STRATASCAN

# Geophysical Survey Report

## Harvey's Foundry, Hayle
## Cornwall

For

Pell Frischmann

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J2081

Hannah Heard BSc (Hons)

REGISTERED IFA ORGANISATION

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| **Field Team:** | Lee Moorhead MSc, Laurence Chadd MA,<br>Steven Russell BSc (Hons) and Mark Styles |
| **Project Manager:** | Simon Stowe BSc (Hons) |
| **Report written by:** | Hannah Heard BSc (Hons) |
| **CAD draughting by:** | Hannah Heard BSc (Hons), Niall Granger BSc (Hons) |
| **Checked by:** | Simon Stowe BSc (Hons) and<br>Peter Barker C. Eng MICE MCIWEM MIFA |


Stratascan Ltd.

Vineyard House
Upper Hook Road
Upton upon Severn
WR8 0SA

Tel: 01684 592266
Fax: 01684 594142
Email: ppb@stratascan.co.uk

www.stratascan.co.uk

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# 1 SUMMARY OF RESULTS

Ground Probing Radar (GPR) and Radiodetection surveys were carried out at Harvey's Foundry in Hayle, Cornwall. The surveys form part of an archaeological investigation and utility mapping survey. The following report discusses the radar anomalies that may relate to areas of ground disturbance and structural remains of archaeological origin.

A number of areas of structural debris or ground disturbance have been identified across the survey area. It is difficult to separate with confidence features of archaeological or modern origin due the urban nature of the environment. A number of deep inclined anomalies have been identified within Areas 1 and 2. These anomalies may represent cut features and subsequent fills, however they may also be caused by an air wave response. A possible shallow cut feature has been identified in the south of Area 3 that may be of archaeological origin. Possible structural remains and debris have been identified situated in close proximity to the railway viaduct in Area 5. These anomalies may be of archaeological origin but may also relate to the railway construction.

# 2 INTRODUCTION

## 2.1 Background synopsis

Stratascan were commissioned to undertake a geophysical survey of an area outlined for a new pipe line. This survey forms part of a utility mapping and an archaeological investigation being undertaken by Pell Frischmann.

## 2.2 Site location

The site is located at Harvey's Foundry, Hayle, Cornwall, at OS NGR ref. SW 557 371

## 2.3 Description of site

The survey area covers a number of roadways passing through the Foundry site. Obstructions within the survey area include portacabins, parked cars, vegetation and modern debris. The ground cover ranges from hardstanding (tarmac and concrete) to gravel and areas of wasteground. The survey area is approximately 1700m².

The underlying geology contains stone created during the Devonian period (a range of Devonian sandstone and limestone) (British Geological Survey South Sheet, Fourth Edition Solid, 2001). The overlying soils are known as Denbigh 2 soils which are typical brown earths. These consist of well drained fine loamy soils over slate or slate rubble (Soil Survey of England and Wales, Sheet 5 South West England).

**Plate 1**: Looking south along Foundry Lane

2.4 Site history and archaeological potential

The following information has been provided by Cornwall Archaeological Unit.

2000. Cahill. N with Cornwall Archaeological Unit. *Hayle Historical Assessment, Cornwall*. Cornwall Archaeological Unit

The survey area is situated at Harvey's Foundry, founded in 1779. Historical records show little pre-industrial activity on the site before 1750. However the site is situated near Carnsew Hillfort, one of the major elements of the prehistoric landscape of the Hayle estuary. Prehistoric and Roman finds within the area suggest that this was a high status settlement/beach head in the Iron Age, Romano-British and Early Medieval periods.

John Harvey built a small foundry in 1779-80. Most of the surviving remains of the Foundry date from a major phase of expansion between 1839 and 1845. The surface area of the Foundry was increased by excavating out the east side of Carnsew to create more level ground, with Foundry Lane created at the same time. There are fragmentary remains of cattle houses and tunnels of unknown use in Foundry Lane.

In Foundry Farm/Foundry Lane all the original buildings recorded in this area survive today, and the historic maps show no evidence for these having replaced any earlier structures. However there is some potential for buried archaeological remains, the foundations of a structure previously attached to the western end of a stable block may survive below ground along with earlier surfacing such as cobbling and drains.

2.5 Survey objectives

The objective of the survey was to identify possible archaeological remains and other buried features such as granite fills, underground voids and culverts. In addition to this a utility mapping survey will also be carried out to find the depths and confirm positions of underground services.

2.6 Survey methods

Ground probing radar was considered the most suitable survey technique due to its ability to survey within an urban environment, its depth of penetration and collection of high resolution data. The identification of possible archaeological remains and buried features were carried out using 200MHz radar to achieve radar collection at depth. The identification of services were carried out using a 400 MHz radar (high resolution radar data) and Radiodetection.

More information regarding the GPR techniques is included in the Methodology section below.

# 3 METHODOLOGY

3.1 Date of fieldwork

The fieldwork was carried out over 7 days from the 7-11th and 14-15th of November 2005 when the weather was variable.

3.2 Grid locations

The location of the radar traverses have been plotted in Figure 1.

3.3 Description of techniques and equipment configurations

Two of the main advantages of radar are its ability to give information of depth as well as work through a variety of surfaces, even in cluttered environments and which normally prevent other geophysical techniques being used.

A short pulse of energy is emitted into the ground and echoes are returned from the interfaces between different materials in the ground. The amplitude of these returns depends on the change in velocity of the radar wave as it crosses these interfaces. A measure of these velocities is given by the dielectric constant of that material. The travel times are recorded for each return on the radargram and an approximate conversion made to depth by calculating or assuming an average dielectric constant (see below).

Drier materials such as sand, gravel and rocks, i.e. materials which are less conductive (or more resistant), will permit the survey of deeper sections than wetter materials such as clays which are more conductive (or less resistant). Penetration can be increased by using longer wavelengths (lower frequencies) but at the expense of resolution (see 3.4.2 below).

As the antennae emit a "cone" shaped pulse of energy an offset target showing a perpendicular face to the radar wave will be "seen" before the antenna passes over it. A resultant characteristic *diffraction* pattern is thus built up in the shape of a hyperbola. A classic target generating such a diffraction is a pipeline when the antenna is travelling across the line of the pipe. However it should be pointed out that if the interface between the target and its surrounds does not result in a marked change in velocity then only a weak hyperbola will be seen, if at all.

The Ground Probing Impulse Radar used was a SIR2000 system manufactured by Geophysical Survey Systems Inc. (GSSI).

The radar surveys were carried out using both 200MHz and 400MHz antennae. These frequency ranges offer a good combination of depth of penetration and resolution.

## 3.4 Sampling interval, depth of scan, resolution and data capture

### *3.4.1 Sampling interval*

The 400MHz radar scans were carried out along traverses 1m apart on an orthogonal grid as shown in Figure 1. The 200MHz radar scans were carried out along traverses 1m apart on a parallel grid as shown in Figures 8 and 9. Data was collected at 40 scans/metre. A measuring wheel was used to put markers into the recorded radargram at 1m centres.

### *3.4.2 Depth of scan and resolution*

The average velocity of the radar pulse was calculated to be 0.087/nsec which is typical for the type of sub-soils on the site. With range settings of 60ns (400Mhz) and 120ns (200MHz) this equates to a maximum depth of scan of 2.6m and 5.2m respectively but it must be remembered that this figure could vary by ± 10% or more. A further point worth making is that very shallow features are lost in the strong surface response experienced with this technique.

Under ideal circumstances the minimum size of a vertical feature seen by a 200MHz (relatively low frequency) antenna in a damp soil would be 0.1m (i.e. this antenna has a wavelength in damp soil of about 0.4m and the vertical resolution is one quarter of this wavelength). It is interesting to compare this with the 400MHz antenna, which has a wavelength in the same material of 0.2m giving a theoretical resolution of 0.05m. A 900MHz antenna would give 0.09m and 0.02m respectively.

### *3.4.3 Data capture*

Data is displayed on a monitor as well as being recorded onto an internal hard disk. The data is later downloaded into a computer for processing.

## 3.5 Processing, presentation of results and interpretation

### *3.5.1 Processing*

The radar plots included in this report have been produced from the recorded data using Radan software. Filters were applied to the data to remove background noise.

### *3.5.2 Presentation of results and interpretation*

*Manual abstraction*

Each radargram has been studied and those anomalies thought to be significant were noted and classified as detailed below. Inevitably some simplification has been made to classify the diversity of responses found in radargrams.

i. Strong and weak discrete reflector.
These may be a mix of different types of reflectors but their limits can be clearly defined. Their inclusion as a separate category has been considered justified in order to emphasise anomalous returns which may be from archaeological targets and would not otherwise be highlighted in the analysis.

ii. Complex reflectors.
These would generally indicate a confused or complex structure to the subsurface. An occurrence of such returns, particularly where the natural soils or rocks are homogeneous, would suggest artificial disturbances. These are subdivided into both strong and weak giving an indication of the extent of change of velocity across the interface, which in turn may be associated with a marked change in material or moisture content.

iii. Point diffractions.
These may be formed by a discrete object such as a stone or a linear feature such as a small diameter pipeline being crossed by the radar traverse (see also the second sentence in 4. below).

iv. Convex reflectors and broad crested diffractions.
A convex reflector can be formed by a convex shaped buried interface such as a vault or very large diameter pipeline or culvert. A broad crested diffraction as opposed to a point diffraction can be formed by (for example) a large diameter pipe or a narrow wall generating a hybrid of a point diffraction and convex reflector where the central section is a reflection off the top of the target and the edges/sides forming diffractions.

v. Planar returns.
These may be formed by a floor or some other interface parallel with the surface. These are subdivided into both strong and weak giving an indication of the extent of change of velocity across the interface which in turn may be associated with a marked change in material or moisture content.

# 4 RESULTS

The results and interpretation for the utility maping survey can be seen in Figures 2-3 and 12-13. The following section will discuss the GPR anomalies identified with both data sets that may relate to features of archaeological origin.

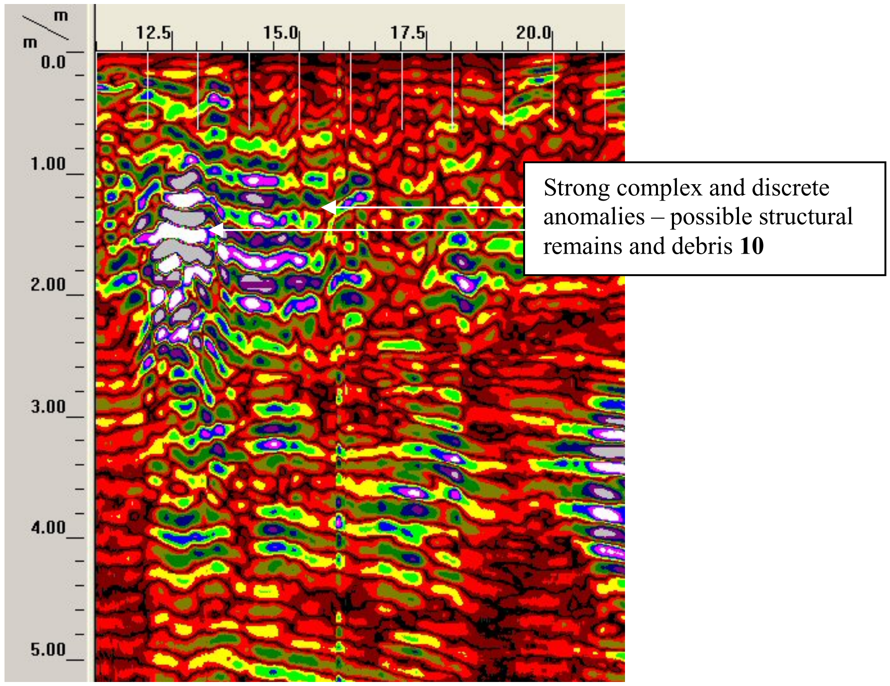
Both radar frequencies have produced a wide range of radar anomalies. Large sections of the roadway data are dominated by near surface planar responses (seen in Figures 4-5 and 8-9). These anomalies are likely to be caused by the construction of the roadway and consequent resurfacing, however some deeper planar responses may represent a previous ground surface relating to the Foundry. A number of linear aligned point diffractions identified as unknown possible services may indicate structural remains or debris of archaeological origin.

The radar anomalies have been identified and characterised into the following catagories:

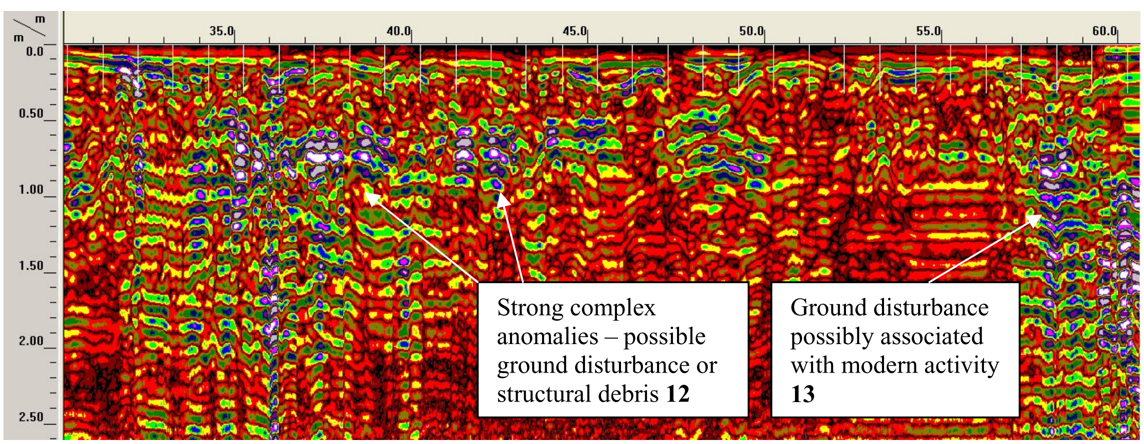
- Strong complex anomalies – possible structural debris of modern or archaeological origin
- Weak complex anomalies – areas of ground disturbance of modern or archaeological origin
- Inclined events – areas of ground disturbance of modern or archaeological origin
- Strong discrete anomaly – possible structural remains

## 4.1 Strong complex anomalies

Situated across the survey area are a number of strong complex anomalies (**1-13**). These anomalies may represent structural debris of modern or archaeological origin. Anomalies **1-4** may represent ground disturbances or structural debris of modern origin due to their shallow depths. Anomaly **5** may represent ground disturbance associated with a nearby service scar and possible service identified by a series of point diffractions. Anomaly **6** is likely to represent ground disturbance associated with a gas service. Anomaly **7** may indicate an area of structural debris of possible archaeological origin. Anomalies **8** and **9** possibly represent modern disturbance from the laying of services. Anomaly **10** may represent structural debris of archaeological origin, possibly relating to the railway construction (Example Radargram 1). Anomalies **11-13** may represent modern ground disturbance caused by the laying of nearby service (Example radargram 2).



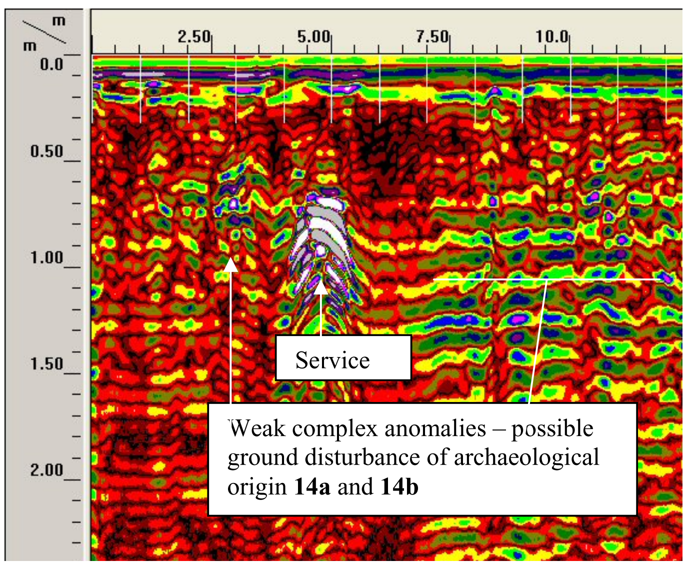

**Example Radargram 1**: 200MHz Area 5. Traverse 3E, 11N-21.5N. Showing complex and discrete anomalies possibly relating to the former railway or structural remains and debris of archaeological origin



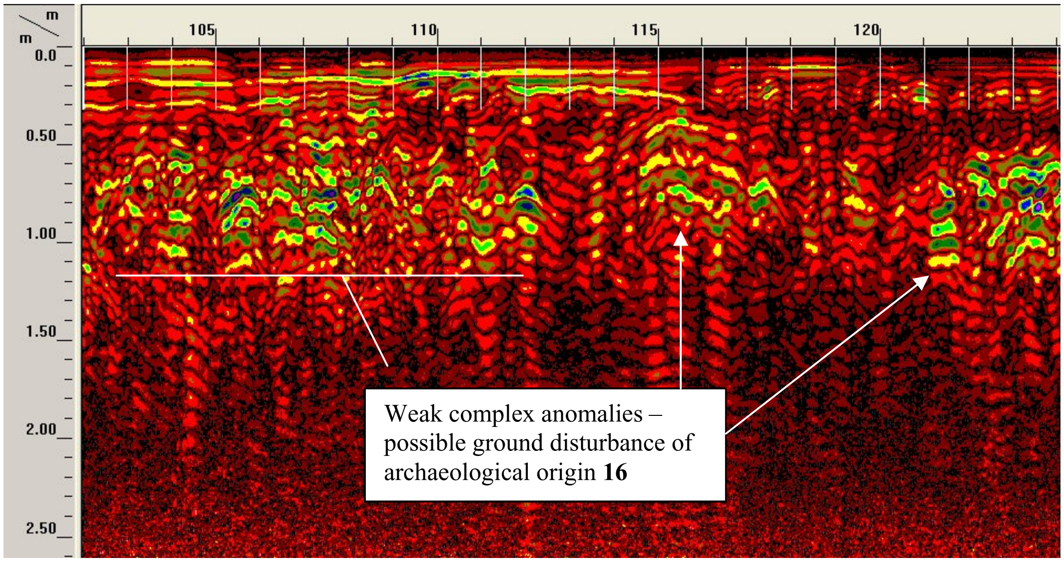

**Example Radargram 2**: 400MHz Area 5. Traverse 22N, 28-61.5E. Showing complex anomalies of possible modern origin

## 4.2 Weak complex anomalies

Anomalies **14-25** represent areas of weak complex anomalies. These anomalies may indicate areas of ground disturbance of modern or archaeological origin. Anomalies **14a-c** may represent areas of ground disturbance of archaeological origin identified approximately 0.5m deep (Example Radargram 3). Anomaly **15** is positioned within an area of broken ground and standing water and therefore is of modern origin. Anomaly **16** situated within Area 3 may represent a large area of ground disturbance of possible archaeological origin (Example radargram 4). Anomalies **17-19** and **21** are likely to be of modern origin, associated with the laying of services or modern activity. Anomaly **20** may represent a discrete area of ground disturbance of unknown origin. Anomalies **22-25** indicate areas of ground disturbance of archaeological or modern origin due to the presence of service runs.




**Example Radargram 3**: 400MHz Area 1. Traverse 3N, 0-12.25E. Showing weak complex anomalies indicating possible ground disturbance

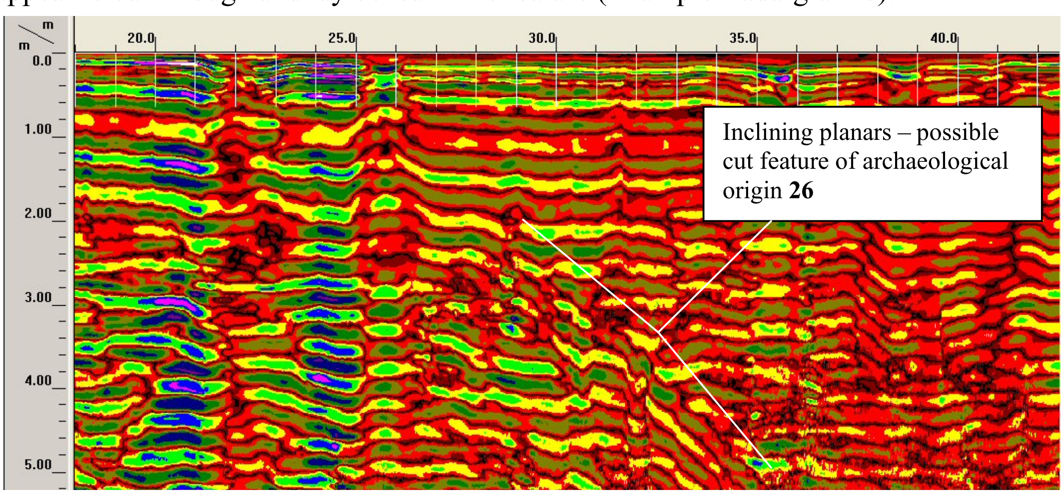



**Example Radargram 4**: 400MHz Area 3. Traverse 64N, 102-125E. Showing weak complex anomalies possibly associated with ground disturbance of archaeological origin

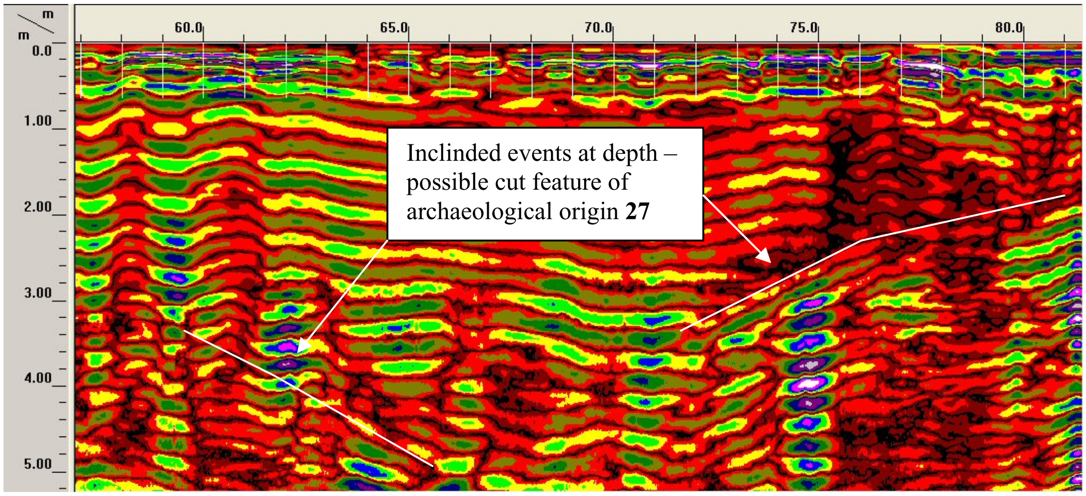
## 4.3 Inclined events

Anomalies **26-30** represent areas of inclined planars. These anomalies may represent possible cut features or fills of archaeological origin, relating to the Foundry or landscaping prior to the Foundry's construction. Anomalies **26** and **27** may represent cut features of possible archaeological origin (Example Radargram 5 and 6). Anomalies **28** and **29** represent large inclining events at depths. These anomalies are likely to be a series of radar waves created by a surface structure (Example Radargram 7).

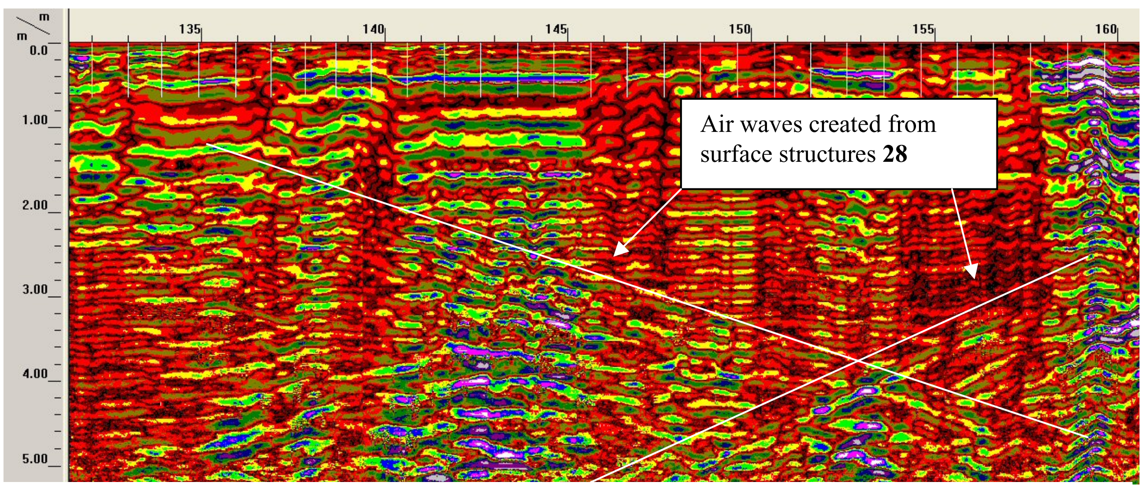
Anomaly **30** is a relatively shallow feature at approximately 0.5m deep. This anomaly may represent a shallow pit or cut feature of unknown origin. A number of services appear to cut through and lay beneath this feature (Example Radargram 8).



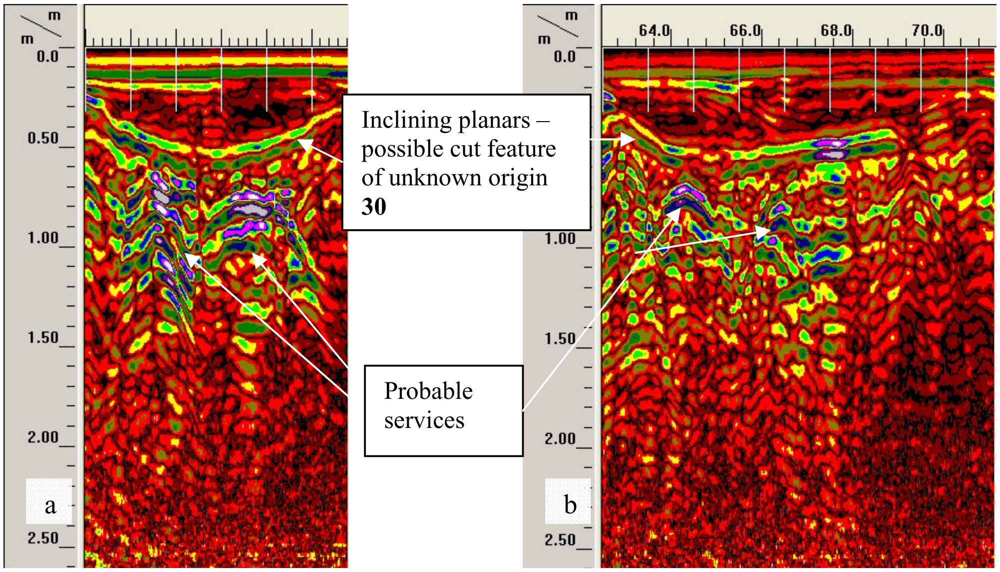

**Example Radargram 5**: 200MHz Area 1. Traverse 0E, 18-42.5N. Showing inclining planars of possible archaeological origin




**Example Radargram 6**: 200MHz Area 1. Traverse 1E, 57-81N. Showing inclined events at depth, possibly representing cut and fill anomalies of archaeological origin



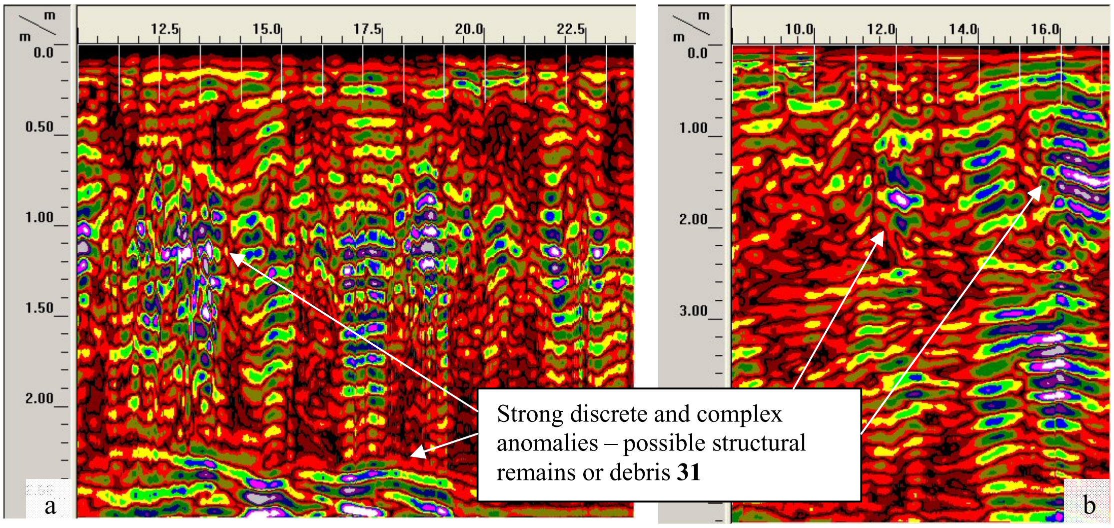

**Example Radargam 7**: 200MHz Area 2. Traverse 102E, 130-161N. Inclining events representing air waves caused by surface structures




**Example Radargram 8**: 400MHz Area 3. (a) Traverse 65E, 56.5-62.25N. (b) Traverse 59N, 62.5-71E. Showing shallow inclining planars possibly representing a pit or cut feature of archaeological or modern origin

## 4.4 Strong discrete anomaly

A strong discrete anomaly has been identified within Area 5 close to the railway viaduct (**31**). This anomaly may indicate structural remains of possible archaeological origin or related to the construction of the railway (Example Radargram 9).




**Example Radargram 9**: Area 5 (a) 400MHz Traverse 3E, 10-23.5. (b) 200MHz Traverse 0E, 8-17N. Showing strong discrete and complex anomalies possibly indicating structural remains or debris

## 5 CONCLUSION

A number of areas of structural debris or ground disturbance have been identified across the survey area. It is difficult to separate with confidence features of archaeological or modern origin due to the urban nature if the environment. A number of deep inclined anomalies have been identified within Areas 1 and 2. These anomalies may represent cut features and subsequent fills, however anomalies **28** and **29** may be caused by near surface structures creating an air wave response. A possible shallow cut feature has been identified in the south of Area 3 and may be of archaeological origin. Possible structural remains and debris have been identified situated in close proximity to the railway in Area 5. These anomalies may be of archaeological origin but may also relate to the construction of the railway.