High Street Green, Hemel Hempstead
Hertfordshire, HP2 7AQ

NDT/Geophysical Investigation of Collapsed Ground

Final Report - 4281

Hertfordshire County Council

PROJECT: High Street Green, Hemel Hempstead, HP2 7AQ

TITLE: NDT/Geophysical Investigation of Collapsed Ground

CLIENT: Hertfordshire County Council

Final Report No: 4281

Compiled By: J Butland BSc (Hons), MSc, FGS

Reviewed By: N O Fleming BSc

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Appendix A - Drawings

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1.0 INTRODUCTION

1.1 Terms of Reference

Purpose:	To establish the plan extent of a void below a 'hole' that has opened at the carriageway and, to conduct an adjacent reconnaissance survey of a section of the road to either side of the 'hole'.
Location:	High Street Green, Hemel Hempstead, Hertfordshire, HP2 7AQ
Consultants:	GB Geotechnics Ltd (GBG)
Instructed by:	Hertfordshire County Council
Survey Date:	22th & 23rd May 2017

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

1.2 Background

A 'hole' opened up suddenly in the road at the western side of the High Street Green carriageway, near the intersection with Branksome Close on Friday 12th May 2017. The 'hole' measures approximately c.500mm x c.500mm in plan and the void beneath was understood to be up to c.8m in depth.

Plate 1 – Close up image of the 'hole'.

Following the opening up of the 'hole', the carriageway and adjacent footpaths were immediately closed to traffic and the public. The road was closed between Adeyfield Road and Ellingham Road and a c.10m x c.10m exclusion fence was erected around the 'hole', footpaths and part of the grassed verges to either side.

Figure 1 – Survey Area indicated by the green outline. Approximate area around 'hole' shown in red and approximate location of visible surface water shown in blue. Not to scale.

Plate 2 – Area of visible surface water.

In addition to the 'hole', further along the road to the south, there is an area where water is visible on the High Street Green Road surface, located immediately to the south of the entrance road into Eastwood Court. It was observed that water was slowly leaking onto the carriageway from below appeared to flow continuously. The water was discoloured with a slight foul smell with frequent suspended sand grains.

As the main investigative technique used was non-intrusive, the findings given in this report are based on indirect measurements and the interpretation/modelling of the ndt/geophysical data. The findings represent the best professional opinions of the authors, based on their experience and the results of intrusive methods of boreholes and excavations carried out else on similar materials.

1.3 Purpose of Investigation

Before reopening the road, remedial works to infill the void and repair the ‘hole’ are required. There is therefore a requirement to establish;

- The extent of the subsurface void.
- Provide information to assist the Engineers with their assessment as to whether the ground is stable enough to support the heavy plant required to remediate the ground.
- The possible cause(s) and the extent of the water visible to the south of the survey area.
- Determine on a reconnaissance basis whether or not there are any further areas of subsurface ground disturbance which could possibility contribute to ground instability in the future.

The investigation was undertaken using Non Destructive Testing (NDT)/geophysical survey techniques which are discussed in further detail below.

2.0 THE SURVEY

2.1 General

The investigation was conducted during 2no. daytime survey sessions by a 2 person survey team working between the hours of c.09:00 and c.16:30 on the 22nd & 23rd of May 2017.

2.2 Survey Areas

A detailed survey was conducted within an area measuring c.10m x 10m centred over the 'hole' location, including the road, footpaths and grassed verge areas.

A section of the carriageway to each side of the detailed survey area was surveyed on a reconnaissance basis, this approach was agreed with the Client in advance of the survey. The reconnaissance survey area extended from southeast of the access road into Eastwood Court to a manhole cover located at the junction with Branksome Close, overall forming a c.150m length of road.

2.3 Site Relocation

There have been no detailed drawings produced of the road. Therefore, an Ordnance Survey plan, which was supplied by the Client, was used for onsite relocation and in the presentation of the GBG findings.

The location of both the detailed survey area and the reconnaissance survey profiles are made to a fixed datum, which is shown in green at Figure 1 and P1a on the accompanying drawing 4281-1; radar survey profile lines are shown with a green trace.

Plate 3 – Approximate position of zero datum shown with a green X (Note Manhole 2905).

The northern edge of a manhole cover (Reference 2905) located at the junction with Branksome Close was selected by the GBG survey team as a zero chainage datum for relocation purposes. A measuring tape was set perpendicular to the edge of the manhole and stretched across the road. Where the tape intersects with the kerb on the eastern side of the carriageway of High Street Green denotes the zero datum.

It is estimated that the horizontal relocation accuracy of any feature identified from the reconnaissance survey accuracy is ±1m. Relocation accuracy of any feature identified within the detailed survey area is estimated to be ±200mm.

2.4 Calibration

The ‘hole’ enabled some physical measurements of the road makeup to be taken which has been used for calibratory purposes of the radar data and microgravity. 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.

2.5 Access and Health & Safety

Following the collapse of the ground, the area surrounding the ‘hole’ was fenced off to the traffic and the public, with pedestrians’ diverted c.4-5m to the west of the hole. In addition to this the road was also closed to through traffic from Branksome Close to Adeyfield Road.

The survey required close proximity to the ‘hole’ for acquisition of both the radar and microgravity data. Due to ground instability, whenever working near the ‘hole’ and within the entire fenced off area the operator wore a harness at all times which was attached to ropes securely anchored around a nearby stable tree. The

Plate 4 – Microgravity survey in progress.

ropes passed through a belay to enable another operative to control the ropes. Should a sudden collapse have occurred the belay device would have prevented the harnessed operative falling.

Access into the fenced area was provided by Ringway (Clients' Maintenance Contractors) who were also responsible for providing safe working for GBG on the carriageway either side of the fenced area, this was achieved by partially blocking the carriageway when GBG were working on the carriageway, which although closed to the public could still be accessed by the residents on the street. All investigative works were overseen and controlled by Richard Knight (Hertfordshire County Council – Highways operational officer).

Generally, good data coverage was collected throughout the survey areas however some data could not been collected underneath and immediately adjacent to the fenced area.

2.6 Survey Techniques

The investigative techniques used were Impulse Radar/Ground Penetrating Radar (GPR) and microgravity as well as visual assessment. Impulse radar was collected in both the detailed survey area around the 'hole', and, across the reconnaissance survey areas to each side. The microgravity however was only collected from the detailed survey area. 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.

2.6.1 Impulse Radar

The principle investigative technique used was Impulse Radar. The data was collected generally at 1m ccs longitudinally and transversely within the detailed survey area centred over the 'hole'. Elsewhere the data was collected on a reconnaissance basis throughout the site where access permitted, typically at 1m longitudinally on the road, pavement and grassed verge areas. Transverse profiles were collected typically at c.25m ccs.

The majority of the survey lines were profiled using transducers operating at frequencies of 200MHz and supplemented by 400MHz in the detail survey area. The equipment was set to collect data to an estimated maximum depth of c.2000mm & c.4000mm for the 400MHz and 200MHz devices respectively, however data was typically resolved to a maximum depth of c.2000mm optimised to provide information relating to the location and extent of potential subsurface voids and areas of ground disturbance.

The recording equipment was linked by a 15m long cable to the transducer device and was operated by the survey team. The surveying equipment was powered by a 10.8V internal DC battery.

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.

2.6.2 Microgravity

This technique involves taking measurements at the carriageway surface to delineate subsurface density variations, by recording slight variations in the earth's gravitational field.

Plate 5 – Microgravity meter at a survey station.

The survey work was undertaken using an auto correcting Scintrex CG-5 microgravity meter, capable of a resolution of c.3 microgal. The data is automatically corrected for marine and solid earth tides, as well as for planetary motion; any instrumental drift is corrected by reference to a single base station which is regularly monitored throughout the survey.

The gravity meter was located at each station for 2-3 minutes with the instrument continually reading and producing an average gravity value.

The gravitational attraction of any mass is a function of its density and the instrument responds therefore to all changes in density within the ground. The closer any particular mass – or lack of mass – is to the instrument, the greater the effect on the overall field: the attraction follows Newton's Law and decays exponentially with distance.

There were 5no. microgravity survey profiles completed; including the centre line of the carriageway and two oil tracks with survey stations at 1m ccs. The locations of each survey station are shown at Fig. 3 on the accompanying GBG drawing 4281-2.

The topography of the relative ground level at each survey station was also measured using an optical level. This is to allow elevation corrections to be made to the raw gravity data.

Microgravity produces the most reliable results in terms of void/cavity detection as defined by British Standards BS5930:2015, however data acquisition is slow and as a result more costly than most other geophysical techniques. For economic reasons and in agreement with the Client only a detailed area around the 'hole' was surveyed using microgravity.

2.6.3 Visual Observations

In addition to the main investigative techniques outlined above, a limited visual assessment of the void below the 'hole' was conducted. This included the use of a digital SLR camera to take photographs from reaching into the void. The photographs will be supplied to the Client with the issue of this report.

Laser measures were used within the void to confirm its length, depth and width. Handheld measuring tapes allowed for measurement of the road surfacing to aid in calibration of the impulse radar data.

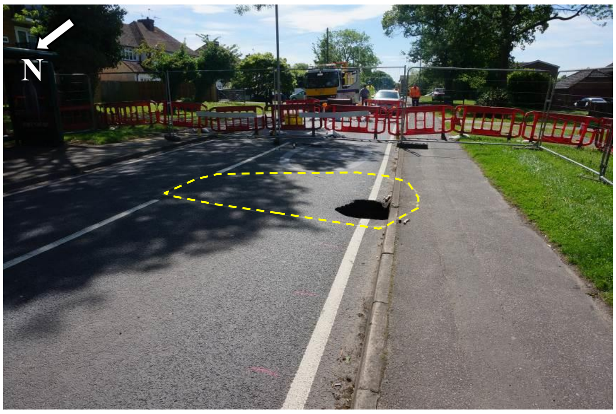


Plate 6 – Approximate extent of void marked on surface by GBG.

At the request of the Client, the approximate extent of the void below and around the ‘hole’ was marked on the ground surface. This outline was approximated based on the apparent horizontal laser measurements and has since been superseded by the extent shown on the accompanying GBG drawing 4281-1 & 2 which is based on the analysis and interpretation of the data collected.

3.0 FINDINGS

3.1 Presentation of Results

The findings of this investigation are discussed below and results have been presented on Drawing Nos. 4281-1 to 2 at ***Appendix A.***

Results on each drawing have been plotted as plans, contour plots, with a schematic section presented with explanatory photographs.

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. Any unusual responses are identified as anomalies.

3.3 General Ground Conditions

The ground surface is variable; consisting of either asphalt in the carriageway and footpath and grass verge to either side of the footpaths. The thickness of the asphalt was variable ranging from c.250-c.500mm (as shown opposite) but was typically c.400-450mm in thickness above subbase/subgrade materials

The natural ground as observed in the void viewed through 'hole' location is silty and sandy clay most likely belonging to the Lambeth Group (LMB) above chalk bedrock of the Lewes Nodular Chalk and Seaford Chalk Formation (SCk). The boundary between the LMB and SCk is highly variable.

Plate 7 – (Top) General image. (Middle) Construction of carriageway at 'hole'. (Below) Geological succession, red line indicates geological boundary.

Overall there are numerous subsurface services throughout the survey area, mainly along the edges of the roadway, beneath footpaths and grassed areas and occasionally in the oil track. Of importance to this investigation are services located on the western side of the carriageway.

Note: GBG did not conduct a subsurface services location survey. Such a survey would be subject to a different scope of works.

3.4 Known Subsurface Feature

The area immediately surrounding the 'hole' was surveyed in detail using Impulse Radar and Microgravity to establish the extent of the void below, as well as any further ground disturbance immediately adjacent which could potentially be unstable.

3.4.1 History

Aerial photographs from recent years found by internet searches show that that subsidence at the site has been ongoing for several years. The image below indicates that subsidence has occurred from at least July 2012. In this image tension cracks are visible consistent with subsidence around the gulley where the present day hole is located.

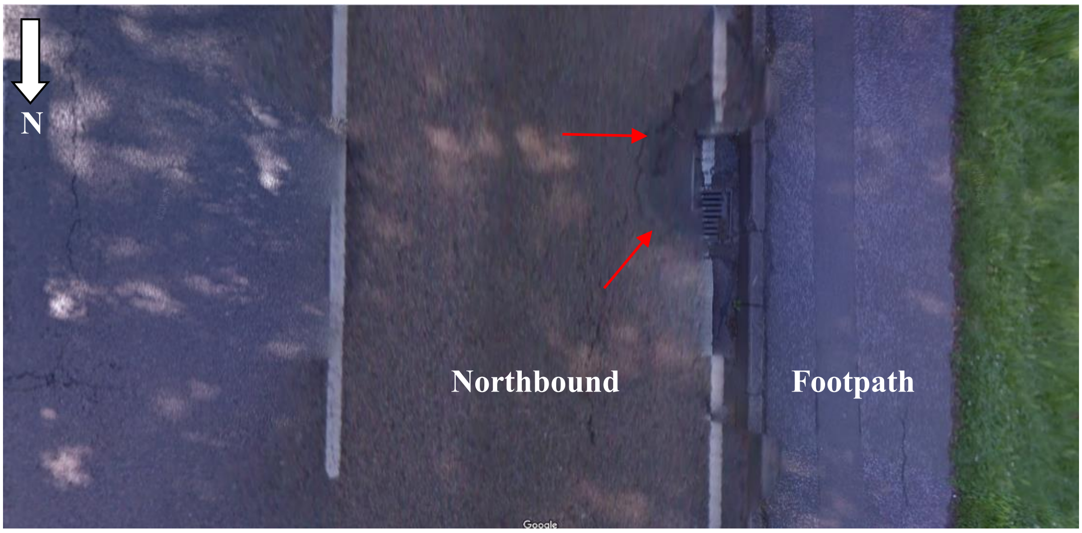


Figure 2 – Image of 'hole' location as shown with the red arrows in July 2012. Not to Scale.

The image is the earliest available that could be found via the internet and it is possible that subsidence could have been occurring earlier than this.

On Friday 12th May 2017, it is understood that the same area as shown above suddenly collapsed, which led to closure of the carriageway and surrounding area including both footpaths and grassed verge areas to either side.

3.4.2 Extent of Void below the 'Hole'

The plan extent of the void below the 'hole' is denoted by a magenta dashed outline at Figs.1 to 4 on drawings 4281 & 2.

Impulse Radar

The magenta outline showing the extent of the void has been determined from analysis of the collected impulse radar data supplemented with physical measurements taken onsite. This line approximately delineates a change from generally well compacted ground to voided ground outside of this line where the ground is well compacted the asphalt is likely to be in immediate contact with the subbase and natural ground alike, however some of this ground may be disturbed (described in detail below). Within the area of this line, the road surfacing materials (asphalt & Subbase) are either poorly supported or entirely unsupported

Microgravity

The results of the microgravity survey are presented as a contour plot at Fig.3 on drawing 4281-2 with the approximate extent of the void identified by Impulse Radar superimposed on top. Additional annotated detailed contour plots, showing only the surveyed road area only are also presented below (these exclude the footpath data).

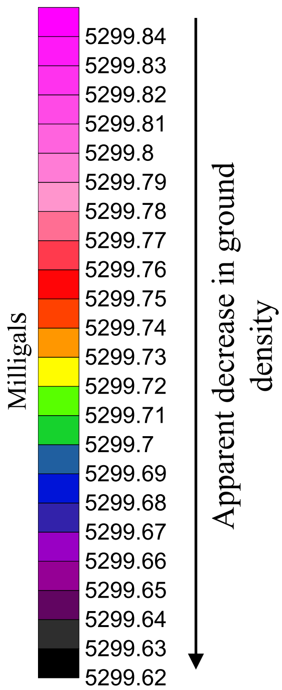


Figure 3 – Microgravity Scale bar.

Where a subsurface void is present it would be expected that the gravity value would be lower, due to an apparent decrease in ground density. In the plots presented, lower gravity values are represented by the darker colours of black through dark purple, consistent with gravity values of 5299.82 to 5299.67 millgals (mGAL) respectively. Gravity values >5299.67 mGALs are consistent with generally well compacted ground denoted by the colours of dark blue through to pink as shown on the scale bar above.

The findings of the microgravity generally match the findings of the impulse radar. An area of low gravity shown by the black and dark purple shading has been interpreted as the void and matches well with the dashed outline of the void identified from the radar. An area of lower gravity also appears to extend away from this voids towards the south east, which is consistent with a subsurface 'tunnel' (discussed in further detail below – Section 3.5). The approximate extent of the 'void' and 'tunnel' has been indicated by the white line on the image below.

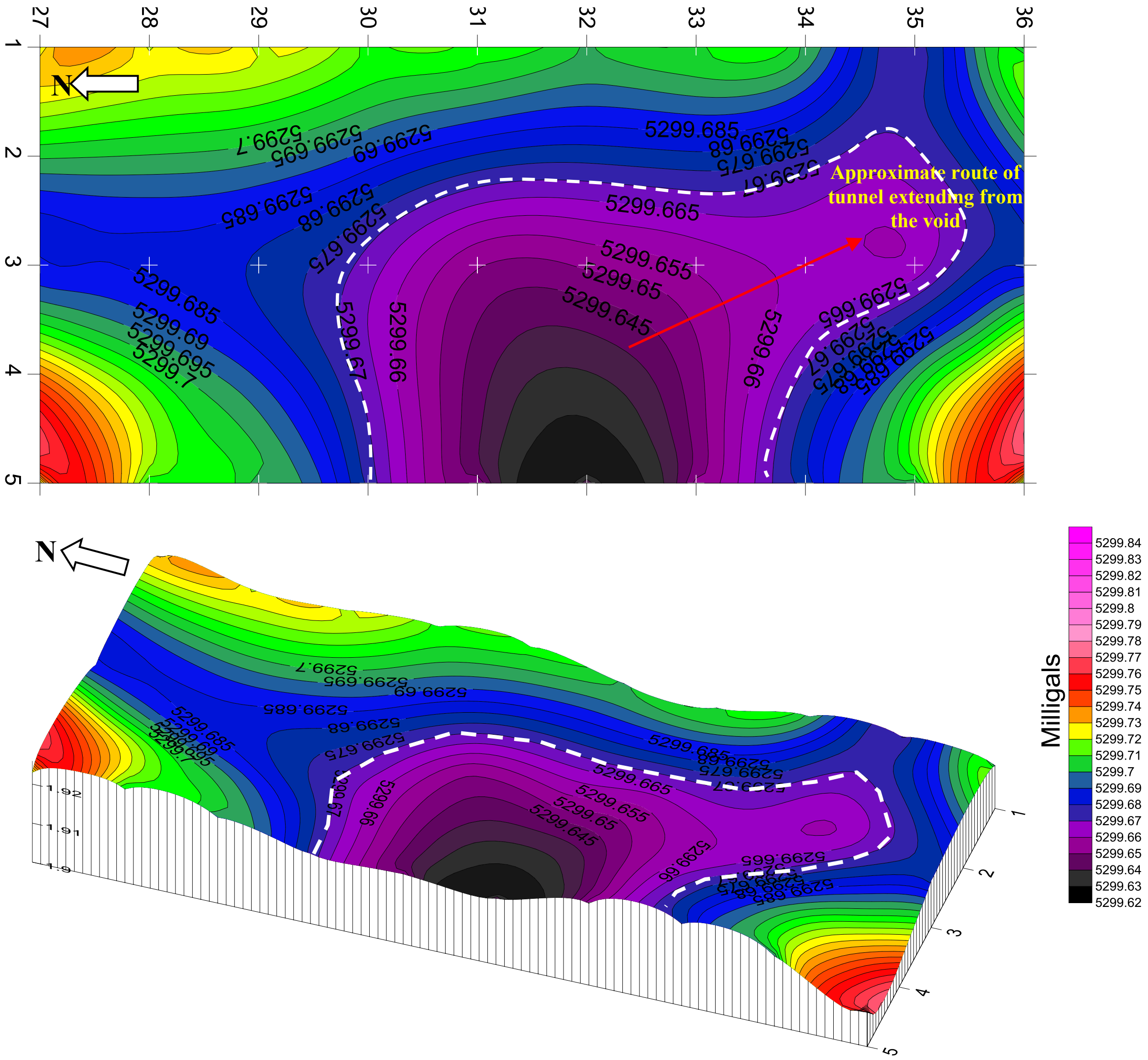


Figure 4 – (Top) General image showing only the road gravity data (Below) 3D image showing the same data. Area of increased engineering risk shown with area delineated with white dash.

The dark blue areas are of relatively low gravity but higher than that of the black and purple in and around the known subsurface void and ‘tunnel’ beneath. These areas are denser and are likely to represent disturbed areas of ground which is currently stable.

Dimensions of Void

The void is c. 5.1m in long by c.5.8m wide (east-west) by c.7.6m in depth equating to at least c.69.46m^3 ($V=4/3\pi r^3$) Note that this does not include the volume of the ‘tunnel’ void (discussed below). The void extends from beyond the west footpath to beyond the centre line of the road (to the east). Its north-south extent is from chainage c. 29.1m to 34.2m measured from the main survey datum.

3.4.3 Possible Mechanism(s)

It is well documented that the area of Hemel Hempstead is highly susceptible to ground instability; either through natural processes or through man induced processes. Where natural processes occur, this is usually attributable to the soluble chalk bedrock (solid) geology being dissolved by water. The removal of the supporting ground through dissolution results in subsidence of the overburden above into the void created below. Man induced processes include collapses above mine shafts & adits of underground workings. Any of these occurrences can also be exacerbated by other human inputs into the ground i.e. leaking services which could accelerate dissolution.

Plate 8 – Leaking Service. Flow direction shown in blue.

When looking into the void via the ‘hole’ running water could be seen and heard and the smell from this was consistent with foul water. A service at an approximate depth of c.5m (although no depth measurements could be taken due to the shape of the 'hole') could be seen to the north side of the void. The outflow was strong flowing to the south east from the severed/broken end of the pipe into the void. The pipe could not be seen directly therefore the diameter, approximate depth and construction could not be determined.

The base of the void was sufficiently incised to indicate that the water had flowed for a considerable amount of time. The water could be seem flowing from the void into the adjoining tunnel (discussed below).

It is not known whether the leaking service has occurred as a result of pre-existing ground instability within the chalk or if the leaking service over a period of time is directly attributable to the formation of the void i.e. the dissolution of the bedrock.

3.5 Subsurface 'Tunnel'

At the base of the void an adjoining subsurface feature ('tunnel') can be seen to extend south eastwards away from the void– shown opposite. The tunnel is cylindrical in shape (c.1-2m in diameter) and located approximately at a depth of c.6-6.5m (Note that due to the geometry of the void accurate depth measurements/dimensions were difficult to achieve).

Plate 9 – (*Top*) General image showing the tunnel location at the base of the void. (*Below*) Close up of assumed tunnel.

This feature is consistent with a subsurface 'tunnel' through the chalk bedrock but it is not known whether this is natural, pre-dating the leaking from the service, or is directly attributed to the leakage from the service.

Within the void there is nothing visually to indicate that the leaking service would remain straight, therefore if the 'tunnel' is a continuation of the leaking service there would be a kink in its route, from north-south near the west footpath, to a more south easterly direction which possibly crosses the carriageway. From what can be seen from the 'hole' above there does not appear to be any of the service left within the 'tunnel' Additionally, the depth of the leaking service is shallower than the 'tunnel' indicating a significant change in level, which would be unlikely when constructing a pipe. However, the depths are approximated and it is possible that inaccuracies should mean a less significant change in height consistent with continuation of the service into the 'tunnel'.

The end of the tunnel (beyond the void) has not been proven, however the microgravity suggests that the end is c.5.5m north east of the 'hole' location.

3.6 Disturbed Ground

Areas of ground disturbance are denoted by orange hatching on drawing 4281-1 & 2, at Figs.1 & 3 respectively. These areas were identified using Impulse radar in both of the detailed and reconnaissance survey areas.

In the areas highlighted with the orange hatching, the radar response was different from the typical background response and has been interpreted as being consistent with disturbed ground.

The majority of these responses are likely to be representative of only minor ground disturbance i.e. poorly compacted backfill of trenches, small scale voids etc. which are deemed unlikely to be of significant engineering concern; but in areas where ground disturbance is coincident over multiple survey profiles it is more likely to be of engineering significance.

There are three main areas identified as being of concern:

- The majority of the ground around the edge of the void has been identified as being disturbed, indicating that the edge to the void is not stable and not clearly defined. The ground to the east of the 'hole' location above the assumed subsurface tunnel is also disturbed.
- An area to the south of Stocks Meadow.
- An area to the south of the Eastwood Court Access Road (discussed in further detail below at Section 3.7).

It is recommended, where safe to do so, that in some of these locations the ground conditions are proven carefully through intrusive means (either by dynamic probing or boreholes) to establish the full nature of the disturbed ground. Care should be taken around any buried services with no intrusive investigations conducted in the detailed survey area i.e. no intrusive works should be conducted over or around the void.

3.7 Surface Water

An area of visible surface water was observed to the south of the Eastwood Court Access Road between chainage c.130-140m. The water was mostly limited to the southbound lane. Anecdotal evidence indicates that the presence of surface water has been ongoing for several months, irrespective of rainfall and temperature variation.

A zone of ground disturbance was resolved in the radar from a depth of c.600-800mm which was generally coincident with the zone of surface water. The zone of ground disturbance exhibited defined edges and contained multiple buried services.

It is probable that the water at the surface is related to a leaking service within the ground. Due to the 'instability' in the area, including the void formation to the north of this zone it is possible that as a result of leaking service(s) this could develop into a subsurface void, if it has not already. Therefore, it is recommended that careful intrusive investigations are undertaken in this area to expose any possible services. Care should be taken to not damage any of the services.

Alternatively, or in addition, detailed geophysical investigations of the area could be undertaken using microgravity to further assess the local density of the ground.

4.0 CONCLUSIONS

A ‘hole’ opened up in the carriageway of High Street Green suddenly on Friday 12th May 2017 leading to the closure of the High Street Green roadway, footpaths and grassed verge areas.

An ndt/geophysical investigation using microgravity and impulse radar was undertaken by GBG to establish the extent of the void beneath the ‘hole’ and whether or not there were any other areas of potential ground instability. The findings from the investigation are:

- The extent of the void below the ‘hole’ as shown on the drawings provided, measures c.5.1m in length (north-south) by c.5.8m (east-west) in width by 7.6m in depth.
- The void was formed either by natural dissolution of the chalk formation from groundwater, or, by a leaking service which was observed looking into the ‘hole'.
- The continuation of the leaking service is unknown, if this does continue into the adjoining ‘tunnel’ there would be a kink in the route and also a change in level (although depth inaccuracies could account for this).
- A suspected subsurface tunnel was observed extending to a distance of at least c.5.5m to the southeast of the void.
- It is recommended that the ‘tunnel’ is investigated further to confirm its eastern extent and to confirm that it is not part of a more expansive ‘tunnel’ network.
- Areas of ground disturbance have been detected notably around the edge of the ‘hole’, in an area to the south of Stocks Meadow, and an area to the south of the Eastwood Court Access Road.
- Surface water to the south of the Eastwood Court Access Road is likely to be as a result of a leaking service(s) within the ground. It is recommended that this area is investigated immediately either through intrusive or geophysical techniques or a combination of both.

- It is recommended that in two of the disturbed areas, away from the 'hole' intrusive investigations are undertaken using dynamic probing or boreholes to prove the exact nature of the disturbed ground.
- It is strongly recommended that no heavy plant is driven within and around the area delineated with a white dashed line (shown on Page.15). Extreme caution should be taken by any operatives working in this area.
- Prior to conducting any intrusive groundworks, we recommend that a full utilities (services) detection survey is carried out to minimise the potential risk of damage to the existing buried infrastructure.
- It is recommended that any records of the routes of services/sewers are consulted.

APPENDIX A

A Drawings

The results of this investigation are presented on Drawing Numbers 4281-1 & 2 as plans, contour plot, a schematic section and explanatory photographs.

The drawings have been provided in colour at A1 size as AutoCad .dwg files.

Note: The base plan used for relocation purposes in the presentation of the results has been reproduced from an Ordnance survey drawing supplied by the Client, and supplemented by measurements taken on site where appropriate.

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

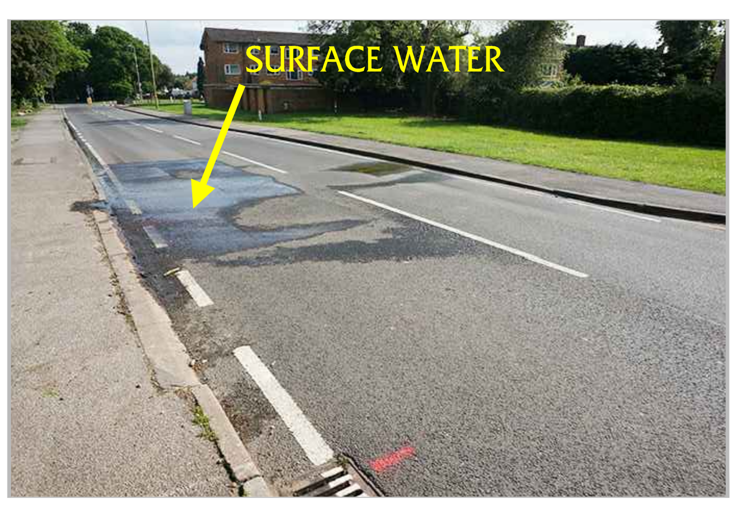
GBG

NDT/GEOPHYSICAL INVESTIGATION OF COLLAPSED GROUND
HIGH STREET GREEN, HEMEL HEMPSTEAD, HERTFORDSHIRE, HP2 7AQ

FIG.1: PLAN OF ENTIRE AREA SURVEYED POSSIBLE SHOWING SUBSURFACE GROUND DISTURBANCE - RECONNAISSANCE SURVEY SCALE 1:200

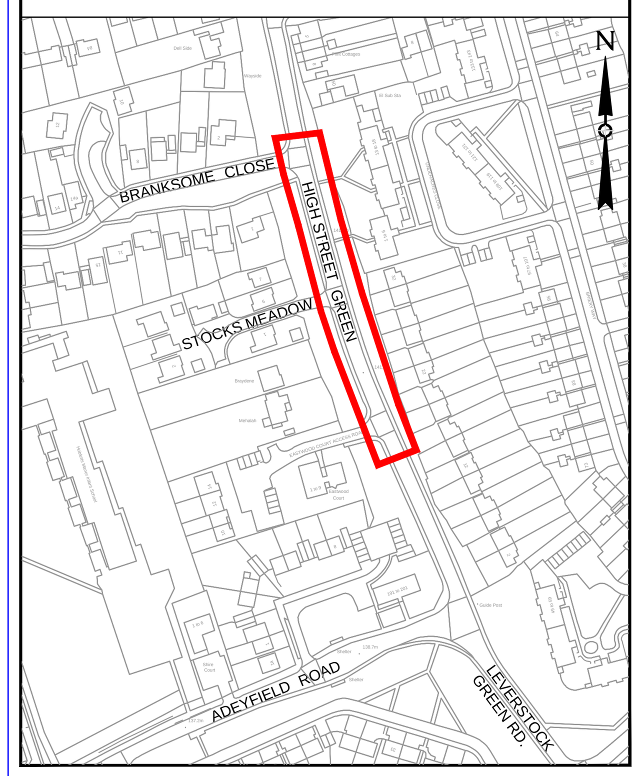
P1a: GENERAL VIEW OF ROAD AT BRANKSOME CLOSE JUNCTION LOOKING NORTH - ZERO DATUM INDICATED

P1b: GENERAL VIEW OF HIGH STREET GREEN LOOKING SOUTH



P1c: AREA OF VISIBLE SURFACE WATER BETWEEN CHAINAGE c.135-145m LOOKING SOUTH

LOCATION MAP - HEMEL HEMPSTEAD



SYMBOLS USED

SURVEY DETAILS

- SITE LOCATION
- ZERO DATUM
- LOCATION OF IMPULSE RADAR SURVEY LINE
- PLAN EXTENT OF DETAILED AREA SURVEYED
- MICROGRAVITY SURVEY STATION
- P1a: PHOTOGRAPH/PLATE NUMBER
- NUMBER & DIRECTION OF VIEW
- 0m CHAINAGE FROM DATUM IN METRES

MATERIAL TYPES PLAN

- APPROXIMATE EXTENT OF 'VOID' - SEE REPORT
- AREA OF SUBSURFACE GROUND DISTURBANCE WITH APPROX. DEPTH TO TOP SHOWN IN mm
- AREA OF INCREASED MOISTURE IN GROUND IDENTIFIED WITH RADAR - DEPTHS NOT RESOLVED

MATERIAL TYPES

- ASPHALT
- ASPHALT SUBBASE/SUBGRADE MATERIAL
- CLAY - ASSUMED LAMBETH GROUP (LMB)
- LEWES NODULAR CHALK AND SEAFORD CHALK FORMATION (SCk)

MICROGRAVITY SCALE BAR

MILLIGALS (MGAL)

5299.84
5299.83
5299.82
5299.81
5299.8
5299.79
5299.78
5299.77
5299.76
5299.75
5299.74
5299.73
5299.72
5299.71
5299.7
5299.69
5299.68
5299.67
5299.66
5299.65
5299.64
5299.63
5299.62

APPARENT DECREASE IN GROUND DENSITY

PROJECT DETAILS

GBG REPORT No. 4281 ACCOMPANIES THIS DRAWING. A TOTAL OF TWO DRAWINGS ARE INCLUDED WITH THIS REPORT, Dwg. No's 4281-1 TO -2.

STRUCTURE INVESTIGATED	CARRIAGEWAY FOOTPATHS AND GRASSED AREAS
LOCATION	HIGH STREET GREEN, HEMEL HEMPSTEAD, HP2 7AQ
PURPOSE OF INVESTIGATION	TO ESTABLISH THE PLAN EXTENT OF A VOID BELOW A HOLE THAT HAS OPENED AT THE GROUND SURFACE, AND TO CONDUCT AN ADJACENT RECONNAISSANCE SURVEY OF A SECTION OF THE ROAD

THIS DRAWING HAS BEEN PREPARED USING EXISTING DRAWINGS AND/OR PRINTS OF DRAWINGS AS SUPPLIED BY THE CLIENT AND SUPPLEMENTED BY MEASUREMENTS TAKEN ON SITE. ALL DIMENSIONS THEREFORE ARE TO BE CHECKED ON SITE PRIOR TO PREPARING DRAWINGS OR COMMENCING ANY WORK.

0 METRES 10

AT A SCALE OF 1:200 - ORIGINAL DWG SIZE A1 (594mm x 841mm)

REF.	REVISION	DATE

ALL ORIGINAL DRAWINGS ARE PRODUCED IN COLOUR

Project: HIGH STREET GREEN, HEMEL HEMPSTEAD, HERTFORDSHIRE

Client: HERTFORDSHIRE COUNTY COUNCIL

Title: NDT/GEOPHYSICAL INVESTIGATION OF COLLAPSED GROUND

Drawn	Date	Scale	Dwg. No.
DU	JUNE 17	1:200	4281-1
CAD	PM	APP	

GBG INNOVATION IN STRUCTURAL INVESTIGATION

GB Geotechnics Limited is a Quality Management Company certified to ISO9001:2008

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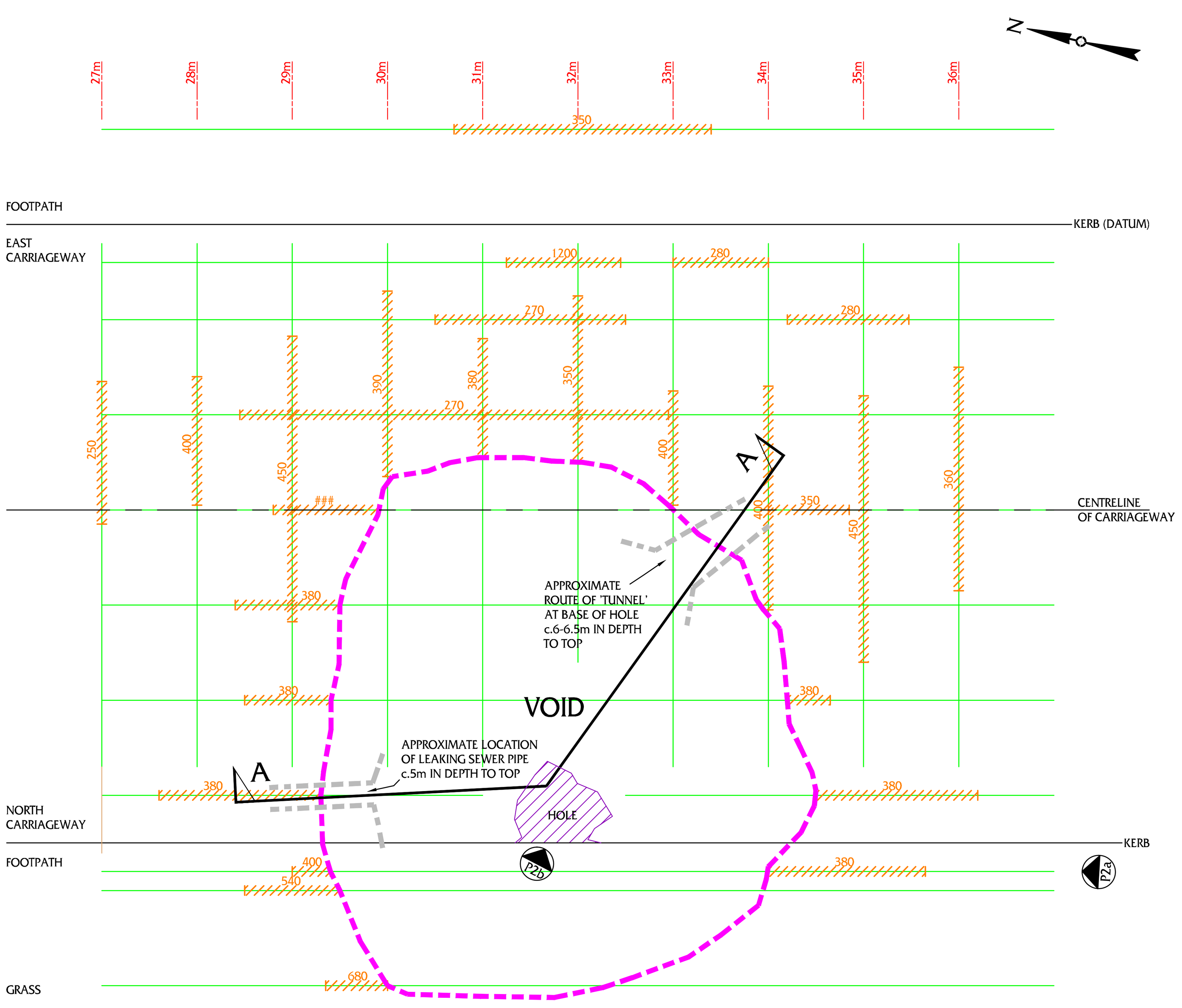
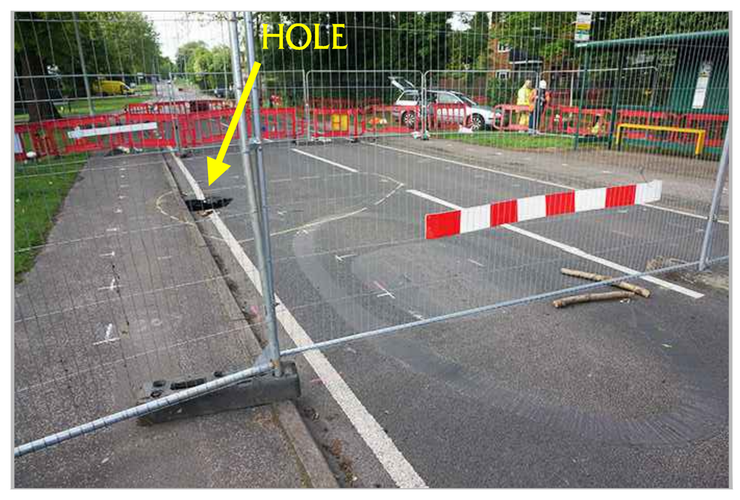
File 4281

FIG.2: PLAN OF DETAILED SURVEY AREA SHOWING 'VOID' EXTENT - IMPULSE RADAR RESULTS SCALE 1:50





P2a: VIEW OF DETAIL SURVEY AREA LOOKING NORTH - 'HOLE' LOCATION SHOWN

P2b: VIEW INSIDE 'VOID' LOOKING SOUTH EAST

FIG.3: PLAN OF DETAILED SURVEY AREA - MICROGRAVITY RESULTS SCALE 1:50

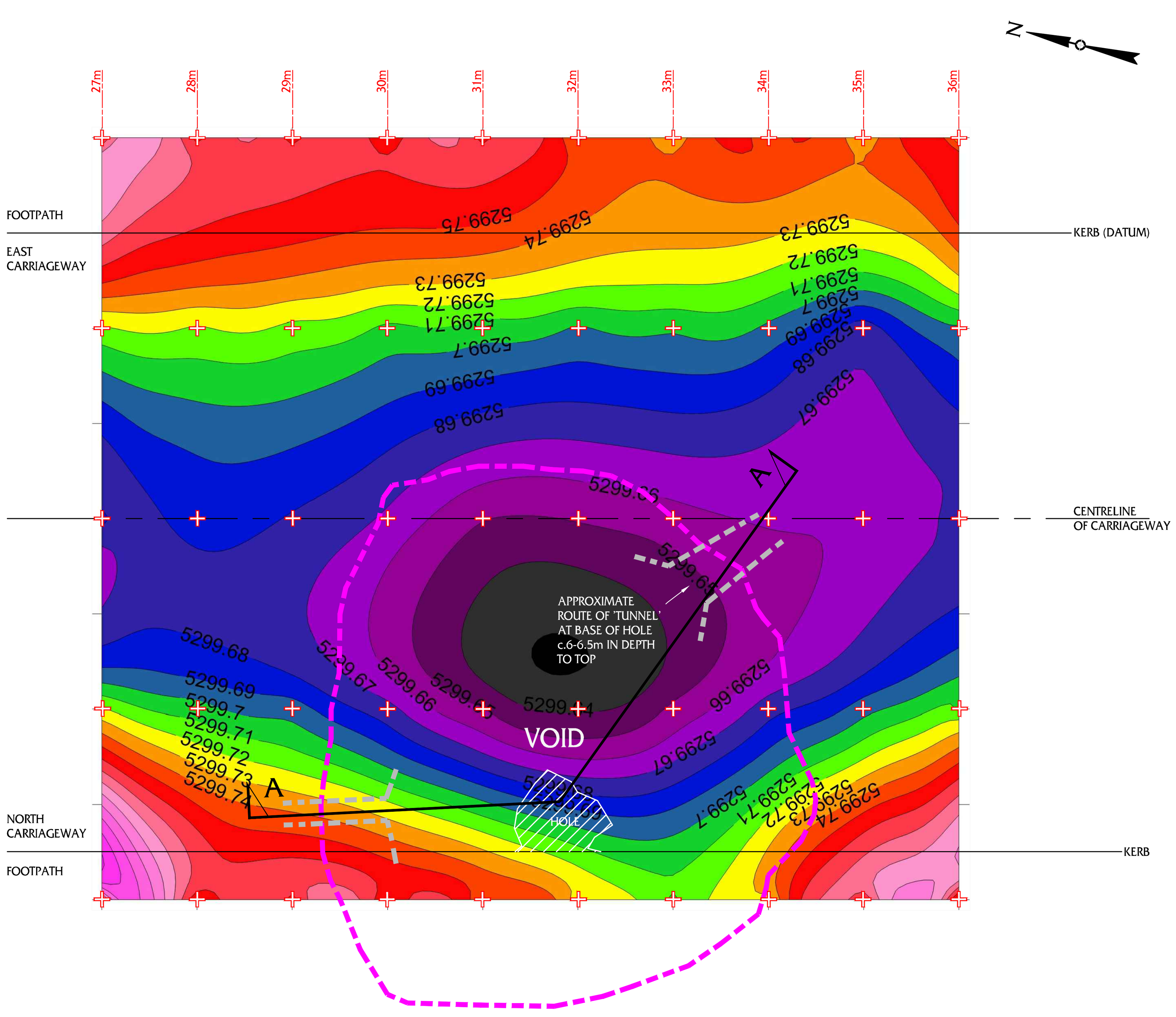
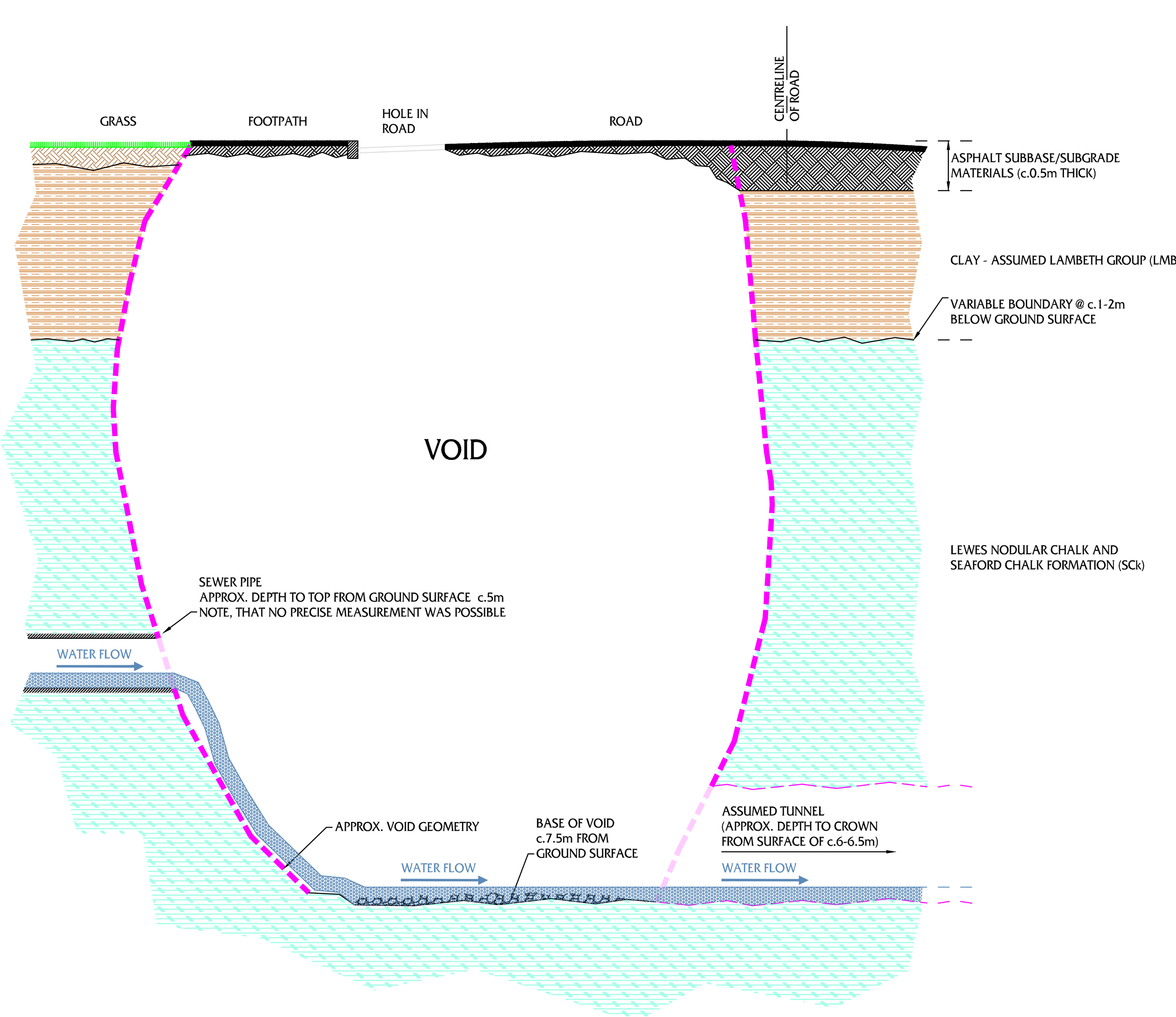
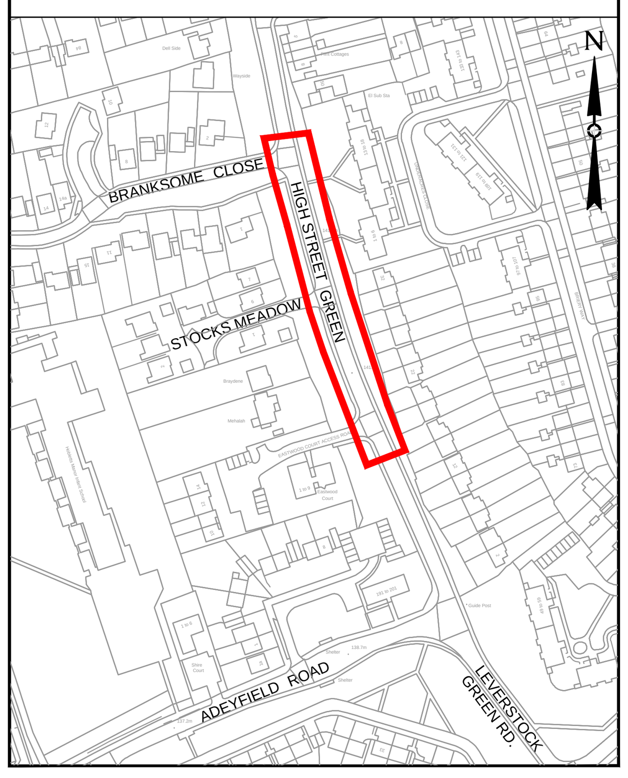


FIG.4: INTERPRETED SCHEMATIC SECTION A-A THROUGH 'VOID' SCALE 1:50



LOCATION MAP - HEMEL HEMPSTEAD



SYMBOLS USED

SURVEY DETAILS

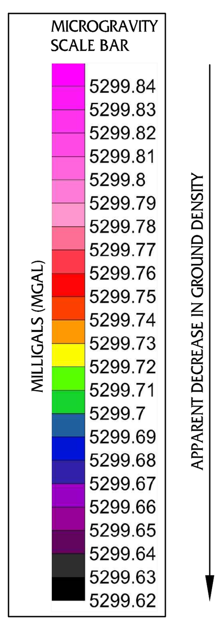
- SITE LOCATION
- ZERO DATUM
- LOCATION OF IMPULSE RADAR SURVEY LINE
- PLAN EXTENT OF DETAILED AREA SURVEYED
- MICROGRAVITY SURVEY STATION
- P1a: PHOTOGRAPH/PLATE NUMBER
- NUMBER & DIRECTION OF VIEW
- 0m CHAINAGE FROM DATUM IN METRES

MATERIAL TYPES PLAN

- APPROXIMATE EXTENT OF 'VOID' - SEE REPORT
- AREA OF SUBSURFACE GROUND DISTURBANCE WITH APPROX. DEPTH TO TOP SHOWN IN mm
- AREA OF INCREASED MOISTURE IN GROUND IDENTIFIED WITH RADAR - DEPTHS NOT RESOLVED

MATERIAL TYPES

- ASPHALT
- ASPHALT SUBBASE/SUBGRADE MATERIAL
- CLAY - ASSUMED LAMBETH GROUP (LMB)
- LEWES NODULAR CHALK AND SEAFORD CHALK FORMATION (SCk)



PROJECT DETAILS
GBG REPORT No. 4281 ACCOMPANIES THIS DRAWING. A TOTAL OF TWO DRAWINGS ARE INCLUDED WITH THIS REPORT, Dwg. No's 4281-1 TO -2.

STRUCTURE INVESTIGATED	CARRIAGEWAY FOOTPATHS AND GRASSED AREAS
LOCATION	HIGH STREET GREEN, HEMEL HEMPSTEAD, HP2 7AQ
PURPOSE OF INVESTIGATION	TO ESTABLISH THE PLAN EXTENT OF A VOID BELOW A HOLE THAT HAS OPENED AT THE GROUND SURFACE, AND, TO CONDUCT AN ADJACENT RECONNAISSANCE SURVEY OF A SECTION OF THE ROAD

THIS DRAWING HAS BEEN PREPARED USING EXISTING DRAWINGS AND/OR PRINTS OF DRAWINGS AS SUPPLIED BY THE CLIENT AND SUPPLEMENTED BY MEASUREMENTS TAKEN ON SITE. ALL DIMENSIONS THEREFORE ARE TO BE CHECKED ON SITE PRIOR TO PREPARING DRAWINGS OR COMMENCING ANY WORK.

0 METRES 4

AT A SCALE OF 1:50 - ORIGINAL DWG SIZE A1 (594mm x 841mm)

REF.	REVISION	DATE

ALL ORIGINAL DRAWINGS ARE PRODUCED IN COLOUR

Project: HIGH STREET GREEN, HEMEL HEMPSTEAD, HERTFORDSHIRE
Client: HERTFORDSHIRE COUNTY COUNCIL
Title: NDT/GEOPHYSICAL INVESTIGATION OF COLLAPSED GROUND

Drawn	Date	Scale	
DU	JUNE 17	1:50	Dwg. No. 4281-2
CAD	PM	APP	

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