INTRODUCTION

Conducting an a technical assessment of potential Unexploded Ordnance (UXO) contaminated sites is often a foreign and challenging experience for most environmental contamination practitioners in New Zealand. Well-meaning attempts to come to grips with munitions contamination problems often lack input from suitably experienced personnel, who through their specialist skills and knowledge resultant from military training and post service commercial experiences, can make significant contributions towards achieving defined outcomes in the early stages of the assessment process. Involvement of ex-service Explosive Ordnance Disposal (EOD) technicians in the field processes of detection, identification and interpreting collected data is essential, as equally is their safeguarding presence to satisfy Occupational Safety and Health obligations.

Munitions related contamination can be present in land (or underwater) from a variety of past activities, some more obvious such as residual unexploded items remaining from live-fire training or in areas of past conflict. Levels of contamination unacceptable in land destined for higher levels of use can also arise from less obvious causes associated with ammunition manufacturing, proof testing, storage and disposal. Munitions contamination presents a wide spectrum of hazard potential, with unexploded projectiles in conflict zones and training areas presenting a high level of risk, through low or nil-risk items that by virtue of their appearance cause alarm and dismay to the uninitiated on encountering, through to expended small arms ammunition residues which while presenting no explosive hazard at all, are generally unacceptable in appreciable densities from an aesthetic point of view.
Armed with a basic understanding of these issues and a knowledge of the field techniques available, the environmental contamination practitioner stands a far higher chance of developing and conducting an assessment with meaningful outcomes which support valid decisions to remediate or not and which support the remedial scoping and specification process. Without this, unplanned remediation expenditures, time over runs and disappointing outcomes are certain, in extreme cases leading to the distinct possibility of injury and its associated liability issues. A UXO technical contamination assessment is a process of disciplined instrumented sampling for munitions and related detritus where nominally parallel transects are searched and finds recorded. The process is generally recognized by the Australian Defence Department and the Queensland EPA, although these ‘regulatory authorities” usually describe the process as “UXO technical assessment”. Field Validation Survey (FVS) is a term mandated by the UXO Section of the WA Government’s Fire and Emergency Services Authority.

PURPOSE

A formal UXO contamination assessment is a valuable tool in the development of a remediation plan and the determination of the costs of remediation. This disciplined and documented process utilises Explosives Ordnance Disposal (EOD) technicians equipped with detection equipment searching along GPS transects identifying Explosive Ordnance (EO) and other items resultant from the manufacture, use and disposal of explosive ordnance. In addition it will identify other issues that will need to be considered when developing a remediation plan; such as terrain, vegetation, underlying geology and ground contamination. Conversely if no evidence of UXO/EO is found, the documented assessment is often sufficient to enable the site to be released for development.

METHOD

There are two primary techniques for contamination assessments; these being a proportional search using analogue metal detectors or magnetometers or a Geophysical Survey and follow up investigation of a selection of the anomalies detected.
Pre-survey Research

Prior to the conduct of any physical works on project site it is desirable to review archival records and historic aerial photography of the site. When interpreted by persons with an understanding of; the conduct of live fire training, operation of storage depots, manufacturing processes, etc., it will aid in the determinations of what items are likely to be encountered and put any finds located during the physical assessment process into context.

An understanding of the activities that have occurred on the site post being contaminated by EO is also useful as subsequent developments may have moved or covered evidence of EO.

Analogue Contamination Assessment

The analogue contamination assessment is primarily used on sites such as ranges, battle areas or munitions manufacture process or storage facilities usually in search of discrete items such as individual items of EO, Explosives Ordnance Waste (EOW), or UXO.

This method involves EOD technicians equipped with metal detectors or magnetometers following GPS transects on a wrist held GPS. The distance between transects will be dependent on the sampling proportion selected; 5m for 20%, 10 for 10%, 20m for 5%, etc.

The technician will walk following an easting or northing using the detector and stopping to excavate and identify any items detected. All items indicating the presence of, functioning or use of Explosive Ordnance are photographed and the co-ordinates recorded. These include the following;

- Items of Explosive Ordnance/Unexploded Ordnance
- Fragmentation and identifiable components of EOW such as tail fins, fuzes, grenade fly-off levers, etc.
- Packaging – often an indicator of firing points or points where rubbish has been collected and dumped.
- Targets – such as 44 gallon drums, vehicles often showing effects of fragmentation or being shot with Small Arms or cannons.

Other factors which provide aid in the determination of a remediation plan are also noted such as;
• Depth of EO/UXO finds. This will determine the type of detection equipment required for the remedial search and the effort (time taken to excavate) to investigate sub-surface items.

• Underlying geological conditions. Certain ground conditions may present a magnetic response to and be detected by magnetometers therefore precluding an accurate search using them.

• Soil conditions. Soft soil will be easier to dig than that of hard and compacted soil though conversely will also allow deeper penetration of projected, fired or dropped UXO.

• Other contamination. Metallic waste such as domestic agricultural rubbish will affect the progress of a UXO remediation due to the necessity to remove such items as they will be located by metal detectors and magnetometers. In such sites, particularly storage and manufacture facilities other hazardous materials such as asbestos are located, though not part of the UXO hazard it is usually of interest to the client or regulatory authority.

• Site Preparation Requirements. Includes identifying any preparatory works for any remediation project such as vegetation reduction, removal of fences, metallic waste removal. In some instances sites may require vegetation reduction to enable the conduct of the assessment.

Geophysical Contamination Assessment

Geophysical Contamination Assessments are primarily used for the assessment of the types of sites or contamination as follows:

• Burial Pits. This method is the most effective for determining the extant of burial pits or munitions burn sites. The sensors are positioned at wider separation than that for the detection of individual items. The survey would be followed up by investigation using plant to cut transects at intervals through the length of the pit to identify the pit contents, its dimensions; breadth and depth.
• Small or Developed Sites. Sites which are either small and/or developed over, e.g. tar sealed, can be surveyed using geophysical survey equipment integrated with HPGPS or DGPS. The survey is followed up by investigating an agreed sample of the anomalies.
EXAMPLE PROJECT

Objectives

A site in western Sydney is being developed for housing. During the Second World War the site was part of a larger military camp and training facility. The site encapsulated a grenade training area and a workshop and storage site for the manufacture of anti-tank mines. Subsequent to its military use the property reverted to being an active dairy farm and was subject to cultivation. A review of historical records and photography identified separate the adjacent areas for assessment as follows:

- The former workshop and campsite. No buildings remained on the site however there was the potential for munitions burials to be present. This was to be surveyed using a magnetometer with sensors set at two metre separation for the purpose of locating any burial pits.

Figure 5: Wartime Photograph of Project Area
The former grenade range site. The location of the range site was identified through historical reviews and an initial site walk through identifying fragmentation and parts of No36M grenades as being within a 4 ha area. It was elected to assess the entire 46ha block in which the range was situated by a 10% analogue metal detector assessment. The purpose of which was to delineate the area requiring the follow up remedial geophysical survey and investigation.

Results

Camp Site. The camp site was surveyed over a period of 4 days with a Geometrics G858 Magnetometer. 47 anomalies were identified and investigated with the assistance of plant within a day. No items relating to EO were found in this site and therefore the recommendation was this part of the site did not require any further UXO investigatory or remedial works. However, asbestos remnant from the demolished camp buildings was found on the location of which was relayed to the client.
Grenade Range Site. The assessment of the grenade range area involved one EOD technician equipped with a Minelab F3 working for four days. The assessment commenced from the south of the site working northward following east-west aligned transects. The finds were consistent with the use of hand grenades in the indicative area.
However as the search progressed to the northern boundary, EOW from the use of 2in mortars and No 36M grenades configured for projection as a rifle grenade were found in a separate impact area to the hand grenade range.

![Figure 10: 2in Mortar Tail](image1)
![Figure 11: Gas check plate for No.36M rifle grenade](image2)

![Figure 12: Grenade Range Assessment Area showing GPS tracks and location of EOW finds](image3)

During the initial assessment a single item of EOW was found approximately 100m from all other items. This area was therefore subjected to an additional assessment search to determine if was where had originally lain or been moved to that point through agricultural activities. An additional three items were found in that area.
On reviewing the finds and their location it decided to conduct a geophysical survey and investigation of 18 ha, this encapsulated all the finds and provided a buffer around them. This area was increased by approximately a hectare due to a find of live UXO near the perimeter of the remediated area.

**CONCLUSION**

This process is part of integrated investigation process and often compliments the findings of historical reviews. The contamination assessment is a relatively inexpensive and efficient process which will provide greater efficiencies and reduce the likelihood of unexpected additional and related costs in any follow up remediation phase. In cases the determination may be that there are no remedial requirements necessary or conversely if a site is heavily contaminated it may be determined that the costs of remediation would be prohibitive and an alternate site developed. As it is a systematic and documented process, the findings will be visible to all stakeholders in the development process from the land owner, developer and approving authorities. It is part of ensuring practicable steps have been taken to ensure the health and safety of those developing the site and those occupying it after the works have been completed.

It essential that such assessments be conducted by persons experienced in the identification of explosive ordnance as seemingly innocuous items when identified by an EOD Technician and put in context will significantly assist in the understanding of such sites.