Appendix A16.9 Archaeological Geophysical Surveys Undertaken as Part of the Environmental Impact Assessment

Geophysical Survey Report

Proposed Regional Wastewater Treatment Plant (WwTP)
Greater Dublin Drainage
Clonshagh, Annsbrook & Newtowncorduff Townlands
North County Dublin

TAG Project 13003

Detection Licenses
Newtowncorduff 13R23
Annsbrook 13R24
Clonshagh 13R25

Client:

Fingal County Council

TARGET archaeological geophysics

TAG PROJECT 13003, REGIONAL WASTEWATER TREATMENT PLANT (APPENDIX 1 TECHNICAL REPORT), GREATER DUBLIN DRAINAGE, NORTH COUNTY DUBLIN

Site Location	As part of the selection process for the site of a proposed Regional Wastewater Treatment Plant (WwTP) for the Greater Dublin Drainage scheme geophysical surveys were conducted across 3 land parcels in North County Dublin, in Clonshagh, Annsbrook and Newtowncorduff townlands. The Clonshagh site traverses 23ha of agricultural located at the northern perimeter of Dublin City, 2km north-east of the M1 interchange with the M50 and N32. Belcamp College lies 0.7km to the south-east, and Dublin Airport 2km to the north-west. The Annsbrook and Newtowncorduff sites comprise 2 land parcels, respectively 20 and 23ha in size, 11.8km north of Clonshagh, situated east and west of the M1 Motorway, 3.3km and 1.4km west of Lusk, 7km north of Swords.
NGR (Irish National Grid)	Clonshagh 319535 241916; Annsbrook 317580 254180; Newtowncorduff 319368 254224.
Topography & Landuse	Flat to undulating arable and pasture lowland.
Soils[1] & Geology[2]	Grey brown podzolics and gley soils overlying till of Irish Sea origin with limestone and shale.
Archaeology[3]	Recorded monuments (RMPs) within 1km of the Clonshagh land parcel include enclosure sites DU015-008, DU015-057, DU015-095; ringforts DU015-033 and DU015-056; Saint Doolaghs church and graveyard DU015-00901-06; 16th/17th century house DU014-056; and Belcamp House DU015-061. The cultural heritage assessment undertaken for the scheme (Alternative Sites Assessment and Route Selection Report (Phase 2); Emerging Preferred Sites and Routes Appendix 6 Cultural Heritage Assessment) identified a further 3 probable ringfort/ringditch sites (CH58, CH64, and CH66), and a possible enclosure (CH62) within 1km of the Clonshagh land parcel. 6 RMPs lie within 1km of the Annsbrook and Newtowncorduff sites, including field system DU008-066; pit burial DU007-034; burnt pit DU007-035; windmill DU008-007; moated site DU008-016; and fulacht fiadh DU008-069. Cultural heritage sites identified within 1km include 2 mounds (CH11); possible ring ditch CH12; possible mill and castle CH23; possible medieval settlement CH25; a possible earthwork associated with the site of Annsbrook House (CH26); part of mill race CH89; and Woodpark House and corn mill CH90 & CH62.
Method	Fluxgate gradiometry

SURVEY OBJECTIVE

The purpose of the geophysical surveys in Clonshagh, Annsbrook and Newtowncorduff was to define the nature and extent of archaeological remains where present at each site. The results from this work will be used to inform on the identification of a preferred site for the proposed regional WwTP.

SUMMARY OF RESULTS

One concentration of archaeological remains has been recorded to the south-west within the Newtowncorduff land parcel, in NG3. This comprises a magnetically strong sub-rectangular ditched enclosure, with adjoining linear/curvilinear responses suggesting the presence of further enclosure remains. Combined the remains identified in NG3 extend over an area c.50m north/south by c.77m east/west.

One circular ditched enclosure, measuring c.40m in diameter, has also been located at the northern edge of the Clonshagh land parcel, in CG3. No further concentrations of definite archaeological response have been recorded from survey within the investigation boundaries at Clonshagh, Annsbrook and Newtowncorduff.

Two concentrations of response, which may represent a levelled enclosure or structural remains, have been recorded within the investigation boundary at Annsbrook, to the north-west (AG1), and south-east (AG7). The remains of a possible early field system have also been recorded to the south within the investigation boundary at Clonshagh in CG2 a possible rectangular enclosure also indicated the south-eastern edge of CG2.

The results from survey demonstrate patterns of former landuse, including remains of possible early field systems, alignments of more recent disused boundaries, past cultivation and recent land drains.

Numerous weak trends are also present throughout the survey results. The potential that some of these may represent plough damaged/shallow remains of archaeological interest should not be dismissed. However, the majority are expected to derive from natural soil/geological variations.

One area of natural soil/geological variation has been recorded to the south-east in the Newtowncorduff land parcel, in NG9.

PROJECT DETAILS

Client	Fingal County Council
Project Engineering Consultants	Jacobs/Tobin
Project Archaeologists	IAC Ltd.
Detection Licenses	13R23 (Newtowncorduff); 13R24 (Annsbrook); 13R25 (Clonshagh)
Author	John Nicholls MSc
Fieldwork	18th February - 8th March & 22-23rd April 2013
Report	16th May 2013

[1, 2] National Soil Survey of Ireland (1980), General Soil Map 2nd Edition, 1:575000, An Foras Taluntais
[3] Archaeological Survey of Ireland (ASI), Archaeological Survey Database.

** This summary forms only a brief and short description of the survey results. The presentation, discussion and interpretation of the survey results are included in the main text of the report.

1 SURVEY METHODOLOGY

1.1 METHODOLOGY

This geophysical investigation employed fluxgate gradiometry to investigate all available lands within the Clonshagh, Annsbrook and Newtowncorduff land parcels. The survey covered a total of 21 areas at Clonshagh (CG1-CG5), Annsbrook (AG1-AG7) and Newtowncorduff (NG1-NG9). The following gradiometer instrumentation and sampling strategy was used for this survey:

Instrumentation	Traverse Interval	Sample Interval	Ha
Bartington Grad601 4 sensor gradiometer cart system combined with GPS	1m	8-10 per m (10Hz)	49

1.2 POSITIONING OF SURVEY DATA

A Trimble VRS Now GPS was used to record GPS locations to a precision of 20-40mm (horizontal and vertical) at a rate of 1Hz along each instrument traverse. These coordinates were subsequently used for positioning of the gradiometer data. Further alignment to Irish National Grid was facilitated by tie-in coordinates at the start and/or end of each survey block.

1.3 DATA PROCESSING

Processing of survey data was undertaken using in-house software and GRASS GIS as follows:

Data Processing
Positioning of gradiometer data according to GPS measurements (in-house)
Gradiometer data de-drift, zero median traverse & clip (in-house)
Gradiometer data gridding by inverse distance weighted surface interpolation (GRASS GIS)
Bicubic spline surface interpolation of gradiometer data (GRASS GIS)
Extraction of ferrous anomalies via SQL query of GIS database table (GRASS GIS)

1.4 DATA DISPLAY AND FIGURES

This report includes location, greyscale and interpretation diagrams for all fieldwork completed within the Clonshagh, Annsbrook and Newtowncorduff sites in the following display formats:

Figure No.	Figure Title	Scale
1-4	Site locations: Clonshagh, Annsbrook & Newtowncorduff	1/25000 & 1/10000
5-16	Interpolated greyscales: Clonshagh CG1-CG5, Annsbrook AG1-AG7 , Newtowncorduff NG1-NG9	1/1500
17-28	Raw (drift/median correction) greyscales: Clonshagh CG1-CG5, Annsbrook AG1-AG7, Newtowncorduff NG1-NG9	1/1500
29-40	Interpretations: Clonshagh CG1-CG5, Annsbrook AG1-AG7, Newtowncorduff NG1-NG9	1/1500

Figures 29-40 present annotated Interpretations of the survey results. Anomalies recorded from survey are highlighted numerically and referred to in the results section of the report.

2 GENERAL CONSIDERATIONS

2.1 ACCESS

Ground conditions within the Annsbrook and Clonshagh land parcels were generally good, both locations being mainly available for survey. Waterlogged and difficult ground precluded fieldwork to the north and south-east at the Annsbrook land parcel, and also within one cultivated field at the centre of the Clonshagh land parcel.

Fieldwork within the Newtowncorduff land parcel was completed in two stages: stage 1 across the relatively dry, pasture to the west; stage 2 resuming in the eastern portion of the site after a drying out period of c.3 weeks. Two small areas containing a dense cover of trees at the northern Newtowncorduff survey perimeter remained unavailable for investigation throughout.

Survey to the limits of each field at the Clonshagh, Annsbrook and Newtowncorduff sites was not always possible due to ground disturbance from machine access during geotechnical investigations.

2.2 SOURCES OF MODERN INTERFERENCE

The survey results contain numerous small-scale and larger concentrations of ferrous response. These are frequently recorded in gradiometer surveys and often caused by modern metallic debris contained within the topsoil or at the ground surface. Large-scale ferrous responses in the data derive from survey in proximity to adjacent fences, boundaries and modern surfaces. Interference from one electricity pylon bordering Newtowncorduff survey locations NG3 and NG4 was noted. The potential that the interference from this electricity pylon may have masked responses of archaeological significance should not be dismissed.

Ferrous anomalies from each block of survey data have been extracted by highlighting all readings beyond the +/-15nT range and exporting these values in shapefile format. This has been achieved via a SQL query of the attribute table in the GIS. This data has subsequently been manually edited in AutoCAD with reference to the greyscale displays for each survey block.

Ferrous responses recorded from this survey are not referred to in the results section of this report unless deemed relevant.

3 FLUXGATE GRADIOMETRY RESULTS

3.1 CLONSAGH SITE

3.1.1 CG1

The results from CG1 display a relatively quiet magnetic background with no characteristic archaeological type responses evident. Several weak linear trends extend across the survey centre and to the north, notably anomalies 1 which are oriented north-east/south-west and north-west/south-east. These anomalies could represent plough damaged responses of archaeological interest. However, they are located at the edge of the investigation perimeter, and the absence of any definitive archaeological patterns in CG1 suggests they derive mainly from natural sources of variation and/or more recent landuse.

A band of elevated positive response in CG1 to the north of the survey perimeter represents natural soil/geological variation in proximity to a stream.

No anomalies of definite archaeological character have been identified in CG1.

3.1.2 CG2

The results from CG2 display a series of curvilinear positive anomalies and connecting trends to the north-west (2) and east of survey centre (3). Responses 2 and 3 may represent the remains of an early field system. Part of a possible ditched enclosure (4) is indicated at the south-eastern survey edge.

Remains of disused boundaries (5) extend from survey centre to the north-east and north-west, with north-west/south-east and north-east/south-west former cultivation also indicated.

Further weak trends apparent throughout CG2 are expected to derive from patterns of former cultivation, natural soil/geological variation and possible former land divisions. The potential that a number of these could represent eroded or magnetically weak archaeological remains should not be dismissed.

No further anomalies of note have been recorded in CG2.

3.1.3 CG3

Part of a sub-circular enclosure (6), measuring c.40m in diameter, has been recorded at the north-eastern limit of CG3. This intersects with the northern site edge by c.2.5m. No responses of archaeological significance have been recorded within the site boundary in association with anomaly 6.

One weak trend (7) traversing the approximate centre of CG3 roughly east/west may represent the remains of a former boundary. Further weak trends have been recorded, notably anomalies 8 to the east of survey centre. These may be significant, although the absence of any definite archaeological patterns in this location suggests a natural or more recent landuse origin is more likely.

A series of circular fluctuations in response traversing CG3 north-west/south-east represent magnetic disturbance from overhead electricity cables.

Natural variation in proximity to the stream bordering the northern site edge continues beyond the site boundary.

No further responses of interest have been recorded from survey in CG3.

3.1.4 CG4.1, CG4.2, CG4.3

The results from CG4.1 indicate a series of possible land drains (9) aligned east/west to the north, and weak linear trends, notably anomaly 10, to the south of survey centre. Similar weak trends extend through CG4.2, notably anomaly 11 to the south of survey centre, and in CG4.3 to the north of the

survey limit. These weak linear trends may be archaeologically significant. However, the absence of any characteristic archaeological patterns suggests they most derive likely from further drainage features, cultivation or natural soil/geological variation.

No responses of archaeological character have been recorded in CG4.1, CG4.2 and CG4.3.

3.1.5 CG5

The remains of a possible former boundary (12) are indicated by weak trends extending roughly east to west across the northern portion of CG5. Intersecting land drains (13) have been recorded to the north-east and numerous weak linear trends (14 & 15) are also apparent, mainly to the north-west. Anomalies 14 may be significant, potentially representing plough damaged enclosure or magnetically weak linear remains, which extend partly beyond the north-western survey limit in CG5.

Further possible boundaries are indicated by weak trends 15 extending north to south and east to west across CG5. Weak trends indicated elsewhere through CG5 are expected to derive from patterns of former cultivation and or natural soil/geological variation.

Remains of former cultivation aligned east to west are indicated to the south in CG5.

3.2 ANNSBROOK SITE

3.2.1 AG1

The results from AG1 display a low level of response throughout. One isolated positive anomaly (16), potentially a pit, has been recorded to the west. One former boundary and a possible former boundary are indicated on a north/south alignment at survey centre and to the east (17 and 18).

The remains of a possible plough damaged enclosure or levelled structure are indicated to the north-east in AG1 by zones of increased response, positive anomalies and weak trends (19). These traverse an area c.30m east/west and are located close to the northern site limit. Two potential pits (20) are indicated c.20m south of 19. Interpretation of anomalies 20 is tentative as they are small-scale, and could derive from natural sources of interference, recent landuse or modern ferrous.

A network of land drains (21) aligned roughly north-west/south-east extends across the eastern portion of AG1. Further weak trends in the results are deemed of limited significance, likely the result of recent landuse and/or natural soil/geological variation.

No further anomalies of interest have been recorded within AG1.

3.2.2 AG2

No responses of archaeological significance have been recorded from survey in AG2. Land drains highlighted as anomalies 22 extend east/west and north-west/south-east throughout the survey block. Remains of former cultivation are also visible in the results mainly on the similar alignment.

3.2.3 AG3

Further north-west/south-east land drains (23) are apparent in AG3, intersecting with the remains of a former boundary indicated by a series of north-east/south-west oriented ferrous responses (24).

One single positive response (25) at the north-western edge of AG3 may be significant, potentially representing the location of an isolated pit. Interpretation of anomaly 24 remains cautious as there are no clear representations of archaeological features in the data set and it is possible that this response could derive from modern ferrous material contained within the topsoil.

No further responses of note are visible in the results from AG3.

3.2.4 AG4

Land drains aligned north-west/south-east extend throughout AG4 and are indicated as anomalies 26. Three weak linear trends, notably 27, are apparent on the same alignment to the east, north-east, and south-east of survey centre. These are deemed to be of limited archaeological interest, and are likely representative of recent patterns of landuse.

No anomalies of archaeological significance are indicated by the results from AG4.

3.2.5 AG5

Land drains highlighted as anomaly 28 are visible on north-west/south-east alignment in AG5.

No further responses of note have been recorded in AG5.

3.2.6 AG6

Land drains highlighted as anomalies 29 on north-west/south-east and north-east/south-west alignments extend throughout AG6.

Three isolated positive anomalies (30, 31 & 32), occasionally bound by weak trends, are evident in the results from AG6 to the north, east and south-west of survey. These may represent isolated linear/sub-angular features of interest. Interpretation remains cautious as the results from AG6 display no definite archaeological patterns.

The remains of a possible former boundary (33) are indicated north of survey centre by a weak linear trend aligned north-west/south-east. A further possible former boundary aligned approximately north/south is indicated by two weak trends extending through the south-eastern portion of AG6.

Weak parallel linear trends (34) east of survey centre in AG6 are thought to represent machine tracks from recent geotechnical studies.

No further responses of note have been recorded in AG6.

3.2.7 AG7

One area of increased response (35) to the west of survey centre in AG7 may represent a possible levelled structure or concentration of plough damaged linear/pit remains. This area of response contains numerous overlapping weak linear trends and two isolated positive responses and may represent remains associated with the site of Annsbrook House (CH26).

One possible former boundary (36) is indicated by a weak trend on north-west/south-east alignment traversing the southern edge of AG7.

Land drains aligned north-west/south-east extend throughout AG6 as anomalies 37.

No further responses of note are indicated by the results from survey in this location.

3.3 NEWTOWNCORDUFF SITE

3.3.1 NG1

The results from NG1 display a low level of background variation. Weak linear trends (38) extend from the centre of survey to the north and east. These are at the limits of instrument detection, and likely the result of variations from natural soil/geological variation.

No further anomalies of interest have been recorded in NG1.

3.3.2 NG2

Remains of former cultivation aligned roughly east/west extend throughout NG2. Weak linear trends are also apparent at survey centre, to the north-east and east (39). The potential that these may be significant should not be dismissed, although a natural/cultivation origin is more likely.

No further anomalies of interest have been recorded in NG2.

3.3.3 NG3

The results from NG3 indicate an enclosure complex defined by a sub-rectangular arrangement of magnetically strong linear ditch remains (40), with peripheral curvilinear anomalies to the south-east (41), and weak trends to the east, south-east, west, and south-west. Combined these anomalies extend c.50m north/south by c.77m east/west. There are no clear indications in the data of pit type anomalies or hearth remains in proximity to anomalies 40 and 41, suggesting that the remains identified could potentially possess a ceremonial rather than settlement context.

No further anomalies of interest have been recorded in NG3.

3.3.4 NG4

Two positive anomalies and peripheral weak trends extend through NG4 to the south (42) and west (43) of survey centre. These may be of interest. They are located more than 75m to the south of the enclosure complex identified in NG3and situated on sloping uneven ground. A potential soil/geological origin for these anomalies should not be dismissed.

No further anomalies of interest are apparent in the results from survey in NG4.

3.3.5 NG5

One isolated positive anomaly (44) is apparent to the north-east of survey centre in NG5. This response is very small-scale and expected to represent deeply buried ferrous contained within the topsoil.

Weak linear/curvilinear trends are visible to the east and west of survey centre (45). These anomalies correspond to shallow variations in topography noted at the time of fieldwork.

A former boundary is indicated by linear anomaly (46) traversing the centre of NG5 approximately north/south.

A possible further boundary indicated by weak trend 47 is apparent on approximate east/west alignment to the south of survey centre, and this intersects with anomaly 46.

No further responses of note are visible in the results from survey in NG5.

3.3.6 NG6

Small-scale positive anomalies, such as 48, are visible to the east, at survey centre, and to the south-west in NG6. These are very insubstantial and expected to derive from ferrous debris contained within the topsoil.

A former boundary (49) on approximate north/south alignment traverses the centre of NG6.

Weak linear and rectilinear trends are visible throughout NG6, notably to the west (50) and north-east (51). These are at the limits of instrument detection. Anomaly 50 may indicate part of an early field system or drainage. The remaining weak trends in the data are largely expected to derive from natural variations in the underlying soils and/or geology.

Land drains (52) are visible in NG6 to the south-east and north-west.

No further responses of archaeological significance are apparent in the results from NG6.

3.3.7 NG7

The remains of a probable early field system are indicated by intersecting linear trends 53, which traverse NG7 north-east/south-west and east/west. Further weak linear trends extend through NG7, mainly to the north-west and west (54), and these may remains of recent landuse or cultivation.

Several poorly defined small-scale positive anomalies are indicated to the west (55) and south-west. These may be of interest. However, they display no sufficient range of response or character to warrant an archaeological interpretation. These anomalies are thought to derive from modern ferrous or natural soil/geological variation.

Land drains (56) aligned approximately north-west/south-east extend through the central portion of NG7.

No further responses of note are evident in the results from survey in NG7.

3.3.8 NG8

Part of a probable early field system (53) extends east to west through the southern portion of NG8. Further small-scale positive anomalies, such as 57, are visible to the east and south-east. These are small-scale, poorly defined and expected to derive from natural variation and/or modern ferrous.

Land drains (58) extend mainly north-west/south-east through NG8.

Interpretation of weak linear trend 59 to the south is uncertain. This anomaly is not expected to be of archaeological significance, rather a result of more recent landuse, potentially a former drain or disused boundary.

No further responses of interest are visible in the results from survey in NG8.

3.3.9 NG9

Three isolated positive anomalies (60) have been recorded in NG9 to the south-east, south-west and west of survey centre. No definitive archaeological features are indicated by the results from survey in NG9. Anomalies 60 are expected to derive from modern ferrous and/or soil/geological variation.

A cluster of irregular positive/negative responses and weak trends (61) north-east of survey centre is expected to derive from natural soil/geological variation. Further weak trends such as 62 to the north-west are indicative of low level interference from soil/geological sources. The potential that some of these anomalies may represent remains of former land divisions and effects from previous landuse should not be dismissed.

Remains of a former boundary (63) and part of a possible early field system (64) are evident traversing NG9 north-east/south-west and north-west/south-east through the southern portion of survey.

Weak linear trends 65 border the northern limit of NG9 and correspond to the present pattern of cultivation in this field. A slight instrument drift from zero during fieldwork is suggested by these anomalies during fieldwork in this location.

No further responses of note are indicated in the results from NG9.

4 CONCLUSIONS

4.1 The gradiometer surveys conducted in connection with the selection process for the site of the proposed Regional WwTP have recorded the location of one enclosure complex in the south-western portion of the Newtowncorduff land parcel. These remains extend through NG3, are highlighted as anomalies 40-41, and cover an area c.50m north/south by 77m east/west. A circular ditched enclosure, which just intersects with the northern limit of the Clonshagh land parcel, has also been identified in CG3, and is highlighted as anomaly 6. No archaeological responses associated with anomaly 6 are visible within the Clonshagh investigation boundary. One possible field system (anomalies 2 and 3) has been recorded to the south within the Clonshagh investigation boundary, and a possible rectangular enclosure associated with this is also visible to the south-east.

4.2 Two further anomaly concentrations, which may represent levelled enclosure or structural remains, have been identified within the Annsbrook land parcel. These are located to the north-west in AG1 (anomalies 19), and to the south-east in AG6 (35). The responses are poorly defined; display no clear pattern or symmetry, and their interpretation remains uncertain. The potential that anomaly 35 may be associated with the site of Annsbrook House (CH26) should not be dismissed.

4.3 Isolated positive responses have been recorded within the Annsbrook and Newtowncorduff (NG4-NG9) land parcels, notably anomalies 16, 20, 25, 31 and 32 in AG1, AG3, AG6 & AG7, and 42, 43, 44, 48, 55, 57 and 60 in NG4-NG9. These are generally small-scale and display no specific range of response or character to warrant a definite archaeological interpretation. The majority of these are expected to derive from natural soil/geological variation, modern ferrous and patterns of former landuse.

4.4 Remains of possible early field systems are indicated by the results from survey within the Clonshagh land parcel, in CG1 (anomalies 2, 3 4), and at Newtowncorduff in NG5-9 (anomalies 47, 50, 53, 64). These are poorly defined, visible mainly as weak trends slightly above background variation, and their interpretation therefore remains tentative. The potential that anomaly 4 to the south-east in CG1 represents part of a settlement enclosure should not be dismissed.

4.5 The results from survey contain numerous linear responses and weak trends deriving from patterns of recent landuse, including remains of disused boundaries, former cultivation and land drains.

4.6 One area of natural soil/geological variation has been recorded to south-east within the Newtowncorduff land parcel, in NG9. Numerous weak trends of likely natural soil/geological origin are also present throughout the results from survey at Clonshagh, Annsbrook, and Newtowncorduff. The potential that some of these may represent plough damaged or shallow archaeological remains should not be dismissed.

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LIST OF FIGURES

APPENDIX 1: TECHNICAL INFORMATION ON INSTRUMENTATION AND DATA

GEOPHYSICAL INSTRUMENTATION

GPR/Ground Penetrating Radar (GSSI SIR-3000): GPR instrumentation comprises 1 central control unit for system configuration and data acquisition, a bistatic antenna (250-500mhz for archaeological purposes), and either a cart or survey wheel fixed with an odometer. GPR transmits a continuous electromagnetic pulse or wave of energy into the ground and records reflections of that energy following its interaction with buried objects and layers below the surface. Data is acquired along parallel transects or within a network of $20m^2/30m^2$ grids with measurements recorded as a function of 2-way travel time (the elapsed time for the energy wave to travel from transmitter to reflector and back to the surface). The strength of GPR reflections is proportional to the conductive and dielectric properties of the layers and objects with which the transmitted energy is incident.

Gradiometry (Bartington Grad601-4 Sensor Combined Gradiometer & GPS array): Gradiometry is perhaps the most widely used technique in archaeological geophysics. A conventional gradiometer system comprises a data logger, and at least 1 fluxgate gradiometer sensor to map variations in soil magnetism caused by buried archaeological features. These variations derive from processes of burning activity and organic enrichment of the soil which occur during phases of archaeological settlement. Gradiometer surveys require survey across a network of $20m^2/30m^2$ grids, or when integrated with GPS and a GIS data can also be collected along regularly spaced parallel lines of infinite length. The minimum recommended sampling routine for gradiometry is 0.25m x 1m.

Resistivity (Geoscan RM15 & Twin Probe Array): Resistivity is generally deployed to target known or suspected buried structures, including building foundations, walled enclosures, remnants of burial cairns, and existing earthworks. Using an array of electrodes mounted on a portable frame a small electrical current is passed through the ground at regular intervals via *current* emitting electrodes and the variations in resistance above background recorded via *potential* probes. Single or parallel twin resistivity systems use a pair or 2 pairs of current and potential probes mounted on a mobile frame with 1 remote *current* and 1 *potential* probe maintained at a stationary location no less than 20m from the survey limit. Standard resistivity sampling intervals are 0.5m x 0.5m, 0.5m x 1m or 1m x 1m, with use of either sampling routine specific to the size and depth of the suspected target(s).

DATA DISPLAY

Greyscale: The greyscale format assigns a cell to each datum according to its location on the grid. The display of each data point is conducted at very fine increments, allowing the full range of values to be displayed within the given data set. This display method also enables the identification of discrete responses barely above background levels of natural soil magnetism.

XY Trace: XY Trace displays provide a near-perspective representation of responses recorded along each instrument traverse. This display format is primarily used for identifying modern ferrous material, but can be informative on location of hearth, kiln and furnace remains, where strong magnetic responses may otherwise be dismissed as modern ferrous in origin. Responses from modern ferrous material can alternatively be identified by extracting readings beyond a specified range (e.g. +/-15nT) within a GIS, and then editing this geo-referenced data over greyscale displays.

Time-slice: Radargrams collected from survey along a grid can be compiled as a 3D volume, then resampled to produce a series of 2D plans at incremental depth/time offsets. A series of Time-slice displays at 25-50cm offsets permits analysis of the varying pattern and depth of responses within a given survey area.