Heron Renewable Energy Plant

GEOPHYSICAL INVESTIGATIONS

- Issue Final
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1. Executive Summary

A geophysical survey was conducted as part of an Environmental Impact Assessment for the Heron Renewable Energy Plant, Immingham, North Lincolnshire. This was in response to a request from the North Lincolnshire Sites and Monuments Record Office, that geophysical survey be undertaken to determine the archaeological potential of the site.

The area surveyed was part of the *Inner Study Area* (Breslin 2009), which will be directly impacted by the construction and operation of the renewable energy plant.

The area was surveyed using a fluxgate magnetometer and this did not identify any areas of high archaeological potential; however, several areas of low/medium potential were identified, particularly in the west and north of the survey area.

The survey was successful, as evidenced by the occurrence of anomalies interpreted as ditches, drainage ditches, plough furrows and former borehole locations. All these features were interpreted as of low archaeological significance or non-archaeological, apart from a series of ditches in the south-west of the survey area. It is difficult to determine whether these ditches in the south-west are archaeological and it is possible that they are the result of recent ground disturbance in this area.

It is important to note that this survey took place in an alluviated environment, which can affect the results of geophysical survey.

2. Statement of Indemnity

Geophysical surveys rely on observations regarding the physical properties of the archaeological remains they attempt to locate. Through experience, it becomes possible for geophysicists to identify features with reasonable accuracy by the physical trace these features leave. It must be noted however, that geophysical interpretation is subjective and no hypotheses offered should be treated as unequivocal.

3. Geophysical Investigations

3.1. Introduction

This survey was commissioned to facilitate the development of the Heron Renewable Energy Plant and forms part of a larger Environmental Impact Assessment.

The survey area was located in Immingham, North Lincolnshire, between the ConocoPhillips Humber Refinery to the west and Immingham Port to the north and east, at OSGB (1936) Coordinates 517395 / 416836 (Figure 1). The survey was within a field forming the south-western part of the Application Area (the north-eastern part of the Application Area is occupied by a working coke-yard and storage area and is not accessible).

Scott Harrison, Ross Murray and Steven Roe conducted the survey, between the dates of 27th July and the 30th of July 2009.

The survey method chosen was fluxgate gradiometry, carried out using a Bartington Instruments Ltd. Grad 601-2 instrument. This method was chosen because it is the fastest and most cost-effective method for large-scale site evaluation.

3.2. Aims

The aims of the survey were to:

- Evaluate the archaeological potential of the surveyed area
- Inform the development of a mitigation strategy for any archaeological remains identified

3.3. Site Description

The site was covered by rough scrub/vegetation consisting of grasses, rushes, thistles and brambles. These conditions precluded survey, so the vegetation was cut to within 15cm of the ground to allow the survey to proceed. Surrounding the site on all sides, there is a drainage ditch/stream, approximately 1.5m – 2m wide, banked on both sides by hedges that were primarily hawthorn, with occasional elderberry and wild rose plants. The hedges on both sides of the stream measured approximately 2m – 2.5m across. The hedgerow in the north-west is noted of historical importance in the Northeast Lincolnshire HER (MLS 20570; Figure 2). The figure also indicates a historic hedgerow to the south, but this has been removed previously by others to facilitate the construction of the improved drainage ditch to the south of the site.

The bedrock geology, in conjunction with the superficial geology, plays a major role in the formation of the soil horizons and the minerals contained within them. These minerals contribute to

the ability of a soil to become magnetically enhanced and therefore, suitable for fluxgate gradiometry survey.

The Geographical Information System (GIS) dataset for the bedrock and superficial geology of the United Kingdom (www.bgs.ac.uk) indicates that the site is located over Cretaceous white chalk. The results of fluxgate gradiometer surveys over chalk and other limestones are generally clear. The results in this case show several anomalies, with a prevalence of plough furrows.

The superficial geology is alluvium (Tidal Flat Deposits), which is often very difficult to penetrate with fluxgate gradiometry. This means that archaeological remains may still be present, but the depth of alluvium may mask the strong signatures that would usually be expected. Approximately 380m to the west, the alluvium interfaces with diamicton till (Boulder Clay), which is likely to be glacially derived. It is composed of very poorly sorted large clasts within a fine matrix. Due to its glacial origin, it is difficult to determine its exact composition.

To the north-west, a series of geophysical surveys were conducted in relation to the ConocoPhillips Humber Refinery (Figure 2). These were conducted between 1999 and 2008, by Geoquest Associates, StratScan and GSB Prospection respectively. The results of the GSB Prospection surveys are summarised in the Lincolnshire SMR GIS dataset (N Lincs SMR: 19771 – MLS19771). One of the survey locations contained "ditch anomalies and pits" and the other "ridge and furrow". The area surveyed by StratScan contained several SMRs listed variously as "Iron Age ditch, Medieval ditch, possible crop marks, open field system and occupation site". Later excavation following these surveys recorded remains relating to Iron age and Romano-British settlement. In addition, approximately 410m south of the site, there is an SMR listed as a medieval house.

3.4. Results

The results are classified according to four categories. These are subjective and site dependant; the classification serves as a visual guide and an aid to the discussion of the results.

High Archaeological Potential – Identifiable, known archaeological feature types that are of high archaeological significance.

Medium Archaeological Potential – Identifiable, known archaeological feature types that are of low archaeological significance OR possible archaeological feature types that could be of high archaeological significance.

Low Archaeological Potential – Possible archaeological feature types that would be of low archaeological significance.

Non-Archaeological – Conspicuous anomalies probably of non-archaeological derivation. Modern plough furrows are also classed as non-archaeological, and are not in the interpretive drawing (figure 5), as they traverse the entire site.

3.4.1. Medium Archaeological Potential (Figure 5)

In the south-west of the survey area, there are a series of ditches that occupy an area of approximately 80m x 35m. The ditches probably extend outside of the surveyed area, to the west and south. An additional, outlying curvilinear ditch lies approximately 35m to the east of the main concentration. The origin of these ditches is unclear, but they are possibly related to modern activity. The south-west of the site was apparently disturbed and the bank to the south-east of the stream may have been reconstructed. This was evidenced by the lack of vegetation and the light beige sandy subsoil that was visible. It may be related to the widening of a drainage ditch that fringes the site in the south.

3.4.2. Low Archaeological Potential (Figure 5)

In the centre of the site, three possible drainage ditches radiate from the centre of the site to the three corners of the field. The lines of the ditches that extend to the west and north-east appear broken, but it can be assumed that they do extend to the corners of the field. The ditch that travels from the centre of the site to the south-east is the best represented in the results and it is clear that this travels directly from the centre of the field to the corner of the survey area and from there, it probably flows into the large drainage ditches that surround the site on all sides.

In the north-east of the site, there is an area of widely fluctuating readings. This gives the appearance of a cluster of irregular anomalies with no discernible pattern. It is likely that these represent natural variations, representative of the changing landscape that would have been characteristic of the area, immediately prior to its reclamation. Conversely, it may represent a period of later inundation, as seems to be the case in the field to the north-west. Cartographic sources suggest that the estuarine mud flats to the north-west had been reclaimed and subsequently reinundated in modern times.

There are approximately six scattered, diffuse anomalies within the survey area. These types of anomalies are often interpreted as pits. The isolation of these anomalies and their diffuse appearance, suggests that they are natural depressions or changes in the subsoil, rather than archaeological pits.

3.4.3. Non-Archaeological (Figure 3)

There are very clear uniform plough furrows evident across the entire site. The furrows are south-west/north-east oriented and are spaced very closely together. The uniformity of spacing and

direction suggests that they were created by modern ploughing methods and are therefore not of any significance. A filter was used during the processing of the data to try to mitigate for the obscuring effect of these plough furrows (Figures 3 and 4). This was successful to some degree, but there are still remnants of the plough furrows in the processed plot of the site.

Across the site there were seven, large positive or positive/negative bipolar anomalies. These correspond with the locations of the boreholes conducted by Rotary Test Drilling as part of the Site Investigation studies for this project. One of these anomalies, near the centre of the north-western edge of the site, does not relate to any recorded locations, but its appearance is identical to those boreholes with confirmed locations.

3.5. Conclusions

The results show that the survey was successful, as it did reveal the possible series of ditches in the south-west, the three ditches that radiate from the centre of the site to the three corners and the irregular anomalies in the north. In addition, the survey revealed evidence of recent ploughing and known boreholes.

The results suggest that there is nothing of high archaeological significance within the survey area and the ditches of medium archaeological potential in the south-west, possibly the most significant anomalies within the survey area, may turn out to be modern in origin.

4. Technical Information

4.1. Survey Strategy

All surveys conducted by Headland Archaeology (UK) Ltd. adhere to the standards described in, *Geophysical Survey in Archaeological Field Evaluation,* English Heritage Research and Professional Services Guideline No. 1 (English Heritage 2008).

The survey was conducted using a Bartington Grad 601-2 dual sensor magnetic gradiometer. The sample rate used was 1m x 0.25m, that is 1m traverses with readings taken every 0.25m. This sample rate is the preferred sample rate when the goal is to evaluate the archaeological potential of an area, rather than to characterise known remains (English Heritage 2008, 22).

Headland Archaeology undertook a survey of the extents of the area prior to commencing the survey and found it to measure approximately 8.1ha. This area was divided in to a series of 20m grids using AutoCAD before beginning the set-out procedure. The grids were laid out with an accuracy of ± 0.05m using a Differential Global Positioning System (DGPS), comprising a Trimble 5700/5800 base and rover system.

The grids were orientated north/south according the National Grid 1936 (OSGB36) and the traverses were walked in an alternating north/south direction. This ensures the greatest contrast between positive and negative readings and increases the likelihood of identifying weakly magnetised features. A series of alternating coloured markers were used to mark the locations of the traverses.

4.2. Data Processing

Destripe	Reduces the slight striping effect sometimes present in data collected bi-directionally, *i.e.* north/south – south/north.
Destagger	Reduces occasional mismatch errors from data collected bi-directionally.
Despike	Reduces the effect of extreme readings caused by the presence of ferrous surface debris.
2D Fast Fourier Transform	Identifies repetitive anomalies, such as plough furrows, and attempts to remove them.
Clip	Clips the high and low data ranges to increase the contrasts in the centre of the data range.

4.3. Archive

The archive should contain (as a minimum standard):

- Full report and graphics, with a digital copy in .pdf
- Raw grid data in .asc file format
- Processed composite data in .asc file format
- Copies of all CAD/GIS data produced during the course of the survey, including the working files from which the figures were produced

Recipients of the full report and archive would normally be the Client, the appropriate County Archaeologist and English Heritage.

The .asc file format is an ASCII format, which can be opened in any text editor. In addition, the files are georeferenced and open directly in a GIS in the appropriate location.

4.4. Written Sources

Breslin, Linn (2009), *Immingham Biomass Plant, Environmental Statement*, Volume 2 (of 4), Issue A1

British Geological Survey GIS Dataset (www.bgs.ac.uk)

English Heritage (2008), *Geophysical Survey in Archaeological Field Evaluation*, English Heritage Research and Professional Services Guideline No. 1, (2nd ed).

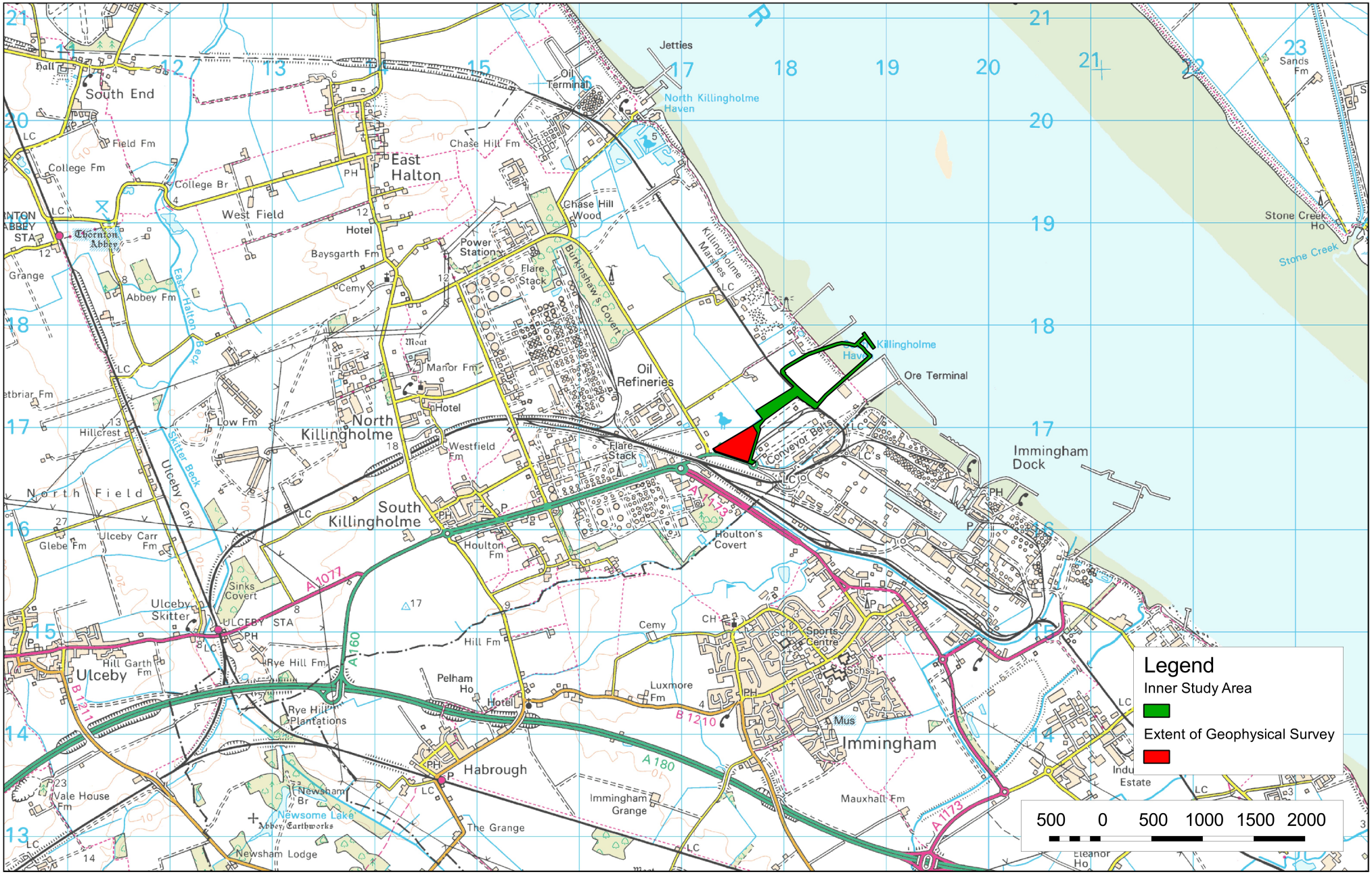

Figure 1 - Heron Renewable Energy Plant, Immingham, North Lincolnshire: 1:50000 Map Showing the Inner Study Area and the Extent of the Geophysical Survey

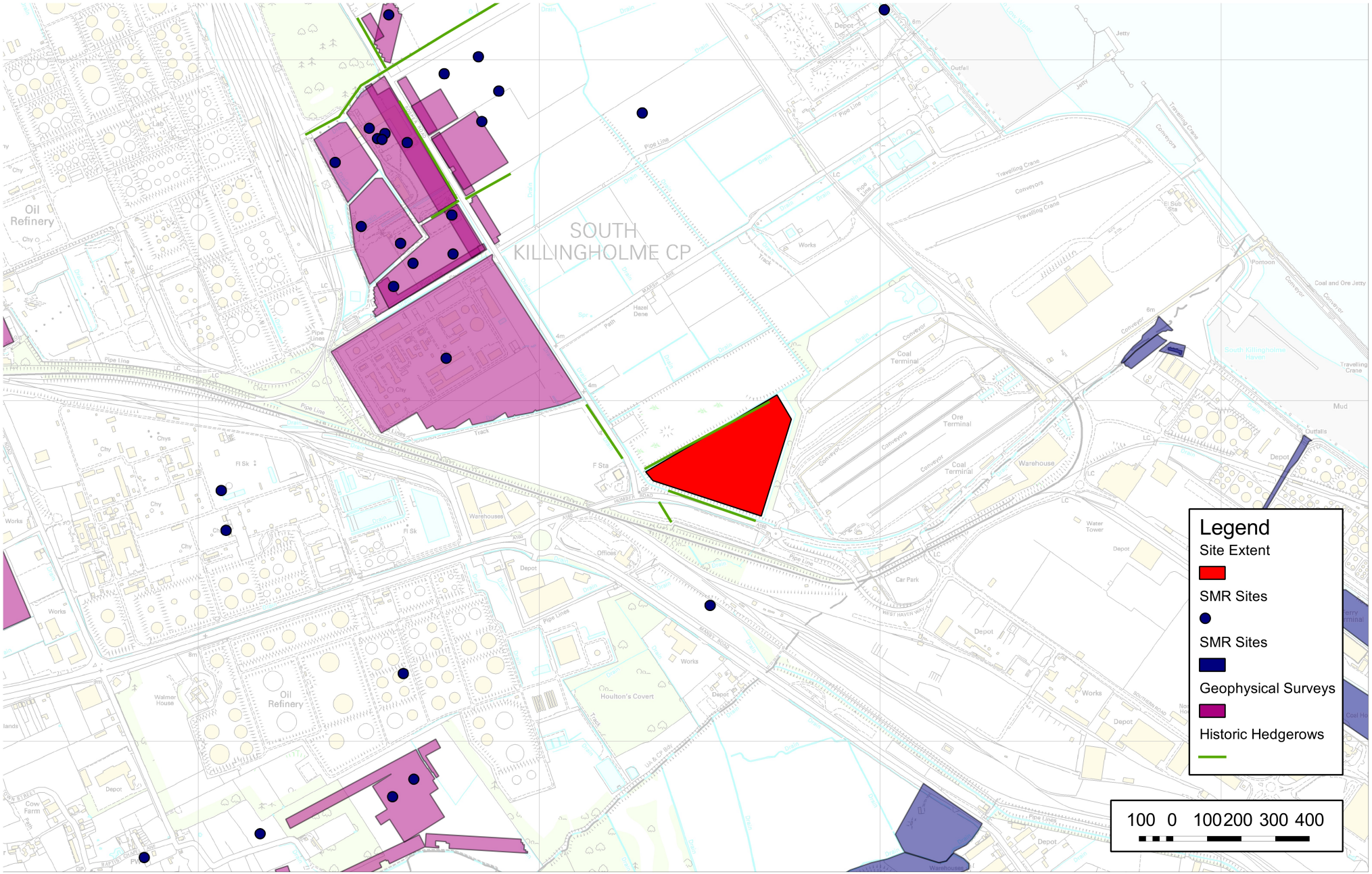

Figure 2 - Heron Renewable Energy Plant, Immingham, North Lincolnshire: 1:10000 Mapping with SMR Detail

Figure 3 - Heron Renewable Energy Plant, Immingham, North Lincolnshire: Raw Data

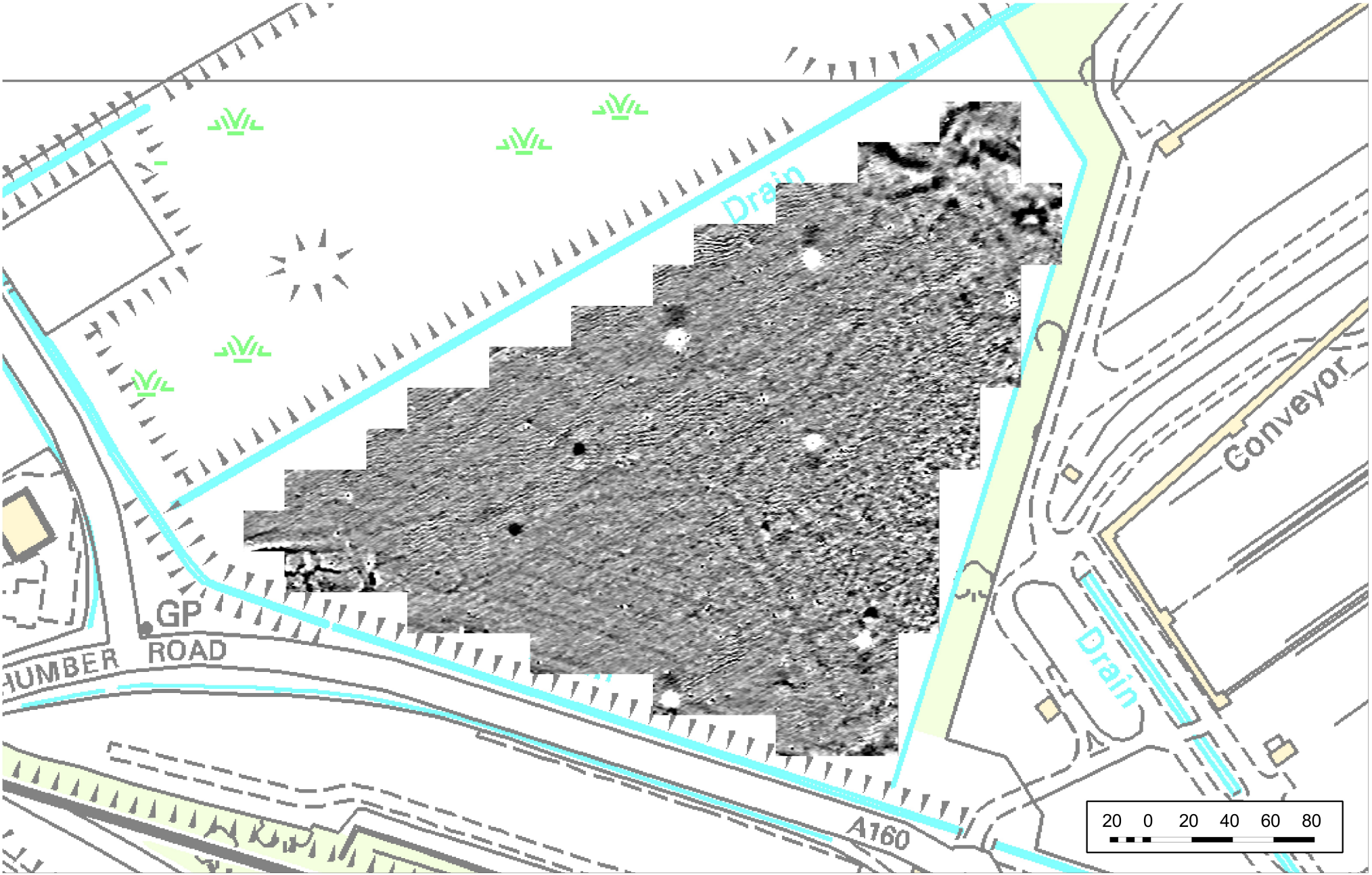

Figure 4 - Heron Renewable Energy Plant, Immingham, North Lincolnshire: Processed Data

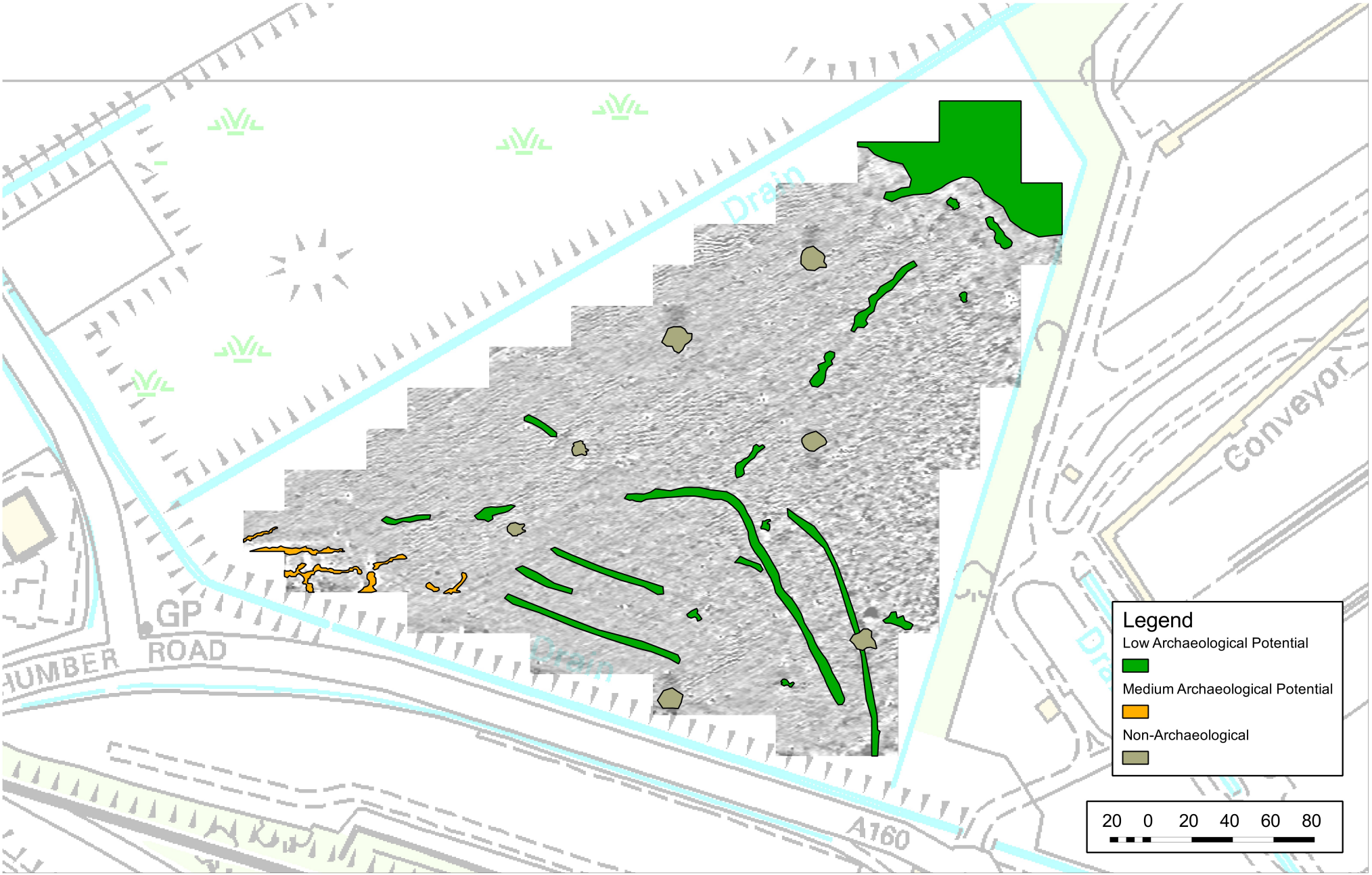

Figure 5 - Heron Renewable Energy Plant, Immingham, North Lincolnshire: Processed Data with Interpretation