

Geophysical Survey of the Caskey Property, Bell Block - Area N

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The logo for Geometria, featuring the word "Geometria" in a bold, yellow, sans-serif font.

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1.0 Introduction

Mitchell Dyer of New Plymouth District Council (NPDC) commissioned Geometria Ltd to undertake a geophysical survey on areas of the Caskey Property, Bell Block, to determine if any archaeological, or potential archaeological features could be identified in the area. The Caskey property is located within the NPDC designated Area N, where a zoning change is proposed. Te Oropuriri Pa, a nationally significant archaeological site, is located on the property.

Russell Gibb and Dan McCurdy from Geometria and Matt Watson from Scantec Limited undertook the geophysical surveys on the 20 - 21st July, 2011.

This report follows two previous reports: the first (Geometria 2010a) summarised the history of Area N, discussed the known archaeology and archaeological excavation work undertaken to date, and addressed some of the options and risks associated with the proposed zoning change and new road between Henwood Road and Egmont Roads. The second report (Geometria 2010b) provided more detailed assessment of the archaeology and risks posed by intensified land use in Area N, including a detailed GIS investigation and analysis of historic land-use change, a field-based archaeological assessment of Area N, and geophysical surveys of areas deemed to represent higher archaeological risk. The Caskey property was not included in the geophysical surveys undertaken during this assessment.

This survey and assessment uses archaeological and geophysical techniques to assess archaeological potential and does not seek to locate or identify wahi tapu or other places of cultural or spiritual significance to Maori. Tangata Whenua, who may be approached independently of this report for advice, may only make such assessments.

1.1 Historic Places Act

Under the Historic Places Act 1993 (HPA) all archaeological sites are protected from any modification, damage or destruction. Section 2 of the HPA defines an archaeological site as:

"any place in New Zealand that either was associated with human activity that occurred before 1900; or is the site of the wreck of any vessel where that wreck occurred before 1900; and is, or may be, able through investigation by archaeological methods to provide evidence relating to the history of New Zealand."

To be protected under the HPA an archaeological site must have physical remains that pre-date 1900 and that can be investigated by scientific archaeological techniques. If a development is likely to impact on an archaeological site, an authority to modify or destroy this site can be sought from the New Zealand Historic Places Trust (NZHPT) in Wellington under Section 11 or 12 of the HPA. Where damage or destruction of archaeological sites is to occur the NZHPT usually requires mitigation.

Most archaeological evidence consists of sub-surface remains and is often not visible on the ground. Indications of an archaeological site are often very subtle and hard to distinguish on the ground surface. Sub-surface excavations on a suspected archaeological site can only take place with an authority issued under Section 18 of the HPA issued by the NZHPT.

1.2 The Resource Management Act 1991.

Archaeological sites and other historic heritage may also be considered under the Resource Management Act 1991 (RMA). The RMA establishes (under Part 2) in the Act's purpose (Section 5) the matters of national importance (Section 6), and other matters (Section 7) and all decisions by a Council are subject to these provisions. Sections 6e and 6f identify historic heritage (which includes archaeological sites) and Maori heritage as matters of national importance.

Councils have a responsibility to recognise and provide for the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, wahi tapu, and other taonga (Section 6e). Councils also have the statutory responsibility to recognise and provide for the protection of historic heritage from inappropriate subdivision, use and development within the context of sustainable management (Section 6f). Responsibilities for managing adverse effects on heritage arise as part of policy and plan preparation and the resource consent processes.

2.0 Survey Area

Four areas were selected for geophysical survey; Areas 1, 2 and 3 are located on the ridgeline associated with the Te Oropuriri Pa site. Areas 1 and 2 are a continuation south along the ridge from the pa, while Area 3 is located below and to the west of the main ridgeline. Area 4 is a low hillock with small swamp below located in the south west of the property (Figure 1).



Figure 1: Location of geophysical survey areas 1-3.

2.1 The Caskey Property (1C2B2)

Part of Te Oropuriri Pa has been excavated over several seasons during the development of the Bell Block bypass¹ and the evidence from those archaeological investigations indicates that more of the pa site lies within the present Caskey property (Figure 2). The exact extent of the site is unknown although the previous research (Geometria 2010:b) concluded it is likely that the site extends over a large area of the ridgeline that bisects the Caskey property (Figure 3) and the adjacent Rowe property to the east.



Figure 2: Previously excavated extent of Te Oropuriri Pa contiguous with the Caskey property.



Figure 3: Looking north over the ridgeline towards the excavated area of Te Oropuriri Pa.

¹ The excavated area of Te Oropuriri was originally part of the Caskey Property 1C2B2.

3.0 Methodology

Two geophysical methods were used: Ground Penetrating Radar (GPR) using a GSSI SIR-3000 GPR system with 400MHz frequency antenna and Magnetometry using a GEM Systems GSM-19WG magnetometer / gradiometer (overhauser type). GPR is well suited for geophysical prospection as it not overly affected by the volcanic (magnetic) qualities of the underlying geology and the data collected provides a clearer picture of the vertical stratigraphy and horizontal features of the surveyed area. Magnetometry was chosen as a complementary survey method as it measures variation in the magnetism of the subsurface and both geomorphologic changes and anthropogenic changes can be inferred from the data.

Area 1 measures 60 x12m and was set out adjacent to the boundary fence separating the Caskey and Rowe properties. GPR lines were measured at 0.5m resolution and magnetometer lines were measured at 0.5m resolution lengthways along the grid.

Area 2 is an extension of Area 1 further up (south) the ridgeline and measures 90 x 12m. This grid was only surveyed using magnetometer lines, which were measured at 0.5m resolution lengthways along the grid.

Area 3 measures 30 x 22m set out parallel to the boundary fence adjacent to the excavated extent of Te Oropuriri. GPR lines were measured at 0.5m resolution and magnetometer lines were measured at 0.5m resolution lengthways along the grid.

Area 4 measures 12 x12m and is located on the top of the low hillock. GPR lines were measured at 1m resolution.

3.1 Geophysical background

Among the features often recognised in archaeological geophysical surveys are fireplaces, houses, and pits (Zickgraf 1999) and shell middens (Dalan et al., 1992).

A geomagnetic response is influenced by three components (Zickgraf 1999:107-9):

1. The magnetic susceptibility of any material affects the magnetic signature to different degrees. Therefore different materials in the ground may present different magnetic signatures. Ferromagnetic materials (e.g. iron) can have their own magnetic signature (remnant magnetism).
2. Le Borgne effect: The magnetic susceptibility of the topsoil to a depth of about 0.30m can be up to 100 times stronger than the susceptibility of the soil at 1m depth. This is due to chemical reactions of the soil close to the surface. Therefore any trench or pit back filled with mainly topsoil shows a much stronger magnetic signature than the surrounding soil.
3. The magnetic field of the earth is constantly changing and influenced by environmental changes, e.g. the intensity of the sun. The configuration of the instrument as a gradiometer, where one magnetometer is positioned close to the soil surface and a second magnetometer set approximately 1 metre apart compensates for environmental changes.

Several types of geophysical anomalies are often found in archaeological contexts (ibid):

Small areas of high (dark) values generally represent substantial burning events such as fireplaces, hearths or hangi. Interpretation of anomalies as fireplaces is based on anomalies similar to the possible pit features but smaller and more discrete. It is expected that these anomalies are the result of induced magnetism by localized burning events.

Ferrous material has remnant magnetism which shows up as a positive and a negative pole surrounding the object i.e. areas of high (dark) values, contiguous with areas of low (light) values.

Pits are often distinguished by the outline or shape of the feature where the fill of the pit has a different magnetic signature to the surrounding undisturbed soil outside the pit. Therefore, possible pit features are interpreted on the basis of a strong magnetic signature from the presumably deeper and denser top soil, suggestive of an in filled pit feature; coupled with geometric shape recognition or patterning, such as a row of square anomalies. House floors are sometimes interpreted by the magnetic response given by the compacted hardened floor, compared to the surrounding area.

4.0 Results

4.1 Area 1

Magnetometry

This narrow grid is set out from the base (left) of the small rise and is bounded to the west by a line of mature pines and to the east by the boundary fence with the Rowe property. The magnetic survey results from Area 1 (a 60 x12m grid – Figure 4) provide evidence of subsurface anthropogenic modification with two large anomalies (Features 1, 2) which may represent pit or house floor features, a possible pit with metal fill (Feature 3) a large metal anomaly (Feature 4), which may be related to buried material from the adjacent fence line, and two small possible pits (Features 5, 6).

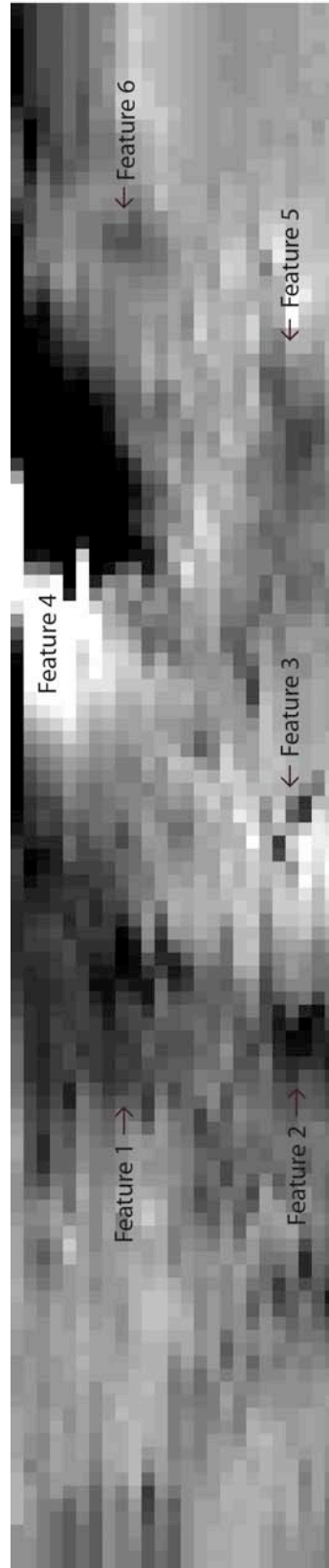


Figure 4: Area 1 magnetometry results and identified feature anomalies.

Ground Penetrating Radar

GPR lines that were measured at 0.5m intervals across the grid have been merged and are shown as depth slices in plan view at 0.1m intervals. Several refractions interpreted as anthropogenic can be seen in the data from a depth of 0.1m to 1.2m (Figure 5). This includes a shallow trench (possibly a modern service trench), a small pit extending to a depth of 0.5m toward the east of the grid, two possible pit features at about 10m along the grid, a deeper possible pit feature that correlates to Feature 1 in the magnetic results, and a possible house floor that correlates to Feature 4 in the magnetic results. Beyond 1.2m deep, refractions from the natural geology begin to appear (figure 6).

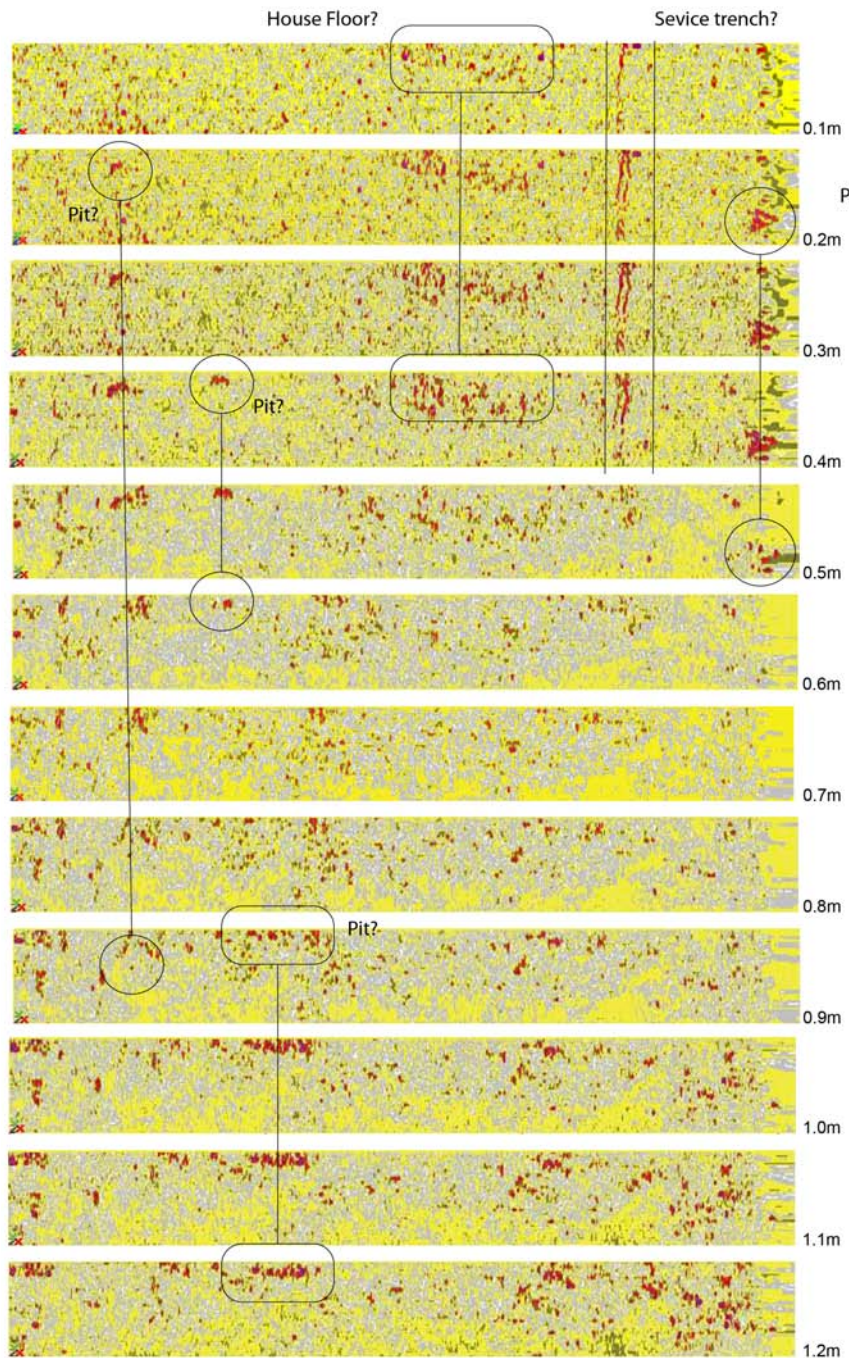


Figure 5: Area 1 GPR results between 0 - 1.2m.

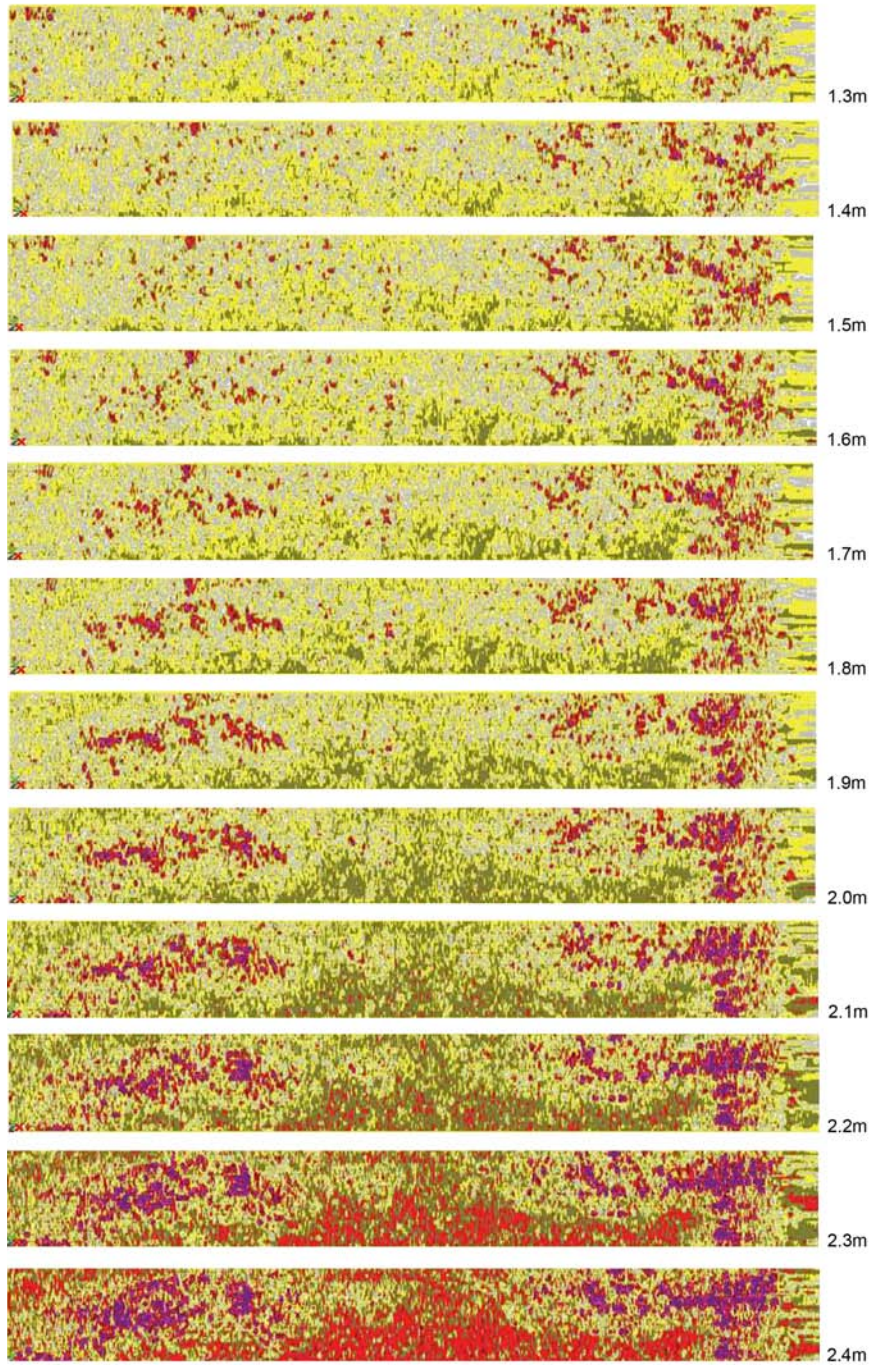


Figure 6: Area 1 GPR results between 1.3 – 2.4m.

4.2 Area 2

Magnetometry

Area 2 grid (90 x 12m) is a continuation of Area 1 that covers the small slightly higher mound (i.e. a possible tihi) to the south of Area 1. This narrow grid is set out contiguous with the end of Area 1 and is bounded to the east by the boundary fence with the Rowe property (Figure 7). Three main anomalies have been identified in the magnetic survey results: a possible pit or series of small pits, some which have metal fill (Feature 7), a large possible metal anomaly (Feature 8) adjacent to the fence line at about 65m, which may be related to buried material from the adjacent fence line or buried construction material, and a feature undetermined origin (Feature 9) near the eastern end of the grid.

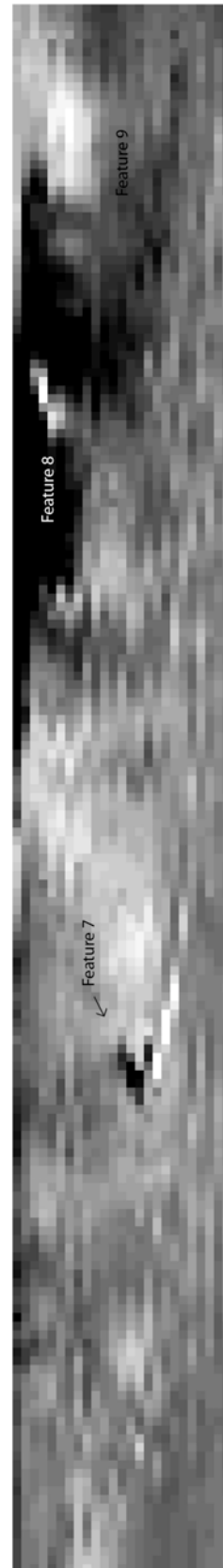


Figure 7: Area 2 magnetometry results and identified feature anomalies

4.3 Area 3

Magnetometry

A number of anomalies have been identified in the results for Area 3 (a 20 x 22m grid – Figure 8). Feature 10 is interpreted as a house floor - its location and shape correspond to the known location of the partially excavated house on the adjacent Te Oropuriri Pa excavation site. Feature 11 is a circular feature, possibly an in-filled rua or fire hearth, while Feature 12 is another possible pit feature with a strong metallic response. Feature 13 is an in-filled ditch with possible postholes. A linear arrangement (Feature 14) is possibly a line of postholes (Figure 9).

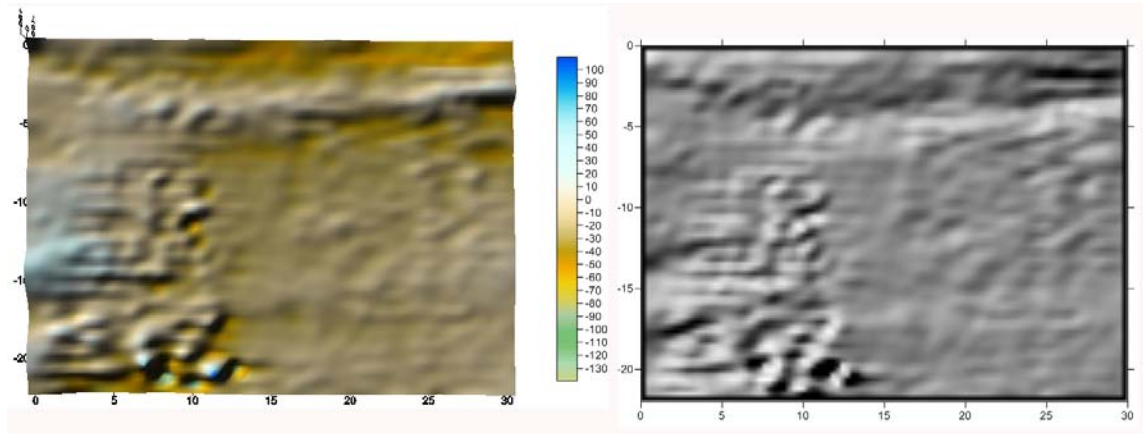


Figure 8: Area 3 magnetometry data intensity values.

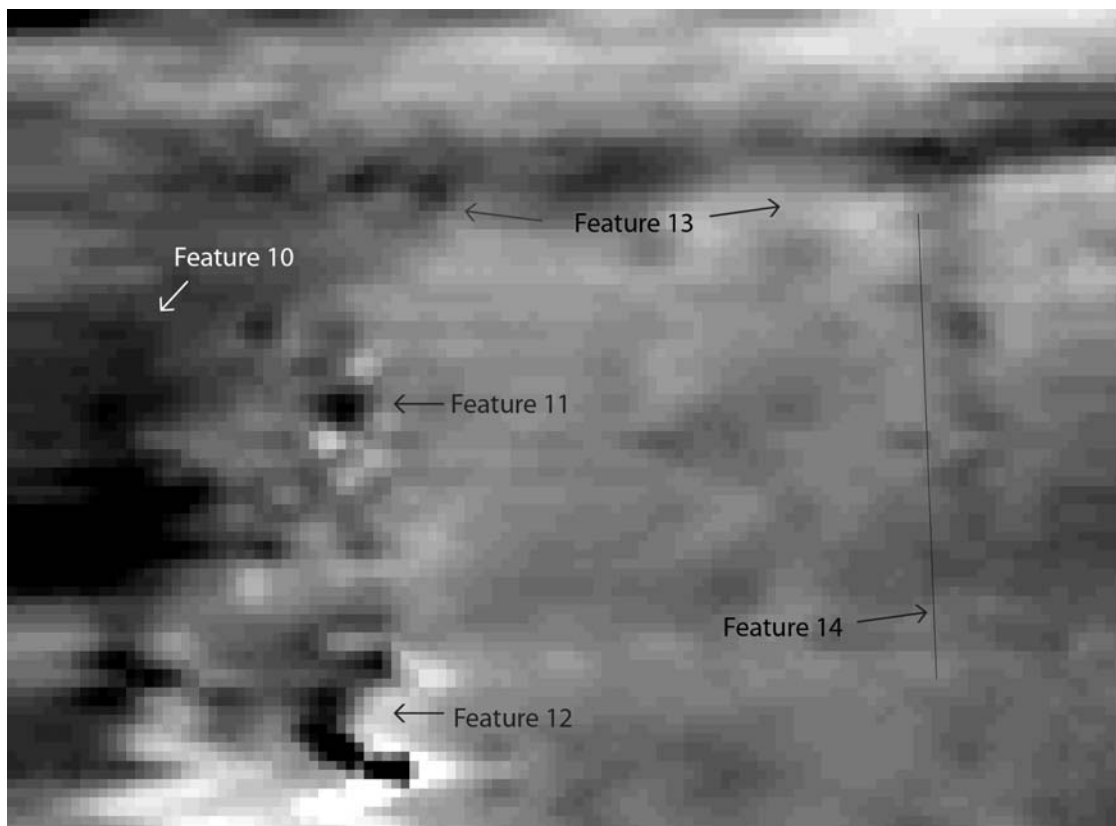


Figure 9: Area 3 magnetometry results and identified feature anomalies.

Ground Penetrating Radar

The GPR results for Area 3 show several refractions indicating anthropogenic subsurface features (Figure 10). An alignment of postholes is recorded from 0.1 to 0.6m deep and this alignment corresponds to the trench alignment Feature 13 identified in the magnetic survey data. A grouping of postholes is also evident in the same location where the house floor has been identified in the magnetic survey data. Two possible pits can be seen in the GPR data, which correspond to Features 11 and 12 in the magnetic survey data. Another linear alignment of postholes is located on the right of the grid.

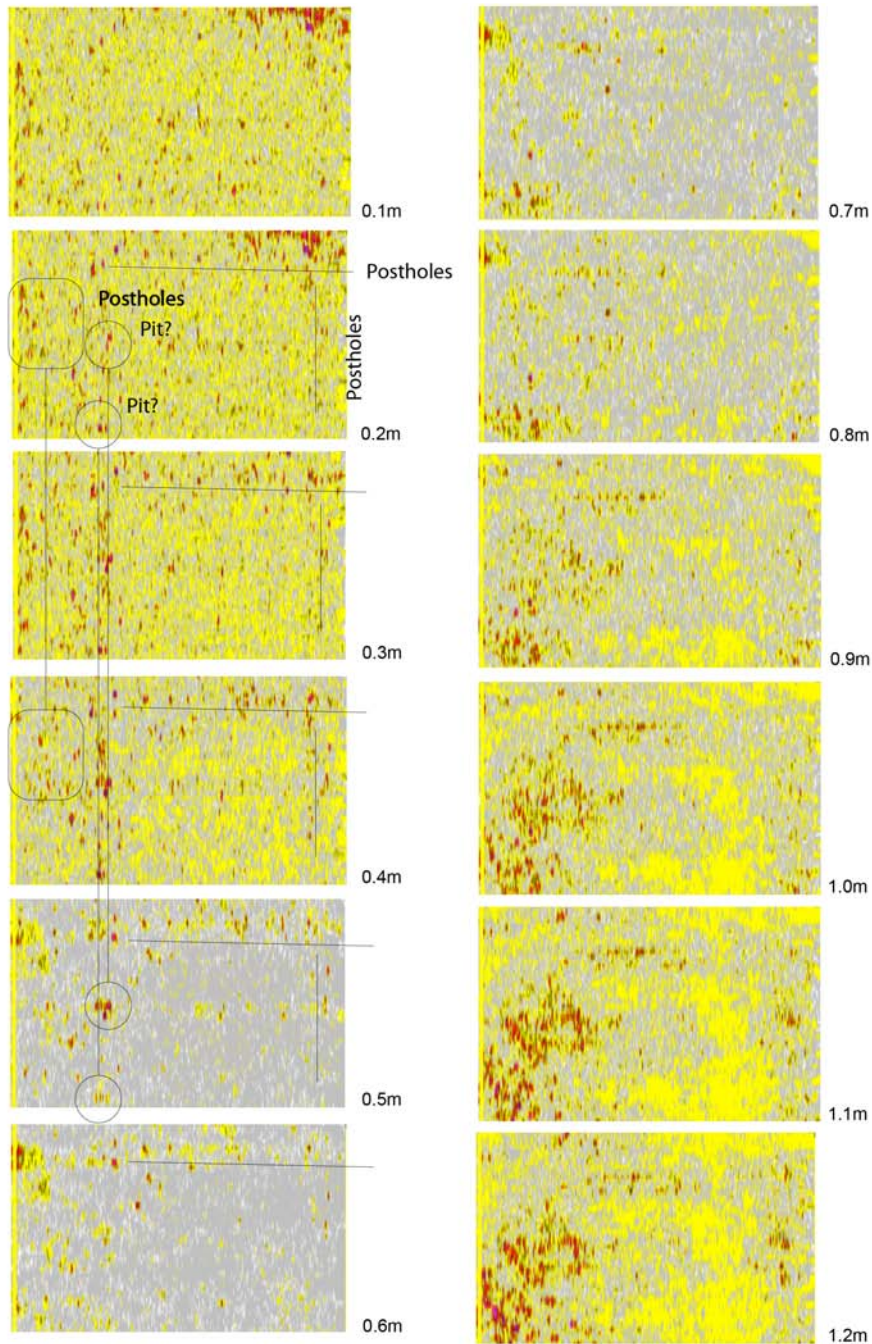


Figure 10: Area 3 GPR results between 0 – 1.2m

A strong set of refractions can be seen cutting diagonally across the left bottom corner of this grid starting at around a depth 1m (Figure 11). This represents a large linear feature, which might be either a filled trench or underground service element. Figure 12 shows several of these features in vertical depth slices.

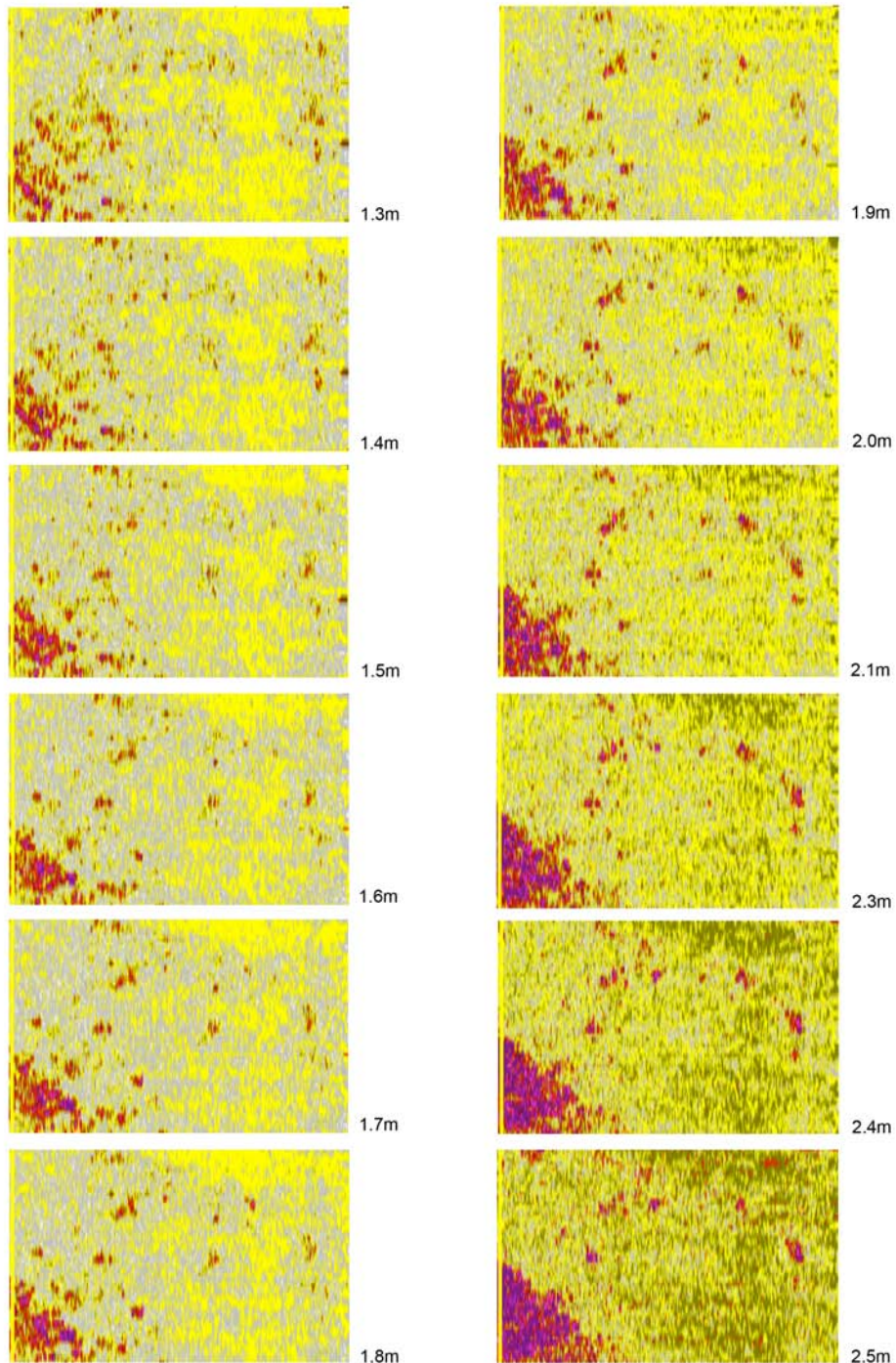
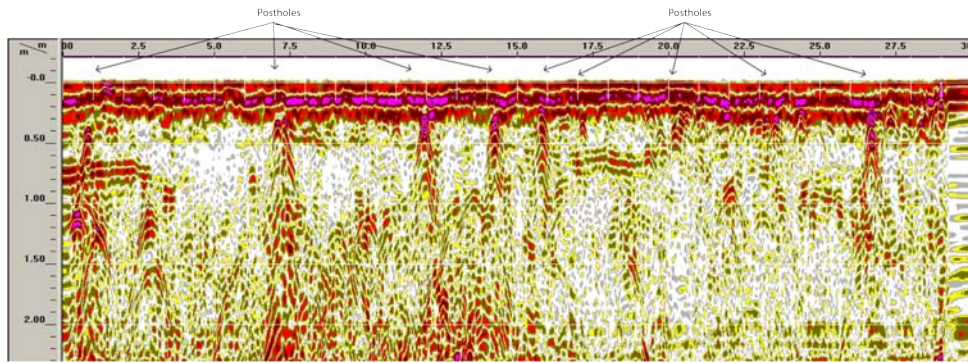
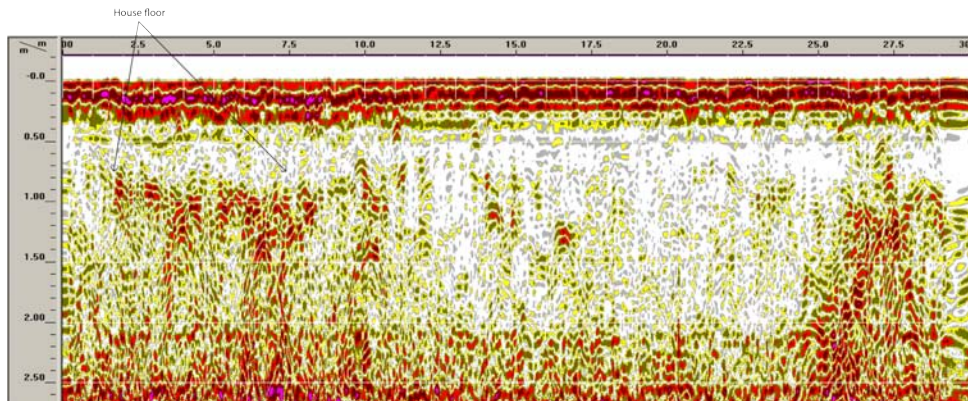


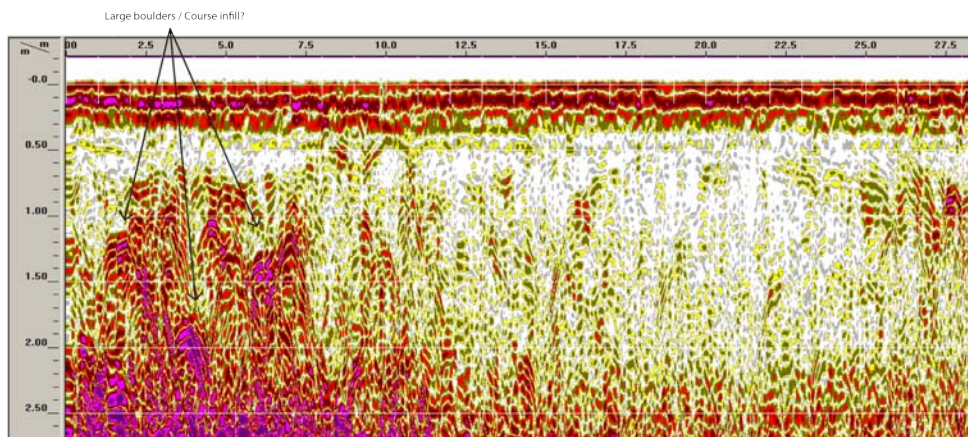
Figure 11: Area 3 GPR results between 1.3 – 2.4m



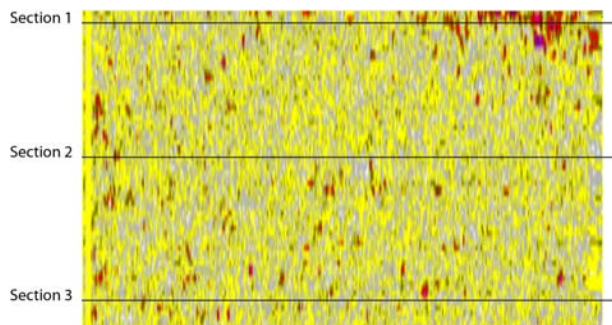
A. Section 1.



B. Section 2.



C. Section 3.



D. Location of Sections.

Figure 12: Area 1 GPR depths slices at (A) 1m, (B) 10m and (C) 20m along the grid (D).

6.4 Area 4

Ground Penetrating Radar

The GPR results for Area 4 (6x12m) show no discernable features that could be interpreted as anthropogenic. One deep (2.2m+) lineation interpreted as a geomorphic feature is noted. The rest of the data has no significant shallow depth refractions (Figure 13,14).

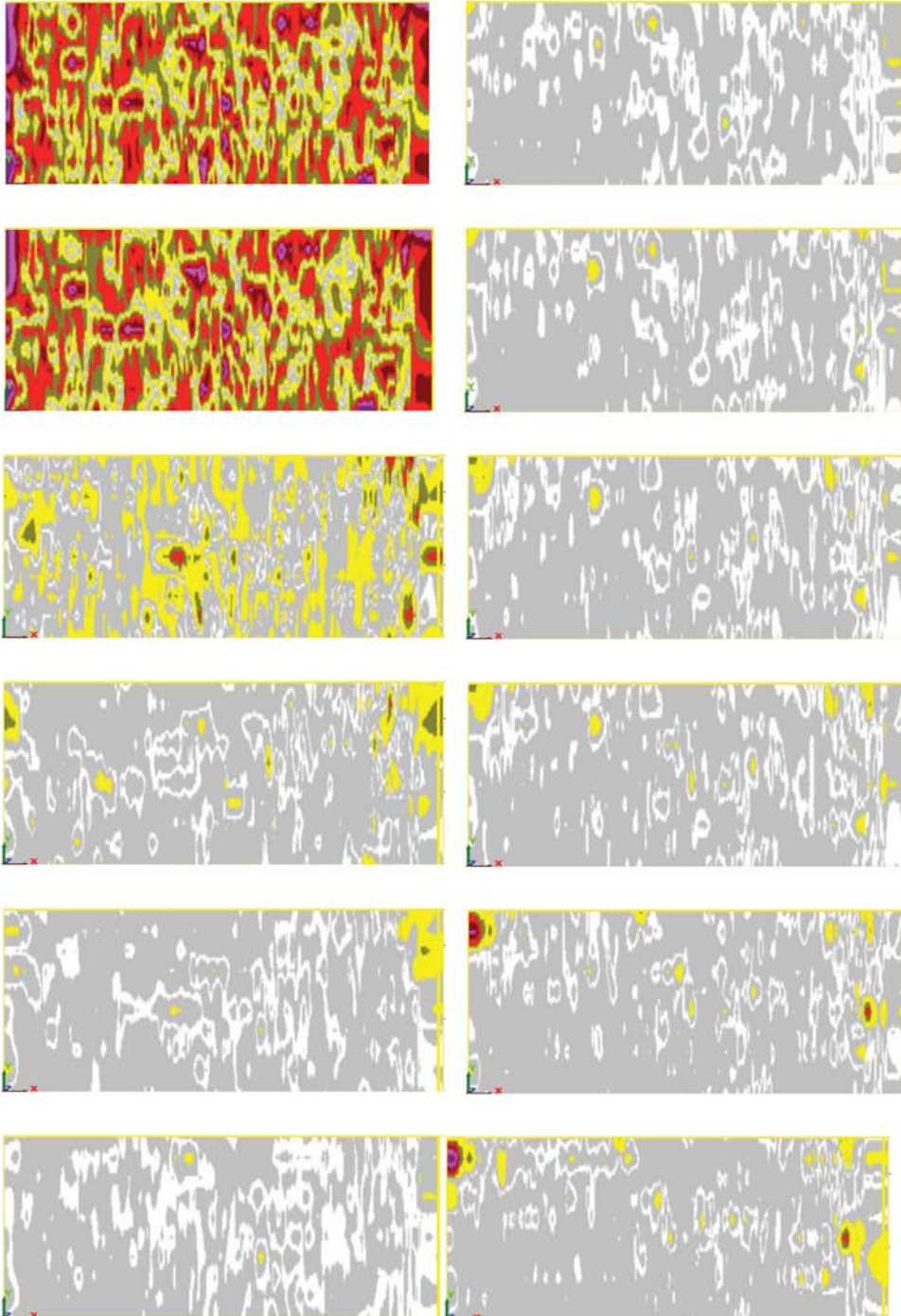


Figure 13: Area 4 GPR results between 0 – 1.2m.

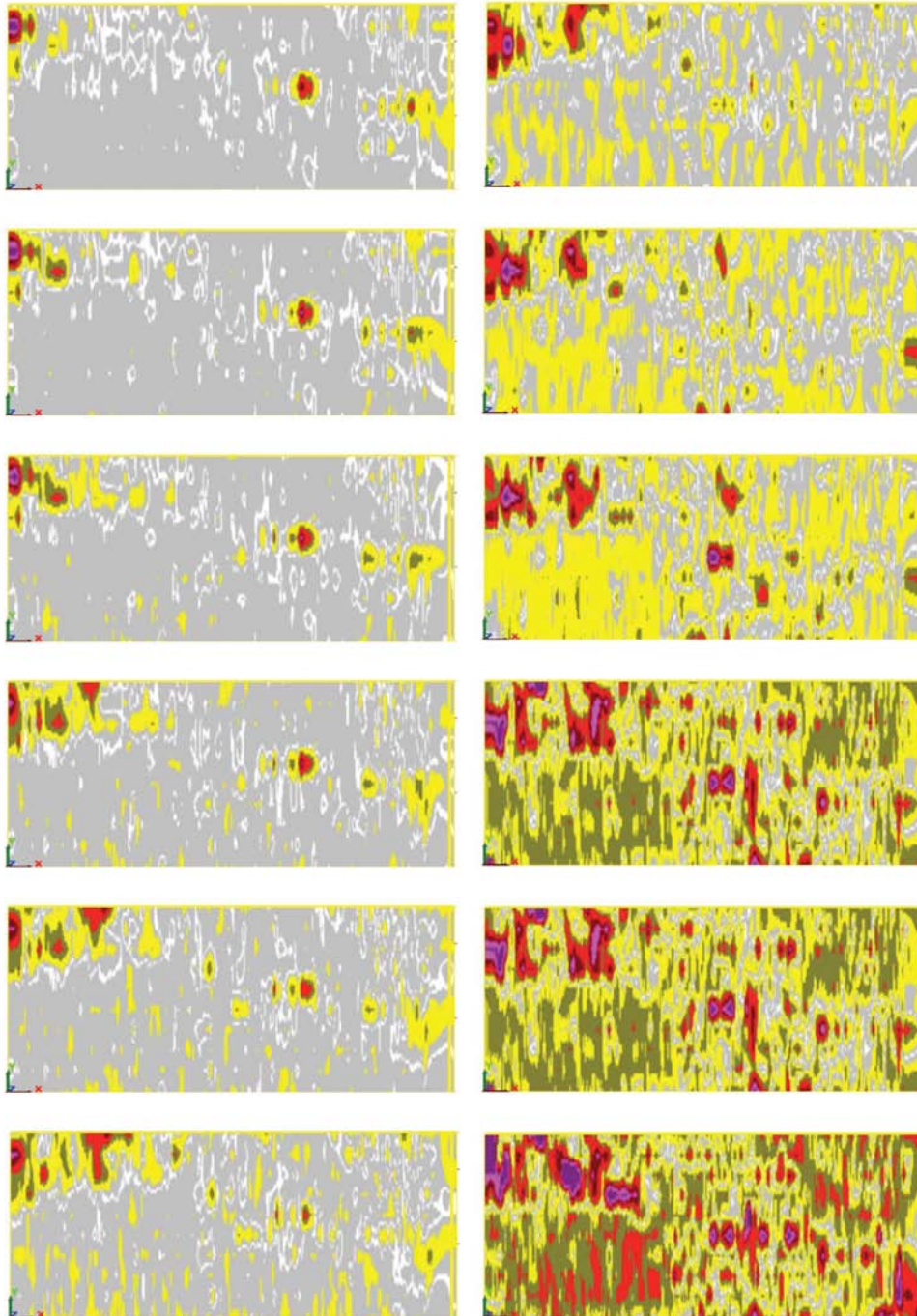


Figure 14: Area 4 GPR results between 1.3 – 2.4m.

5.0 Discussion

The Area 1 results indicate some subsurface modification and this is expected given the location, topography and the contiguous archaeology of Te Oropuriri to the north. Anomalies in the GPR and magnetic survey data have been preliminarily identified as possible pits and a possible house floor that has been truncated by the boundary fence. A small trench, possibly a modern service trench is also present. There is reasonably good correlation between the two data sets.

The Area 2 results are more difficult to interpret due to the presence of a large magnetic anomaly, which tends to mask the values in the range where we would expect to see archaeological features. However there is enough evidence from the results to infer anthropogenic change in this grid. The surface of this area has a number of depressions, some of which may be modern, some of which have the appearance of rectangular pit forms. Unfortunately the data range is too high to interpret these.

Of all the areas surveyed, Area 3 presents the best results with a number of features identified, and excellent correlation between the GPR and magnetic survey data. A large trench, house floor, possible pit features and an alignment which possibly represents another posthole alignment or filled trench have been interpreted from the magnetic data and these are also identified in the corresponding GPR data. The magnetometry data shows a strong delineation between an area of intensive modification on the west half of the grid and a less disturbed area to the west. It is not clear what this boundary represents; it may be a delineation of a large occupation area within the pa, and the adjacent area might be open space within the pa where no structures were erected. This would be similar to other areas in the already excavated adjacent pa.

The GPR data clearly shows postholes along the trench and also the area of the house floor. The house floor anomaly position corresponds to the known position of a partially excavated large house projecting from the Te Oropuriri excavations into the Caskey property. The second posthole/trench alignment is also apparent but it is not completely clear whether this is a filled trench or not. Two pit features are also evident. The large anomaly that cuts diagonally through the southwest corner of the data is significant but difficult to interpret. The sharp linear form would suggest an infilled ditch or large service feature, but in the GPR cross-section it appears to be more representative of larger refractions, such as large rocks.

Area 4 shows no obvious anthropogenic subsurface modification with large geomorphic lineation running through the grid.

The results from Areas 1-3 confirm the extension of Te Oropuriri into the Caskey property although a high response range masking low return signals in the data has hindered the extent and identification of potential archaeological features in Area 2. That said, it is apparent that subsurface disturbance is occurring along the ridge up to the second knoll.

Further investigation of the results would be warranted to ground truth the results in Areas 2 and 3. The possible pit features near the top knoll in Area 2 and the linear arrangement in Area 3, provisionally interpreted as a posthole alignment or filled trench could be tested to confirm the results.

6.0 Recommendations

1. Undertake a limited test excavation of limited areas in Area 2 and 3 to confirm the presence and origin of suspected archaeological features in these areas.

7.0 References

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