



1ST LINE DEFENCE



Welcome to 1st Line Defence

1st Line Defence are the UK's market leaders in the provision of unexploded ordnance (UXO) risk mitigation services. We address and provide solutions to the risk posed across the UK and around the world from unexploded bombs and munitions related to current and former military land use and aerial bombing.

“Excellent service and speedy response. Appreciate your transparency and involvement and would be happy to use your services on any future developments we undertake.”

Senior Design Coordinator, Galliford Try

Why is UXO an issue?

Many areas of the UK have been left with a legacy of explosive ordnance contamination – either as a result of bombing sustained during the two World Wars or as a result of current/historic military activity. Such contamination can pose a serious problem to construction and development projects, as the consequences of encounter or initiation can be significant. These finds are regularly reported by the media and there have been numerous examples of 'near misses' involving large high explosive bombs in recent years.

Away from urban areas, the primary concern is often land currently or formerly used by the military. Features such as military airfields, army camps, WWII defensive positions, training areas and ranges can leave a legacy of contamination as a result of items being mis-fired, lost, burnt, buried or otherwise discarded or disposed of.

Many cities and towns across the UK sustained significant aerial bombardment. Thousands of tons of ordnance was dropped on major areas of industry, population, and other primary targets such as transport infrastructure, airfields and gas works. Bombing accuracy was generally poor, with large areas around specific targets often being affected, and with bombs sometimes being dropped indiscriminately in so-called 'tip and run' incidents. A proportion of these bombs failed to function as designed (estimated at between 10 and 20%) and fell as unexploded bombs (UXBs). Whilst numerous UXBs were noted and dealt with at the time, many hundreds remain buried.

If left in situ and undisturbed, these bombs and other items of UXO generally present no immediate risk. However, construction projects and other intrusive ground works have the potential to encounter and initiate such devices. The recent increase in large finds is thought to be at least in part a result of deeper foundations and remediation and redevelopment of previous 'brownfield' sites in inner city areas.





How can we help?

Our expertise lies in the assessment and management of UXO risk. Risk assessment is the key starting point of any UXO risk management plan. **1st Line Defence** produces detailed and comprehensive desktop reports on the potential risk posed by UXO on a site (see Express Preliminary and Detailed UXO Risk Assessment sections). The thorough study and review of historical evidence allows us to assess the likelihood of UXO contamination. When considered with relation to what is planned on a site and the works methodology proposed, the likelihood of UXO remaining, of encountering UXO and the consequences of this are then assessed. If a viable risk is identified, **1st Line Defence** can recommend and provide a range of mitigation measures to allow the risk to be reduced to as low as reasonably practicable (ALARP).



Brett Kinsman
Managing Director

Who are we?

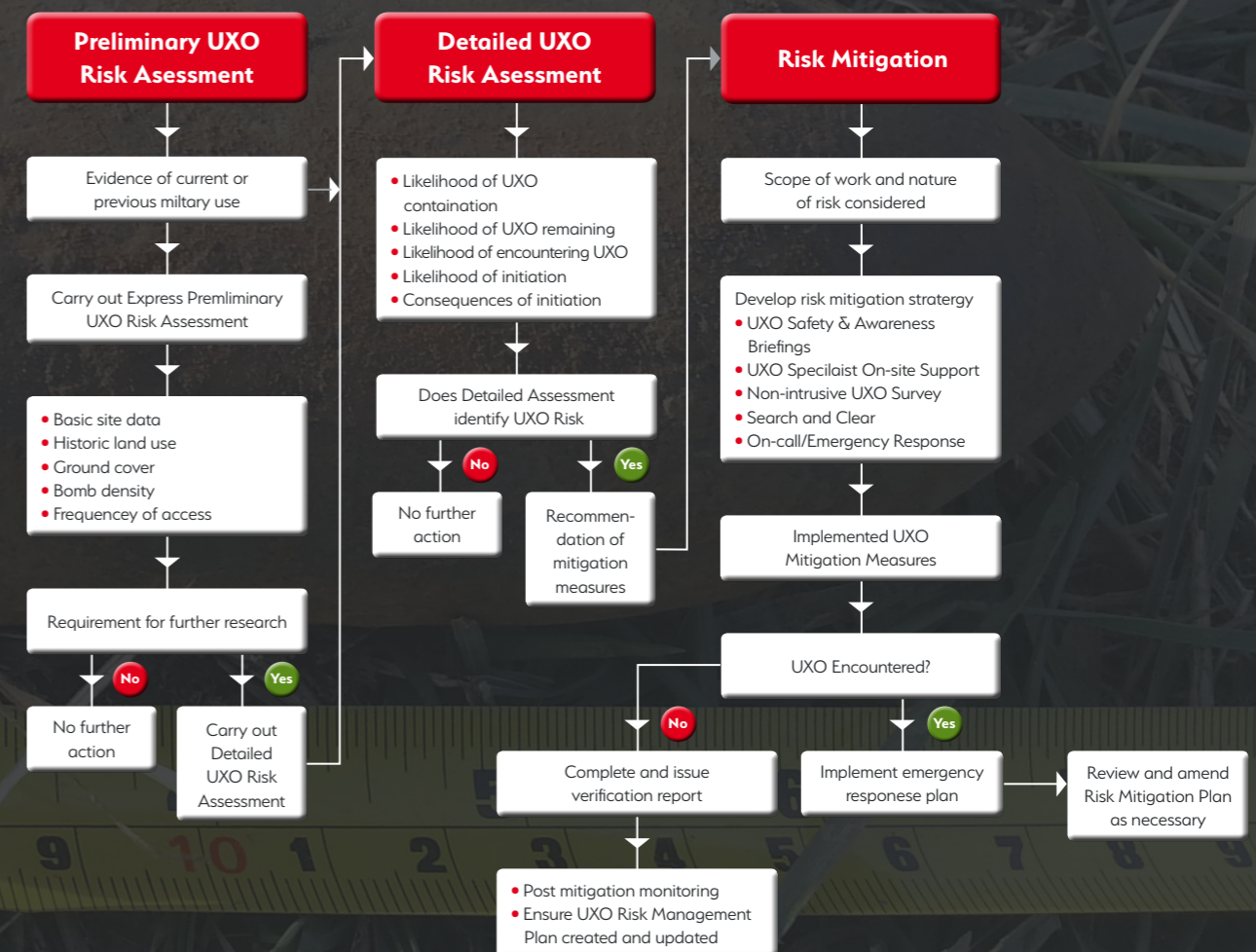
1st Line Defence was founded in 2011 by MD Brett Kinsman, a skilled ex-Army UXO professional with decades of experience in both military and commercial UXO roles. His ethical stance and rigorous impartiality has seen the company grow rapidly to become the foremost provider of UXO services in the UK.

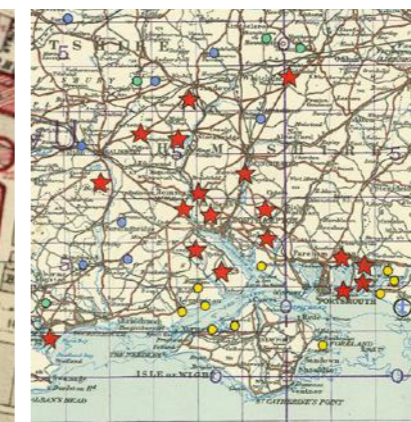
Our goal is to ensure that the legacy of unexploded ordnance contamination in the UK is dealt with safely and effectively to minimise risk to those who might encounter it. We are dedicated to advancing and improving our capabilities by investing in new equipment and new plant, technologies and systems, providing our clients with the most cost effective solutions to their UXO threat.

Professional and highly competent UXO specialists are integral to the success of our company and the UXO services we provide. Supported by a large and dedicated team at our offices in Hertfordshire, by 2018 our engineers have provided their expertise to safely mitigate UXO risk at over 2,800 projects across the UK. We are very proud and pleased that our friendly, open and common-sense approach helps us to ensure that the majority of our work continues to come from repeat business and recommendations.

Whatever our clients knowledge of UXO risk, and whatever the size or scope of project, 1st Line Defence can be entrusted to offer expert help and guidance, working closely with you to ensure that any potential risk is correctly and thoroughly assessed and providing the expertise and support to ensure that the risk is mitigated.

The process of risk assessment and mitigation is outlined in the flowchart below:





UXO Risk Assessments

“Always helpful and friendly. Excellent product with efficient turnaround.”

Geotechnical Engineer, Intégral Géotechnique



Express Preliminary UXO Risk Assessment

Providing a fast, accurate overview of Unexploded Ordnance Risk

For the vast majority of sites in the UK, the risk of encountering buried UXO will be very low or negligible and can be screened out at a very early stage without the need for further research or costly proactive risk mitigation measures. However, construction professionals often do not have time and resources to undertake this screening process themselves.

1st Line Defence can produce a quick, cost-effective Express Preliminary UXO Risk Assessment for any site in the UK. Our assessments are produced by graduate researchers and UXO specialists and are entirely non-automated and bespoke to your project. Each assessment makes use of our extensive historical archives, internal library, internet resources and unique UXO geo-databases which include datasets not available in the public domain, and can be delivered within one working day of order.

Bespoke and Non-automated

Our Express assessment directly conforms to CIRIA C681 guidelines "Unexploded Ordnance, a Guide for the Construction Industry". Each document will consider the following factors:

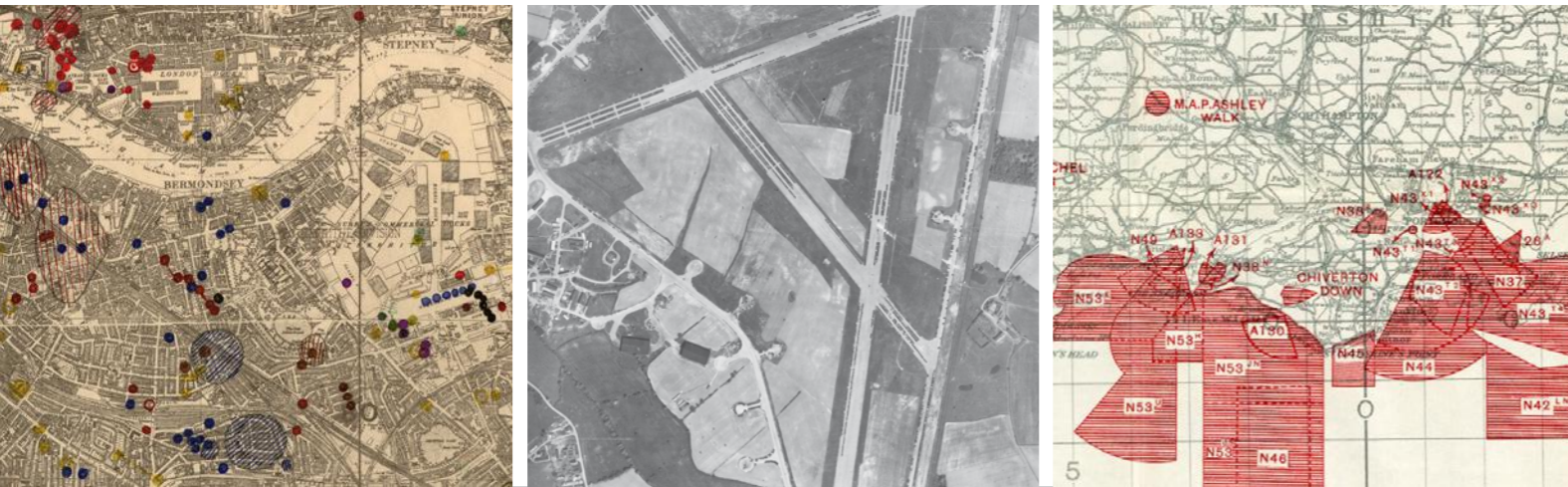
- ▶ Basic Site Data, Site History and Land Use
- ▶ Previous Military Use
- ▶ Indicators of Potential Aerial Delivered UXO Threat
- ▶ Consideration of any Mitigating Factors
- ▶ Extent and Nature of Proposed Intrusive Works
- ▶ Requirement for Additional Research or Risk Mitigation Works

Our Express reports make use of any data which is available to us in-house or online. If we find that we do not have enough information to fully assess the risk, or we know that additional data would be available which would allow the risk level to be fully qualified, we will recommend that more research is undertaken in the form of a Detailed UXO Risk Assessment. This does not necessarily mean that the site is at risk, but rather a full assessment cannot be made with the information available, and the report will explain why it is considered that more investigation would be required within the document. However, in many cases, we will have enough data to discount the risk and recommend that 'no further action' is taken for the site.

Left: London Bomb Census Mapping
Centre: WWII-era RAF Airfield
Right: 1945 Armament Training Areas Map

Detailed UXO Risk Assessment

Comprehensive, bespoke historical research for complete confidence



During these works, we found
1st Line Defence to be very professional,
helpful and carried out the work to a high
safety and quality standard

Project Manager, VolkerFitzpatrick

An assessment of potential UXO risk to a project is the first step in any UXO Risk Management Plan. It is normally recommended that in the first instance, a site should be screened by undertaking a Preliminary UXO Risk Assessment – using relatively basic factors to assess whether there is any need for undertaking further research, or whether any potential risk from UXO can obviously be negated at that stage. If the risk cannot be discounted, the next stage would be to commission a Detailed UXO Risk Assessment.

The purpose of the detailed assessment is to examine in depth, using both internal and external resources, the likelihood of encountering explosive ordnance during proposed works at a site. This includes an evaluation of the associated risk, and if necessary, make recommendations for appropriate risk mitigation measures.

1st Line Defence has a reputation for producing the most comprehensive Detailed UXO Risk Assessments in the industry. Fully compliant with CIRIA C681 (Unexploded Ordnance, A Guide for the Construction Industry), the reports allow the potential risk on any site in the UK to be fully qualified.

Our graduate research team produce entirely bespoke documents, utilising all of the pertinent historical information and resources that can be obtained or that prove to be available. All of the data collected for an assessment – mapping, photography, written records, bomb maps etc. is presented within the reports and analysed in detail. We ensure that our findings and conclusions are clear and concise, so that a client can fully understand and appreciate the reasoning/ rationale behind our risk assessments. Each report goes through a rigorous quality assurance procedure, being both management and peer-reviewed to ensure that the research is comprehensive, consistent and the evaluations are well-defined and justified.

As standard we use information from local and national archives, historical mapping, high resolution WWII-era aerial photography, written ARP bomb incident reports, Luftwaffe target information, bomb census mapping and any other resource that is available to us, depending on the site and the nature of the risk.



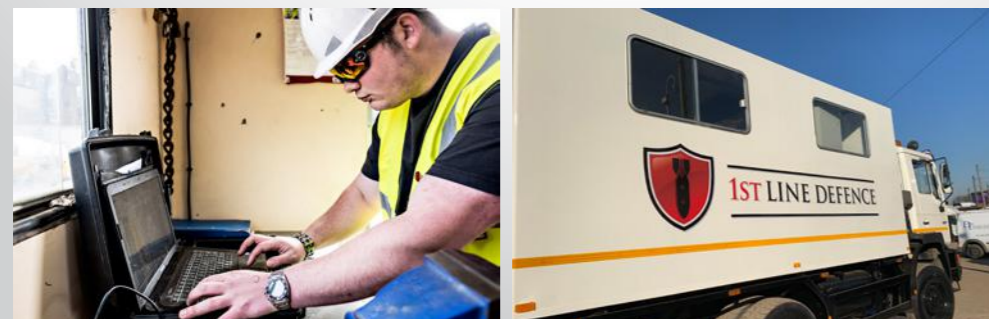


Intrusive UXO Magnetometer Survey

Deep intrusive magnetometer survey ahead of piling or boreholes.

On sites where a risk of encountering deep buried unexploded bombs (UXBs) has been assessed, and where piled foundations are planned, **1st Line Defence** can provide an Intrusive Magnetometer Survey to provide clearance ahead of individual pile locations or clusters and boreholes. This method permits survey at depths beyond the detection capabilities of non-intrusive methods and in conditions where a non-intrusive survey is not suitable, such as in areas of made ground and gross ferro-contamination. Anomalies identified during the survey, which are modelled as having similar characteristics to a UXB, can be avoided or investigated dependent upon the site conditions and the client's requirements.

The ground conditions present will determine the average amount of surveys that can be conducted per day. Each day, the data collected is sent back for quality assurance by in-house geophysicists to look for and model any anomalies on our own proprietary software. If a magnetic signature is detected with characteristics similar to a buried iron bomb, the position of the anomaly can be triangulated using additional surveys and the anomaly either investigated or avoided.



Survey Layout

Based on a drawing of the proposed pile layout, 1st Line Defence will calculate the minimum number of surveys that would be required to cover each pile location and create a coordinate list and drawing of survey positions. Each survey can provide a column of clearance (diameter dependant on ground conditions) with either individual piles or clusters covered by each survey (dependant on pile spacing) reducing the overall number of surveys required. Prior to works commencing, the client would be required to provide a permit to dig, service clearance and sometimes an operated excavator.

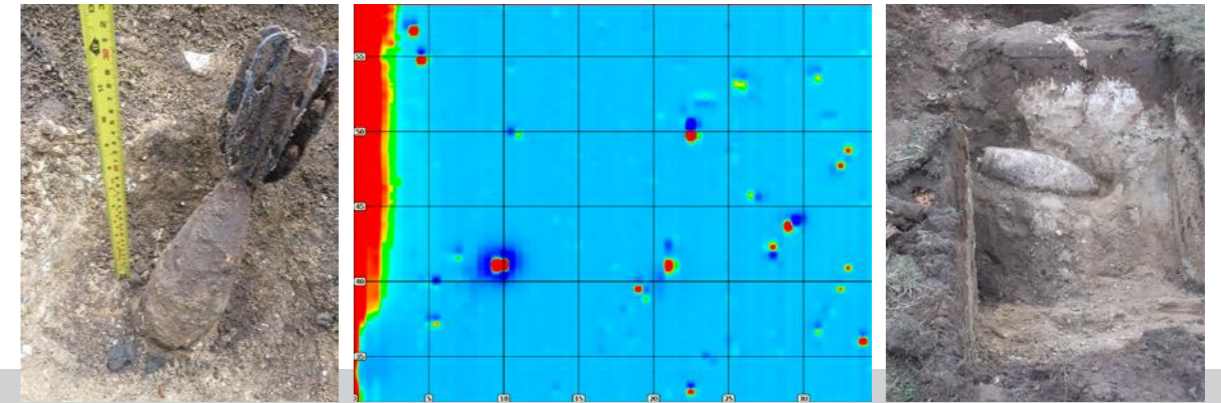


The magnetometer probe is pushed into the ground by a survey rig using hydraulic pressure. The survey can be deployed on different platform configurations to suit specific sites (20 tonne modified CPT rig, mini rig, overwater survey etc.). If the site is 'brownfield' and significant Made Ground is present, we would often ask that an excavator be provided to dig out shallow obstructions. Where there is significant or particularly dense Made Ground, there may be a requirement for 'pre-drilling' of the survey positions. This is purely to facilitate the survey through dense Made Ground where brick/concrete fragments would not allow the probe to be pushed into the ground. As the probe is pushed into the ground, a 'real-time' display of the magnetometer reading is fed back to the survey engineer present. This allows for a check of both ferrous anomalies directly beneath the

The survey engineer will push the probe down to a previously assessed 'Maximum Bomb Penetration Depth' for a 500kg bomb (an assessment based on factors such as the ground conditions/geological strata present on the site including the density and type of geology present obtained from borehole logs), or will terminate the survey when the maximum tonnage push of the rig is reached (when a density is reached through which it is assessed a UXB would not have penetrated).



Top Left: Rig 2 Tracked
 Top Centre: Rig 1 6x6
 Top Right: Rig 3 Mini Crawler
 Left: Rig 5 6x6
 Right: Rig 4



Non-Intrusive UXO Magnetometer Survey

Survey Greenfield Sites for Buried UXO Risks

The survey system is designed to detect sub-surface ferrous anomalies which have the potential to be UXO-related. The methodology is similar to that of a standard geophysical survey. The area to be investigated is divided into boxes by the **1st Line Defence** survey team, and each box surveyed in lanes covering the whole area. Generally this will be a walkover survey, but for larger areas, or to increase production, the survey can be mounted on a variety of platforms including towed arrays from vehicles. The area to be surveyed should be 'walkable' by a survey team and free from obstructions and vegetation.

The data from each day of survey is logged and sent back to our in-house geophysical team for processing and interpretation. The bespoke software used allows a 'false colour' map of the site to be produced showing all ferrous anomalies. The data can be filtered to allow the modelling and selection of discrete targets. From this, a coordinated 'target list' can be produced showing anomalies which model similar to buried UXO, and which are recommended for investigation.

It is often not practicable to investigate every ferrous anomaly detected (as there will sometimes be too many to make this possible). In these cases, the selection will be based on either a percentage of the total targets and/or every target above a certain modelled mass/volume (depending on the nature of the threat). This effectively constitutes a 'risk reduction' exercise allowing the risk to be reduced to as low as reasonably practicable.

Target Investigation

The investigation of targets is the second phase of the process and is undertaken by a team of UXO clearance specialists. Each target is located using GPS and excavated by hand and/or machine. If UXO-related, the target would be identified, classified and the appropriate response procedure initiated. The discovery of significant UXO may result in a re-assessment of the number of targets which require investigation. If non-UXO related, the items would be recorded and removed if necessary. At the end of the process, a report is issued detailing the clearance operation, what was found, if there is any residual risk still present and any further recommendations.

Survey Parameters/Limitations

The survey is very effective on ground which is relatively 'clean' and which does not contain too much background ferrous contamination. Areas with significant amounts of Made Ground such as 'brownfield' sites, which have either been previously developed or in-filled, are often too contaminated with scrap and materials such as brick, clinker, rebar and reinforced concrete, for discrete ferrous anomalies which could be UXO-related to be identified. Certain surface features such as chain link fencing, vehicles and pylons can also influence the data collection and mask potential ordnance.

In optimum ground conditions, the system can detect a buried 50kg German iron bomb at a depth of around 4m below ground level (the 50kg was the most commonly dropped high explosive bomb making up approximately 60% of the total deployed). The survey is also effective at detecting shallower buried items of Land Service Ammunition (items such as grenades, mortars and projectiles).

“1st Line Defence are extremely accommodating during all aspects of our work, regularly meeting tight deadlines and providing quality work at short notice.”

Geotechnical Engineer, GEA Ltd



On-site UXO Support

UXO expertise on-site during groundworks.

De-risk excavation and drilling with a 1st Line Defence UXO Specialist

Where a risk of UXO has been identified, one of the most conventional risk mitigation measures is to have a UXO Specialist present on-site to support proposed open excavation or site investigation works. 1st Line Defence employ highly trained and qualified ex-military explosive ordnance disposal operatives from the Army, Air Force or Navy (or current reservists) to undertake a range of on-site support measures depending on the methodology of works and nature of the risk.



Watch & Brief Support

If open excavations are planned, and if mitigation measures such as a non-intrusive magnetometer survey are not viable or appropriate, then a UXO Specialist can be provided to support and monitor the works. The operative would work closely with the ground operative/machine operator to ensure that excavations are undertaken in a controlled manner and to provide immediate response to any suspect or suspicious items that are encountered. Any such items can be assessed and identified. If deemed to be UXO or UXO related, direct control measures can be put in place depending on the nature, type and condition of the item. The UXO Specialist will also provide UXO Safety Awareness Briefings to all new ground personnel.

Borehole Support

If a risk from deep buried unexploded bombs has been identified on a site, and ground investigation works such as boreholes or window samples are planned, a hand-held 'down-hole' magnetometer survey can be undertaken. The 1st Line Defence operative would work closely with the drillers to survey each borehole in 1m stages using a specialised probe. The survey would continue until an assessed 'maximum bomb penetration depth' is reached (based on localised ground conditions), at which point the borehole can progress un-supported.

The magnetometer allows the operative to detect buried ferrous anomalies which have the potential to be UXO related. If such an anomaly is detected, the operative can recommend that the borehole is terminated and moved, or the anomaly investigated.

UXO Safety & Awareness Briefings

Providing all new ground personnel with safety and awareness briefings is an essential part of any UXO Risk Management Plan. It also ensures principal contractors are fulfilling their duty of care to employees.

The briefings are provided in the form of a Tool Box Talk. One of our experienced UXO Specialists will provide a short talk on UXO risk tailored specifically to the risk on that particular site. The 1st Line Defence Specialist will utilise a set of information cards to allow the brief to be undertaken anywhere on site.

The typical structure of a talk will be:

- ▶ Explain the nature and type of assessed risk based on historical research
- ▶ Show what to look out for
- ▶ Explain what to do if a suspect item is encountered
- ▶ Offer basic instruction in explosive ordnance recognition
- ▶ Detail emergency response procedures
- ▶ Explain basic mechanisms for initiation and importance of 'Do Not Touch'
- ▶ Answer questions and queries that operatives may have

UXO Briefings are recommended on any site where a potential risk from UXO has been identified – often this will be in combination with on-site support/clearance work.

On lower risk sites, training can act as an effective stand-alone mitigation measure as a minimum precaution. Even on sites that have been assessed as 'Low' risk, it is still recommended that briefings are provided so that staff know the background to the risk assessment, what to look out for, and what to do in the event that a suspect item is encountered. It should be noted that the level on such sites has been assessed as 'Low Risk', not 'No Risk'.

“Your 1st Line Defence operative was a joy to work with. He was really great with our volunteers and was incredibly informative about his work – not to mention lending a hand to our dig!”

Project Manager, City of London



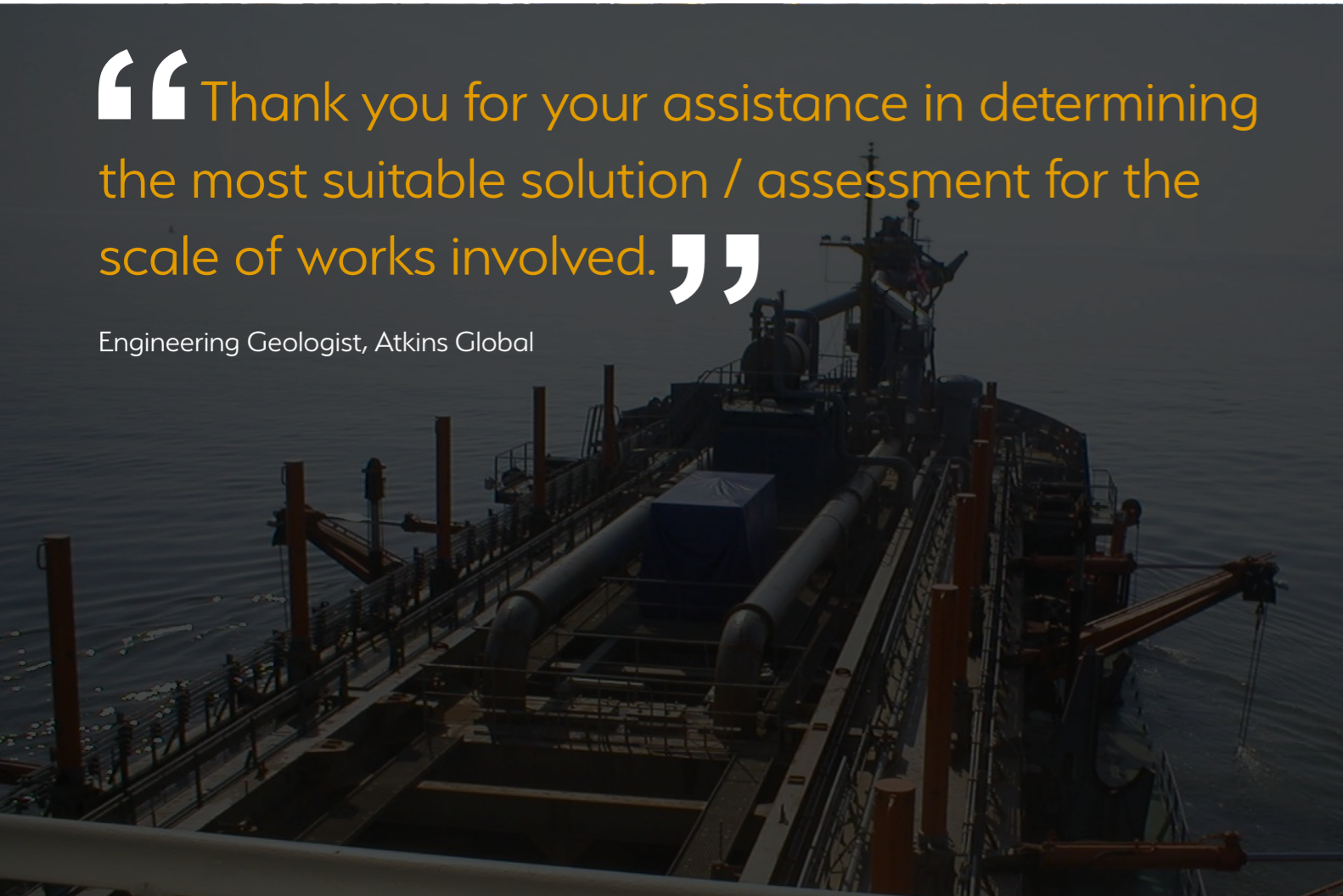


Offshore UXO Services

Unexploded Ordnance in the marine environment can present a significant risk to offshore construction and development projects. We offer a range of support services for any offshore project – from sub-sea cables to wind farm installations, offshore structures and dredging operations.

“Thank you for your assistance in determining the most suitable solution / assessment for the scale of works involved.”

Engineering Geologist, Atkins Global



Historic contamination can originate from sources as diverse as WWI and WWII bombing and shelling, offensive and defensive mining, munitions dumping, offshore firing ranges, coastal defences and anti-submarine weaponry.

Our personnel have specialist experience working in environments ranging from rivers and lakes to docks, beaches, intertidal zones and deep offshore works. Services include:

- ▶ UXO Dredging Support
- ▶ ROV Survey
- ▶ Multi-sensor Marine Survey
- ▶ Magnetometer Survey
- ▶ Diver Investigation
- ▶ UXO Specialist providing support to Debris Clearance operations
- ▶ Marine Ordnance Clearance and Disposal
- ▶ Site and work specific UXO Risk Assessments

Offshore UXO Risk Assessments

Access bespoke and detailed historic UXO Risk Assessments for any offshore project in the UK.

Our assessments take into consideration not only the historic risk of contamination in an area, but also factors such as the scope of the proposed works, seabed geology, burial, water depth and risk/ consequences of detonation. All of our research and mitigation recommendations conform to CIRIA Guidelines C754 ‘Assessment and Management of Unexploded Ordnance (UXO) Risk in the Marine Environment’. We consider evidence including:

- ▶ History of Area
- ▶ WWI German and Allied Sea Mines
- ▶ WWII German and Allied Sea Mines
- ▶ Firing Ranges/Seaward Armament Training Areas
- ▶ Naval Exercise/Training Areas
- ▶ Wrecks
- ▶ Munitions Dump Sites
- ▶ Explosive Ordnance Finds
- ▶ Coastal Gun Batteries
- ▶ WWI and WWII Bombing and Shelling
- ▶ Offshore Incidents Involving Munitions
- ▶ Aircraft Activity and Crashes
- ▶ Submarine Exercise Areas

All data collected is presented within the report with analysis. All relevant sources of information will be accessed, analysed and presented to the client. If warranted, the assessments include bespoke mitigation options to reduce risk as far as reasonably practicable.





Other Services

Quality Assurance and Consulting

Ensure UXO risk mitigation is appropriate justified and effective

Perhaps you want a second opinion for an existing UXO risk assessment. Maybe you're new to ordnance risks and need advice you can trust. **1st Line Defence** offers a range of Consultancy and Quality Assurance services. We ensure sure that standards are being met, best practice is being followed and UXO risk mitigation measures are appropriate and justified.

We have developed a strong reputation for quality, standards and integrity, and are commonly a point of contact for clients who are new to UXO risk. You may have questions and queries about a project, or require a second opinion over advice or support work that you have received.

Our consultants and specialists are known for ensuring their input remains entirely impartial and objective.

Services include:

- ▶ Preliminary and Detailed Risk Assessments on potential UXO/UXB risk
- ▶ Risk mitigation measure recommendations and emergency response planning
- ▶ Advice and project management in the early development of a project
- ▶ UXO Risk Management Plans
- ▶ Third Party Quality Assurance and Control

On call/Rapid Response

Provisioning full-time Unexploded Ordnance (UXO) Specialist support may be necessary for some projects – but clearly not for all.

Our UXO On-call/Rapid Response service offers a pre-arranged response covering both routine and emergency call-outs.

One or more **1st Line Defence** UXO Specialist is assigned to your site and fully pre-briefed with relevant risk analysis. Whenever you need routine advice on risk mitigation measures, or encounter potential UXO, one call will dispatch an ordnance engineer to attend (immediately if needed) to advise or manage the incident.

Benefits of Rapid Response:

- ▶ 1-2 hour response for sites in London and the South-East
- ▶ Peace of mind – assistance just a phone call away
- ▶ Prevent delays – a UXO specialist can often identify an object as inert or non-UXO

Overseas UXO Support

Landmine and UXO Clearance

1st Line Defence has access to all mine action resources; including trained people, detector equipment, mechanical clearance systems and detection dogs.

We can conduct all mine action operations in accordance to your bespoke situation and the specific needs of your project.

Our teams comprise a pool of experienced EOD experts and national de-miners. Detection dog teams use the most appropriate method for landmine and explosive ordnance clearance. We can deliver Battle Area Clearance (BAC) solutions in areas with no landmine presence. We can also deploy armoured and remote-controlled machines to remove vegetation and undergrowth in preparation for the manual demining teams or dogs.

All projects are managed by our experienced overseas team based within the UK complying with a robust Quality Management System (QMS), and in accordance of International Mine Action Standards.

Surveys

Commission our Desktop, Non-technical and Technical UXO Surveys.

Available as a standalone service, surveys provide a comprehensive report detailing all data gathered on the suspected presence of landmines and UXO within a designated area. This will clarify the Explosive Remnants of War (ERW) threat posed to your project.

Route Assessments

Get access to areas in which you need to operate. Let us clear routes to your target destination.

Mine/UXO Risk Training

Ensure your employees and management are professionally briefed to understand and manage UXO risks.

EOD Training

Let us train your individuals or groups up to supervisory level.



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