Service Road at High Street Green, Hemel Hempstead Hertfordshire, HP2 7AA

NDT/Geophysical Investigation of Surface Cracking to Road

Final Report - 4644

Hertfordshire County Council

PROJECT: Service Road at High Street Green, Hemel Hempstead, HP2 7AA

TITLE: NDT/Geophysical Investigation of Surface Cracking to Road

CLIENT: Hertfordshire County Council

Final Report No: 4644

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1.0 INTRODUCTION

1.1 Terms of Reference

Purpose:	To investigate an area of surface cracking on a 'service road' located towards the northern end of the High Street Green carriageway, opposite the entrance to Farmhouse Lane.
Location:	High Street Green, Hemel Hempstead, Hertfordshire, HP2 7AA
Consultants:	GB Geotechnics Ltd (GBG)
Instructed by:	Hertfordshire County Council
Survey Date:	21st October 2019

This report is the final report of this investigation. It therefore supersedes any previous reports whether written or oral.

1.2 Background

A c.115m long section of carriageway has been closed to traffic due to the formation of a large crack along its centre. The carriageway is located immediately adjacent to High Street Green and opposite the entrance to Farmhouse Lane, Hemel Hempstead. The road is referenced as a 'Service Road" by the Client and is shown as High Street Green on aerial maps.

Satellite Image showing position of survey area highlighted in red.

From information supplied by Richard Knight, Casework and Investigations Manager for Hertfordshire County

Council, it is understood that the cracking has been present for a number of years; however, the road was closed as of 1st October 2019 due to a sudden increase in the severity of the cracking, principally the longitudinal cracking.

GBG have also been advised that this section of carriageway saw a significant increase in traffic volume during a short period earlier this year when a fracture to a gas pipe resulted in the main High Street Green carriageway being closed near the roundabout to Farmhouse Lane. Traffic was diverted along the service road while repairs were carried-out.

Stake/probing tests by the Client suggest the crack is up to c.500mm deep in places and measurements made by GBG show widths up to 65mm. There is also a c.40mm difference in surface level of the asphalt where the cracking is most severe.

Left: General view looking South of the cracking along service road. Right: View showing the difference in surface level either side of the longitudinal crack.

In addition to the cracking, an area of ground subsidence is also present located on the Eastern grass verge immediately adjacent to the service road and c.28m from the northern entrance. This area has a footprint of c.2.5m² and has subsided up to c.300mm compared to the surrounding area. The kerb has also

Area of ground subsidence in grass verge highlighted in yellow.

dropped in this location when compared to the rest of the road.

The Client is unaware as to the origins/development of this ground subsidence, but street images viewed by GBG on the internet show that a slight deformation was present during November 2015, when the most recent street available images were taken. The size of the subsided area now appears to be significantly larger (>50%) when compared to the 2015 images.

Prior to this survey, GBG have conducted 3no. previous investigations along the main High Street Green carriageway and grass verges to determine the cause and extent of ground deformation/subsidence; these include GBG Project Nos. 4281, 4300 & 4382 – reports issued on 8th June 2017, 2nd October 2017 & 10th January 2018 respectively.

1.3 Purpose of Investigation

The purpose of this investigation is to determine the possible cause of the cracking and whether or not there are any associated voids which could compromise the integrity of the carriageway and its immediate surroundings.

The Client has expressed particular concern regarding subsurface voiding, which has been experienced in other sections of High Street Green, for an example, see previous GBG survey Project No. 4300 issued on 2nd October 2017.

Of importance to this investigation are the location of buried services, especially those which could be water bearing, as leaks can cause 'washout'/removal of underlying material resulting in the formation of voids beneath the carriageway. The bedrock in this area is known to be chalk which is susceptible to dissolution/acid attack and can often lead to karstic activity (sinkholes etc.)

2.0 THE SURVEY

2.1 General

The investigation was conducted during 1no. daytime weekday survey session by a 3-person survey team working between the hours of c.09:00 and c.15:30 on 21st October 2019.

2.2 Survey Area

The survey area is located off the northern end of the main High Street Green carriageway, directly opposite the entrance to Farmhouse Lane. The area is comprised of the ‘Service Road”, also labelled as High Street Green carriageway and its Western footpath, which fronts the residential properties of 201-215 High Street Green. The satellite image on page 2 of this report shows the approximate extent of the survey area.

The GBG proposal submitted to the Client (reference: *1019 jb Herts CC High Street Green 4 P1*) previously stated that the grassed area separating the service road and main High Street Green carriageway (see adjacent image) would also be included within the survey, however this was retracted by the Client while onsite as it is owned by a different local authority: Dacorum Borough Council.

Image showing the grassed area removed from survey by Client.

The option to include this area within the single day survey was proposed to Dacorum Borough Council by Hertfordshire County Council, but this was declined. Its inclusion in the original GBG proposal was due to the c.2.5m² area of ground subsidence highlighted above in section ***1.2 Background*** of this report. The Client requested that GBG collect some data over the subsided area in order to provide comment on the possible cause and sub-surface extent in case it directly related to the cracking observed on the service road.

The dimensions of the survey area are c.115m in length (North-South) by c.8m in width (East-West) throughout most of the area, widening to c.20m towards the North and South ends where the service road meets the main carriageway. The East-West dimension has been measured from the Eastern kerb of the service road to the footpath, which fronts the residential properties, and the North-South extent has been measured from kerb to kerb along the service road.

2.3 Site Relocation

Radar data was collected using a calibrated survey wheel and a Real Time Kinematic (RTK) GPS unit set to record DMS (Degrees, Minutes, Seconds) co-ordinate values. DMS values are easily converted to standard latitude and longitude positions for integration into Google Maps/Earth, thus allowing radar plots to be scaled and directly overlain onto Google satellite/map images.

Please note that the software used for production of the survey results does not allow for presentation in National Grid format.

Relocation to any subsurface features identified on the drawings can be made to onsite surface features such as kerbs, road markings and lamp posts.

It is estimated that relocation to any features described in this report are accurate to ±0.5m of the position shown.

2.4 Calibration

A direct depth calibration for the data collected at this site could not be undertaken, the interpretation of the data is therefore based on a typical radar bulk velocity of 11cm/ns.

Accuracy of the depths quoted are therefore expected to be good to ±10% but with no specific allowance having been made for variations in material condition and/or moisture content.

It is thought that the geological sequence consists of Clay belonging to the Lambeth Group overlying chalk of the Lewes Nodular and Seaford Chalk Formation.

An understanding of the geological sequence has been derived through analysis of geological maps and from within the ‘void’ which opened on High Street Green which was previously investigated by GBG (Report No.4281). The previous void is c.415m South of the current investigation.

A water services map and drainage map were supplied by Hertfordshire County Council which have been used to aid in the interpretation of collected data – see Appendix B.

2.5 Access and Health & Safety

Due to the severity of the cracking, the service road has been closed since 1st October 2019 to prevent further damage to the carriageway, and to avoid damaging vehicles and harming cyclists. Traffic barriers and signage were in place at the two entrance points of the service road to stop access to road vehicles.

Residents of 201-215 have been given special dispensation for continued use of the carriageway to access their properties; however, residents were informed by the Client of our survey works and a traffic management team (supplied by Ringway) were in place to coordinate and control the limited amount of traffic. During the survey works, only 3 vehicles required access to the carriageway and on each occasion, all persons working within the road closure were notified prior to access being granted.

The road closure allowed for clear and unrestricted access to the entire survey area and no issues were encountered. Figures 1 and 2 on Drawing 4644-1 in Appendix A of this report show the survey coverage achieved using different radar survey systems/antennae during the survey works.

2.6 Survey Techniques

The investigative technique used for this survey was Impulse Radar/Ground Penetrating Radar (GPR). Technical Information, providing background detail to the NDT/geophysical equipment and methods used in this investigation, is available on request. An outline description of the main on-site survey techniques used during this investigation is provided below.

Impulse Radar

The data was collected at a density down to 1m ccs longitudinally and transversely over the entire survey area, including the entirety of the service road and the grass verge and footpath to the West.

The survey lines were profiled using transducers operating at frequencies of 270MHz and 400MHz. The equipment was set to collect data to an estimated maximum depth of c.2000mm & c.4000mm for the 400MHz and 270MHz devices respectively; however, data was typically resolved to a maximum depth of c.3000mm optimised to provide information relating to the location and extent of potential subsurface voids and areas of ground disturbance.

Image of the Impulse Radar Multi-channel Raptor System in use by GBG.

The 270MHz recording equipment was linked by a 15m long cable to the transducer device and was powered by a 10.8V internal DC battery. The 400MHz data was collected using an all-in-one push cart system by Impulse Radar Raptor system (see image above) with a multi-channel array, allowing for data collection along a single survey plane. The system also utilises 8no. channels for greater data quality.

The survey method allows for on-site interpretation to adjust and control survey settings and procedures. Recovered signals were recorded digitally onto a removable SD memory card which allows for more detailed analysis of the data off site

CAT Scan

A service locator unit was profiled along the entirety of the survey area to identify any "live"/powered services. Positions were marked-up on site using a water-based spray paint and GPS coordinates noted for integration on to GBG drawings.

3.0 FINDINGS

3.1 Presentation of Results

The findings of this investigation are discussed below and results have been presented on Drawing Nos. 4644 1-6 presented at ***Appendix A*** of this report**.**

Results have been plotted as plans (radar depth slices) with explanatory photographs.

The results have been superimposed onto Google Maps/Earth images of the survey site.

3.2 Overview

Signals returned from the subsurface contain a wide variety of information. Not all of this information is of engineering value, and much relates to the electrical properties of the material of which it is made.

The purpose of the analysis, therefore, is to identify the information contained in the signals, which relate directly to the engineering problem in hand.

Some consideration needs to be given to the nature and cause of the signals recorded however, and explanation as appropriate is given here. A full and exhaustive exposition of the theory of operation is, however, inappropriate.

The analysis here is essentially comparative: comparisons can be made firstly within the data collected from similar targets over the total survey, and a basic response of ground identified. Finally, a comparison is made with the numerous similar sites that we have surveyed elsewhere and from visual observations made during a previous survey at the hole into the void below the carriageway nearby. Any unusual responses are identified as anomalies.

3.3 General Ground Conditions

The interpreted ground conditions and appropriate radar slices have been shown at Figs.3-5 on drawings 4644-2 and are summarised below. The plots display reflection amplitude in the radar data, which highlights changes in condition and material; a scale bar is shown on the right-hand side.

The crack was sufficiently wide at its surface to allow a direct measurement of the asphalt thickness of the service road along its centre, this typically varied between c.200-220mm, which corresponds to the general thickness of the asphalt across the whole road as determined from the radar data. The asphalt overlays a visible concrete layer c.180-200mm thick, which has also experienced a severe amount of cracking; shown in the photo below.

Left: view looking into crack showing asphalt & concrete layer beneath. Right: general view looking North along carriageway showing longitudinal crack along centre of road & regular transverse cracks across road surface.

The continuous longitudinal crack along the centre of the road and the regular transverse surface cracks within the asphalt are most probably reflective of joints in the underlying concrete layer. The cracks/joints have opened up and some differential vertical movement has occurred, notably along the centre line of the road. The road appears to have some light reinforcement or perhaps a thin mesh.

The radar data identifies a further material boundary at a depth of c.680-700mm The composition of the material beneath the concrete cannot be confirmed without performing intrusive investigations, however the response is consistent with Made Ground/Fill, which is likely to consist of subbase materials and reworked clay once belonging to the Lambeth Group. Underlying the Made Ground/Fill the response is consistent with Chalk Formations.

Image of service/telecoms cover located on grass verge, note the white spray-paint in the bottom left signifying the exit point of a service.

3.4 Location of live services

The grassed verge section on the Western footpath fronting the residential properties had several manhole covers and service/telecom covers located along its length, as well 4no. lampposts spaced regularly. A CAT scan was conducted in order to trace the path of any live/powered services exiting these positions. GBG marked the position/path of any services identified with a water-based non-permanent white spray paint. GPS positions were recorded for each service identified and have been overlain onto a satellite image presented opposite and at Figure 6 on drawing 4644-3.

Image showing the position, in red, of services identified by CAT scan. The yellow dots show the position of lampposts.

Multiple services were identified from the CAT scan, highlighted in red on the adjacent image. The position of the 4no. lampposts along the Western grass verge, shown with a yellow dot, indicates the purpose of some of the services identified (power cables).

There are 2no. services which run parallel to the footpath fronting the residential properties. According to the plans provided by the Client (see Appendix B) these could be water services and drainage routes; it is possible that service trenches house multiple service types, laid at varying depths.

A service trench is visible in the asphalt at the South-West corner to the service road – yellow arrow on image above. A CAT scan was conducted here but no live/powered services were identified in this position.

Please note, GBG did not conduct a full CAT scan survey to trace the full-extent of the services identified, instead limiting the CAT scan to the survey area only. Hence 6no. services have been traced to the Eastern kerb of the service road only.

3.5 Additional Services

Radar data has been processed and plotted on to a 3D plot which can be manipulated to show different depth slices within the structure surveyed. Only the depth slices which show relevant information/features have been presented in this report.

For this section, please refer to Figures 6-10 on drawings 4644-3 & 4644-4 in Appendix A.

Services

There have been 5no. linear features identified within the radar data each at a depth of c.400-500mm i.e. within the made ground below the concrete slab. These features are coincident with services located via the CAT scan and known water service positions.

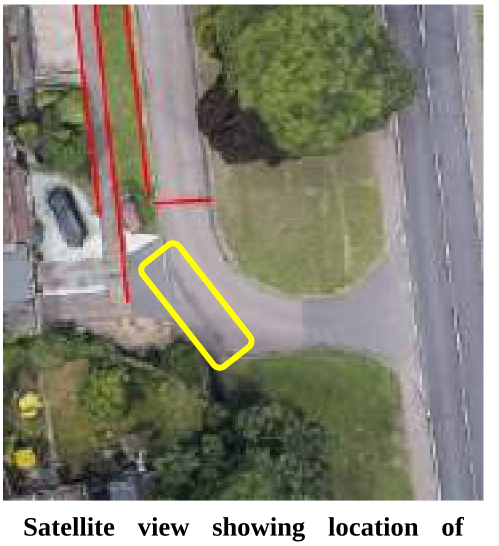
Features A and E were not identified during the CAT scan, but are clearly visible within the radar data. These appear to be located in the same positions as those shown on the Affinity Water map (provided by Client) of known water services and shown in Appendix B of this report.

Feature D could also be associated with the path of water services, as one does cross the road at this location. This feature is also visible from the surface in the form of a reinstated trench; a CAT scan revealed that a live/powered service is also located here and connects to a lamppost on the Western grass verge.

Similar to Feature D, both Features B and C were identified during the CAT scan and both appear to extend towards lampposts positioned on the Western grass verge. A reinstated trench is also visible in the location of Feature C.

There is another trench visible (shown with yellow outline in image below) in the asphalt running diagonally across the South-West corner of the road, as indicated in Section *3.4 CAT Scan Service Locations.* Radar identified a linear feature (buried service) corresponding to the position of the trench at a depth of 340mm.

The surface trench seems to correlate to the location of a known drainage channel/path by Thames Water – refer to map in Appendix B. Unfortunately, the route of this feature cannot be traced beyond the Western kerb of the service road. Please note, the drainage system map, provided by the Client from Thames Water, is somewhat vague as it has drawn the service routes as straight lines between points, thus the potential for the actual route to deviate from the map is quite likely.



Satellite view showing location of diagonal trench (yellow rectangle) located at South-West corner of service road.

Drawing 4644-4 shows the location of Feature F identified in the radar data, at a depth of c.250-270mm. The route of Feature F directly correlates to the position of a service identified during the CAT scan. The CAT scan suggests this service eventually connects to the Northern-most lamppost and crosses the service road carriageway (W-E) near the North entrance point.

3.6 Area of Subsidence

Area of subsidence and subsurface voiding

Limited radar data was collected over the area of subsidence on the grass verge adjacent to the service road carriageway. Survey lines on the grass verge typically extended c.4-5m away from the full-extent of the area of subsided ground. Drawing 4644-5 shows a 270MHz radar data slice in this area, the plot shown represents a depth of 300mm – little variation was observed throughout the dataset and therefore this radar plot is representative of all the 270MHz data collected.

There is no evidence of any subsurface voiding located immediately below the area of subsidence, furthermore, the radar did not identify any buried/hidden service routes in this location. The service maps provided by the Client in Appendix B also show no suggestion of service routes within this area either.

Please note however, the close proximity of a subsurface anomaly - Feature G described below.

Feature G

An additional subsurface anomaly (Feature G) has been identified adjacent to the area of subsidence as highlighted at Fig.13 & 14 on drawing 4664-6. Feature G is c.1.8m North-West from the area of ground subsidence.

This roughly ‘circular in plan’ feature spanning c.3.4m North-South and c.3.7m East-West has been identified within the service road from a depth of c.400mm from below the asphalt. The depth of this feature places it within the boundary between the concrete layer and underlying Made Ground/Fill substrate.

The regularity of its shape, being roughly circular, indicates that Feature G is possibly the remains of a buried structure. It is possible that this may be associated with a chamber or area of subsurface voiding.

We recommend that further investigations are conducted within this area to determine/clarify the extent and nature of Feature G.

3.7 Possible Cause of the Cracking

Several buried services have been identified by CAT scanning and radar but the position/routes of these sub-surface utilities are not directly coincidental with the main cracking pattern visible in the asphalt. There was no evidence of any buried service running along the centre line of the carriageway. In fact, almost all services identified in the service road were orientated perpendicular (transverse) to the main longitudinal North-South crack.

The length and linearity of the crack along the centre of the carriageway would suggest a widespread mechanical fault in the near surface rather than a specific, focused location of issue, i.e. subsurface voiding, indicating that the longitudinal crack may have formed along a joint in the concrete. Anecdotal evidence from the Client on site and residents would suggest this is likely as a result from the sudden increase in traffic experienced earlier this year when the service road was used as a bypass for the Main High Street Green carriageway during repairs to a gas leak.

An increase in traffic, particularly by larger vehicles such as heavy goods vehicles can cause significant pressure imbalances within the road substrate, particularly if the carriageway was not designed for such loads; resulting in mechanical movement and eventually leading to cracks and other defects.

The majority of the damage is likely to have occurred to the underlying concrete layer due to its firmness and rigidity atop a possibly softer Made Ground/Fill layer, with the asphalt topping mirroring any damage in the concrete. Radar data has identified extensive cracking within the concrete layer.

Of particular concern now though, is the ability for water to penetrate through the carriageway structure. As mentioned previously, the underlying chalk geology of this area is highly susceptible to dissolution/acid attack, due to it being a principle aquifer, which can result in the formation of subsurface voids i.e. sinkholes.

This is of heightened importance with the arrival of the Winter period, whereby any areas of water ingress can cause further mechanical issues via freeze-thaw action, which could result in further damage to the carriageway and therefore providing more routes for water ingress.

4.0 SUMMARY

An NDT/Geophysical investigation was undertaken on the 21st of October 2019 over the service road carriageway and its Western footpath to investigate the possible cause of extensive cracking to the asphalt and to determine if there is a link to any subsurface voiding. There was also a requirement to identify service locations and determine their nature.

- A CAT scan survey found numerous "live"/powered services within the survey area; most of these appear to be linked to the positions of lampposts.
- Radar identified additional services likely related to the position of known water services and the route of a drainage channel when compared to maps provided.
- The ground conditions of the carriageway can be classified as asphalt atop a layer of concrete overlying an unknown layer, highly likely to be Made Ground/Fill. Overlying the Lewes Nodular Chalk and Seaford Chalk Formation (Undifferentiated).
- The crack pattern visible in the asphalt likely mirrors defects in the underlying concrete, possibly original joints or failure points under load.
- An area of ground subsidence, located on the Eastern verge adjacent to the service road carriageway had no associated subsurface voiding or buried/hidden services directly beneath.
- 1no. non-linear feature was identified within the radar data at c.400mm depth. Its origin is unknown and requires further investigation.

There is no indication of any large subsurface voids within the survey area.

The cause of the cracking is likely a result of a sudden increase in traffic during a period earlier this year when a gas leaked caused the main High Street Green carriageway to be closed temporarily. The increased load resulting in widespread mechanical movement in the near surface of the structure.

5.0 RECOMMENDATIONS

It is recommended that Feature G is investigated further through intrusive means to determine its nature and structure; non-intrusive tests are unlikely to elicit any more detail than that already provided here.

Repairs should be conducted on the carriageway to remedy the damage/cracked areas and mitigate against further damage. We recommend that special attention be paid to the underlying concrete layer as we expect this to be of particularly poor condition, as is visible in some locations from the surface. It may be necessary to break-out and replace large sections where damage is irreparable.

With Winter approaching, it is recommended that repair works are conducted relatively soon to prevent any further damage associated with the adverse weather conditions.

APPENDIX A

A Drawings

The results of this investigation are presented on Drawing 4644 1-6 as Satellite Images overlain with radar plots. Explanatory photographs have been provided where necessary.

The drawings have been provided in colour.

All dimensions are to be checked on site prior to preparing any drawings or commencing any works.

Service Road at High Street Green, Hemel Hempstead, Hertfordshire, HP2 7AA

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Figure 1 & 2: Plan View of Site showing Radar Survey Lines Across the "service road" and the Western footpath.

The image on the left (Fig1.) shows the coverage achieved with the 400MHz multi-channel raptor radar system, and the image on the right (Fig2.) is the 270MHz radar antennae coverage.

Pin and polygon (hatched yellow) denotes position and surface extent of subsidence on grassed verge. At the request of the Client, additional radar data was collected here in order to provide a brief comment on extent and severity of the subsidence. A full survey was not undertaken as this land is owned by a different local authority - Dacorum Borough Council.

Site Map

KEY

Extent of Area Surveyed

P1 **Photo Reference**

Survey Line; with a green and red node representing the start and end of the line, respectively

Dwg No. 4644-1

Client: Hertfordshire County Council

Project: Service Road at High Street Green, Hemel Hempstead, Hertfordshire, HP2 7AA

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NDT/Geophysical Investigation of Surface Cracking to Road

Figure 3, 4 & 5 (left to right): Plan view of site showing subsurface boundary layers in the "service road". See Section *3.3 General Ground Conditions* in main report for more details.

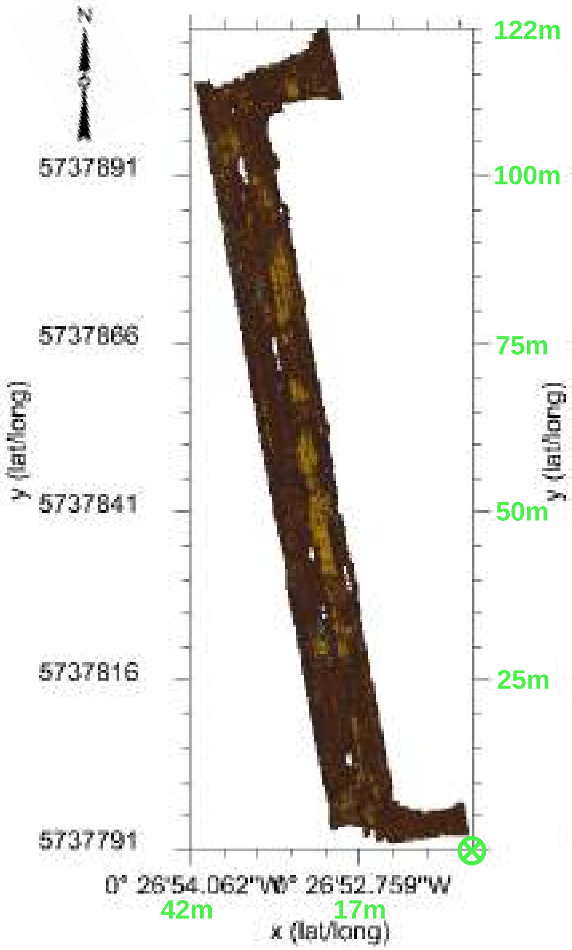


Fig.3 Radar data slice taken at a depth of c.220mm depth showing the interface of top of concrete and asphalt (in yellow).

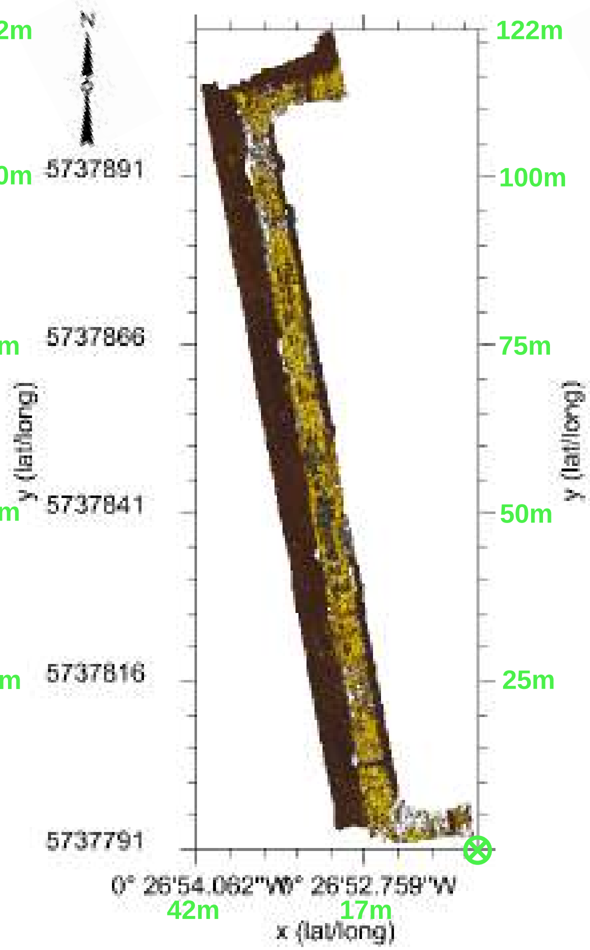


Fig.4 Radar data slice showing the interface (in yellow) between the concrete and made ground/fill at a depth of c.400mm.

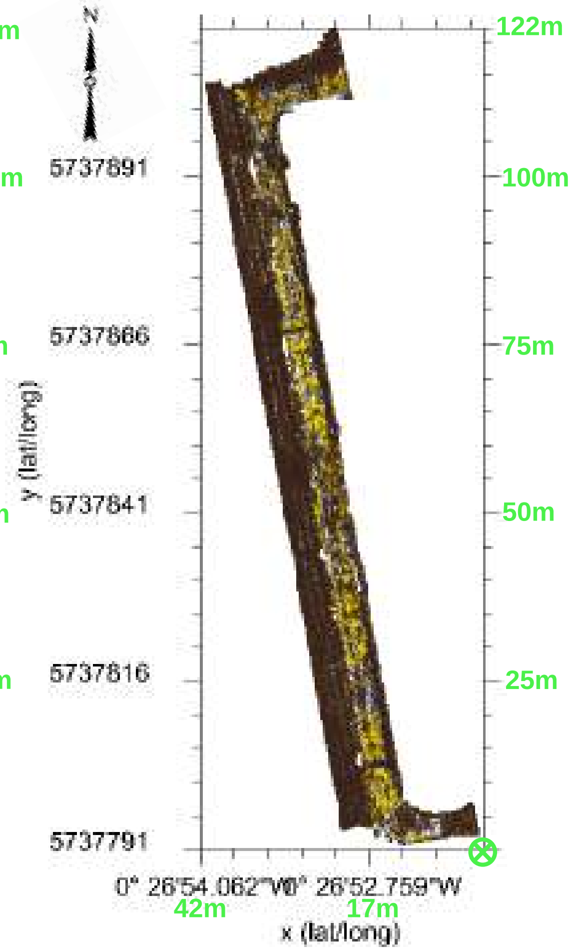
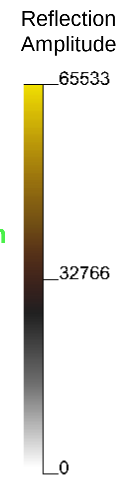


Fig.5 Radar data slice showing the boundary between made ground/fill and the underlying geology (in yellow), at c.700mm depth from the surface.



Site Map

KEY

Extent of Area Surveyed

Zero Datum of Survey Area

P1 Photo Reference

Dwg No. 4644-2

Client: Hertfordshire County Council

Project: Service Road at High Street Green, Hemel Hempstead, Hertfordshire, HP2 7AA

Service Road at High Street Green, Hemel Hempstead, Hertfordshire, HP2 7AA

NDT/Geophysical Investigation of Surface Cracking to Road

Figure 6 & 7: Radar data slice at a depth of 410mm; overlain onto a satellite image (left) and shown separately with annotations to features A-E identified at this depth (right).

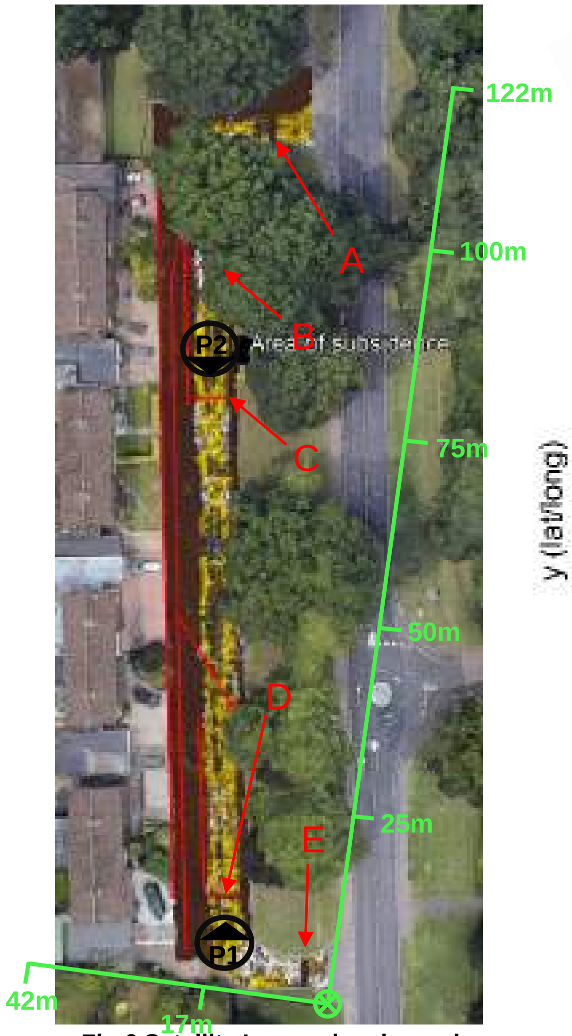
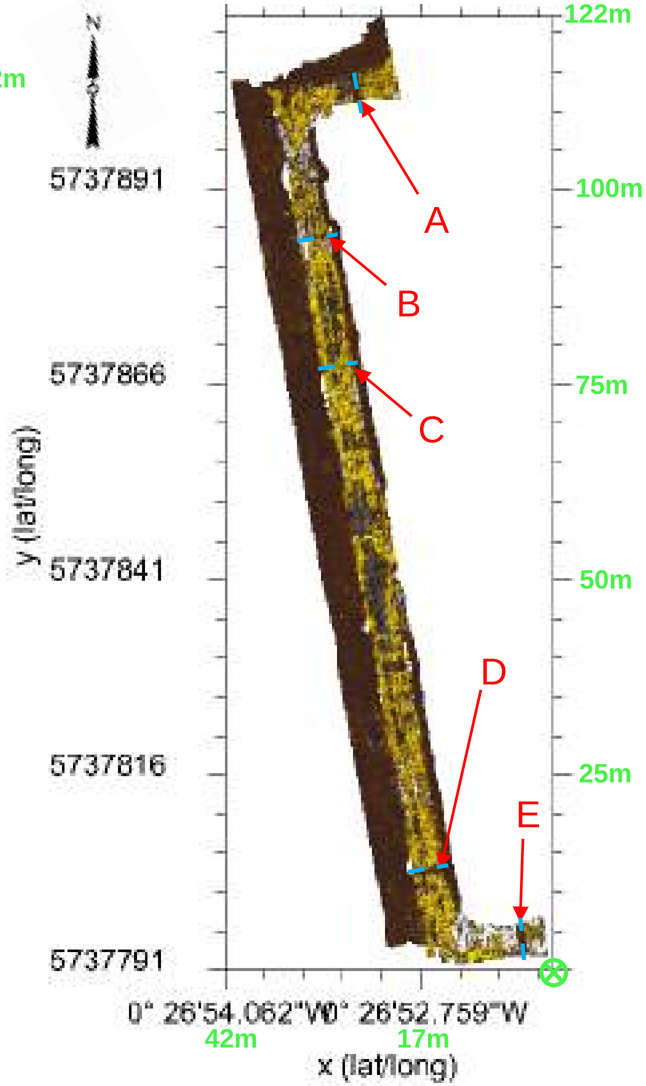
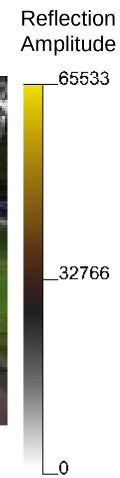


Fig.6 Satellite Image showing radar overlay and CAT scan results in red.



P1: View looking North along road. Visible service trench (D) in asphalt highlighted by red arrow.

P2: View looking South along road. Visible service trench (C) in asphalt highlighted by red arrow.



Site Map

KEY

- Extent of Area Surveyed
- Zero Datum of Survey Area
- A Feature Reference
- Linear Feature
- P1 Photo Reference

Dwg No. 4644-3

Client: Hertfordshire County Council

Project: Service Road at High Street Green, Hemel Hempstead, Hertfordshire, HP2 7AA

Service Road at High Street Green, Hemel Hempstead, Hertfordshire, HP2 7AA

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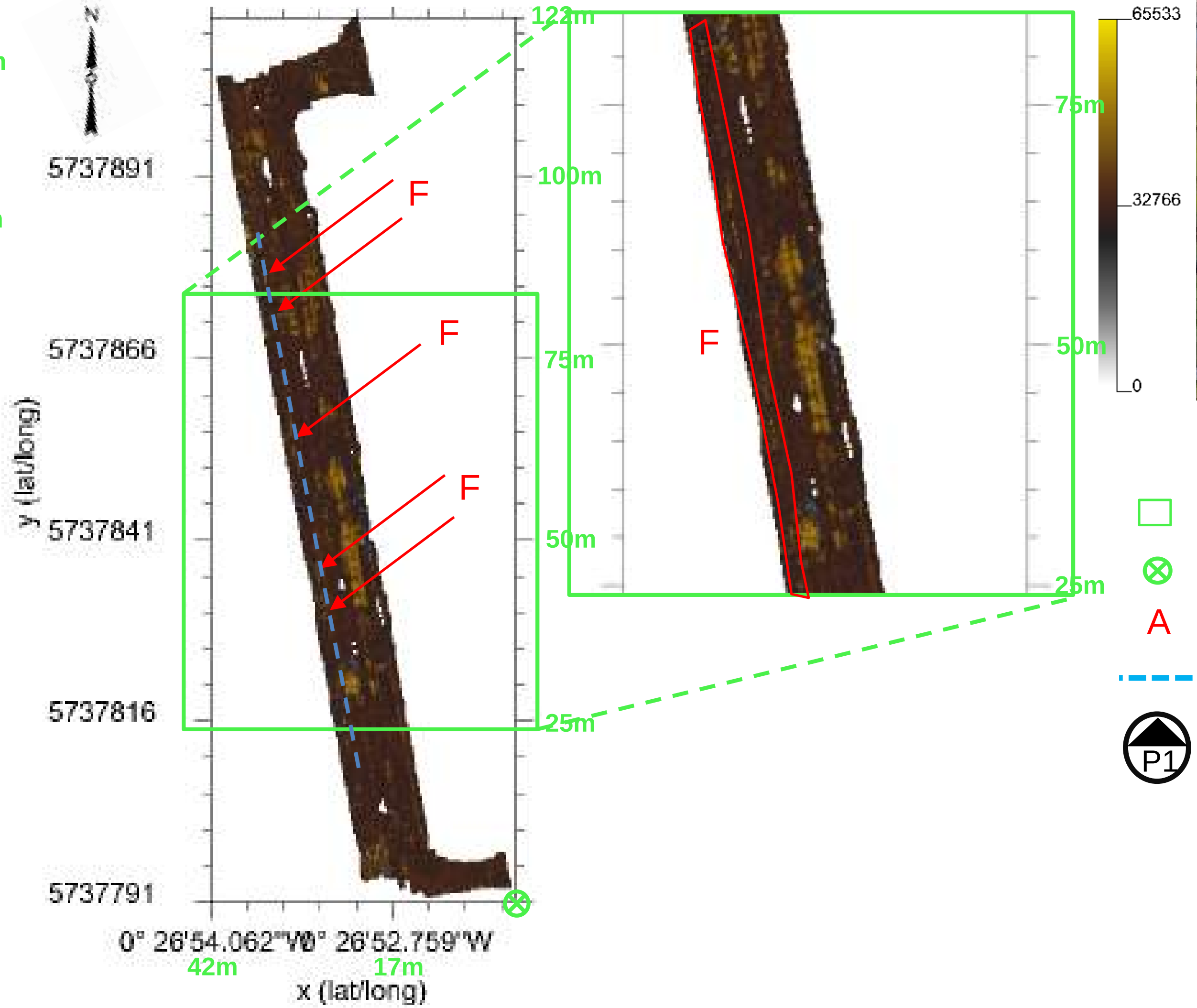
Figure 8, 9 &10: Plan view showing location of Feature F running perpendicular to edge of footpath fronting residential properties. Plot of radar data slice at 250mm depth has been increased in size to show Feature F more clearly.

Fig.8 Satellite Image showing radar overlay and CAT scan results in red.



Site Map

KEY

	Extent of Area Surveyed
⊗	**Zero Datum of Survey Area**
A	**Feature Reference**
	Linear Feature
P1	**Photo Reference**

Dwg No. 4644-4

Client: Hertfordshire County Council

Project: Service Road at High Street Green, Hemel Hempstead, Hertfordshire, HP2 7AA

GBG

RICS

Service Road at High Street Green, Hemel Hempstead, Hertfordshire, HP2 7AA

NDT/Geophysical Investigation of Surface Cracking to Road

Figure 11 & 12: Plots displaying 270MHz radar data collected at a depth slice of 300mm.
Figure 12 on the right shows location of ground subsidence in relation to radar data.

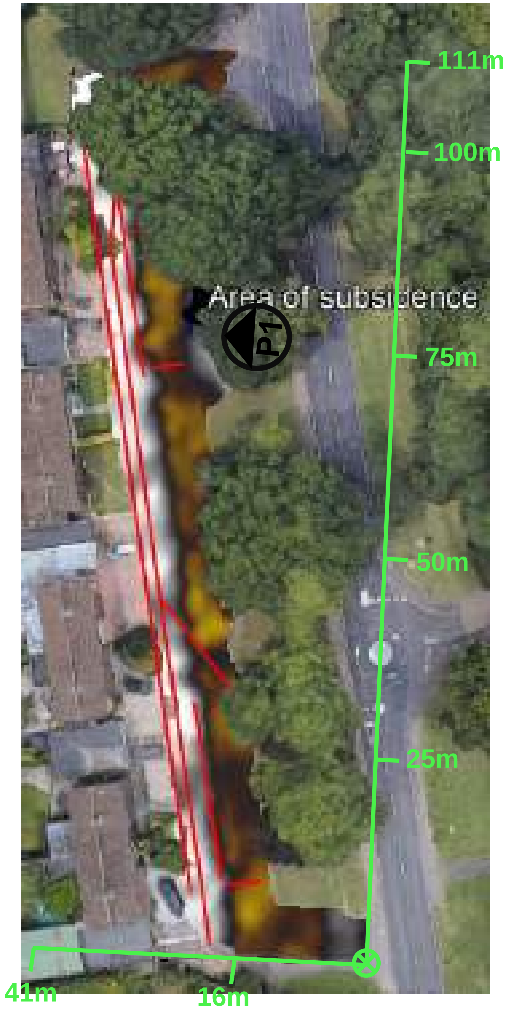
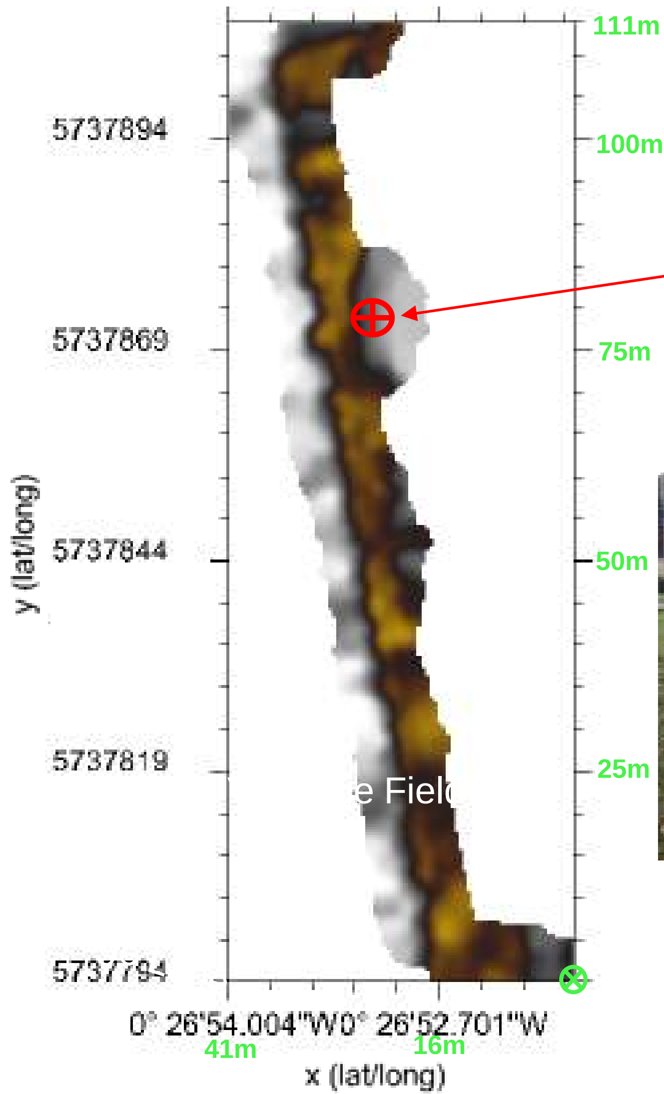
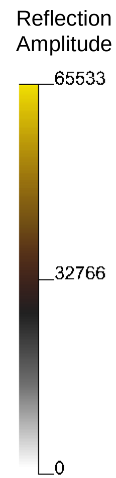


Fig.11 Satellite Image showing radar overlay and CAT scan results in red.





Site Map

P1: View looking West towards subsided area

KEY

- Extent of Area Surveyed
- Zero Datum of Survey Area
- A Feature Reference
- P1 Photo Reference

Dwg No. 4644-5

Client: Hertfordshire County Council

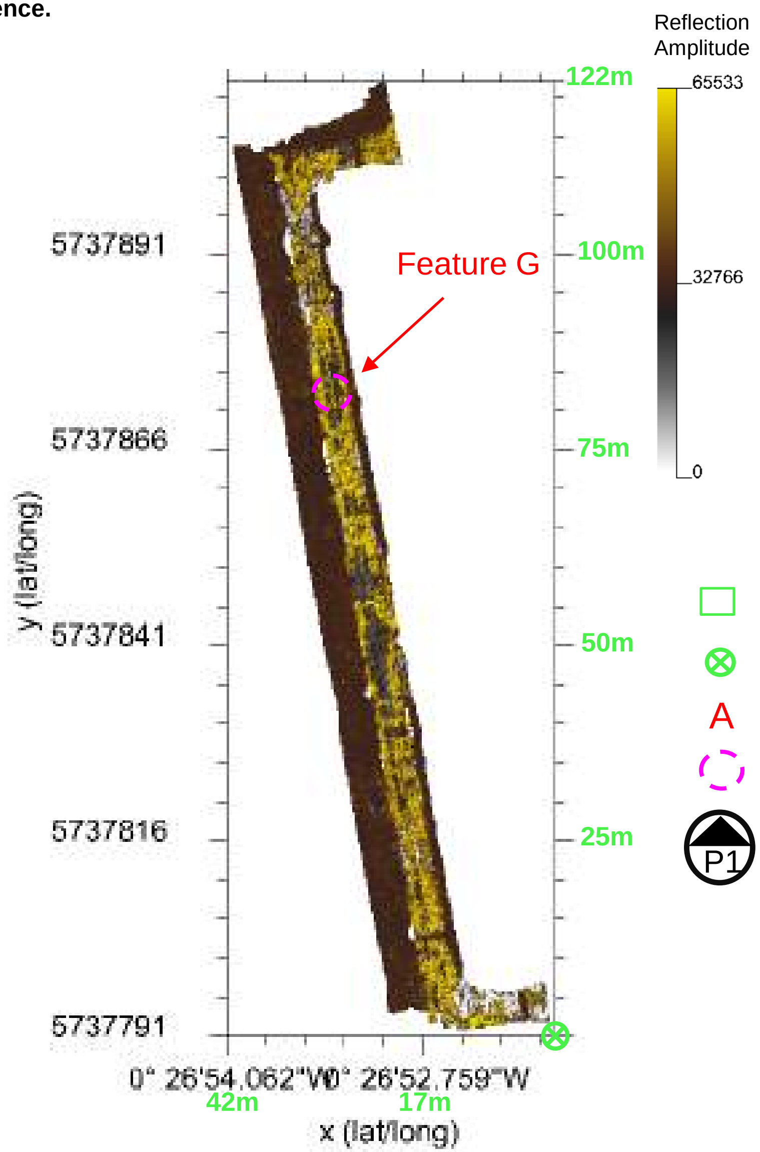
Project: Service Road at High Street Green, Hemel Hempstead, Hertfordshire, HP2 7AA

Service Road at High Street Green, Hemel Hempstead, Hertfordshire, HP2 7AA

NDT/Geophysical Investigation of Surface Cracking to Road

Figures 13: Satellite image showing location of Feature G adjacent to area of subsidence.
Figure 14: Plot of radar data slice taken at c.410mm depth; Feature G highlighted.

Fig.13: Satellite Image showing radar overlay and CAT scan results in red.



Site Map

KEY

- Extent of Area Surveyed
- Zero Datum of Survey Area
- A Feature Reference
- Extent of Feature
- P1 Photo Reference

APPENDIX B

B Utility/Services Drawings

A water services map by Affinity Water (left) and drainage systems map by Thames Water (right) has been supplied by Hertfordshire County Council.