



Phase 1 (Desk Study) Investigation Report

On a site at

**The Oaks, Oak Road
Wrexham Industrial
Estate, Wrexham,
LL13 9RG**

For

Cefn Park Developments Limited



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EXECUTIVE SUMMARY

Background	The site is located to the south of Oak Road, Wrexham, centred on approximate National Grid Reference 339680, 349070. Access to the site can be gained via a gated entrance off Oak Road opposite Abbey Road. Opus has not been provided with any formal site layout, however it is understood that the proposed development will likely comprise industrial units (warehouses etc.) with associated access roads and car parking area. In the absence of specific information to the contrary, it has been assumed that site levels will not change significantly.
Current	The site is irregular in shape and covers an area of approximately 22 hectares. Ground levels vary across the site with the highest point located just north east of the centre of the site (34m AOD) and the lowest point located beside the River Clywedog in the south east corner of the site (24m AOD). The site boundary is defined for the most part by Oak Road to the north, and Redwither Brook and the River Clywedog to the south. The boundary deviates around several smaller plots of land to the west and the north east resulting in its irregular shape. The site is heavily overgrown with vegetation, leaving parts of the area inaccessible due to topography. The northern and western parts of the site typically comprise smaller plants with occasional semi-mature, mature trees and bushes. The southern and eastern parts are dominated by mature trees and large bushes. The area along the southern boundary resembles a woodland environment with little vegetation on the ground between mature trees. A network of paths cross the site, some of which are of concrete construction; associated with the paths were several concrete tunnels which are thought to be related to historical site uses. Some of the smaller paths appear not to have been used recently and are heavily overgrown. A large area of compacted gravel, which according to aerial photographs has been used as a car park, lies in the northernmost sector of the site. Many small bricked buildings remain on the site, particularly in the southern and eastern areas. Other structures of note include a set of concrete tank cradles located in the north eastern sector of the site and an open manhole to the east of the central area of the site. Potential Asbestos Containing Material (ACM) was noted in the north east sector of the site beside the concrete track running south from Oak Road. Large corrugated cement sheets were found, together with smaller fragments at the site boundary with Oak Road, it is considered that they are the result of fly tipping; Four sets of overhead electricity lines were noted to exist on site, one of which roughly bisects the site running north to south and consists of large lattice tower pylons carrying 3 no. cables. The remaining lines are carried by wooden pylons; Evidence of water services was noted during the walkover. 2 no. below ground chambers were noted in the north east part of the site beside the concrete track



	running south from Oak Road. Missing covers made it possible to see that one of the chambers contains standing water. A bund was noted at the site boundary on the concrete path leading onto the site from the west. Himalayan Balsam, a non-native species, was noted in large quantities in the southern part of the site, particularly along the banks of Redwither Brook and the River Clywedog, along with Japanese Knotweed (refer to Kingdom Ecology Ltd.'s Ecological Assessment, dated November 2016) along the bank of Redwither Brook. Suspected Giant Hogweed was also found around the site in low densities. A manmade pond located in the south eastern corner of the site was found to contain smooth newts, which are not a protected species (refer to Kingdom Ecology Ltd.'s Ecological Assessment). The entrance to a rabbit warren was observed in the southern area of the site. It has been noted that evidence of current unauthorised site uses such as 4x4 driving and paintballing activities have been recorded.
History	On site The site consisted of a number of open fields from 1873 with unnamed roads and paths crossing the site in various places. There was an unnamed brook in close proximity to the south western site boundary and six ponds present across the site. The site was developed to form part of the wider Royal Ordnance Factory (ROF) Wrexham facility during World War II for the production of core propellant materials. The Historical Scoping Report produced by Townscape in March 2017 indicates that from the information available the Oaks site was one of the final phases of the much larger ROF site and the evidence is that the Oaks site was never fully completed or was ever operational in terms of propellant manufacture, and that production was focused on the more central areas of the ROF site. Due to national security measures at the time, no surveying of the site was undertaken and as such no historical maps exist of the building configurations during the war period. As a result of the lack of information, exact comments on the changes to the site layout during those years cannot be made, however a pre-desk study 'Unexploded Ordnance Survey' completed by Zetica has identified that the site occupied an area of banded magazines and explosive stores associated with No.2 Factory. Additionally, it also identified anti-invasion defences, including at least 7No. pillboxes on the site. The most complete historical map closest to that time period is the 1954 map, which shows the site to comprise six large buildings in the north western part of the site and a number of smaller buildings in the remaining sectors of the site. Some of these buildings are thought to be new constructions or refurbishments of old ROF Wrexham storage units used for new industrial uses. There are a number of roads crossing the site and joining the present buildings/bunkers and pillboxes. ROF Wrexham was progressively closed down at the end of the WWII and vacated by 1950. There are, what are believed to be, industrial buildings present on the 1961-1964 mapping in the south eastern sector of the site, which include blast protection. It is believed that these were erected when the site was operational as ROF Wrexham to be used in cordite production and were simply



	omitted on 1954 historical mapping. No further information specifying purpose of those buildings is recorded on historical maps. Along with the new units, additional infrastructure is present including hydrants, water tanks and electricity pillars/posts. In 1972, electricity pillars were upgraded to Electricity Transmission Line with pylons crossing the site through its north western, centre and south centre part. By the 1970s, the large former factory buildings in the centre and north western part of the site had been demolished and from 1982 to 2016, the site appears to have been abandoned and left in a derelict state. During WWII the site was in the Rural District (RD) of Wrexham, which officially recorded 278No. High Explosive (HE) bombs with a very low bombing density of 3.8 bombs per 405ha. However, there are no readily available records of HE bombs falling on or in close proximity to the site and documented reports from former employees of the ROF during the war period indicate that the site was not bombed during WWII. When considering this, the overall risk associated with UXO is considered as low. Off site The subject site formed only a small part of the ROF Wrexham facility (located in its centre east part). Information from the 1954 mapping and online research suggest that the ROF complex was spread over a large area of 700 ha to minimise any damage from aerial attacks. Historically, the surrounding land use has been predominantly industrial, with a mix of commercial and residential land uses also present. In the 1960s the majority of the former ROF became part of the Wrexham Industrial Estate, including many retail units, unspecified works, engineering works, depots and factories, and has continued to expand and undergo development until around 2006 when it reached the size it is today.
Geology & Hydrogeology	Solid: Kinnerton Sandstone Formation (Sandstone) – majority of the site. Salop Formation (Mudstone, Sandstone and Conglomerate) - north and north western part. Drift: Devensian Till (clay) – majority of the site. Alluvium deposits (Clay, Silt, Sand and Gravel) and River Terrace Deposits (Sand and Gravel) in the south eastern corner of the site located by River Clywedog. Groundwater – Bedrock Primary Aquifer (majority of the site) and Secondary A Aquifer - The north and north western sectors. Surface water - the nearest river (primary) is located 3m south west of the site (Redwither Brook). The second nearest river (primary) is located 15m south east of the site, which appears to be the River Clywedog. The stretch of the site along the south western and central western (along the Redwither Brook) and south eastern corner (along the River Clywedog) is

	considered to lie within an Environment Agency Flood Risk Zone (extreme flooding and flooding from rivers or sea without defences). A number of areas of the site are located within an area at risk of surface water flooding (low, medium and high). Mainly the area of the site along the south western and central western (along the Redwither Brook), south eastern corner (along the River Clywedog) and numerous patches across the site.
Coal Mining and Mineral Extraction	The majority of the site is located in an area which was not historically mined for coal, only the small fragment in the south eastern corner of the site (along the River Clywedog) is located within a coal mining reporting area (development low risk area). Risks from coal mining generally arise from three distinct failure mechanisms associated with: • Abandoned, often unrecorded shallow “pillar and stall” workings at or near outcrop; • Subsidence associated with ongoing or recently completed deep “longwall” mining; and, • Collapse of mine entries (adits or shafts). In this case the geology dictates that shallow workings can only occur a considerable distance west of the site, as the overlying Kinnerton Sandstone Formation (without any significant coal seams) is at outcrop locally. The risk associated with deep longwall mining from the former Bersham Colliery, which closed in 1986, is insignificant as 30 years has elapsed since mine operations were completed. There are no recorded shaft entries within 5km of the site. Mineral Extraction: • There are no BGS Recorded Mineral Sites located within 1km of the site; • There are no natural or man-made mining cavities within 1km of the site; and, • The site is not located within a Brine Compensation Area.
Initial Conceptual Site Model (ICSM)	On site Made Ground associated with the demolition of former and current buildings may give rise to contaminants such as: • Toxic heavy metals (from paint and pipe work) • Sulphates • Polycyclic Aromatic Hydrocarbons (PAHs) from the incomplete combustion of solid fuels • Semi-Volatile and Volatile Organic Compounds (SVOCs and VOCs) from cordites ingredients i.e. nitroglycerine • Asbestos Containing Material (ACM) may be present, associated with the age and construction of the buildings (assuming that the material was not removed in a controlled manner) • Hydrocarbons (associated with fuel storage areas) • Potential for the generation of hazardous ground gases (methane and carbon dioxide) through the potential decomposition of organic matter and potentially infilled water bodies and backfilled ponds



	It is considered unlikely that the site is impacted by potential contamination associated with the manufacture of propellants during the war, when considering the half-lives of the primary constituents of the propellants and the 60 + years since operations ceased on site. However, possible buried/forgotten explosive waste may be present on site in the areas occupied by former banded magazines and explosive stores associated with former Factory No.2. The electricity pylons forming the Electricity Transmission Line were constructed post 1970s, when the use of PCBs was phased out. However, it is considered that the electricity pillars constructed in the 1960s could potentially have held PCB containing transformers / other equipment and, despite exhibiting a very low mobility, they are considered a potential source of contamination. It should be noted that any PCB impact is expected to be small in quantity and confined to the immediate area around the former location of the pillars. It is anticipated that there is a low to moderate risk from on-site contaminants associated with the historical use of the site and from Made Ground deposits. Off site Historically, the surrounding land use has been predominantly industrial, with a mix of commercial and residential land uses also present. The wide range of activities and processes at the Wrexham Industrial Estate throughout its history could potentially give rise to SVOCs and VOCs, PAH's, heavy metals and hydrocarbons. Unknown composition and volumes of Made Ground will also be present off-site; associated with the demolition of the former ROF buildings, which along with infilled historical water features and ponds pose a potential for the generation of hazardous ground gases through the decomposition of organic matter. It is anticipated that the present day uses of Wrexham Industrial Estate including storage of potentially hazardous materials and waste streams generated in the various businesses are actively managed to ensure minimal environmental impact; therefore, it is considered that the overall risk associated with the above off-site sources is considered low to moderate.
Recommendations	A detailed intrusive Site Investigation (SI) will be able to assess the thickness and composition of Made Ground, together with allowing the bearing capacity and physical parameters of the superficial drift and Made Ground soils to be determined, with a possibility for delineating the depth to the superficial soil / solid geology interface, all of which may then be used to determine the most appropriate foundation solution. The SI should also be designed to assess the chemical composition of the underlying ground conditions across the site to confirm the findings of the initial conceptual site model. A detailed flood risk assessment should be undertaken in the stretch of the site located within an EA Flood Risk Zone. Also, risk of surface water flooding across the site should be assessed. Despite a suspected low risk rating for UXO, it is recommended that a detailed UXO Desk Study is undertaken to confirm this prior to any SI. The UXO Desk Study can also inform safe working procedures for the SI and construction workers.

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APPENDIX A	Drawings
	MR V-R6399.00/01 Site Location Plan
	MR V-R6399.00/02 Site Plan
APPENDIX B	Site Walkover Survey Photographs
APPENDIX C	Selected Historical Maps
APPENDIX D	Zetica Regional Unexploded Bomb Risk: Isle of Anglesey and Pre-desk Study Assessment

1.0 INTRODUCTION

1.1 Background

Opus International Consultants (UK) Ltd (Opus) has been commissioned by the Client (Cefn Park Developments Limited) to undertake a Phase I Desk Study at the parcel of land located south of Oak Road, Wrexham.

Opus has not been provided with any formal site layout, however we have been informed that the proposed development will likely comprise industrial units (warehouses etc.) with associated access roads and car parking area. In the absence of specific information to the contrary, it has been assumed that site levels will not change significantly.

A current site layout plan is presented as Drawing No. MR V-R6399.00/02 within Appendix A.

1.2 Scope of Works

This report will include a review of historical plans, geology, hydrogeology, site sensitivity, flooding information, mining records and any pertinent local authority information available to facilitate in the completion of a dual purpose (Environmental and Geotechnical) desk study.

The report has been designed in general accordance with BS 10175:2011 + A1:2013 the British Standards Code of Practice for the Investigation of Potentially Contaminated sites and with Environment Agency (EA) document Model Procedures for the Management of Contaminated Land (Contaminated Land Report 11 (CLR11)).

1.3 Sources of Information

The following sources of information have been consulted as part of the desk study for the site:

- Envirocheck Database Report (ref. 95650640_1_1 dated August 2016);
- Environment Agency Website;
- BRE Report 211, Radon Protection Measures for Buildings;
- Historical Ordnance Survey Maps via Envirocheck;
- BGS Geological Mapping;
- BGS Historical Borehole Records;
- Zetica Online Bomb Mapping and Pre-Desk Study Assessment;
- Wrexham County Borough Council Planning Portal via website;
- The Coal Authority Development Referral Plans - online research - <http://mapapps2.bgs.ac.uk/coalauthority/home.html>;
- BGS Borehole Scans online research: <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>;
- Technical Report WA/91/4 “Applied geological mapping in the Wrexham area: geology and land-use planning.” B. A. Haines; available online: <http://nora.nerc.ac.uk/510077/1/WA91004.pdf>;

- Department of the Environment Industry Profile ‘Chemical Works – explosives, propellants and pyrotechnics manufacturing works’;
- Site history online research -
https://en.wikipedia.org/wiki/Wrexham_Industrial_Estate#ROF_Wrexham;
<http://www.wrexham.com/history/history-wrexhams-royal-ordnance-factory-43060.html>;
- Online research ‘Processes in the Manufacture of Cordite’
<http://www.dalbeattie.com/ministryofsupplyfactorydalbeattie/processes.html>;
- Online research ‘Proposed development at Deamon Tweeks, 75 Ash Road South, Wrexham Industrial Estate, Wrexham; Ecological Method Statement & Management Plan’ ces ecology;
<http://planning.wrexham.gov.uk/Planning/home.page>;
- Online research ‘Local Planning Guidance Note No.29- Wrexham Industrial estate Employment Development and Nature Conservation’
<https://www.wrexham.gov.uk/assets/pdfs/planning/lpg/guide29.pdf>;
- DEFRA Magic Maps;
- Oak Road, Wrexham Industrial Estate – Ecological Assessment, Kingdom Ecology Ltd, November 2016;
- The Oaks, Desk based Assessment of Archaeology, Ref B3041A.02, Gifford & Partners, April 2000; and,
- The Oaks, Desk based Assessment of Archaeology, Ref B3041A.04, Gifford & Partners, June 2000.

1.4 Limitations

This report has been produced on behalf of the Client, Cefn Park Developments Limited, and no responsibility is accepted to any Third Party for all or any part. This report should not be relied upon or transferred to any other parties without the express written authorisation of Opus. If any unauthorised Third Party comes into possession of this report, they rely on it at their own risk and the authors owe them no duty of care or skill.

Findings and opinions conveyed within this report are based on information obtained from a variety of sources as detailed within this report, which Opus believes are reliable. Nevertheless, Opus cannot and does not guarantee the authenticity or reliability of the information it has relied upon.

The site plans enclosed in this report should not be scaled from.

2.0 THE SITE

2.1 Location & Access

The site is located to the south of Oak Road, Wrexham, centred on approximate National Grid Reference 339680, 349070, as shown on Drawing No. MR V-R6399.00/01 Site Location Plan (Appendix A).

Access to the site can be gained via the gate off Oak Road opposite Abbey Road.

2.2 Site Description

A site walkover was conducted on Tuesday 6th September 2016 and the following observations were made:

- The site is irregular in shape and covers an area of approximately 22 hectares. Ground level varies across the site with the highest point located just north east of the centre of the site (34m AOD) and the lowest point located beside the River Clywedog in the south east corner of the site (24m AOD);
- It has to be noted that much of the northern central part of the site is anticipated to be elevated locally due to demolition of buildings historically present there;
- The site is heavily overgrown with vegetation, leaving much of the area inaccessible. The northern and western parts of the site typically comprise smaller plants with occasional semi-mature, mature trees and bushes. The south and eastern parts are dominated by mature trees and large bushes. The area along the southern boundary resembles a woodland environment with little vegetation on the ground between mature trees. A network of paths cross the site, some of which are of concrete construction; associated with the paths were several concrete tunnels, which are thought to be related to historical site use. Some of the smaller paths appear not to have been used recently and are heavily overgrown. A large area of compacted gravel, which, according to aerial photographs, has been used as a car park, lies in the northernmost sector of the site. Many small bricked buildings remain on the site, particularly in the southern and eastern areas;
- The site is used regularly by members of the public; anecdotal visual evidence suggests that 4x4 vehicles have been frequently driven over the site and there is also physical evidence to indicate that the site has been used as a venue for airsoft 'wargames'. No indication of forced entry by vehicular traffic onto the site was noted;
- Himalayan Balsam, a non-native species, was noted in large quantities in the southern part of the site, particularly along the banks of Redwither Brook and the River Clywedog, along with Japanese Knotweed (refer to Kingdom Ecology Ltd.'s Ecological Assessment, dated November 2016) also along the bank of Redwither Brook. Suspected Giant Hogweed was also found around the site in low densities. A manmade pond located in the south eastern corner of the site was found to contain smooth newts, which are not a protected species (refer to Kingdom Ecology Ltd.'s Ecological Assessment). The entrance to a rabbit warren was noted in the southern area of the site;
- Many small bricked buildings exist on the site, particularly in the southern and eastern areas. The structures were not entered during the walkover due to health and safety risks. The condition of some of the buildings is poor with missing and spalling brickwork noted;

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- Other structures of note include a set of concrete tank cradles located in the north eastern part of the site. Several concrete tunnels were also found on site. An open manhole was noted to the east of the central area of the site;
 - Potential Asbestos Containing Materials (ACMs) were noted in the north eastern part of the site beside the concrete track running south from Oak Road. Large corrugated cement sheets were found, together with smaller fragments at the site boundary with Oak Road. It is considered that they are the result of fly tipping;
 - 4 no. sets of overhead electricity lines were noted to exist on site, one of which roughly bisects the site running north to south and consists of large lattice tower pylons carrying 3 no. cables. The remaining lines are carried by wooden pylons;
 - Evidence of water services were noted during the walkover. 2 no. below ground chambers were noted in the north eastern part of the site beside the concrete track running south from Oak Road. Missing covers made it possible to see that one of the chambers contains standing water; and,
 - The site boundary is defined for the most part by Oak Road to the north, and Redwither Brook and the River Clywedog to the south. The boundary deviates around several smaller plots of land to the west and the north east resulting in its irregular shape. A bund was noted at the site boundary on the concrete path leading onto the site from the west.

Photographs taken during the site walkover are presented in Appendix 'B'.

3.0 ENVIRONMENTAL ASSESSMENT

3.1 Site History

The history of the site is recorded over selected periods by the maps inspected, selected copies of which are included in Appendix 'C'. The account presented in this report is restricted by specific time periods represented by these maps only.

Available historical Ordnance Survey maps of the site and surrounding area from 1873 to 2016 were inspected. Where the historical maps are unavailable, online record searches and Zetica pre-desk study assessment have been undertaken (World War II period). Significant potential sources of contamination or historical features within 250m of the site are described in Table 1 (below and overleaf).

Table 1 Site History

Period	On Site	Off Site (within 250m)
1873	The site is undeveloped and comprises a number of open fields, unnamed roads and paths. An unnamed brook is present in close proximity to the south western site boundary. Six ponds are present across the site.	The immediate surrounding area consists mainly of open fields with some farm buildings. Unnamed roads are located adjacent to the northern, north eastern and north western site boundary. There are several ponds located around the site and within 250m of the site boundary. The River Clywedog is located adjacent to the south eastern site boundary.
1899-1938	Three ponds are now present on site.	No significant changes.
Online research 1939-1945	The site has been developed as part of the Royal Ordnance Factory (ROF) during the Second World War and comprises six large factory buildings in the north western sector of the site and a number of smaller WWII buildings in the remaining parts of the site. After 1945, the production facilities closed. The site only formed a small part of the much larger ROF, and was located in the centre east part of the complex. A number of roads cross the site providing access to the buildings.	The ROF complex incorporates a large area, with the buildings designed with thick walls with no windows, only small shuttered openings and reinforced roofs. The individual units were surrounded with earth banks both to deflect blasts and to direct any explosives from within the buildings upwards.

Table 1 (Cont...)

Period	On Site	Off Site (within 250m)
1954	The site now comprises six large abandoned buildings in the north western sector of the site and a number of smaller buildings in the remaining parts of the site.	Several buildings of varying size (and unspecified use) and roads are now present around the northern, north western and western part of the site (larger part of abandoned ROF). The buildings and infrastructure form part of the much larger ROF complex and were used in cordite production.
1961-1964	The former factory buildings on site are now shown with blast protection. Additional buildings have been erected in the south eastern sector of the site. Several hydrants are present across the site. Several electricity pillars/posts are present across the site. Water tanks are present in the centre west part of the site. Two ponds are present in the south eastern part of the site. The unnamed brook is now noted as Redwither Brook.	The unnamed road adjacent to the north and north eastern site boundary is now noted as Oak Road. Other roads surrounding the site are now named. Wrexham Industrial Estate, including a large number of unspecified works, is present adjacent to the west, north west, north and north east site boundaries. A railway line is present approximately 100m north of the site boundary. Blast protections are also present around the site.
1972	The electricity pillars/posts have now been replaced with an Electricity Transmission Line with pylons crossing the site through the north western, centre and south centre part. Some hydrants are no longer present on site.	Additional engineering works, depots and factories are now present within Wrexham Industrial Estate, some buildings were demolished, some erected or changed use. Four electric substations are now present within Wrexham Industrial Estate, the closest located approximately 200m north of the site boundary. A number of unspecified tanks are present within Wrexham Industrial Estate, the closest located approximately 190m north east of the site. A filling station is noted to lie approximately 110m north east of the site. A number of ROF bunkers located to the north east of the site have been demolished with a large power cable factory, including unspecified tank, in their place.



Table 1 (Cont...)

Period	On Site	Off Site (within 250m)
1979	The large former factory buildings (ROF) in the centre and north western part of the site are no longer shown.	Further changes and development of Wrexham Industrial Estate have occurred.
1982-1994	The site is now derelict and overgrown.	Further demolition of the ROF buildings located to the north western and north eastern area of the site and development of Wrexham Industrial Estate, including changing of building use. Additional substations are noted, the closest being located approximately 40m north of the site boundary. A pumping station is present approximately 20m west of the site.
2000-2016	No significant changes.	Further changes and development of the Wrexham Industrial Estate is noted, including: • Bowling Bank Garage is located adjacent to the north eastern site boundary; • R&R Engineering is located approximately 10m north east of the site; • J Burton Stone Masonry is located adjacent to the north eastern site boundary; • R&J Motors is located adjacent to the north eastern site boundary; • Higher Oak SAAB Authorised Garage is located adjacent to the north centre site boundary; • Quartzelec Ltd is located approximately 15m north west of the site; • RC Motors is located approximately 25m north west of the site; • Williams is located approximately 40m north west of the site; • Entec is located approximately 50m west of the site; • TRW Automotive Aftermarket is located adjacent to the western site boundary; • S.M. Shepherd CVR is located approximately 80m north west of the site; • Spectrum Business Park is located approximately 150-220m west and south west from the site and includes: • Cooke Bros. (Tattenhall) Limited; • Tt Calco Limited; • C P Pharmaceuticals Limited; and, • Hi-mark Automotive Ltd. The Power Cable Factory is now Premier Decorations Ltd.

3.1.1 On site

The site consisted of a number of open fields from 1873 with unnamed roads and paths crossing the site in various places. There was an unnamed brook in close proximity to the south western site boundary and six ponds present across the site. The site was developed to form part of the wider Royal Ordnance Factory (ROF) Wrexham facility during World War II and was used for the manufacture and storage of cordite – a smokeless explosive made from nitrocellulose, nitroglycerine and petroleum jelly used in ammunition. Due to national security measures at the time, no surveying of the site was undertaken and as such no historical maps exist of the building configurations during the war period.

As a result of the lack of information, exact comments on the changes to the site layout during those years cannot be made; however, a pre-desk study ‘Unexploded Ordnance Survey’ completed by Zetica, has identified that the site occupied an area of banded magazines and explosive stores associated with the No.2 Factory (assumed to be located off-site). Additionally, it also identified anti-invasion defences, including at least 7No. pillboxes on the site.

The most complete historical map closest to that time period is the 1954 map, which shows the site to comprise six large buildings in the north western part of the site and a number of smaller buildings in the remaining sectors of the site. Some of these buildings are thought to be new constructions or refurbishments of old ROF Wrexham storage units used for new industrial uses. There are a number of roads crossing the site and joining the present buildings/bunkers and pillboxes.

ROF Wrexham was progressively closed down at the end of WWII and vacated by 1950. There are, what are believed to be, industrial buildings present on the 1961-1964 mapping in the south eastern sector of the site, which include blast protection. It is believed that these were erected when the site was operational as ROF Wrexham to be used in cordite production and were simply omitted on the 1954 historical mapping. No further information specifying purpose of those buildings is recorded on the historical maps.

Along with the new units, additional infrastructure is present including hydrants, water tanks and electricity pillars/posts. In 1972, the electricity pillars were upgraded to an Electricity Transmission Line with pylons crossing the site through its north western, centre and south centre part. By the 1970s, the large former factory buildings in the centre and north western part of the site had been demolished and from 1982 to 2016, the site appears to have been abandoned and left in a derelict state.

3.1.2 Off site

The subject site formed only a small part of the ROF Wrexham facility (located in its centre east part). Information from the 1954 mapping and online research suggest that the ROF complex was spread over a large area of 700 ha to minimise any damage from aerial attacks.

Historically, the surrounding land use has been predominantly industrial, with a mix of commercial and residential land uses also present.

In the 1960s, the majority of the former ROF became part of the Wrexham Industrial Estate, including many retail units, unspecified works, engineering works, depots and factories, and has continued to expand and undergo development until around 2006 when it reached the size it is today.

The businesses that could pose potential risk to the subject site have been summarised in section 5.1.2. Off-site potential sources and potential contaminants generated by them are included in the Conceptual Site Model.

3.2 Geology, Hydrogeology and Hydrology

It is considered that most of the site is underlain by natural drift deposits of Devensian Till (clay). Alluvium and River Terrace Deposits are also anticipated to be present along the course of the Redwither Brook and River Clywedog. According to the Environment Agency (EA), the Till deposits beneath the majority of the site are designated as an Unproductive Strata, whereas the Alluvium and River Terrace Deposits are both designated as Secondary A Aquifers.

The site is also shown to lie on a geological bedrock boundary, with a large area of the site (south eastern, central and central north) being underlain by the Kinnerton Sandstone Formation (Sandstone) and the remainder of the site (north and north western) underlain by Salop Formation (Mudstone, Sandstone and Conglomerate). According to the Environment Agency (EA), the bedrock beneath the majority of the site is designated as a Principal Aquifer (associated with the Sandstone), with the remainder of the site designated as a Secondary A Aquifer.

The majority of the site, except the stretch along the south western and central western (along the Redwither Brook) and south eastern corner (along the River Clywedog), is considered to be underlain by soils of Low Leaching Potential, in which pollutants are unlikely to penetrate the soil layer.

The north western sector of the site is shown to be within an Outer zone (Zone 2) and centre and centre north part of the site is shown to be within Total catchment (Zone 3).

The Envirocheck report shows the nearest river (primary) to be located 3m south west of the site (Redwither Brook), with another primary river located 15m south east of the site, which appears to be the River Clywedog.

The stretch of the site along the Redwither Brook and the River Clywedog is considered to lie within an Environment Agency Flood Risk Zone (extreme flooding and flooding from rivers or sea without defences).

Part of the site is also located within an area at risk of surface water flooding (low, medium and high), again mainly along the Redwither Brook and the River Clywedog, but also numerous patches across the wider site.

3.3 Coal Mining and Mineral Extraction

3.3.1 Coal Mining

The majority of the site is located in an area which was not historically mined for coal, only the small fragment in the south eastern corner of the site (along the River Clywedog) is located within a coal mining reporting area (development low risk area).

Risks from coal mining generally arise from three distinct failure mechanisms associated with:

- 1) Abandoned, often unrecorded shallow “pillar and stall” workings at or near outcrop;
- 2) Subsidence associated with ongoing or recently completed deep “longwall” mining; and,

3) Collapse of mine entries (adits or shafts).

In this case, the geology dictates that shallow workings can only occur a considerable distance west of the site, as the overlying Kinnerton Sandstone Formation, without any significant coal seams, is at outcrop locally. The risk associated with deep longwall mining from the former Bersham Colliery which closed in 1986, is insignificant as 30 years has elapsed since mine operations were completed. There are no recorded shaft entries within 5km of the site.

The Coal Authority Development Referral Plans (which are available online at <http://mapapps2.bgs.ac.uk/coalauthority/home.html>) indicate that a small portion of the site lies within the “Low Risk Category” within which the following development advice was obtained at the time of the initial data acquisition:

Development Low Risk Area - Standing Advice

The proposed development lies within a coal mining area which may contain unrecorded coal mining related hazards. If any coal mining feature is encountered during development, this should be reported immediately to the Coal Authority on 0345 762 6848.

*Further information is also available on the Coal Authority website at:
www.gov.uk/government/organisations/the-coal-authority*

Property specific summary information on past, current and future coal mining activity can be obtained from: www.groundstability.com

Standing Advice valid from 1st January 2015 until 31st December 2016

3.3.2 Mineral Extraction

The Envirocheck report details the following mineral related information:

- There are no BGS Recorded Mineral Sites located within 1km of the site;
- There are no natural or manmade mining cavities within 1km of the site; and,
- The site is not located within a Brine Compensation Area.

3.4 Environmental Considerations

Specific details relating to the environmental setting of the site are presented within the environmental database report (available upon request). The salient issues which relate to the site are summarised as follows:

- There are no Control of Major Accident Hazard Sites (COMAH) within 1km of the site;
- There are no Notification of Installations Handling Hazardous Substances (NIHHS) sites within 1km of the site;
- There are thirty six Contemporary Trade Directory Entries located within 250m of the site, the nearest three are located 16m east (Higher Oak Garage - vehicle sales), 20m east (D K Motor Services - car body repair and painting services) and 28m east (R&J Motors – car repair services);
- There are no Contaminated Land Register Entries and Notices located within 1km of the site;
- There are no Integrated Pollution Controls within 250m of the site;
- There are eleven Integrated Pollution Prevention and Control entries within 250m of the site, the nearest is located 119m east of the site (Hlc Waste Management Services Ltd with a valid status and permit number Bk8303);
- There are no Local Integrated Pollution Prevention and Control entries within 500m of the site;
- There are two Local Authority Pollution Prevention and Controls within 250m of the site, the closest is located 40m north of the site (R C Motors Wrexham Ltd with status permitted and permit reference WCBC/PG1/1RCM);
- There are no Local Authority Pollution Prevention and Control Enforcements within 500m of the site;
- There is one Substantiated Pollution Incident located on site and three located within 250m of the site. The incident on site occurred on 14th July 2002 (pollutant: smoke) with significant air impact, minor water impact and no land impact. The nearest off site incident was located 35m north west of the site and occurred on 25th May 2007 (pollutant: firefighting run-off) with significant water impact, minor air impact and no land impact;
- There are two Pollution Incidents to Controlled Waters on site and ten located within 250m of the site. Both on site incidents occurred in Water Company Sewage, Pickhill Bridge, one regarding chemicals – other inorganic (blocked sewage) and the other farm effluent/slurry (mechanical failure);
- There are no Prosecutions Relating to Authorised Processes located within 500m of the site;

- There are three Registered Radioactive Substances entries within 250m of the site, the nearest is located 175m north of the site (Eurocare Environmental Services Ltd with status of authorisation superseded and permit reference Bi3024);
- There are no Planning Hazardous Substance Consents or Enforcements within 1km of the site;
- There are six Discharge Consents located within 250m of the site, the nearest one being located 4m south west of the site in Wrexham Recycling Centre Rewither on 31st October 2002 (regarding trade discharges into freshwater stream/river);
- There are no Prosecutions Relating to Controlled Waters within 1km of the site;
- There are two Enforcement and Prohibition Notices within 250m of the site, the nearest is located 174m north of the site (Clinical Waste Incinerator on 18th February 2001 regarding disposal of liquid waste by methods other than incineration). The second is located 178m north of the site (Clinical Waste Incinerator on 22nd September 2000 regarding the identification of actual and potential contraventions of the authorisation with regard to monitoring of emissions);
- There is one active Fuel Station located 454m north east of the site;
- There are no Explosive Sites within 1km of the site;
- The site is not located within a Nitrate Vulnerable Zone; and,
- There are no environmentally sensitive sites located within 500m of the site.

3.5 Radon

The Building Research Establishment have produced their revised document BR211 (“Radon guidance on protective measures for new buildings” 2007 Edition). This provides a staged framework to determine whether radon protective measures should be afforded to new buildings.

The Envirocheck report is incomplete and only details the north western sector of the site where it states that part of this sector lies within a lower probability radon area (whereby less than 1% of properties are above the action level), and the other part lies within an intermediate probability radon area (whereby 5 to 10% of properties are estimated to be at or above the action level).

Therefore, for the purpose of this report, it has been assumed that the entire site is located in an intermediate probability radon area, whereby 5 to 10% of properties are estimated to be at or above the action level, where basic radon protective measures are necessary in the construction of new dwellings or extensions. This is to be confirmed by the Local Building Control Officer before commencing any site works.

3.6 Asbestos

During the site walkover on Tuesday 6th September 2016, potential Asbestos Containing Material (ACM) was noted in the north eastern area of the site. Several large fragments of corrugated cement sheeting were found beside the concrete track running south west from Oak Road and some smaller fragments were found at the end of the track on Oak Road itself. These are believed to be a result of fly tipping.

Asbestos Containing Material (ACM) may still be present within structures associated with the former ROF (assuming that the material was not removed in a controlled manner upon decommission). It is the duty of the principal / demolition contractor to satisfy themselves that no asbestos is present within the buildings prior to demolition.

3.7 Landfill and Waste Treatment Sites

- There are no Historical Landfill Sites located within 250m of the site;
- There are no BGS Recorded Landfill Sites located within 1km of the site;
- There are no Registered Landfill Sites located within 250m of the site.
- There are no Local Authority Recorded Landfill Sites located within 250m of the site.
- There are two Integrated Pollution Control Registered Waste Sites located within 250m of the site. Both are under the same address and are located 175m and 179m north of the site (Sterile Technologies (Newcastle) Ltd, permit references: Bi1595 and Bm2349, dealing with incineration within the waste disposal industry; status: authorisation superseded and revoked – now IPPC);
- There are eight Licensed Waste Management Facilities (Locations) located within 250m of the site. The nearest is located 86m north west (Bluestone Chemicals Ltd, site category: treatment – chemical with licence expired);
- There is one Registered Waste Transfer Site within 250m of the site. It is located 191m north west of the site (Reynolds services – North Western Insul', with licence reference: EAWML37221 with very small input rate and no known restriction on source of waste); and,
- There are six Registered Waste Treatment or Disposal Sites within 250m of the site. The nearest is located 92m north west of the site (Bluestone Chemical Ltd, with license reference NOW-524-L (L76) with very small input rate and waste produced/controlled by licence holder).

3.8 Ground Gas

According to the Envirocheck report, there is one potentially infilled water body on site and twelve others within 250m of the site. Given that the historical mapping indicates six ponds to have been present on site in 1873, with only two remaining in the south east section of the site by 1964, it is likely that there may be a number of infilled water bodies across the site.

In the haste to construct the Royal Ordnance Factory during the war years, it is likely that the ponds were not excavated in their entirety down to suitable non-organic ground, but were backfilled until the ground was suitable to house the facilities. With this in mind it is likely that there still exists unknown thicknesses and occurrences of organic material, which could pose a hazardous ground gas generation potential.

Made Ground associated with the demolition of former and current buildings may also give rise for the generation of hazardous ground gases (methane and carbon dioxide) through the potential decomposition of organic matter.

3.9 Local Authority Planning Information

Opus has undertaken a search of Wrexham County Borough Council Planning Portal to review any information relevant to the site. The following environmentally pertinent information was found:

- R & R Engineering, Oak Road, Wrexham, LL13 9RG; Extension to existing storage building (case number: P/2010/0852, date 07/10/2010; decision: granted).



3.10 Unexploded Ordnance (UXO)

According to the Regional Unexploded Bomb Risk map provided by Zetica, the site lies within an area of low bomb risk.

Zetica was contacted to produce a Pre-Desk Study Assessment identifying potential sources of Unexploded Ordnance (UXO) on site and discuss whether enemy bombing may provide a potential risk to the site. The full Pre-Desk Study Assessment and Regional Unexploded Bomb Risk map are included in Appendix 'D'.

The Zetica Pre-Desk Study Assessment has identified WWII Military Activity on or affecting the site as previously identified. The cordite section of the wider ROF was served by at least 3No. Nitroglycerine and 2No. Nitrocellulose works. The subject site occupied an area of banded magazines and explosive stores associated with No. 2 Factory. During WWII the site was in the Rural District (RD) of Wrexham. Wrexham RD officially recorded 278No. High Explosive (HE) bombs with a very low bombing density of 3.8 bombs per 405ha.

This would indicate that the overall risk associated with UXO is high, however there are no readily available records of HE bombs falling on or in close proximity to the site and further research appears to corroborate this. Documented reports of former employees of the ROF, from the Archive of WWII Memories collated by the BBC, suggest that the ROF was not bombed during the war. As a result, it may be possible to reduce the risk rating to Low, however it is recommended that, prior to doing so, a detailed UXO Desk Study is obtained to assess and possibly zone the hazard level on site prior to any SI. The UXO Desk Study can also inform safe working procedures for the SI and construction workers.

Opus has provided a detailed scope of a UXO Desk Study and Risk Assessment, which is also attached as Appendix 'D'.

3.11 Ecological Sensitivity

According to DEFRA's online interactive map, the site does not lie in any Sites of Special Scientific Interest, Areas of Outstanding Natural Beauty or National Nature Reserves.

Possible Himalayan Balsam was recorded in large quantities in the north eastern, eastern and southern areas of the site, particularly along the banks of Redwither Brook and the River Clywedog, along with Japanese Knotweed (refer to Kingdom Ecology Ltd.'s Ecological Assessment, dated November 2016) also along the bank of Redwither Brook. Suspected Giant Hogweed was also detected around the site in low densities. A man-made pond located in the south east corner of the site was found to contain smooth newts, which are not a protected species (refer to Kingdom Ecology Ltd.'s Ecological Assessment). The entrance to a rabbit warren was noted in the southern area of the site.

4.0 GEOTECHNICAL ASSESSMENT

4.1 Ground Conditions

The following assessment of the ground conditions expected on site is based solely on the desk study information and data obtained from the British Geological Survey (BGS) (summarised in Table 2 overleaf) and Technical Report WA/91/4 “Applied geological mapping in the Wrexham area: geology and land-use planning.”. An online search of BGS borehole data indicates a significant amount of information available with respect to the general surrounding area.

For the purpose of this report, nine borehole records (SJ34NE42 – 60.5m begl, SJ34NE44 - 59.93m begl, SJ34NE121 – 47.00m begl, SJ34NE120 – 45.10m begl, SJ34NE34/1 – 34.44m begl, SJ34NE34/4 – 34.14m begl, SJ34NE34/6 – 30.48m begl, SJ44NW1 – 47.85m begl and SJ34NE25 – 18.00m begl) have been selected, which are located to the south west, west, north west (parallel to Redwither Road), north (parallel to Oak Road) and north east (approximately 1.5km from site) of the site, with one located within the north western boundary of the site (between Oak Road and TRW Automotive Aftermarket).

The site’s Ground Level varies, with the highest point located just north centre of the site (34m AOD); and the lowest point located beside the River Clywedog in the south east corner of the site (24m AOD). Consequently the thickness of drift materials (alluvium and glacial strata combined) is expected to vary accordingly. It has to be noted that much of the northern central part of the site is anticipated to be elevated locally due to demolition of the buildings historically present there.

The existing BGS boreholes (reviewed in Table 3 overleaf) identified the base of the superficial drift materials (top of possible sandstone bedrock – Salop Formation – between 59.93 and 60.50m begl). Possible Kinnerton Sandstone bedrock was encountered at 47.85m begl. The overlying cohesive deposits were recorded starting between 58.20 – 59.90m begl and ending between 59.60 – 59.93m begl. Above those basal sands and gravels deposits starting between 32.30 – 59.60m begl and ending between 46.00- 60.50m begl. The basal sands and gravels are overlain by cohesive deposits starting between 0.30m begl (beneath topsoil) or 1.00m begl (beneath Made Ground) and ending between 32.30 – 51.30m begl. The cohesive deposits are overlain by either topsoil or Made Ground.

Table 2 BGS Published Information

Borehole No	Date	Owner	Depth [m begl]	Title
SJ34NE42	N/A	Institute of Geological Science	60.50	Dee & Clwyd, River Division
SJ34NE44	1979	Institute of Geological Science	59.93	Wrexham Industrial Estate
SJ34NE121	1987	Strata Surveys Ltd. Middleswich	47.00	Wrexham Industrial estate, Chem. Disposal. 2A
SJ34NE120	1987	Strata Surveys Ltd. Middleswich	45.10	Wrexham Industrial estate, Chem. Disposal. 1A
SJ34NE34/1	1966	N/A	34.44	Wrexham Ind Est. Bicc Site. 1
SJ34NE34/4	1966	N/A	34.14	Wrexham Ind Est. Bicc Site. 4
SJ34NE34/6	1966	N/A	30.48	Wrexham Ind Est. Bicc Site. 6
SJ44NW1	1903	Geological Survey and Museum, South Kensington	47.85	Roddens Hall Sutton Green
SJ34NE25	1977	Institute of Geological Science	18.00	Redwither, Abenbury

Table 3 BGS Geology

Stratum	Occurrence	Typical depth[begin]	Comment
Made Ground	Across the site	Typically up to 1.00m	Unsuitable founding stratum
Alluvium	Along River Clywedog – south eastern corner of the site	Not proven	Unsuitable founding stratum
River Terrace Deposits	Along Redwither Brook	Not proven	May be suitable founding stratum
Glacial Drift	Across the majority of the site	Typically: 1. Below topsoil (0.30m) or Made Ground (1.00m) and ends between 32.30 – 51.30m; and, 2. Starts between 58.20 – 59.90m and ends between 59.60 – 59.93m.	Likely to be suitable founding stratum. Proven in SJ34NE42 and SJ34NE44
Basal Sand and Gravel	Across the site	Typically starts between 32.30 – 59.60m and ends between 46.00 – 60.50m	Suitable founding stratum. Proven in SJ34NE42, SJ34NE44 and SJ34NE121
Bedrock (Salop Formation)	North and north western part of the site	Between 59.93 – 60.50m and is not proven	Suitable founding stratum. Encountered in SJ34NE42, and SJ34NE44
Bedrock (Kinnerton Sandstone)	Across the majority of the site	47.83m	Borehole located approximately 1.50km north east of the site.

4.1.1 Anticipated Material Characteristics

The following materials can reasonably be anticipated to be present on site:

- Made Ground;
- Alluvium;
- River Terrace Deposits;
- Glacial Till;
- Basal Sand and Gravel;
- Salop Formation Bedrock; and,
- Kinnerton Sandstone Formation Bedrock.

Each of these is described in broad engineering terms in turn below. It should be noted that all parameters identified are subject to review pending completion of site specific investigation, in-situ testing and laboratory testing.

- **Made Ground**

Likely to comprise remains of the former and current buildings, may include voids / old basements, concrete and tarmac obstructions requiring breaking out, together with oversize gravel, metal, glass, household rubbish, industrial waste and blast protection mound. Engineering geology characteristics are site specific dependent on type of fill and method of emplacement. Locally the made ground soils are known to comprise a dark red brown, soft to firm consistency slightly silty clay.

- **Alluvium**

Likely to be compressible clay material – potentially with peaty / organic horizons. Variable thickness depending on old meander patterns of natural river system. Alluvial deposits consist of soft clays c. 1.50m thick, medium dense clayey fine sand, c. 3.00m thick; medium dense silty sand and gravel from 0.50 to 7.00m thick.

- **River Terrace Gravel**

River Terrace deposits typically sands and / or gravels and locally cobbles and boulders and thin bands of firm silty clay and clayey silt up to 1.50 m thick. Clays compressible with low bearing capacity, unsuitable as fill. Excavations need support and dewatering.

- **Glacial Till**

Glacial drift is the coarsely graded and extremely heterogeneous sediment of a glacier; till is the part of glacial drift deposited directly by the glacier. Its content may vary from clays to mixtures of clay, sand, gravel, and boulders. Where present, it is likely to be mainly silty sandy clays with gravel cobbles and occasional boulders. Bands of sand and gravel which can be water bearing. Clays of low to intermediate compressibility with small settlements. Excavations stable in short term but may deteriorate on wetting. Suitable as fill at low moisture content.

- Basal Sand and Gravel

Likely to consist of a dense or very dense coarse sub-angular and angular gravel with cobbles and boulders. The material will be locally derived and is anticipated therefore to reflect local bedrock materials i.e. will be predominantly sandstone and mudstone.

- Salop Formation Bedrock

Red and red-brown mudstone, and red-brown (mostly sublitharenite) sandstone containing beds of pebbly sandstone and conglomerate itself containing Carboniferous limestone and chert clasts, and thin '*Spirobis*' limestone beds and caliche in the lower part of the unit.

- Kinnerton Sandstone Formation

Sandstone, red-brown to yellow, generally pebble-free, fine- to medium-grained, cross-stratified. Dominantly Aeolian. Coarse grained and cemented when fresh but weather to a sand which may be water-bearing giving rise to running conditions.

4.2 Foundation Design

At this juncture, Opus has not been provided with the details of any formal site layout plans incorporating structural loading or proposed sites levels. However, we have been informed that the proposed development will likely comprise industrial units (warehouses etc) with associated access roads and car parking area.

Shallow strip footings and extended strips are only likely to be viable for relatively small, lightly loaded building units in those areas where Made Ground is relatively thin and alluvium is absent. For larger footprint, and heavily loaded building structures it is likely that some form of ground improvement, semi or full raft foundations, or piled foundations will be required.

A foundation zone plan based on the results of intrusive geotechnical site investigation establishing depth to competent material should then be developed. In areas where the depth to competent stratum exceeds around 1.75m, alternative foundation solutions as referenced above may be required including i.e. the potential use of rafts and/or piles.

Foundation depths should take account of the presence of existing and proposed trees with foundations deepened locally in accordance with the requirements of NHBC Standards (adopted by the Building Control in terms of providing Building Regulation Approval) where foundations are seated on clay soils. It is recommended that at working drawing stage a foundation schedule is prepared for the development taking account of the soil plasticity and the locations of trees.

A detailed intrusive geotechnical site investigation will be required to confirm the most appropriate foundation options.

5.0 INITIAL CONCEPTUAL SITE MODEL (ICSM)

This ICSM has been produced to identify potential contamination sources, migration pathways and receptors within the study area in accordance with Environment Agency guidance CLR 11 (2004) and BSI 10175 (Code of Practice for Investigation of Potentially Contaminated Land).

5.1 Potential Sources of Contamination

5.1.1 On-site Potential Sources

Made Ground associated with the demolition of former buildings may give rise to the following contaminants:

- Toxic heavy metals (from paint and pipe work);
- Sulphates and acidic pH soil from acids used in nitroglycerine production (Sulfuric Acid - 57% and Nitric Acid - 43%);
- Polycyclic Aromatic Hydrocarbons (PAHs) from the incomplete combustion of solid fuels used on site;
- Semi Volatile and Volatile Organic Compounds (SVOCs and VOCs) used as solvent cleaning agents (such as Acetone, ethanol, cyclohexanone etc...);
- Asbestos Containing Material (ACM) may be present, associated with the age and construction of the buildings (assuming that the material was not removed in a controlled manner);
- Total Petroleum Hydrocarbon fractions (TPH) associated with heating oils, fuel oils and other mineral oils used by machinery, all of which are likely to have been stored on the site;
- Possible buried/forgotten explosive waste may be present on site in the areas occupied by former bundled magazines and explosive stores associated with former Factory No.2, (waste explosives materials can pose a hazard either through their accidental deflagration or through their toxicity to humans, animals and plants);
- Small scale and localised Polychlorinated Biphenyls (PCBs) associated with the transformers or other equipment previously used on the electricity pillars noted on site and constructed in the 1960s; and,
- Hazardous Ground Gases (methane and carbon dioxide), through the decomposition of organic matter in both the Made Ground and potentially infilled water bodies.

Following review of the Historical Scoping Report, produced by Townscape in March 2017, together with documented archive information and statements, it is considered highly likely that the site was used primarily for storage. Although the historical storage of chemicals could potentially pose an on-site risk, it is unlikely that existing contaminants (such as Nitrocellulose, Nitro-glycerine) from the cordite manufacturing processes, will still be present in significant quantities on site when considering the half-lives of the above primary constituents (<10 minutes for Nitro-glycerine) and the 60 + years since operations ceased on site.

It is anticipated that there is a **low to moderate** risk from on-site contaminants associated with the historical use of the site and from Made Ground deposits.

5.1.2 Off-site Potential Sources

Historically (aside from the ROF) the surrounding land use has been predominantly industrial, with a mix of commercial and residential land uses also present (see Table 1 in Section 3). The potential contaminants associated with the ROF as listed in Section 5.1.1 are also viable off-site sources (as the manufacturing and storage was spatially distributed across the wider area. Rather than list those contaminants again, Opus has reviewed the most significant and viable land uses in the vicinity of the subject site and their associated potential contaminants. The summary is as follows:

- Car Service, body shops and workshops (Bowling Bank Garage, R&J Motors, Higher Oak SAAB Authorised Garage, RC Motors, TRW Automotive Aftermarket, S.M. Shepherd CVR, Williams)
 - » Heavy metals, PAHs, non-chlorinated and chlorinated solvents, paint coatings, thinners, inorganic compounds and detergent constituents (within vehicle washing areas);
- Premier Decorations Ltd (former Power Cable Factory) as an electric lighting equipment factory
 - » Heavy metals, phosphors and PCBs; there is an unspecified tank located on site, which may potentially have contained fuels or heating oil, giving rise to the potential for TPHs and PAHs to impact the site through migration of leaks and spills;
- R&R Engineering (steel engineering)
 - » Heavy metals, TPHs, PAHs, non-chlorinated and chlorinated solvents;
- Entec (metal recycling)
 - » Heavy metals, TPHs and PAHs;
- Quartzelec Ltd (electrical and electro-mechanical) as an electric boxes and coil manufacturer
 - » Heavy metals (such as copper), phosphors and PCBs;

It is anticipated that the present day uses of Wrexham Industrial Estate, including storage of potentially hazardous materials and waste streams generated in the various businesses, are actively managed to ensure minimal environmental impact. It is therefore considered that the overall risk associated with the above off-site sources is **low to moderate**.

5.2 Migration Pathways

Migration pathways are defined as the courses chemicals take from a source to an exposed organism or receptor. The exposure pathway can be direct (i.e. stays within the same exposure media) or indirect transport from one medium to another takes place.

Receptors may be potentially at risk from the identified potential sources of contamination via the following pathways:

- Migration of mobile contaminants on or off site via services, sewers and manmade conduits;
- Direct contact, ingestion and inhalation of contaminants on site;
- Breathing dust / fibres and vapours from contaminated soil in outdoor air. Vapours can also migrate into buildings resulting in inhalation by the occupants;



- Certain hydrocarbon compounds (historically used / stored at the site) may impact controlled waters via leaching and / or vertical / lateral migration;
- Migration of hazardous ground gas and/or vapours via permeable strata and service ducts into indoor air or other enclosed spaces or excavations; and,
- Conflagration and explosion caused by uncontrolled detonation of discarded/buried historical ordnance/explosives (UXO).

5.3 Receptors of Contamination

Receptors are defined as human or non-human organisms that have the potential to experience adverse effects from direct or indirect exposure to contaminated material.

5.3.1 Human Receptors:

The following potential human health and environmental receptors have been identified:

- Site investigation and construction workers during the redevelopment (acute exposure);
- Future site users; and,
- Users of adjacent areas due to off-site migration of gases, vapours or contaminated dust.

Neighbouring site users, site investigation contractors and construction workers are only considered to be receptors during the construction phase of works due to the potential presence of ACM in the Made Ground. Basic dust control and appropriate PPE should suffice to mitigate against the risks to these receptors.

Control measures are likely to be recommended in the UXO Desk Study, which will help in minimising the risk of encountering UXO.

5.3.2 Controlled Waters

The following potential controlled waters receptors have been identified:

- Redwither Brook;
- River Clywedog;
- The Alluvium/River Terrace deposits (Secondary A Aquifers);
- Kinnerton Sandstone Formation (Principal Aquifer); and,
- Salop Formation (Secondary A Aquifer).

5.3.3 Ecological Sites / Ecosystems

The Kingdom Ecology Ltd's Ecological Assessment Report, dated November 2016, concludes that the site is considered to be of ecological importance supporting botanical and invertebrate features assessed as being of District value together with locally important breeding birds and bats.

The site has previously been of greater ecological value, with its designation of Local Wildlife Site in 1994, due to its variety of species-rich grassland and scrub. The Report has concluded that, without further management of the site, key habitats will deteriorate further with the ultimate loss of flower-rich grasslands and the various wildlife reliant upon them.

The report further recommends the reversal of the impacts of scrub invasion and restoration of varying habitats by encouraging extensive areas of flower-rich grassland with tall grassland, scrub and wetlands. It further considers the enhancement of the site's nature conservation value by retaining an appropriately sized area of the key habitats and with obligations through the planning system to secure long term management of the site.

For further information, refer to the Assessment Report.

6.0 RESULTS AND RECOMMENDATIONS

6.1 Results

Consideration of any on-site contamination will need to be made in the context of the proposed development. At this stage, it is understood that the site is to be redeveloped with commercial end use.

The desk study indicates that the site was predominantly agricultural land prior to World War II, when it was developed into part of the Royal Ordnance Factory Wrexham with associated infrastructure. The site is considered to have occupied an area of bunded magazines and explosive stores associated with the No. 2 cordite Factory (assumed to have been located off-site). After the war, production facilities at ROF Wrexham closed, however many of the buildings were left in place and taken over for various commercial / industrial uses. During the 1970s, buildings in the centre and north western part of the site were demolished and the former 1960s electricity infrastructure (which crossed the site) was upgraded to an Electricity Transmission Line with pylons. The site appears to have been abandoned since the 1980s until present day.

A pre UXO desk study provided by Zetica noted that Wrexham Regional District officially recorded 278No. High Explosive (HE) bombs with a very low bombing density of 3.8 bombs per 405ha. However, there are no readily available records of HE bombs falling on or in close proximity to the site. The Townscape Historical Scoping Report further suggests that the buildings were dispersed and earth bounded over a large and wide area, making bombing from the air almost impossible. When considering this and the potential for discarded / buried historical ordnance, the overall risk associated with UXO is considered as **low**, however it is suggested that a detailed UXO desk study is undertaken to confirm this prior to any intrusive investigation on site.

The majority of the site is anticipated to be underlain by Made Ground (expected to be typically approximately 1.00m in thickness, locally deeper where previous structures were constructed), underlain by natural deposits of alluvium and glacial deposits, varying accordingly to existing site levels. Superficial drift materials are expected to be underlain by sandstone bedrock (Kinnerton Sandstone Formation) and mudstone, sandstone and conglomerate (Salop Formation).

A number of areas of the site are located within an area at risk of surface water flooding (low, medium and high). These are mainly located along the south western and central western (along the Redwither Brook), south eastern corner (along the River Clywedog) and numerous other patches across the site.

Possible Himalayan Balsam was recorded in large quantities in the north eastern, eastern and southern part of the site, particularly along the banks of Redwither Brook and the River Clywedog. Suspected Giant Hogweed was also found around the site in low densities. A man-made pond located in the south east corner of the site was found to contain smooth newts, which are not a protected species, during surveys undertaken by Kingdom Ecology Ltd.

The Initial Conceptual Site Model has identified on site potential sources of contamination including Asbestos Containing Materials (ACM), TPH, PAH, toxic heavy metals, PCBs, chlorinated and non-chlorinated solvents and hazardous ground gases all associated with the historical activities on and surrounding the site. Whilst potential pollutant linkages are present, the site has been deemed to have a **low to moderate** of on-site contamination given the age since activities ceased and the expected localised containment of any impact.

It is considered unlikely that existing contaminants (such as Nitrocellulose, Nitro-glycerine) from the cordite manufacturing processes, will still be present in significant quantities on site when considering the half-lives and the 60 + years since operations ceased on site.

6.2 Recommendations

A detailed intrusive Site Investigation (SI) will be able to assess the thickness and composition of Made Ground, bearing capacity, physical and strength properties of the superficial drift and also determine the depth to solid geology, all of which may then be used to aid in determination of the most appropriate foundation solution. The SI should also be designed to assess the chemical composition of the underlying ground conditions across the site to confirm the findings of the initial conceptual site model.

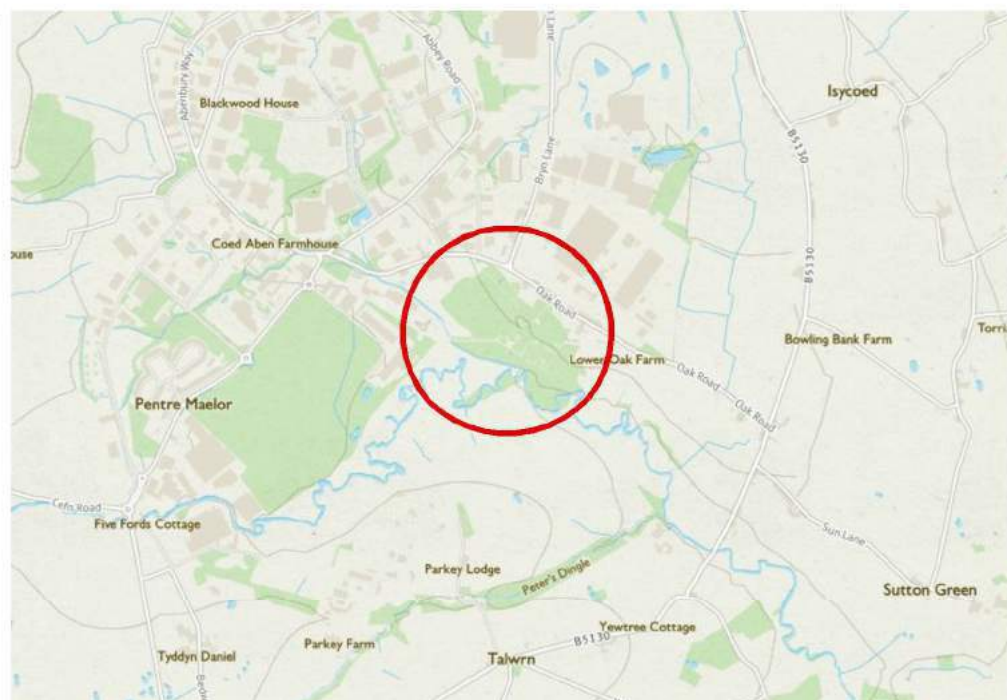
A detailed flood risk assessment should be undertaken in the stretch of the site located within an EA Flood Risk Zone. Also, the risk of surface water flooding across the site should be assessed.

Despite the residual low risk rating of the site in terms of Unexploded Ordnance (UXO), it is recommended that a detailed UXO Desk Study should be undertaken to confirm this prior to any intrusive SI. The UXO Desk Study can also inform safe working procedures for the SI and construction workers.

APPENDIX A

Drawings





Cefn Park Developments Ltd



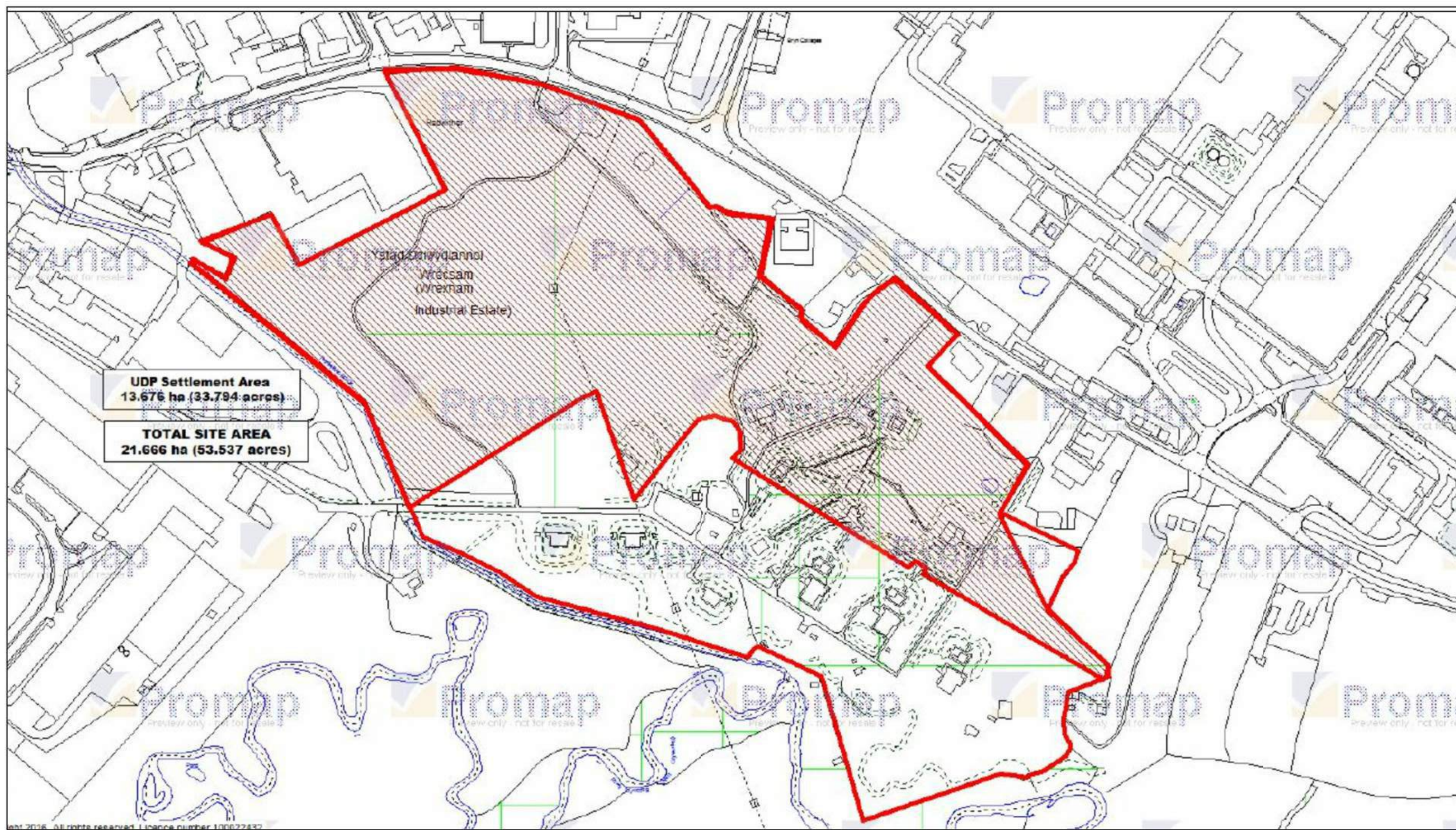
OPUS
Manchester Office
+44 161 873 7400

5th Floor, MacLaren House
Talbot Road
Manchester M32 0FP

Project
The Oaks, Oak Road Wrexham Industrial Estate

SITE LOCATION PLAN

Revision			Amendment			Approved Date			Designed			Approved			Approved Date			SITE LOCATION PLAN			
									</												



UDP Settlement Area
13.676 ha (33.794 acres)

TOTAL SITE AREA
21.666 ha (53.537 acres)

NOTES

1. DO NOT SCALE.
2. This drawing is to be read in conjunction with all other relevant drawings.
3. All boundaries are approximate.

KEY

— SITE BOUNDARY

Revision	Amendment	Approved	Revision Date

Cefn Park Developments Ltd



OPUS

Manchester Office
+44 161 873 7400

5th Floor, MacLaren House
Talbot Road
Manchester M32 8FP

Designed	Approved	Approved Date
MJ	SH	SEP 2016
Drawn	Scales	
MJ	Not to Scale	

Project The Oaks, Oak Road Wrexham Industrial Estate	
Sheet Site Plan	
Sheet No. 02	Revision -

1:1
@ A3
0 10 20 30 40 50 mm

APPENDIX B

Site Walkover Survey Photographs





Plate 1:

General view into the site from the access point opposite Abbey Road facing south west.



Plate 2:

General view of the compacted gravel area at the north of the site facing south east.





Plate 3:
Typical view of the landscape in the north and east portions of the site.



Plate 4:
Typical view of the wooded area along the southern boundary of the site.



Plate 5:
Example of the mature trees which exist on site.



Plate 6:
Typical wooden electricity pylon.





Plate 7:
Typical metal lattice electricity pylon.



Plate 8:
Typical view along the concrete paths on the site.





Plate 9:
Front view of the large building at the north of the site facing south east.



Plate 10:
Example of a damaged building in the north east area of the site.





Plate 11:
Typical example of concrete box tunnels on site.



Plate 12:
Tower located in the north east area of the site near Oak Road, looking north west.





Plate 13:
Tank cradles located in the north east area of the site.



Plate 14:
Detailed view of an open manhole located in the central area of the site.





Plate 15:
View of the water chamber covers located in the north east area of the site looking north west.



Plate 16:
Redwither Brook flowing south at the south western boundary of the site.





Plate 17:

**View of an open area of the River Clywedog near the southern end of the site.
Note Himalayan Balsam in the left of the picture.**



Plate 18:

**Typical view of the Himalayan Balsam growing along the southern boundary of
the site beside the water courses.**





Plate 19:
Typical view of a path through the Himalayan Balsam growing along the southern boundary of the site beside the water courses.



Plate 20:
General view over a manmade pond / water container in the south west corner of the site looking north east.





Plate 21:
Detailed view of a suspected Smooth Newt in the manmade pond.



Plate 22:
Rabbit warren entrance located in the south western area of the site.



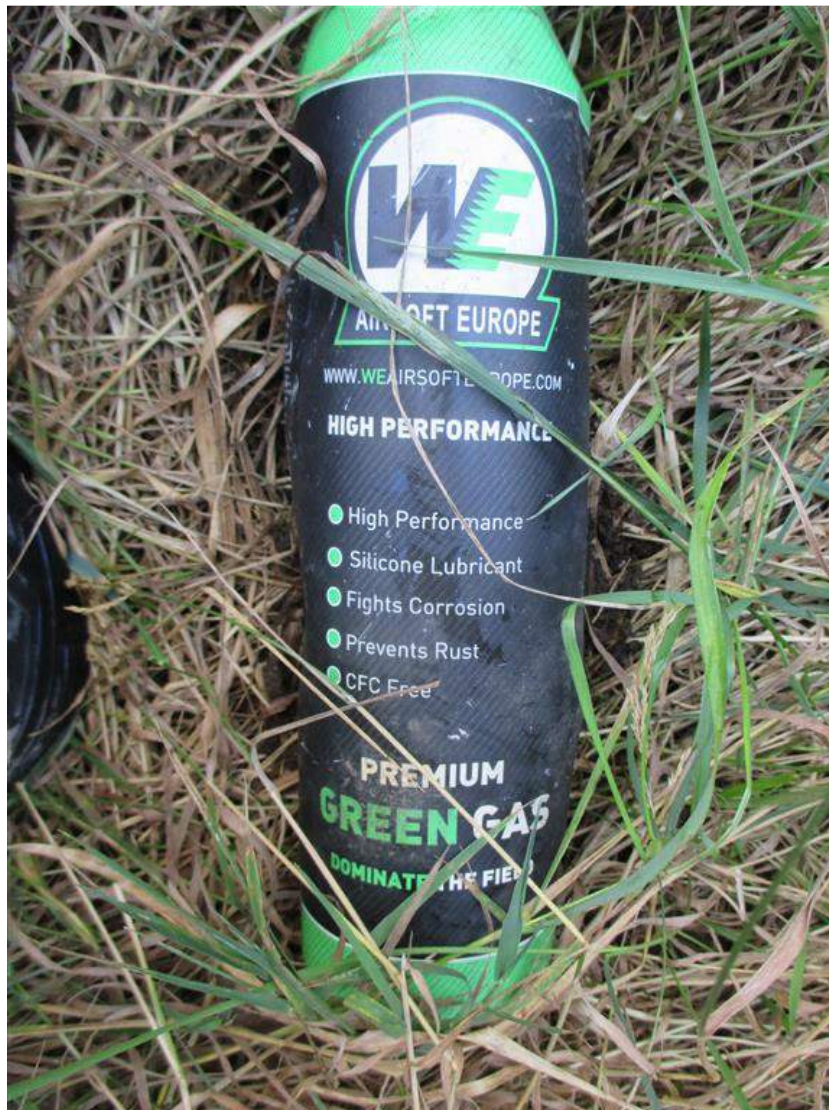


Plate 23:
Detailed view of discarded gas canister associated with airsoft located in the northern end of the site.





Plate 24:
Possible ACM found in the north east area of the site near Oak Road.



Plate 25:
Fragments of possible ACM by the north eastern site boundary with Oak Road.





Plate 26:
General view into the site from the access point from Oak Road in the north east of the site.



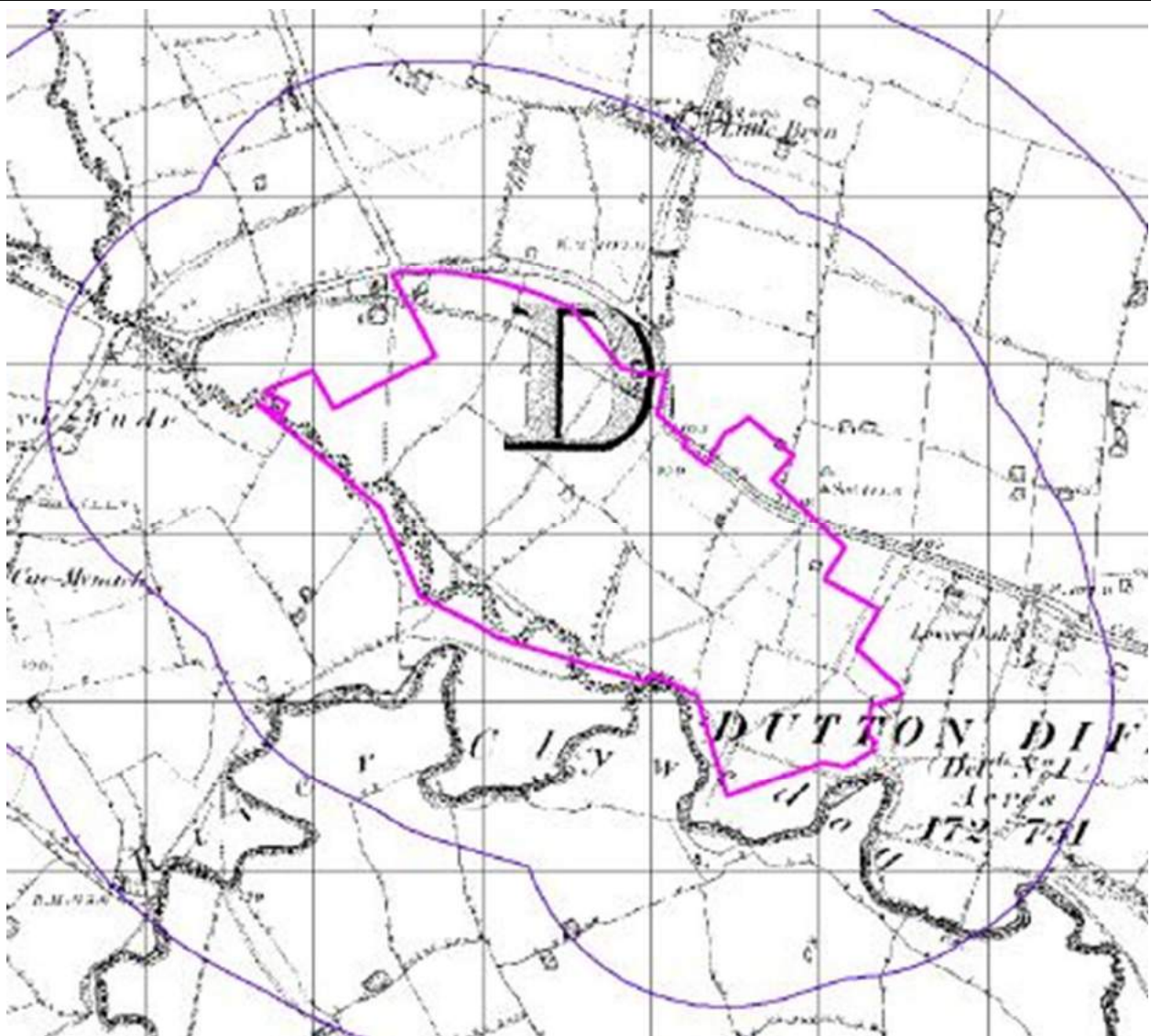
Plate 27:
Bund located at the south western site boundary.



APPENDIX C

Historical Plans

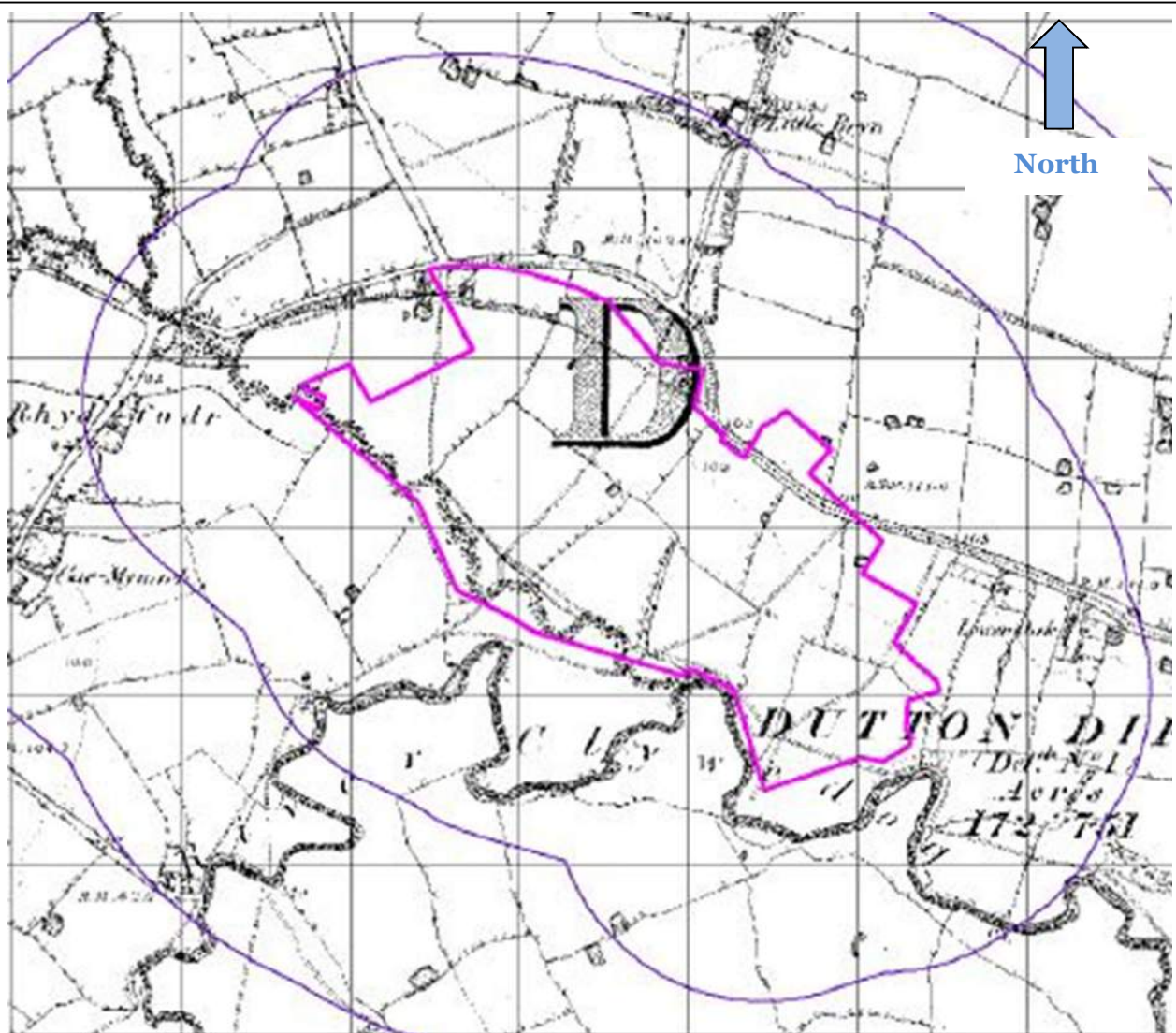




Historical Map

Dated: 1879

Original Scale: 1:10,560

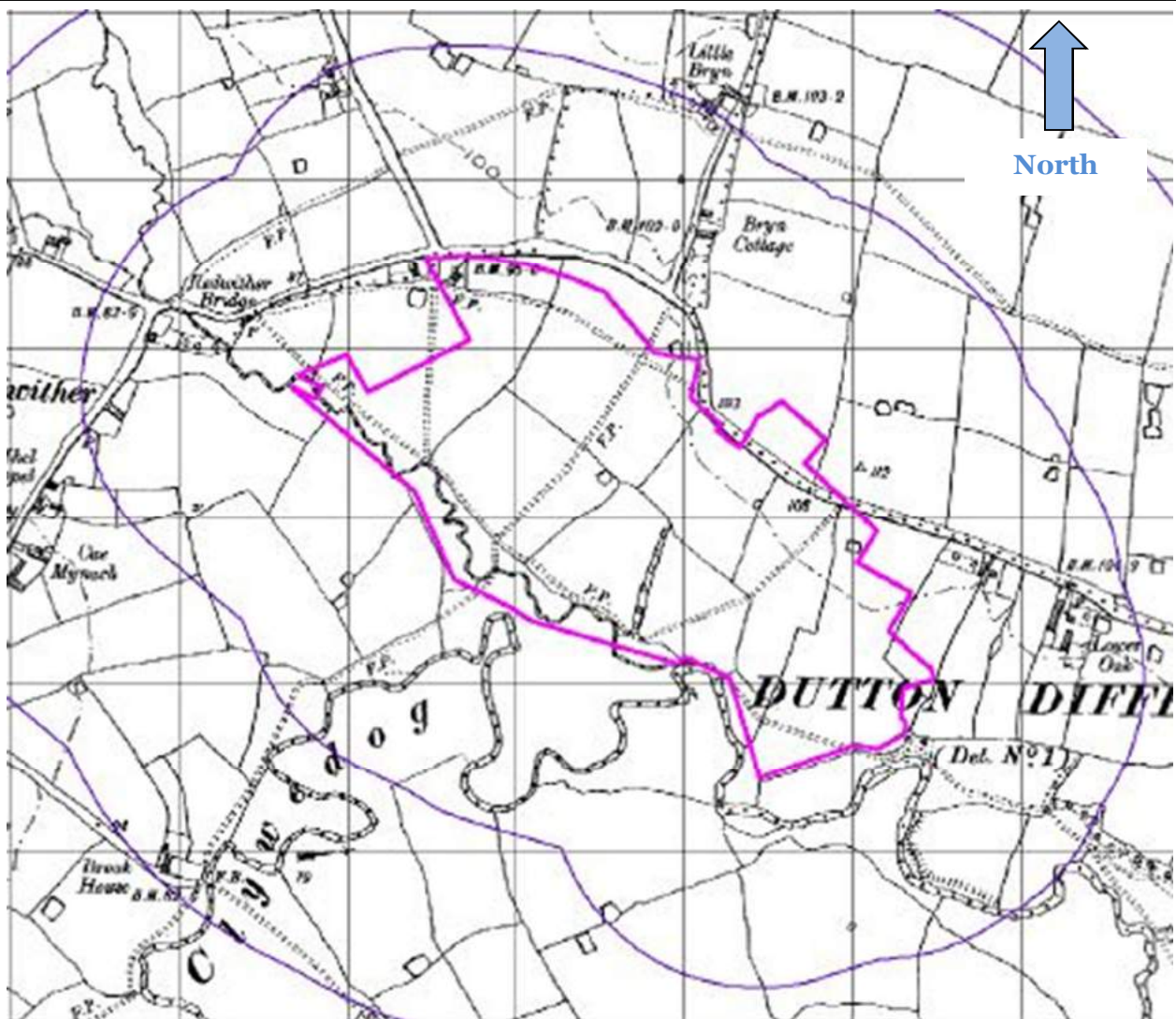


OPUS

Historical Map

Dated: 1881

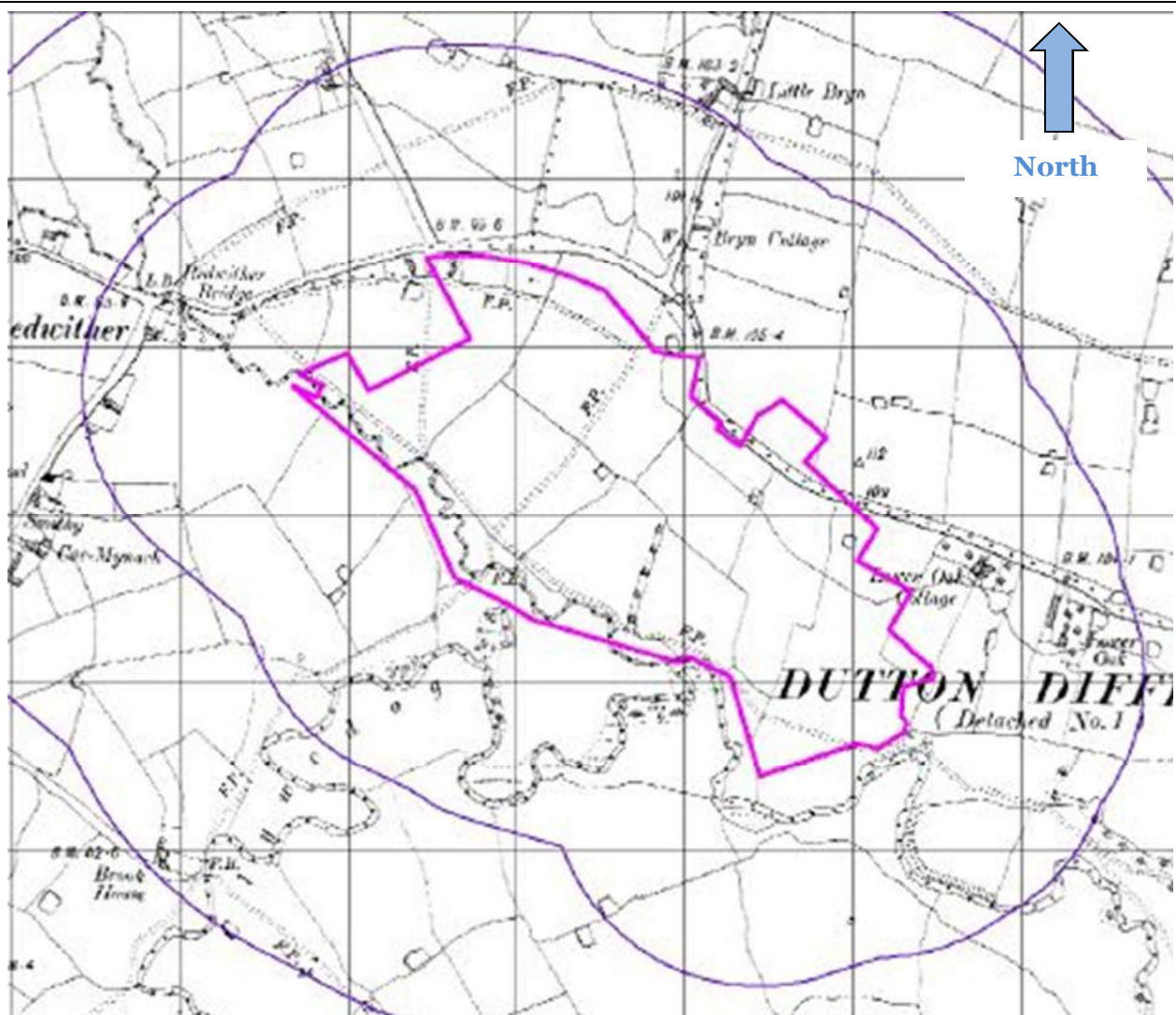
Original Scale: 1:10,560



Historical Map

Dated: 1899

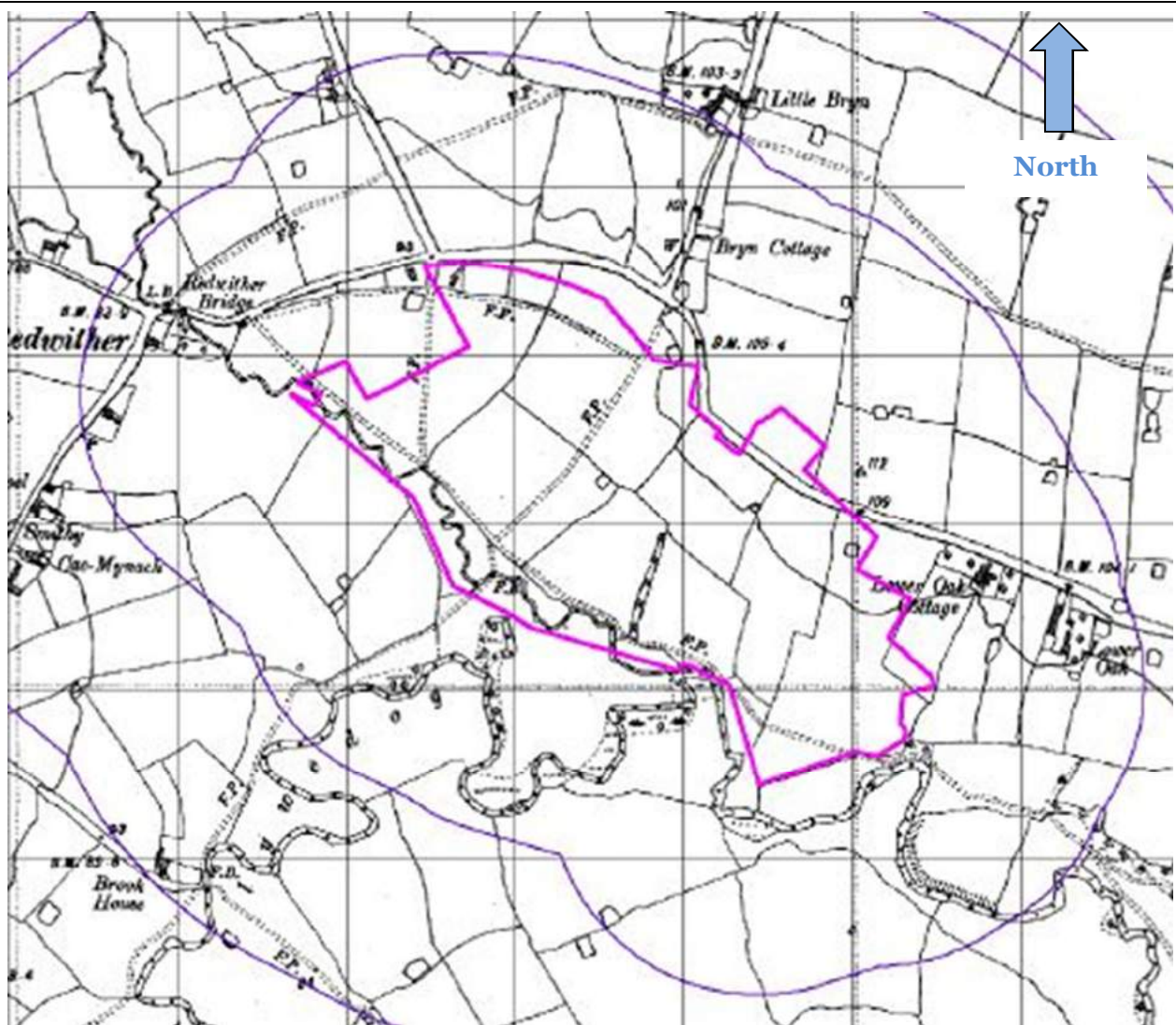
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Historical Map

Dated: 1914

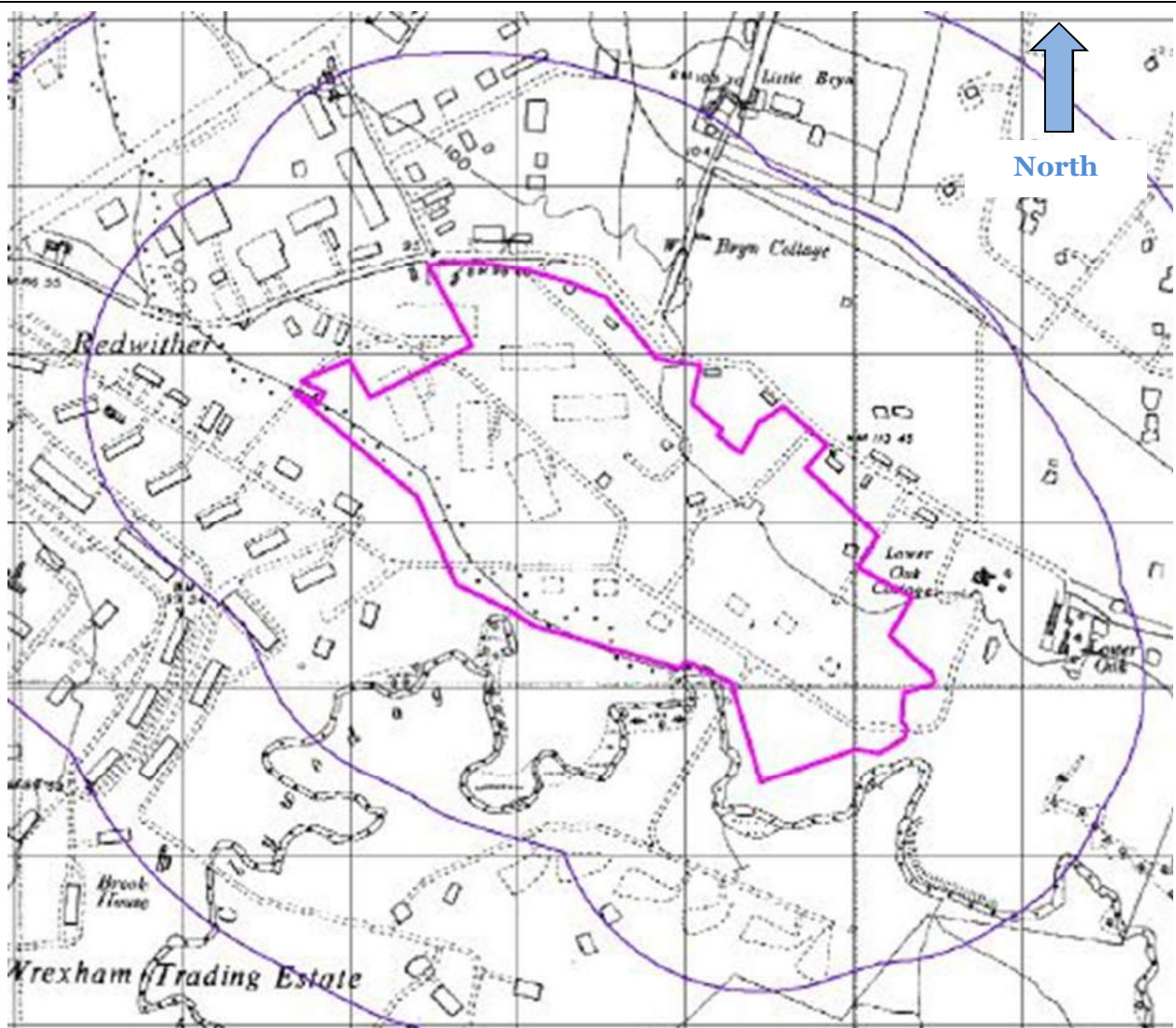
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Historical Map

Dated: 1938

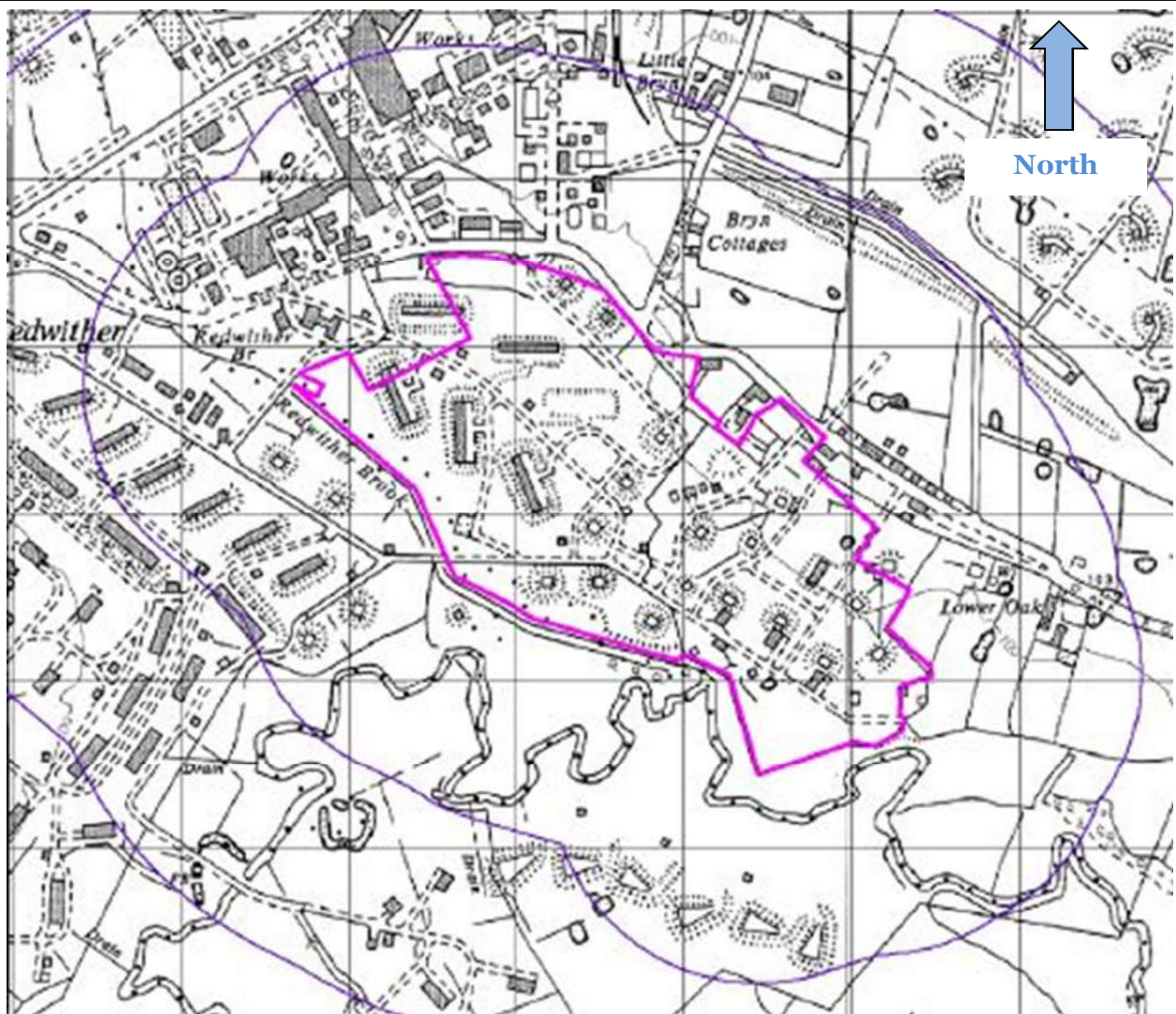
Original Scale:
1:210,560



Historical Map

Dated: 1954

Original Scale: 1:10,560

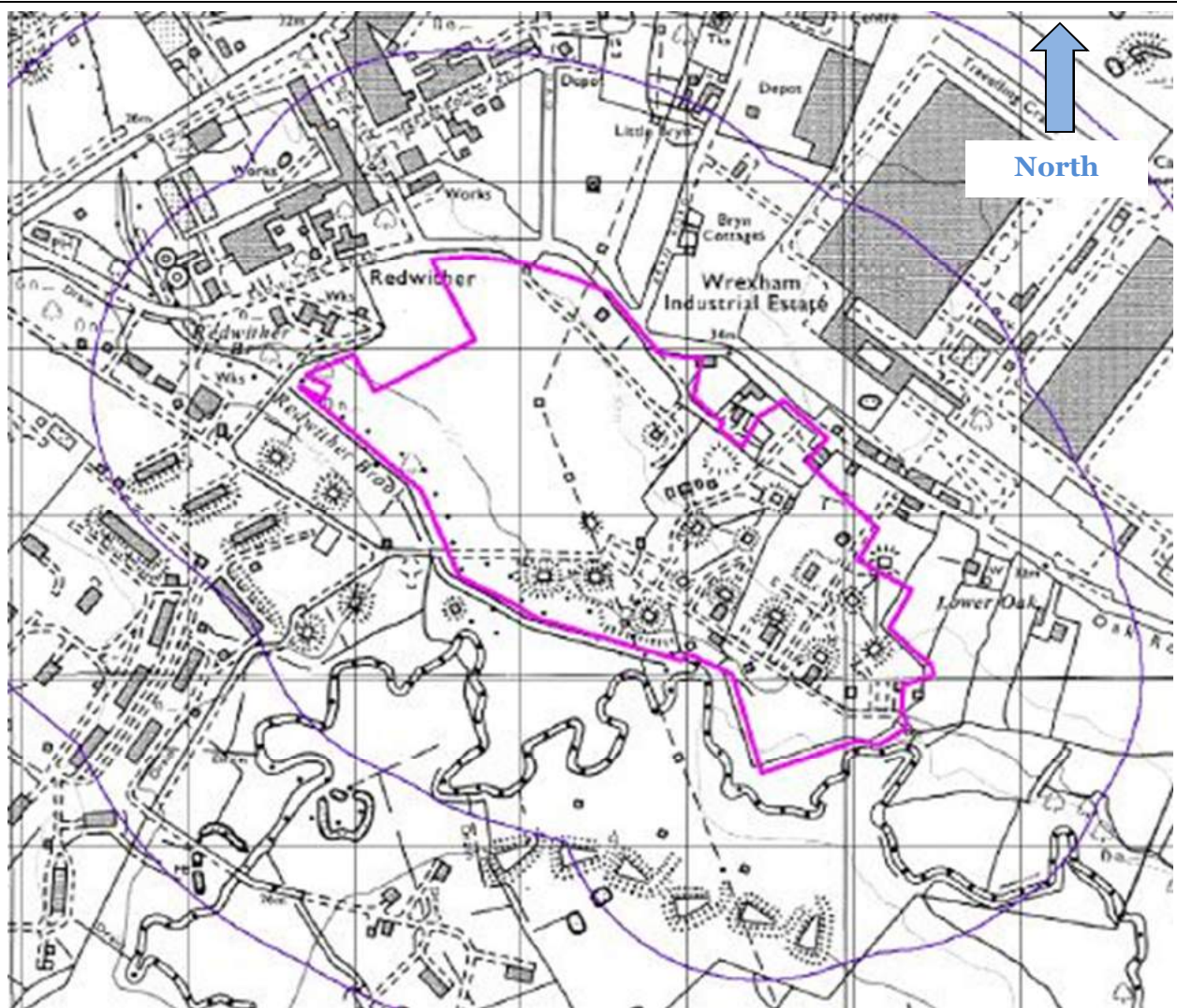


OPUS

Historical Map

Dated: 1964

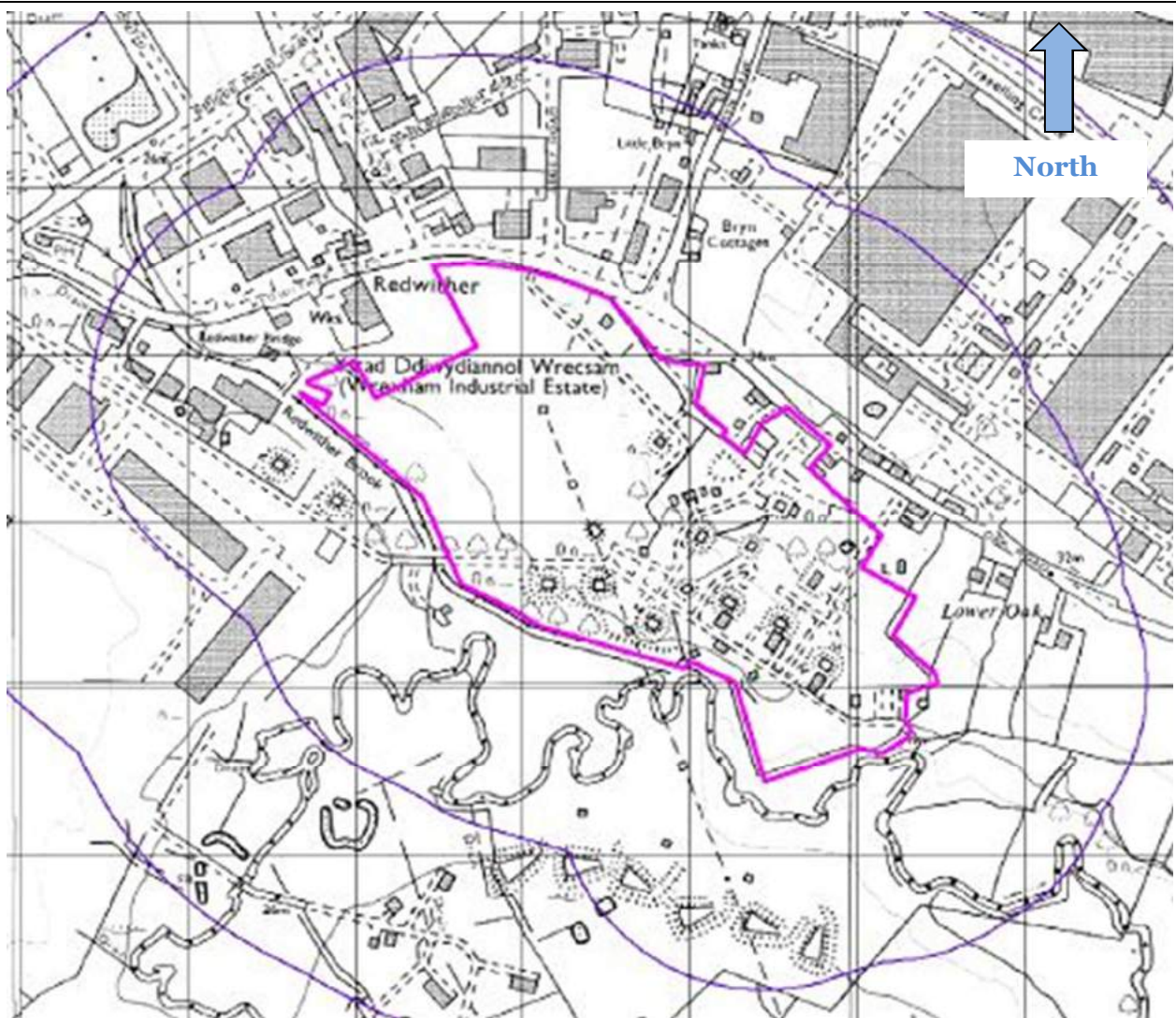
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Historical Map

Dated: 1979

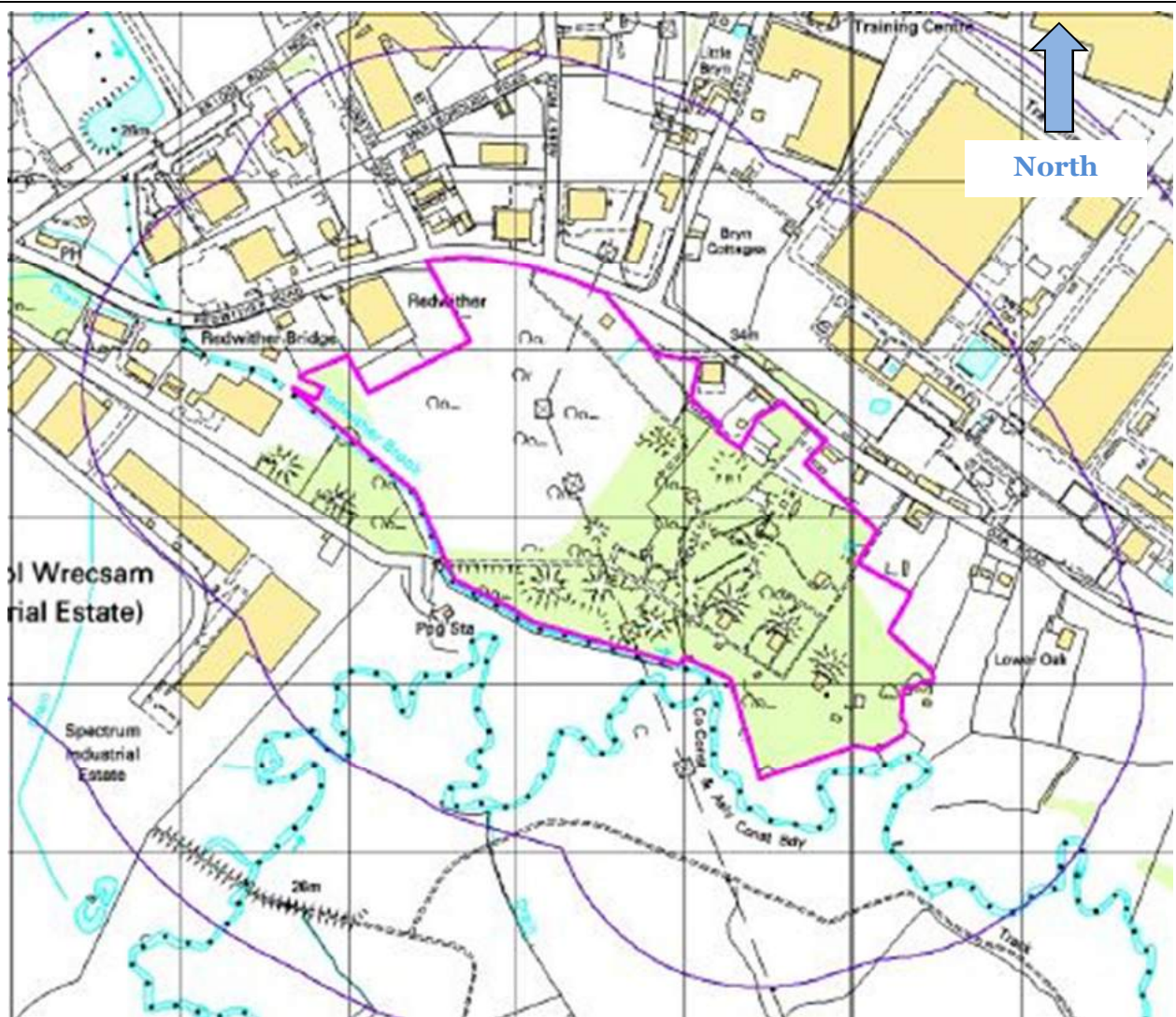
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Historical Map

Dated: 1992

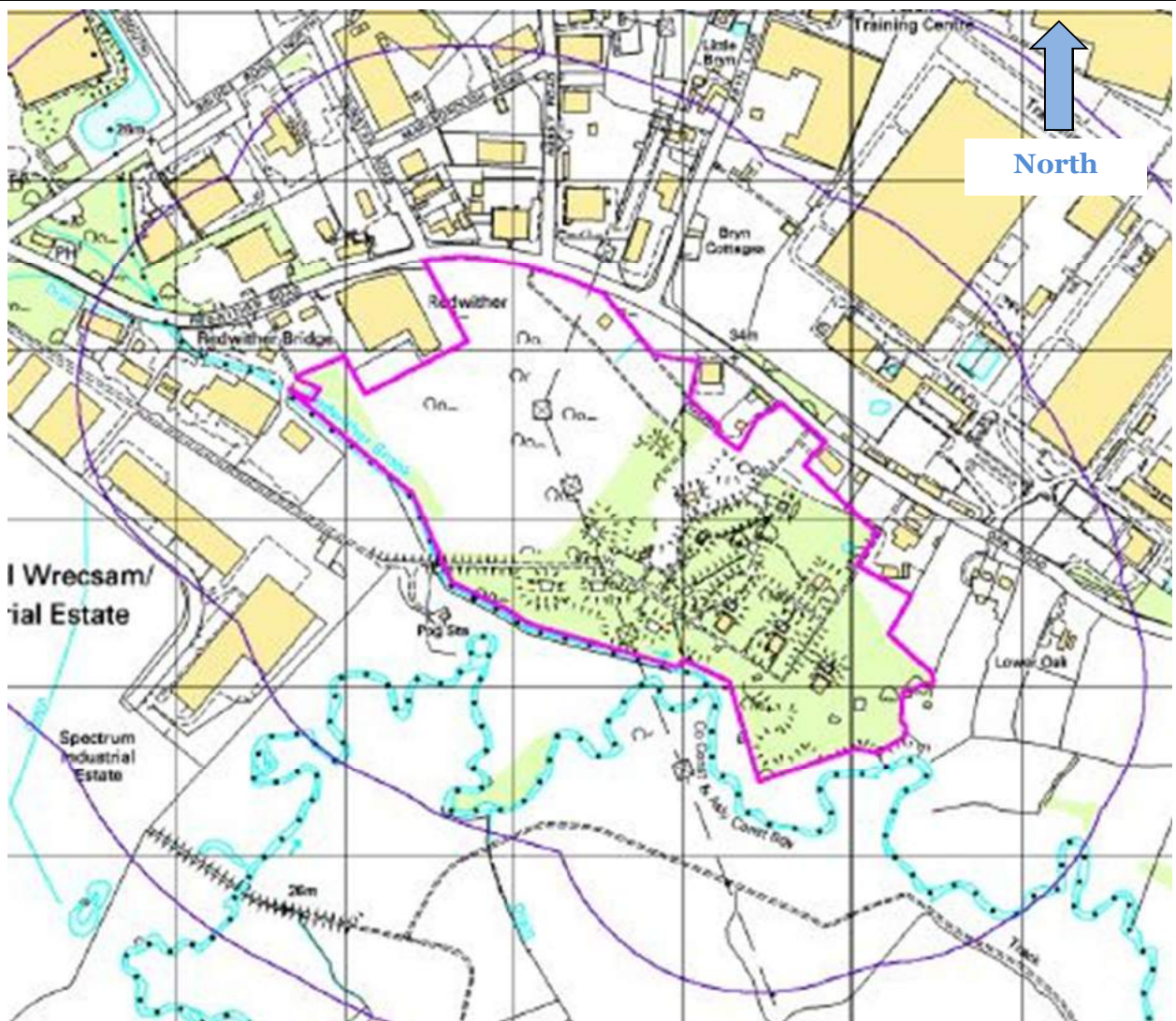
Original Scale: 1:10,000



Historical Map

Dated: 2000

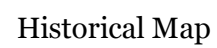
Original Scale: 1:10,000



Historical Map

Dated: 2006

Original Scale: 1:10,000



Dated: 2016

Original Scale: 1:10,000

APPENDIX D
Zetica Regional Unexploded Bomb Risk:
Isle of Anglesey & Pre-desk Study Assessment



REGIONAL UNEXPLODED BOMB RISK

ISLE OF ANGLESEY

DENSITY OF BOMBS PER BOROUGH			
Borough	High explosive	Anti-personnel	Incendiary
Holyhead	24	0	0
Rhyl	2	0	0
Prestatyn	3	0	0
Flint	53	0	0
Porthmadog	0	0	0

OTHER WWII TARGETS

- military
- transport
- utilities
- industry
- docks
- other

BOMB TONNAGE

- >1000
- >500
- >100
- > 0
- unverified

BOMB RISK

- high
- moderate
- low



The information in this regional UXB risk map is derived from a number of sources and should be read in conjunction with the "Users' Guide" (printed overleaf). Zetica cannot guarantee the accuracy or completeness of the information or data.

This map covers regions of coast with beaches, estuaries and alike. Further consideration of the bomb risk is required in these areas. The often inaccessible nature and changing ground conditions (e.g. movement of silt that may contain ordnance) means that historical bombing records for these areas are often poor or inaccurate and further assessment of the bomb risk may be required as part of a site specific study.

A FOUR-STEP PROCESS



Risk assessment and method statement from a qualified explosive ordnance clearance (EOC) operative.



Surface geophysical survey to allow shallow groundwork.



MAGCONE detects UXBs and obstructions on piling layout to the no-risk depth.



Detected UXBs can be dealt with by our EOC engineers and a Clearance Certificate issued for the site.



For more details on this and related services, telephone: +44 (0) 1993 886682 or visit our website: www.zetica.com

BOMB MAP USERS' GUIDE

Sources of information and explanation of bomb risk

Why?

Unexploded bombs (UXB) still present a risk to construction projects long after the end of the Second World War (WWII). UXBs often entered the ground unnoticed at high velocity and penetrated to a depth of several metres. Here they remain – vulnerable to disturbances from construction work. Beyond the depth of shallow excavation work, the greatest risk is to piling, drilling and probing crews. A piling rig could repeatedly hit a UXBs with considerable force before the crew realises an obstruction has been impacted. It could then be up to 72 hours before the detonator activates.

Who?

The responsibility for avoiding UXB risk usually lies with construction companies or house builders particularly those who are redeveloping urban sites. In addition, project engineering or environmental consultants are expected to advise their clients of a site's history. Other interested parties include those organisations whose employees are physically at most risk from intrusive works, normally piling companies, drillers or probing operators.

How?

UXB risk should be assessed for every site, but especially those in known heavily bombed areas or those situated near war-time strategic installations that were priority targets for enemy aircraft, for example, airfields. Zetica's regional bomb risk map is therefore a first point of reference from which the relative, potential abundance of UXBs can be judged. Consultants then advise their clients that an ordnance-risk desk study is required, which they may obtain from external sources. Construction companies or house builders who assess their own risk could choose to come direct to Zetica.

When?

Do not wait for the piling or drilling company to be on site before thinking about UXB risk – it will inevitably cause delays and higher costs. Request the regional bomb risk map from Zetica as soon as a site is being considered, and then use it to help you or your clients to decide if an ordnance-risk desk study is required.

Where?

Maps can be obtained for any county in England, Scotland, Wales or Northern Ireland – or for any London borough. They can help determine the areas that were most heavily bombed – but no part of the country should be considered 100% safe from UXB risk. Even remote rural areas can have a high risk if, for example, they were locations for decoy airfields or beacons that were lit to fool enemy pilots into thinking they had located a burning city that had been successfully hit by others in the raid.

How to use this regional map

This map is designed to give you an indication of the potential risk from UXBs in your area. If you are conducting work that involves excavation, piling or other disturbance of the ground, then you should use the map to identify the category of risk for your site.

The risk boundaries are a guide, compiled from data based on the political areas for which records are held; being just outside a high-risk area does not mean there is no UXB risk. You should use the map to assist in your decision of whether to investigate the UXB risk further.

Information on the regional risk remaining from UXBs in the UK

Zetica has built the largest UXB database of its kind in the UK. It includes a unique digital library of bomb census data, and maps showing key strategic points and bombing densities from the First and Second World Wars. The main sources of information include records from central government (Public Records Office), the Ministry of Defence, and the German Luftwaffe.

Using information from this database, Zetica has published maps of UXB risk on a regional, county and borough scale. The maps indicate relative degrees of UXB risk based on available records for bombing densities and known targeted areas for regions within the UK. The risk is broken down into individual boroughs, towns or cities. The data are based on the historical boroughs and are then overlaid onto the modern map. It is important to note that more-detailed research may be required for individual sites, particularly where proximity to a potential WWII target means the local risk may be higher.

High risk

Areas designated as high risk are those that show a high density of bombing hits (50+ bombs per 1000 acres) and abundant potential WWII targets. In high-risk regions, further action to mitigate UXB risk is considered essential.

Moderate risk

Moderate-risk regions are those that show a bomb density of between 11 and 50 bombs per 1000 acres and that may contain potential WWII targets. Action to mitigate the risk is considered essential, albeit more likely that a reduced scope of work is required compared with that needed for high-risk regions.

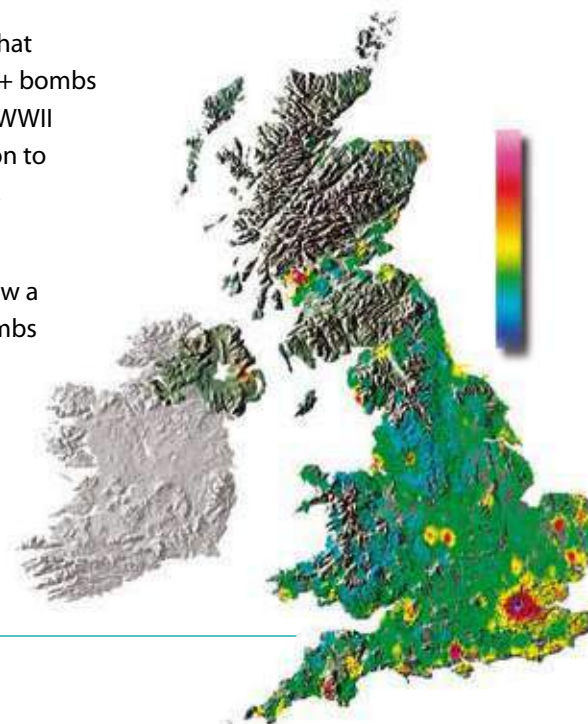
Low risk

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. In general, further action to mitigate the risk is considered prudent, although not essential. Care is required when assessing the risk for specific sites where the risk may be higher because of local wartime activity.

Other WWII targets

Other regions with the risk of UXBs are key strategic points as defined by the government during WWII as representing potential enemy targets. Where these exist outside areas mapped as high, moderate or low risk, a site-specific assessment of the UXB risk may be required.

Relative UXB risk across UK



What to do if...

...you have a site that has a potential UXB risk

In the absence of current legislation requiring you to address the risk from UXBs, your responsibilities under health and safety legislation and regulations such as construction design and management require that you address all identified risks. The first stage is to request further advice from a professional adviser such as Zetica, or to gain more site-specific information by commissioning an ordnance-risk desk study. Then a strategy to deal with the risk can be established that is tailored to your proposed work.

...you find a suspect item or require advice

If during site works you find a suspect (ordnance-related) item, it is very important that you do not touch or move it (even if it has already been moved by an excavator). If it is clearly ordnance related, then dial 999 and ask for the police. Ensure that the area around the item is kept as clear as possible without placing yourself at risk. If you are unsure and do not wish to cause undue alarm, or you just require some advice, then you can call Zetica. We have experienced qualified UXB specialists on hand who can offer support and advice during any site works.

More-detailed procedures should be established in advance if you are in an area where the risk of finding a UXB is shown to be significant (moderate to high).

Site-specific desktop studies

Zetica is able to provide high-quality, site-specific UXB risk information for any residential, industrial or commercial property in the UK. These desktop studies provide details of the bombing density within an area and for the site itself, in order to indicate the risks of UXBs still being present. A risk assessment is provided to facilitate informed decision making on whether any further risk mitigation measures are required.

Pre-Desk Study Assessment

Site:	Oak Road, Wrexham Industrial Estate, Wrexham,
Client:	OPUS
Contact:	Mikolaj Jakuc
Date:	22 nd September 2016
Pre-WWI Military Activity on or Affecting the Site	None identified.
WWI Military Activity on or Affecting the Site	None identified on the Site. National Shell Factory (NSF) No.43 Wrexham, manufacturing 18-pounder (-pdr) and 13-pdr shells, was located in the vicinity of the Site.
WWI Strategic Targets (within 5km of Site)	■ NSF Wrexham. ■ Transport infrastructure and public utilities.
WWI Bombing	None identified.
Interwar Military Activity on or Affecting the Site	None identified.
WWII Military Activity on or Affecting the Site	The Site is within the official WWII boundary of the former Royal Ordnance Factory (ROF) Wrexham. ROF Wrexham covered an area of 700 hectares (ha) and manufactured explosive propellants, particularly cordite. The cordite section of the factory was served by at least 3No. nitroglycerine and 2No. nitrocellulose works. The Site occupied an area of banded magazines and explosive stores associated with No. 2 Factory.
WWII Strategic Targets (within 5km of Site)	The following strategic targets were located in the vicinity of the Site: ■ ROF Wrexham, on the Site. ■ Anti-invasion defences, including at least 7No. pillboxes on the Site. ■ 1No. Royal Air Force operational training station (RAF Wrexham). ■ Transport infrastructure and public utilities. ■ Anti-Aircraft (AA) defences.
WWII Bombing Decoys (within 5km of Site)	None.
WWII Bombing	During WWII the Site was in the Rural District (RD) of Wrexham. Wrexham RD officially recorded 278No. High Explosive (HE) bombs with a very low bombing density of 3.8 bombs per 405 hectares (ha). There are no readily available records of HE bombs falling on or in close proximity to the Site.

Post-WWII Military Activity on or Affecting the Site	ROF Wrexham was progressively closed down at the end of WWII and vacated by 1950.
Recommendation	During WWII the Site comprised part of ROF Wrexham, which is associated with several potential sources of Unexploded Ordnance (UXO) and explosives residue hazard. Given this, a detailed desk study to assess and possibly zone the hazard level on the Site is recommended.
This summary is based on a cursory review of readily available records. Caution is advised if you plan to action work based on this summary. It should be noted that where a potentially significant source of UXO hazard has been identified on the Site, the requirement for a detailed desk study and risk assessment has been confirmed and no further research will be undertaken at this stage. It is possible that further in-depth research as part of a detailed UXO desk study and risk assessment may identify other potential sources of UXO hazard on the Site.	



unexploded ordnance



UXO DESK STUDY & RISK ASSESSMENT

Client: Opus International
Location: Wrexham
Ref: E6437-16
Date: 22nd September 2016



Zetica Limited
Units 15 & 16 Hanborough Business Park
Long Hanborough
Oxfordshire
OX29 8LH
Telephone 01993 886682

Email quotes@zetica.com
Website www.zetica.com



CLIENT PROPOSAL

Location: Wrexham
Client: Opus International
Contact: Mikolaj Jakuc
Reference: E6437-16
Date: 22nd September 2016



1. REQUIREMENT

UXO Desk Study & Risk Assessment

The Client has requested a proposal for a detailed Unexploded Ordnance (UXO) Desk Study & Risk Assessment for a Site that Zetica's pre-desk study assessment determined was within the boundary of Royal Ordnance Factory (ROF) Wrexham.

The Site was located in the vicinity of magazines and explosive stores associated with No. 2 Factory, which may provide a possible source of UXO hazard.

The aim of the assessment is to provide an understanding of any potential UXO hazards associated with the proposed site works and suggest a range of risk mitigation options as appropriate.

2. SCOPE

UXO Desk Study & Risk Assessment

The Site

The Site is an ~22ha area to the south of Oak Road, Wrexham as shown in the client's drawing given as Figure 1 below.

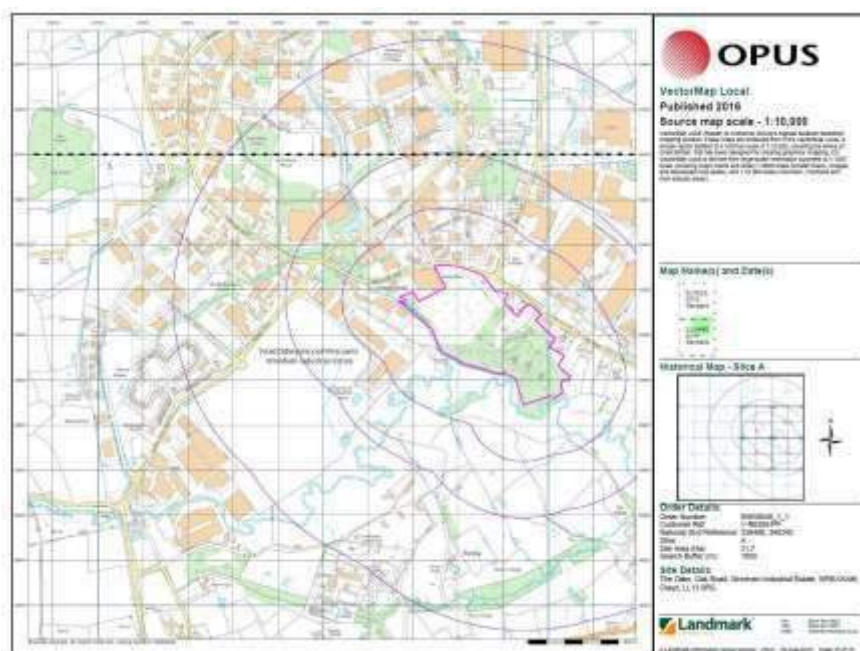


Figure 1 - Site location (study extents outlined in red).

UXO Desk Study & Risk Assessment	
Aims	The UXO desk study will provide a site specific assessment to:- ■ Zone the UXO hazard level across the Site. ■ Provide a risk assessment for likely future site activities. ■ Provide a choice of risk mitigation measures.
Method	Zetica will undertake in-depth research exceeding the requirements of the Construction Industry Research and Information Association (CIRIA) guidance C681 'Unexploded Ordnance (UXO), a guide for the construction industry'. We will undertake visits to both local and National Archives and make enquiries to a range of organisations to gain information specifically for your Site. Typical information sourced includes (but is not limited to) the following:- ■ Records for military activity from pre-WWI to present day. ■ Records of WWI and WWII enemy aerial bombardment. ■ Records held by the Ministry of Defence and Central Government. ■ Records held by public libraries and record offices. ■ Records held by local Authority records. ■ Records of officially abandoned bombs. ■ Historical maps. ■ Historical aerial and other photography. ■ Ammunition technical resources. ■ Published geological, hydrological and hydrogeological information.
Report	Throughout the research period, we will provide regular updates on the sources of UXO hazard we have identified and where appropriate a tentative risk estimation will be included in these summaries. Zetica's formal report will include:- ■ A comprehensive factual account of the activities that may provide a source of UXO hazard. ■ A plan of UXO hazard zones (AutoCAD/GIS where base plan is provided). ■ Risk assessment of the identified UXO hazards in the context of the site conditions, proposed works on the Site and your risk tolerance. Our reports are written to be accessible and comprehensible to a wide target audience. They provide background information for those not familiar with UXO hazards, whilst the site specific information is clearly segregated for those who are familiar with UXO hazards and do not need to read the background information.

UXO Desk Study & Risk Assessment

Why use us?

We have undertaken some of the largest and most prestigious UXO risk assessments conducted within the UK. These include the primary UXO assessment for the 2012 Olympics, the HS2 High Speed Rail Link and a number of studies for areas of the UK equivalent to entire counties.

Our UXO desk studies lead the industry in their content, quality and objectiveness because:-

- Our UXO desk studies are undertaken by a dedicated team of 5 highly qualified (Degree and PhD qualified) and experienced researchers that specialise in undertaking UXO/Military historical research and risk assessments.
- We provide regular updates of our findings throughout the research period, so you don't have to wait for the final report to find out what sources of UXO hazard may exist.
- We don't rely on the internet or previously published records (potentially collated a few years ago) as our primary source of information.
- We go to local archives, libraries and local authority offices to get information specific to your site. We feel that more readily available information (such as bombing densities) is usually insufficient to provide a real understanding of the potential UXO hazard.
- We deliberately seek several sources for the same information in order to identify inconsistencies and so establish the level of reliance we can place on the data being used.
- We source a comprehensive set of historical aerial photographs for our review (not just the small selection typically offered by other web-based information providers).
- We don't 'pad out' our reports with background information, instead we clearly highlight site specific information you need to concentrate on, so you don't have to wade through pages of information on how bombs work or how many have been found in Europe since WWII.
- We can provide scaled AutoCAD hazard drawings which can also be supplied in a number of popular GIS formats including shp, kml and mif.
- The unusually detailed in-depth research we undertake, enables us to provide confident and robust assessments of UXO hazard. We rarely have to 'err on the side of caution' as is more typical in the industry.
- We are not reliant on follow-on UXO risk mitigation work as a primary source of income. This means you can rely on our assessments as being accurate and truly objective.
- If we recommend some form of risk mitigation, whenever possible, you will be provided with a choice of options so that you can choose those most acceptable to you. Our recommendations by default follow the ALARP (As Low As is Reasonably Practical) principle.

Programme	Enquiries will be placed immediately on receipt of a written instruction. After 5No. working days, Zetica will provide a summary of progress including a preliminary UXO hazard assessment. The formal report would then follow after a further 5No. working days. Zetica is reliant on government agencies such as the MoD and so sometimes this programme may vary. A final delivery will be agreed on award of contract.
Links to additional useful information	■ http://zeticauxo.com/guidance/uxb-risk-maps/ UK UXB Risk maps to give an overview of regional WWII bombing densities. ■ http://zeticauxo.com/guidance/guidance/industry-guidance/ Zetica's best practice paper on UXO risk assessments. ■ http://zeticauxo.com/wp-content/uploads/2014/12/Zetica-Statistical-basis-for-assessing-the-risk-of-unexploded-bombs.pdf Externally verified process for quantitative UXO risk assessment. ■ http://zeticauxo.com/guidance/uxb-bomb-depth-calculator/ Tool for calculating the probable depths of penetration for UXB. ■ http://zeticauxo.com/guidance/uxb-risk-calculator/ Tool for estimating probability of striking and detonating a UXB. ■ http://zeticauxo.com/wp-content/uploads/2014/12/Zetica-Understanding-the-limits-of-detectability-of-UXO.pdf Paper identifying the critical issues surrounding UXO detection limits. ■ http://zeticauxo.com/wp-content/uploads/2014/12/UXO-Awareness-Poster.pdf UXO awareness poster for use on notice boards. ■ http://zeticauxo.com/guidance/ordnance-data-sheets/ Ordnance data sheets for likely types of anticipated UXO. ■ http://zeticauxo.com/guidance/uxo-information-sheets/ Information data sheets detailing potential sources of UXO. ■ www.zetica.com Complementary services for infrastructure and hazard mapping.

3. PRICE

UXO Desk Study & Risk Assessment	
Price	£1,950
Conditions	Prices do not include VAT. Subject to Zetica terms and conditions or a review of the client's form of professional services contract. This proposal is valid for 90 days.
Base mapping	Provision of OS base mapping / CAD tiles with your instruction will help to ensure that zoning of the UXO hazard level on the Site will precisely overlay your own plans.
Ordering	By written instruction, order or by signing and return of this proposal.
Your name	
Your signature or order No.	
Your position	
Your contact details	☎
	✉
Further information	If you require further information please contact us by one of the methods detailed below.
Contacts	☎ 01993 886682
	✉ quotes@zetica.com
By signing (or including an order No.) and returning this proposal, you are acknowledging your instruction to proceed with the services as described. Zetica will immediately place all enquiries to ensure a rapid turnaround of any information.	

Established for over 25 years, Zetica's services include

- Desk studies
- Unexploded ordnance risk assessments and risk mitigation
- Topographic surveys
- Utility services detection
- Environmental and engineering geophysical surveys
- Transport infrastructure surveys
- Archaeological surveys
- Pipeline & cable route surveys
- Intrusive ground investigations

More details are available at

www.zetica.com



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