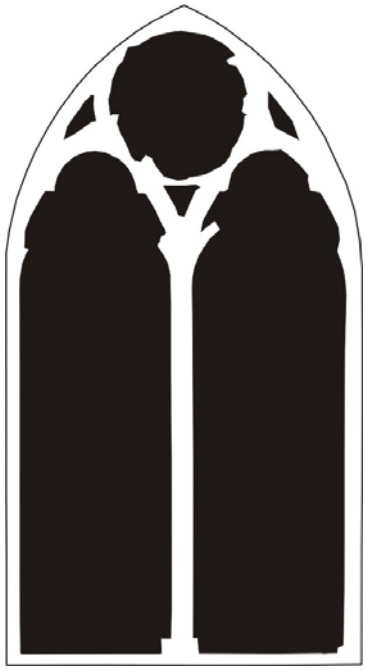
Netley Abbey
Topographic and Geophysical Survey Report
December 2005



SREP 13/2005

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Netley Abbey, Hampshire: Topographic and Geophysical Survey Report December 2005

Summary

This report documents the topographic and geophysical surveys carried out on the site of the Cistercian Abbey at Netley Abbey, Hampshire in April 2005. The ground plan of the surviving abbey buildings, as well as some of the building elevations were surveyed using total station survey instruments. Geophysical techniques were also used, namely resistivity, magnetometry and magnetic susceptibility.

The geophysical survey revealed features associated with the Mediaeval monastery, confirming discoveries made during excavations and clearances in the mid-19th century and revealed new structural evidence in the area between the main monastery buildings and the Abbot's Lodge to the east. These features are likely to be either garden features, associated with the tudor mansion or ancillary buildings of the medieval monastery.

1. Introduction

Between 4th and 15th April 2005 a geophysical and topographic survey was conducted at Netley Abbey in Hampshire by staff and students of the Department of Archaeology at the University of Southampton, on behalf of English Heritage. Work was initiated with the aim of producing a new survey of the abbey and its immediate environs, to facilitate a clearer understanding of the archaeological development and use of the site over the past 1000 years.

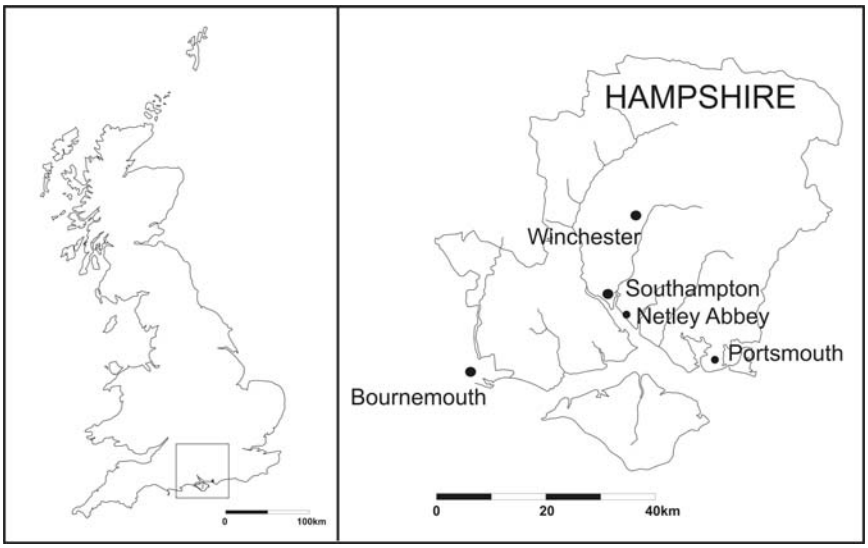

Figure 1 Location map of Netley Abbey, Hampshire

1.1 Location and Background

Netley Abbey is situated on the east side of Southampton Water (Fig. 1), close to the village of Netley. The abbey and its surroundings cover an area of some 2 ha, with the land on which the abbey is built situated in a slight hollow. The site is surrounded on the north and east sides by private gardens, to the west by the main Southampton to Netley road, and on the south by a ditch.

1.1.1 The Medieval Abbey

Netley Abbey, or more properly The Abbey of St. Mary Edwardstow was founded by Peter des Roches, Bishop of Winchester as a Cistercian house. Although he died in 1238 his executors were able to found the monastery in his name a year later in 1239 (Hare 1993, 207). The site at Netley was acquired in about 1240 and temporary accommodation as well as more permanent buildings were probably started in around 1241 (Hare 1993, 210). The Abbey church was probably started in around 1244 with additional (though by no means substantial) funds being provided by King Henry III, who also insisted on laying the foundation stone of the church (Hare 1993 208-210). Henry liked to style himself as the sole founder of the Abbey, despite the fact that his grants of land and money were rather less than generous.

Grants of lead and oak trees to the Abbey in 1251 and 1252 as well as a silver gilt processional cross in 1253 by the King make it likely that the church was being roofed during this period and that the building was probably in use as a church (Hare 1993, 210). All the major surviving parts of the monastery appear to have been completed very quickly, possibly within 50 years (Hare 1993, 211), none of the ancillary buildings providing storage, workshops or hospitality appear to have survived the conversion to a tudor mansion. The whole site was enclosed by a large bank and ditch (Figure 5) and would have contained other buildings as well the fish ponds which survive to the east of the site. The abbey was always poorly endowed and suffered as a consequence, in 1536 there were only seven monks and its annual income was assessed as £100 12s 8d making it amongst the poorest Cistercian houses in England (Hare 1993, 212). As a result of this valuation Netley was included in the first raft of Henry VIII's dissolution of lesser houses with an annual income of less than £200 and it was shut down in 1536 (Hare 1993, 216; Thompson 1952, 4).

1.1.2 The Tudor Mansion

Henry granted the abbey to Sir William Paulet, later Marquis of Winchester, who set about converting the buildings into a mansion suitable for a high ranking member of the aristocracy. The church was converted into a hall and kitchen by the addition of internal brick walls and the dismantling of the north transept, whilst the east end of the choir was kept as a chapel (Hare 1993, 217-218). The main frontage of the

mansion was the south side of the cloister. The refectory was demolished and a turreted façade with a central arched entrance constructed. The cloister walks were removed and the square space converted into a courtyard with a central fountain. A private garden was laid out between the main buildings and the Abbott's lodge to the east.

The house passed to Edward Seymour, the Earl of Hertford (1537-1621) who entertained Elizabeth I there in 1560. Seymour died at Netley in 1621.The house remained in use through most of the seventeenth century and in 1665 the Hearth Tax returns show it was one of the largest houses in Hampshire. In 1660 the Earls of Hertford were re-instated as the Dukes of Somerset. After the death of Frances Devereux, Duchess of Somerset in 1674 the abbey was sold in 1676 and sometime after this went out of use. A description of 1719 records demolition of parts of the church in 1704 and stonework from the abbey was used in restoration of St Mary's church in Southampton in 1710-11 and again in 1722-23 (Hare 1993).

Figure 2 *Netley Abbey from the south east in 1786*

1.1.3 Archaeological Background

By the nineteenth century the ruins had passed to the Chamberlayne family and had become very overgrown and were suffering severe losses of stonework to looters. In 1860 Thomas Chamberlayne cleared rubbish and stonework from the site in order to build a sea wall along Southampton water (Kell 1863, 65). A lot of the later partitions inserted for the Tudor mansion were removed, trees and undergrowth cleared and

most of the rooms cleared of material to their original floor levels. The site was also made secure from looters by the provision of lodgings for a porter in the south range of the Tudor mansion.

Chamberlayne allowed the clearances to be observed and further excavations to be carried out by the Reverends Edmund Kell and J.A. Addison (Kell 1863, 66, 70). As a result of their excavations and observations most of the main buildings could be located with a certain amount of confidence. Their most important discovery was the site of the medieval refectory which had been demolished at the time of the dissolution, in order to allow the building of the south range of the mansion to be seen today (Kell 1863, 87). As was usual in Cistercian Abbeys it was located on the south side of the cloister and set perpendicularly to it. They also located the foundations of a building about 36 metres south west of the refectory, which they called the infirmary (Kell 1863, 87). This places the building under the current car park and key holders lodge.

Figure 3 The entrance to the Abbey as it appeared in the second half of the nineteenth century. The building with the mullioned windows and chimney on the left is part of the main south range of the Tudor mansion and at this time had been converted for use as a porter's lodge. The path curved round to the entrance through the tudor arched entrance where a turnstile gave access to the cloister area The trees, path and luxuriant undergrowth have now all been removed as have the chimney and

roof of the porter's lodge. Photograph taken by Henry Taunt in 1893 English Heritage NMR Ref. CC56/00866.

Further excavations were undertaken in 1893 by Henry Taunt, the Oxford photographer and antiquarian (Jones & Taunt 1899, Taunt 1907). He seems to have been unaware of Kell's excavations 30 years earlier, as he claims to have been the first to excavate and find the foundations of the refectory (Jones & Taunt 1899, 26). Despite this lapse Taunt's excavations are useful because of the pictorial record he left of his work and the state of the Abbey buildings at the end of the 19th century (see Figures 3 and 4). Taunt did make the interesting observation that he thought there were traces of buildings in the garden area between the main monastery buildings and the Abbott's Lodge and that he thought excavation of this area would yield interesting information (Jones & Taunt 1899, 44).

Netley's location on one of the gravel terraces has meant a number of Palaeolithic axes have been found in the area and in 1867, during the construction of Netley hospital, a Roman coin hoard of the late 3rd century AD was found (ADS).

The site passed into state ownership in 1922 and became the responsibility of the Ministry of Works and shortly after this in 1923-1924 the whole site was re-surveyed by the Ordnance Survey, including elevations of the main walls (NA: WORK 31/1515-1518).

Figure 4 *Excavations at Netley Abbey carried out by Henry Taunt in the summer of 1893. The trench contains one the walls of the original Refectory, looking north. In the background can be seen the south range of the Tudor mansion, part of which was used as the porter's lodge at this time. The entrance arch through to the cloister can just be seen behind and to the right of the tree in the centre. All the trees, undergrowth and fences have now been removed (See also Figure 3) English Heritage NMR Ref. CC56/00906.*

During the mid to late 1990's the area to the east of the Abbey, around the medieval fish ponds, was developed for residential purposes. As a result of advice from the County Archaeological Officer for Hampshire that archaeological remains may be disturbed a number of desk based assessments, watching briefs and excavations were carried out (ADS) and in 1999 ground works for a new house were monitored and a section of the precinct moat was revealed (Anon. 1999).

2. Methodology

2.1 Survey Method

For the survey at Netley Abbey, total stations were used to record the topography of the abbey surroundings and a detailed building survey of the abbey in plan. In addition, two forms of geophysical prospection techniques were applied, resistivity and Magnetometry, to record evidence of buried structural remains. Magnetometer survey was chosen as a relatively time-saving and efficient survey technique (Gaffney *et al.* 1991, 6), suitable for detecting kilns, hearths, ovens and ditches, but also walls, especially those constructed from brick (Geoscan Research 1996a; Scollar *et al.* 1990, 362ff). Resistance survey was chosen as the primary technique for locating larger stone and brick foundations, walls and pits or ditches, and as a technique that had already been used successfully at a number of abbey sites in the region (Clark and Sly 1998; Edmonds, Sly and Strutt 2002; Strutt 2004).

A multiplexed Resistivity survey was also conducted in the nave, chancel and transepts of the abbey church, together with a magnetic susceptibility survey of the site. Although Magnetometry and magnetic susceptibility were carried out, the results did not record any features of note and are not presented here.

2.2 Survey Strategy

For the survey, grids of 30m by 30m were set out using a Leica TC 600 series total station. The survey grid was located on a north-south axis, with transects running in a west-east direction. The magnetometer survey was conducted using a Geoscan Research FM36 Fluxgate Gradiometer. Readings were taken on 1m traverses, at 0.5m intervals (see Appendix 1). The resistivity survey was carried out using a Geoscan Research RM15 Resistance Meter. Readings were taken at 1m intervals along 1m traverses. To optimise the integration of the different sets of results, the same survey grids were utilised for each method, and recording was initiated in the same direction for magnetometry and resistivity.

The survey data were processed using Geoplot 3.0 software. The processing of data was necessary to remove any effects produced by changes in the earth's magnetic field during the course of survey, and to minimise any interference in the data from surface scatters of modern ferrous material and ceramics. Magnetometer data were despiked to remove any large peaks or 'spikes' from the data produced by material on the surface of the field. A mean traverse function was then applied to average out any changes in the data produced by the 'drift' in the earth's magnetic field. Filters were subsequently applied to smooth out any high frequency, small disturbances in the data. Finally 0.5m values were interpolated from the existing readings to improve the spatial resolution of the results across the traverse lines.

Resistivity data were despiked to remove any high resistance peaks from the data. Grids were then edge-matched to ensure uniformity of data across the survey area. High and low pass filters were also applied to counter any effect from changes in the geology and from responses to small shallow features. Finally 0.5m values were interpolated from the existing readings to improve the spatial resolution of the results.

The TCR 600 total stations were also used to record the changes in topography at the site. Measurements were taken at 4-5m intervals across the site, and at points were changes in the topography were present. These measurements were downloaded into Liscad software, and a topographic model was produced.

A detailed plan of the extant buildings was also conducted using the total stations. Measurements were taken along the line of the walls of the structure using a red laser, and a plan was then reproduced from the measurements in Liscad.

3. Survey Results

3.1 The Topographic and Building Survey

The topography of the site at Netley Abbey shows evidence both of buried archaeological remains dating to the medieval history of the abbey and its use as a manor house, and signs of the re-landscaping of gardens linked to the manor in the 16th century (Fig. 5). The site is approached by a modern entrance to the south-west, where the ground slopes gently upwards **(A)**, then levels out in an area **(B)** measuring some 90m by 30m. The ground along the southern edge of this area slopes steeply **(C)** into a ditch that marks the boundary of the site. To the north, the ground slopes up **(D)** towards the abbey, and the ground shows some signs of buried structures in this area (see the resistivity below). The remains of the abbey are entered by a doorway **(E)**. This gives access to two rooms along the southern side of the cloister, the kitchen **(F)** to the left, measuring 12m by 8m, and the warming room **(G)** measuring 12m by 6m.

Beyond this is the abbey cloister **(H)** which measures 32m by 34m. In the centre of the cloister there is a small knoll **(I)** standing 0.5m higher than the surrounding ground, showing the possible location of a fountain. The abbey church is situated along the north side of the cloister, with the north wall of the cloister forming one side of the nave **(J)**. The walls of the nave measure 35m in length, and are subdivided by pillars into seven sections. A window in the fifth section looks out across the cloister. An entrance to the church is located at the west end of the church. The crossing of the church **(K)** is marked by the footings of four massive pillars, each measuring over 2.4m across. The chancel to the east **(L)** measures 19m from east to west and 16m from north to south, and is overlooked by an impressive arched window in the east wall. The remains of the south transept are extant to the south **(M)** with the remnants of two side chapels. However, the walls of the north transept **(N)** have been removed, and a slight slope in the modern topography is the only evidence for the location of the transept.

The remains of a structure are visible to the outside of the church **(O)**, measuring 7.6m across. The buildings to the south of the church, along the east side of the cloister comprise the library and sacristy **(P)**, then the chapter house **(Q)**, which measures 11m by 10m, and the parlour **(R)** measuring 7.6m by 3m. Beyond this are situated the day room **(S)** and the possible misericord **(T)**, then the buttery **(U)**, and running to the east the reredorter or infirmary. Outside of the infirmary is located the garden terrace of the Tudor manor house. The ground rises **(W)** to form a terrace aligned on the east gable of the infirmary. Above this there lies a level area of lawn **(X)** measuring 40m by 50m, part of the garden of the manor. To the east of this stands the Abbott's House **(Y)**, a structure consisting of three rooms, including a large store to the west. The northern edge of the garden **(X)** is marked by a second slope **(Z)** leading up to the area to the east of the church **(A')** and the possible location of the cemetery. The ground to the north of the cemetery slopes steeply upwards to the edge of the site **(B')**. A narrow strip of ground is located to the west of the abbey ruins

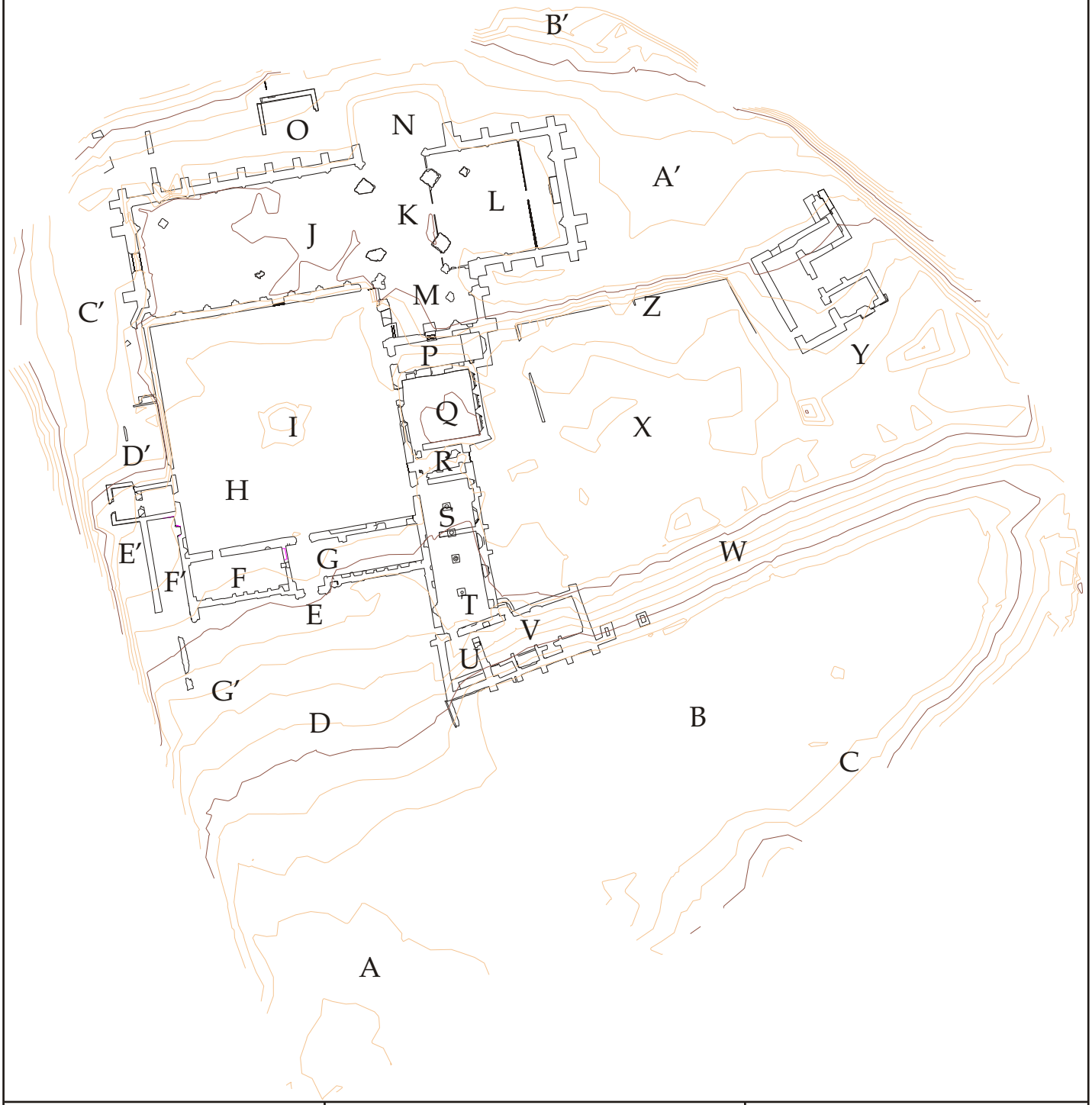

Fig. 5 The modern topography of Netley Abbey and its immediate surroundings, showing the results of the topographic survey in 2005

N

0 60m

Netley Abbey
Hampshire

(C'), measuring 30m across at its widest, and sloping gently down towards the site entrance. The ruins of a number of structures are present here, including a low wall **(D')** to the west of the cloister, two small chambers of brick and stone **(E')**, and a long room **(F')** measuring 20m by 5m to the west of the abbey kitchen. A solitary low ruined wall **(G')** is visible on the ground to the south.

3.2 The Resistivity Survey

Results of the resistivity survey at Netley Abbey were particularly striking (Figs 6 and 7), illustrating the full extent of the monastic complex. The area to the south of the extant remains was void of any substantial features **[r1]**. A number of high resistance maculae are located to the east on the lower terrace, and although they are somewhat unclear, they suggest that some structures may have been located on the lower terrace. They consist of a faint linear feature and two maculae **[r2]** situated on the slope of the terrace, together with a faint rectilinear feature **[r3]** measuring 12m across. Several other irregular maculae are located here **[r4]** with two other linear features. Close to the modern boundary of the site two linear anomalies **[r5]** show the potential presence of a structure. To the north of the site entrance a high resistance rectilinear feature **[r6]** is situated to the south of the kitchen and warming room. This measures 30m by 12m and indicates the extent of the refectory building of the abbey. This structure encloses an area **[r7]** measuring 30m by 17m immediately to the south of the warming room.

The wall of the cloister garth is visible in the results as a high resistance linear feature located inside the extant remains of the cloister. The wall follows the south side of the cloister **[r8]** for 35m, then turns to the north **[r9]**. The north-west corner is undiscernable, and may mark a break in the line of the structure. The feature continues along the north side of the cloister **[r10]**, and then returns to the south. A large high resistance macula is situated in the centre of the cloister garth **[r11]**, measuring some 5m in diameter, marking the location of a fountain, with a second macula located immediately to the south.

A number of rectilinear features are located within the extant walls of the abbey church. They consist of a large room **[r12]** measuring 25m by 10m, followed by a second similar chamber sub-divided into two parts **[r13]** and **[r14]**. A small chamber is located in the crossing of the church **[r15]**, and another room is located to the east **[r16]** measuring 15m by 10m. The remains of the foundations for the north transept and chapel can be seen in the results **[r17]** and **[r18]**.

An extensive part of the monastic complex has been mapped in the resistivity to the east of the possible misericord and infirmary. The features are arranged around an open area **[r19]** measuring over 40m by 20m. To the north there are two rectilinear features **[r20]** and **[r21]**, each measuring 15m by 10m. A similar feature **[r22]** is located along the east side of **[r19]**, and a larger chamber is situated to the south **[r23]**, aligned on the extant walls of the infirmary. A small structure is located between the abbey and Abbott's House, of rectilinear form, and consisting of two

Fig. 6 Greyscale image of the resistivity survey results from Netley Abbey

N

0 60m

Netley Abbey
Hampshire

Fig. 7 Interpretation plan of the resistivity survey results from Netley Abbey

N

0 60m

Netley Abbey
Hampshire

rooms **[r24]** and **[r25]**. It is aligned with the Abbott's House, and may be part of the medieval abbey. A number of small maculae are located to the north **[r26]** under the manor garden. A high resistance linear anomaly **[r27]**, measuring 50m in length probably marks a wall associated with the garden. A second linear feature **[r28]** may mark a second wall linked to the garden, or may in fact be a boundary to the cemetery to the east end of the church. Two other linear anomalies **[r29]** and **[r30]** may also be associated with the cemetery.

A series of small rooms are located off the northern extant wall of the church. They comprise three chambers, the first **[r31]** measuring 10m by 15m, the second **[r32]** 17m by 12m, and the third **[r33]** 8m by 10m. All are related to the Tudor manor. Evidence of a similar room can be seen to the west of the church entrance **[r34]**, together with evidence of a small wall to the south **[r35]** linked to the manor, and other potential outbuildings to the west of the refectory **[r36]**.

3.3 The Multiplexed Resistivity Survey

Multiplexed Resistivity survey was conducted in the interior of the church, and in the cloister. Preliminary results from the church interior (Fig. 9) indicate the substantial nature of the building foundations located within the church, probably relating to the plan of the Tudor manor house. In addition two large high resistance maculae were picked up in the crossing of the church, and in the middle of the north transept.

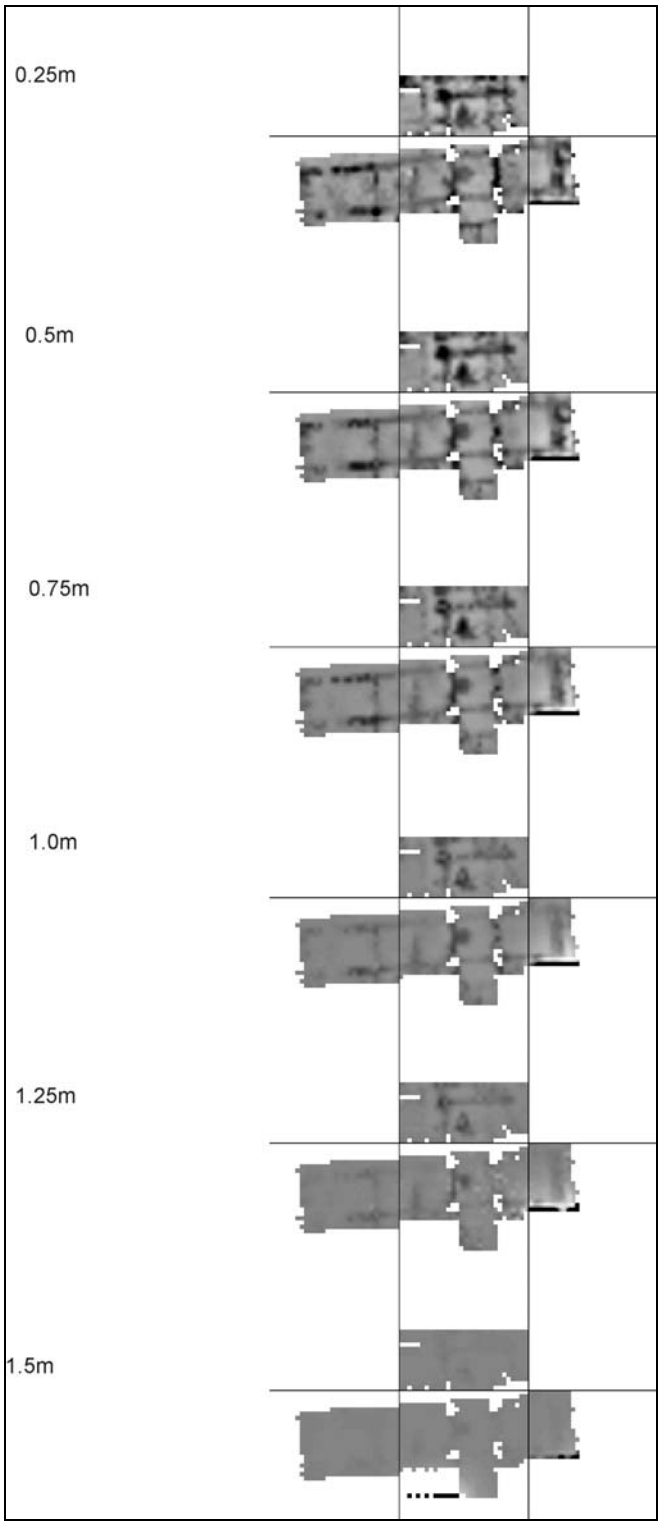

Figure 8 *Greyscale images of the multiplexed resistivity results from the church interior*

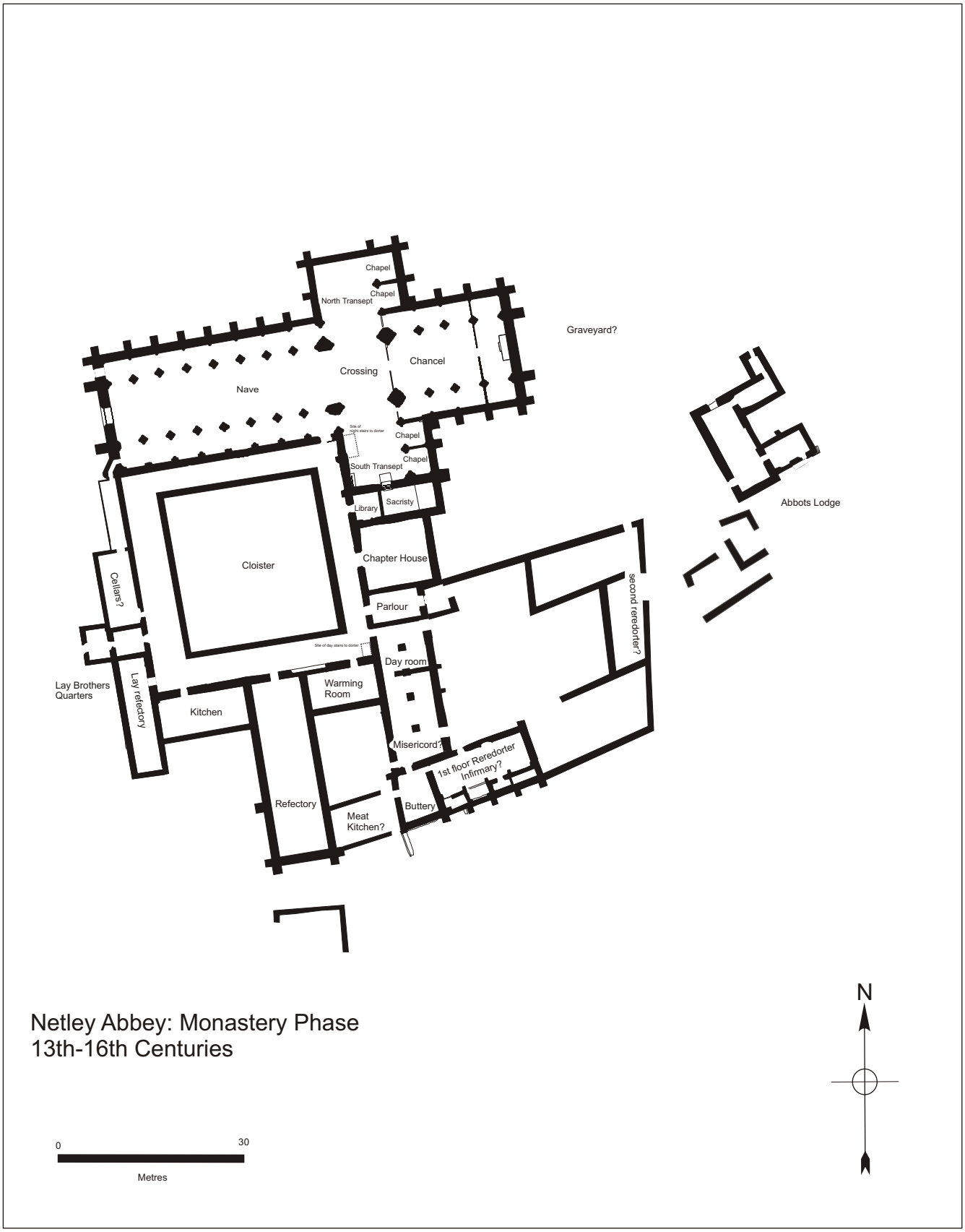

Fig. 9 Phase plan of the medieval abbey

4. Discussion

The resistivity survey has confirmed the findings of previous excavations on the site and raised interesting questions about previously unknown structures of both the medieval abbey phase and the Tudor Mansion phase.

The position of the refectory was confirmed to the south of the cloister but the most interesting results were to the east of the main claustral buildings in the Tudor garden area. The results here could be interpreted in a number of ways. The high resistance marks could be the result of garden features of the Tudor Mansion period.

They could be the remains of an infirmary complex, a feature that was common to a number of Cistercian abbeys such as those at Byland, Kirkstall and Roche, all of which have infirmary complexes to the southeast of the main monastic buildings (Figure 10).

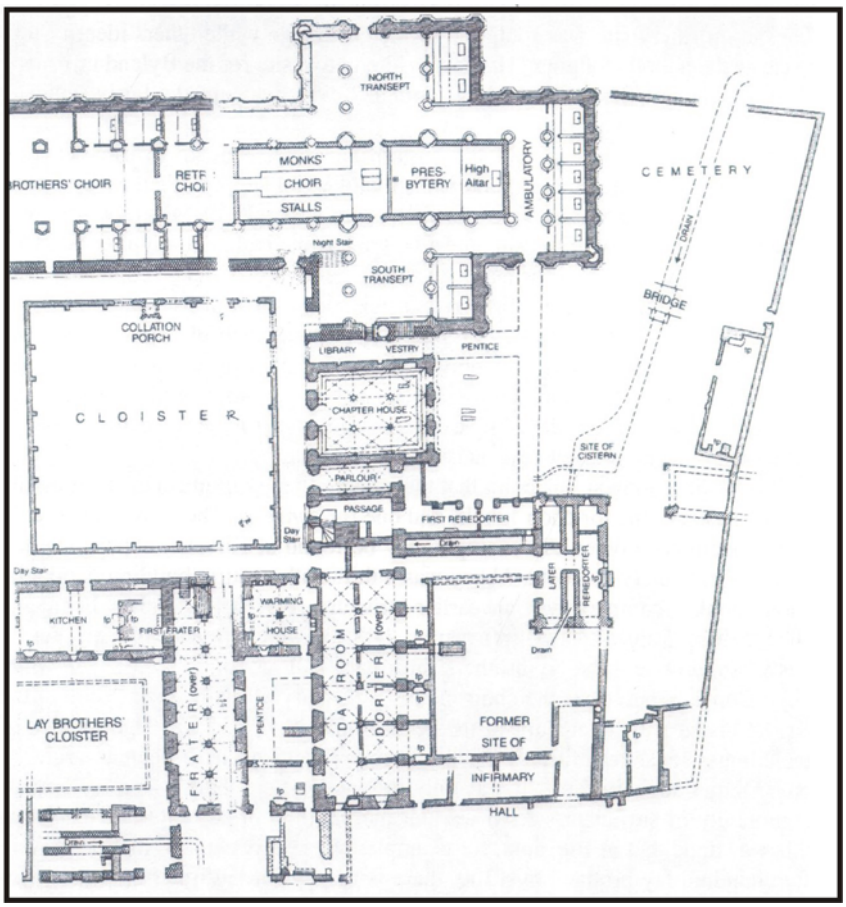

Figure 10 Byland Abbey, showing the infirmary complex to the south-east of the main monastic buildings (from Cassidy-Welsh 2001)

These infirmary complexes were part of a wider phenomenon of infirmary building, especially in Yorkshire, at Cistercian abbeys in the 13th century (Cassidy-Welch 2001,

133). Given this programme of infirmary building in the thirteenth century it would seem likely that as a thirteenth century foundation Netley would have had a similar complex of buildings. Given the preference to locate this complex to the east of the main monastic building at sites such as Roche, Byland and Kirkstall and the lack of any geographical or topographical impediment to such a range at Netley, it would appear to be reasonable to suppose that the geophysical anomalies in the area of the Tudor garden could, in part at least, represent such a complex (Fig. 9). Such an arrangement would also bring the Abbot's Lodge back as an integral part of the abbey complex, rather than its current, rather peripheral location. The complete destruction of such a complex would not be unusual as most of the infirmary buildings at Roche and Byland have also now gone (Cassidy-Welch 2001, 134-135). In fact the situation at Byland is very interesting because it provides a close parallel to the problems of identifying building function at Netley. The loss of many of the buildings at Byland has led to continuing argument about the precise function and location of structures in the south-east area of the site most particularly where the Abbot's Lodge was located (Cassidy-Welch 2001, 136-137), a situation and state of affairs closely mirrored at Netley.

Where these infirmary complexes do exist they usually contain a standard set of buildings including an infirmary hall, infirmarer's lodgings, cellar, chapel and sometimes a separate cloister. Bell (1998, 211-238) argues that the eastern site for Cistercian infirmaries was dictated by the need for water supply, which in most cases, including Netley, ran to the south of the site (Cassidy-Welch 2001, 137). In some cases a separate infirmary hall was provided for the lay brothers, usually at some distance from the monk's infirmary. There appears to have been no hard and fast rule for the provision of such a building, for example at Rievaulx, with five hundred lay brothers, there was no separate lay infirmary (Cassidy-Welch 2001, 137). The possibility remains that one the buildings seen during excavations in the mid-nineteenth century to the south of the original refectory may be the lay infirmary for Netley (Kell 1863; Taunt 1907).

The changes that occurred to the complex after the dissolution of the monasteries, and the creation of a Tudor mansion around the shell of the abbey, are clearly represented in the geophysics and the extant structural remains. It is interesting to note the two 'wings' of the manor that were constructed around the church and rooms to the east of the cloister (Fig. 11). The rooms created in the church were probably the kitchen, great hall and, in the chancel of the church, the family chapel. The walls of the chapter house, parlour, day room and library were partly demolished to provide access to all via a gallery. The cloister was turned into a courtyard with central fountain. The refectory of the abbey was demolished and a monumental turreted façade was constructed to the south as the principal entrance to the house. The rooms situated to the north of the church are adjacent to the kitchen area, and probably represent either store rooms or servants quarters.

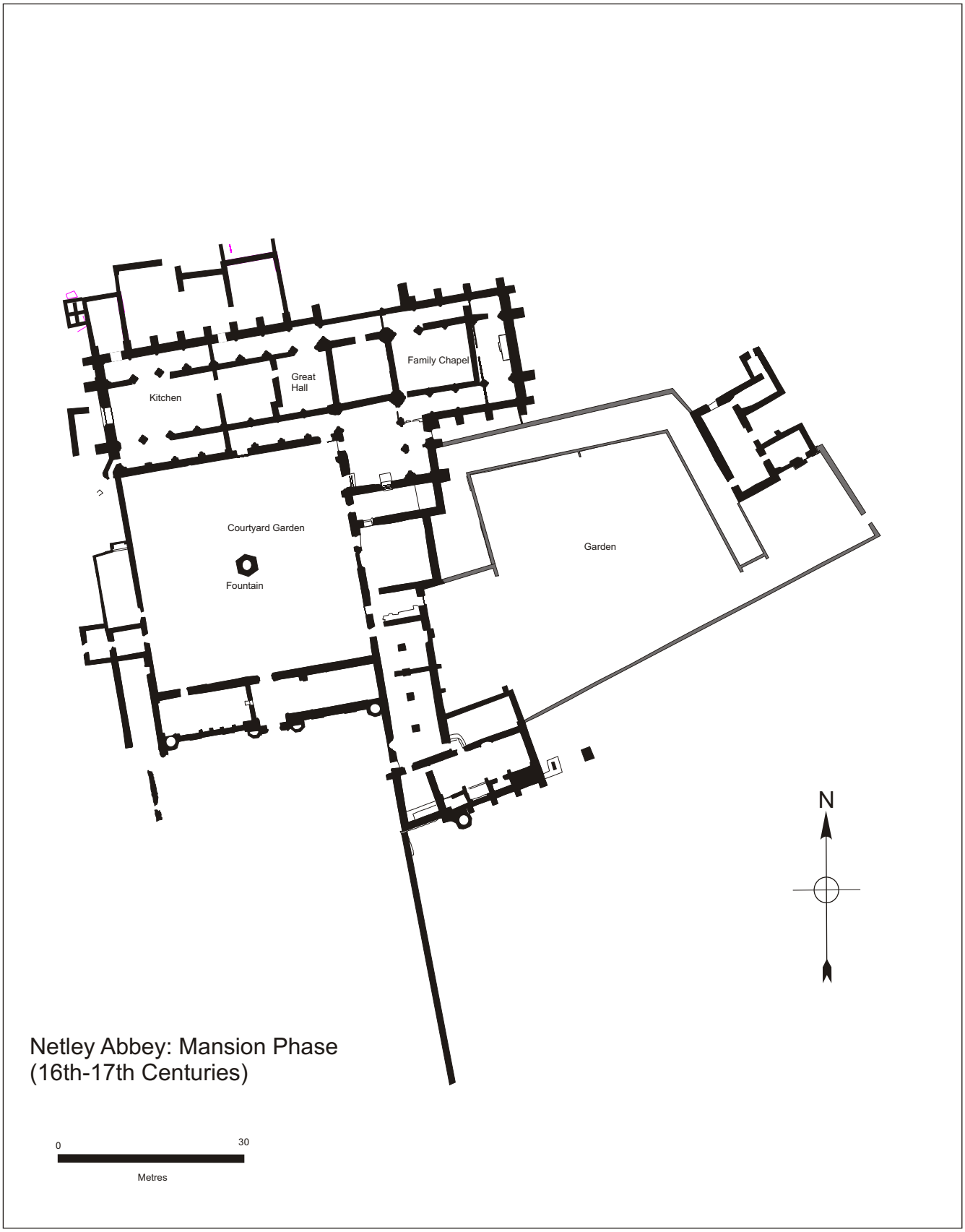

Fig. 11 Phase plan of the Tudor manor house

5. Conclusions

The results of the 2005 survey were successful in locating a number of features associated with the abbey and manor at Netley. The results show the extent and nature of the abbey as a whole, including the outer structures of the complex that are no longer standing, and the features located in the cloister and to the south of the kitchen. The remains of the manor house located within the shell of the medieval church are also represented in the survey results.

6. Recommendations

The topographic and geophysical survey work carried out at Netley Abbey in 2005 has raised some interesting questions about the nature of buried structures, particularly in the eastern and south-eastern areas of the site. A programme of further works to characterise these structures is set down as follows:

1. Limited test pitting/area excavation. The main area to concentrate on would be the terrace of the Tudor gardens to the east of the main Abbey buildings. Excavations here would seek to characterise the structures found in the resistivity survey and confirm them as either garden features and/or medieval ancillary buildings of the abbey. Further excavation would be needed on the lower terrace in the south-east area of the site to characterise the anomalies noted in this area in the resistivity survey.
2. Extension of the topographic and geophysical surveys to include open areas of the Abbey precinct e.g. the grounds of Netley Castle, the areas around the fishponds to the east of the site and the enclosure bank and ditch.
3. Full publication of the survey and excavation results.
4. Multiplexed resisitivity of the Tudor garden area to try and characterise the structures found in this area.

7. Statement of Indemnity

Whilst every effort has been made to ensure that interpretation of the survey presents an accurate indication of the nature of sub-surface remains, any conclusions derived from the results form an entirely subjective assessment of the data. Geophysical survey facilitates the collection of data relating to variations in the form and nature of the soil. This may only reveal certain archaeological features, and may not record all the material present.

Acknowledgements

The project was undertaken as part of the practical element of the 2nd year field survey course and 3rd year geophysics course of the Archaeology Department of the University of Southampton. Thanks are due to English Heritage for allowing and supporting the work, especially: Pam Braddock (Regional Curator for Hampshire & the Isle of Wight) whose initial idea and enthusiasm made the project possible; David Baines for granting the Section 42 licence consent for the survey work; Eileen and Alan Blondel (key holders at Netley Abbey) whose interest and support were greatly appreciated. Thanks also go to Professor David Hinton for his interest and support and for providing information for the background to the site.

The project was managed and directed in the field on behalf of the Department Of Archaeology, University of Southampton by Tim Sly, Dominic Barker and Kris Strutt and supervised in the field by James Cole.

The directors also wish to thank the following students, whose hard work and good humour contributed greatly to a very successful and enjoyable project; Max Allison-Wright, Kayt Armstrong, Rachel Dare-Edwards, Ian Denty, John Diffey, Matthew Easton, Lorna Graham, Joe Hine, James Howe, Jody Joy, Steve Kemp, Aimee Kleinman, William Leabeater, Sandra Lofano, Kate Longcliffe, Vikki Nisbett, Matt O'Neill, Eleftheria Paliou, Richard Potter, Katie Robbins, Chantelle Smith, Alex Soar, Stephen Surridge, Cerian Trevan , Elizabeth Wormer-Pando

Plate 1 Topographic survey within the south transept

Plate 2 Topographic survey in the day room

Appendix 1 Details of Survey Strategy

Date of Survey: 4th – 15th April 2005
Site: Netley Abbey
Region: Hampshire
Hampshire County Monument Number: 5
Grid Reference: SU 45 09
Surveyor: University of Southampton
Personnel: Dominic Barker, Tim Sly, Kristian Strutt
Geology: Tertiary Sands and Gravels

Survey Type 1: Topography
Approximate area: 2 hectares
Sample interval: 5m
Instrument: Leica TCR 600 total station

Survey Type 2: Resistivity
Approximate Area: 2 hectares
Grid size: 30m
Traverse Interval: 1m
Reading Interval: 1m
Instrument: Geoscan Research RM15
Resolution: 0.1 Ω
Probe Configuration: Twin electrode
Probe Separation: 0.5m

Survey Type 3: Magnetometer
Approximate Area: 1.5 hectares
Grid size: 30m
Traverse Interval: 1m
Reading Interval: 0.5m
Instrument: Geoscan Research FM36
Resolution: 0.1 nT
Trigger: Encoder

Appendix 2 - Archaeological Prospection Techniques Utilised by APSS

The following appendix presents a summary of prospection methods, implemented by Archaeological Prospection Services of Southampton (APSS) to determine the extent and nature of sub-surface archaeological structures, remains and features. The methodology usually applied by APSS places an emphasis on the integration of geophysical, geochemical and topographic survey to facilitate a deeper understanding of a particular site or landscape.

Geophysical Prospection

A number of different geophysical survey techniques can be applied by archaeologists to record the remains of sub-surface archaeological structures. Magnetometer survey is generally chosen as a relatively time-saving and efficient survey technique (Gaffney *et al*. 1991, 6), suitable for detecting kilns, hearths, ovens and ditches, but also walls, especially when ceramic material has been used in construction. In areas of modern disturbance, however, the technique is limited by distribution of modern ferrous material. Resistivity survey, while more time consuming is generally successful at locating walls, ditches, paved areas and banks, and the application of resistance tomography allows such features to be recorded at various depths. APSS also implement close contour topographic survey over areas of prospection, to record any important relic of archaeological features in the present topography, but also provide vital information on the changing ground surface for the geophysical prospection results. A summary of the survey techniques is provided below.

Resistivity Survey

Resistivity survey is based on the ability of sub-surface materials to conduct an electrical current passed through them. All materials will allow the passing of an electrical current through them to a greater or lesser extent. There are extreme cases of conductive and non-conductive material (Scollar et al 1990, 307), but differences in the structural and chemical make-up of soils mean that there are varying degrees of resistance to an electrical current (Clark 1996, 27).

The technique is based on the passing of an electrical current from probes into the earth to measure variations in resistance over a survey area. Resistance is measured in ohms (Ω), whereas resistivity, the resistance in a given volume of earth, is measured in ohm-metres (Ω/m).

Four probes are generally utilised for electrical profiling (Gaffney et al. 1991, 2), two current and two potential probes. Survey can be undertaken using a number of different probe arrays; twin probe, Wenner, Double-Dipole, Schlumberger and Square arrays.

The array used by APSS utilises a Geoscan Research RM15 Resistance Meter in twin electrode probe formation. This array represents the most popular configuration used in British archaeology (Clark 1996; Gaffney et al. 1991, 2), usually undertaken with a

0.5m separation between mobile probes. Details of survey methodology are dealt with elsewhere (Geoscan Research 1996).

A number of factors may affect interpretation of twin probe survey results, including the nature and depth of structures, soil type, terrain and localised climatic conditions. Response to non-archaeological features may lead to misinterpretation of results, or the masking of archaeological anomalies. A twin probe array of 0.5m will rarely recognise features below a depth of 0.75m (Gaffney et al 1991). More substantial features may register up to a depth of 1m. With twin probe arrays of between 0.25m and 2m, procedures are similar to those for the 0.5m twin probe array.

Although changes in the moisture content of the soil, as well as variations in temperature, can affect the form of anomalies present in resistivity survey results, in general, higher resistance features are interpreted as structures which have a limited moisture content, for example walls, mounds, voids, rubble filled pits, and paved or cobbled areas. Lower resistance anomalies usually represent buried ditches, foundation trenches, pits and gullies. In addition to the normal twin electrode method of survey, a Geoscan Research MPX15 multiplexer can be utilised with the Resistance Meter, allowing multiple profiles of resistivity to be recorded simultaneously, or resistance tomography to be carried out up to a depth of 1.5m. APSS generally survey, as with the twin electrode configuration, to a resolution of 1 or 0.1Ω, with readings every metre or half metre.

Magnetic Survey

Magnetic prospection of soils is based on the measurement of differences in magnitudes of the earth's magnetic field at points over a specific area. Principally the iron content of a soil provides the basis for its magnetic properties. Presence of magnetite, maghaemite and haematite iron oxides all affect the magnetic properties of soils. Although variations in the earth's magnetic field which are associated with archaeological features are weak, especially considering the overall strength of the magnetic field of around 48,000 nanoTesla (nT), they can be detected using specific instruments (Gaffney et al. 1991).

Three basic types of magnetometer are available to the archaeologist; proton magnetometers, fluxgate gradiometers, and alkali vapour magnetometers (also known as caesium magnetometers, or optically pumped magnetometers). Fluxgate instruments are based around a highly permeable nickel iron alloy core (Scollar et al. 1990, 456), which is magnetised by the earth's magnetic field, together with an alternating field applied via a primary winding. Due to the fluxgate's directional method of functioning, a single fluxgate cannot be utilised on its own, as it can not be held at a constant angle to the earth's magnetic field. Gradiometers therefore have two fluxgates positioned vertically to one another on a rigid staff. This reduces the effects of instrument orientation on readings.

Fluxgate gradiometers are sensitive to 0.5nT or below depending on the instrument. However, they can rarely detect features which are located deeper than 1m below the surface of the ground.

Archaeological features such as brick walls, hearths, kilns and disturbed building material will be represented in the results, as well as more ephemeral changes in soil, allowing location of foundation trenches, pits and ditches. Results are however extremely dependent on the geology of the particular area, and whether the

archaeological remains are derived from the same materials. For fluxgate gradiometer survey, the Geoscan Research FM36 is used. Survey is carried out at 0.1nT resolution, with readings taken every 1m by 0.5m. Around 1.5 to 2 hectares are surveyed each day.

Topographic Survey

The modern ground surface or topography often contains important information on the conditions and nature of an archaeological site, and the potential existence of structures buried beneath the soil (Bowden 1999). The changes in topography can also have a great influence on determining the nature of features in a geophysical survey. Therefore it is vital to produce a detailed and complete topographic survey as part of the field survey of any given site. This generally entails the recording of elevations across a grid of certain resolution, for instance 5 or 10m intervals, but also the recording of points on known breaks of slope, to emphasis archaeological features in the landscape.

Survey is usually undertaken by APSS using a total station or electronic theodolite, although Global Positioning Satellite systems (GPS) are also utilised, to record the survey points. Computer software is then used to produce Digital Elevation Models of the results. Normally, survey is carried out using a Leica total station, with readings taken every 4 metres, and also on the breaks of slope of important topographical features. The resolution can be increased where necessary. Up to 5 hectares per day can be covered.

Integrated Survey Methodology

The survey work carried out by Southampton is always produced as part of an integrated survey strategy, designed to affiliate all of the geophysical survey techniques to the same grid system, which would be used for geochemical soil sampling and surface collection. Surveys are normally based on an arbitrary grid coordinate system, tied into a national system or to a series of hard points on the ground corresponding to points on a map. A set of 30m grids are then set out to provide the background for the magnetometry, resistivity, and other survey techniques which will complement the results, for instance fieldwalking and geochemical sampling.

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Web Resources

ADS Archaeological Data Service http://ads.ahds.ac.uk

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