

Royal Alexandra Hospital, Rhyl

Phase 1 Preliminary Risk Assessment

Curtins Ref: 074057-CUR-00-XX-RP-GE-001

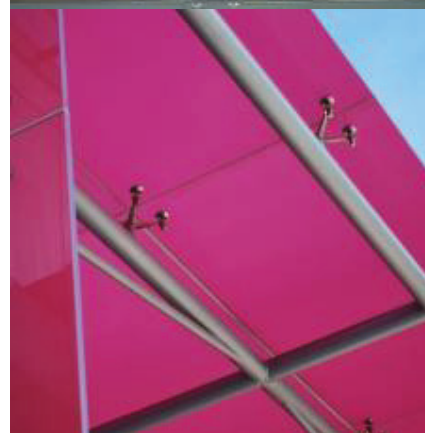
Revision: V01

Issue Date: 07 February 2020

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Rev	Description	Issued by	Checked	Date
V01	Issue to Client			07/02/2020

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Executive Summary

Appointment	In January 2020 Curtins were instructed by Kier to undertake a Phase 1 Preliminary Risk Assessment of the Royal Alexandra Hospital site located at Marine Drive, Rhyl, LL18 3AS. The site is centred on NGR SJ014820 and covers an area of approximately 1.73 Ha. It is understood that the proposed site development is to include the construction of a new hospital building in the south eastern part of the site.
Current Site Status	The eastern half of the site is currently occupied by the Royal Alexandra Hospital and associated car parking and soft landscaping. Alexandra Road runs through the centre of the site, oriented SW – NE. The western portion of the site is occupied by a day hospital and a pre-operative assessment clinic.
Site History	Earliest mapping (1871) shows that the site was occupied by a residential structure and an associated path with the majority of the site surrounding the property being undeveloped. Alexandra road was constructed through the site prior to 1899. The Royal Alexandra Hospital appears under construction on 1899 mapping prior to its opening in 1902, from when it covered the majority of the north eastern section of the site. Two tanks are marked on site from 1973. By 1980, the hospital building had been expanded to the south east and a structure is present on the south western side of Alexandra road. A day hospital has been constructed on the western half of the site by 1988. The tanks are no longer marked on 1990 mapping, though a 2012 Asbestos Survey refers to an "Oil Tank Building" still being present on site. Several hospital-associated structures are demolished between 1988 and 2020. Throughout the site's history, its surroundings are generally occupied by residential properties with limited contaminative potential.
Geology	BGS mapping indicates the site is underlain by Blown Sands superficial deposits and Kinnerton Sandstone bedrock. A previous site investigation found Made Ground to a depth of between 0.90m and 2.00m overlying natural sand and clay. The exploratory holes reached a maximum depth of 5.00m and did not encounter bedrock. Additionally, a BGS recorded borehole 175m south west of the site was advanced to depth of 25.00m and did not encounter bedrock. The site is located in a low probability radon area where <1% of homes are estimated to be at or above the radon Action Level.
Hydrogeology	The site is underlain by a Principal Aquifer associated with the bedrock formation. The superficial deposits are designated as a Secondary A Aquifer. The site is not located within a Source Protection Zone (SPZ). There are no groundwater abstraction points within 1km of the site.
Hydrology	The nearest surface water feature is the Irish Sea 131m north of the site. There are no surface water abstractions within 1km. There are no discharge consents within 500m of the site. No pollution incidents have been recorded within 200m of the site.
Unexploded Ordnance Risk	The risk from UXO associated with WWII bombing to construction workers is considered to be Low.
Initial Ground Contamination Assessment	The risk from Made Ground posed to the site's end-users and groundwater is considered to be Moderate / Low due to the expected lack of contamination in the Made Ground. The risk posed to surface water is considered to be Low due to the distance to the nearest surface water feature. The risk posed to site end-users from ground generating gases arising from organic / putrescible soils and infilled land (water) near the site is considered to be Moderate.
Recommendations	The following recommendations are made with regards to further works at the site: 1. Undertake an intrusive ground investigation; 2. Undertake a GQRA as part of the ground investigation; and 3. Undertake Ground Gas Monitoring over a period of two-three months for methane, carbon dioxide, oxygen, hydrogen sulphide, gas flow in l/hr, weather conditions and barometric pressure (with confirmation if falling, steady or rising). It is further recommended that this work is completed in advance of any development works taking place.

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1.0 Introduction

1.1 Project Background

In January 2020 Curtins were instructed by Kier Construction Northern to undertake a Phase 1 Preliminary Risk Assessment of the Royal Alexandra Hospital site located at Marine Drive, Rhyl, Denbighshire, North Wales, LL18 3AS.

The location and extent of the site is shown in *Figure 2.1* on the following page. It is understood that the proposed site development is to include the construction of a new hospital building in the south east corner of the site, with associated car parking. A proposed site plan is included in *Appendix A*.

1.2 Scope of Services

The Phase 1 PRA is intended to provide an overview of the geo-environmental and geotechnical setting of the site, prior to the proposed development of the site.

Proposed development drawings for the site are included in *Appendix A*.

Through this overview, the Phase 1 PRA aims to develop both a working conceptual and ground model for the site, as well as present an initial assessment of any risks that could be presented to the development including its intended end users and the wider environment.

Specifically, the Phase 1 PRA provides an initial assessment of the site regarding:

- a) Potential on and offsite contamination from historical and/or current uses, including potential ground gas generating sources;
- b) The potential impact on the wider environment by historical and or current use of the site of interest;
- c) The potential impact from surrounding land uses and other environmental factors;
- d) Potential problems associated with geological features such as faulting, mineral extraction, mining and land instability;
- e) The location of apparent sub-surface structures that may affect the proposed redevelopment; and

Consideration of detailed flood risk, ecology and archaeological issues are outside of the scope of this report.

1.3 Previous Reports

The following existing reports have been provided by the client and have been referenced as part of this Phase 1 PRA:

- Environmental Essentials (2012) – Report Reference P-80383 – Management Survey – Royal Alexandra Hospital, Beechwood Road, Rhyl (Ref. 12), including surveys of the following buildings:
 - P-133942 – Royal Alexandra Hospital
 - P-133985 – Out-Patients Department
 - P-133986 – Estates
 - P-133987 – Tank Oil Building and Ducts
 - P-133988 – Mortuary
 - P-134883 – Main Building
 - P-138305 – Glan Traeth EMI Ward
- CC Geotechnical Ltd. (2014) – Report Reference CCG-C-14-7813 – Ground Investigation Report for Site at Royal Alexandra Hospital, Rhyl (Ref. 11).
- Public Health England (2014) – Report of Address Search for Radon Risk for Conwy and Denbighshire NHS Trust, Royal Alexandra Hospital, Marine Drive, Rhyl, LL18 3AS (Ref. 13)

2.0 Current Site and Surrounding Area Details

2.1 Site Location and Current Details

Site use, location and description are shown below in *Table 2.1* and *Figure 2.1*.

Table 2.1 – Site Details

Site Address	Conwy & Denbighshire NHS Trust, Royal Alexandra Hospital, Marine Drive, Rhyl, LL18 3AS
NGR	SJ014820
Area of Site	Approximately 1.73 Ha
Current Site Use and Description	The site slopes slightly to the south, ranging between 8m-10m AOD and is accessed off Alexandra Road, which runs through the centre of the site. The eastern half of the site is occupied by the Royal Alexandra Hospital, additional associated structures including a mortuary, dentist and out-patients department and associated car parking and soft landscaping. The western portion of the site is occupied by a day hospital, it's associated car park and a pre-operative assessment clinic. Brick walls are present around the majority of the site boundary. East Parade is present along the northern site boundary, Russell Road to the south and Grosvenor Road to the east. The western boundary is marked by a row of houses.

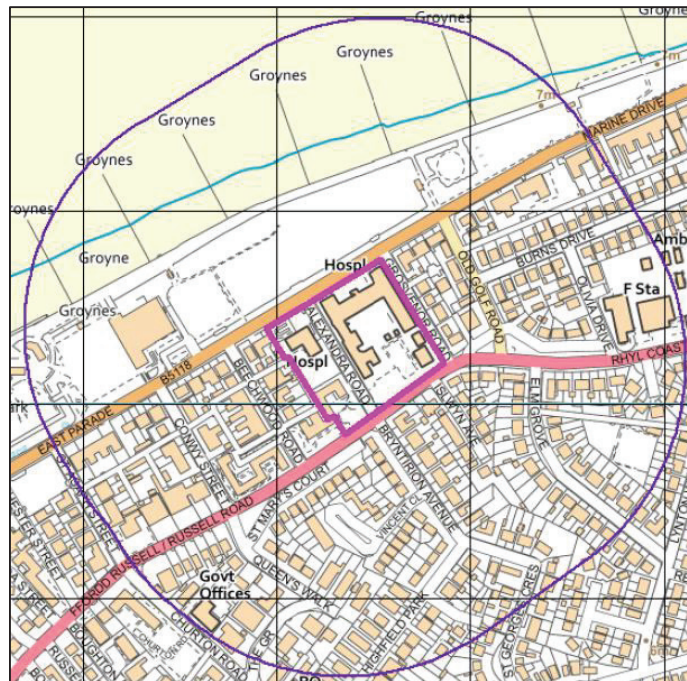


Figure 2.1 – Site Location Plan (site boundary shown in pink and 100m buffer in purple).
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2.2 Surrounding Area Details

The following information was established through undertaking an environmental database search (Envirocheck report (Ref.1) included in *Appendix B*).

Table 2.2 – Surrounding Land Uses

Surrounding Area	N	The East Parade road, followed by an area of Public Open Space, the Marine Parade Road (B5118) and the Irish Sea.
	E	Grosvenor Road, with residential dwellings beyond.
	W	Residential dwellings.
	S	Russell Road with residential dwellings beyond.

3.0 Site History

A review of the available historical mapping and other information for the site, as presented within the Envirocheck Report (Ref.1), has been undertaken and is presented in *Table 3.0* below.

Table 3.0 – Previous Site and Surrounding Area Uses and Potential Sources of Contamination. *Bold text refers to on-site activity.*

Date	Description	Potential Sources of Contamination
1871 - 1880	The earliest available mapping (1871) shows the site occupied by a structure labelled as “Plas-tirion” – rough Welsh translation is “Gentle Place” – which is surrounded by undeveloped land. A path leading to the structure is present in the western part of the site. There is an unnamed road running along the southern border of the site. The majority of the land within 100m of the site is undeveloped, though some residential dwellings are present around 80m south. Two ponds are present near the site, one 15m to the south west and another 50m to the south east. The Irish Sea is present 130m north of the site. The town of Rhyl is present from 150m south west.	• Potential for uncontrolled deposition of Made Ground during the construction of the on-site structure and path.
1899 - 1902	Alexandra Road now runs NW-SE through the centre of the site. The previous on-site structure has been demolished and the Royal Alexandra Hospital is shown to be under construction as of 1899 and opened in 1902. The portion of the site to the south west of Alexandra Road is undeveloped. Plas-tirion parade now runs along the north western border of the site and Grosvenor road is present along the eastern border. The ponds previously present near the site are no longer marked. Residential dwellings are now present adjacent to the south western boundary of the site and around 20m to the north east, including structures labelled as “Hendre”, “Anerley” and “Kenmore”.	• Potential for uncontrolled deposition of Made Ground during on-site demolition and construction. • Potential for ground gas generation from infilled ponds near the site.
1912 - 1914	The construction of the Royal Alexandra Hospital has been completed and it now covers the majority of the north eastern section of the site. The portion of the site south west of Alexandra Road has now been partitioned into three sections. This area is still mostly undeveloped, aside from a small structure in the south western corner and another next to Alexandra Road. Marine Parade has been constructed 100m north of the site and Bryn-tirion Avenue has been constructed 20m south of the site.	• Potential for uncontrolled deposition of Made Ground during the Royal Alexandra Hospital and other on-site structures. • Waste associated with the operation of the Royal Alexandra Hospital.
1938 - 1953	No changes have occurred on-site during this period. Rhyl has been expanded, with residential structures now present from 20m south of the site. Additional residential development has also taken place from 30m east of the site. Marine Parade has been expanded to the west.	• Potential UXO risk related to WWII bombing.

Date	Description	Potential Sources of Contamination
1959 - 1980	No significant changes occur on-site between 1959 and 1968. 1973 mapping shows that some development has occurred in the eastern corner of the site, including the construction of two "Tanks", possibly associated with the oil storage for the boiler house. Mapping from 1980 shows that the hospital buildings have been expanded to the south east and an additional structure has been constructed near the southern boundary. A structure is present on the south western side of Alexandra Road from 1980 Residential development of the surrounding area continues through this period.	• Potential for uncontrolled deposition of Made Ground associated with the expansion of the hospital and the construction of the new building. • Potential for spillage or leakage of pollutants from the two tanks.
1988 - 2020	A day hospital and associated garden have been constructed in the western corner of the site as of 1988. The "Tanks" are no longer present on 1990 maps, however asbestos surveys undertaken in 2012 (Ref. 12) reference the presence of an "Oil tank building". 1991 mapping shows that the hospital has again been re-developed, with some sections in the east and south-east being demolished. Between 2006 and 2020, a structure adjacent to the eastern wing of the hospital and another on the southern boundary of the site are demolished. Residential development in the surrounding area continues throughout this period. The Sun Centre is constructed 80m north east between 1988 and 1991.	• Potential for uncontrolled deposition of Made Ground during the development of the hospital.

Potential sources of onsite contamination are further discussed in *Section 6.0*.

4.0 Geology, Hydrogeology and Hydrology

4.1 Geology and Hydrogeology

A study of the Envirocheck (Ref. 1) Report and the British Geological Survey (BGS) 1:50,000 mapping records (Bedrock and Superficial Editions) for Rhyl (Sheet 095) (Ref.2) indicates the following geological and hydrogeological succession underlying the site:

Table 4.1a – Geological/Hydrogeological Succession

Geology	Associated Hydrogeological Classification
BGS Records do not indicate the presence of Made Ground on site, however the site's history suggests that there is potential for localised Made Ground deposits.	N/A
Blown Sand ¹	Secondary A Aquifer ²
Kinnerton Sandstone ³	Principal Aquifer ⁴

Notes:

1. These comprise sand that has been transported by wind, or sand consisting predominantly of wind-borne particles.
2. These are 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.
3. Sandstone, red-brown to yellow, generally pebble-free, fine- to medium-grained, cross-stratified.
4. These are layers of rock or drift deposits that have high intergranular and/or fracture permeability – meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifers.

There are no BGS recorded faults on or near the site.

The site is not situated within a Source Protection Zone (SPZ) and there are no groundwater abstraction points within 1km.

4.1.1 Previous Investigation Ground Conditions

A site investigation was undertaken on the eastern portion of the site by CC Geotechnical Ltd. in September 2014. This investigation comprised 9 no. Windowless Sampler Boreholes and 5 No. foundation inspection pits. Their report (Ref. 11) states that they found Made Ground to a depth of between 0.90m and 2.00m, generally consisting of slightly silty slightly gravelly fine to medium sand, with gravel that included anthropogenic material such as concrete, brick and “slag” in addition to limestone and sandstone. The natural deposits underlying the Made Ground generally consist of loose slightly silty, slightly gravelly sand overlying firm to stiff slightly sandy slightly gravelly silty clay. The clay was identified at depths ranging from 1.70m near the southern boundary of the site to 3.90m in the north east, with the most northern boreholes not identifying any clay. All but one of the boreholes were advanced to 4.00m, while WS7 was advanced to 5.00m. No exploratory hole reached bedrock. Two of the exploratory holes identified organic rich deposits, at depths of 2.70m and 3.50m and thicknesses of 0.15m and

0.10m respectively. BGS borehole records include a series of four boreholes (references SJ08SW10a – d) located 175m south west of the site, the findings of these boreholes are generally consistent with the on-site investigation. No boreholes from this series reached bedrock, with a maximum depth of 25.00m being reached by SJ08SW10c, the findings of which are reproduced below in Table 4.1b. One borehole (d) notes the presence of “traces of organic matter” between 2.50m and 3.00m.

BGS Borehole Reference	Strata Description
SJ08SW10c	Made Ground 0.00m – 2.10m: Loose brown silty medium sand with occasional small fragments of clinker, brick, mortar and coal.
	Blown Sands 2.10m – 3.30m: Very loose grey/brown silty fine to medium sand with traces of clay.
	Alluvial Deposits 3.30m – 20.00m: Alternating bands of soft to firm silty clay and silty fine to coarse gravelly sand with fine to coarse gravel.
	Glacial Till 20.00m – 25.00m: Stiff to Very Stiff reddish-brown very silty clay with occasional fine gravel.

4.1.2 Mining

A review of the Coal Authority interactive mapping (Ref. 4) for the area indicates that the site is not located within a coal mining reporting area. Therefore, the risk to development from historic coal mining is considered to be **Low** and has not been considered further.

There are no recorded BGS mineral sites within 1km of the site.

4.1.3 Other Ground Stability Issues

The Envirocheck Report (Ref. 1) confirms that there is a no hazard to low risk from the following ground stability hazards on the site; collapsible ground, compressible ground, ground dissolution, landslide ground, running sands and shrinking or swelling clay.

There is a moderate risk of running sands hazard recorded 74m to the north west of the site.

4.1.4 On-site Ground Gas Sources

Two exploratory holes from September 2014 site investigation identified organically rich deposits with thicknesses between 0.10m - 0.15m and depths between 2.70m and 3.50m. BGS Borehole record SJ08SW10d (175m south west of site) notes the presence of “traces of organic matter” within natural soils at a depth of 2.50m – 3.00m. Additionally, Borehole reference SJ08SW23 (421m west of the site) notes a layer of “Dark grey to black, saturated organic SILT” at a depth of 9.10m – 9.45m.

Historical mapping identifies the presence of “Tanks” on site, while Asbestos surveys (Ref. 12) for the site identify the presence of an “Oil Tank Building”. Contamination present in the Made Ground or natural soils related to spillages and leakages from these oil tanks has the potential to produce ground gas.

4.1.5 Off-site Ground Gas Sources

There are no recorded landfill sites within 1km of the site.

Historical maps show the presence of two ponds within 50m of the site that were later infilled with unknown material as part of the development of the site's surroundings.

The Envirocheck report (Ref. 1) identifies four potentially infilled land (water) sites within 500m of the site, dating from between 1914 and 1956. The closest is situated 372m to the south east.

The Envirocheck (Ref. 1) and UK Radon mapping (Ref.5) confirms the site is situated in an area of where less than 1% of homes are estimated to be at or above the radon Action Level. On this basis, it is unlikely that radon protection measures will be required. A Radon Risk Report (Ref. 13) acquired for the site in 2014 confirms the above assessment.

Where the new development incorporates a basement, advice of a specialist Radon assessor should be obtained.

4.2 Hydrology

The nearest surface water feature is the Irish Sea, located approximately 131m to the north. A watercourse referred to as “The Cut” or “Rhyl Cut” is also present approximately 450m to the south east. There is no river quality data available for this feature.

Due to the proximity of the Irish Sea, there is potential for the groundwater to be influenced by tidal effects.

No pollution incidents to controlled waters have been recorded within 500m of the site.

There are no surface water abstractions or active discharge consents recorded within 500m of the site.

5.0 Unexploded Ordnance Risk Assessment

Military activities including those conducted as part of both the First and Second World Wars have resulted in a legacy of unexploded ordnance (UXO) being present within the shallow soils of the UK.

UXO result from various sources including both allied (military training) and German (bombing raids) with a guide figure of approximately 10% of all munitions failing to function as designed.

The likelihood of UXO being encountered on a development site is influenced by several factors including; the proximity to strategic targets, the nature of the development works being undertaken and evidence of local damage in the post-war periods amongst others. To determine the likelihood of UXO being present on a site, a step-wise risk assessment process is followed. This process is outlined within CIRIA C681 Unexploded Ordnance: A Guide for the Construction Industry (Ref.6) with the following commentary considered to represent a Preliminary Risk Assessment intended to guide if and where there is a requirement for a Detailed Risk Assessment.

5.1 Preliminary UXO Assessment

Risk mapping (Ref.7) for UXO's has placed the site in a Low risk area. Low-risk regions are those with a bombing density of up to 10 bombs per 1000 acres. These areas are considered to have a significant but low UXB risk.

A review of the available historic mapping did not identify any evidence of any bombing hits on or near the site. The risk mapping indicates that there are no Luftwaffe targets within 1km of the site. Other online sources (Ref. 10) indicate that Rhyl was targeted for bombing during the war on two occasions, 12/03/41 and 01/06/51, with no significant damage being recorded.

Based on the forgoing commentary, the risk of encountering UXO associated with WW1 or WW2 bombing on site as part of the ground investigation or development works is assessed as **Low**.

If unexploded ordnance is discovered during any works, stop immediately, prevent access to the area, and inform the police. If the site boundary or location changes then the UXO risk should be reassessed.

6.0 Conceptual Site Model & Qualitative Risk Assessment

The conceptual site model (CSM) and Qualitative Risk Assessment (QRA) are presented in the table within this section.

The CSM details the source-pathway-receptor linkages or potential pollutant linkages (PPL) that have been identified for the site. The QRA details the associated level of risk relating to these potential pollutant linkages.

The CSM and QRA concern risk to human health and water environment with additional, more specific risk assessment protocols contained within the main body of this reporting, as detailed in *Section 6.1* below.

The QRA follows the framework outlined within CIRIA C552 (Ref.8) which is summarised within *Appendix C*.

The 'risk rating' within the QRA refers to the risk that the source, pathway, receptor linkage or PPL is complete. Unless specifically stated it does not necessarily refer to an immediate risk and is intended to be used as a tool to assess the necessity for further assessment/investigation.

6.1 Additional Risk Assessments

The following risk assessments, listed below, are not included within the main CSM and QRA but nonetheless can be of critical importance to the onward development of the site:

- The risk presented by Mining is discussed and assessed in *Section 4.1.2*.
- The risk presented by Radon is discussed and assessed in *Section 4.1.5*.
- The risk presented by Unexploded Ordnance is discussed and assessed in *Section 5.0*.

Under current health and safety legislation, employers are required to carry out their own appropriate risk assessments and mitigation to protect themselves and their employees, other human receptors and the environment from potential contamination. Such risks must be adequately mitigated by law, specifically the Construction Design Management (CDM) Regulations, 2015 (Ref.9) which require that potential risks to human health and the environment from construction activities are appropriately identified and all necessary steps taken to eliminate / manage that risk. It has been assumed that any future construction works on site will be undertaken in compliance with these requirements.



- The table below represents the first stage in the land quality risk assessment process: The Qualitative Risk Assessment.
- For a development site to be deemed 'suitable for use', the level of risk needs to be brought down to acceptable levels, i.e. low to very low risk. The purpose of each stage of risk assessment is ultimately to establish, if there is a requirement for additional levels of assessment to be made to have sufficient confidence to support a risk characterisation or management decision, e.g. remedial action.
- In the absence of specific site data, a Generic Quantitative Risk Assessment is invariably recommended.

Conceptual Site Model			Qualitative Risk Assessment			Recommended Actions
Source	Pathway(s)	Receptor(s)	Consequence	Likelihood of Occurrence	Risk Rating	
Significant sources of on-site contamination: • Made Ground of unknown composition from uncontrolled deposition of materials onsite during the construction and demolition of on-site structures throughout the site's history. • Existing asbestos surveys (Ref. 12) of on-site structures show the presence of various Asbestos Containing Materials, potentially suggesting that ACMs may also have been present in historical structures that have been demolished. • Potential for spillages or leakages from the tanks present on-site.	Direct contact, ingestion, inhalation (dust and vapours)	End-user of site (Commercial) & Construction Workers	Medium Chronic health risk	Low Likelihood Based on the site's development history and lack of historical industrial use, the likelihood of encountering significant contamination within the Made Ground is considered to be Low. There is potential for localised contamination related to the tanks or demolition of ACM-containing structures. Likelihood of construction workers coming into contact with contamination on site can be reduced by appropriate PPE.	Moderate / Low	Generic Quantitative Risk Assessment Recommended as part of the ground investigation.
	Vertical migration through the superficial deposits (soils) May occur due to existing service corridors and physical processes including: capillary action and downwards into the natural deposits through infiltration.	Controlled Waters (Groundwater) Principal Aquifer (Bedrock) overlain by Blown Sands (Secondary A Aquifer). There are no groundwater abstraction points within 500m. The site is not within a designated Source Protection Zone.	Medium Pollution of sensitive water resources	Low Likelihood While there is the potential for localised contamination to migrate vertically through the superficial deposits to the bedrock principal aquifer, there is a low likelihood of significant contamination being present in the Made Ground.	Moderate / Low	Generic Quantitative Risk Assessment Recommended as part of the ground investigation. Target the oil tanks building and surroundings.
Significant sources of off-site contamination:	Uncontrolled deposition of Made Ground during the construction of roads and structures near the site's boundaries.	Controlled Waters (Surface Water) Nearest surface water features are the Irish Sea 131m north and the Rhyl Cut 450m south east. No surface water abstraction points within 1km.	Medium Pollution of sensitive water resources	Unlikely Considering the distance from the site to the nearest surface water receptor and the expected lack of contamination within the Made Ground, this pathway is considered unlikely.	Low	No further action required
Significant sources of ground gas:	Vertical and horizontal migration through existing service corridors and the underlying superficial deposits	End-user of site (Commercial)	Medium Human health risk	Likely It is likely that ground gas will be generated by the localised organic deposits identified in the previous site investigation. There is also potential for gas generation from the infilled ponds near the site boundary and from any localised organically rich deposits present in the Made Ground.	Moderate	Generic Quantitative Risk Assessment Recommended as part of the ground investigation.

7.0 Conclusion and Recommendations

The qualitative risk assessment (QRA) determined a varied level of level of risk associated with the proposed development.

The QRA concluded by recommending that generic quantitative risk assessments (GQRA) were conducted to confirm the assessment of risk ascribed to each of the respective potential pollutant linkages (PPLs). It is recommended that the GQRA is conducted as part of a ground investigation in support of the engineering design of the proposed development.

In summary, the following recommendations are made:

- Undertake an intrusive ground investigation;
- Undertake a GQRA as part of the ground investigation; and
- Undertake ground gas monitoring over a period of two-three months for potential hazardous gases.

It is further recommended that the site investigation works are completed in advance of any development works taking place.

7.1 Contaminants of Concern

Potential contaminants of concern associated with the sources identified within the Conceptual Site Model in *Section 6.0* of this reporting include but are not limited to: broad range aliphatic and aromatic hydrocarbons present within any fuel oils; polycyclic aromatic hydrocarbons (PAHs); inorganic compounds including heavy metals; and asbestos present in discarded building materials. It is not anticipated that there is significant risk to the site from hospital waste being deposited historically on site.

Potential contaminants associated with the airborne dust/particulates include but are not limited to: polycyclic aromatic hydrocarbons and inorganic compounds including toxic metals that are also accounted for by potential onsite contaminants of concern.

7.2 Other Considerations

The requirement for additional surveys, e.g. arboricultural and ecological surveys, should be confirmed through advice from a suitably qualified and experienced professional.

8.0 References

1. Landmark (2020) Envirocheck Report (report no. 232272312_1_1).
2. British Geological Survey (BGS) Solid and Drift Editions (1970) 1:50,000 mapping, Sheet No. 095 (Rhyl).
3. BGS Geology of Britain Viewer <http://mapapps.bgs.ac.uk/geologyofbritain/home.html> (accessed January 2020).
4. Coal Authority Interactive Map Viewer, <http://mapapps2.bgs.ac.uk/coalauthority/home.html> (accessed January 2020).
5. UK Maps of Radon, <http://www.ukradon.org/information/ukmaps> (accessed January 2020).
6. CIRIA (2009) Unexploded Ordnance: A Guide for the Construction Industry (report no. C681).
7. Zetica Regional Unexploded Bomb Risk map, <https://zeticauxo.com/downloads-and-resources/risk-maps/> (accessed January 2020).
8. CIRIA (2001) Contaminated Land Risk Assessment. A guide to good practice (report no. C552).
9. Health and Safety Executive (2015) Construction (Design and Management) Regulations.
10. War State and Society – Bombing Britain – Full dataset, <http://www.warstateandsociety.com/Bombing-Britain> (accessed January 2020)
11. CC Geotechnical Ltd. (September 2014) – Report reference CCG-C-14-7813 - Ground Investigation Report for Site At Royal Alexandra Hospital, Rhyl
12. Environmental Essentials (April 2012) – Report reference P-80383 – Management Survey, Royal Alexandra Hospital, Beechwood Road, Rhyl, LL18 1SG
13. Public Health England (July 2014) - Report of Address Search for Radon Risk – Conwy & Denbighshire NHS Trust, Royal Alexandra Hospital, Marine Drive, Rhyl, LL18 3AS