Geophysical Survey Report

Dawn Meats Ireland (Slane)
Extension to Wastewater Treatment Plant (WWTP)
with treated effluent rising main pipeline

Painestown, Seneschalstown, Dollardstown, Hayestown-Carnuff Little & Ardmulchan, Navan, Co. Meath

Prospection Licence No. 21R0182

Client: Panther Environmental Solutions Ltd., on behalf of Dawn Meats Ireland (Slane)

Planning Authority: Meath County Council.

Planning Ref. : 21/424

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shanarc archaeology

Copies of this report have been presented to:	The client, the Department of Housing, Local Government and Heritage, and the National Museum of Ireland.
Please Note:	The International and European conventions on the protection of cultural heritage ratified in Ireland have been taken into consideration for the purposes of this report. The National Monuments Act 1930 (as amended), the Heritage Act 1995, Architectural Heritage (National Inventory) and Historic Monuments (Miscellaneous Provisions) Act 1999, The Planning and Development Act 2000 (as amendment), and guidelines issued by the statutory bodies have been consulted in the assembly of this report. All of the recommendations made within this report are based on drawings provided by the client at the time of writing. Should any alterations be made to design drawings, further assessment may be necessary. Recommendations are subject to approval by the National Monuments Service at the Department of Housing, Local Government and Heritage.
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1. Introduction

A geophysical survey was carried out by Seán Shanahan of Shanarc Archaeology Ltd. for Panther Environmental Solutions Ltd. on behalf of Dawn Meats Ireland, in association with a proposal by Dawn Meats Ireland to construct an extension to an existing wastewater treatment plant (WWTP), with works to include a treated effluent rising main pipeline to a discharge point on the River Boyne.

The purpose of the geophysical survey is to address heritage related observations and/or recommendations of the Development Applications Unit at the Department of Tourism, Culture, Arts, Gaeltacht, Sport and Media in respect of the proposal under Planning Ref. 21/424. The Development Applications Unit recommended that an Archaeological Impact Assessment should be compiled, to include the results of geophysical survey and archaeological testing at locations of archaeological potential on the proposal.

The geophysical survey targeted an area of identified archaeological potential, a greenfield area on the south bank of the River Boyne in Ardmulchan townland, marking the outfall location of the proposed effluent rising main pipeline.

The aim of the survey was to identify any geophysical responses within the defined survey area on the bank of the River Boyne that could potentially represent previously unknown archaeological features or deposits, to assess the nature and extents thereof, and to inform a subsequent programme of archaeological testing at this location.

A detailed gradiometer survey was carried out under licence 21R0182 issued by the Department of Housing, Local Government and Heritage to licensee Seán Shanahan of Shanarc Archaeology Ltd.

2. Site Description and Survey Conditions

The WWTP proposal is sited in a rural and predominantly agricultural environment. The effluent treatment plant at an existing Dawn Meats facility is situated in Painestown townland, and the effluent rising main pipeline is aligned along a section of Windmill Road, the L1013, Yellow Furze Road, the L1600 (Boyne Road) and an unnamed local road leading from the L1600 to private lands abutting the River Boyne at the discharge point, traversing Painestown, Seneschalstown, Dollardstown, Hayestown-Carnuff Little and Ardmulchan townlands. The terminal of the effluent rising main pipeline, sited to a pasture field on the floodplain of the River Boyne in Ardmulchan townland, was the targeted location of the geophysical survey (Figures 1 and 2).

Survey ground conditions were optimum, with the survey area comprising short pasture throughout. The ground surface was largely level, with no obvious surface archaeological anomalies, and with irregular low banks of dumped spoil forming a rough line close to, and parallel with the river bank.

The edge of the river floodplain is marked by a low scarp outside and to the south of the survey area, with a second scarp or steep bank marking the edge of the unnamed local road above the survey area, from which rubbish, including aluminum and other metal items, had been dumped. Visible items of metal were removed from the survey area in advance of commencing. An electric fence, comprising 2 x strands of wire, marked the northern edge of the survey area, utilised to exclude cattle from accessing the river; a second timber post and rail fence, incorporating wire, also delineated the west bank of a stream marking the eastern edge of the survey area. It was anticipated that both fencelines would affect the survey data.

3. Geophysical Survey

The geophysical survey was conducted on the 21st July 2021. Weather at time of survey was sunny, warm and dry.

3.1 Introduction to Geophysical Survey

Geophysical survey is a systematic measurement of some physical property related to the earth. There are numerous sources of disturbance of this property, some due to cultural heritage features, some due to the measuring method, and others that relate to the environment in which the measurement is made. No disturbance, or 'anomaly', is capable of providing an unambiguous and comprehensive description of a feature, in particular in archaeological contexts where there are a myriad of factors involved.

The measured anomaly is generated by the presence or absence of certain materials within a feature, not by the feature itself. Not all archaeological features produce disturbances that can be detected by a particular instrument or methodology. For this reason, the absence of an anomaly must never be taken to mean the absence of an archaeological feature. The best surveys are those which use a variety of techniques over the same ground at resolutions adequate for the detection of a range of different features.

In general, topsoil is more magnetic than subsoil, which can be slightly more magnetic than parent geology, whether sands, gravels or clays; however, there are exceptions to this. The reasons for this are natural, and are due to biological processes in the topsoil that change iron between various oxidation states, each differently magnetic. Where there is an accumulation of topsoil, or where topsoil has been incorporated into other features, a greater magnetic susceptibility will result.

Within landscapes, soil tends to accumulate in negative features like pits and ditches and will include soil particles with thermo-remanent magnetization (TRM) through exposure to heat if there is settlement or industry nearby. In addition, particles slowly settling out of stationary water will attempt to align with the ambient magnetic field at the time, creating a deposit with depositional remanent magnetization (DRM).

As a consequence, magnetic survey is nearly always more a case of mapping accumulated magnetic soils than structures, which would not be detected unless they were magnetic in their own right e.g. built of brick or tile. As a prospecting tool, the magnetic survey is thus indirect. Fortunately, the mechanisms outlined above are commonplace and favoured by human activity, and it is nearly always the case that cut features will alter in some way the local magnetic field.

3.2 Survey Methodology

Survey data was collected using a Bartington Grad 601-2 instrument, a gradiometer specifically designed for use in archaeological prospection. A gradiometer survey detects subtle variations in the local magnetic field, recording measurement variations in nano-Tesla (nT). This extremely sensitive survey instrument is capable of detecting magnetic soil variations to 0.01nT, making it ideal for surveying in a diverse range of archaeological, geological and soil morphological conditions.

To ensure consistent high quality data the survey device was calibrated in the field. Data was collected in zigzag traverses, with a sample interval of 0.25m and a traverse interval of 1m, providing 3200 readings per 20m x 20m grid.

The survey grids were set-out using a Trimble R12i GPS unit with real-time VRS Now technology. The accuracy of grids is an essential part of gathering quality data that can be easily identified again in the field. The accuracy of the grids at Ardmulchan had a 0.01m tolerance. This potential inaccuracy is augmented by the type of survey employed. Generally, gradiometry data can have a displacement of up to 25cm due, in part to the strength of the readings and/or the depth of the recorded response.

The survey area comprised three adjacent 20m x 20m grids, set up from west to east; however, the easternmost grid was a partial grid only, its extent dictated by the stream on the eastern edge of the survey area (Figure 2). The total area surveyed measured 1060m² (0.26 acres).

GPS coordinates for the survey area are show on Figure 2, and more detailed survey tie-in information can be made available upon request.

3.3 Data Display

Scaled summary greyscale images of the complete survey area are provided in Figure 3 and Figure 4. Figure 5 provides interpretations of the data shown.

Additional raw gradiometer data in the form of greyscale images and xy-trace plots are available upon request.

3.4 Survey Results

The data collected during the survey provided a number of varying magnetic responses, primarily comprising what appears to be modern ferrous disturbance.

However, there were also several responses indicating potential archaeological features. Interpretative results of the survey data are highlighted in Figure 5.

4. Conclusions & Recommendations

Small geophysical survey areas pose somewhat of an interpretative challenge, as it is more difficult to determine whether certain magnetic responses comprise individual features or form part of a larger landscape trend that may be archaeological, modern or natural in origin.

While the majority of the geophysical survey data gathered at Ardmulchan appears to indicate modern ferrous disturbance, the survey did produced some evidence for potential archaeological activity within the proposed effluent rising main pipeline outfall area. Due to the limited site area it is impossible to tell whether any of these potential archaeological features are standalone or whether they formed part of a larger trend. Evidence would suggest the potential archaeology consists of possible pit features, though excavation would be required to determine the exact nature and archaeological significance of these.

It is recommended that prior to any commencement of development works the site should be subjected to archaeological testing, with particular focus on the areas indicated by the geophysical data as having archaeological potential.

A report detailing the results of the test excavation should be used to identify if features of archaeological potential are located within the development area and what the likely impacts of the development will be.

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5. Interpretive classes

Introduction

Key to interpretation is the separation of each anomaly into broad classes, namely whether anomalies are caused by agricultural processes (e.g. ploughing, composting, drainage etc.), geological factors or whether a structure of archaeological interest is likely. Within these, anomalies are in turn classified by whether they most likely represent a fill or a drain, or a region of differing data texture etc. More detailed descriptions are included below.

The actual means of classification is based upon geophysical understanding of anomaly formation, the behaviour of soils, landscape context and structural form. For example, to consider just one form of anomaly: weakly dipolar discrete magnetic anomalies of small size are likely to have shallow non-ferrous sources and are therefore likely to be pits. Larger ones of the same class could also be pits or locally-deeper topsoil but if strongly magnetic could also be hearths. Strongly dipolar discrete anomalies are in all cases likely to be ferrous or similarly magnetic debris, although small repeatedly heated and in-situ hearths can produce similar anomalies.

Agriculture – field boundaries

Coherent linear dipolar enhancement of magnetic field strength marking ditch fills, narrow bands of more variable magnetic field or changes in apparent magnetic susceptibility, are all included within this category if they correlate with boundaries depicted on the Ordnance Survey maps. If there is no correlation then these anomaly types are not categorised as field boundaries.

Agriculture – cultivation

Banded variations in apparent magnetic susceptibility caused by a variable thickness of topsoil, depositional remanent magnetisation of sediments in furrows or susceptibility enhancement through heating (a by-product of burning organic matter like seaweed) tend to indicate past cultivation, whether ridge-based techniques, medieval ridge and furrow or post medieval 'lazy beds'. Modern cultivation, e.g. recent ploughing, is not included.

Agriculture – drains

In some cases it is possible to identify drainage networks either as ditch-fill type anomalies, noisy or repeating dipolar anomalies from terracotta pipes or reduced magnetic field strength anomalies from culverts, plastic or non-reinforced concrete pipes. In all cases identification of a herring bone pattern to these is sufficient for inclusion within this category.

Archaeology – fills

Any linear or discrete enhancement of magnetic field strength, usually with a dipolar character of variable strength that cannot be categorized as a field boundary, cultivation or as having a geological origin is classified as a fill potentially being of archaeological interest. Fills are normally earthen and include an often invisible proportion of heated soil or topsoil that augments local magnetic field strength. Inverted anomalies are possible over non-earthen fills, e.g. those that comprise peat, sand or gravel within soil. This category is subject to the 'habitation effect' where, in the absence of other sources of magnetic material, anomaly strength will decrease away from sources of heated soil and sometimes to the extent of non-detectability.

Former enclosure ditches that contained standing water can promote enhanced volumetric magnetic susceptibility through depositional remanence and remain detectable regardless of the presence of other sources of magnetic material.

Archaeology – other discrete

This category is secondary to fills and includes anomalies that by virtue of their character are likely to be of archaeological interest but cannot be adequately described as fills. Examples include strongly magnetic bodies lacking ferrous character that might indicate hearths or kilns. In some cases anomalies of ferrous character may be included.

Archaeology – structures

On some sites the combination of plan form and anomaly character, e.g. rectilinear reduced magnetic field strength anomalies, might indicate the likely presence of masonry, robber trenches or rubble foundations. Other types of structure are only included if the evidence is unequivocal, e.g. small ring ditches with doorways and hearths. In some circumstances a less definite category may be assigned to the individual anomalies instead.

Archaeology – zones

On some sites it is possible to define different areas of activity on the basis of magnetic character, e.g. texture and anomaly strength. These might indicate the presence of middens or foci within larger complexes. This category does not indicate a presence or absence of anomalies possibly of archaeological interest.

Geology – discrete

On some sites, e.g. some gravels and alluvial contexts, there will be anomalies that can obscure those potentially of archaeological interest. They may have a strength equal to or greater than that associated with more relevant sources, e.g. ditch fills, but can normally be differentiated on the basis of anomaly form coupled with geological understanding. Where there is ambiguity, or relevance to the study, these anomalies will be included in this category.

Geology – zones

Not all changes in geology can be detected at the surface, directly or indirectly, but sometimes there will be a difference evident in the geological data that can be attributed to a change, e.g. from alluvium to tidal flat deposits, or bedrock to alluvium. It some cases the geophysical difference will not exactly coincide with the geological contact and this is especially the case across transitions in soil type.

Services

All overhead (OH) and underground (UG) services are depicted where these are detectable in the data or may influence aspects of the interpretation.

Texture

Geophysical data varies in character across areas, due to a range of factors including soil chemistry, near surface geology, hydrology and land use past and present. Where these variations are of interest or relevance to the study they are included in this category.

6. Technical Information

6.1 Instrumentation & Methodology

Gradiometer Survey

A detailed gradiometer survey may be conducted to define any responses detected during scanning; alternatively it may be applied as a stand-alone methodology. Detailed survey is typically applied with a sample interval of 0.25m and a traverse interval of 1m, to allow for accurate detection of potential archaeological responses. Survey data is generally collected in grids of 40m x 40m or 20m x 20m, though occasionally grids of 10m x 10m and a transverse interval of 0.5m may be used if higher resolution data is found to be necessary.

In recording data using geophysical instruments, two traverse techniques can be applied: zig-zag or parallel. Parallel traverses offer more security from possible errors. Zig-zag traverses are quicker, giving rapid ground coverage, however this traverse type has a tendency for response of alternate traverses during gradiometery surveys, which is generated by the mistiming of a surveyors walking speed. This can be treated during the processing stage; however, it can never be fully removed. Zig-zag traverses can also produce a stripping effect on the data. This is identified as alternating dark and light bands, but is only seen in gradiometer and GPR data. It is caused by the misalignment of the two magnetometers in gradiometery data, and is an effect of tilting and lifting of the antennae over differentiating ground cover within GPR results (Ernenwein and Kvamme 2008, 143). These however, can be removed during data processing. The similarities between this type of error, and that of the geophysical representation of cultivation marks, means such responses can be inadvertently processed out. Linear earthworks positioned parallel to traverses can also be mistaken as stripping. Zig-zag traverses were employed exclusively at Ardmulchan. The application was considered with respect to resolution, sloping and expected archaeological activity.

Bartington GRAD 601-2

A Bartington 601-2 fluxgate gradiometer was employed throughout the geophysical survey at Ardmulchan. This machine consists of a highly susceptible core, usually made of mu- metal. The fluxgate gradiometer employs two magnetometers, separated 0.5m or

1m vertically apart (the distance between the two sensors determines the depth of penetration of the instrument).

This extremely sensitive survey instrument is capable of detecting magnetic soil variations to 0.01nT, making it ideal for surveying in a diverse range of archaeological, geological and soil morphological conditions.

Trimble GeoXH 6000

A Trimble GeoXH 6000 logger is a handheld GPS device which utilizes VRS Now real-time corrections and H-Star technology to give 0.10m accuracy in the field. This highly accurate device was used to precisely set-out the geophysical survey grids at Ardmulchan.

7. Bibliography

Ernenwein, E.G. and Kvamme, K. L., 2008. "Data processing issues in large-area GPR surveys: correcting trace misalignments, edge discontinuities and striping." In *Journal of Archaeological Prospection*. Vol. 15, Issue 2, pp. 133-149.

Schmidt, A. *et al*., 2015. *Guidelines for the use of Geophysics in Archaeology*. *EAC Guidelines* 2. Europae Archaeological Consilium (EAC), Belgium.

Note:

All background maps acquired from http://map.geohive.ie/mapviewer.html (accessed July 2021), and used in accordance with OSi Licence No. 0077921.

8. Figures

Figure 1: Project overview (*in red*) relative to location of geophysical survey area (*in yellow*) on the south bank of the River Boyne (OSi Licence No. EN 0077921).

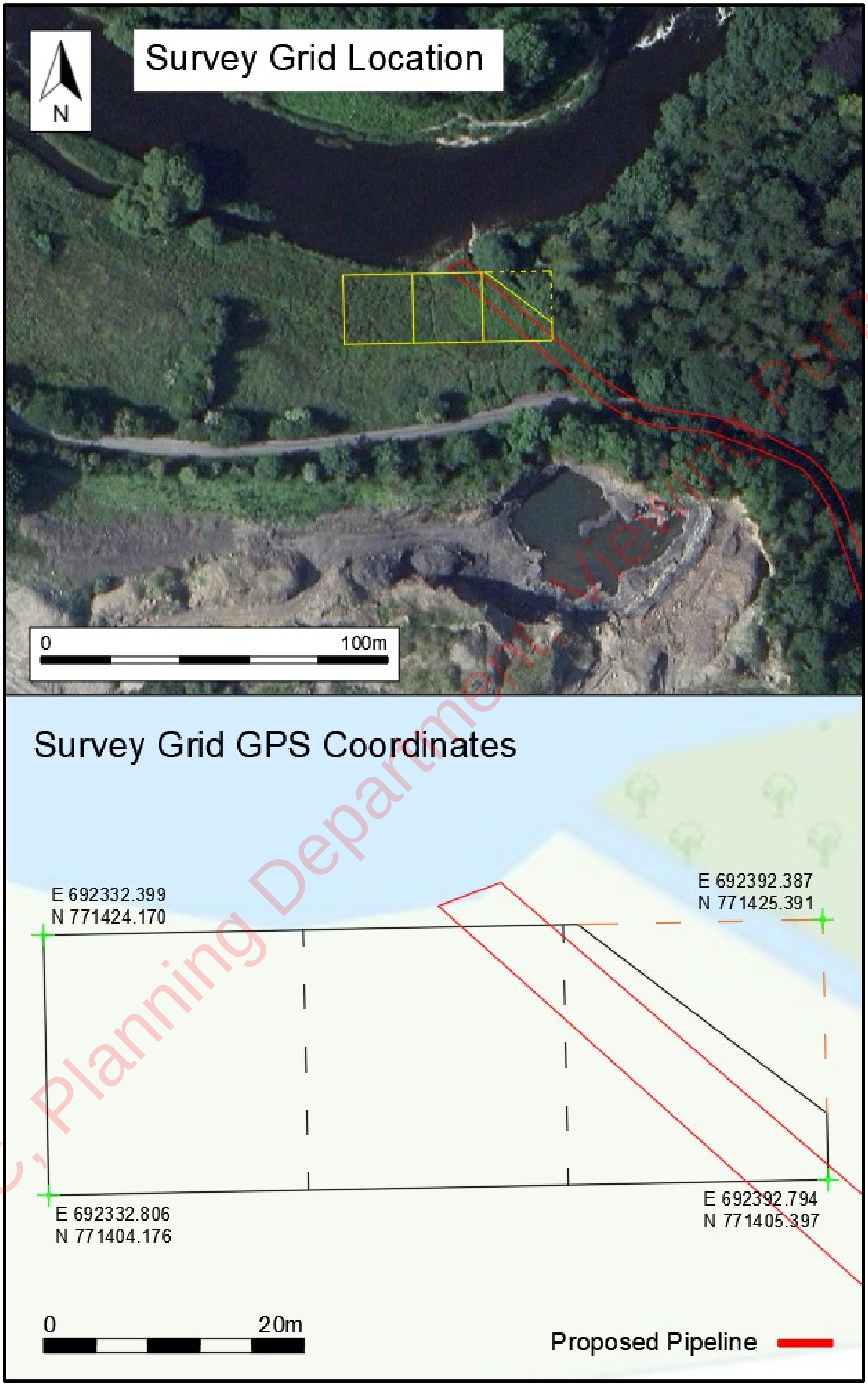

Figure 2: Geophysical survey grid location (*in yellow*) and GPS coordinates relative to pipeline outfall (*in red*).

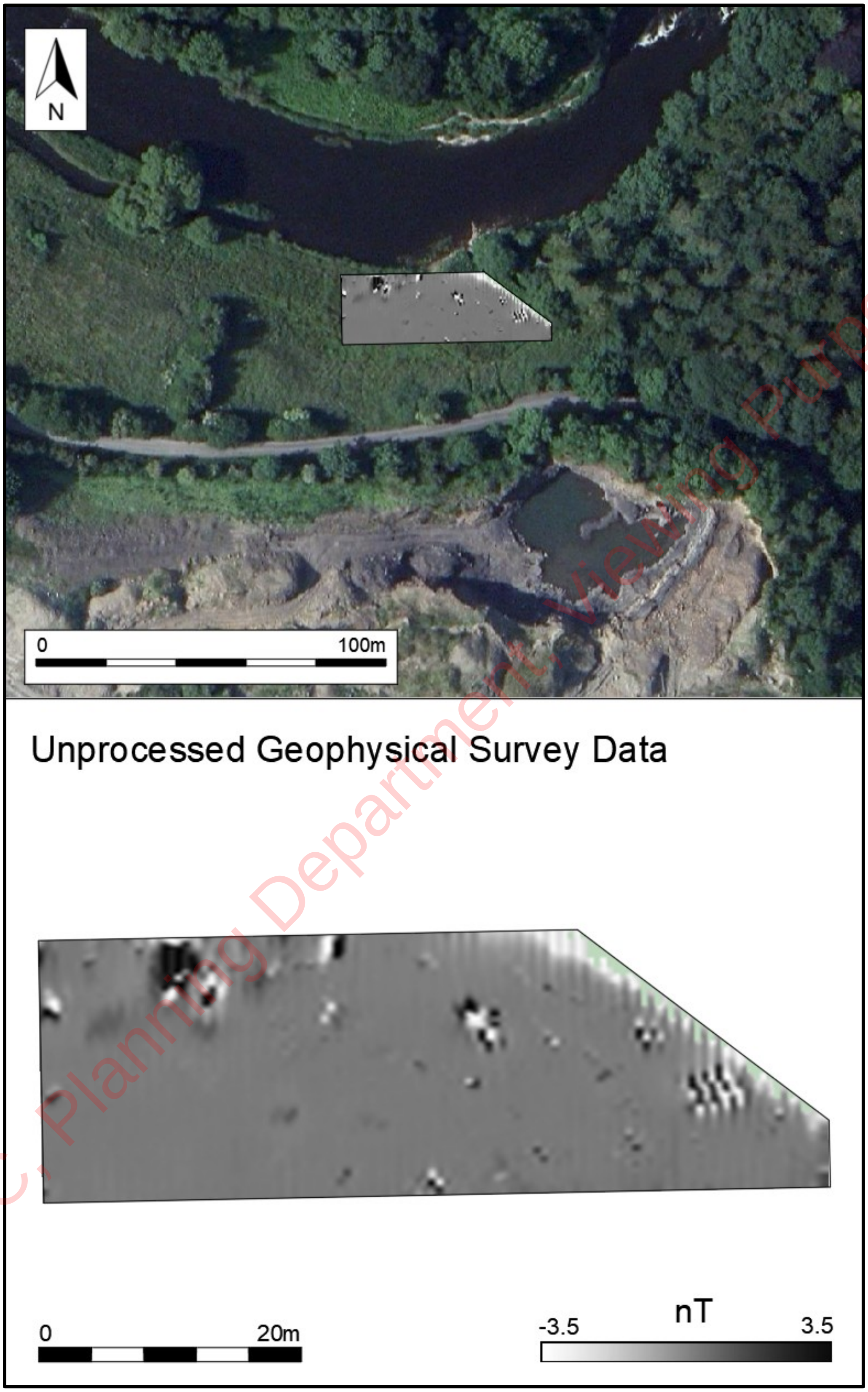

Figure 3: Unprocessed geophysical survey data.

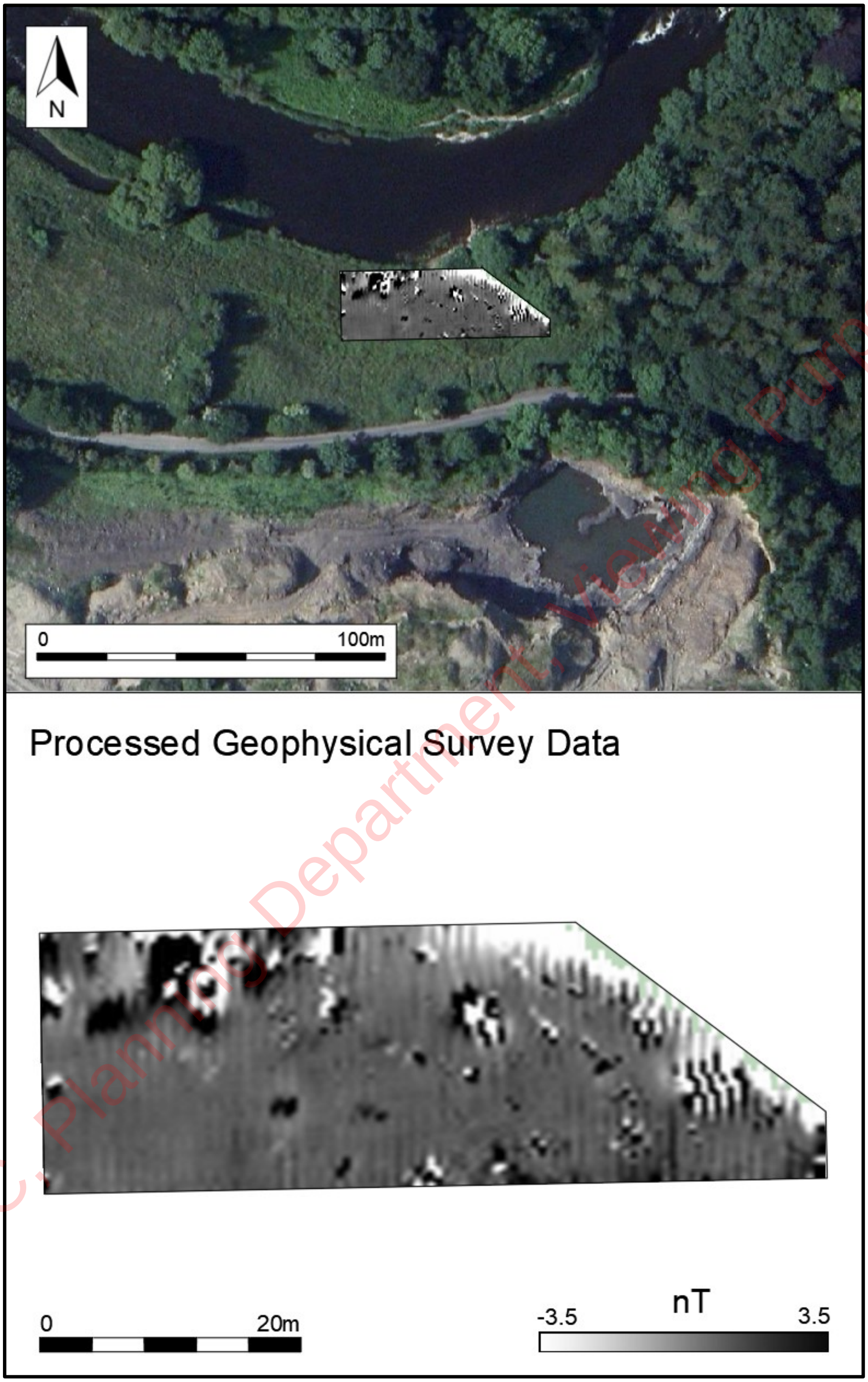

Figure 4: Processed geophysical survey data.

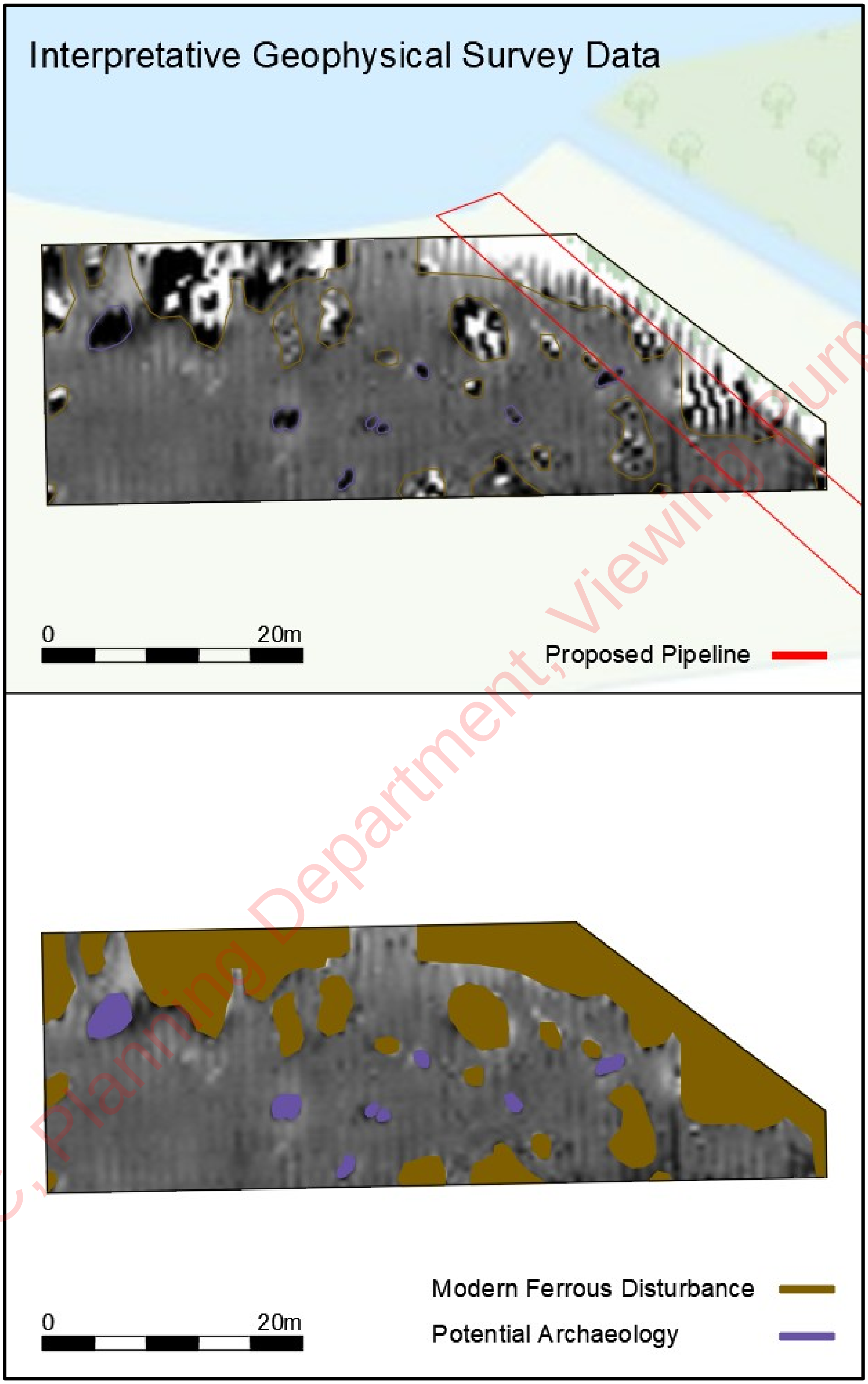

Figure 5: Interpretive geophysical survey data.