

**AN ARCHAEOLOGICAL WATCHING BRIEF
ON LAND AT WEST BURTON POWER STATION,
DISTRICT OF BASSETLAW, NOTTINGHAMSHIRE**

An Archaeological Watching Brief on Land at West Burton Power Station, District of Bassetlaw, Nottinghamshire

Central National Grid Reference: SK 480200 385900

Site Code: WBN 07

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1. NON-TECHNICAL SUMMARY

- 1.1 An archaeological monitoring and recording exercise was undertaken in September 2007 in association with a programme of geotechnical site investigations on land at West Burton Power Station in the District of Bassetlaw, Nottinghamshire. The central National Grid Reference of the site is SK 480200 385900. The work was undertaken by Pre-Construct Archaeology Limited and commissioned by PB Power on behalf of EDF Energy.
- 1.2 The site was originally earmarked for an additional power plant, known as West Burton 'B', in the 1980s, although this proposal was never followed through. Following a new development proposal, the archaeological work was required as a planning condition ahead of the construction of a new combined cycle gas turbine power plant.
- 1.3 The site is located in north Nottinghamshire, c. 15km north-east of Retford, and lies close to the west bank of the River Trent, which here defines the county boundary with Lincolnshire. Lying within the curtilage of West Burton Power Station, the site is bounded to the north, west and south-west by parts of the existing facility, the main elements of which are the 1960s coal-fired plant and a more recent flue gas desulphurisation plant. To the south-east, the site is bounded by open farmland, including a scheduled area representing a former medieval settlement at West Burton.
- 1.4 Pre-Construct Archaeology Limited undertook a desk-based archaeological assessment of the site in 2005. It concluded that the potential for archaeological remains of all eras, with the exception of the medieval period, was low. For the medieval period, the potential for remains was considered moderate to high, due to the close proximity to the site of West Burton medieval settlement. In addition, map regression has shown that a 19th century building (a 'Cheese House') stood in the north-eastern corner of the site, of which sub-surface remains could survive. Also, the potential for palaeoenvironmental remains at the site was considered moderate to high, given its situation adjacent to the River Trent.
- 1.5 The site has a mounded form, due to the dumping of fuel ash waste in recent decades and this material is known to be many metres thick in places. The very presence of this material – and the treatment of the ground surface at the time it was deposited - are important considerations regarding the potential survival and preservation of archaeology at the site.
- 1.6 The archaeological work monitored various geotechnical investigations, principally a series of ten machine-excavated trial pits. In addition, two trial pits were excavated specifically for archaeological purposes, to investigate the site of the former Cheese House. At every location but one, modern topsoil gave way to a considerable thickness of fuel ash, up to 3.70m thick, this being the lowermost deposit reached in each case. No relic topsoil was reached during the trial pitting. Additional geotechnical data has recorded the full thickness of the fuel ash and characterised the nature of the underlying geological strata. At the final location, one of the two pits sited to investigate the former building, part of a linear feature was recorded cutting into natural alluvial silt at depth of 1.85m below ground level. It was filled with probable fuel ash and underlay other dumped material and then the main dump of fuel ash.

2. INTRODUCTION

2.1 General

- 2.1.1 This report describes the methodology and results of an archaeological monitoring and recording exercise (hereafter 'watching brief') carried out in association with a programme of geotechnical investigations on land at West Burton Power Station, Nottinghamshire (Figure 1a).
- 2.1.2 Pre-Construct Archaeology Limited (PCA) undertook the watching brief during September 2007. The work was commissioned by PB Power on behalf of EDF Energy and was required as a planning condition imposed on the consent to construct a combined cycle gas turbine (CCGT) plant, on land adjacent to the existing coal-burning power station.
- 2.1.3 The archaeological potential of the site was first highlighted in an archaeological desk-based assessment (DBA) in 2005.¹ The site lies immediately to the north of a scheduled area containing extensive earthwork remains representing a medieval settlement and open field system at West Burton (Figure 1b). Related remains of that period could potentially extend into the proposed development site. In addition, late 19th century mapping shows a building, named as a 'Cheese House', lying within the north-eastern portion of the site, although there are no upstanding remains of the structure. The site also has potential for important palaeoenvironmental remains, given its situation adjacent on the floodplain of the River Trent.
- 2.1.4 The watching brief was undertaken according to a Written Scheme of Investigation² (WSI), which was submitted to and approved by the Senior Archaeological Officer at Nottinghamshire County Council. The site is known – from previous geotechnical investigations - to have an extensive covering of pulverised fuel ash (PFA), for the most part at least 4m thick. While the principal broad aim of the watching brief was to record archaeological data by monitoring the variety of geotechnical investigations being undertaken, specific objectives were to record the depth of PFA in a series of trial pits (TPs) and to establish, if possible, whether or not the site had been stripped of its topsoil prior to the deposition of the PFA. In addition, two TPs were excavated specifically to locate any sub-surface remains of the former Cheese House.
- 2.1.5 At the time of writing, the project archive is housed at the Northern Office of PCA, at Unit N19a, Tursdale Business Park, Durham. The completed project archive, comprising written, drawn, and photographic records will be ultimately deposited with the appropriate body in Nottinghamshire, under the site code WBN 07. The **Online Access to the Index of Archaeological InvestigationS** (OASIS) reference number for the project is: preconst1-35212.

2.2 Site Location and Description

- 2.2.1 West Burton Power Station is located in the District of Bassetlaw in north Nottinghamshire, c. 15km north-east of Retford, c. 1km to the south-west of the village of Bole and c. 0.3km to the north-east of the village of Sturton le Steeple (Figure 1a).

¹ PCA Limited 2005.

² PB Power and PCA Limited 2007.

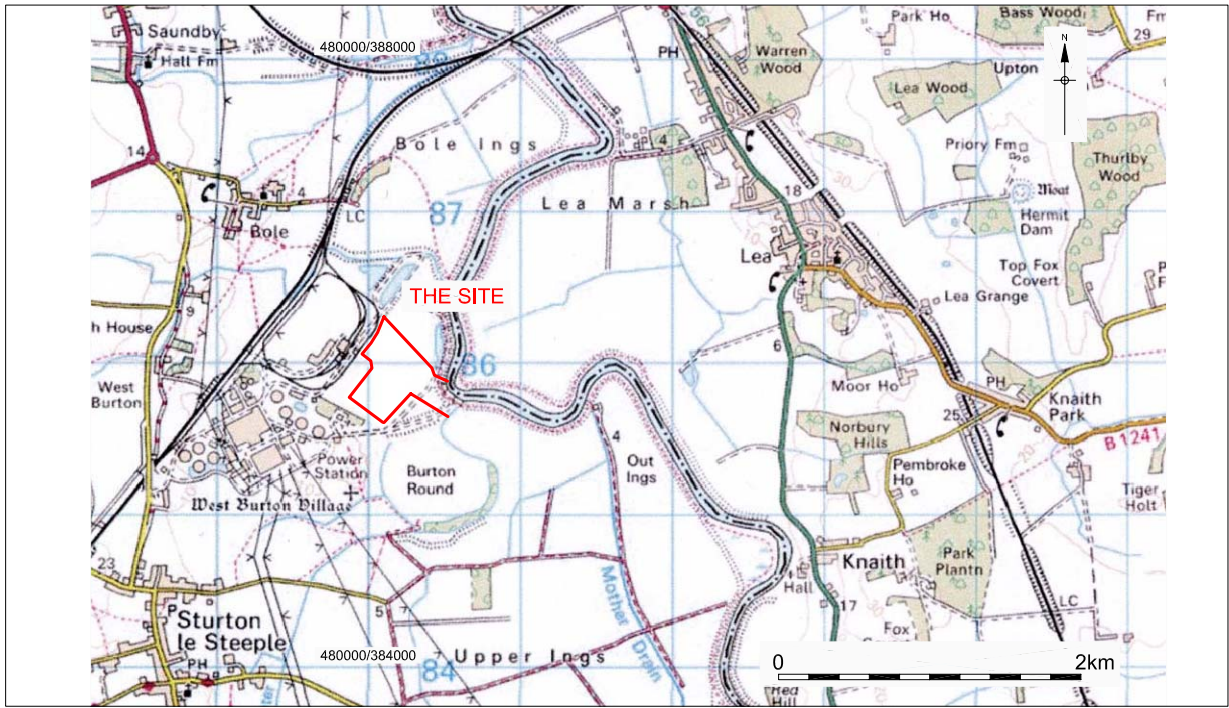


Figure 1a. Site location
Scale 1:50,000

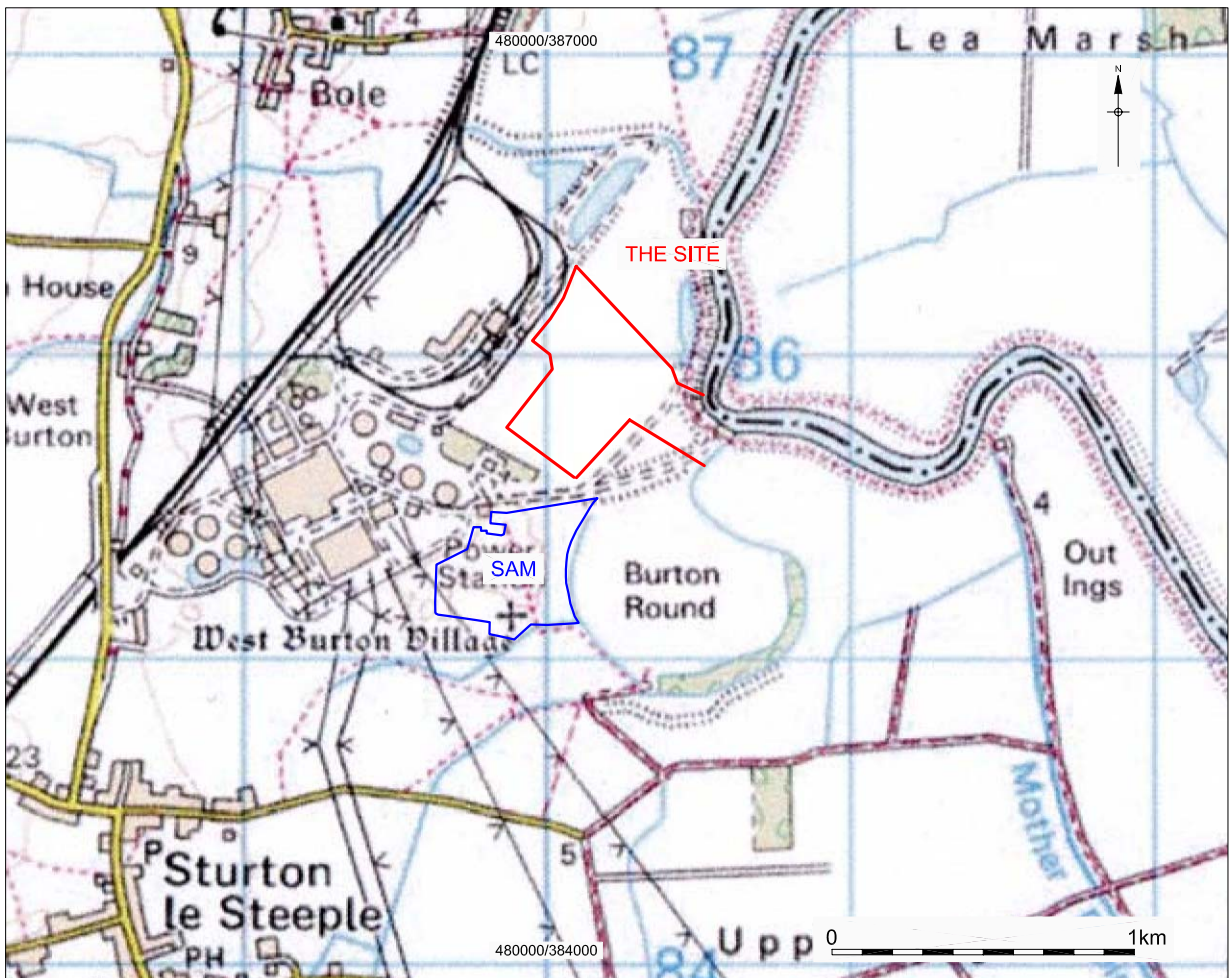


Figure 1b. Site location with SAM boundary
Scale 1:25,000

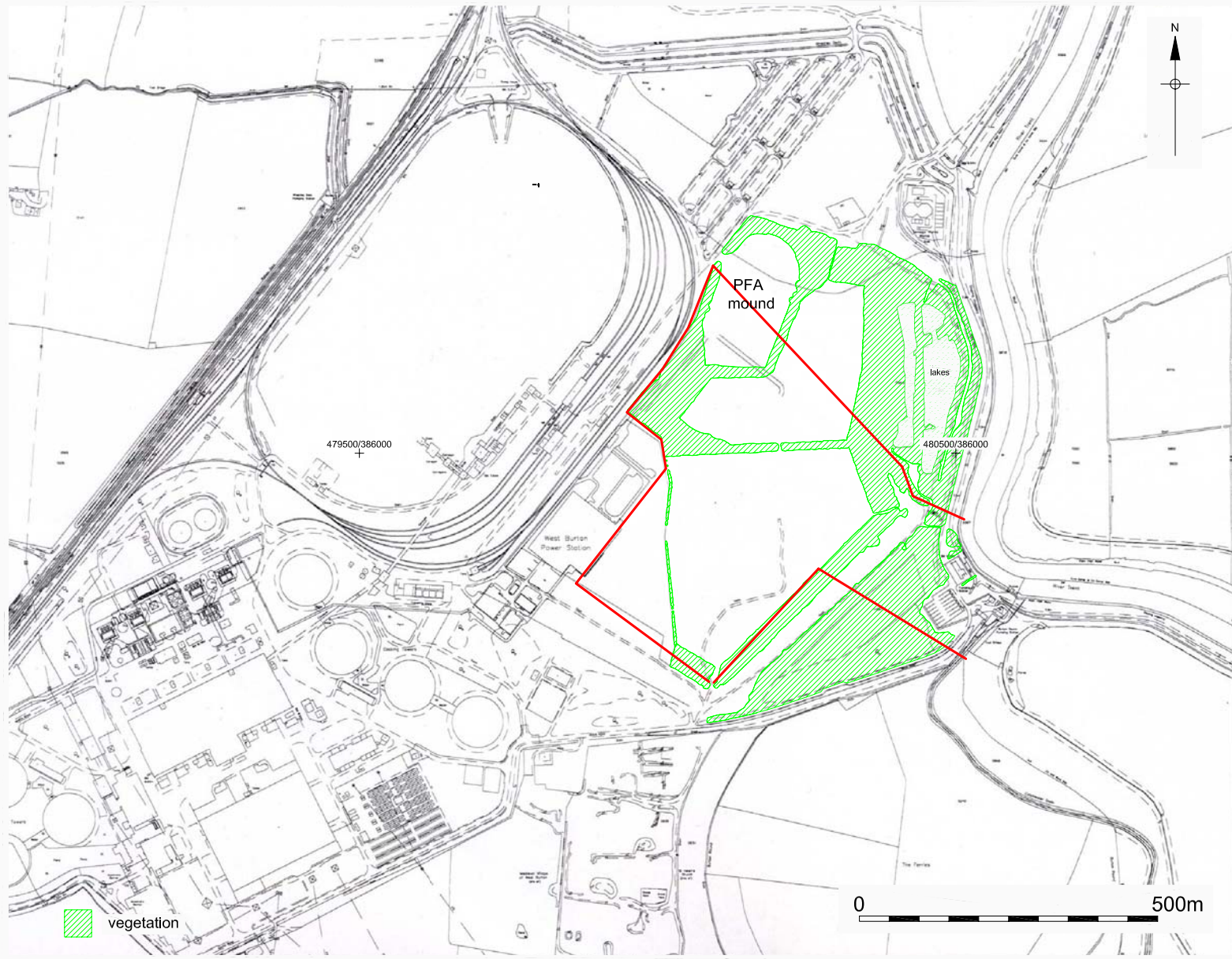


Figure 2. Site detail
Scale 1:10,000

- 2.2.2 The power station has an overall area of more than 160 hectares. The site under investigation lies within the easternmost portion of land within the curtilage of the power station, comprising an area of c. 19 hectares. It is an open area immediately to the north-east of the existing coal-burning plant, which was constructed in the 1960s. Its central National Grid Reference is SK 480200 385900 (Figures 1a and 2).
- 2.2.3 The site under investigation lies close to the west bank of a meandering stretch of the River Trent, with River Road skirting its eastern boundary. At this location, the Trent delineates the county boundary with Lincolnshire, with the market town of Gainsborough situated on the eastern side of the river. The overall power station site is situated within three parishes: Bole, Sturton le Steeple and West Burton.
- 2.2.4 Ground level across the site has been artificially raised due to extensive dumping of pulverised fuel ash (PFA) from the time West Burton Power Station started its full operation in 1969 through to the late 1980s. Previous geotechnical investigations have shown that there is probably a minimum cover of 4m of PFA across the site.³ Prior to the PFA dumping, the site was predominantly drained relatively low-lying agricultural land on the Trent floodplain; now there is an overall effect of mounding across the site.
- 2.2.5 The site comprises two main areas of open scrubland generally skirted by strips of recently planted broad-leaved woodland (Figure 3). Inside the north-western boundary is an open area overgrown with longer grass and bushes, with part of a large mound of exposed PFA occupying the northernmost corner of the site. The south-westernmost portion of the site is an overgrown triangular area, delineated to the east by a low hedgerow. There are artificial fishing lakes immediately to the north-east of the site, lying within a mixture of semi-natural and, again, recently planted woodland.

2.3 Geology and Topography

- 2.3.1 The sub-surface ground conditions and geology of the site are well characterised due to the aforementioned previous site investigations. In general, ground conditions encountered during these works have been consistent with the published geological literature. The geological sequence below the site is (from the surface down): Alluvium, River Terrace Gravels, Mercia Mudstone Bedrock, Sherwood Sandstone Group.
- 2.3.2 The Alluvium is associated with Wheatley Beck and the River Trent and comprises soft brown silty clay with lesser amounts of sandy silts. It is up to 9m in thickness, with the maximum thickness occurring immediately adjacent to the River Trent. The River Terrace Gravels comprise brownish red, medium to coarse sub-rounded gravels in sand, with occasional cobbles and mudstone fragments. There are occasional clay lenses and clayey/silty zones throughout. These gravels are up to 5-6m in thickness with the thickest deposits representing palaeochannels cut into the underlying Mercia Mudstone. Mercia Mudstone underlies the entire area within the Trent Valley and in this area outcrops in a general N-NW to S-SE direction, dipping eastwards in the vicinity of the site. Described as reddish brown mudstone with varying amounts of gypsum within joints and fractures, it is at least 250m-300m thick beneath the site.

³ For example, PB Power 2006 (report on fieldwork undertaken October 2005).

- 2.3.3 Lying on the floodplain of the River Trent, the site occupies naturally flat and relatively low-lying land at c. 7.0m AOD. Immediately to the south of the site is 'Burton Round', the remains of a dried-up oxbow lake formed by a meandering of the Trent (Figure 1b). The land enclosed by this feature is known as 'The Ferries'. To the north is another former oxbow lake, 'Bole Round', with an area known as 'Bole lngs' to the north of that. These features appear on the earliest editions of the Ordnance Survey in the second half of the 19th century. Wheatley Beck, to the north of the site, flows to in an easterly direction into the Trent, while the river itself is known to be tidal.
- 2.3.4 As previously mentioned, dumping of PFA is known to have raised the ground level across the site since c. 1969.⁴ Recent survey data shows that ground level now stands at c. 8.50m in the southernmost area, rising to c. 12m OD towards the centre, and then to c. 13.40m OD at the northern boundary of the site (Figure 3). A distinct mound of PFA within the extreme northernmost part of the site rises to in excess of 17m OD. Along the eastern boundary of the site, the edge of the PFA mound is clearly evident; at the north-eastern corner of the site, ground level falls from c. 11.50m inside the perimeter plantation to c. 7-8m OD to the east of that, then drops sharply to a level of c. 4-5m OD, along the base of a drainage ditch. To the east, River Road skirts the river, with its surface at a height of c. 7.40m OD.
- 2.3.5 At the time of writing there is no information available regarding possible ground contamination. Ongoing geotechnical and contaminated land studies should yield such information.

2.4 Planning Background

- 2.4.1 Government guidance set out in '*Planning Policy Guidance Note 16: Archaeology and Planning*' (PPG16) states that where nationally important archaeological remains, and their settings, are affected by development, whether scheduled or not, there should be a presumption in favour of their physical preservation. Councils are therefore always urged to implement policies for the protection, enhancement and preservation of sites of archaeological interest, with the prime objective being preservation of remains *in situ*.
- 2.4.2 The site proposed for the CCGT plant falls within the administrative areas of Nottinghamshire County Council (NCC) and Bassetlaw District Council (BDC). The '*Nottinghamshire and Nottingham Joint Structure Plan*' contains '*Policy 2/10*' relating to 'scheduled ancient monuments and other sites of archaeological interest'.
- 2.4.3 The archaeological and palaeoenvironmental potential of the proposed CCGT site was first demonstrated by the aforementioned DBA. The County Sites and Monuments Record (SMR) lists two scheduled monuments adjacent to the site, namely a 'medieval settlement and open field system immediately south-east of Low Farm' (National Monument Number (NM No.) 29915), formerly West Burton Deserted Medieval Village (DMV), and the associated site of 'St. Helen's church and graveyard' (NM No. 29915a). Although the site lies just to the north of these monuments, and beyond their boundaries, it certainly has potential for archaeological remains of the medieval period and, to a lesser extent, other archaeological eras.

⁴ A plan was provided showing the topography of the site prior to the construction of West Burton Power Station. Information from that plan has been added to Figure 3 to show the pre-power station ground level at specific locations.

- 2.4.4 The following conditions were placed on consent, given by the Department for Business Enterprise and Regulatory Reform under Section 36 of the 'Electricity Act 1989', for the construction and operation of the CCGT plant at West Burton:

“Condition (26): The commencement of the Development shall not take place until there has been submitted to, approved in writing by, and deposited with, the Council, a scheme of archaeological investigation and mitigation and an associated implementation programme. Thereafter the approved scheme shall be implemented in accordance with the approved implementation programme, unless otherwise agreed in writing by the Council.

Condition (27): The scheme approved pursuant to Condition (26) shall provide for:

(i) any person nominated by the Council to be permitted safe access to the part of the Site where the find is made;

(ii) finds of national importance to be evaluated and, where practicable, preserved in situ; and

(iii) phasing of works.

Condition (28): Any further investigations and recording of such finds as are considered necessary by the Council shall be undertaken prior to the construction of any part of the Development on that part of the Site where such finds are identified, and in the case of finds of national importance in accordance with the phasing of works approved pursuant to Condition (27)(iii), unless otherwise approved in writing by the Council.

Reason: To allow the surveying of the site for archaeological artefacts and the recovery of any important archaeological discovery before construction of the main Development begins.”

- 2.4.5 These conditions were imposed on the recommendation of the Senior Archaeological Officer (SAO) at Nottinghamshire County Council (NCC).

2.5 Archaeological and Historical Background

- 2.5.1 A thorough study of the archaeological and historical background to the site appears in the DBA prepared by PCA in 2005. That document should be consulted for full details, references and map regression, although a summary of the findings is included below.
- 2.5.2 There are 18 entries relating to archaeological sites or finds on the Nottinghamshire SMR located within c. 1.5km of the site. These monuments include: standing buildings, earthworks and two entries associated with the scheduled areas of West Burton medieval settlement and open field system and St. Helen's church and graveyard (NM Nos. 29915 and 29915a, respectively).⁵
- 2.5.3 The site lies within a river valley close to the River Trent, which has produced evidence for occupation and exploitation during the prehistoric period. There is no known evidence for prehistoric activity within the immediate vicinity, but similar areas in the region have produced evidence of Neolithic and Bronze Age occupation, principally settlement and farming. In addition, Bronze Age artefacts and canoes have previously been recovered from the Trent.

⁵ DCMS 1998.

- 2.5.4 Because of its relatively low-lying floodplain situation, there is evidence of attempts at drainage improvements in the wider area during the Roman period, with later improvements undertaken during the 17th and 19th centuries. The Roman settlement of Littleborough (*Segelocum*) lies only c. 4km to the south-east of the site, on the River Trent. The line of the Roman road, which linked Doncaster to Ermine Street and Lincoln, runs to the south of the site through the village of Sturton le Steeple. Roman field systems are preserved further west, near Retford.
- 2.5.5 Evidence for settlement and farming in the area during the medieval period is well preserved. The village of Bole (located c. 1km to the north-west) and the village of Sturton le Steeple (c. 2km to the south-west) represent evidence of continuous settlement and agricultural use of the area since the medieval period. Known features derived from the medieval landscape include these villages, as well as ridge and furrow earthworks that formed part of large open arable fields. The scheduled area of West Burton medieval settlement and open field system lies immediately to the south of the site. A series of earthworks represent the buried remains of a village that lay adjacent to the former west bank of the Trent. West Burton or 'Burtone' was first recorded in the Domesday Book of 1086 where it is documented as being owned by the Archbishop of York and Roger de Busli. A map of 1750 shows the village still in existence at that time, with 15 houses and church on the site, although by the early 19th century the settlement had practically disappeared. The surviving earthwork remains include hollow ways, building platforms for houses and barns and the associated scheduled area of St. Helen's church and graveyard.
- 2.5.6 During the compilation of the DBA, the earliest mapping available for the site was John Grundy's map of 1769. This demonstrates how the River Trent has changed course in recent centuries and the village of West Burton is represented by a church, presumably St. Helen's. The Ordnance Survey map sequence shows the rural nature of the study site and its environs, from the mid to late 19th century onwards, prior to the construction of the power station. Low Farm, to the south of the site and occupying part of the site of the DMV, and a Cheese House,⁶ within the north-eastern corner of the site (at NGR 480410 385920) are illustrated on the mapping from the 1st edition of the Ordnance Survey, although neither are named until the 1900 edition. St. Helen's church was largely demolished in 1895, although it appears in ruinous state on Ordnance Survey mapping until the 1947 edition.
- 2.5.7 As well as the archaeological potential of the site, there is also good potential for palaeoenvironmental material given its setting and particularly since the site is known to be underlain by a substantial depth of alluvium. Deposition of alluvium is often related to a change in the micro-environment, frequently as a result of human interference, for example, in prehistoric times, due to forest clearance for arable or pastoral farming. Such changes may be revealed by analysis of the data usually in the form of sediments, pollen, molluscs, micro and macrofossils. At sites in close proximity to active watercourses there are usually two types of sediments recorded: peat and alluvial silt. They are very different in character and the palaeoenvironmental information that they provide is similarly diverse.

⁶ A distinct structure where cheese would be stored whilst maturing, the equivalent of a granary for an arable farmer.

2.6 Aims and Objectives

- 2.6.1 In broad terms, the watching brief aimed to record archaeological information by monitoring a programme of geotechnical investigations, which involved a variety of intrusive techniques: Of particular importance were the exposures within a series of machine-excavated trial pits (TP07/01-10)
- 2.6.2 A previous geotechnical investigation in 2005 included eight machine-excavated trial pits (TP05/01-08, see Figures 3 and 4). One, TP05/04, located in the south-western part of the site, recorded a layer, interpreted as a buried topsoil, lying beneath PFA at 4.10m below ground level and overlying natural till. If correct, this suggests that PFA was dumped upon the existing ground surface without any prior stripping of topsoil. This would have preserved any archaeological remains *in situ* at the site, below the PFA, existing topsoil and any sub-soil(s). The remaining seven trial pits in 2005 failed to reach the base of the PFA, despite attaining depths of c. 4.50m at more than one location.
- 2.6.3 With similar additional information potentially available during the current geotechnical investigations, the work therefore offered an opportunity to map the pre-PFA ground surface at the site. Comparison of such a sub-surface model with the development and construction design could, therefore, allow the identification of areas where the development was more likely to impact on archaeological remains, for example, in areas where PFA was relatively shallow and deep foundations are proposed. Such areas could then be targeted for a subsequent archaeological evaluation. The proposed layout of the development is shown in Figure 4, although precise details of foundation types and depths are not available at the time of writing.
- 2.6.4 The potential of the various other geotechnical techniques for recovering significant archaeological data was uncertain. Therefore, the Nottinghamshire SAO requested that at least some archaeological monitoring was undertaken to establish whether data of potential archaeological significance was being adequately recorded as part of the geotechnical work and thus determine the extent to which archaeological monitoring of these techniques should continue.

3. ARCHAEOLOGICAL METHODOLOGY

3.1 Fieldwork

3.1.1 Fieldwork was undertaken in accordance with the relevant standard and guidance document of the Institute of Field Archaeologists (IFA).⁷ PCA is an IFA-Registered Organisation. A WSI for the archaeological investigation was prepared prior to its undertaking.

3.1.2 Geotechnical site investigations were being conducted using a variety of invasive techniques.⁸ The main works comprised:

- Pressuremeter Boreholing (PR), at 25 locations, to c. 30m depth, testing every 1m.
- Standard Penetration Tests (SPT), boreholing at 10 locations, to c. 30m depth, testing every 1m.
- Cone Penetration Tests (CPT), testing at 33 locations, pursued until refusal in the sub-stratum.
- Trial Pits (TP), machine-excavated at 10 locations, to c. 4m depth.

3.1.3 Part of the mandate of the watching brief was to conduct initial monitoring of all invasive geotechnical techniques in order to gauge the potential impact upon any archaeological or palaeoenvironmental deposits and, primarily, to assess whether or not information relevant to archaeological interpretation was being adequately recorded by the geotechnical work. This initial archaeological monitoring was carried out during three separate periods of site attendance; 5-7, 17-19 and 27-28 September 2007.

3.1.4 The main conclusion of initial archaeological monitoring of all techniques other than trial pitting was that the procedures being employed for recording geotechnical information would adequately record potential archaeological information of relevance. Therefore, it was concluded that extended archaeological monitoring was not required of the PR, SPT and CPT techniques.

3.1.5 Ten trial pits (until further notice referred to as TP01-12, without the addition of the 07 identifier) were excavated for geotechnical purposes by back-acting machine (Figures 3 and 4). These investigations were continuously monitored by the attendant archaeologist between 17-19 September. Two additional trial pits (TP/11 and TP/12) were excavated, using a 360° excavator acting under the direct supervision of the attendant archaeologist, in the vicinity of the former Cheese House. The main aim was to determine whether or not any sub-surface remains of this building survived, while at the same time assessing whether any such remains were at risk from the development, this being largely dependent on the depth of any overlying PFA. Details of all 12 trial pits are shown in Table 1 and their locations are shown on Figures 3 and 4.

⁷ IFA 2001.

⁸ Soil Mechanics 2007.

- 3.1.6 In addition to monitoring geotechnical operations, the attendant archaeologist inspected a number of other site activities. For example, the periphery of the site was being stripped of vegetation at the time of the work. Such activity caused disturbance only within existing modern topsoil, although PFA was observed below topsoil on occasion. It was concluded, therefore, that such work would be highly unlikely to disturb archaeological deposits. The adjacent site of West Burton DMV was also inspected, drawing the conclusion that the important archaeological remains at that site were under no threat from activities being conducted in association with preliminary elements of the programme of works for the proposed power station development.

3.2 Post-excavation

- 3.2.1 The written, drawn and photographic records represent the archaeological data recovered during the watching brief. Post-excavation work involved checking and collating site records. A written summary of the archaeological results was then compiled, as described below in Section 4.
- 3.2.2 No artefactual material was recovered during the work. Although organic material was noted in TP/02, no bulk samples for palaeoenvironmental analysis could be collected due to Health and Safety considerations.
- 3.2.3 The complete project archive, in this case comprising only written and drawn records (including all material generated electronically during post-excavation), will be packaged for long term curation. No material was recovered that required specialist stabilisation or an assessment of potential for conservation research. The depositional requirements of the appropriate receiving body will be met in full.

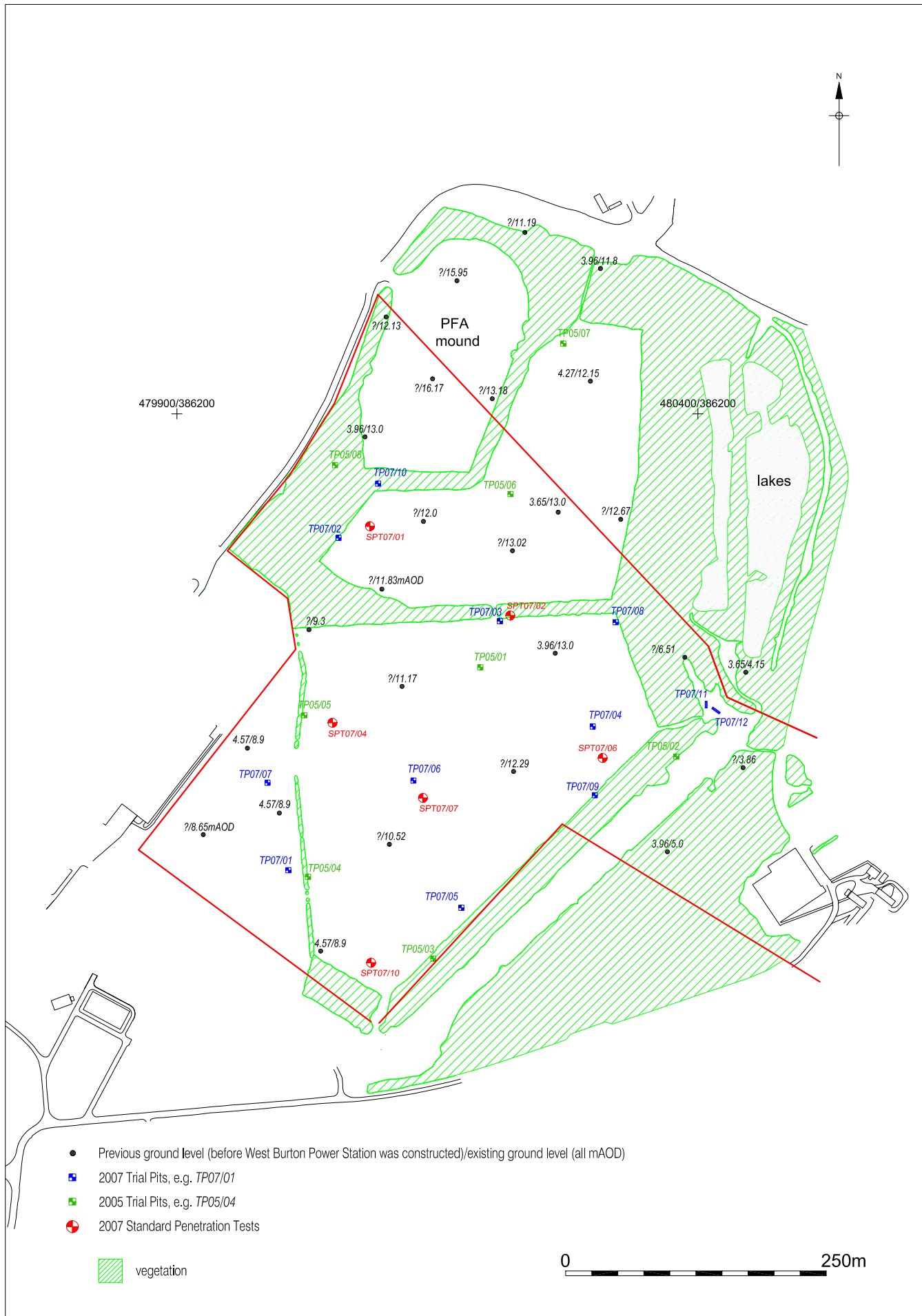


Figure 3. Location of TPs (2007 & 2008) and SPTs (2007) Scale 1:5,000

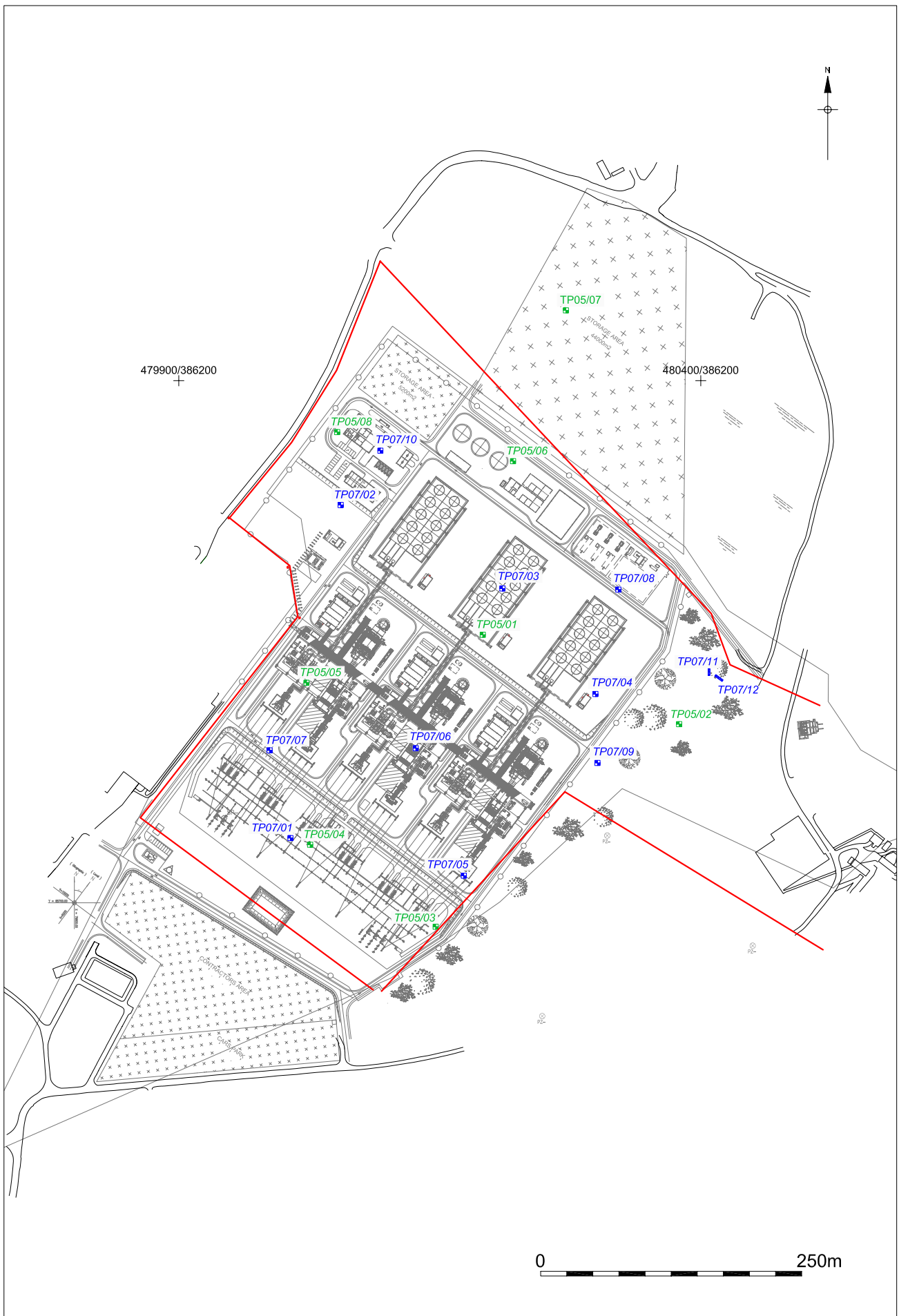


Figure 4. Proposed development and location of TPs (2007 & 2005)
Scale 1:5,000

4. ARCHAEOLOGICAL RESULTS

4.1 Phase 1: Natural

- 4.1.1 The earliest deposit recorded during the trial pitting was in TP12, where the basal deposit was a layer, TP12/08, comprising soft dark brownish grey silt, mottled with mid pinkish red clay. This material, evidently alluvial silt, was encountered at a depth of c. 1.85m below the ground surface but its thickness could not be established.
- 4.1.2 Some of the other geotechnical investigations continued to sufficient depth to record naturally derived material. The earliest stratum encountered was generally marl, typically overlain by sand or sand and gravel. Table 2 collates the results of trial pitting and Standard Penetration Tests (SPT) – by rotary open hole drilling - in order to establish the thickness of the PFA and identify underlying deposits in the vicinity of each of the trial pits.

4.2 Phase 2: Post-medieval/Modern?

- 4.2.1 Part of a possible linear feature, TP12/07, was recorded in TP12, cutting into the previously described alluvium, TP12/08. As revealed, the feature extended c. 2m in length, with part of what appeared to be its north-eastern side exposed, this running NW-SE. The excavated portion revealed a steep side, falling at c. 45-50°, which was c. 0.60m deep. Hand excavation ceased at the water table, although the base of the feature – which can be described as undulating – was evidently exposed at this depth. As exposed, the feature appeared to be at least c. 1.80m wide.
- 4.2.2 A single fill, TP12/06, was recorded for the putative linear feature. It comprised loose mid to dark grey ash mixed with medium to coarse gravel and with frequent small fragments of cinder/other vitrified material throughout. Some very small sherds of late post-medieval pottery - including bone china - were observed within this deposit, although they could not be recovered, and well-preserved organic material, comprising reed and/or grass as well as possible tree bark, was observed at the basal limit of excavation.
- 4.2.3 The function of feature TP12/07 is uncertain. However, given its location, it could conceivably represent the 'grubbed out' foundations of the Cheese House that TP12 was sited to locate, rather than being a linear feature, such as a ditch, related to land drainage or field demarcation. Its fill was dumped material, close in composition to the PFA assigned to Phase 3, which, therefore, possibly represents initial dumping of waste from the power station at the site. It may be reasonable to suggest that the demolition debris in one of the overlying dump layers, TP12/04, as described below, was derived from the former building.
- 4.2.4 The fill of feature TP12/07 was overlain by a similar ash and gravel deposit, TP12/05, up to 0.30m thick, which was in turn overlain by a layer, TP12/04, up to 0.10m thick, comprising firm mottled light and dark brown clay with frequent fragments of brick and occasional fine and medium sub-rounded gravel throughout. The fragmented bricks in this deposit were of late post-medieval, probably 19th century date. Deposits TP12/05 and TP12/04 could equally be assigned to Phase 3 and, therefore, could derive from the initial episode of dumping of PFA and other materials on the site.

4.3 Phase 3: Modern

- 4.3.1 PFA was encountered in all twelve trial pits, as shown in Table 1. At some locations more than one distinct layer (up to a maximum of four, in both TP05 and TP07) could be distinguished in the overall thickness of PFA, although all the material has been assigned to the same broad category.
- 4.3.2 PFA can be generally described as homogeneous light to mid grey fine-grained ash with a friable, becoming loose, consistency once excavated. However, generally *in situ*, and more noticeably at depths below 3.0m, it had a far more compact consistency, on occasion becoming resistant to machine excavation. Its cohesive strength was particularly demonstrated in both TP03 and TP10 at depths of 3.60m and 3.85m, respectively, where excavation had to be terminated due to the compaction of the PFA.
- 4.3.3 In TP01, TP07 and TP08, at depths greater than 3.0m, the PFA quickly saturated and liquefied when the water table was reached. This rendered further investigation at these locations impossible, due to Health and Safety considerations. The water table was also reached in TP12, at c. 2.40m below the ground surface.
- 4.3.4 The thickness of the PFA was only established in TP12, the easternmost of all the trial pits located in the eastern margin of the main mound of dumped fuel ash. However, as mentioned above, some of the other geotechnical investigations continued to sufficient depth to reach the lower interface of the PFA upon the main mound and record natural geological material. Table 2 collates the results of trial pitting and the SPT – by rotary open hole drilling - to give an indication of the thickness of the PFA in the vicinity of each of the trial pits.
- 4.3.5 Topsoil was recorded as the uppermost deposit wherever trial pitting was undertaken. It was categorised as a dump, rather than a naturally developed soil, since it must post-date the late 1980s, when PFA dumping ceased. Again, details are shown in Table 1.

TP No.	Co-ordinates		Dimensions (m)	Height agl (m AOD)	Max. depth (m)	Overall thickness (m)		Depth reached (m)		Comments
	E	N				Topsoil	PFA	Natural	Water Table	
TP07/01	480006.985	385761.991	3.60 x 0.70	8.78	4.00	0.30	3.70	Not reached	3.20	Three separate layers of PFA recorded
TP07/02	480055.066	386080.989	4.00 x 0.80	13.58	4.00	0.30	3.70	Not reached	Not reached	/
TP07/03	480210.012	386001.014	3.80 x 0.90	12.52	3.60	0.30	3.30	Not reached	Not reached	/
TP07/04	480299.079	385899.944	3.60 x 0.70	11.95	4.00	0.30	3.70	Not reached	Not reached	Clay lens recorded under topsoil
TP07/05	480172.984	385725.966	3.80 x 0.70	10.44	4.00	0.30	3.70	Not reached	Not reached	Four separate layers of PFA recorded
TP07/06	480126.982	385848.034	3.90 x 0.80	10.92	4.00	1.40	2.60	Not reached	Not reached	/
TP07/07	479987.008	385845.987	3.70 x 0.70	9.01	3.80	0.17	3.63	Not reached	3.10	Four separate layers of PFA recorded
TP07/08	480321.042	385999.969	3.60 x 0.80	13.28	3.80	0.68	3.12	Not reached	3.10	/
TP07/09	480301.037	385833.947	3.90 x 0.70	11.35	4.00	0.28	3.72	Not reached	Not reached	/
TP07/10	480093.089	386132.970	3.70 x 0.80	13.15	3.85	0.28	3.57	Not reached	Not reached	/
TP07/11	480407.967	385920.957	6.50 x 1.90	6.70	3.50	0.40	3.10	Not reached	Not reached	Two separate layers of PFA recorded
TP07/12	480417.127	385915.412	8.90 x 1.90	5.40	2.65	0.43	1.02	1.85	2.40	Two separate layers of PFA recorded; linear feature recorded, cut into natural alluvium
TP05/01	-	-	-	13.00	3.65	0.59	3.06	Not reached	Not reached	PFA cobbles recorded at lower depths
TP05/02	-	-	-	11.50	3.75	0.23	3.52	Not reached	Not reached	/
TP05/03	-	-	-	7.90	0.75	0.15	0.60	Not reached	Not reached	Abandoned due to service
TP05/04	-	-	-	11.25	4.55	0.70	3.40	4.55	Not reached	Topsoil incl. 0.15m of overlying 'made ground'; natural was plastic black till, underlying 0.45m of 'original topsoil'
TP05/05	-	-	-	10.50	4.55	0.35	3.65	Not reached	4.55	/
TP05/06	-	-	-	13.00	4.00	0.35	3.65	Not reached	Not reached	Topsoil incl. 0.15m of overlying 'made ground'
TP05/07	-	-	-	12.40	3.75	0.35	3.40	Not reached	Not reached	/
TP05/08	-	-	-	11.50	4.40	0.10	4.30	Not reached	Not reached	/
Notes										
<i>Heights (m AOD) at ground level are estimated for TP05/01-08, based on notes on topography in 2005 report</i>										

Table 1: Collated trial pitting data from 2005 and 2007

SPT No.	TP No.	Height agl (m AOD)	Max. depth (m)	Sequence (deposit thickness in m)						
-	TP07/01	8.78	4.00	Topsoil (0.30)	PFA (3.70+)					
-	TP07/05	10.44	4.00	Topsoil (0.30)	PFA (3.70+)					
SPT07/10	-	8.44	25.0	Ash (3.20)	Sand (0.80)	Brown & grey clay (2.30)	Sand (0.80)	Marl (4.90)		
-	TP07/02	13.58	4.00	Topsoil (0.30)	PFA (3.70+)					
-	TP07/10	13.15	3.85	Topsoil (0.28)	PFA (3.57+)					
SPT07/01	-	13.41	35.50	Soil & PFA (1.50)	PFA (10.0)	Ash & sand (1.0)	Sand (1.0)	Sand & gravel (2.0)	Sand & weathered marl (1.0)	Marl 4.0
-	TP07/03	12.52	3.60	Topsoil (0.30)	PFA (3.30+)					
-	TP07/08	13.28	3.80	Topsoil (0.68)	PFA (3.12+)					
SPT07/02	-	12.72	35.50	Soil & PFA (1.50)	PFA (9.0)	Ash & sand (1.0)	Sand (2.0)	Sand & gravel (1.0)	Sandy marl (1.0)	Marl (7.0)
-	TP07/04	11.95	4.00	Topsoil (0.30)	PFA (3.70+)					
-	TP07/09	11.35	4.00	Topsoil (0.28)	PFA (3.72+)					
SPT07/06	-	11.65	22.00	Ash (8.0)	Brown clay (4.0)	Sand (1.30)	Weak marl (1.70)	Strong marl (7.0)		
-	TP07/06	10.92	4.00	Topsoil (1.40)	PFA (2.60+)					
SPT07/07	-	11.32	22.00	PFA (8.0)	Brown sand (3.0)	Weak marl (1.0)	Marl (7.0)			
-	TP07/07	9.01	3.80	Topsoil (0.17)	PFA (3.63+)					
SPT07/04	-	9.98	22.00	PFA (6.0)	Ash (3.20)	Marl (2.80)	Weak marl (4.0)			
Notes										
<i>Trial Pits (TP) and Standard Penetration Tests (SPT) grouped by location (see Figure 3)</i>										
<i>Descriptions of deposits in SPT taken from borehole logs provided by Soil Mechanics</i>										

Table 2: Collated trial pitting and SPT (by rotary open hole drilling) data from 2007

5. CONCLUSIONS

- 5.1 All twelve trial pits, TP07/01-12 (the 05 and 07 identifiers – which distinguish the 2005 and 2007 geotechnical investigations - are used for clarity in this section), recorded modern topsoil overlying PFA. At eleven locations, the PFA had a minimum thickness of between 2.60m and 3.72m, but in none of these trial pits was the lower interface of the PFA reached. In the remaining location (TP07/12), PFA c. 1.0m thick was recorded, but this overlies other dumped material, some of potentially similar origin. The SPT undertaken as part of the geotechnical programme established that PFA was 8-10m thick across the more elevated portions of the site, decreasing in thickness towards the site margins, for example it was c. 3.0m thick towards the southernmost corner of the site.
- 5.2 No relic topsoil was encountered during the current programme of trial pitting. In the 2005 geotechnical work, TP05/04 recorded relic topsoil at a depth of 4.10m below ground level. It is worthy of note that TP05/04 reached a depth of 4.55m, while the maximum depth of excavation possible at any location in the current trial pitting investigation was 4.0m. TP07/01, located in the approximate vicinity of TP05/04 (Figure 3), did not extend to sufficient depth to penetrate the PFA. Scrutiny of the results of the other geotechnical investigations undertaken during the current work suggests that relic topsoil does not generally survive below the PFA. Therefore, while no definite conclusion can be drawn as to whether or not topsoil was stripped from the site prior to the dumping of PFA in the 1970s-1980s, the collated evidence indicates that relic topsoil is not generally present below PFA across the majority of the site.
- 5.3 At only a single location during the current programme of trial pitting was a natural deposit encountered, this being towards the eastern limit of the site, in TP07/12, where natural alluvial silt was exposed at a depth of 1.85m below ground level. In the 2005 geotechnical work, TP05/04 recorded the aforementioned relic topsoil overlying a layer of plastic black glacial till at a depth of 4.50m below ground level. It is perhaps again worthy of mention that the maximum depth of excavation possible at any location in the current investigation was 4.0m. Geological material was reached below the PFA in some of the other geotechnical investigations, for example the aforementioned SPT generally reached sand, or occasionally clay, overlying marl.
- 5.4 TP07/12 was sited specifically to locate sub-surface remains of the former Cheese House. While no *in situ* structural remains or associated features, such as 'robbed-out' foundation trenches, relating to the building were recorded, a putative linear feature was recorded. This may have been related to the grubbing out of the building's foundations, although this is not certain. The feature was filled with ashy material similar to PFA, perhaps suggesting that the feature dates to the time when PFA dumping initially commenced at the site, c. 1970. An overlying dump layer did contain 19th century brick rubble potentially derived from the building, although again this is not certain.

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