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Utility Mapping Ltd


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# Ground Penetrating Radar Survey Report

# RAF Cranwell

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## Warner Surveys Utility Mapping Ltd.
## The Arch
## 48-52 Floodgate St
## Birmingham
## B5 5SL

## March 2020


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|---|---|---|---|---|
| **Head Office** | Unit 22, Theale Lakes Business Park, Moulden Way | **READING** | RG7 4GB | +44(0)118 930 3314 |
| **London Office** | G.3, Bedford House, 69-79 Fulham High Street | **LONDON** | SW6 3JW | +44(0)203 651 7549 |
| **Bristol Office** | 5th Floor, 1 Temple Way | **BRISTOL** | BS2 0BY | +44(0)117 301 8137 |
| **Birmingham Office** | The Walker Building, 58 Oxford Street, Digbeth | **BIRMINGHAM** | B5 5NR | +44(0)121 752 1220 |

www.warnersurveys.com
info@warnersurveys.com

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## 1.0 Introduction

The works are to undertake a Ground Penetrating Radar (GPR) within a predefined survey area. The survey has been undertaken and has been issued in 2D format for information purposes to further the client's understanding of the existing sub-surface obstructions and anomalies across site. The field work was carried out during February 2020.

## 2.0 Scope of Works

The technical requirements of the ground scanning survey brief are to identify and locate all possible underground obstacles within specified survey limits, with particular interest in locating abandoned air-raid shelters, as shown on the image below. A high-density array ground penetrating radar survey was undertaken where terrain allowed.


## 3.0 Problems Encountered / Site Limitations

Parts of the site were unsuitable for ground penetrating radar due to tree coverage. Within our proposal, a 5m radius around each tree was excluded for this reason. We have attempted to exceed this exclusion where possible. Areas where vehicles were parked were also excluded from the survey area.

## 4.0 Control and Data Processing

The survey has been oriented to Ordnance Survey (OS) using RTK GPS equipment. The surveyed data was processed using GPR SLICE software and the final product edited and completed using BricsCAD software.

## 5.0 Modes of Detection Used

We have used all reasonable efforts expected of experienced and qualified staff to detect and map all possible obstructions positioned below the surface. Factors outside our control (for example vegetation and adverse ground conditions) may limit the effectiveness of these techniques and we cannot guarantee 100% detection.

Ground works should always be undertaken with caution in this regard and should be carried out with attention paid to HSE document HSG47 “Avoiding danger from underground services”.

## 6.0 Ground Penetrating Radar

An Impulse Radar Raptor High Density Array GPR antenna, emitting both 450MHz, is a vehicle towed system which is pulled across the site using overlapping search transects, to ensure maximum coverage. It used to detect for areas where the subsurface environment has been disturbed and where possible buried utilities or subsurface features are present.

To do this the GPR emits microwave signals into the ground. When the emitted energy encounters a buried object or a boundary between the materials having differing Relative Dielectric Permittivities (RDP), the signals are returned to the receiver and it records a two-way travel time and the strength of the signal. For best results a contrast in the RDP is needed between the target and host material.

Radar travels at different speeds through different mediums and the more conductive or saturated the medium, the signal will attenuate, which may limit the effective depth range of GPR investigation.

Linked to the GPR equipment is a Leica Global Navigation Satellite System (GNSS) which records the position of the GPR as it is moved around the site, by using these systems in tandem it allows for more accurate location of subsurface features.

The GPR data is collected and electronically stored until so it can be ‘post processed’ away from site. Post processing is a desktop exercise by which an analysist can take considerably more time to analyse and assess the obtained data as well as building up a bigger picture of the area by making comparison and joining together the hyperbolas generated by the radar data to create strings in CAD that represent a likely utility service or underground feature. GPR SLICE a specialist piece of software was used to stitch together the tomography images using the observations recorded by the GNSS receiver. It also allows the data to be viewed in 3 dimensions, with the software interpreting the GPR readings and GNSS position information to automatically identify subsurface features and aid in the detection process.

Metadata contained within the Report/ CAD drawing is as follows:

- Location of possible sub surface anomalies believed to be buried structures
- GPR Scan Data imagery identifying findings
- AutoCAD and PDF drawing showing scan locations and findings

| Detection Technique | Equipment Trade Name | Manufacturers Details |
|---|---|---|
| Ground Penetrating Radar | Impulse Radar Raptor18 channels towed array GPR | Appendix 1 |


**Impulse Radar Raptor**

### 6.1 Limitations of GPR

- Reinforcement bars, high ground water and made up ground can limit penetration.
- The minimum size of asset that can be detected diminishes with depth (10% rule e.g. a 5-6cm diameter target might not be detectable using the GPR if buried deeper than 50-60cm).
- The ground conditions generally allowed depth penetration of 1.50-1.80m across the site

GPR works best with proximity between the antenna and the ground, excessive movement on uneven surfaces can lead to signals being lost, producing poor quality data. Uneven surfaces could also lead to a disparity between the GPRs odometer and actual distances the GPR has travelled when completing scans. This could lead to the position of anomalies not being accurately placed.

### 6.2 Calibration Procedures

Calibration is scheduled on an annual basis with the manufacturer.

Our GPR survey equipment has built in self-checking and calibrating systems which are activated when the device is turned on and during the software initialisation. The equipment cycles through a series of checks to ensure that all systems are correctly functioning. Should any of these systems fail, an error message is displayed, the equipment will not be used and returned to the dealer/supplier for servicing and calibration.

### 6.3 Horizontal & Vertical Accuracy

Accuracy of underground utilities can vary depending on the type / size of service, its depth (vertical) and local soil conditions. Whilst best practice is implemented, errors may occur in relation to the positions given for buried services and anomalies, and in certain cases, this error may be in excess of +/- 20% of the value stated.

Depths obtained by ground penetrating radar will usually be to the top of the service or anomaly.

For accurate position and depth measurements we would always recommend trial holes being dug to confirm the presence of buried services.

### 6.4 Survey Results

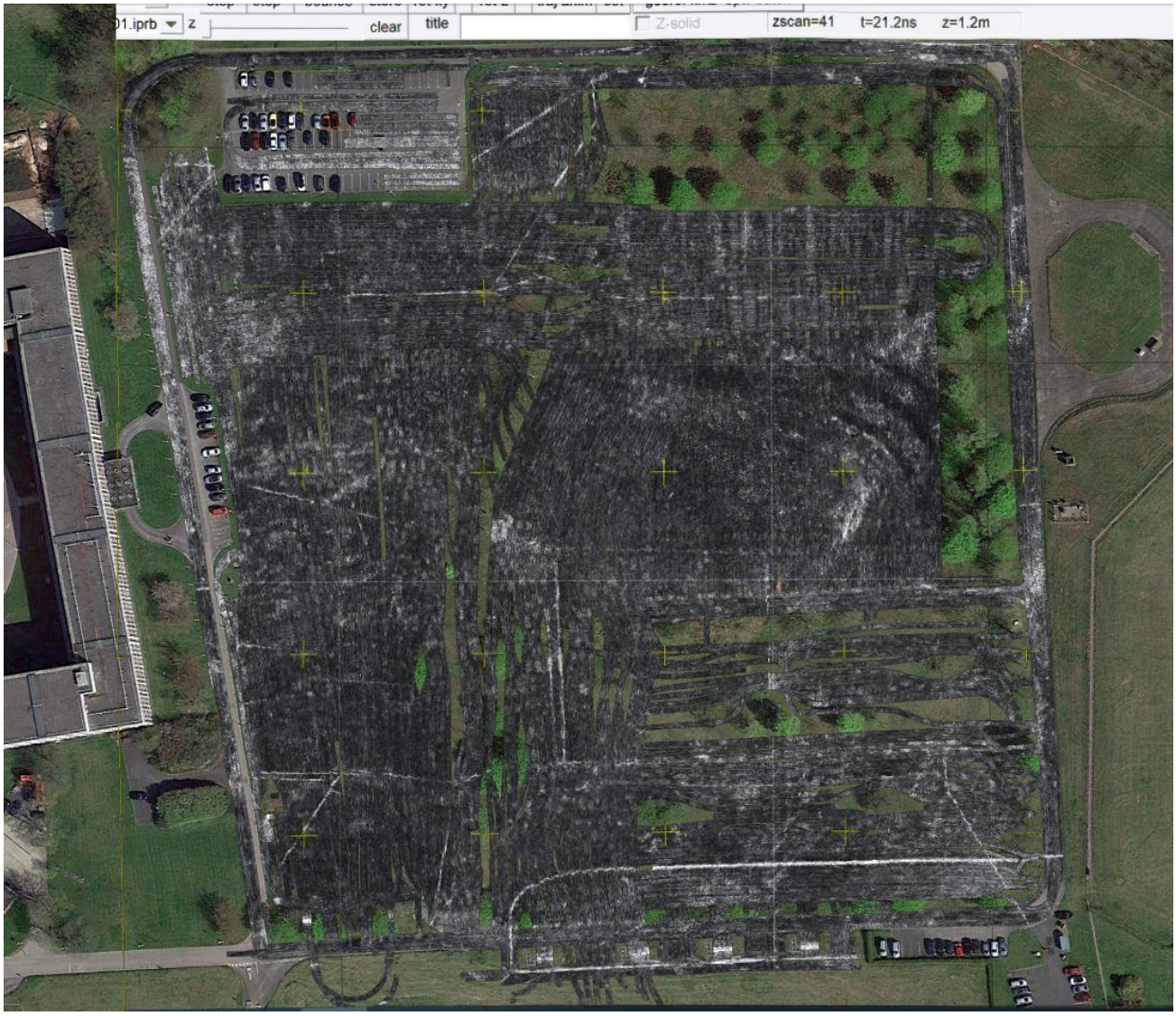


Figure 1 – GPR data overlayed onto Google Earth image to show surveyed area

### 6.4.1 Area 1

The survey area was extended to the opposite side of the road as there are exisitng accesses to known air-raid shelters. This area was scanned to provide us with information showing what the klnown structures would look like within the radar data.

Figure 2 – Four known accesses to air-rais shelters can be seen (taken from East - West)

Figure 3 – Taken from West – East

Figure 4 – Picture taken within stair well, with access door at the top of the picture.

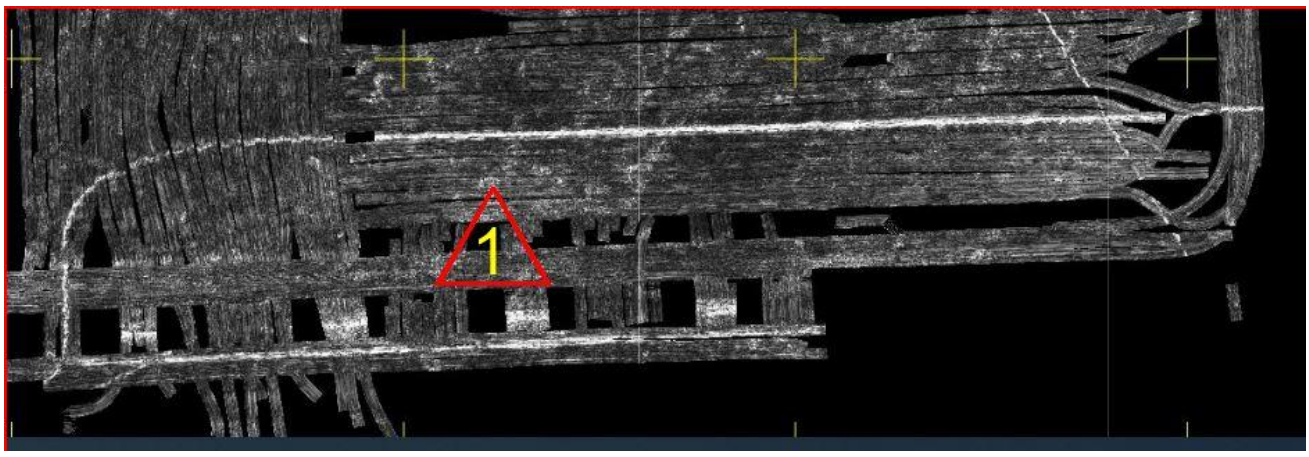


Figure 5 – Processed radar data for Area 1 from GPR Slice.

Strong signal responses can be seen at the accesses to the air-raid shelters. Responses are consistent at each entrance. Numerous linear features which are potentially services can also be seen within the data.

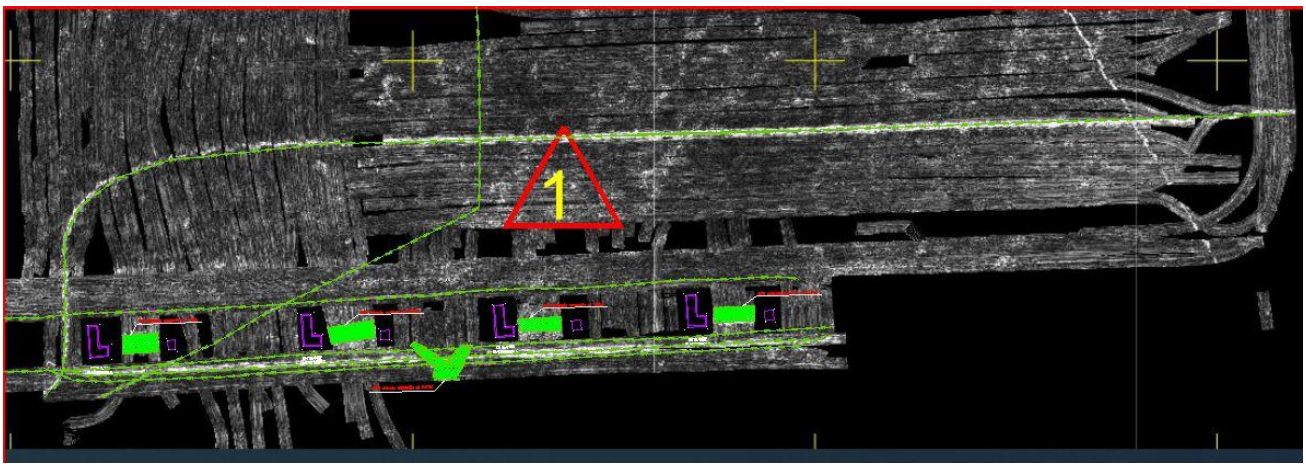


Figure 6 – Area 1 Radar data with picked targets added.

Entrance locations to existing shelters have been taken from the topographical survey and are shown in purple. Numerous linear features which are potentially services can also be seen within the data.

### 6.4.2 Area 2

Figure 7 – Area 2 shown from West to East

Figure 8 – Taken from South to North

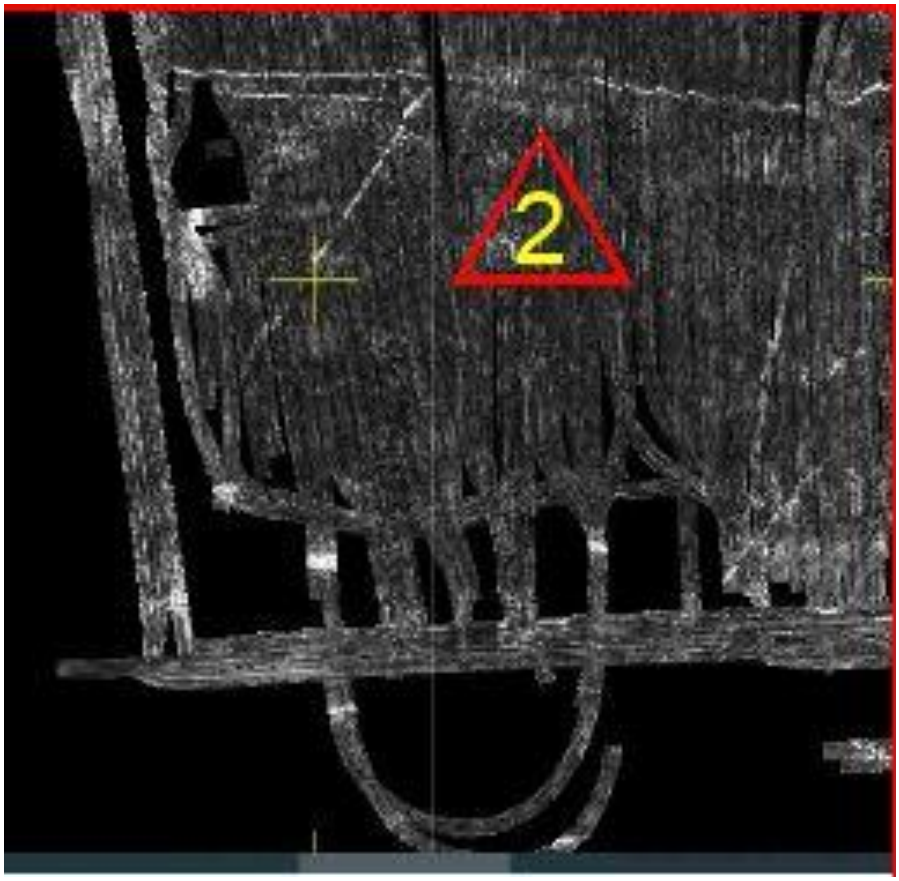


Figure 9 – Processed radar data for Area 2 from GPR Slice.

Strong signal responses can be seen at the accesses to the air-raid shelters. Responses are consistent at each entrance, and with those in area 1. Numerous linear features which are potentially services can also be seen within the data.

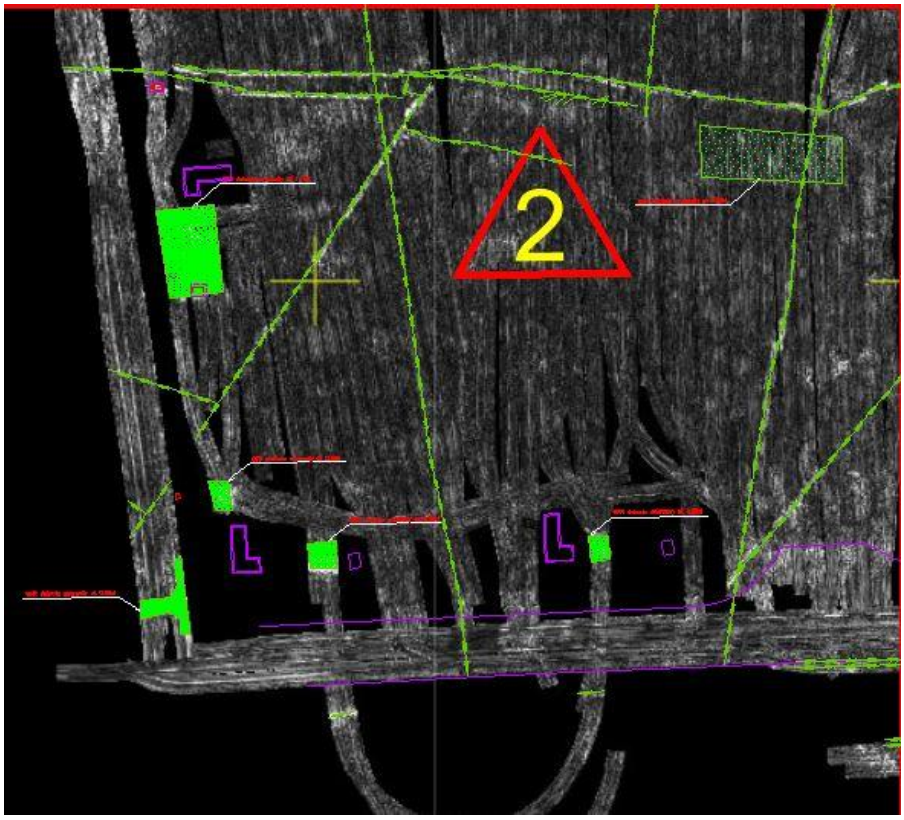


Figure 10 – Area 2 Radar data with picked targets added.

Entrance locations to existing shelters have been taken from the topographical survey and are shown in purple. Numerous linear features which are potentially services can also be seen within the data.

### 6.4.3 Area 3

Figure 11 – Area 3 (picture taken from South to North)

Figure 12 – Area 3 (picture taken from East to West)

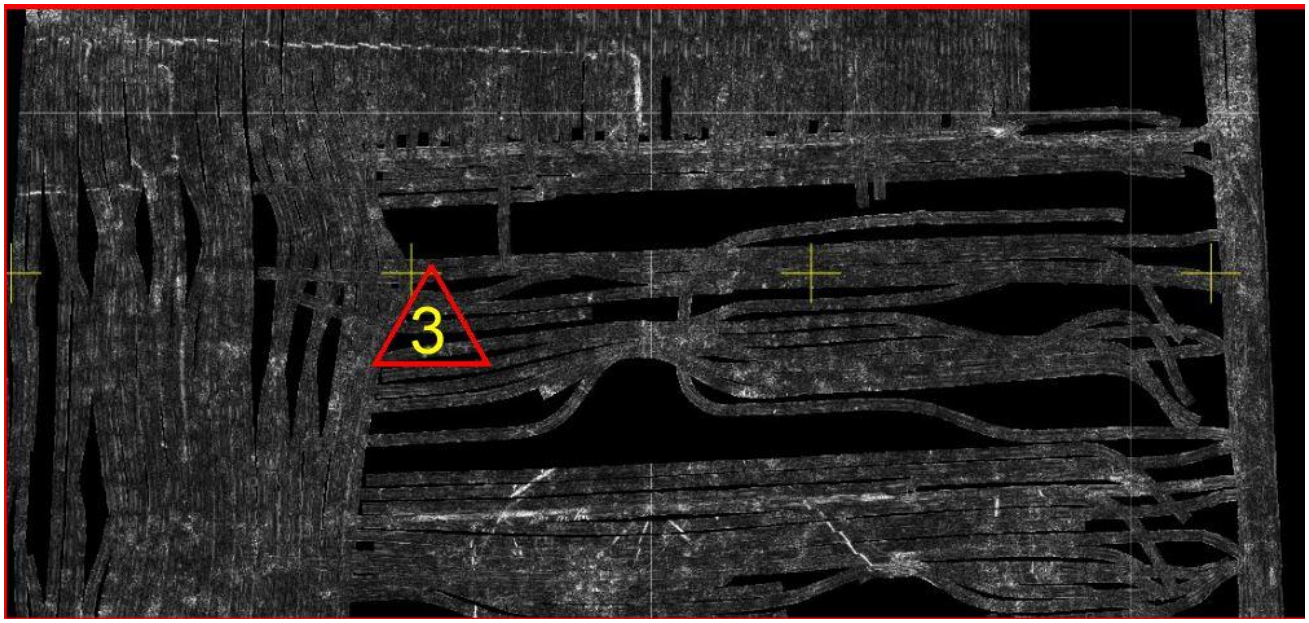

Figure 13 – Processed radar data for Area 3 from GPR Slice.

Numerous trees and above ground obstructions were present (including a pump chamber) within this area. At the top of this data section were six areas that were identified by the site contacts as being possible areas of existing underground structures. These areas provided no significant response within the radar data.

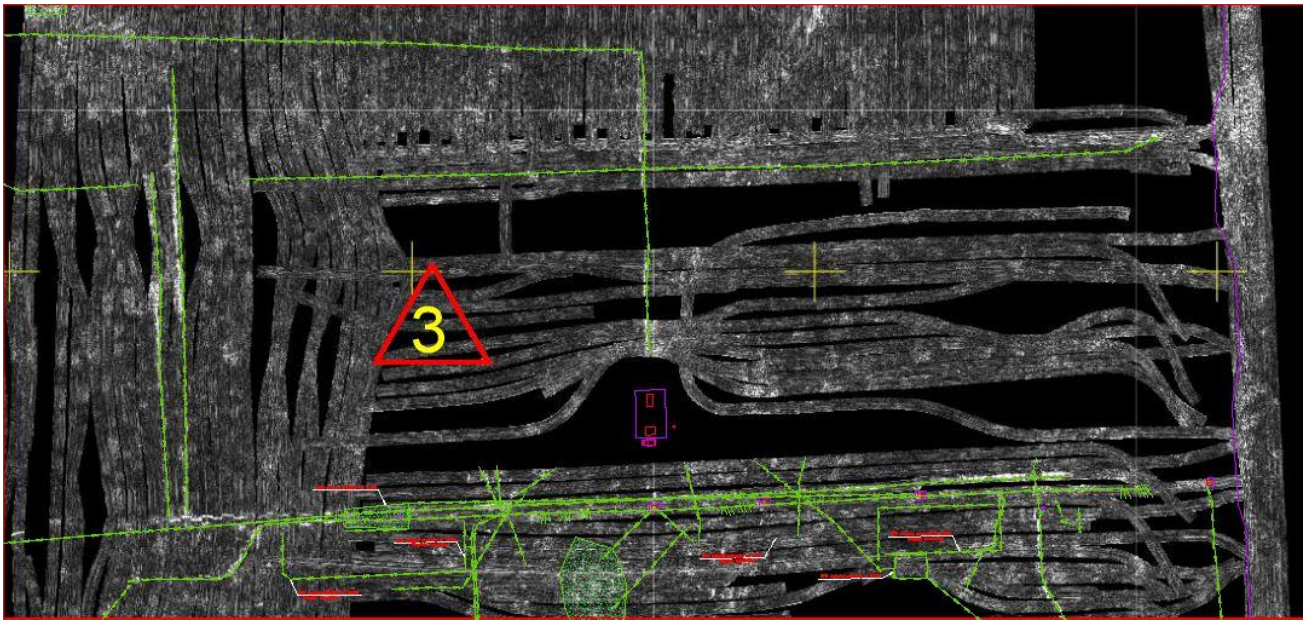

Figure 14 – Area 3 radar data with picked targets added.

The pump chamber location has been taken from the topographical survey and is shown in purple. Numerous linear features which are potentially services, some of which will be drainage from the pump chamber, can also be seen within the data.

### 6.4.4 Area 4

Figure 15 – Area 4 (picture taken from South-East to North-West)

Figure 16 – Area 4 (picture taken from North to South)

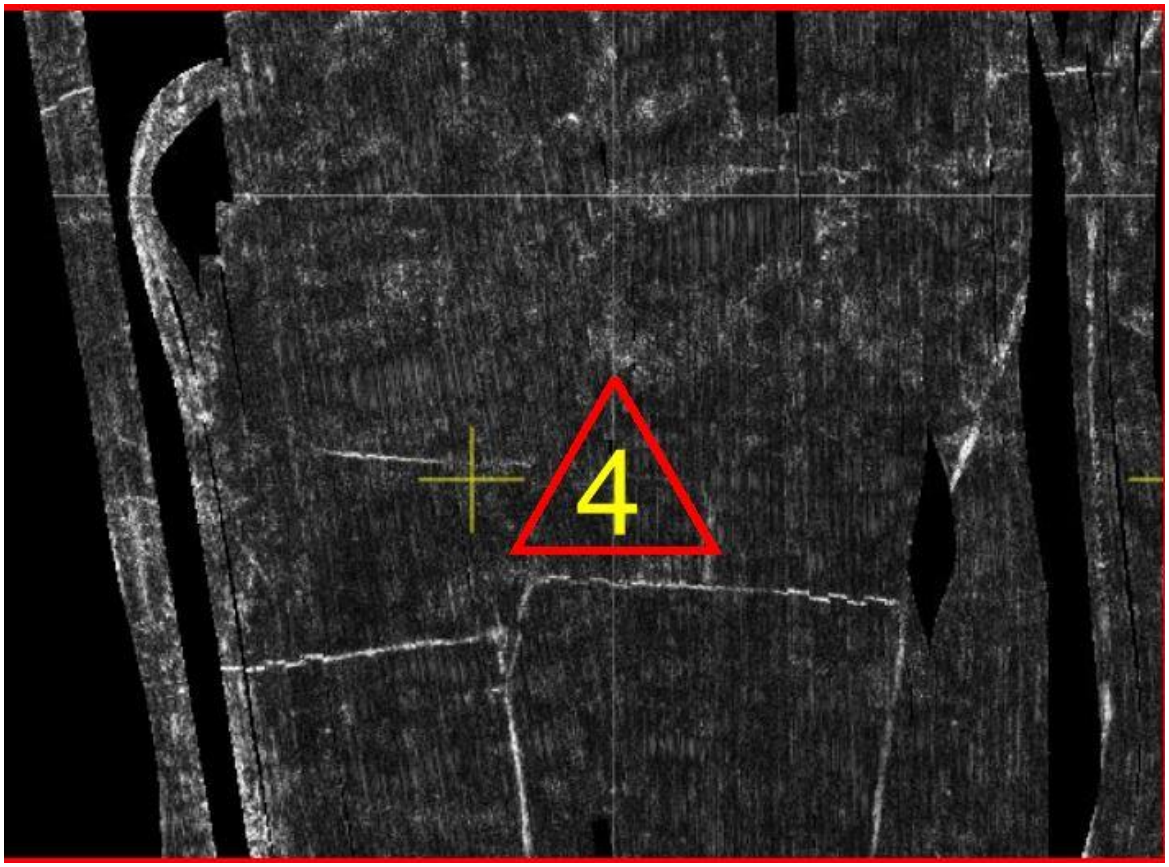


Figure 17 – Processed radar data for Area 4 from GPR Slice.

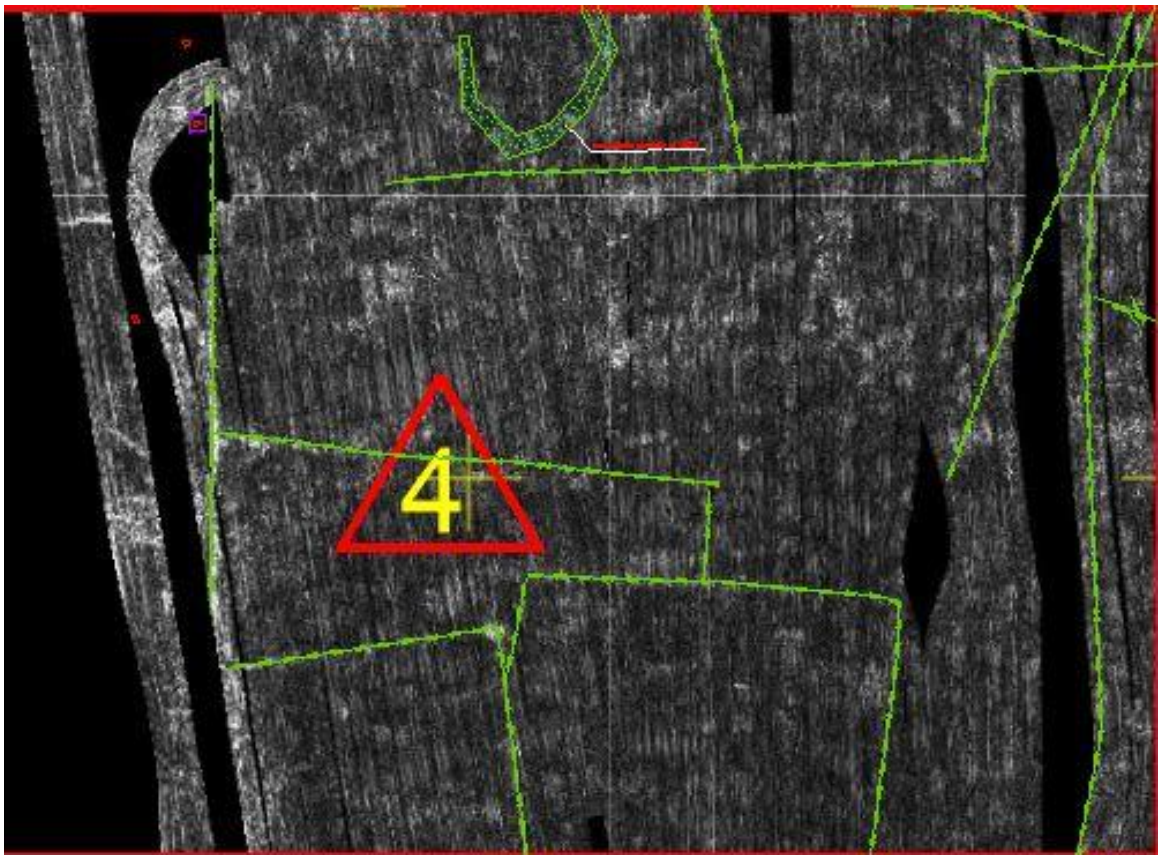


Figure 18 - Area 4 radar data with picked targets added. Numerous linear targets, which are likely to be buried services, can be found within the radar data.

### 6.4.5 Area 5

Figure 19 – Area 5 (picture taken from North to South)

Figure 20 – Area 5 (picture taken from West to East)

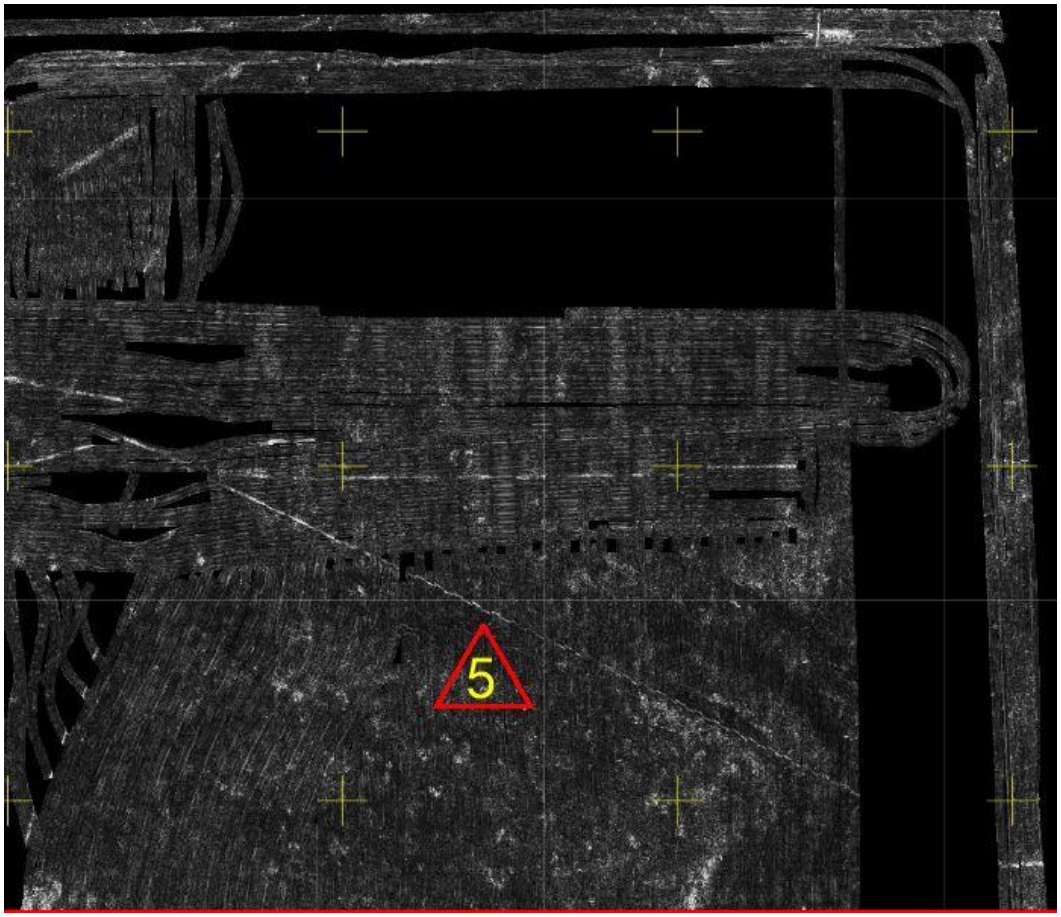


Figure 21 – Processed radar data for Area 5 from GPR Slice.

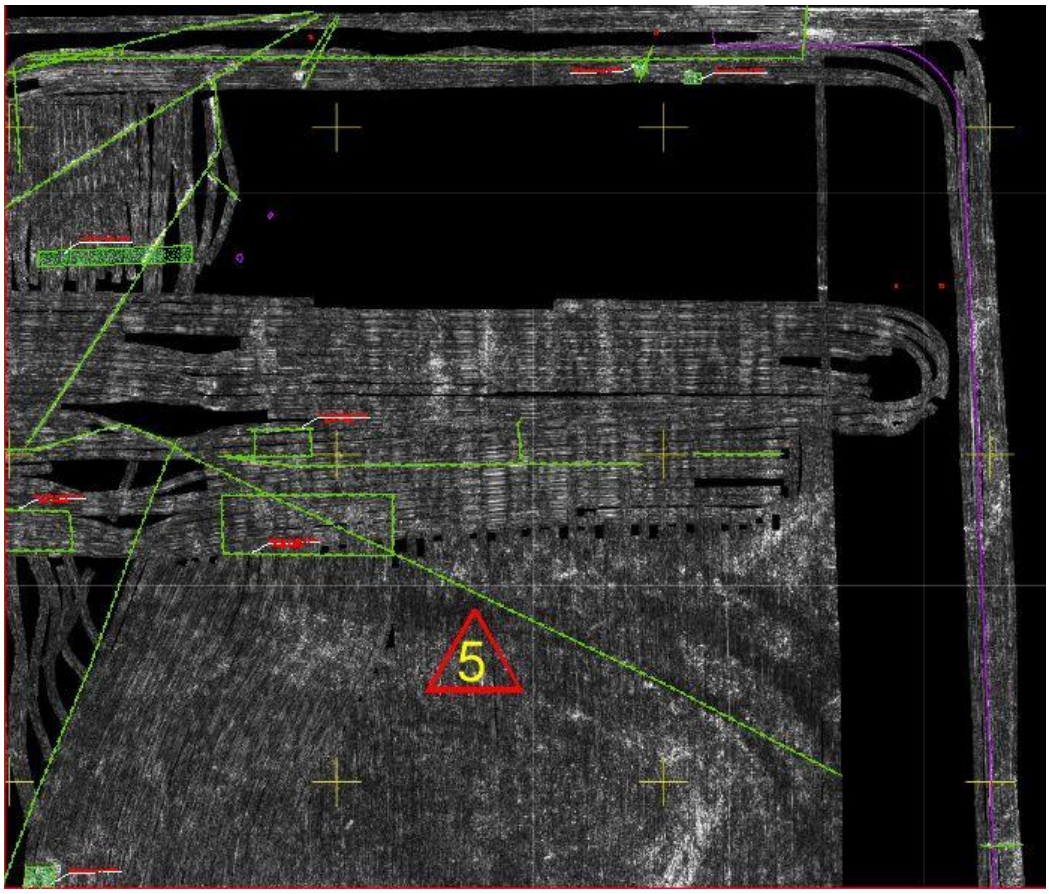


Figure 22 – Area 5 radar data with picked targets added.

Large areas of trees were present within this survey area, which limited GPR coverage. Numerous linear features are present which are likely to be buried utilities. There are also responses that may indicate the presence of existing foundations.

### 6.4.6 Area 6

Figure 23 – Picture showing the North-East car park

Figure 24 – Picture taken from North to South

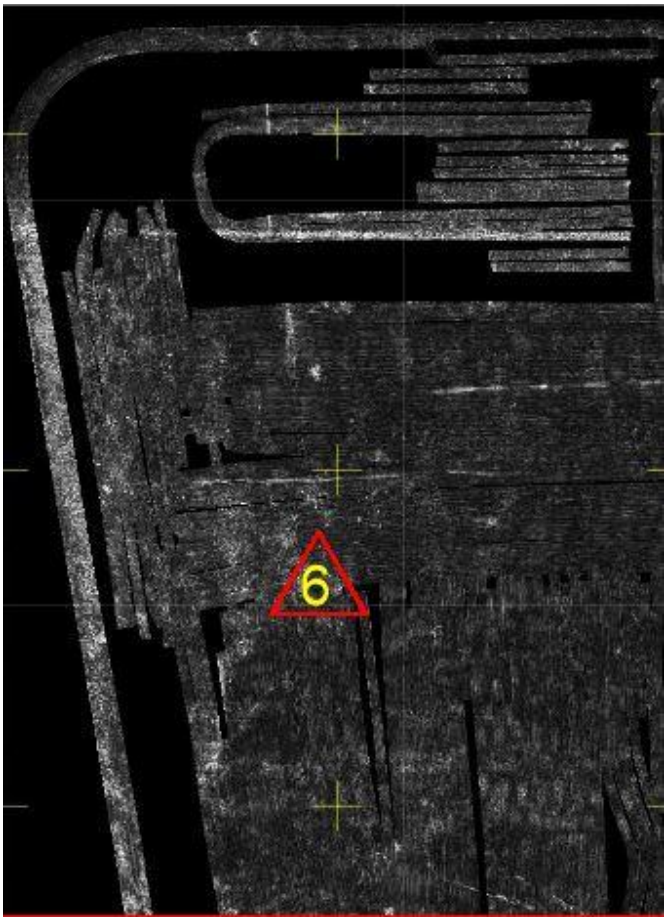

Figure 25 – Processed radar data for Area 6 from GPR Slice

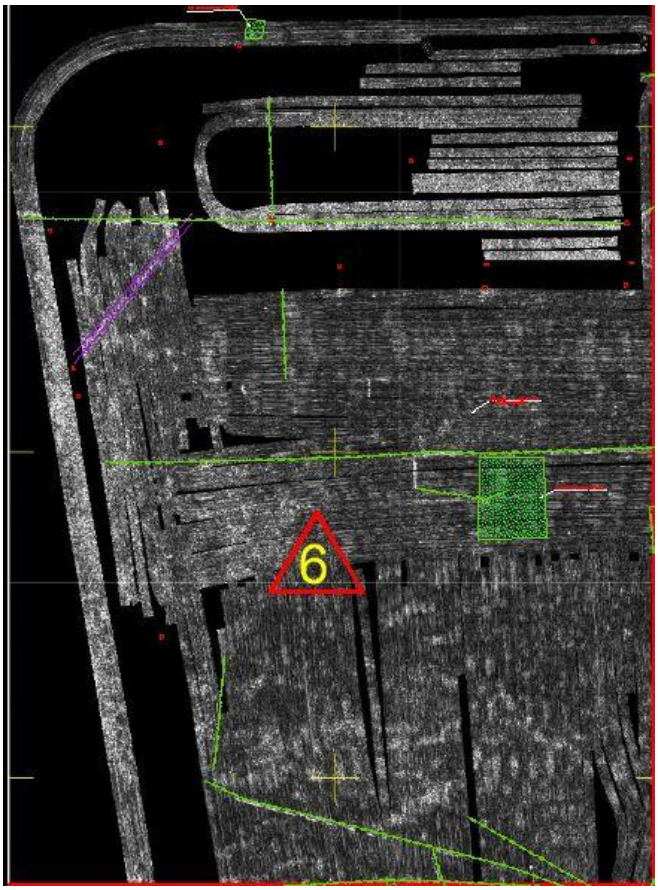

Figure 26 – Area 6 radar data with picked targets added.

Large areas of trees and parked vehicles were present within this survey area, which limited GPR coverage. Numerous linear features are present which are likely to be buried utilities. There are also responses that may indicate the presence of existing foundations.

## 7.0 Final Presentation / Deliverables

The GPR survey results have been overlayed, in 2D format, onto the topographical survey undertaken by Warner Surveys. This report should be read in conjunction with drawing RT2200592P0001-P0012.

## 8.0 Conclusion

Following the field work, all radar data was successfully processed and positioned onto the existing topographical survey. Many linear features were detected that indicate the presence of numerous utility features across the site. Additional anomalies were located that could indicate that there are existing foundations also found within the site.

The main area of interest within the results was around the known/existing air raid shelters towards the South & South-East of the site, where all seven responses were consistent. This acts as a control scan, which gave us an idea of what the responses would look like within areas that the shelters are suspected to be buried/abandoned. Unfortunately, we were unable to detect any similar signals anywhere else on the site. Depth penetration averaged around 1.50-1.80m across the site.

We would always recommend that trail pits are hand dug to accurately identify, locate and prove depths of buried services. Due to the dangers of striking underground services, we would certainly suggest that this be undertaken following the HSE Avoiding danger from underground services (HSG47) best practice, along with safe digging practices whenever there is the requirement to break ground. Should there be any intrusive works planned, a Type-A (Verification) survey would be recommended to confirm the exact location of structures.

## 9.0 Disclaimer



Ground Penetrating Radar techniques combined with visual inspection have been used to map the underground features shown on this plan/report. Warner Surveys use all reasonable efforts expected of experienced and qualified staff combined with calibrated equipment to perform our surveys; however, the completeness of any underground survey cannot be guaranteed. Depths are provided as a guide only.

Please note that not all buried pipes, utilities and features can be detected and mapped due to conditions outside of our control, such as depth, location, material type, geology and proximity to other services. It is recommended that trial holes are undertaken to confirm identification, location and depth of services at critical locations.

Warner Surveys cannot be held responsible for any inaccuracies beyond those that could be reasonably expected of a competent company. No utility mapping survey can be considered a 100% accurate depiction of the sub-surface environment and the use of these drawings does not remove the requirement for the use of safe digging techniques at all times in line with HSG47.

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