the former Transit Site tank farm (i.e. between the Port and the SUBC development), the managed high tide level will be expected to be higher than standing groundwater levels (based on groundwater data included within the SUBC ES). Although the managed high tide level will be lower than the corresponding peak natural high tide levels, the potential for a wider groundwater / tidal water mixing zone remains. The conceptual model developed for the intertidal zone suggests that fresh groundwater discharges might migrate slightly further down the beach profile, marginally reducing this zone of groundwater / tidal water mixing.

18.4.10.32 Landmark Information Group Envirocheck Report_ 43785108_1_1 provides BGS Groundwater Flooding Susceptibility mapping. According to the BGS mapping, the eastern seawall landfall and visitor facility location are located in a zone classified as having a high susceptibility to groundwater flooding. A composite Groundwater Flooding Susceptibility map for the entire onshore area is presented as Figure 18.10 (included within Volume 2).

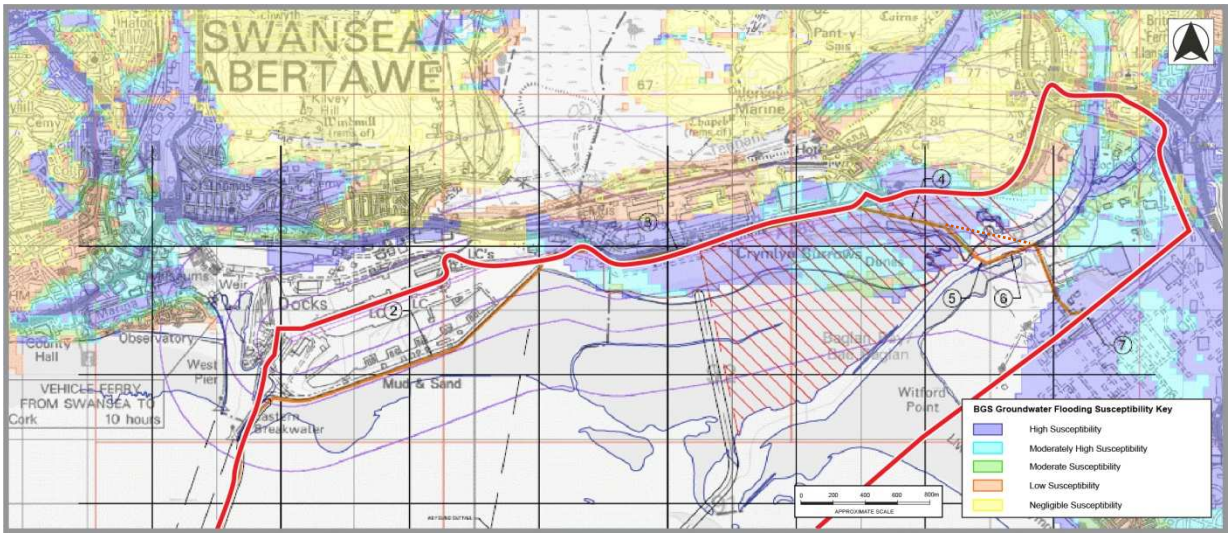

Figure 18.10 Groundwater Flooding Susceptibility mapping, including the northern redline study area boundary for the Project.

18.4.10.33 The Groundwater Flooding Susceptibility mapping also indicates a zone of susceptible land to the north of the Project, along the alignment of the A483 Fabian Way. This includes a significant proportion of land along this corridor that is classified as having a High Susceptibility or Moderately High Susceptibility. Changes to the groundwater regime in this area creates a potential risk of altering the susceptibility to groundwater flooding. In particular, changes to the timing and duration of groundwater discharge to the intertidal zone could affect the susceptibility of up-gradient areas to groundwater flooding.

18.4.10.34 The URS supplementary report Groundwater-Intertidal Zone Discharge: Conceptual Model states that, under natural conditions, the observed areas of groundwater seepage are at or towards the top of the beach profile. The relationship between the high and low tide ranges and the seepages is not anticipated to change as a result of the operation of the Project. This would mean that the seepage area should be exposed for a similar

length of time on the natural and managed tidal cycles. It is assessed that the effect on the flow of groundwater from these seepages is likely to be limited. This suggests that operation of the Project is unlikely to have any significant adverse effect on the groundwater flood risk for the medium to high risk areas identified further inland. The lower managed tidal level, and expected marginally lower elevation of groundwater seepages on the beach has the potential to marginally reduce overall groundwater levels up-gradient of the Project, which would result in a minor beneficial effect in terms of groundwater flood risk (Chapter 17: Hydrology and Flood Risk).

Surface water features

18.4.10.35 The nearest surface water features to the Project are the enclosed waters of Swansea Docks, the tidal waters of Swansea Bay and the Tennant Canal. A number of ponds known locally as 'slacks' are situated within the Crymlyn Burrows SSSI.

18.4.10.36 Surface water features are discussed further within Chapter 17: Hydrology and Flood Risk, of this Environmental Statement.

18.4.11 Potential sources of contamination

Contamination sources within the Project area

18.4.11.1 A review of the potential for contamination of soils and groundwater in the onshore areas of the Project has been based on the known land-use history on site, land-use in the surrounding area and the results from previous intrusive investigations (for the Transit Site tank farm area). It should be noted however that parts of the Project area have undergone remediation works as part of other schemes in order to render those areas "suitable for use" as required under the development control regime.

18.4.11.2 The same approach will apply to the development footprint for onshore elements of the Project. Contaminant sources will require remedial action to mitigate their presence, to a standard that renders the "site suitable for use". This suitability is judged on the basis of risk assessment for the most sensitive receptors that have been identified.

18.4.11.3 Table 18.8 presents a list of potential on-site contamination sources, based on the areas of proposed onshore development and historic land uses identified.

Table 18.8 Potential on-site contamination sources

Historic Land Use	Areas	Potential Contaminants
Infilled / reclaimed land	Western Seawall landfall Western Landfall Building Grid Connection	Metals & Metalloids, Phenols, chlorides, sulphates, sulphides, Polycyclic Aromatic Hydrocarbons (PAH), coal/coke, asbestos, cyanides.

Historic Land Use	Areas	Potential Contaminants
Dock railway network	Western Seawall landfall Western Landfall Building Grid Connection	Possible iron & steel wastes used as fill material. Atrazine & simazine herbicides were used as herbicides to keep tracks clear of vegetation which may have accumulated in trackside drainage, PCB were used in transformers in electrical substations. Diesel and other organic hydrocarbons associated with oils, fuel and grease. If ash was used as filled material this may have polycyclic aromatic hydrocarbons (PAHs) associated, phenols and sulphates associated with it. Asbestos from lagging.
Hydrocarbon transfer &storage	Western Seawall landfall Western Landfall Building Grid Connection	Hydrocarbon fuels and oils. Gasoline, kerosene, diesel, crude oils, BTEX* and other chemicals. Asbestos from fire protection coatings
Timber yard	Grid Connection	Timber treatments – if used: creosote, copper-chrome arsenate (CCA), sodium pentachlorophenoxide, light organic solvents, organo-chlorine pesticides (e.g. dieldrin, but unlikely given age of site)
Fish meal works	Western Landfall and Building Grid Connection	Not established
Coal loading docks	Western Landfall and Building Grid Connection	Metals, metalloids, sulphates, sulphides, cyanides
Chemical works	Grid Connection	Light hydrocarbons / solvents, especially BTEXS*

Note: BTEX(S) – benzene, toluene, ethylbenzene, xylenes, (styrene)

Off-Site Contamination Sources

18.4.11.4 The extent of historical industrial development within the areas surrounding the Project prevents any comprehensive assessment of the likely off-site contaminant sources. In particular, the widespread industrial development in and around the Swansea Docks complex has the potential to have resulted in widespread land contamination across the area.

18.4.11.5 For the purposes of this assessment, only those areas of off-site development that have been assessed as having the greatest impact on the Project area are listed individually within Table 18.9. These areas are included on the basis of their proximity to the Onshore Works, or the likelihood of mobile contaminants that might affect the Onshore Works.

Table 18.9 Potential off-site contamination sources

Historic Land Use	Areas within approximately 500m	Potential Contaminants
In filled / reclaimed land	Extensive within docks area. Also ground levels made up to development grade in Transit Site tank farm area and within former Baglan Bay chemical works.	Metals & Metalloids, Phenols, chlorides, sulphates, sulphides, Polycyclic Aromatic Hydrocarbons (PAH), coal/coke, asbestos, cyanides.

Historic Land Use	Areas within approximately 500m	Potential Contaminants
Dock railway network	Extensive within docks area.	Possible iron & steel wastes used as fill material. Atrazine & simazine herbicides were used as herbicides to keep tracks clear of vegetation which may have accumulated in trackside drainage, PCB were used in transformers in electrical substations. Diesel and other organic hydrocarbons associated with oils, fuel and grease. If ash was used as filled material this may have polycyclic aromatic hydrocarbons (PAHs) associated, phenols and sulphates associated with it. Asbestos from lagging.
Hydrocarbon transfer & storage	Extensive along southern / eastern side of Queen's Dock, including Queen's Dock Oil Terminal and adjacent Transit Site tank farm. Also associated with the transfer pipelines through Crymlyn Burrows to Baglan Bay.	Hydrocarbon fuels and oils. Gasoline, kerosene, diesel, crude oils, BTEX* and other chemicals. Asbestos from fire protection coatings.
Paint Works	North of Area B.	Inorganic & Organic Pigments, organic dyes, binders such as phenol formaldehyde, amino compounds and oils, organic solvents.
Spelter Works	North of Area B.	Zinc, aluminium, magnesium, lead, titanium, mineral acids, oils, fuels.
Coal loading docks	Extensive within docks complex	Metals, metalloids, sulphates, sulphides, cyanides.
Chemical works	Grid Connection Works	Light hydrocarbons / solvents, especially BTEXS*
Tin Plate Works	In vicinity Kings Dock North of eastern arm landfall	Tin, copper, antimony, lead, oils & fuels.
Power Station- Thermo Electric	King's Dock	Metals, metalloids and their compounds, PAH's, fuels oils, lubricating oils, inorganic compounds such as ammonium salts, boron, hydrazine & sulphides, sulphate, phosphate, chloride, sulphuric & hydrochloric acid, sodium hydroxide, asbestos.
Car Engine Works	North of eastern landfall / Eastern Landfall viewing platform	Metals, Metalloids and their compounds, inorganic ions, acids, alkalis, asbestos, solvents, fuels & oils, asbestos.
Gas works / coke works	Land between King's Dock & Queen's Dock Western end Queens Dock	Ammonical liquors, coal tar, spent oxide, foul lime, metals, coal dust, PAH's.

18.4.11.6 Of the potential off-site sources listed, only those related to the transfer and storage of hydrocarbons are expected to have a potential impact on the Project. The on-going remediation of these areas is expected to reduce the associated risks to the achievement of a "suitable for use" level by the time that construction of the Project begins.

Ground gas

18.4.11.7 The presence of made ground, particularly in and around the Swansea Docks complex, indicates that there is the potential for elevated levels of ground gas to be present. No detailed monitoring of ground gas has been undertaken.

Unexploded ordnance (UXO)

18.4.11.8 The Swansea area was heavily bombed during the Second World War and so an UXO survey was undertaken prior to the commencement of the offshore ground investigation works. A similar study will be undertaken for the Onshore Works area prior to the commencement of any intrusive geo-environmental investigation and/or substantial excavation and piling works.

18.5 Potential impacts and mitigation measures

18.5.1 Site preparation and construction phase

18.5.1.1 During the construction phase of the Project there are a number of potential impacts relating to the geology, hydrogeology or contaminated land that may have a direct or indirect impact on sensitive receptors. The potential impacts during construction will generally relate only to the construction period itself and will be temporary in nature.

18.5.1.2 All construction works undertaken at the Project will be carried out in accordance with procedures and mitigation measures outlined in the Construction Environmental Management Plan (CEMP) as detailed in Chapter 4: Project Description.

18.5.1.3 The principal impacts and the required mitigation measures are discussed in the following sections. The potential sources, pathways and receptors in the context of land quality and hydogeological receptors for the site preparation and the construction phase of the Project are presented in Table 18.10.

Table 18.10 Potential sources, pathways and receptors for consideration during the site preparation and construction phases

Sources
General construction activities/site preparation materials
Construction of piled foundations / below ground structures
Localised soil and groundwater contamination in made ground and underlying strata (as identified in Table 18.8)
Off-site soil and groundwater contamination migrating on-Site (as identified in Table 18.9)
Pathways
To Human Health Receptors: • Vapours – Migration of vapours through made ground into above ground buildings. • Particulate – Ingestion, inhalation and dermal contact with soil particulates. • Permeation – Migration of contaminant substances through plastic potable water supply pipes. • Gas – Migration of ground gases through confined permeable rock strata to buildings. • Human exposure to soils during construction and excavation works and movement of soils offsite. • Historical and current service routes which may act as preferential pathways for contaminant migration.
To Controlled Waters Receptors: • Leaching – Migration of contaminant substances from soils into perched water and groundwater. • Migration of impacted perched water and groundwater, if present, to surface water.
To Environmentally Sensitive Areas: • Leaching – Migration of contaminant substances to soil and groundwater of designated SSSI, SAC and Ramsar site Crymlyn Bog and Crymlyn Burrows SSSI and Pant Y Saint local nature reserve
Receptors
Human Health Receptors: • Workers onsite during construction works. • Workers onsite once the development has been built. • The general public and staff visiting the Project once it is operational. • Nearby residents and workers within local commercial and residential properties.

Controlled Waters Receptors: • Surface waters of the River Tawe and River Neath located to the east and west of the Project. • Bathing waters of Swansea Bay.
Environmentally Sensitive Areas: • Designated SSSI, SAC and Ramsar site Crymlyn Bog and Crymlyn Burrows SSSI and Pant Y Saint local nature reserve.

18.5.2 Soil and groundwater contamination

18.5.2.1 Based on the results of the baseline assessment which was carried out as part of the ES, it is considered that the magnitude of the impact of the contamination risks identified for the areas identified for onshore construction activities are minor. The footprint of the Onshore Works avoids areas of known contamination, particularly those associated with former oil industry infrastructure.

18.5.2.2 For all areas of permanent construction works and for areas of temporary construction works (e.g. temporary access roads, construction yards, lay-down areas), further phased investigation and assessment will be completed to confirm that the impacts are minor. These further investigation and assessment works will be undertaken in accordance with the requirements of CLR11, GPLC1-3, GP3 and the detailed requirements of any relevant consent conditions. Further sampling will be undertaken within footprint of the Onshore Works.

18.5.2.3 Contamination within soils has the potential to impact adversely the health of construction workers. Health and Safety mitigation measures, appropriate to the chemical composition of the ground (and, potentially, the groundwater), will be evaluated and implemented to protect the health of construction workers. As a result of these measures, any existing contamination is expected to have a low magnitude of impact and is therefore of negligible significance to construction workers.

18.5.2.4 Any cut and fill works will be carried out with due regard to the current Waste Management Regulations.

18.5.2.5 In order to reduce the volume of soil being disposed of off-site, materials will be reused to level the Project, where possible. The procedure for managing the re-use of soils at the Project will be documented in a Materials Management Plan which will be produced in general accordance with CLAIRE Code of Practice 'The Definition of Waste: Development Industry Code of Practice', 2011 (CLAIRE, 2011).

18.5.2.6 Where surplus soil needs to be disposed of, it will be disposed of to an appropriate, licensed landfill facility, in accordance with current Duty of Care responsibilities and other statutory requirements. As required by the Landfill Directive, inert, non-hazardous and hazardous waste will require pre-treatment prior to disposal.

18.5.2.7 Prior to disposal soil will need to be characterised following the methodology described in the Environment Agency publications 'Framework for the Classification of Contaminated Soils in Hazardous Wastes', version 1 and 'Guidelines on sampling and testing of wastes to meet landfill waste acceptance procedures' version 1.

18.5.3 Storage of potentially contaminating materials and accidental spillage

18.5.3.1 During construction, there is potential for accidental spillage of contaminants from vehicles and construction materials, and for chemicals, oils or fuels stored on-site during

operation to leak or be spilled and so enter the sub-surface. This could detrimentally impact soil and groundwater quality which could, in turn, have an impact on sensitive receptors.

18.5.3.2 The magnitude of the impact on the land due to accidental spillage of fuels from construction vehicles is dependent on the frequency and size of the spillage, but is assessed as being likely to be low subject to implementation of the CEMP.

18.5.3.3 To alleviate the potential impact from accidental fuel and chemical spills, mitigation measures will be employed, including storage within bunded areas to contain chemical spillages during construction. Appropriate site-specific method statements for the construction works will cover storage and use of chemicals and fuels during construction. Emergency procedures will include the use of spill kits and booms to deal with fuel and chemical spillages in accordance with regulatory guidance (e.g. Environment Agency pollution prevention guidelines). It is proposed that standard duties of care are employed within the Project with regard to delivery, use and storage of potentially contaminating materials and liquids (bunded storage platforms, control of substances hazardous to health (COSHH) assessments and safety inductions etc). This is secured by the CEMP.

18.5.4 Asbestos

18.5.4.1 Asbestos is a common contaminant within made ground fill materials, and will be included within the suite of determinands scheduled as part of site investigation works for the proposed Onshore Works footprint. The proposed Western Landfall Building will be located in the vicinity of an existing building which appears to have asbestos cement cladding. Sampling and analysis of cladding debris on the ground surface indicated that this material does contain asbestos. Collection and removal of this material, and other materials containing asbestos, will be subject to the applicable waste management practices. It is anticipated that the materials observed on site would be classified as hazardous waste and would require appropriate disposal. If further testing, prior to the start of construction, identifies the presence of asbestos, then appropriate measures will be implemented to mitigate the risks and deal with the asbestos. This will be in accordance with the Hazardous Waste Regulations (Environment Agency PPGs) and the relevant Health and Safety guidelines. Residual impacts following implementation of appropriate mitigation measures specified in this chapter and summarised in Chapter 23: Mitigation and Monitoring are considered to be of **negligible** significance.

18.5.5 Disturbance of dust and silt

18.5.5.1 Dust and silt resulting from disturbance during construction activities may arise as a result of the movement of potentially contaminated soil by construction machinery. The impacts from disturbance would be further increased if the dust and silt is contaminated. This could result in the silting up of surface waters or could have adverse effects on the health of construction workers and the general public.

18.5.5.2 Mitigation of potential dust impacts that will be implemented are discussed in further detail within Chapter 16: Air Quality of this ES. During construction, these will include covering or damping down of dusty surfaces during dry weather and wheel washing of vehicles exiting the Project area. Road clean of relevant highways would be implemented if necessary. It is also prudent to note that any temporary storage of materials will incorporate appropriate risk control measures (e.g. stockpiles will be appropriately

fenced off in designated areas and covered or damped down if likely to generate dust). This is secured by the CEMP.

18.5.6 Geotechnical considerations

18.5.6.1 The thickness of made ground and superficial deposits present in the vicinity of the Project is known. As a result, geo-environmental investigation (GI) will be undertaken within the footprint of the Onshore Works prior to their commencement. The results of the GI will be used to establish the most appropriate foundation design solution(s) and the need, if any, for remediation works.

18.5.6.2 Whether a piled foundation solution is required will be decided by the observed ground conditions and the result of appropriate geotechnical testing and design. Selection of a pile type / construction method will be based on consideration of the technical requirements for supporting the building loads, and the potential for creating a preferential pathway for contaminant migration through the underlying geological strata units.

18.5.6.3 Construction of large structures over made ground and / or unconsolidated superficial deposits has the potential to result in settlement and subsidence of the ground over time. Through implementation of appropriate foundation design and possible ground improvement, residual impacts are considered to be of **negligible** significance.

18.5.6.4 The implementation of appropriate foundation design and piling methods will result in a negligible impact to ground conditions at the Project in terms of settlement, subsidence, instability and the creation of preferential contaminant migration pathways.

18.5.6.5 Appropriate foundations will be designed following completion of an appropriate Phase 2 geotechnical intrusive investigation at the Project, and Piling Risk Assessment, undertaken in accordance with EA Guidance: Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention, National Groundwater & Contaminated Land Centre report NC/99/73. New buildings will be constructed with suitably designed foundations to ensure that the long-term settlement of the building will occur within acceptable limits.

18.5.6.6 Aggressive ground conditions such as elevated sulphate concentrations and low pH values in soil and groundwater have the potential to cause significant degradation to sub-surface concrete structures. The potential for aggressive ground will be assessed as part of the Phase 2 site geotechnical intrusive investigation through analytical testing of soil and groundwater. The relevant Building Research Establishment (BRE) guidance (BRE website - http://projects.bre.co.uk), states that the required composition of concrete can be selected to ensure a negligible impact to sub-surface building materials.

18.5.7 Ground gas

18.5.7.1 The impact of ground gas at this stage is assessed as being of negligible significance for Western Landfall Building. A Phase 2 Geotechnical investigation will include monitoring for the presence of ground gases in accordance with existing guidance published by BRE and BSI standard (BS 8576:2013. If a need is identified at this point, ground gas mitigation measures will also be incorporated into the foundation design of the buildings. Implementation of these mitigation methods will result in a negligible impact on the Project.

18.5.8 Underground structures

18.5.8.1 Underground structures, such as existing service lines, are known to exist beneath the Project. Prior to the commencement of excavation works, appropriate steps including a detailed survey of the services locations and depths will be taken to ensure that construction activities do not disturb any live services.

18.5.8.2 Of particular environmental significance is presence of former underground hydrocarbon transfer pipes across the Crymlyn Burrows area. Accidental disturbance of these buried structures could result in the loss of any hydrocarbon product retained within the pipelines.

18.5.8.3 Provided that service clearance procedures are followed, the impact on the various underground structures is considered to be of negligible significance.

18.5.9 Unexploded ordnance

18.5.9.1 Encountering unexploded ordnance during piling and deep excavation represents a potential major short-term adverse impact to the safety of construction workers. The UXO desk study report will assess the risk of encountering UXO on site and recommend mitigation, with the aim of rendering potential adverse impacts negligible. Such mitigating measures could include:

I. Explosive Ordnance Safety and Awareness Briefings for personnel conducting intrusive works;

II. Unexploded Ordnance Site Safety Instructions for site personnel;

III. The presence of an Explosive Ordnance Disposal (EOD) Engineer on site to supervise open excavations; and

IV. down-hole intrusive magnetometer surveys of all deep intrusive works and target investigation of suspect anomalies.

18.5.9.2 With the measures identified above implemented, the potential impact on unexploded ordnance during development is considered to be of negligible significance.

18.5.10 Operational phase

18.5.10.1 The assessment of land contamination in respect of new development is based on a “suitable for use” approach. Any risk assessment, remediation and verification works that are required will be agreed, implemented and validated as part of the pre-construction and / or construction phase.

18.5.10.2 Operational phase impacts associated with land contamination are therefore limited to the storage and use of potential contaminants on a site, i.e. the potential for further land contamination to occur through the operation of the development, which is not relevant for the Project.

18.5.10.3 The operational phase land quality impacts are therefore assessed as negligible.

18.5.10.4 Operation of the Project will result in a change to the tidal cycle, as presented in Chapter 4: Project Description. This can be best described as a slight displacement of the tidal cycle affecting the foreshore area within the Lagoon (approximately 3km long) and a slight reduction in tidal height as schematically illustrated below.

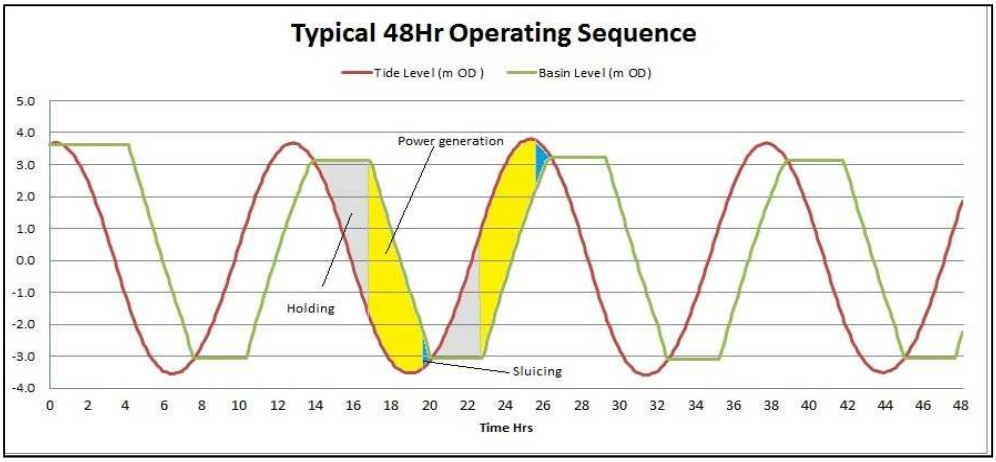

Figure 18. 11 Lagoon typical 48hour operating sequence

18.5.10.5 A discussed in the baseline assessment, the discharge of shallow groundwater through the intertidal zone changes through the various phases of the tidal cycle. High tide would be expected to impound groundwater, and typically results in bank storage of groundwater and of saline tidal recharge. The bank storage is then discharged at intertidal springs over the receding tide, along with the general groundwater discharge flux (Appendix 18.1, Volume 3).

18.5.10.6 The rate and volume of discharge depends on the permeability of the beach deposits / strata, area of the discharge zone, head difference between the up-gradient groundwater and the discharge point and the time period over which the head difference exists. The net difference across the tidal cycle should be negligible, as the overall tidal cycle is simply shifted by approximately 2.5 hours– i.e. the time available for groundwater discharge through the intertidal zone should, on average, remain the same.

18.5.10.7 Additionally, the observed areas of groundwater seepage are at or towards the top of the beach profile. The relationship between the high and low tide ranges and the seepages is not anticipated to change with operation of the Project. This means that the seepage area should be exposed, allowing groundwater discharge, for a similar length of time on the natural and managed tidal cycles. The effect on the flow of groundwater from these seepages is therefore assessed as negligible.

18.5.10.8 The area of foreshore impounded by the Project is approximately 3.7km in length. Approximately 2km is backed by the Queen's Dock/King's Dock Complex. As a result, it is anticipated that these water features will represent the dominating influence on groundwater in this area and therefore their presence will temper any effects from the Lagoon. In addition to this, the amount of time spent at high or low water will not change significantly (Figure 18.11), but will only be displaced slightly for the section of foreshore not adjacent to the docks. No significant effects on groundwater are anticipated.

18.5.11 Decommissioning

18.5.11.1 After 120 years, the Project is expected to adopt one of the following options:

I. replace, upgrade and extend life of the generating station; and

II. remove turbines / M&E equipment and continue leisure use of the Lagoon water area.

18.5.11.2 No further land quality impacts are anticipated by the decommissioning or continuation of the Project.

18.5.11.3 Decommissioning the Project could have a potential impact on the groundwater flow and discharge regime, as Swansea Bay reverts to a more natural tidal cycle. The decommissioning phase impacts of reverting to a natural cycle are assessed as negligible.

18.6 Residual impact assessment and conclusions

18.6.0.1 The impact of the Project on land quality and hydrogeology has been assessed through the identification of baseline environmental quality and the potential sources, magnitudes and significance of any impacts. The assessment has been based on professional judgement, data and reviews of relevant literature, policies and legislation.

18.6.0.2 No significant impacts on land quality are expected to occur throughout the construction and operational phases, provided that standard mitigation measures are applied as discussed above. Table 18.11 summarises the residual impacts on land quality and the hydrogeological regime.

Table 18.11 Summary of residual impacts (post-mitigation)

Description	Geographic Scale	Impact Significance
Construction Phase		
Release of suspended sediment	Local	Negligible
Use and storage of hydrocarbon fuels and oils	Local	Negligible
Use of concrete and cement products	Local	Negligible
Disturbance of contaminated land	Local	Minor Beneficial
Disturbance to groundwater	Local	Negligible
Preferential pathways	Local	Negligible
Operational Phase		
Groundwater flood risk	District	Negligible or Minor Beneficial
Disturbance of groundwater flow	Local	Negligible
Decommissioning Phase		
Disturbance of groundwater flow	Local	Negligible

18.7 Cumulative impact assessment

18.7.1 Overview

18.7.0.1 This section assesses the impact of the Project in combination with the potential effects of other developments within a 5km radius, and which are considered sufficiently close to have potential for cumulative impacts to arise in conjunction with the Project. Consented and proposed schemes within this area have been identified. The schemes are listed in Table 18.12. All other schemes and projects identified in Chapter 2: EIA Process and Assessment of Significance, have been considered. Those schemes not listed in Table 18.12 have been excluded as they are considered to be unlikely to cause interactions with the Project which would result in different or enhanced effects. This

consideration is based upon professional judgement, supported by evidence including: the presence of the other schemes in the existing baseline as they are already complete/operational; distance from the Project; and developments which are not of a type likely to interact with the Project in any way. For this reason, only the scheme listed below is considered further.

Table 18.12 Schemes with cumulative impact potential

Project and Location	Current Status	Potential issues to be considered
Swansea University Bay Campus – on shoreline adjacent to Crymlyn Burrows.	Planning permission granted. Construction ongoing.	Beneficial improvement in land quality through remediation of on-site / near site contamination sources.

18.7.2 Construction and operational cumulative impacts

18.7.2.1 The enabling / preparation works for the SUBC include remediation of land contamination risks associated with part of the former Transit Site tank farm. The standard of remediation will be appropriate to achieve "suitable for use" status, as agreed with the regulatory authorities and as demonstrated through the provision of verification reporting on completion of remediation. Remediation of these contamination sources represents a **moderate beneficial** reduction in risk for the Project.

18.7.2.2 It is considered that the residual impact of the Project on ground conditions will be negligible provided that standard, current guidelines are adopted in design and that appropriate mitigation measures are applied. Any adverse cumulative impact therefore will be due to the impact of the other scheme, rather than in combination with the Project. It is also assumed that the cumulative scheme will undertake suitable investigation and assessment of ground conditions and that any remediation deemed to be necessary is completed in line with available regulatory guidance.

18.7.2.3 No cumulative impacts are assessed for the operation of the Project in conjunction with the SUBC on land quality and hydrogeology.

18.7.3 Conclusions

18.7.3.1 The proposed Onshore Works and Grid Connection Works include parcels of land that have been historically utilised by land uses that might have resulted in land contamination.

18.7.3.2 However, the proposed locations for the Onshore Works generally avoid the areas which represent the highest levels of risk associated with historic land use. These are assessed as including the former Queen's Dock Oil Terminal, associated Transit Site tank farm and Baglan Bay chemical works.

18.7.3.3 A range of potential contaminants has been identified for the land uses identified for the Onshore Works areas. Standard mitigation measures of detailed site investigation, risk assessment and remediation in design and implementation will be employed where required. This approach is consistent with Environment Agency / Defra Contaminated Land Report 11: Model Procedures for the Management of Land Contamination.

18.7.3.4 Implementation of the proposed approach will mitigate land contamination risks during construction of the Project.

18.7.3.5 Residual land contamination risks are therefore assessed to be **negligible**.

18.7.3.6 Operation of the Project will result in slight displacement of the natural tidal cycle over a short section of foreshore (<2km). This could potentially change the groundwater discharge flux through the intertidal zone, which might result in changes to standing groundwater levels to the north and east of the Project area. Conceptual model development for the intertidal zone suggests that fresh groundwater discharges might migrate slightly further down the beach profile, marginally reducing the zone of groundwater / tidal water mixing. Based on the assessment undertaken, a slight reduction in the potential for saline intrusion and groundwater flood risk might be expected adjacent to the SUBC, with little difference expected, compared to current conditions, between the SUBC and Swansea Port complex.

18.7.3.7 Residual hydrogeology risks are therefore assessed to be **negligible**.

18.8 References

British Geological Survey. 1:50,000 Geological Map Sheet 247 Swansea. Solid and Drift Edition.

BS 8576:2013 Guidance on investigations for ground gas. Permanent gases and Volatile Organic Compounds (VOCs)

City and County of Swansea, (2008); 'Unitary Development Plan'.

City and County of Swansea, (TBC); 'Local Development Plan' http://www.swansea.gov.uk/index.cfm?articleid=28061

City and County of Swansea, (2005); 'Contaminated Land Inspection Policy'.

CLAIRE Code of Practice 'The Definition of Waste: Development Industry Code of Practice', 2011

Building Research Establishment Guidance

Contaminated Land: Applications in Real Environments (CLAIRE), (2010); 'A Framework for Assessing the Sustainability of Soil and Groundwater Remediation'.

Construction Industry Research and Information Association (CIRIA), (2001); 'Guidance C532. Control of Water Pollution from Construction Sites: Guidance for Consultants and Contractors'.

Construction Industry Research and Information Association (CIRIA), (2001); 'Guidance C665. Assessing Risks Posed by Hazardous Ground Gasses to Buildings'.

Construction Industry Research and Information Association (CIRIA), (2001); 'Guidance C697. The SUDS Manual'. Environment Agency, (2009); 'Water for life and livelihoods. River Basin Management Plan. Western Wales River Basin District'.

DEFRA (2012) Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, April 2012

Environment Agency, (2004); 'Contaminated Land Report 11, Model Procedures for the Management of Land Contamination.'

Environment Agency, (2010); 'Guiding Principles for Land Contamination'.

Environment Agency, (2012); 'Groundwater Protection: Principles and Practice (GP3)'.

Environment Agency; 'Pollution Prevention Guidelines 01: General Guide to the Prevention of Pollution' http://www.environment-agency.gov.uk/.

Environment Agency; 'Pollution Prevention Guidelines 02: Above Ground Oil Storage Tanks'.

Environment Agency, 'Pollution Prevention Guidance 03: Use and Design on Oil Separators in Surface Water Drainage Systems'.

Environment Agency, 'Pollution Prevention Guidance 04: Disposal of Sewage where no Mains Drainage is available'.

Environment Agency; 'Pollution Prevention Guidelines 05: Works in, near or liable to affect watercourses'.

Environment Agency; 'Pollution Prevention Guidelines 06: Working at construction or demolition sites'.

Environment Agency, 'Pollution Prevention Guidelines 07: Refuelling Facilities'.

Environment Agency; 'Pollution Prevention Guidelines 20: Dewatering Underground Ducts and Chambers'.

Environment Agency; 'Pollution Prevention Guidelines 21: Pollution Incident Response Planning'.

Environment Agency, (2006); 'Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination'

Environment Agency, (2009); 'Science Report SC050021/SR2, Human Health Toxicological Assessment of Contaminants in Soil'.

European Commission, (2004); 'EC Directive 2004/35/EC on Environmental Liability'.

European Commission, (2000); 'EC Directive 2000/60/EC establishing a framework for the Community action in the field of water policy'. (The Water Framework Directive, WFD)

http://projects.bre.co.uk/ConDiv/concrete%20standards/default.html

HMSO, (1990); 'Environmental Protection Act 1990' (Part IIA).

HMSO, (1991); 'The Water Resources Act'.

HMSO (1990); The Town and Country Planning Act.

HMSO, (1995); 'Environment Act'.

HMSO, (2003); 'The Water Act'.

HMSO, (2012); 'Environmental Protection Act 1990: Part 2A. Contaminated Land Statutory Guidance'.

HMSO, (2009);'Environmental Damage (Prevention and Remediation) Regulations'.

HMSO, (2010); 'Environmental Permitting (England and Wales) Regulations'.

HMSO, (1999); 'Anti-Pollution Works Regulations'

HMSO, (2009); 'Water Resources Act 1991 (Amendment) (England and Wales) Regulations'.

HMSO, (1984); 'The Building Act'. The Building Act 1984, Building (Amendment) Regulations 2012: Circular 02/2012

HMSO, (2003); 'The Water Resources (Environmental Impact Assessment) (England and Wales) Regulations'.

Human Health Toxicological Assessment of Contaminants in Soil, Science Report SC050021/SR2

HMSO, (2009); 'The Groundwater (England and Wales) Regulations'.

4Landmark Information Group, (2013); 'Envirocheck® Report_ 43785108_1_1'.

Neath Port Talbot County Borough Council, (2008); 'Unitary Development Plan, Adopted version, March 2008'.

Neath Port Talbot County Borough Council, (2005); 'Contaminated Land Policy'.

NHBC / Environment Agency / Chartered Institute of Environmental Health, (2008); 'R&D 66, Guidance for the safe development of housing on land affected by contamination'.

ODPM, (2000); 'The Building Regulations
www.legislation.gov.uk/uksi/2000/2531/contents/

Ordnance Survey, '1:25,000 Explorer Sheet No. 165, Swansea'.

National Assembly for Wales, (2006); 'Guidance on the Remediation of Contaminated Land'

South West Wales Strategic Planning Group, (2001); 'Regional Planning Guidance'.

URS Corporation Ltd, (2010); 'Report Ref.: 49311733, The Bay Science and Innovation Campus, Swansea University. Environmental Statement'.

URS Corporation Ltd, (2009); 'Report Ref.: 49311733/BRRP003, The Bay Science and Innovation Campus Site Investigation and QRA'. (Technical Appendix 14-1 of the Environmental Statement, 2010)

URS Corporation Ltd, (Date); Report Ref.: 49311733/, The Bay Science and Innovation Campus, Swansea University. Environmental Statement, 2010. Volume III Technical Appendix 14-2

URS Report 'Closure Report for Transit Site Tank 856, BP Oil Llandarcy Refinery', December 2007, Final, Issue2.

Welsh Assembly Government, (2008); 'The Wales Spatial Plan: People Places, future', 2008 Update.

Welsh Assembly Government, (2009); 'One Wales: One Planet, a new Sustainable Development Scheme for Wales'.

Welsh Government, (2012); 'Planning Policy Wales, Edition 5'.

Welsh Assembly Government, (2006); 'The Contaminated Land (Wales) Regulations Guidance on the Remediation of Contaminated Land, National Assembly for Wales Circular 2006, as amended

Welsh Government, (2012); 'The Contaminated Land (Wales) (Amendment) Regulations