PLUMLEY LIMEBEDS
Northwich
Cheshire

Survey Report

Oxford Archaeology North

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Prepared by:	Matt Town	Chris Wild
Position:	Project Supervisor	Project Officer
Date:	March 2002	
Checked by:	Jamie Quartermaine	Signed……
Position:	Senior Project Manager	
Date:	March 2002	
Approved by:	Rachel Newman	Signed…….
Position:	Director	
Date:	March 2002	
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Oxford Archaeology (North)
Storey Institute
Meeting House Lane
Lancaster
LA1 1TF
t: (0044) 01524 848666
f: (0044) 01524 848606

w: www.oxfordarch.co.uk
e: info@oxfordarch.co.uk

© Oxford Archaeological Unit Ltd 2002
Janus House
Osney Mead
Oxford
OX2 0EA
t: (0044) 01865 263800
f: (0044) 01865 793496

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CONTENTS

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SUMMARY

Oxford Archaeology North (OAN) (formerly Lancaster University Archaeological Unit) were invited by Cheshire County Council Environmental Planning to undertake an archaeological recording programme of the remains of the industrial plant at Plumley Limebeds, Northwich, Cheshire (SJ 708 750). The programme was designed in accordance with a brief by the Archaeology Officer (Development Control) for Cheshire County Council. The land is presently a nature reserve but is on the site of a former ammonia soda works complex, which has been highlighted as being of particular importance in a recent step 1 report on the Chemical Industry for the Monuments Protection Programme (MPP) of English Heritage (D Cranstone pers comm). In addition, there are the remains of a munitions plant, constructed at the outset of the First World War, which produced calcium nitrate, an essential raw material for the production of high explosives. Munitions plants of this period are extremely rare and the site is of considerable archaeological importance.

An identification survey of the whole site was undertaken in November 2000, alongside a basic level of fabric recording of a surviving warehouse, the results of which were presented within an interim report. This was to be closely followed by a detailed survey of the munitions plant and a more detailed mitigation survey of the warehouse; however, in the event this was delayed because of the outbreak of foot and mouth disease and was thus not completed until December 2001.

As a result of the identification survey, the remains of the Ammonium Soda Plant (Ascol) and the ancillary industrial structures can be broadly equated with the buildings shown on the historical mapping.

The detailed survey of the munitions plant, which followed on from the identification survey, established the detailed character of the plant and, in conjunction with the cartographic sources, it was possible to establish the overall processes of production; however, as much of the superstructure was dismantled and removed in 1918/9, an understanding of the detailed process has been limited.

The detailed fabric survey of the warehouse has been able to establish its development and role within the production process. The building has large buttresses constructed around three sides, and it had been initially interpreted as a blast-proof warehouse, for the storage of explosives. However, it has been established that the plant produced calcium nitrate, a raw material for the production of explosives, but no actual explosives were ever produced at the site; it has also been established that the buttresses to the building were a later addition. It can therefore be confirmed that this was not a blast-proof warehouse. The buttresses were in a second phase of the building's development and this was followed by an extension of a bagging plant on the south side (Phase 3). The extension is shown on a plan dated to 1918 and it is evident that the principal alterations occurred during the 1914 to 1918 period of activity the munitions works. The next phase of its development was when the building was adapted for warehouse storage by the nearby Associated Ethyl works (later Octel) at some stage after 1939, which involved the demolition of the bagging plant and the blocking of some apertures. The warehouse finally fell out of use in the 1980s.

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Oxford Archaeology North (OAN) (formerly Lancaster University Archaeological Unit) would like to thank Paul Dwerryhouse and Ian Whittaker of Cheshire County Council for providing considerable assistance in the course of the project, and for providing copies of the 1910 and 1946 photographs. We would also like to thank Mark Leah, Archaeology Officer for Cheshire County Council, for his support and assistance in the course of the survey and Alan Moores for providing invaluable advice and information relating to the site.

The initial walk-over survey was undertaken by Matthew Town, and the fabric survey was by Chris Wild, Matthew Town and Andi Scott. The watching brief was undertaken by Andi Scott. The detailed survey of the munitions plant was carried out by Dan Elsworth and Andi Scott. The drawings were prepared by Neil Wearing, Andi Scott, and Jamie Quartermaine. The report was written by Matthew Town, Chris Wild, and Andi Scott and was edited by Jamie Quartermaine and Rachel Newman. The project was managed by Jamie Quartermaine.

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1. INTRODUCTION

1.1 CONTRACT BACKGROUND

1.1.1 Oxford Archaeology North (OAN) (formerly Lancaster University Archaeological Unit) was invited by Cheshire County Council Environmental Planning to undertake a programme of archaeological recording at Plumley Limebeds, Northwich, Cheshire (SJ 708 750). The work was undertaken in advance of a programme of reclamation and environmental improvement of the site for leisure and recreation. The land is presently a nature reserve but is on the site of a former ammonia soda works complex, and a First World War calcium nitrate munitions plant; the site has been highlighted as being of particular importance in a recent Step 1 report on the Chemical Industry for the Monuments Protection Programme (MPP) of English Heritage (D Cranstone pers comm). The study followed on from, and was informed by, an archaeological assessment of the overall study area undertaken by the University of Manchester Archaeological Unit in August 1999 (UMAU 1999). The programme was designed (*Appendix 2*) in accordance with a brief (*Appendix 1*) by the Archaeology Officer (Development Control) for Cheshire County Council, to create an identification survey of the surviving remnants of the site, to undertake a fabric survey of the large warehouse, and, subject to the results of the identification survey, to evaluate key elements of the landscape. In the event it was agreed with the Archaeology Officer that a detailed survey of the munitions plant should replace the programme of trial trenching, as this would provide more pertinent information about the site. In addition, a more detailed fabric survey was required of the warehouse to provide a mitigative record in the event of its demolition. The initial walk-over survey and level 2 fabric survey of the warehouse were undertaken in November 2000, and the results were presented in an interim report (LUAU 2001). The detailed survey of the munitions plant and the detailed fabric survey of the warehouse were started in February 2001, but the surveys had to be suspended because of the outbreak of foot and mouth disease and were not resumed until December 2001. An archaeological watching brief was also undertaken during the excavation of test pits and boreholes by Cheshire County Council Environmental Planning in August / September 2001 and the results are presented within this report.

1.2 TOPOGRAPHICAL AND GEOLOGICAL BACKGROUND

1.2.1 ***Location and Current Land-use***: the study area, which lies *c*1km west of Plumley village and *c*0.5km south of the A556, at SJ 708 750, is a Site of Special Scientific Interest and a nature reserve managed by the Cheshire Wildlife Trust. Most of the site is covered with woodland, with a sizeable pond in the south-east. Immediately to the north of the study area is the moated Holford Hall, the moat and moat platform of which are a Scheduled Ancient Monument. The hall is a Grade II* Listed Building, and the bridge across the moat is Grade II (UMAU 1999).

1.2.2 ***Geology:*** the solid geology of virtually all the study area comprises Lower Keuper Saliferous Beds, with Middle Keuper Marl in the extreme south-west corner. The overlying drift geology is predominantly Boulder Clay, but in the eastern half of the study area and running approximately north-north-east by south-south-west is a thin

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band of alluvium (Edwards *et al* 1954). To the south-east of the study area, beyond the railway line, are surviving peat deposits of the wetland of Holford Moss (Leah *et al* 1997, 102-3). The tithe award for Plumley names a field in the south-east corner of the study area as Moss Field, suggesting that this wetland once extended into the study area (UMAU 1999).

1.2.3 ***Topography:*** the topography of much of the study area is fairly flat, at a height of *c*30m OD. However, in the north is an extensive mound of lime waste, with sides rising *c*7-8m high. The ground level in parts of the east of the study area is reported to have been raised by the tipping of material from the construction of the M6 in the 1960s: to that period also belongs the construction of the present large pond (UMAU 1999).

1.3 HISTORICAL BACKGROUND

1.3.1 Most of the study area lay within the township of Plumley, the exception being the south-west corner which lay within Lostock Gralam. Immediately north of the study area lies the moated site of Holford Hall (CSMR 1235). The present house is a part of a larger timber-framed building of early seventeenth century date constructed for Mary Cholmondeley, heiress of Christopher Holford of Holford. The late nineteenth century Ordnance Survey (OS) first and second edition maps (1882 and 1899) show the study area as being agricultural land (UMAU 1999).

1.3.2 John Henry Davies bought the Holford Hall estate in the early 1900s and exploratory borings were carried out, revealing brine measures. In September 1906 Davies offered to sell the estate for £340 per acre to Ivan Levinstein, a Manchester dyemaker, who in turn sought the assistance of Arthur Chamberlain, chairman of the Birmingham ammunition firm of G Kyloch & Co, with the intention of developing the property as an ammonia soda works (UMAU 1999). The purchase was completed in 1907, and the Ammonia Soda Company Ltd (Ascol) was founded as a private limited company in July of the following year (Plate 1); in 1912 the firm was launched as a public company. The prospectus for the Conversion recorded that '*The Company was established for manufacturing amongst other things Soda Ash by the Solvay Ammonia process. In addition to Soda Ash, Soda Crystals are now being manufactured and the company contemplates the manufacture of Caustic Soda and Bicarbonate of Soda*' (*ibid*). High optimism surrounded the conversion and the prospectus included geological reports indicating that the supply of brine on the company's land was almost inexhaustible, but subsequent profits were disappointing. In 1916 a controlling interest in the company was acquired by Brunner, Mond & Co, but, prior to that date, this firm had attempted to limit the activities of the Ammonia Soda Company Ltd by buying up land around the Plumley works; they also took daily samples from a stream below the works in the hope of finding evidence of pollution. It may be added that the main written accounts of the works were by Brunner, Mond & Co, and reflect that company's views. A personal account from Herbert Levinstein (son of Ivan Levinstein) maintained that the failure of the Ammonia Soda Company Ltd's plant at Plumley was a lack of brine caused deliberately by Brunner, Mond & Co who owned the land across the railway and sank two brine shafts and built a pumping station as close to the Ascol works as possible (*ibid*). Brine was pumped from there to reservoirs where the brine could flow by gravity to Brunner Mond's Lostock ammonia soda works. The corporate

history attributes the failure to lack of water and stream contamination (George Twigg pers comm; UMAU 1999).

1.3.3 ***Munitions:*** in the Great War, Brunner Mond became a leading player in the production of explosives, producing and purifying TNT (Tri-Nitro-Toluene), and in the production of Amatol. Britain was well-placed for the production of TNT; its main ingredient, Toluene, derived from coal tar and benzene, and the explosive was regarded as safer than its counterparts such as Lyddite (Picric Acid), as it could not be exploded by flame or strong percussion. Old dyeworks, using good sources of coal tar, were rapidly converted to the production of TNT, mainly in the area around Manchester; Brunner Mond converted an idle caustic soda factory at Silvertown in East London to its production, and carried out hazardous purification of the substance at its Northwich plants (Cocroft 2000). Pure TNT was relatively expensive to produce, but, by mixing it with ammonium nitrate, it was possible to produce an effective but more economic explosive, known as Amatol, at a ratio of approximately 1:4 between the two substances. Ammonium nitrate was also used to create Nitric Acid, a prime raw material of most explosives (including TNT), and consequently there was a considerable demand for ammonium nitrates at the outset of the war. Prior to the war, nitrates had been derived from saltpetre (potassium nitrate) which derived from Chile, but submarine blockades meant it became difficult to rely on this supply and a more local alternative was sought. One option was to create ammonium nitrate from calcium nitrate, and Brunner, Mond & Co became experts in this process, through their extensive knowledge of the handling of ammonium soda manufacture (Watts 1923).

1.3.4 ***Plumley Munitions Plant:*** the ammonium nitrate production process became centred on a number of pre-existing plants in Cheshire (Cocroft 2000), particular that at Lostock Gralam, near Northwich. The raw material, calcium nitrate, was derived by treating sodium nitrate with calcium chloride, and was produced at an experimental plant that was established, on behalf of the Ministry of Munitions, alongside the Ammonia-Soda plant at Plumley. Between 1916 and 1918, the Plumley munitions plant produced 62,110 tons of calcium nitrate and 91,210 tons of calcium nitrate tetrahydrate (Watts 1923, 53).

1.3.5 ***Post-War Operations:*** after the end of World War I, the munitions plant was demolished (in 1918-9) and the original Ammonia Soda plant reverted to the production of Soda Ash. In 1919, however, the Ammonia Soda Company Ltd went into voluntary liquidation on the grounds of poor market conditions (UMAU 1999). Brunner Mond then bought the site outright and production continued, but in 1926 the site was finally closed. From the 1940s to the 1980s a large warehouse on the site was used to store sodium salts by Associated Octel (Moores forthcoming) (Plate 2).

1.4 ARCHAEOLOGICAL BACKGROUND

1.4.1 The earliest known plan of the works is that on the 1908 OS 1:2,500 map**,** which shows the complex to have consisted of several buildings in the western half of the study area. These were served by their own railway network, linked with the adjacent main line, and were approached from the north-west by the routeway named Ascol Drive after the company. The only other known plan to show the

works was drawn by AW Tangye (*c*1910-14), of Brunner Mond & Co, which also includes a sketch of the buildings and is annotated with the names and function of the various parts shown; although the date is uncertain it was produced approximately between 1910 and 1914. Neither the 1908 plan nor that by Tangye includes the largest structure still standing on the site, the buttressed warehouse building, which was built as part of the 1914 munitions works.

1.4.2 In the east of the study area, the 1908 map indicates the location of a brine shaft sunk in 1907; however, there are a further four brine wells, three of which are known to have been sunk in the period 1906-8 (A Moores pers comm).

1.4.3 Maps produced in 1918 (1918 Site Plan and 1918 Site Drainage Plan) show that there were two main plants, the earlier soda ash plant in the eastern part of the site, and the larger munitions plant towards the southern end of the site. The eastern and northern part of the site was occupied by large lime waste mounds. The next published OS map of the site, in 1938, shows the works' railway network intact, but no buildings are shown apart from the warehouse and two small structures**.** The use of the warehouse, and the remainder of the site, during the inter-war years is uncertain, but the Associated Octel plant constructed in the late 1930s just beyond the study area, on the south side of the main line, used the warehouse for storage until the 1980s when this last element of the Plumley works finally closed (UMAU 1999).

1.4.4 The railway within the study area had been removed by the mid-1950s as it does not appear on either the OS mapping or on aerial photographs of the period. The aerial photographic evidence from the mid-1950s shows that light woodland had already become established on at least the western side of the study area, with this tree cover becoming denser and spreading across most of the study area by the 1970s (*ibid*).

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2. METHODOLOGY

2.1 PROJECT DESIGN

2.1.1 A project design was submitted by OAN for an archaeological study of the study area, in accordance with a brief prepared by Cheshire County Council (*Appendix 1*); and, following acceptance of the project design by the Archaeological Officer, OAN was commissioned by Cheshire County Council Environmental Planning to undertake the work. The brief required an identification survey, and a programme of evaluation trenching to investigate the site, but in the event it was agreed with the Archaeological Officer that a detailed survey should be undertaken of the munitions plant in place of the trial trenching. It was also requested by the client that a more detailed survey be undertaken of the munitions warehouse, as mitigation in advance of its proposed demolition. The enhanced programme of works was defined within a revised project design in January 2001 (*Appendix 2*). A watching brief was requested by the client during the excavation of a series of geological test pits across the Plumley study area, although only those in the area of the Ascol plant and the munitions plant were subject to a watching brief; this work was undertaken in August / September 2001. In all other respects the revised project design has been adhered to in full; the work was consistent with the relevant standards and procedures of the Institute of Field Archaeologists, and generally accepted best practice.

2.2 IDENTIFICATION SURVEY

2.2.1 An identification survey was undertaken to enhance an existing topographic survey of the site, extending over an area of 0.25 sqkm. This served as the basis for planning and undertaking further archaeological work on the site; it represents the minimum standard of record and is appropriate for the discovery of previously unrecorded sites. Its aim was to record the existence, location and extent of surviving surface features, and involved the annotation of maps of the site provided by Cheshire County Council.

2.2.2 The identification survey was undertaken in the autumn 2000, when the density of vegetation within the area was diminished. The reconnaissance was undertaken in a systematic fashion, walking on approximately 10m wide transects within the extent of the defined study area, but the interval was varied according to the density of the undergrowth and the sensitivity of the area; hence more intensive investigation was undertaken in the area of the industrial plants and a less intensive survey was carried out in the area of the lime mounds. The reconnaissance was undertaken in conjunction with Alan Moores, who has considerable knowledge of the site.

2.2.3 As required in the brief, the survey involved the enhancement of the existing topographic survey to give greater detail than was already shown and to depict features that were not previously defined. There was no requirement for new survey work to be undertaken, and any identified features that were remote from detail depicted on the maps was not located to a high level of accuracy. There were considerable amounts of earthwork detail extending across the whole of the site which were not shown on the existing base survey and, because of the difficulty in

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recording detail that was remote from depicted detail, the more subtle of these earthworks features were not recorded.

2.2.4 The annotations were transferred from the site paper copy into the base drawing as a separate layer within a CAD system (AutoCAD 14). The features were cross referenced with those features shown on the 1918 map of the site (1918 Site Drainage Plan), which was incorporated as a Raster backdrop within the CAD drawing to enhance the correlation between surviving and historic features.

2.2.5 The results of the identification survey are presented in the site gazetteer and the site map (Fig 5).

2.3 DETAILED SURVEY OF THE MUNITIONS PLANT

2.3.1 A further, more detailed, instrument survey was undertaken of the munitions plant to follow on from the identification survey. The work was started in February 2001, but was suspended because of the Foot and Mouth outbreak, and resumed in December 2001. The survey comprised a detailed landscape survey undertaken of the First World War Plant, and the results were incorporated into those of the identification survey (Figs 5 and 6). The survey concentrated on the core area in the heart of the complex through systematic field walking of the study area to identify features unrecorded by the previous survey and to provide a more accurate and detailed survey of the relict landscape.

2.3.2 The recording was undertaken to an OAN level 2b survey (LUAU 1996), which is equivalent to RCHM(E) level 2. Survey control was established over the site by closed traverse and internally was accurate to +- 15mm; the control network was located onto the existing survey of the site by tying into clearly defined topography such as the warehouse.

2.3.3 The surface features were surveyed by EDM tacheometry using a total station linked to a data logger, the accuracy of detail generation being appropriate for a 1:500 output. The digital data were then transferred onto a portable pen computer for manipulation and later transfer to other digital or hard media. Film plots were produced so that the archaeological detail could be drawn up in the field as a dimensioned drawing on the plots with respect to survey markers. Most topographic detail was also surveyed, particularly if it was archaeologically significant or was in the vicinity of archaeological features. The survey drawings were generated within a CAD system and were merged with the identification survey.

2.3.4 ***Photographic Survey:*** in conjunction with the archaeological survey, a photographic archive was generated, which recorded significant features and general landscapes. It was undertaken using 35mm black and white and colour slide film.

2.3.5 ***Site Gazetteer:*** the survey was accompanied by a gazetteer description of individual archaeological features, which related directly to the survey mapping. This stage of the survey involved a detailed assessment of the site and its general context and has expanded upon the gazetteer and survey results of the interim report.

2.4 FABRIC SURVEY OF THE WAREHOUSE

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2.4.1 The survey of the warehouse was undertaken in two stages; initially a survey to RCHM(E) level 2 was carried out, resulting in the production of a plan of the site, a photographic record, and a description of the structure. This was followed in December 2001 by a more detailed survey to RCHM(E) level 4 standard which produced cross-sections across the building and elevation drawings of the internal and external walls, in conjunction with a more detailed fabric description. The results of the Level 2 survey have been presented as an interim report (LUAU 2001), and the results of the full survey, including the data from the Level 2 survey, are presented here.

2.4.2 ***Instrument Survey:*** the instrument survey methodology for both stages of work was the same, the difference being in the amount of detail captured. The survey was undertaken by means of a reflectorless total station, which is capable of measuring distances to architectural detail by reflection from the surface of that detail element (without need of a prism), and therefore allows for the recording of detail with limited access. The survey was undertaken with respect to a series of accurately surveyed control stations established by traverse around the outside of the building. The graphic results of the survey were digitised into an industry- standard Computer Aided Draughting (AutoCAD 14) system to enhance the manipulation and presentation of the results. The survey resulted in the production of elevation drawings of the external eastern and northern walls, the internal southern and western walls, the internal cross wall, cross-sections across the east/west and north/south axes, and the ground plan.

2.4.3 ***Photographic Survey:*** a general oblique photographic survey was undertaken of the warehouse in accordance with the RCHM(E) Levels 2 and 4 recording. The record was fully indexed and photographic views were shown with respect to the existing architects' plans.

2.4.4 A conventional monochrome medium format record was undertaken of the warehouse, including external elevations and appropriate architectural detail. A record was made in 35mm colour print and black and white formats of the interiors of the structure and showed similar detail to the medium format record, as well as a broad range of generalised views.

2.4.5 The photographic record of the warehouse included:

i) general external coverage (colour print and medium format black and white);

ii) general internal coverage (black and white contact prints and colour print (35mm));

iii) general views showing the overall setting of the buildings;

iv) close-up views of significant internal and external architectural details (black and white contact prints and colour print (35mm));

v) general views of representative structural detail (black and white contact prints and colour print (35mm));

vi) detailed views of the roof structure (black and white contact prints and colour print (35mm)).

2.4.6 ***Descriptive Record:*** the survey of the site involved the production of a detailed descriptive record of the fabric of the building in accordance with the RCHM(E) Level 4 standard. This involved internal and external examination of the extant

fabric, and an assessment of the development of the building and its archaeological significance.

2.5 TEST PIT WATCHING BRIEF

2.5.1 A permanent presence watching brief was maintained for the duration of the groundworks associated with the excavation of a series of test pits for a geological survey of the study area. Only those test pits which were in the environs of the Ascol or munitions plant were subject to archaeological watching brief. In conjunction with the excavation of the test pits, a series of boreholes was also established across the site, but these were not subject to an archaeological watching brief.

2.5.2 The work consisted of the monitoring of the excavation of the test pits (Fig 15), which were typically *c*2m x 0.4m in size, excavation being undertaken using a mini digger. The programme of field observation accurately recorded the location, extent, and character of any surviving archaeological features within the groundworks and the watching brief was also required to limit the amount of disturbance to the surrounding archaeological structures. This work comprised observation during the groundworks, the systematic examination of any subsoil horizons exposed, and the accurate recording of all archaeological features and horizons, and any artefacts, identified during observation.

2.5.3 The recording comprised a full description and preliminary classification of features or materials revealed, on OAN *pro-forma* sheets, and their accurate location, on plan. Records were kept of all the test pits of the watching brief, even if the results were negative. A plan was produced of the locations of the test pits (Fig 15). All areas of archaeological interest were photographed both in general terms and in specific details.

2.6 ARCHIVE

2.6.1 The results of the work programme formed the basis of a full archive to professional standards, in accordance with current English Heritage (1991) guidelines. This archive is provided in the English Heritage Centre for Archaeology format, as a printed document, and will be submitted to the Cheshire Record Office. A synthesis (the evaluation report and index of the archive) will be submitted to the Cheshire Sites and Monuments Record and the National Monuments Record.

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3. MUNITIONS PLANT SURVEY RESULTS

3.1 INTRODUCTION

3.1 The survey of the munitions plant follows on from the earlier identification survey which examined the whole of the Plumley site and has been presented within the interim report (LUAU 2001). The results of the earlier identification survey are presented within the site gazetteer and on the site map (Fig 5), alongside the results of the detailed survey. Presented below are the results of the detailed survey of the munitions plant (Sites 3-6, 15, and 20-22).

3.1.2 ***Munitions Plant:*** the layout of the munitions plant is shown on a 1918 Site Drainage Plan (Fig 3), which has been digitally superimposed onto the survey plan (Fig 6). The munitions plant buildings are also outlined on a 1918 sketch map (1918 Site Plan) which gives the functions of the individual structures as follows: 'Boilers, Mixers and Pans'; 'Crystalliser Shed'; 'Shops and Laboratories'; and 'Reaction and Salt Pans', and 'Salt Pans'. Brunner Mond Records (Watts 1923) indicate that this plant produced calcium nitrate by treating sodium nitrate, extracted from the brine, with calcium chloride. This process took place in the salt pans where the brine was initially collected, purified and concentrated, and was then passed on through a series of stages, including one where the brine concentrate was allowed to react with calcium chloride. The calcium nitrate was then dehydrated using heat from boilers and crystallised out in the crytalliser shed. The calcium nitrate was bagged, weighed, and stored in the warehouse. While the basic process and the functions of the main buildings could be established from the documentary sources, the function of individual structures and the detailed industrial process can only be tentatively postulated from the evidence of the survey of the plant, as much of the superstructure was lost when the site was demolished after the end of the First World War.

3.1.3 The features on the site have been grouped as far as possible on the basis of the correlation between the observed features and the outlines of the buildings from the 1918 Site Drainage Plan. Mostly it has been possible to establish the edges of the former buildings, and these largely coincide with the outlines on the historical mapping; however, for the southern part of Building 3 and Building 20, there is either no surface evidence or the edges identified differ from those on the historical mapping.

3.2 BUILDING 3 (BOILERS, MIXERS AND SALT PANS)

3.2.1 This was shown on the 1918 Site Drainage Plan as a long rectangular building orientated north/south; the northern section of the building was described as 'Pans', and the southern section was described as 'Boilers and Mixers' on the 1918 Site Plan. The building was situated to the east of the main railway lines (Site 10), (Fig 6) and west of the crystalliser shed (Site 4) which runs parallel to it. Extending east/west across the middle of the structure was a pair of parallel, prominent well-defined banks which have the appearance of decayed and overgrown walls (3.8) (Fig 6). These clearly demarcated the features both to the north and south and were potentially dividing walls; the presence of a marked gap between the banks/walls

suggest that these were both end walls and that the 'Pans' section and 'Boilers and Mixers' section were within two discrete buildings.

3.2.2 ***Salt Pans' Structure (3.1, 3.2 and 3.5-7):*** remnants of the salt pans were clearly visible in the northern part of the structure where they survived as rectilinear platforms flanked by east/west aligned linear ditches that led to the west towards a large, broad open ditch (3.11) and, to the east, via small channels, to a smaller north/south ditch on the eastern side. The relationship between the cross ditches and the large western ditch (3.11) was very ill-defined because of subsequent erosion and vegetation cover, but it would appear that some of the ditches ran off to the west and others run off to the east, but none ran off from both sides of the pans. This would suggest two distinct aqueous products from the process. The surfaces of the platforms were irregular but do not appear to have any depressions or hollows. It is to be presumed that the salt pans themselves were superstructures on top of these platforms, which must have been removed at the point of demolition (1918-1919).

3.2.3 The edges of the structure surrounding the pans were somewhat ill-defined, in part because such a building is likely to have been a simple and possibly open structure forming a roof over the pans. While it would be expected that there would be concrete stanchion supports, there were none on either side of this northern part of the building that can be correlated with the building. There was a building edge, defined as a very sharp break of slope, around the south-western part of the structure, but this became increasingly degraded and obscured by vegetation and the line became untraceable further to the north. The eastern side of the building possibly corresponded to a prominent bank at the eastern edge of the salt pans, but there were no definitive remains of the walls to confirm the eastern line of the building.

3.2.4 ***Boilers and Mixers (3.3, 3.4, 3.9 and 3.10):*** the interior of this part of the building was relatively open, particularly to the south. In the north was a series of large concrete pads (3.3 and 3.4), some of which had mounting bolts and may have been engine mounts. These were associated with two very large, deep and irregular depressions, which had no definitive form, but were entirely within the southern part of Building 3. It is possible that they were formed as a result of the removal, at the point of demolition (in 1918/1919), of large iron components (and hence had scrap value) which had been part buried; such components could perhaps have been the boilers.

3.2.5 The western side of the structure was edged by sharply defined breaks of slope, and in places there are elements of brick facing, indicating that this break of slope reflects the line of a brick wall. In the central section of the east side of the building, the edge was defined by a similar sharply defined break of slope, which was associated with a series of square / rectangular concrete pads (3.3 and 3.4). In the southern part of the building, the eastern edge was somewhat uncertain; the 1918 Site Drainage Plan showed the building narrowing towards the south, whereas there was a series of concrete stanchion supports (3.9) associated with a north/south ditch which is in line with the building edge further to the north. If element 3.9 did form the eastern edge of the building, it would imply that the southern element had a different shape to that shown on the 1918 Site Drainage Plan.

3.2.6 Set into the western edge of the boilers and mixers building was a small complex of overlapping foundations (3.10). The base element of this is a quadrilaterally-shaped raised platform (3.10c), on top of which was a prominent rectangular structure (3.10b) well-defined by earthen banks, which were probably the remains of collapsed walls. At the southern side of this structure was a small intact brick-built structure (3.10a), which was *c*1.5m in height, 2m square, and sat on a concrete base and was open to the west. As the structural complex was on the western edge of Building 3, this was probably a related component, but its precise function is unknown.

3.3 BUILDING 4 (CRYSTALLISER SHED)

3.3.1 The building appeared on the site plans as a long rectangular structure which was described on the 1918 Site Plan as the 'crystalliser shed'. It was edged on the western and eastern sides by lines of concrete stanchion supports with steel mounting bolts protruding (4.7 and 4.8) (Plate 7). Each concrete pad was 1.25 x 0.7m in size and had two sets of four bolts, one set at each end, and each pad clearly supported two adjacent stanchions. In between each of the stanchion supports was a narrow gully (*c*1m wide) which was in places edged to the east by the edge of a concrete platform. These concrete pads clearly defined the extent of a steel-framed building and the ditches were probably robber trenches from the removal of the part buried side panels.

3.3.2 Extending down much of the length of the building was a concrete platform (4.4), which, at its northern end, supported a series of ten concrete rectangular pillars, standing to 2.5m in height, which were alternately narrow and wide (Plate 4). The narrow ones were solid and the wide ones had a central arch through them. Extending from the top of the arches were long support bolts, for a linear, and presumably steel, beam running along the tops, on either side of the pillars. To judge by their location and complexity of design, they were almost certainly an integral part of the crystallisation process, possibly to support evaporation pans, but their precise function is uncertain.

3.3.3 Extending east/west, between the concrete platform (4.4) and the western wall of the building (4.7), was a series of steel beams (4.2) (Plate 6) set at regular intervals; these were configured to have a wide flat top to provide support for a probable raised floor in the south-western part of the building.

3.3.4 To the west of the linear concrete platform was a chimney base and associated engine mount (4.1). To the immediate north of the engine mounting was a concrete rectangular trough with axle supports on either side; this would appear to be a pit for a pulley wheel driven by the adjacent engine. To the south of the chimney base, and at the extreme southern end of the building, was the highest standing structure within the munitions plant (4.3) (*c*4.5m high) (Plate 5); it was a large (2.8m x 2.8m), square concrete structure with a cylindrical shaped interior, the base of which sloped down towards an access hatch on the northern side. Being of concrete construction, it was clearly not associated with any heat process and may have been a silo or mixing vessel.

3.3.5 At the northern end of the building was a series of large rectangular concrete pads, including a large concrete machine base with threaded mounting bolts, which was

adjacent to a circular, concrete, but brick-lined base. This was 1.5m in diameter and was possibly a small chimney base.

3.4 BUILDING 5 (REACTION AND SALT PANS)

3.4.1 Building 5 was shown as a long structure on the 1918 Site Drainage Plan, and was annotated as 'Reaction and Salt Pans' on the 1918 Site Plan. It was a line of 15 salt pans comprising raised rectangular platforms, with very well-defined edges to the south, east and north, which were divided by flat-bottomed east/west orientated cross ditches. The cross ditches ran into a large, deep north/south ditch (Site 21) to the east of the salt pans; the latter was up to 1.5m below the level of the platforms. There were significant differences of form between the salt pans of this group and those of Building 3; these have much broader and deeper cross ditches, the platforms were more prominent and more sharply defined, and there was only a single north/south ditch on one side of the salt pans, as opposed to the salt pans of Building 3, which had ditches, albeit of different sizes, on both sides of the building. The subtle differences between the two blocks of salt pans may reflect the fact that they served different stages of the process. The annotation of 'Reaction and Salt Pans' against this building indicates that this was where the brine was treated with Calcium Chloride, and this could explain the differences in form between the two groups.

3.4.2 The long building appears to have been subdivided into two structures, as there were prominent parallel walls (5.8) (Plate 3), separated by a 10.4m gap, which appear to define the terminals of the north and south parts of the building; however, there was no such divide shown on the 1918 Site Drainage Plan.

3.4.3 As with the northern part of Building 3, there was relatively little evidence for a structural edge corresponding to the line of the building as shown on the 1918 Site Drainage Plan. In the northern part the plan corresponded to sections of north/south bank and the western edges of the pans, but to the south the documented building line coincided with an alignment of concrete pads against the western edges of the pans, which were possibly stanchion supports for a steel-framed building.

3.4.4 To the immediate north of Building 5 was a small brick and concrete building (Site 15), which comprised a 5m x 2.5m structure with a central channel down the length of the block and a small gap on the north side. Its proximity to the Building 5 complex would suggest that it was a related entity; however, its function is unknown.

3.5 BUILDING 6

3.5.1 Site 6 was an unnamed rectangular structure, alongside two circular features, all of which were shown on the 1918 Site Drainage Plan. The surface features comprised a brick-lined pond (6.1), a series of large concrete blocks (6.2), and a secondary pond and brick-lined channel (6.3) linked to the larger pond; there was no evidence of the circular features shown on the 1918 plan. The principal feature, the large pond (6.1) had an irregular shape, but a straight western edge, alongside which was a series of concrete stanchion supports (Plate 8). While no stanchion supports were observed on the eastern side of the pond, it is probable that these were part of a steel-framed

superstructure, and may correspond to the rectangular structure shown on the 1918 Site Drainage Plan. Extending from the northern side of the pond is a secondary pond linked by a brick-lined channel, which was evidently a part of the overall complex, although the function is unknown.

3.5.2 Adjacent to the pond was a pair of large, concrete blocks (6.2), the largest of which was 0.6m high; both had mounting bolts set into the corners and were potentially engine mountings. To the west of the two blocks was a pair of brick-built tanks (2.1m x 1.25m overall); their function is unknown.

3.5.3 The function of the remains is not self-evident from the surface remains, and while the 1918 Site Plan shows no structure in the area of these remains, it does have the words 'Gas Producer' in the vicinity of where the building should be. It is therefore possible that this function relates to Building 6.

3.6 BUILDING 20 (SHOPS - LABS)

3.6.1 A linear building, shown on the 1918 Site Drainage Plan as being a discrete element from the Crystalliser Shed to the north, was described on the 1918 Site Plan as 'Shops - Lab'. The building was edged to the west by a low brick wall in places, but overall this edge was relatively uncertain, in part because, where there were observed edges, these did not correspond to the wall line on the 1918 Site Drainage Plan.

3.6.2 The main structural remains were in the northern part of the building (20.1), which comprised a rectangular, almost square, structure, clearly edged to the east and north by a brick wall edge; the western and southern edges were over grown and ill-defined. To the west of this structure were five interrelated concrete stanchion support blocks; four of the blocks formed a well-defined rectangle, and a fifth continued the eastern line to the north. There was, however, no evidence for a sixth block continuing the western line.

3.6.3 To the south of these elements, the area within the defined building was relatively featureless, edged only by a brick wall to the east. To the west there were a few lines of uncertain break of slope but these did not clearly correlate with the 1918 cartographic evidence. There was, however, a line of four concrete stanchion supports extending south from the southern edge of 20.1, although their function is uncertain.

3.6.4 In the south-eastern part of the building was an irregular mound, possibly reflecting building collapse, which was edged by a brick wall to the east and had two steel 'I'-sectioned joists protruding vertically; this would clearly indicate the remains of a structural component of the building.

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4. FABRIC SURVEY OF THE MUNITIONS WAREHOUSE

4.1 GENERAL DESCRIPTION

4.1.1 The warehouse was a rectangular structure measuring 31m by 28m and was approximately 14.5m in height (Fig 7). It was buttressed on three sides (the north, west and south sides) and the east side faced towards the railway lines (Site 10), where there was an external loading bay (A Moores pers comm) (Plates 12 and 15). It was of brick construction in English Garden Wall Bond, comprising a repeating sequence of three courses of stretcher bricks and one header course. The height of four courses was approximately 0.34m and the bricks were machine-made, and appeared to be of late nineteenth or early twentieth century date. The main walls and buttresses were bonded with pale orangey-grey cement/sand mortar.

4.1.2 The building had a double span, corrugated roof, which was east/west aligned, each with raised central louvres, and there were small metal chimneys at the east and west ends. Internally, the building was divided into two cells by a central wall, supporting the valley between the two roofs, with nine arched openings between the two cells. The eastern end of the interior had a concrete loading platform that is continuous through both cells.

4.2 EXTERNAL ELEVATIONS

4.2.1 ***North External Elevation (Fig 8):*** the northern elevation was 10.5m high and had eight buttresses to the west of the large doorway at the eastern end. There was also a pedestrian entrance *c*1.5m from the western end of the elevation, between the westernmost buttresses. The wall appeared to comprise a single phase of construction, with later buttresses roughly keyed into the lower part of the wall. The timber tie beams of the trusses extended through to the external face of the wall and were flush with it. There were several structural cracks extending up through most of the height of the building, several of which have been repointed in pale grey cement mortar. The buttresses measured 0.96m in width and extended almost to the full height of the elevation; the external ends of the tie beams were visible above the buttresses. They have been roughly keyed into the walls for the lowest 3-4m, and from there upwards are built free-standing, such that several are now moving away from the walls. A drain pipe runs down the centre of the north side of the building. The guttering at the top of the elevation and the eastern and central down pipes have been replaced in plastic, the eastern having mostly collapsed. The central rendered brick drain survives at the base of the wall and several fragments of cast iron drainpipe were observed nearby.

4.2.2 The eastern doorway was originally a sliding door but has subsequently been replaced by a later twentieth century shuttered door (Plate 16). The buttresses do not extend east of the edge of the door, showing that they were contemporary with, or post-date the sliding door. The pedestrian entrance at the western end of the elevation had a hanging bolt loop on the lower west side at floor level, suggesting that the original door was hung externally on this side. The doorway has been narrowed by 0.17m on its eastern side with brick, similar in type and mortar to those used in the main wall. The remainder of the door was later blocked with late

twentieth century brick, in English Garden Wall Bond comprising five rows of stretchers, and bonded with hard, pale grey cement mortar. A concrete sill, visible below the door, runs the full width between the buttresses, below the initial narrowing, and is *c*0.18m thick. The door had a concrete lintel, with a steel beam spanning the whole bay between the buttresses 0.87m above. Two wooden blocks (0.15m x 0.1m) set within the wall above, and three similar blocks in the bay to the east at the same height, strongly suggest there was a canopy above the doorway and the bay to the east. The form of the canopy is unclear, as is its relationship with the buttresses, which it probably pre-dates.

4.2.3 ***East External Elevation (Fig 9):*** the eastern elevation was a contemporary construction in the same materials as the rest of the building. The wall was 10.5m high at either end, rising to 14.5m at the apex of the two gables. The wall had two large apertures, central to each gable, each measuring 3.2m high and 11m wide, located 1.15m above the present ground level. Each aperture was constructed of a steel 'I'-sectional beam lintel supported by two vertical 'I'-sectional beams equidistantly spaced from the brick sides of the apertures, forming three bays to each aperture. The lintels comprised three beams bolted together with fishplates, whilst the vertical members are single-piece with flared heads, and continue within the brickwork below the aperture and below the present ground level. This strongly suggests that they were part of the original construction of the building. The jambs of both apertures were of faced brick, with dressed sandstone pads, 0.35m x 0.25m, immediately below each end of the steel lintel. The apertures were blocked with brick, later in style to those used in the construction of the wall, but in the same English Garden Wall Bond. The blocking was recessed 0.06m on the external face, and was bonded with a black ash/cement mortar, typical of the late nineteenth/early twentieth centuries. Roughly squared sockets, each *c*0.25m x 0.2m were cut into the brickwork; there were three above the lintel of each aperture, and a fourth beyond the outside edge at the same height. These appeared to relate to a canopy above each aperture, but clearly post-dated the original build. A further aperture, 1.35m x 1.2m, 2.05m above the northern bay of the southern main aperture, was blocked in a similar style to those below. It had a three-course brick arch, similar in style to those on the southern elevation and on the central cross-wall, and was slightly wider at the base on the northern side. It appeared to represent an opening for lifting gear to move materials from the internal platform onto the sidings to the east. The widening to the northern side is probably associated with a drive-train for the lifting equipment. A joist socket, 0.25m below the centre of the aperture and 0.2m x 0.15m in extent, probably housed a support for the lifting gear. A fishplate, 1.65m to the south, may also be associated.

4.2.4 The elevation had a central downpipe from the valley between the roof spans. The pipe was cast iron, and badly damaged, with the lowest 3.5m missing. It was loosely fixed to the main elevation with timber pads, although the lowest 7.1m appear to have been originally recessed into the wall within an aperture 0.18m deep. A row of eight steel pipes, cut flush with the wall, was also observed 1.65m above the two main openings; their function is unclear.

4.2.5 ***South External Elevation (Plate 11):*** the southern elevation is 10.5m high and was in the same constructional form as the other walls of the building. The wall had seven buttresses, similar to those on the northern elevation, and these also did not

extend to the eastern end, where there were two blocked, arched doorways (Plate 14); the blocking was in the same style as the apertures on the eastern elevation. The doorways led from the internal platform into the former structures to the south of the main building (shown on the 1918 Site Drainage plan). The eastern doorway is 3.2m high and 2.3m wide and had a brick arch three courses high; the western of the two doors was 3.0m high and 1.4m wide and was of similar construction. Both doorways had a concrete floor extending through them into a former structure to the south; this was roughly cut when the apertures were blocked and the former building to the south was demolished. Part of the footings of this former structure to the south were observed at the south-east corner of the structure, but without excavation it was not possible to describe them in any detail. Two wall scars were also observed: one immediately to the west of the blocked arched doorways, and one 6.2m to the west. The easternmost was keyed into the southern wall to a height of *c*4.5m and was constructed in line with the western jamb of the western aperture; it was probably contemporary with the construction of this aperture. It had a roof scar for a pitched roof above, with a single purlin socket on each pitch and a socket for a ridge purlin. The wall scar to the west was similar in height, but was only keyed into the wall at three points, suggesting that it was a later addition to the wall. It also had an associated roof scar, suggesting a pitched roof, but without a purlin socket on the eastern pitch, and with three purlin sockets on the western pitch, two of which were positioned to the west of the wall. This suggests that the structure had a projecting canopy on its western side. The western purlin socket was cut into a buttress; it was much less roughly cut than the others, and was cut to the exact size for the purlin, whereas the others are slightly ragged.

4.2.6 At the western end of the elevation, between the western two buttresses, was a blocked pedestrian entrance. It was in a comparable position to that in the western side of the northern elevation, and was slightly wider (0.1m) than the original aperture in the northern elevation, but this one had never been narrowed. It also had a similar concrete lintel and steel girder and wooden blocks above, suggesting a canopy in the same style. The broken remains of a much later canopy, located solely between the western two buttresses, was observed. It was attached to the wall immediately above the door and comprised a timber frame and felt cover, probably dating to the latest phase of use of the building. The doorway was blocked in the late twentieth century with brick using a pale cement mortar, probably as a security measure after the building had become disused.

4.2.7 Evidence of a below ground east/west aligned tunnel to the east of the ponds was observed below the two easternmost buttresses; it was, however, impossible to determine any extent or function without excavation.

4.2.8 ***West External Elevation:*** the western elevation was constructed in the same style as the eastern elevation, but has no apertures; instead it has six later buttresses of the same style and height as those on the north and south elevations. The northern and southernmost buttresses are flush with the wall ends, with two buttresses at 3.5m spacings towards the centre at either side. The central part of the wall is not buttressed, and had a central downpipe, now broken, from the roof valley into a brick-sided drain. The pipe had a metal access ladder covering it, for access onto the roof, which was also broken *c*4m below the valley. In the angle formed by the southern buttress and the western buttress of the southern elevation was a patch of render, 4mm thick, extending 0.35m along each face and 3m high. Its purpose was

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unclear, but suggests that there may have been a structure added to the south-western corner of the building during its later phases.

4.3 INTERNAL ELEVATIONS (FIGS 10 AND 11)

4.3.1 The internal walls were of contemporary build to the external walls, and were constructed of the same materials. All walls narrowed by one skin (0.12m) near the top of the wall, which was 6.25m above ground level on the north and south elevations and 7.45m on the east and west elevations. The north wall (Plate 13) had eight internal buttresses, each projecting 0.35m from the wall face to a height of 7.5m and projecting only 0.12m for the remainder of the wall height. These formed part of the original build of the structure, and did not align exactly with the later buttresses added to the external elevations. The south wall (Fig 11) was similar but had only seven buttresses, due to the two doorways at the eastern end. On the west wall (Fig 10) there was a buttress of similar size in the centre of each gable, and there was an additional buttress either side of the upper, narrower, wall, projecting only 0.12m, and flush with the wall face below. There is no evidence for a floor level at the narrowing of the walls in the upper part of the building and it was presumably undertaken in order to reduce material costs.

4.3.2 ***Internal Cross-wall (Plate 9 and Fig 12):*** the interior of the building was split into two cells by an east/west aligned cross-wall (Fig 12) (0.34m thick), with nine arches, allowing access between the cells. Each arch had a three-course-high brick arch, 3m high and 2.44m wide, supported on brick piers (1.08m square) (Plate 9), which also formed buttresses to the wall above. As with the external elevations, the walls and buttresses narrowed at the top of the walls. The wall was keyed into a central buttress in both the east and west elevations, and was of contemporary construction using similar materials.

4.3.3 ***Internal Surfaces:*** the internal floor was of concrete, with shallow drainage channels along the north and south internal walls (*c*0.05m deep). At the eastern end of the building was an internal loading platform, 0.9m high and 3.9m deep (Plate 10) (Fig 13). It had a concrete floor, with a brick western face, which was constructed in English Garden Wall Bond. The concrete floor was edged with a row of black bull-nosed bricks, to form a smooth edge to the platform. The platform was of contemporary construction with the original building; the eastern arched opening in the cross-wall was raised by 0.9m to accommodate the platform, and the two external doorways at the eastern end of the southern elevation were constructed to the height of the platform.

4.4 ROOF STRUCTURE (FIGS 13 AND 14)

4.4.1 The east/west aligned double span roof had eight trusses to each cell, with a raised louvre above the seven bays between the eastern and western trusses. The trusses were adapted queen post trusses, with the principal rafters rising to the straining beam, but with the post continuing up to an upper collar within the louvre, with king strut and braces above. All trusses were jointed with metal bolts, some joints also having metal straps. The roof was covered with corrugated iron, with corrugated plastic glazing in alternate bays of the louvres.

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5. WATCHING BRIEF RESULTS

5.1 INTRODUCTION

5.1.1 As part of an extensive programme of geological investigation, a watching brief was undertaken to examine a limited number of test pits (Fig 15). These were selected on the basis of their proximity to sensitive archaeological remains and the watching brief was intended as much to prevent damage to adjacent earthwork remains as to investigate the sub-surface remains.

5.2 TRIAL PIT 17

5.2.1 Trial Pit 17 was excavated adjacent to the modern track to the north of the munitions plant. It was orientated roughly east/west, was *c*2m x 0.4m in extent, and 2.6m in depth. The topsoil consisted of dark grey-brown clay sand with *c*20% ash content to a depth of 0.2m. Below this, a 0.2m band of gravel and ash was identified, which was probably made-up ground from the nearby works. At a depth of 0.2m below ground level, the southern edge of a square brick-built structure (1.28m x 0.4m x 1.6m) was identified in the western end of the trench. This was composed of machine-made red brick, with mortared joints, and was potentially a form of water tank. To the north, the central 1.2m part of the trench comprised a reddish brown sand clay and a certain amount of water seepage was noted between 0.71m and 1.2m below the ground surface.

5.2.2 At a depth of 0.4m the soil matrix changed to a firm grey-brown sandy clay with 50% gravel content, and below 1.6m depth the natural reddish brown sandy clay was identified.

5.3 TRIAL PIT 18

5.3.1 Trial Pit 18 was situated to the immediate north of the drainage ditch for the salt pans forming part of Building 3; it was orientated roughly east/west and measured *c*2m x 0.4m and 2.5m deep. The topsoil consisted of dark grey-brown clay sand with *c*40% ash content to a depth of 0.2m. Below this was a 0.2m thick band of stiff, light brown sandy clay, with <5% root action, which was clearly made-up ground. Below 0.6m, the soil became a light-brown medium-coarse clay sand, although the clay content was only slight at this level.

5.3.2 The soil matrix changed at a depth of 1.2m to a firm orange-brown sandy clay with 20% gravel content and the occasional large boulder within the matrix. No archaeological features or artefacts were identified in this trial pit.

5.3.3 On completion of the excavation of this trial pit, a topsoil strip was undertaken from its eastern edge towards the access track. This revealed a 0.32m depth of topsoil overlying the light brown sandy clay subsoil layer. Two banks (each *c*2.2m wide) and a slight ditch (0.8m wide) were bisected by the trench, 6.9m to the east of the pit.

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5.4 TRIAL PIT 19

5.4.1 The trial pit was located to the east of the Ascol works, to the south-east of the large kilns (1.5). It was orientated roughly north-east / south-west and was *c*2.7m x 0.45m and 2.65m deep. The topsoil consisted of dark grey brown clay sand with *c* 40% ash content to a depth of 0.1m, consistent with other parts of the site. Below this was a 0.8m thick band of made ground, comprising a silty sand with 10% ash, gravel and brick rubble. Below a depth of 0.4m, a north/south aligned brick wall was identified 6.41m from the centre point of concrete bases (1.4). The wall was a mortared red brick structure with a rubble infill, and was 0.3m wide with a 0.2m gap between the opposing faces. An area of slag, *c*0.7m thick, was identified to the south-east of the wall, with a spread of lime to the north of that. The natural subsoil appears at 0.9m below the existing ground level.

5.4.2 As this trench was located away from the access trackway, an 'S'-shaped trench was excavated to a depth of 0.6m below the surface, running back towards the track from the northern end of the trial pit in order to ascertain the extent of the wall and any associated features. This revealed a 4m wide spread of lime/concrete, at a distance of 1.2m from the edge of the pit, and immediately to the south-east of the iron tank (Fig 15). The line of this trench bisected the bank to the east, which comprised 0.4m of topsoil above a layer of ash, cinder and burnt stone.

5.5 TRIAL PIT 20

5.5.1 This trial pit was positioned immediately to the north of the kiln bases (1.5) of the Ascol works; it was orientated roughly north/south, measured *c*2m x 0.4m, and was 2.5m deep. The topsoil consisted of a 0.2m band of stiff, light-brown clay sand with <5% root action and 10% ash, timber and gravel. Immediately below this was a 0.5m thick layer of concrete that sealed a 0.2m layer of light-grey sandy gravel and ash with 1% root action. Excavation of this layer revealed an east/west orientated 12" drainage pipe covered by timber. Examination of the 1918 Site Drainage Plan showed this pipe to be part of the drainage system in place at that time.

5.5.2 From 0.7m to 1.4m in depth was a layer of masonry and fragments of foundations were seen within the natural reddish brown clay sand that had been redeposited around these foundations. This layer was undisturbed, below the wall, from 1.4m to the maximum excavation of the trial pit at 2.5m.

5.6 TRIAL PIT 37

5.6.1 Trial Pit 37 was situated to the north of the track leading to the warehouse. It was orientated roughly south-west/north-east, and measured *c*2.1m x 0.4m and 2.6m deep. The topsoil consisted of dark-grey brown clay sand and moss to 0.2m below the ground level. Below this, a 0.7m thick band of stiff, light-yellow brown sandy gravelly clay was identified. From a depth of 0.9m to 1.1m, this layer became stiffer and included medium-sized, sub-rounded pebbles within the clay. At 1.9m, this layer gave way to a medium orange-brown sandy clay with very few inclusions. Despite the proximity of archaeological remains in the area, no archaeological features or artefacts were identified in this trial pit.

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5.7 TRIAL PIT 38

5.7.1 This trial pit was positioned to the south of the main track and immediately north of the warehouse. It was orientated east/west and measured *c*2.2m x 0.4m in size and was 2.8m deep. Due to the unstable nature of the adjacent Ascol buildings, care was taken to locate the trench away from any foundations. The topsoil consisted of dark grey-brown clay sand with a *c*40% ash content, to a depth of 0.2m, as was found elsewhere on the site. Below this a 0.05m thick band of medium orange-brown sand was uncovered above a 0.25m thick band of black silty sand, gravel and ash, which was clearly a layer of made-up ground. From 0.5m to 0.9m in depth, a deposit of stiff yellow-brown sandy gravelly clay was identified, overlying a 0.3m depth of medium orange-brown sandy clay. At 1.3m to 2.6m in depth was a firm brown sandy gravelly clay, with pockets of light yellow-brown clay sand towards the bottom of the trial pit; this contained no artefacts and was considered to be a natural subsoil.

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6. CONCLUSIONS

6.1 AMMONIA SODA PLANT

6.1.1 Early ammonia soda plants are rare; the Plumley site is one of only ten recorded by English Heritage's MPP programme for the Chemical Industry, the rest having either been destroyed entirely or severely altered by later use (UMAU 1999). The survey results have conclusively shown the extensive survival of remains associated with all phases of the chemical plant, through both its civilian and war-time use, for the production of ammonium nitrate.

6.2 MUNITIONS PLANT

6.2.1 ***Assessment:*** the detailed survey of the Munitions Plant, coupled with the documentary evidence, has enabled an assessment of the site, its functionality, and its archaeological significance. At the outset of the First World War there was an enormous demand for nitrates as a component of explosives and also for the production of Nitric Acid, an essential chemical for the production of high explosives. The normal source had been potassium nitrate imported from Chile, but this supply could not cope with the enormous demand, particularly after it was disrupted by the German submarine blockade. In Germany, the response to the same desperate shortage was the innovation of the revolutionary Haber process for extracting nitrogen from the air, a technique not available in Britain until late in the war; the first British Nitric Acid plant, based on the Haber process, was not completed until after the Armistice (Cocroft 2000, 157). In Britain the solution came in the form of a distinctive brine from the Cheshire salt beds which was rich in sodium nitrate. The sodium nitrate could be converted easily into calcium nitrate and from thence to ammonium nitrate, a constituent of Amatol and raw material for the production of Nitric Acid. Although there were other processes, also using the Cheshire Brines, this calcium nitrate process made up 58% of the total ammonium nitrate production during the First World War (Watts 1923, 54). The Plumley plant was not simply another munitions plant, it was an essential source of nitrates, without which the war effort could not have been adequately supplied and thus the outcome of the war may have been very different. The degraded physical remains of what was always intended to be a short-lived plant, within a dense woodland, do not provide an impression of a site of undue significance. However, its key, but somewhat forgotten, role in the war, coupled with the fact that there are remarkably few munitions plants from the First World War surviving, means that this is a site of very considerable historical and archaeological importance. The site was not identified within the archaeological record at the time of the MPP Stage 1 Report on the chemical industry and was consequently not assessed; however, on the basis of survival and key historic importance, the site warrants protection by scheduling.

6.2.2 ***Functionality:*** although the overall and generalised process for the production of calcium nitrate at the site is understood, the detailed process of how this was implemented is far from clear. Between 1918 and 1919 the plant was demolished. To judge by the relatively few spoil mounds and evidence of physical collapse, however, and also that some of the more durable concrete remains are still upstanding to some substantial height, it would appear that no attempt was made to

level the site. However, there is very little surviving ironwork and it is evident that the valuable, recyclable iron element of the plant, which made up the key components of the site, were systematically removed; the evidence of large irregular hollows (3.3) and robber trenches beside the former walls suggest that some considerable effort was expended to extract all materials of scrap value. Without the survival of the key components of the plant, an interpretation of its detailed operation is limited; however, described below is a tentative outline of the plant's operation.

6.2.3 The 1918 Site Drainage shows that the brine was extracted from No 2 borehole (Site 13) and passed via a six inch pipe to the easternmost of the set of salt pans (this site was not investigated as part of the present detailed study). The brine was passed through a succession of salt pans, during which the heavier materials settled out in the pans and by evaporation the brine became more concentrated. The refined sodium nitrate-rich brine was then passed into the pans in Building 5, where they were first refined by evaporation and then were treated with calcium chloride, producing a solution of calcium nitrate and sodium chloride (household salt). The heavier waste material from the refinement process was discharged into cross ditches and thence into the large north/south ditch Site 21 (Fig 6). There was no corresponding ditch on the western side of the salt pans and it is to be presumed that the refined calcium nitrate-rich brine was pumped into the pans in the northern part of Building 3 for further concentration of the brine. The heavier waste material was discharged via cross channels into the large north/south ditch, Site 3.11, and the refined and concentrated material would have been led by other ditches to the north/south ditch to the east of the salt pans. The brine would have been heated to boiling temperature for the crystallisation process, but it is not clear if the brine was pumped into the boiler building (southern part of Building 3) for preheating before being passed to the crystallisation building (Building 4), or if the brine was pumped straight to Building 4 and heated there. As no heating vessels survive, it is difficult to assess the precise mechanics of the process.

6.2.4 The brine was a mixture of more than one salt, primarily sodium chloride and calcium nitrate, and it was essential that the crystallisation process allowed for the separate crystallisation of the all-important nitrate from the household salt. This, the key part of the process, can only be tentatively surmised from the observed evidence, but was potentially undertaken within a long evaporation pan constructed on top of the concrete pillars (4.4) and, as the brine passed down the pan, the salts would have selectively crystallised out along the pan, allowing for the separation.

6.2.5 The extracted calcium nitrate crystals would then have been transported to the warehouse (Site 7) for bagging, storage, and ultimate transportation out of the site on rail tracks. The warehouse, however, was not simply for storage of the calcium nitrate, it would also have served for storage of the calcium chloride which was a principal reactant for the process and would have been required in some quantity.

6.3 MUNITIONS WAREHOUSE

6.3.1 The building has had several phases of activity, and appears to have been initially constructed as a storage building, having a large internal volume, a high roof, and a large loading ramp supplied from rail tracks. The walls are relatively thin, with

support given by a large number of small internal buttresses. The upper parts of the walls are even thinner, and this combination suggests that the building was constructed in the most cost-effective manner, by using the minimum amount of materials necessary. The loading bays in the eastern elevation, and the doors in the north-west and south-west corners of the building, most probably had external canopies at this stage. It is evident that there was a structure adjoining the south-eastern corner of the building with a north/south aligned pitched roof, with two access doors from the internal loading platform.

6.3.2 The second phase of construction appears to relate to the construction of the external buttresses which were added to the north, south, and west elevations. It would appear that the original build had been too minimal in its use of materials, and that additional support was required to stabilise the structure to allow for the external pressures of stored materials against the walls. At the Hotties glass factory, St Helens, similar large buttresses were added to the building when it was converted for dolomite storage (Heawood *et al* forthcoming). No buttresses were added to the eastern wall, as the loading bay was clearly still in use and could not be buttressed without blocking access; there would also not have been any stored materials in this area and so this wall would not have needed the same level of external support.

6.3.3 The third phase of construction was the addition of a western extension to the structure, extending out from the south-east corner of the warehouse. This involved the construction of an additional north/south aligned wall which was only roughly keyed into the main building, and was clearly a later addition. This new cell had a pitched roof of similar height to the original structure to the east, but the western pitch extended significantly beyond the new western wall, forming a canopy. This suggests that the new wall was open, in part, allowing access to the settling tanks to the west. Its roof structure has been set into both the southern wall of the warehouse and also into a buttress and must therefore have been constructed after the construction of the buttresses.

6.3.4 The fourth phase of construction relates to a change of function of the building, from an open-sided warehouse associated with the railway, to a more secure storage facility. All openings on the eastern elevation were blocked during this phase, presumably as the railway fell out of use, and the two doorways into the added structure to the south-east were also blocked; it is probable that this south-eastern structure was also demolished at this time. The doorway in the north-west corner was blocked at the end of this phase; it may have been narrowed during the initial part of this phase (or possibly in Phase 2/3), and it is likely that the sliding door to the north-east was replaced with the roller-door at the time of its change in function. Drainpipes also appear to have been replaced in plastic, and the canopy over the south-west door was added during this phase, the earlier canopy above this door, and that in the north-western corner, having possibly been removed in Phase 2/3.

6.3.5 The final phase of construction relates to the abandonment of the structure, with the blocking of the door in the south-west corner of the building, to prevent access.

6.3.6 ***Dating:*** the brick-lined tanks to the immediate south of the warehouse (Site 7b) are shown on the 1908 OS map, before the construction of the warehouse, and are described on the Tangye sketch and plan (1910-1914) as 'water cooling'. The

warehouse, constructed at the same time as the munitions plant in 1914, was evidently constructed around these cooling tanks.

6.3.7 The 1918 plan (1918 Site Drainage Plan) shows that the building at the south-eastern corner of the warehouse was a 'bag weighing plant' and evidently the product of the munitions plant (calcium nitrate) was bagged and weighed there for storage in the warehouse and for outward distribution. Significantly, it shows the outline of both the original building and also the later extension (Phase 3). Clearly the construction of Phases 1 - 3 had all been implemented by the time of the 1918 map.

6.3.8 The 1938 edition OS map shows the warehouse with the south-eastern extension in place, but by the time of the 1954 OS map they have been removed. This period coincides with the adaptation of the warehouse by the nearby Associated Ethyl works (later Octel), which was established in 1939 (A Moores pers comm). It would appear therefore that Phase 4 alterations were implemented at some date after 1939.

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7. BIBLIOGRAPHY

7.1 CARTOGRAPHIC SOURCES

Ordnance Survey, 1882 first edition 6" to 1 mile map, XXXIV

Ordnance Survey, 1899 second edition 6" to 1 mile map, XXXIV

Ordnance Survey, 1908 25" to 1 mile map, XXXIV

Ordnance Survey, 1938 6" to 1 mile map, XXXIV

Ordnance Survey, 1954 6" to 1 mile map, SJ 77 SW

Tangye, AW, 1910-1914 Plumley Works, plan and sketch (Brunner Mond UK Ltd Archives)

1918 Site Plan, sketch plan of the Ascol and Munitions plants (Brunner Mond UK Ltd Archives), copy provided by Cheshire County Council

1918 Site Drainage Plan, outline plan of the Plumley site showing drainage (Brunner Mond UK Ltd Archives), copy provided by Cheshire County Council

1919 Site Plan, outline sketch plan of the site, with the munitions plan absent (Brunner Mond UK Ltd Archives), copy provided by Cheshire County Council

7.2 SECONDARY SOURCES

Cocroft, D, 2000 *Dangerous Energy*, London

Edwards, W, Trotter, FM, and Wray, DA, 1954 *British regional geology: The Pennines and adjacent areas*, 3 edn, London

English Heritage, 1991 *Management of Archaeological Projects*, 2nd edn, London

Heawood, R, Krupa, M, and Martlew, D, forthcoming *The Hotties excavation and Building Recording at the No 9 Tank House, Watson St, St Helens, Merseyside*, Lancaster

Lancaster University Archaeological Unit (LUAU), 1992 *Cheshire Weaver Valley Rolling Programme: an archaeological assessment*, unpubl rep

Lancaster University Archaeological Unit (LUAU), 1996 *Survey Levels*, unpubl doc

Lancaster University Archaeological Unit (LUAU), 1998 *Platts Hall, Northwich, Cheshire: Fabric Survey*, unpubl rep

Lancaster University Archaeological Unit (LUAU), 2001 *Plumley Limebeds, Cheshire: Interim Survey Report*, unpubl rep

Leah, M, Wells, C, Appleby, C, and Huckerby, E, *The wetlands of Cheshire*, Lancaster Imprints **5**, Lancaster

Moores, A, forthcoming *The History of Plumley Village*

University of Manchester Archaeological Unit (UMAU), 1999 *Cheshire Strategic Programme of Reclamation: an archaeological assessment*, unpubl rep

Watts, JI, 1923 *The first fifty years of Brunner, Mond & Co, 1873-1923*, Manchester

APPENDIX 1
PROJECT BRIEF

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APPENDIX 2
PROJECT DESIGN

Oxford
Archaeology
North

January 2001

CHESHIRE STRATEGIC PROGRAMME OF RECLAMATION
PLUMLEY LIMEBEDS, NORTHWICH

CHESHIRE

ARCHAEOLOGICAL SURVEY

Proposals
The following project design is offered in response to a request from Cheshire County Council, Environmental Planning, for an archaeological survey of Plumley Limebeds, Northwich.

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1. INTRODUCTION

1.1 CONTRACT BACKGROUND

1.1.1 Oxford Archaeology (North) (OA(N)), formerly Lancaster University Archaeological Unit, has been invited by Cheshire County Council Environmental Planning to submit a project design and costs for a field inspection, an archaeological survey and fabric survey at Plumley Limebeds, Northwich, Cheshire. The work is being undertaken in advance of a programme of reclamation and environmental improvement of the site for leisure and recreation. This follows on from and is informed by an archaeological assessment of the overall study area undertaken by the University of Manchester Archaeological Unit in August 1999 (UMAU 1999). The project design is in accordance with a brief by the Archaeology Officer (Development Control) of Cheshire County Council. The land is presently a nature reserve but is on the site of a former ammonia soda works complex, which has been highlighted as being of particular importance in a recent step 1 report on the Chemical Industry for the Monuments Protection Programme of English Heritage (D Cranstone, pers comm).

1.2 ARCHAEOLOGICAL BACKGROUND

1.2.1 The ammonia soda works dates from 1912 with the establishment of the Ammonia Soda Company Ltd (Ascol) which was established to manufacture Soda Ash. In 1916 the site was acquired by Brunner Mond & Co and the site started the manufacture of calcium nitrate, which was used in the manufacture of explosives. In 1919, following the end of the First World War the plant was closed, ostensibly because of the drop in demand for munitions (UMAU 1999).

1.2.2 Maps produced in 1918 show that there were two main plants, the earlier soda ash plant in the eastern part of the site, and the larger munitions plant towards the southern end of the site. The eastern and northern part of the site was occupied by large lime waste mounds. The Ordnance Survey map of 1938 shows that although the railway network of the site was still in place, all but a large warehouse and a two smaller structures were then standing. The warehouse was originally constructed to store munitions, and, as a result, was supported by extensive buttresses to make it blast proof. Its survival through to the present in part reflects its over engineered structural integrity and also that it was subsequently used for storage by the nearby Associated Ethyl works which were constructed in 1939 to provide ethylene glycol for aircraft engines. By 1950 OS mapping shows that the railway network in the area had been removed (UMAU 1999).

1.3 OXFORD ARCHAEOLOGY (NORTH)

1.3.1 OA(N) has considerable experience of the evaluation and excavation of sites of all periods, having undertaken a great number of small and large scale projects during the past 18 years. Evaluations and assessments have taken place within the planning process, to fulfil the requirements of clients and planning authorities, to very rigorous timetables. OA(N) undertook the initial assessment of the area as part of the Cheshire (Weaver Valley) Rolling programme (LUAU 1992) and has also undertaken a fabric survey of buildings within the nearby Brunner Mond plant at Lostock Gralam (LUAU 1998). OA(N) has also undertaken numerous assessments, landscape surveys and evaluations on industrial sites throughout the North-West. OA(N) has the professional expertise and resource to undertake the project detailed below to a high level of quality and efficiency. OA(N) and all its members of staff operate subject to the Institute of Field Archaeologists (IFA) Code of Conduct and Oxford Archaeology is a registered organisation with the IFA (no 17).

2. OBJECTIVES

2.1 The following programme has been designed in accordance with a brief by Mark Leah, Archaeology Officer (Development Control) for Cheshire County Council to create an identification map of the surviving remnants of the site, to provide an inspection survey of the area, to undertake a detailed survey of the First World War Munitions Plant and to undertake a fabric survey of the large warehouse. The required stages to achieve these ends are as follows:

2.2 INSPECTION SURVEY

2.2.1 An inspection survey will be undertaken to enhance an existing topographic survey of the site. It will involve the annotation of the earlier survey record and should correlate the surface evidence with the historic maps. The field survey would be undertaken in conjunction with Mr Alan Moores, who has considerable knowledge of the site and its operation.

2.3 DETAIL SURVEY

2.3.1 A programme of detail landscape survey will be undertaken of the First World War Plant, and the results will be incorporated with those of the inspection survey.

2.4 FABRIC SURVEY OF THE BLAST-PROOF WAREHOUSE

2.4.1 A survey to RCHM(E) Level 2 will be undertaken of the building, and an option for the implementation of an RCHM(E) Level 3 survey is also costed.

2.5 SURVEY REPORT

2.5.1 A written report will assess the significance of the data generated by this programme within a local and regional context. It will examine the archaeological implications of the reclamation and landscaping proposals.

3. METHODS STATEMENT

3.1 The following work programme is submitted in line with the stages and objectives of the archaeological work summarised above.

3.2 FIELD INSPECTION

3.2.1 It is proposed that a basic identification survey of the study area be undertaken extending over an area of 0.25sqkm. This will serve as the basis for planning and undertaking further archaeological work on the site and represents the minimum standard of record, it being appropriate to exploratory survey aimed at the discovery of previously unrecorded sites. Its aim is to record the existence, location and extent of surviving surface features, and will involve the annotation of maps of the site provided by Cheshire County Council.

3.2.2 At present the area is considerably overgrown with both undergrowth (nettles) and leaf overgrowth to the extent that considerable areas are inaccessible, and will severely inhibit any surface recording programme. It is therefore recommended that the survey be undertaken in the Autumn when the density of vegetation will be diminished. The reconnaissance will be undertaken in a systematic fashion, walking on approximately 10m wide transects within the extent of the defined study area, but the interval will be varied according to the density of the undergrowth and the sensitivity of the area; hence more intensive investigation will be undertaken in the area of the industrial plants and less intensively in the area of the lime mounds. The reconnaissance will be undertaken in conjunction with Alan Moores who has considerable knowledge of the site.

3.2.3 As required in the brief, the survey will involve the enhancement of the existing topographic survey to show greater detail than is already shown and to depict elements of features that are not presently depicted. There is no requirement for new survey work to be undertaken, and therefore any identified features that are remote from detail depicted on the maps will not be located to as high a level of accuracy. There are considerable amounts of earthwork detail extending across the whole of the site which are not shown on the topographic survey and, because of the difficulty in recording detail that is remote from depicted detail, the more subtle earthworks features will not be recorded.

3.2.4 The base survey can be provided within a CAD format, and consequently the annotations will be transferred from the site paper copy into the base drawing as a separate layer within a CAD system (AutoCAD14). The features will be cross referenced with those features shown on the 1918 map of the site, which will be presented as a rasta backdrop within the CAD drawing to enhance the correlation between the surviving and the historic features. The maps will be depicted with site numbers corresponding to the gazetteer of the documentary study in order further to enhance the correlation between the observed and the documentary records.

3.3 DETAIL SURVEY OF THE FIRST WORLD WAR PLANT

3.3.1 ***Reconnaissance:*** a reconnaissance will be undertaken of the area of the First World War Plant. The extent of the survey will be determined by what can be surveyed within the six days of fieldwork. The survey will concentrate on the core area in the heart of the complex and if areas can not be recorded they will be the areas of lesser archaeological significance around the periphery of the complex. The reconnaissance will consist of systematic field walking, of the study area to identify sites for accurate survey. The survey will aim to identify, locate and record features on the ground that will need to be recorded.

3.3.2 The area has in places dense ground cover and can only be undertaken during the winter / spring months.

3.3.3 ***Instrument Survey:*** it is proposed to undertake a level 2b survey (see OA(N) survey levels, *Appendix 1*) of the sites identified by the walkover, which is equivalent to RCHM(E) level 2. All appropriate topographic detail will be recorded to provide an appropriate context for the archaeological detail. Although the survey data will include altitude information this will not be used for the production of the level 2b survey (unless the contour survey option is adopted).

3.3.4 Survey control will be established over the site by closed traverse and internally will be accurate to +- 15mm; the control network will be located onto the existing Survey of the site by tying into clearly defined topography such as the warehouse).

3.3.5 The surface features will be surveyed by EDM tacheometry using a total station linked to a data logger, the accuracy of detail generation being appropriate for a 1:500 output. The digital data will be transferred onto a portable computer for manipulation and later transfer to other digital or hard mediums. Film plots will be output via a plotter. The archaeological detail will be drawn up in the field as a dimensioned drawing on the plots with respect to survey markers. Most topographic detail will also be surveyed, particularly if it is archaeologically significant or is in the vicinity of archaeological features. The survey drawings will be generated within a CAD system and will be merged with the initial phase 1 survey (*Section 3.2*). The results can be output at any scale.

3.3.6 ***Photographic Survey:*** in conjunction with the archaeological survey a photographic archive will be generated, which will record significant features and general landscapes. It will be undertaken in 35mm black and white and colour slide film.

3.3.7 ***Site gazetteer:*** the survey would be accompanied by a gazetteer description of individual archaeological features, which will relate directly to the survey mapping. This stage of the survey will involve a detailed assessment of the site and its general context and will be undertaken by an experienced industrial archaeologist. It will expand upon the gazetteer of the interim report.

3.4 LEVEL 2 FABRIC SURVEY OF THE WAREHOUSE

3.4.1 ***Plans:*** a ground plan of the warehouse will be created by means of a reflectorless total station. The reflectorless total station is capable of measuring distances to architectural detail by reflection from the surface of that detail element; consequently it does not require the placement of a prism on the detail. It is therefore an ideal tool for the recording of detail where there is limited access. The survey will be undertaken with respect to a series of accurately surveyed control stations established by traverse around the outside of the building. Where possible the survey of the plan will be enhanced by manual survey techniques onto a film base. The survey will record all significant, extant structural elements, inclusive of blocked apertures, masonry joints and changes in internal levels. The graphic results of the survey will be digitised into an industry standard Computer Aided Draughting (AutoCAD 14) system to enhance the manipulation and presentation of the results.

3.4.2 ***Photographic Survey:*** a general oblique photographic survey will be undertaken of the warehouse in accordance with the RCHM(E) Level 2 recording. The record would be fully indexed and photographic views would be shown with respect to the existing architects' plans.

3.4.3 A conventional monochrome medium format record would be undertaken of the warehouse including external elevations and appropriate architectural detail. A record would be made in

35mm colour print and black and white formats of the room interiors and would, show similar detail to the medium format record as well as a broad range of generalised views.

3.4.4 The photographic record of the warehouse will include:

i) General external coverage (colour print and medium format black and white).

ii) General internal coverage (black and white contact prints and colour print (35mm)). This will include internal elevations of the rooms.

iii) General views showing the buildings relationship to other associated buildings and showing the overall setting.

iv) Close-up views of significant internal and external architectural details (black and white contact prints and colour print (35mm)).

v) General views of representative structural detail (black and white contact prints and colour print (35mm)).

vi) Detail views of the roof structure (black and white contact prints and colour print (35mm)).

3.4.5 ***Description and Analysis:*** a visual inspection of the site will be carried out and a basic level of descriptive record will be created in accordance with the Royal Commission on Historic Buildings in England (RCHME) Level 2 standard. It will involve the internal and external examination of the extant fabric, and will generate a summary assessment of the period and significance of the buildings.

3.5 LEVEL 4 FABRIC SURVEY OF THE WAREHOUSE

3.5.1 In addition to that undertaken for Level 2, this would normally require additional survey drawings, and in particular the drawing of cross-sections through the building, detail drawings of structural detail such as trusses and drawings of key elevations. The photographic requirements would be for any internal and external detail relevant to the building's design which is not adequately covered by the general photography for the level 2 survey, and also photography which relates the building to its setting; in addition it would provide rectified photography to enable the production of elevation drawings (*Section 3.5.2*). The written account would involve the account of the buildings form and development, an account of the building's past and present use, evidence for the former existence of demolished structures associated with the building, copies of documentary records of the building, and secondary information relating to the building.

3.5.2 ***Survey Drawings:*** two cross-sections will be produced: a north/south cross-section across the line of the roofs, and an east/west cross-section through the centre of the northern bay. Selected elevations will be drawn so as to record the more important elements of the structure, but will not result in unnecessary duplication; it is proposed to record the following elevations: North external elevation, south internal elevation, west internal elevation, east external elevation and the north face of the internal dividing wall. The cross-sections would be surveyed by means of the reflectorless instrument (*Section 3.4.1*), and would then be plotted for on-site manual survey enhancement. The elevations would be surveyed by a combination of reflectorless instrument survey and rectified photography. Rectified photography will be taken from near ground level and will capture all but the elevation tops; it will be undertaken by in-house survey specialists and will be undertaken in black and white using a medium format camera. Control for the rectified photography will be provided by reflectorless instrument, and will record the locations of clearly defined elements of structural detail rather than targets to prevent the need for physically accessing the walls; it will also record the tops of the elevations. The rectified photography will be output at an appropriate scale; it will be scanned into a computer and presented as a raster backdrop within AutoCAD. Where there is any distortion within the photographic base, the digital image will be subject to digital correction using Archis software to convert the images to fully rectified images. The corrected images will then be incorporated as a rasta backdrop within AutoCad and the elevation drawings will be drawn up as a vector drawing from the rectified base.

3.5.3 The final drawings will show all significant stone detail, such as quoins, and significant brick detail, but will not involve the digitising of all brick detail.

3.5.4 The analytical approach for the Level 4 survey will be the same as that applied to the Level 2 survey, although there will be additional recourse to undertaking an investigation of the site within libraries and the Cheshire Record Office, and would follow on from that undertaken to date by the documentary assessment (UMAU 1999). A visual inspection and analysis of the building would be carried out by experienced in-house staff. The visual inspection will allow for the interpretation and analysis of the building. It will involve the internal and external examination of the extant fabric, where health and safety allows, and will generate a description and assessment of the period and significance of the building. Where possible it will define the form and character of the building within a regional context.

3.5 SURVEY REPORT

3.5.1 ***Archive:*** the results of Stages 3.1-3.5 above will form the basis of a full archive to professional standards, in accordance with current English Heritage guidelines (*Management of archaeological projects*, 2nd edition, 1991). The project archive represents the collation and indexing of all the data and material gathered during the course of the project. The deposition of a properly quantified, ordered, and indexed project archive in an appropriate repository is considered an essential and integral element of all archaeological projects by the Institute of Field Archaeologists in that organisation's Code of Conduct. This archive will be provided in the English Heritage Centre for Archaeology format, as a printed document, and a synthesis (the survey report and index of the archive) will be submitted to the relevant Sites and Monuments Record. The archive will be deposited with the County SMR within six months of the end of the fieldwork.

3.5.2 All drawings will be produced within a CAD system and can be output at any size or medium that is required. Each sheet will be fully titled. Particular attention will be paid to achieving drawings of the highest quality and accuracy.

3.5.3 The archive will be formed of all the primary documentation, including the following:

- Survey Information
- Building Record Sheets
- Context Records
- Finds Records
- Sample Records
- Field / Inked Drawings and digital copies of CAD data
- Photographic negatives, prints and colour transparencies
- Written report
- Administrative records

3.5.4 ***Report:*** three copies of a written synthetic report will be submitted to the client and two copies to the SMR. The report will present, summarise, and interpret the results of the programme detailed in Stages 3.1-3.5 above, and will include an index of archaeological features identified in the course of the project, with an assessment of the sites development. It will include the following:

- Summary of the results
- Acknowledgements statement
- Methodology statement
- Copies of the brief and project design
- Summary of past and present land-use
- Summary of the historical background
- Location Plan
- Plans, cross-sections and elevations

- Monochrome and colour photographs as appropriate
- Description of archaeological features
- An interpretation of the results
- Statement of the archaeological implications of the proposed development.

3.6 OTHER MATTERS

3.6.1 ***Access:*** it is understood that access to the site will be arranged by the client, who will also negotiate with English Nature for the work to be undertaken within the reserve. It is presumed that the client will have responsibility for site security.

3.6.2 ***Health and Safety:*** OA(N) conforms to all health and safety guidelines as contained in the Oxford Archaeology Manual of Health and Safety and the safety manual compiled by the Standing Conference of Archaeological Unit Managers. The work will be in accordance with Health and Safety at Work Act (1974), the Council for British Archaeology Handbook No. 6, *Safety in Archaeological Fieldwork* (1989). All site procedures are in accordance with the guidance set out in the Health and Safety Manual compiled by the Standing Conference of Archaeological Unit Managers (1991) and risk assessments are implemented for all projects.

3.6.3 ***Confidentiality:*** the report is designed as a document for the specific use of the client, for the particular purpose as defined in the project design, and should be treated as such; it is not suitable for publication as an academic report, or otherwise, without amendment or revision. Any requirement to revise or reorder the material for submission or presentation to third parties beyond the project brief and project design, or for any other explicit purpose can be fulfilled, but will require separate discussion and funding.

3.7 PROJECT MONITORING

3.7.1 ***Cheshire County Council:*** Any proposed changes to the project brief or the project design will be agreed with the Archaeology Officer, Cheshire County Council and the client.

4. WORK PROGRAMME

4.1 The following programme is proposed:

4.2 ***Inspection Survey***

A three day period is required to undertake the site survey.

4.3 ***Detail Survey of the Munitions Plant***

A six day period is required to undertake the survey

4.4 ***Fabric Survey (Level 2)***

A two day period is required to undertake the fabric survey.

4.5 ***Fabric Survey (Level 4)***

An five day period is required to undertake the fabric survey.

4.6 ***Post survey and preparation of report***

A 15 day period will be required to complete this element.

4.7 OA(N) can execute projects at short notice once an agreement has been signed with the client.

4.6 The project will be under the management of **Jamie Quartermaine, BA, Surv Dip, MIFA** (Unit Project Manager) to whom all correspondence should be addressed. The work will be directed by a project officer, who will be appointed once a start date has been agreed with the client. All Unit staff are experienced, qualified archaeologists, each with several years professional expertise. Project Officers in Unit terminology are senior field archaeologists, capable of organising and running complex projects and undertaking less complex work quickly and efficiently to a high standard.

APPENDIX 3
GAZETTEER

The sites are marked on the base plan as site numbers, but these can include within them structure numbers which mark out particular elements observed on the ground. Some information in the gazetteer is taken from the UMAU Assessment report (1999); pre-industrial sites are excluded due to the lack of any known in the area.

Site number **1**
Site Name Ammonia Soda Works Main Building Complex
NGR SJ 7062 7503
Site Type Factory
Period 1908-1926
Source UMAU (1999) Site P10
Description

The Ammonia Soda Works complex is part of a forthcoming study by Alan Moores (forthcoming). The assessment (UMAU 1999) describes the site as: 'a large structure, indicated on the 1908 map (1:2500) and named there as Ammonia Soda Works, this being the largest building complex belonging to those works. The main part of this complex formed a rectangle, *c*75m x 52m, aligned roughly north to south divided by a wall along its long axis. The Tangye sketch [1910-1914] and an early photograph [*c*1910] show this building to have been of two storeys. The eastern half of this building is annotated as Finishing Machines, the western half as Saturators. Adjoining the northern end of the western half of this building, the OS map shows a smaller range, annotated on the Tangye plan as 5 boilers. This plan shows that this building had been extended on the south side, this extension being annotated as 2 new boilers. The accompanying sketch shows these boiler houses as of one or one and a half storeys. To the south of the boiler houses, and west of the main building, the plans shows a detached Boiler Chimney; on the east side of the main building was also a detached chimney, annotated F.M chimney, presumably an abbreviation for finishing machines. Both the sketch and the early photographic evidence show these chimneys to have been the tallest features on the site. Aligned across the northern end of this main building, the 1908 map shows a narrow range, divided along the same axis as the cross-wall in the main building itself. The Tangye plan shows a different arrangement, of a range mainly aligned alongside the eastern half of the main building; that range is annotated as 'Distiller Tower Shed'. On the accompanying sketch and early photograph, this is the tallest building within this complex, at four or five storeys high, with windows on every side. Adjoining this, in turn, on the north was a wider range, shown on the sketch as a one or a one and a half storey building and annotated as Blowing & [?] Vacuum Engine House. To the east of that building and running northwards, the 1908 and Tangye plans show a line of four circular structures, annotated on the Tangye plan and sketch as 'Kilns' (1.5). That sketch shows these as tall cone-shaped structures, set within a shared superstructure. The site of this building complex is vacant on the 1938 map and later maps. However, extensive remains still survive within the woodland.

'The density of the trees means that their full extent and the exact position of individual features is difficult to ascertain. Running immediately south of the central east/west path through the study area, but obscured from that path by the vegetation, is a line of four circular concrete bases [1.5], each 5m wide and at least *c*0.7m high, which can be identified with the bases of the four kilns or Solvay towers indicated on the 1908 plan and by Tangye. To the west of the two southernmost of those tower bases is a group of concrete beds [1.6], with holding down bolts, which correspond to the position of the Blowing and Vacuum Engine House on the Tangye plan and sketch; set within these beds are also two concrete shafts, *c*lm square, one *c*15m deep, the other much shallower but probably infilled. Immediately to the south of this engine house site are the remains of two parallel lines of vertically placed cast-iron or steel 'I' beams, surviving to a height of *c*0.5m [1.7]. These correspond to the site of the four or five storey Distiller Tower Shed, and are presumed to have formed part of that building's supporting frame. To the south of this area are two circular concrete bases, one 6m wide and *c*lm high with a flue hole, the other *c*2m wide, and a square concrete base with two holding down bolts. It is unclear how those features relate to the map evidence, unless the larger of the circular bases belonged to the boiler chimney on the west side of the main building. On the east side of the site, to the east of the southernmost of the four 'kiln' bases, are the remains of a circular iron tub, *c*1.7m in diameter, and *c*0.5m deep [1.9]. To the south of the southernmost of the four kiln bases, are two other

circular bases, each *c*4m in diameter [1.4]. These roughly correspond to the position of what appears to be two chimneys shown on an early photograph. Further south again, are two parallel rows of concrete structures. The more westerly of these comprises three substantial possible bases [1.2], *c*3m wide, *c*3m high, ranging between *c*4m and 7m in length, each with an arched passage, *c*1.7m high and *c*0.7m wide, running along its length, with other such passages running across these. The easterly row [1.3] comprises a line of five or six concrete bases *c*2m wide, *c*2m high, and *c*3m long, with holding down bolts on their upper surfaces; at the northern end of this row there is also a smaller concrete base on the same alignment. These two rows of concrete structures, which are visible on a 1954 1:5000 aerial photograph, lie within the eastern half of the main building, annotated Finishing Machines on the Tangye plan, and are aligned along the long axis of that structure. To the east of these bases, and roughly on the same axis, are three brick-arched culverts [1.10]. The northernmost of these leads via a short inlet and sluice gate (comprising a cast-iron frame with an infill of bricks) into a brick-lined tank, partly silted up but still holding water. This culvert is also linked by a silted up channel to one of the two other culverts, to the south, which also has the remains of a sluice. This lies adjacent to the third culvert, which leads directly into a small pool.'

Very little can be added to this extensive description except for the following details. A series of I-beams was noted west of the engine house, associated with a drain which runs to the north-west out of a brick culvert (1.1). To the south-west of the drain were two concrete ground anchors which may have held a cable to support the boiler chimney described above, as they appeared to have been aligned with it. To the south-west of the arched structures was a series of low walls, which may be the remains of the west wall of the factory; a line of 'I'-beams ran north from these walls, turning westwards towards another concrete base. To the east of the bases was a series of tanks and concrete structures, whose function is uncertain. The series of circular bases (1.4) described to the south of the four main Solvay tower bases was in fact three structures in a row; these had holes in their tops, were made of brick and concrete, and had low passages running north/south through the middle. A collection of concrete blocks and a manhole to the south-west of the factory may be the footings of an outbuilding.

Site number **2**
Site Name Crystal Soda Plant and associated tanks
NGR SJ 7065 7514 (plant) and SJ 7067 7511 (tanks)
Site Type Factory
Period World War I
Source UMAU (1999) Sites P14 and P17
Description

The assessment (UMAU 1999) describes the site as: a 'structure *c*35m x 22.5m shown on the 1908 (1:2500) map, on a site shown as vacant on the 1897 map and again as vacant on the 1938 map. It was named on the Tangye plan as Crystal Plant, and shown on the accompanying sketch as of roughly two storeys with a gabled bay running across its south end. The site of this building includes stone and concrete footings. North of these are three large concrete bases, *c*1.5-2m long, *c*1.5m wide, 2.5m high, with an arched passage, *c*1.6m and 0.2m wide, running along their length; the arrangement is similar to the larger bases at Site P10 [Site 1], but without the transverse passages. To the north-west of these is a brick-lined pit, *c*1m square.'

The site was as described in the assessment, though great numbers of concrete and I-beam stanchions were noted, forming a lattice between the south end of the site and the concrete structure (Structure 2.10). To the north, the stanchions continue along the east and west sides but were notable by their absence in the centre. The north edge was marked by a low mound. To the east of the factory, at approximately the mid-point, was a line of low concrete blocks which may have formed the south edge of the eastern extension shown on the site plans. To the immediate south of the factory were two tanks, which were each 2.5m wide by *c*4m long. There was a large concrete block to the east of the tanks and another small iron tank to the south; a short drain led west from these tanks.

Site number **3**
Site Name Boilers, Mixers and Pans - Munitions Plant
NGR SJ 7095 7492
Site Type Factory
Period World War I

Source 1918 site plans; Site Survey

Description

The building is shown on the 1918 plans as a long rectangular building orientated north/south, the northern section of which was described as 'Pans', and the southern section as 'Boilers and Mixers' on the 1918 Site Plan. The building was situated to the east of the main railway lines (Site 10), and west of the crystalliser shed (Site 4) which ran parallel to it. In the northern part of the complex was a series of rectilinear platforms (salt pans) (3.1, 3.2 and 3.5-7), flanked by a series of east/west aligned linear ditches that led towards an eastern bank and a steep-sided, large, long flat-bottomed ditch to the west (3.11). These east/west ditches probably denote a drainage system associated with the overlying salt pans. The southern part of the complex was relatively open but included a series of concrete pads (3.3 and 3.4), large irregular hollows, and a platform with a square brick structure on top (3.10). The two sections were divided by a pair of parallel banks / walls which would appear to have been dividing walls. The western side of the structure was edged by sharply defined breaks of slope, and in places there were elements of brick facing indicating that this break of slope reflected the line of a brick wall. In the central section of the east side of the building, the edge was defined by another sharply defined break of slope, associated with a series of square / rectangular concrete pads (3.3 and 3.4). To the north the eastern edge of the building was defined by a rather amorphous broad bank. In the southern part of the building, its eastern side was somewhat uncertain; the 1918 Site Drainage Plan shows the building narrowing towards the south, whereas there was a series of concrete stanchion supports (3.9) associated with a north/south ditch which was in line with the building edge further to the north. If element 3.9 was the eastern edge of the building, it would imply that the southern part of the building had a different shape to that shown on the 1918 Drainage Plan.

3.1 An irregular platform edged to the north, south and east by narrow ditches (overall *c*20m x 9.7m); to the east of the east ditch was a broad irregular bank. A central ditch led from the eastern ditch through the broad bank and linked into a further north/south ditch on the east side of the bank. The surface of the platform was irregular, in part reflecting the terrain of a forest floor, rather than that of the original salt pan. There was no extant feature reflecting a basin or trough for the salt pan; and it is to be presumed that the salt pan itself was a component removed during the demolition.

3.2 A series of parallel ditches that extended from the break of slope and marked the western edge of the structure, and a bank at the eastern edge. The ditches to the west ran off into the large north/south ditch (3.11), while at the eastern end some of the ditches terminate, and others diverted through the eastern bank to a north/south ditch to the east of the bank.

3.3 A series of concrete pads and upright stanchions. The largest concrete pad was to the north-west (2.1m square), which was flush with the ground and was on the edge of a large, deep irregular hollow to the west. Nearby, orientated east/west, was a 0.7m high concrete block with securing bolts in the top, which was possibly an engine base. In line with its northern edge were two 'I'-shaped stanchions protruding *c*0.2m from the ground. Also in line to the east was a sandstone pad which was in line with the bank defining the eastern edge of the platform and this may relate to the superstructure of the building. Dominating this part of the building were two very irregular, and deep hollows, which were entirely within the outline of the building. The depressions have not retained water, even though there were several other more formally constructed hollows around in the area which have. There was no sign of structure within them, and one tentative suggestion is that these were the hollows following the removal of deep, large structural components (perhaps boilers) when the site was demolished.

3.4 This comprised two pairs of concrete blocks. The westernmost blocks were flush with the ground, and the northernmost of these had protruding lugs on the east and west sides. Of the eastern pair, the southern block was the larger, extending to *c*0.6m high. The northern block had thick threaded bolts extending from each corner which would suggest that it was a stanchion support. The eastern pair of blocks was associated with an irregular earthen mound that extends parallel to the line of the structure as shown on the 1918 Drainage Site Plan, and was approximately in line with the eastern edge of the building observed to the north.

3.5 A platform edged by ditches to the south, north and east (overall *c*19m x 6.5m). The eastern ditch linked up to the north and south ditches and an offshoot from this extended through the bank at the eastern edge of the platform to a further north/south ditch.

3.6 A rectangular platform edged to the south, north, and east by ditches (overall *c*15m x 11m). In the north-eastern corner was a deep irregular hole of unknown function. An offshoot from the eastern

ditch led into a further ditch running north/south along the eastern edge of the salt pans. To the west, the ditches ran into the large north/south ditch, 3.11.

3.7 A platform edged by ditches to the south and north (overall *c*20m x 6.6m). The southern ditch linked up to an offshoot which extended through the bank at the eastern edge of the platform to a further north/south ditch.

3.8 A pair of parallel, prominent well-defined banks had the appearance of decayed and overgrown walls; they ran the full width of the structure and were possibly end walls or dividing walls of the salt pan sheds. Both extended into the prominent bank which defined the western edge of the structure. The banks were 0.5m high and were very regular in form. Adjacent was a rectangular concrete block which was aligned parallel to these banks and was on the line of the eastern edge of the building.

3.9 A series of structural features at the south-west end of Building 3. From plotting the 1918 Site Drainage Map onto the survey map, this area would appear to have been beyond the extent of Building 3, which was shown to narrow at its southern end. These structural remains, however, were aligned with the edges of the northern part of Building 3 and were potentially related. The principal feature was a linear, brick-edged depression, now water filled, which had an alignment of square concrete pads along the eastern edge of the ditch. The concrete pads, with threaded mounting bolts protruding from the top, were evidently stanchion supports. These were probably the supports for a steel-framed building, and were aligned with the edge of Building 3 to the north (at 3.4). Due west from the southernmost stanchion support was a short section of brick-lined edge, orientated east/west, adjacent to a rectangular hollow, which may reflect an east/west return of the structure. Also within the group were further concrete pads, albeit without mounting bolts, which did not have any consistent relationship or alignment with other exposed elements; their function was uncertain. At the southern edge of the group, near 6.3, was a series of brick-lined depressions on an approximate east/west alignment, which were associated with concrete pads; their function was also unknown.

3.10 This would appear to be a component of Building 3 and comprised an intact brick-sided structure (a), *c*1.5m in height and 2m square, which sat on a concrete base. It was open to the west and adjacent to a rectilinear and much larger structure (b), defined by earthen banks, which were probably the remains of a collapsed superstructure; there was an irregular 'L'-shaped depression in its interior. This rectangular structure was itself on top of an irregular quadrilaterally-shaped, large platform (c), which extended from the northern edge across the whole feature. All elements were interrelated and the structure was in line with the western edge of Building 3, and was probably a related component.

3.11 To the west of the salt-beds is a large, broad, and deep flat bottomed and steep sided ditch. It extends only for the length of the northern part of Building , and was equivalent to the large ditch 21.1 to the east of the Site 5 salt beds. it has no obvious outlet at its northern or southern ends and is presently filled with water.

Site number **4**
Site Name Crystalliser Shed - Munitions Plant
NGR SJ 7105 7492
Site Type Factory
Period World War I
Source 1918-9 site plans
Description

The building appeared on the site plans as a long rectangular structure which was described on the 1918 Site Plan as the 'crystalliser shed'. The building was edged on the western and eastern sides by lines of concrete stanchion supports with steel securing rods protruding (4.7 and 4.8). Within the building was a series of concrete structures which were evidently integral to the crystallisation process (4.1, 4.3 and 4.4) and extending up the middle of the building was a long, linear concrete foundation to which elements, such as floor joists (4.2), were linked. At the northern end of it was a series of ten large upstanding concrete pillars (4.4). East of the arched structure was a linear north/south depression, aligning with structure 4.4, with a concrete block (4.5) to the north.

4.1 A series of concrete irregular-shaped blocks to the north of the putative 'silo' (4.3) associated with a sub-circular chimney base. The chimney base had an irregular shape and was split into two sub-circular sections divided by a rectangular slot, lined with brick; the chimney base survives to a height

of 0.75m. To the north of the chimney base was a concrete machine base with a series of steel mounting bolts protruding, and on its northern side was a concrete rectangular trough. On the north side of the trough was a raised support with mounting bolts protruding, and similar bolts extend from the machine base on the south side of the trough. These appeared to be the axle supports for a pulley wheel and the trough was evidently a wheel pit. The wheel pit was 2.5m long and could have accommodated a wheel of no greater than 2.3m diameter. To the south of the chimney base were two irregular-shaped concrete platforms of unknown function.

4.2 Extending east/west out from the main concrete platform (4.4), and ending at the western wall / edge of the building (4.7), was a series of steel beams set at regular intervals. The beams comprise a pair of opposing 'U' cross-section steel joists, so that they in effect have an 'I' section and provide a flat upper base. They either provided support for a structure or more probably they supported a raised floor between the central structure and the building's edge. The putative floor joists occur only in the south-eastern part of the building.

4.3 This was the highest standing structure within the munitions plant, standing to *c*4.5m. It was a large (2.8m x 2.8m) square concrete structure with a cylindrical interior, and the base of the internal chamber slopes down towards an access hatch on the northern side. The structure was extremely thick and was either intended to take extensive internal pressures or was much higher than present and the thick walls supported a high superstructure. It was constructed of concrete and therefore involved no heat processes. It was probably either a large silo or a mixing vessel. To the east of the structure was a concrete pad and there was another to the south.

4.4 This was the central structure of the crystallisation building. It comprised a long, *c*2.5m wide, concrete platform running almost the whole length of the building, which had, at its northern end, a series (10 in total) of large, high concrete pillars standing to 2.5m height. The pillars were alternately narrow and wide. The narrow ones are solid and the wide ones have a central arch through them. The arches were orientated north / south and were 1.5m high. In the internal sides of the arches, a series of four internal recesses could be seen, at the tops of which were the bolted heads of four large rods; the recesses were probably to provide access to the bolts which extend from the tops of the wide pillars. These were threaded support rods possibly for a linear, and presumably steel, beam running along the tops, and on either side, of the pillars. No rods extend out from the narrow pillars. Extending out from the northern end of the structure was an 'L'-shaped concrete pad, but its function or its relationship with the concrete pillars was not known.

4.5 A rectilinear, elongated concrete platform was against the eastern edge of the building, as indicated by an adjacent stanchion (4.8). The platform had no support rods and was not a machine base. Nearby, and to the south, was a rectangular, brick-edged hollow.

4.6 A series of mainly rectangular platforms was visible in at the northernmost part of the building. The southernmost, and largest, of these extended out from the pad at the northern end of 4.4. This large concrete platform was very poorly defined, being largely overgrown. At its northern edge was a circular, concrete/brick base 1.5m in diameter which was possibly a chimney base. A relatively high concrete pad (0.25m) formed the northern edge of the group and had steel mounting bolts at its corners; therefore the structure was possibly a machine base.

4.7 A series of rectangular stanchion mountings with protruding bolts extended along the full western extent of the building. The line of these stanchion supports corresponded closely to the western edge of the building, as shown on the 1918 Site Drainage Plan (superimposed on the survey plan (Fig 5)). Each concrete pad was 1.25 x 0.7m and had two sets of four bolts, one set at each end. These were the bases for the stanchions of the steel-framed building, and each pad evidently supported two adjacent stanchions. In between each of the stanchion supports was a narrow gully, *c*1m wide, which in places was edged to the east by the sharply defined western edge of a concrete platform. Between this line of stanchion supports and structure 4.4 was a rectangular brick-edged hollow of uncertain function.

4.8 The stanchion supports and gully on the eastern side of Building 4 were closely comparable to those of 4.7; in particular the form of the concrete pads and arrangement of bolts was the same. The gully, however, was narrower (0.7m wide) and was more sharply defined. This was evidently the eastern edge of Building 4 and its line closely corresponded to the eastern edge of the building as shown on the 1918 Site Drainage Plan.

Site number **5**
Site Name Salt Pans
NGR SJ 7115 7492
Site Type Building
Period World War I
Source 1918-9 site plans
Description

A series of salt pans, comprising raised platforms divided by east/west cross ditches which ran into a large north/south ditch (24) to the east of the structure. The long structure appeared to have been subdivided into two structures, as there were prominent walls (5.8), with a separating gap in between, which appeared to define the north and south edges of two shorter structures. The western edge of the building, as shown on the 1918 Site Drainage Plan, corresponded to short sections of north/south bank, and the western edges of the pans. To the south was an alignment of concrete pads against the western edges of the pans and these were possibly stanchion supports for a steel-framed building over the pans. A further north/south bank was observed in line with these concrete pads and adjacent to pan 5.9.

5.1-4 These salt pans comprised well-defined raised platforms, with very well-defined edges to the east, but were less well-defined to the west; to the east it had a sharp drop into a deep, wide drainage channel (21). The northern edge of 5.1 was irregular and less well-defined, but that to the south, and both north and south of 5.2, were sharply defined. The sharp definition suggests that there is an underlying brick or concrete edge to the platform. The surfaces of all four platforms were somewhat irregular. The southern edge of platform 5.3 was ill-defined and the west edge was irregular, and extends to the west of the line of those to the north. Pan 5.4 had an irregular northern edge.

5.5-6 Salt pans 5.5 and 5.6 had the same basic form as 5.1 to 5.4, except that 5.1 was slightly lower, with respect to the external ground surface to the west, but both were very-well defined around all edges. Between 5.5 and 5.6 the drainage ditch had a flat bottom, with a small depression and an associated concrete block in the middle. The surfaces of both platforms were somewhat uneven, though they probably reflected the subsequent surface of the forest floor rather than the original structure.

5.15/5.7 These two pans were broadly similar to those to the north, except that they were less well-defined and 5.7, in particular, had a slightly more irregular edge. To the west of both structures was a north/south bank, which was approximately on line with the edge of Building 5, as defined by the 1918 Site Drainage Plan. To the south of 5.7 were two pairs of concrete pads within sub-rectangular depressions.

5.14/5.8 Pan 5.14 was the southernmost of the block, and was edged to the south by a low brick retaining wall, which was up to 0.75m in height, and formed a clearly defined south-eastern corner. A further brick retaining wall was to the south, defining the northern edge of a further block of salt pans (5.9-13). Between the two was a broad, flat-bottomed gap, which was much larger than the ditches between the salt pans. This would appear to reflect the division between two very similar buildings; however, there was no divide shown on the 1918 Site Drainage Plan. Set against 5.14, on its southern side, was a small square concrete pillar, with an arched recess within; the recess extends below the level of the adjacent ground surface.

5.9-10 Site 5.9 was a very amorphous salt pan, which was generally ill-defined, particularly to the north and south. In the ditch, between this and 5.8, was a large concrete block, apparently *in-situ*, and of unknown function. Along the western edge of platform 5.9 was a linear north/south bank, approximately on the line of the western edge of the building as shown on the 1918 Site Drainage Plan. Site 5.10 was also very ill-defined, although it was better defined to the south. It had a very shallow ditch extending down the middle. It was of similar width to the salt pans in the northern group but was narrower than the rest of the southern group.

5.11/5.16 These two pans were covered in bracken and thus very difficult to discern. They were divided by an ill-defined and shallow ditch, which was shallower than the equivalent ditches to the north of 5.11 and south of 5.16.

5.12 This pan was also covered in bracken but was better defined than 5.11 and 5.16 to the north. It was separated from 5.13 by a relatively well-defined ditch.

5.13 This area was clearly edged to the north by a cross ditch but had no identified southern edge. If it was a pan, there was no corresponding ditch to the south. It was well-defined to the east by drainage channel 24.2.

Site number **6**
Site Name Unnamed building - munition plant
NGR SJ 7075 7488
Site Type Brick-lined tank
Period World War I
Source 2001 Detail Survey
Description

The feature comprised three principal elements: a brick-lined pond (6.1); a series of large concrete blocks (6.2); and a secondary pond and brick-lined channel (6.3) linked to the larger pond. The outline of the larger pond (6.1) appears to correspond to a small rectangular building shown on the 1918 Site Drainage Plan, which was shown as being adjacent to two round features.

6.1 A brick- and concrete-lined irregular-shaped pond, is now filled with water. A series of stanchion supports were located adjacent to the eastern side of the pond and, while no stanchions were observed on the eastern side of the pond, it was probable that these were part a steel-framed superstructure. The 1918 Site Drainage Plan shows two circular features due north from the pond; however, there was no evidence for any circular features in this area.

6.2 A pair of large, prominent concrete blocks were situated to the south of 6.1, the largest of which was 0.6m high. They both had mounting bolts set into the corners and were potentially engine mountings. Both had narrow slits set into the northern sides. The smaller western block was directly adjacent to the end of the pond and it was probable that it was a related component. To the west of the two blocks was a pair of brick-built tanks (2.1m x 1.25m overall); their function was unknown.

6.3 Extending from the northern side of the pond was a secondary pond linked by a brick-lined channel. This was evidently a part of the overall complex, although the function is unknown.

Site number **7**
Site Name Munitions Plant Warehouse
NGR SJ 7065 7492
Site Type Warehouse
Period World War I
Source UMAU (1999) Site P13
Description

7.1 The assessment (UMAU 1999) describes the structure as: ‘a tall warehouse, built of machine-made brick, with twin gables aligned east/west, massive buttresses on the south, west and north, and a mansard roof. In the eastern elevation, each of the two bays contains a horizontal 'I'-beam, centrally supported by two iron pilasters. Beneath these beams and between these pilasters, the brickwork of the wall was inset from a height of *c*1m above the ground; the inset brickwork seems to be infillling, and the whole arrangement was suggestive of blocked loading bays, presumably associated with the railway which ran along this side of the building. In the southern bay in this elevation, there was a blocked camber-headed window above the I-beam. No other windows were observed in the building. There were small doorways, blocked with brick, at the west ends of both the north and south elevations, and a wider shuttered door at the east end of the north elevation. At the eastern end of the south elevation were two tall brick-arched doorways, that on the left narrower than that on the right. Both have been blocked with brick. The thresholds of these two doors were *c*1m above ground level, and the two were evidently once set within a projecting gable, the evidence of which is the ghost of a gabled roof line in the south elevation, complete with holes for the ridge-beam and a purlin on either side'.

7.2 Adjacent to the warehouse were two rectangular brick-lined ponds, each 8m x 18m in size. These were shown on the 1908 OS map, before the construction of the warehouse, and were described on the Tangye sketch and plan (1910-1914) as 'water cooling'.

Site number **8**

Site Name Repair Sheds / Oil Store
NGR SJ 7056 7498
Site Type Building
Period 1908/1914
Source UMAU (1999) Site P8
Description
Described in the assessment (UMAU 1999) as: 'a rectangular structure shown on the 1908 map (1:2500) on a site vacant in 1897. Aligned approximately north/south, *c*75m x 15m, and shown divided into four bays, the three southernmost were each *c*20m long. The plan and sketch by A W Tangye names this building as "Repair Sheds", and shows it as a single-storey structure with a chimney to the rear. On the 1908 map (but not on the Tangye plan) a smaller structure, *c*10m x 7.5m, was shown *c*7.5m to the south. Neither structure was shown on the 1938 map. However, a 1954 1:5000 aerial photograph shows what may have been agricultural material stored on the site of the 'Repair Sheds'; a standing building was also shown on the site of the smaller structure to the south. Both sites were shown as vacant on later maps and aerial photographs examined and now lie within the woodland. A line of low moss-covered dumps of ceramic and other waste material roughly coincides with the site of the larger building; this same area also includes an overgrown brick/concrete-lined pit, *c*l.5m long, lm wide and at least 0.75m deep.'

The survey examined the area of the building, but no dumps of ceramic waste, nor the brick-lined pit, were located, probably due to the high vegetation. The southern building was visible, however, as a low concrete turfed-over wall which corresponds to the given dimensions. This building was marked on the 1918 Site Plan as an 'oil store'.

Site number **10**
Site Name Railway lines and sidings
NGR SJ 7066 7524 - SJ 7075 7482; SJ 7080 7483 (centre)
Site Type Railway
Period 1908
Source UMAU (1999) Sites P16 and P22
Description
A line of sidings, serving the Ammonia Soda Works and the munitions warehouse, was visible as a linear embankment, *c*1m high, covered with trees and adjacent to the main line track still in use. The sidings were shown on the 1908 and 1938 maps, although by the 1954 map the track was no longer shown. The sidings survived as a low wall running east/west; these sidings adjoin the main railway track which runs north as a trunk line, ostensibly for the movement of materials out of the factory. The railway lines were recorded in the assessment (UMAU 1999) as: 'Railway line running north/south across the study area, linking with the main line to the south via sidings (P22). The main plant [Site 1] and the Crystal Plant [Site 2] were each located on either side of this line, which also served the warehouse building [Site 7]. This line was now heavily overgrown but can still be traced for most of its course as an earthwork.' Between the soda ash plant and the northern boundary, a bank with a ditch on the west side was visible. To the east of Site 1 and the warehouse the line divided into two. The course of the eastern branch was visible as an open but water-logged track *c*3-4 wide, while the course of the western branch survived as a boggy ditch of similar width. To the south of the warehouse, the course of the line can be partly traced as a dry ditch. The 1908-1938 maps show a branch line running between the main works complex (Site 1) and the repair sheds (Site 8) and similarly crossing the study area from north to south. However, no evidence for the second line was identified on the ground during the survey.

Site number **11**
Site Name Reservoir
NGR SJ 7056 7495
Site Type Reservoir
Period 1908-1914
Source 1918 Site Drainage Plan
Description
This was a shallow linear reservoir visible to the south of the repair sheds (Site 8), and was shown as an 'Ascol reservoir' on the 1918 Site plan. The pond measured approximately 40m in length and 5m in width, and was full of water when surveyed.

Site number **12**
Site Name Wincham Brook Tributary
NGR SJ 7099 7476
Site Type Brick culvert
Period 1908-1914
Source 1918 drainage maps
Description
A brick and concrete culvert was shown on the 1918 drainage maps running north/south along the east side of the site, replacing a pipe which originally ran on brick pylons (Site 14). This culvert was still running, carrying the brook around the effluent beds. An open Y-shaped drain was visible to the south.

Site number **13**
Site Name Brine Shaft
NGR SJ 7098 7496
Site Type Building (demolished)
Period 1908
Source UMAU (1999) Site P30
Description
Described in the assessment (UMAU 1999) as : 'a Shaft (Brine) shown on the 1908 (1:2500) map, on site vacant in 1897. Shaft was shown as set within an L-shaped structure, with maximum dimensions of *c*1lm x 7m; an elongated earthwork, *c*30m x l0m, was shown immediately to the south. The same arrangement is shown, and the brine shaft is again named, on the 1938 and 1954 maps. This shaft was sunk in 1907. This site is still evident, comprising brick and concrete footings, belonging to three adjacent structures. The remains of the northern two of these were partly obscured by demolition infill. The remains of the southern of the three include the top of the bore pipe. A horizontal pipe also leads north-westward from this site. It is reported that the shaft was in use until the 1960s and that the buildings associated with the borehole were demolished in the early 1980s (A Moores pers comm).'

The remains were still visible, although partially covered by rubble and water (due to flooding of the area). Close inspection was consequently not possible. The borehole was shown, on a 1910 photograph (Plate 1), as topped by a derrick; there were two buildings shown to its east and a further building to the south.

Site number **14**
Site Name Brick Pylon
NGR SJ 7093 7517
Site Type Structure
Period 1908-1914
Source UMAU (1999) Site P26
Description
The assessment report (UMAU 1999) describes the structure as: 'a machine-made brick surround (blue Staffordshire brick), situated within the centre of an extensive pond, and rising *c*2m above the water. The original function of this structure is uncertain, but it was said to have stood adjacent to brick-built cooling tanks, *c*2m high, which were demolished *c*1960 (A Moores pers comm)'.

The brick structure is likely to be a pipe support or pylon for a pipe which ran across the lake; the support was shown on the 1918 drainage plan as holding '*the old 18" pipe for the stream*', later diverted into the culvert (Site 12).

Site number **15**
Site Name Shelter
NGR SJ 7073 7507
Site Type Shelter
Period World War I
Source UMAU (1999) Site P19
The site was described in the assessment (UMAU 1999) as: 'a structure *c*5m wide comprising two parallel concrete walls *c*lm wide, lm apart and standing *c*lm high above ground level. The interior is sunken. The

northern wall is broken by a gap *c*0.5m wide, the base of which is partly filled by brick'. The structure was shown on the 1918 Site Drainage Plan, and it was captioned; however, the text is unreadable on the copy available to OAN. It was immediately adjacent to the Site 5 salt pans and was clearly a related feature; however, it had no mounting bolts and was not an engine mounting; its function is unknown.

Site number **16**
Site Name Brick Pylons
NGR SJ 7065 7520
Site Type Structure
Period World War I
Source 1918-19 site plans
Description
Two brick pylons were visible along the north-west side of the lime beds, with the latter standing *c*4m high and the former 2-3m high. These were square structures and were shown on the 1918 Site Drainage Plan as carrying overhead pipes or cables. To the west-north-west of the easternmost pylon was a square water tank.

Site number **17**
Site Name Dressing rooms/canteen
NGR SJ 7045 7525
Site Type Building
Period 1908 -1914I
Source 1918-19 site plans
Description
The sole remnants of this building were a sub-rectangular low brick (overgrown) wall with a manhole at the north-west end. This building appears to correspond roughly to an outbuilding to the rear of the dressing rooms. The structure measures 10m by 5m and stands 0.5m high. No other remains were visible.

Site number **18**
Site Name Lime Beds
NGR SJ 7085 7520
Site Type Lime Waste Mound
Period World War I
Source UMAU (1999) Site P23
Description
Described in the assessment (UMAU 1999) as: 'extensive lime waste mound, with sides up to *c*8-9m high. These sides have a bank to their upper edge, retaining the inner, dry, lime waste. On the north the bank was capped with material which includes boiler clinker. The upper part of the mound had thin woodland cover and the form of the feature is best understood from map and aerial photographic evidence. The feature was discernible on the 1954 map when it was shown as comprising a large kidney-shaped earthwork with an irregular shaped enclosure on the east. An aerial photograph of 1955 shows the kidney-shaped mound subdivided by banks running roughly north-east to south-west, and on later aerial photographs these banks can still be discerned as lines of trees. The 1955 aerial photographs shows the adjoining irregular enclosure, like the main mound itself, as defined by an external bank. On later aerial photographs that enclosure was distinguishable by its comparative lack of vegetation. The concrete remains of a World War II anti-aircraft position were reported to be situated on the mound (A Moores pers comm), but this site was not located during the present survey.'

The site was shown on the 1918 drainage plan as 'Old Lime Bank' (18a). The same map shows an area to the east of the present lime beds as 'New Lime Bed' (18b) and on the 1918 Site Plan as 'Effluent Lagoon'; this area has now been taken in as a field and has been ploughed extensively, though banking was still visible to the east alongside the culvert (Site 12).

Site number **19**
Site Name Ascol Main Offices
NGR SJ 7045 7514
Site Type Building

Period 1908-1910
Source Site plans 1918-19
Description
West of the Crystal Soda plant, and the north/south railway depression, and immediately adjacent to the track, was a low square brick structure (shown on the 1918 map as a free-standing square building south-east of the offices). This may be another oil store, similar to Site 8. A brick manhole was visible to the south-west. These buildings themselves were no longer visible (apart from a series of dumps of crockery and other waste visible to the north and east of the structure).

Site number **20**
Site Name Shops and Laboratories
NGR SJ 7074 7492
Site Type Building Foundations
Period World War I
Source 1918 Site Plans
Description
A linear building is shown on the 1918 Site Drainage Plan as being a discrete element from the Crystalliser Shed to the north, and was described on the 1919 Site plan as 'Shops - Lab'. The building was edged to the west by a brick-lined wall edge in places, but the western edge was relatively uncertain, in part because where there were observed wall edges these do not correspond to the wall line from the 1918 Site Drainage Plan.

20.1 A rectangular, almost square-shaped structure was identified at the northern end of the Shops / Labs part of the complex. It was edged to the east by a brick-lined wall edge, which was lost at the north-east corner, but also extended part way along the northern edge of the structure. The western edge of the brick structure was very overgrown but would appear to correspond to the eastern side of a small ditch which runs north / south. The southern edge was very-ill defined but corresponded to a break of slope which terminated at a concrete stanchion support; this ill-defined edge was potentially an internal division, although there was no evidence of a north/south wall continuing south from the western side of 20.1. To the western of the brick structure were five interrelated concrete stanchion support blocks. Four of the blocks formed a well-defined rectangle, and a fifth continued the eastern line to the north, but there was no evidence for a block continuing the western line. A sixth block was to the south of the four and not in alignment and, despite its proximity, may not be a related component.

20.2 The central section of the building was a relatively featureless area edged by the brick wall to the east; the only edge on the western side was an ill-defined break of slope extending south from a large concrete pad to the south of 20.1. At the south of this break of slope was an ill-defined eastern return which linked with a further short section of north/south break of slope. None of these breaks of slope correspond to the lines of the building as shown on the 1918 Site Drainage Plan.

A line of four concrete stanchion supports extended north / south near the northern part of 20.2 and its northernmost stanchion support was on the line of the southern wall of 20.1.

20.3 An amorphous mound edged to the east by a brick wall and an irregular break of slope to the west lay to the south of 20.2. The brick-edge to the east corresponded to the line of the 'Shops-Lab' building on the 1918 Site Drainage Plan but there were no structural components corresponding to the western edge of the structure. In the centre of the mound were two upright 'I'-section stanchions. A further stanchion support was located at the southern end of the feature.

Site number **21**
Site Name Munitions Plant
NGR SJ 7075 7505 - 7079 7485
Site Type Drainage Ditch
Period World War I
Source 1918-9 site plans; Detail Survey 2002
Description

21.1 A broad ditch (*c*13m across), to the east of the northern salt pans of Site 5, took the outfall from the salt pans. It was very deep, up to 1.5m below the adjacent salt pans. Along its eastern side was a deeper and narrower, possibly formerly culverted, drain.

21.2 A broad ditch (*c*7.25m across), but narrower than 21.1, ran to the east of the southern salt pans of Site 5. It was up to 1.5m deep and was fed by the cross ditches between the salt pans. There was a culverted channel running through the base of the ditch. The cross ditch between pans 5.11 and 5.10 became a causeway that extended across the broad ditch; the culverted channel began to the immediate south of this causeway.

Site number **22**
Site Name Munitions Plant
NGR SJ 7071 7505
Site Type Spoil Heaps
Period World War I
Source 1918-9 site plans
Description
A series of 13 small circular spoil heaps was located to the north of the Crystalliser Shed. There was, however, no direct relationship between these spoil mounds and the shed (Site 14) and they were probably related to later works carried out in the area and not to the munitions plant.

Site number **23**
Site Name Salt Pans (munitions plant)
NGR SJ 7077 7504 - 7081 7485
Site Type Salt pans
Period World War I
Source 1918 site plans
Description
A long linear ditch was identified adjacent to the broad ditch (Site 21) to the east of the salt pan complex, Site 5. It corresponds in position to a building shown on the 1918 Site Plan as 'Salt Pans'. There were none of the cross-ditches of Site 5 evident; however, it has not been examined in detail as part of the munitions plant survey. It was recorded as part of the initial assessment (LUAU 2000).

ILLUSTRATIONS

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PLATES

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Oxford Archaeology (North)

January 2001

CHESHIRE STRATEGIC PROGRAMME OF RECLAMATION PLUMLEY LIMEBEDS, NORTHWICH

CHESHIRE

ARCHAEOLOGICAL SURVEY

Proposals

The following project design is offered in response to a request from Cheshire County Council, Environmental Planning, for an archaeological survey of Plumley Limebeds, Northwich.

1. INTRODUCTION

1.1 CONTRACT BACKGROUND

1.1.1 Oxford Archaeology (North) (OA(N)), formerly Lancaster University Archaeological Unit, has been invited by Cheshire County Council Environmental Planning to submit a project design and costs for a field inspection, an archaeological survey and fabric survey at Plumley Limebeds, Northwich, Cheshire. The work is being undertaken in advance of a programme of reclamation and environmental improvement of the site for leisure and recreation. This follows on from and is informed by an archaeological assessment of the overall study area undertaken by the University of Manchester Archaeological Unit in August 1999 (UMAU 1999). The project design is in accordance with a brief by the Archaeology Officer (Development Control) of Cheshire County Council. The land is presently a nature reserve but is on the site of a former ammonia soda works complex, which has been highlighted as being of particular importance in a recent step 1 report on the Chemical Industry for the Monuments Protection Programme of English Heritage (D Cranstone, pers comm).

1.2 ARCHAEOLOGICAL BACKGROUND

1.2.1 The ammonia soda works dates from 1912 with the establishment of the Ammonia Soda Company Ltd (ASCOL) which was established to manufacture Soda Ash. In 1916 the site was acquired by Brunner Mond and Co and the site started the manufacture of calcium nitrate, which was used in the manufacture of explosives. In 1919, following the end of the First World War the plant was closed, ostensibly because of the drop in demand for munitions (UMAU 1999).

1.2.2 Maps produced in 1918 show that there were two main plants, the earlier soda ash plant in the eastern part of the site, and the larger munition plant towards the southern end of the site. The eastern and northern part of the site was occupied by large lime waste mounds. The Ordnance Survey map of 1938 shows that although the railway network of the site was still in place, all but a large warehouse and a two smaller structures were then standing. The warehouse was originally constructed to store munitions, and, as a result, was supported by extensive buttresses to make it blast proof. Its survival through to the present in part reflects its over engineered structural integrity and also that it was subsequently used for storage by the nearby Associated Ethyl works which were constructed in 1939 to provide ethylene glycol for aircraft engines. By 1950 OS mapping shows that the railway network in the area had been removed (UMAU 1999).

1.3 OXFORD ARCHAEOLOGY (NORTH)

1.3.1 OA(N) has considerable experience of the evaluation and excavation of sites of all periods, having undertaken a great number of small and large scale projects during the past 18 years. Evaluations and assessments have taken place within the planning process, to fulfil the requirements of clients and planning authorities, to very rigorous timetables. OA(N) undertook the initial assessment of the area as part of the Cheshire (Weaver Valley) Rolling programme (LUAU 1992) and has also undertaken a fabric survey of buildings within the nearby Brunner Mond plant at Lostock Gralam (LUAU 1998). OA(N) has also undertaken numerous assessments, landscape surveys and evaluations on industrial sites throughout the

North-West. OA(N) has the professional expertise and resource to undertake the project detailed below to a high level of quality and efficiency. OA(N) and all its members of staff operate subject to the Institute of Field Archaeologists (IFA) Code of Conduct and Oxford Archaeology is a registered organisation with the IFA (no 17).

2. OBJECTIVES

2.1 The following programme has been designed in accordance with a brief by Mark Leah, Archaeology Officer (Development Control) for Cheshire County Council to create an identification map of the surviving remnants of the site, to provide an inspection survey of the area, to undertake a detailed survey of the First World War Munitions Plant and to undertake a fabric survey of the large warehouse. The required stages to achieve these ends are as follows:

2.2 INSPECTION SURVEY

2.2.1 An inspection survey will be undertaken to enhance an existing topographic survey of the site. It will involve the annotation of the earlier survey record and should correlate the surface evidence with the historic maps. The field survey would be undertaken in conjunction with Mr Alan Moores, who has considerable knowledge of the site and its operation.

2.3 DETAIL SURVEY

2.3.1 A programme of detail landscape survey will be undertaken of the First World War Plant, and the results will be incorporated with those of the inspection survey.

2.4 FABRIC SURVEY OF THE BLAST-PROOF WAREHOUSE

2.4.1 A survey to RCHM(E) Level 2 will be undertaken of the building, and an option for the implementation of an RCHM(E) Level 3 survey is also costed.

2.5 SURVEY REPORT

2.5.1 A written report will assess the significance of the data generated by this programme within a local and regional context. It will examine the archaeological implications of the reclamation and landscaping proposals.

3. METHODS STATEMENT

3.1 The following work programme is submitted in line with the stages and objectives of the archaeological work summarised above.

3.2 FIELD INSPECTION

3.2.1 It is proposed that a basic identification survey of the study area be undertaken extending over an area of 0.25sqkm. This will serve as the basis for planning and

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undertaking further archaeological work on the site and represents the minimum standard of record, it being appropriate to exploratory survey aimed at the discovery of previously unrecorded sites. Its aim is to record the existence, location and extent of surviving surface features, and will involve the annotation of maps of the site provided by Cheshire County Council.

3.2.2 At present the area is considerably overgrown with both undergrowth (nettles) and leaf overgrowth to the extent that considerable areas are inaccessible, and will severely inhibit any surface recording programme. It is therefore recommended that the survey be undertaken in the Autumn when the density of vegetation will be diminished. The reconnaissance will be undertaken in a systematic fashion, walking on approximately 10m wide transects within the extent of the defined study area, but the interval will be varied according to the density of the undergrowth and the sensitivity of the area; hence more intensive investigation will be undertaken in the area of the industrial plants and less intensively in the area of the lime mounds. The reconnaissance will be undertaken in conjunction with Alan Moores who has considerable knowledge of the site.

3.2.3 As required in the brief, the survey will involve the enhancement of the existing topographic survey to show greater detail than is already shown and to depict elements of features that are not presently depicted. There is no requirement for new survey work to be undertaken, and therefore any identified features that are remote from detail depicted on the maps will not be located to as high a level of accuracy. There are considerable amounts of earthwork detail extending across the whole of the site which are not shown on the topographic survey and, because of the difficulty in recording detail that is remote from depicted detail, the more subtle earthworks features will not be recorded.

3.2.4 The base survey can be provided within a CAD format, and consequently the annotations will be transferred from the site paper copy into the base drawing as a separate layer within a CAD system (AutoCAD14). The features will be cross referenced with those features shown on the 1918 map of the site, which will be presented as a rasta backdrop within the CAD drawing to enhance the correlation between the surviving and the historic features. The maps will be depicted with site numbers corresponding to the gazetteer of the documentary study in order further to enhance the correlation between the observed and the documentary records.

3.3 DETAIL SURVEY OF THE FIRST WORLD WAR PLANT

3.3.1 ***Reconnaissance:*** a reconnaissance will be undertaken of the area of the First World War Plant. The extent of the survey will be determined by what can be surveyed within the six days of fieldwork. The survey will concentrate on the core area in the heart of the complex and if areas can not be recorded they will be the areas of lesser archaeological significance around the periphery of the complex. The reconnaissance will consist of systematic field walking, of the study area to identify sites for accurate survey. The survey will aim to identify, locate and record features on the ground that will need to be recorded.

3.3.2 The area has in places dense ground cover and can only be undertaken during the winter / spring months.

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3.3.3 ***Instrument Survey:*** it is proposed to undertake a level 2b survey (see OA(N) survey levels, *Appendix 1*) of the sites identified by the walkover, which is equivalent to RCHM(E) level 2. All appropriate topographic detail will be recorded to provide an appropriate context for the archaeological detail. Although the survey data will include altitude information this will not be used for the production of the level 2b survey (unless the contour survey option is adopted).

3.3.4 Survey control will be established over the site by closed traverse and internally will be accurate to +- 15mm; the control network will be located onto the existing Survey of the site by tying into clearly defined topography such as the warehouse).

3.3.5 The surface features will be surveyed by EDM tacheometry using a total station linked to a data logger, the accuracy of detail generation being appropriate for a 1:500 output. The digital data will be transferred onto a portable computer for manipulation and later transfer to other digital or hard mediums. Film plots will be output via a plotter. The archaeological detail will be drawn up in the field as a dimensioned drawing on the plots with respect to survey markers. Most topographic detail will also be surveyed, particularly if it is archaeologically significant or is in the vicinity of archaeological features. The survey drawings will be generated within a CAD system and will be merged with the initial phase 1 survey (*Section 3.2*). The results can be output at any scale.

3.3.6 ***Photographic Survey:*** in conjunction with the archaeological survey a photographic archive will be generated, which will record significant features and general landscapes. It will be undertaken in 35mm black and white and colour slide film.

3.3.7 ***Site gazetteer:*** the survey would be accompanied by a gazetteer description of individual archaeological features, which will relate directly to the survey mapping. This stage of the survey will involve a detailed assessment of the site and its general context and will be undertaken by an experienced industrial archaeologist. It will expand upon the gazetteer of the interim report.

3.4 LEVEL 2 FABRIC SURVEY OF THE WAREHOUSE

3.4.1 ***Plans:*** a ground plan of the warehouse will be created by means of a reflectorless total station. The reflectorless total station is capable of measuring distances to architectural detail by reflection from the surface of that detail element; consequently it does not require the placement of a prism on the detail. It is therefore an ideal tool for the recording of detail where there is limited access. The survey will be undertaken with respect to a series of accurately surveyed control stations established by traverse around the outside of the building. Where possible the survey of the plan will be enhanced by manual survey techniques onto a film base. The survey will record all significant, extant structural elements, inclusive of blocked apertures, masonry joints and changes in internal levels. The graphic results of the survey will be digitised into an industry standard Computer Aided Draughting (AutoCAD 14) system to enhance the manipulation and presentation of the results.

3.4.2 ***Photographic Survey:*** a general oblique photographic survey will be undertaken of the warehouse in accordance with the RCHM(E) Level 2 recording. The record

would be fully indexed and photographic views would be shown with respect to the existing architects' plans.

3.4.3 A conventional monochrome medium format record would be undertaken of the warehouse including external elevations and appropriate architectural detail. A record would be made in 35mm colour print and black and white formats of the room interiors and would, show similar detail to the medium format record as well as a broad range of generalised views.

3.4.4 The photographic record of the warehouse will include:

i) General external coverage (colour print and medium format black and white).

ii) General internal coverage (black and white contact prints and colour print (35mm)). This will include internal elevations of the rooms.

iii) General views showing the buildings relationship to other associated buildings and showing the overall setting.

iv) Close-up views of significant internal and external architectural details (black and white contact prints and colour print (35mm)).

v) General views of representative structural detail (black and white contact prints and colour print (35mm)).

vi) Detail views of the roof structure (black and white contact prints and colour print (35mm)).

3.4.5 ***Description and Analysis:*** a visual inspection of the site will be carried out and a basic level of descriptive record will be created in accordance with the Royal Commission on Historic Buildings in England (RCHME) Level 2 standard. It will involve the internal and external examination of the extant fabric, and will generate a summary assessment of the period and significance of the buildings.

3.5 LEVEL 4 FABRIC SURVEY OF THE WAREHOUSE

3.5.1 In addition to that undertaken for Level 2, this would normally require additional survey drawings, and in particular the drawing of cross-sections through the building, detail drawings of structural detail such as trusses and drawings of key elevations. The photographic requirements would be for any internal and external detail relevant to the building's design which is not adequately covered by the general photography for the level 2 survey, and also photography which relates the building to its setting; in addition it would provide rectified photography to enable the production of elevation drawings (*Section 3.5.2*). The written account would involve the account of the buildings form and development, an account of the building's past and present use, evidence for the former existence of demolished structures associated with the building, copies of documentary records of the building, and secondary information relating to the building.

3.5.2 ***Survey Drawings:*** two cross sections will be produced: a north/south cross section across the line of the roofs, and an east/west cross section through the centre of the northern bay. Selected elevations will be drawn so as to record the more important elements of the structure, but will not result in unnecessary duplication; it is proposed to record the following elevations: North external elevation, south

internal elevation, west internal elevation, east external elevation and the north face of the internal dividing wall. The cross sections would be surveyed by means of the reflectorless instrument (*Section 3.4.1*), and would then be plotted for on-site manual survey enhancement. The elevations would be surveyed by a combination of reflectorless instrument survey and rectified photography. Rectified photography will be taken from near ground level and will capture all but the elevation tops; it will be undertaken by in-house survey specialists and will be undertaken in black and white using a medium format camera. Control for the rectified photography will be provided by reflectorless instrument, and will record the locations of clearly defined elements of structural detail rather than targets to prevent the need for physically accessing the walls; it will also record the tops of the elevations. The rectified photography will be output at an appropriate scale; it will be scanned into a computer and presented as a raster backdrop within AutoCAD. Where there is any distortion within the photographic base, the digital image will be subject to digital correction using Archis software to convert the images to fully rectified images. The corrected images will then be incorporated as a rasta backdrop within AutoCad and the elevation drawings will be drawn up as a vector drawing from the rectified base.

3.5.3 The final drawings will show all significant stone detail, such as quoins, and significant brick detail, but will not involve the digitising of all brick detail.

3.5.4 The analytical approach for the Level 4 survey will be the same as that applied to the Level 2 survey, although there will be additional recourse to undertaking an investigation of the site within libraries and the Cheshire Record Office, and would follow on from that undertaken to date by the documentary assessment (UMAU 1999). A visual inspection and analysis of the building would be carried out by experienced in-house staff. The visual inspection will allow for the interpretation and analysis of the building. It will involve the internal and external examination of the extant fabric, where health and safety allows, and will generate a description and assessment of the period and significance of the building. Where possible it will define the form and character of the building within a regional context.

3.5 SURVEY REPORT

3.5.1 ***Archive:*** the results of Stages 3.1-3.5 above will form the basis of a full archive to professional standards, in accordance with current English Heritage guidelines (*Management of archaeological projects*, 2nd edition, 1991). The project archive represents the collation and indexing of all the data and material gathered during the course of the project. The deposition of a properly quantified, ordered, and indexed project archive in an appropriate repository is considered an essential and integral element of all archaeological projects by the Institute of Field Archaeologists in that organisation's Code of Conduct. This archive will be provided in the English Heritage Centre for Archaeology format, as a printed document, and a synthesis (the survey report and index of the archive) will be submitted to the relevant Sites and Monuments Record. The archive will be deposited with the County SMR within six months of the end of the fieldwork.

3.5.2 All drawings will be produced within a CAD system and can be output at any size or medium that is required. Each sheet will be fully titled. Particular attention will be paid to achieving drawings of the highest quality and accuracy.

3.5.3 The archive will be formed of all the primary documentation, including the following:

- Survey Information
- Building Record Sheets
- Context Records
- Finds Records
- Sample Records
- Field / Inked Drawings and digital copies of CAD data
- Photographic negatives, prints and colour transparencies
- Written report
- Administrative records

3.5.4 ***Report:*** three copies of a written synthetic report will be submitted to the client and two copies to the SMR. The report will present, summarise, and interpret the results of the programme detailed in Stages 3.1-3.5 above, and will include an index of archaeological features identified in the course of the project, with an assessment of the sites development. It will include the following:

- Summary of the results
- Acknowledgements statement
- Methodology statement
- Copies of the brief and project design
- Summary of past and present land-use
- Summary of the historical background
- Location Plan
- Plans, cross sections and elevations
- Monochrome and colour photographs as appropriate
- Description of archaeological features
- An interpretation of the results
- Statement of the archaeological implications of the proposed development.

3.6 OTHER MATTERS

3.6.1 ***Access:*** it is understood that access to the site will be arranged by the client, who will also negotiate with English Nature for the work to be undertaken within the reserve. It is presumed that the client will have responsibility for site security.

3.6.2 ***Health and Safety:*** OA(N) conforms to all health and safety guidelines as contained in the Oxford Archaeology Manual of Health and Safety and the safety manual compiled by the Standing Conference of Archaeological Unit Managers. The work will be in accordance with Health and Safety at Work Act (1974), the Council for British Archaeology Handbook No. 6, *Safety in Archaeological Fieldwork* (1989). All site procedures are in accordance with the guidance set out in the Health and Safety Manual compiled by the Standing Conference of Archaeological Unit Managers (1991) and risk assessments are implemented for all projects.

3.6.3 ***Confidentiality:*** the report is designed as a document for the specific use of the client, for the particular purpose as defined in the project design, and should be

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treated as such; it is not suitable for publication as an academic report, or otherwise, without amendment or revision. Any requirement to revise or reorder the material for submission or presentation to third parties beyond the project brief and project design, or for any other explicit purpose can be fulfilled, but will require separate discussion and funding.

3.7 PROJECT MONITORING

3.7.1 ***Cheshire County Council:*** Any proposed changes to the project brief or the project design will be agreed with the Archaeology Officer, Cheshire County Council and the client.

4. WORK PROGRAMME

4.1 The following programme is proposed:

4.2 ***Inspection Survey***
A three day period is required to undertake the site survey.

4.3 ***Detail Survey of the Munitions Plant***
A six day period is required to undertake the survey

4.4 ***Fabric Survey (Level 2)***
A two day period is required to undertake the fabric survey.

4.5 ***Fabric Survey (Level 4)***
An XXX day period is required to undertake the fabric survey.

4.6 ***Post survey and preparation of report***
A 15 day period will be required to complete this element.

4.5 OA(N) can execute projects at short notice once an agreement has been signed with the client.

4.6 The project will be under the management of **Jamie Quartermaine, BA, Surv Dip, MIFA** (Unit Project Manager) to whom all correspondence should be addressed. The work will be directed by a project officer, who will be appointed once a start date has been agreed with the client. All Unit staff are experienced, qualified archaeologists, each with several years professional expertise. Project Officers in Unit terminology are senior field archaeologists, capable of organising and running complex projects and undertaking less complex work quickly and efficiently to a high standard.

REFERENCES

Lancaster University Archaeological Unit (LUAU), 1992 *Cheshire Weaver Valley Rolling Programme: an archaeological assessment*, unpubl rep

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Lancaster University Archaeological Unit (LUAU), 1998 *Platts Hall, Northwich, Cheshire: Fabric Survey,* unpubl rep

University of Manchester Archaeological Unit (UMAU), 1999 Cheshire Strategic Programme of Reclamation: an archaeological assessment, unpubl rep

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0 500 1000 1500
metres

Fig 1: Plumley Limebeds Study Area: Location Map

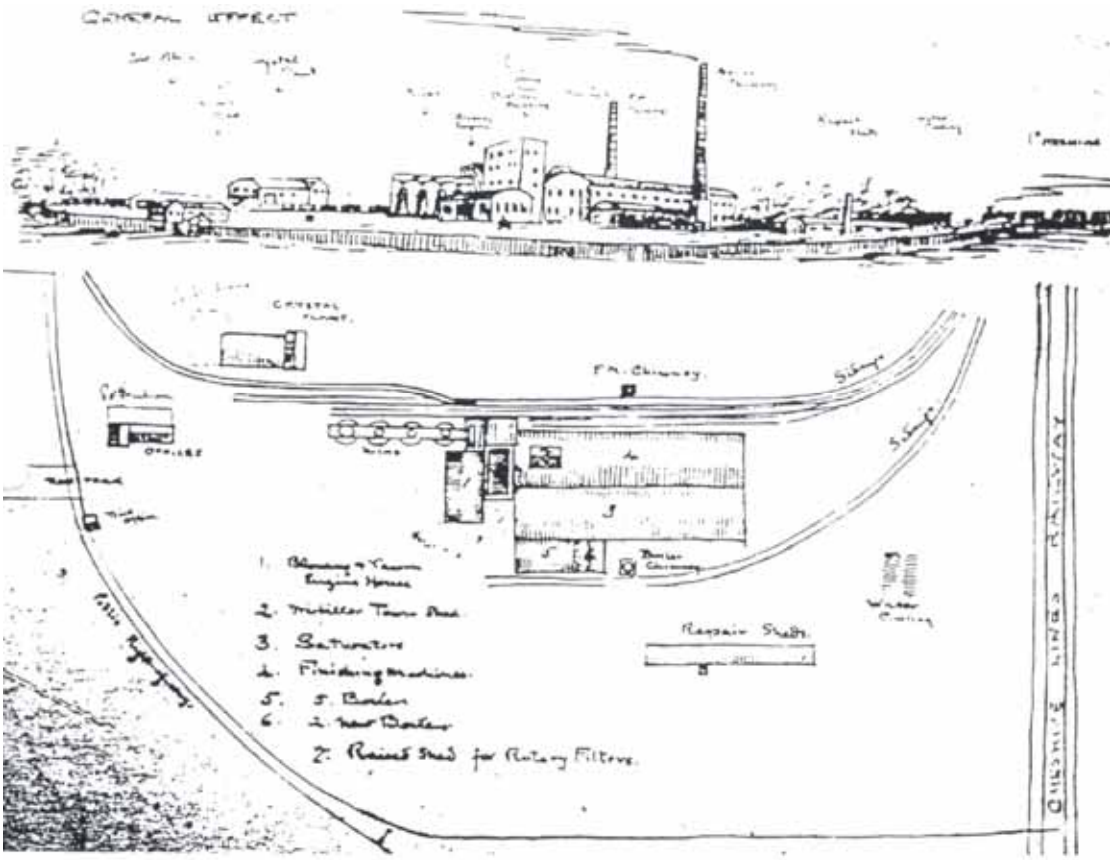


Fig 2 Plan and sketch of the Ammonium Soda Company Ltd works by AW Tangye (dated 1910-14)

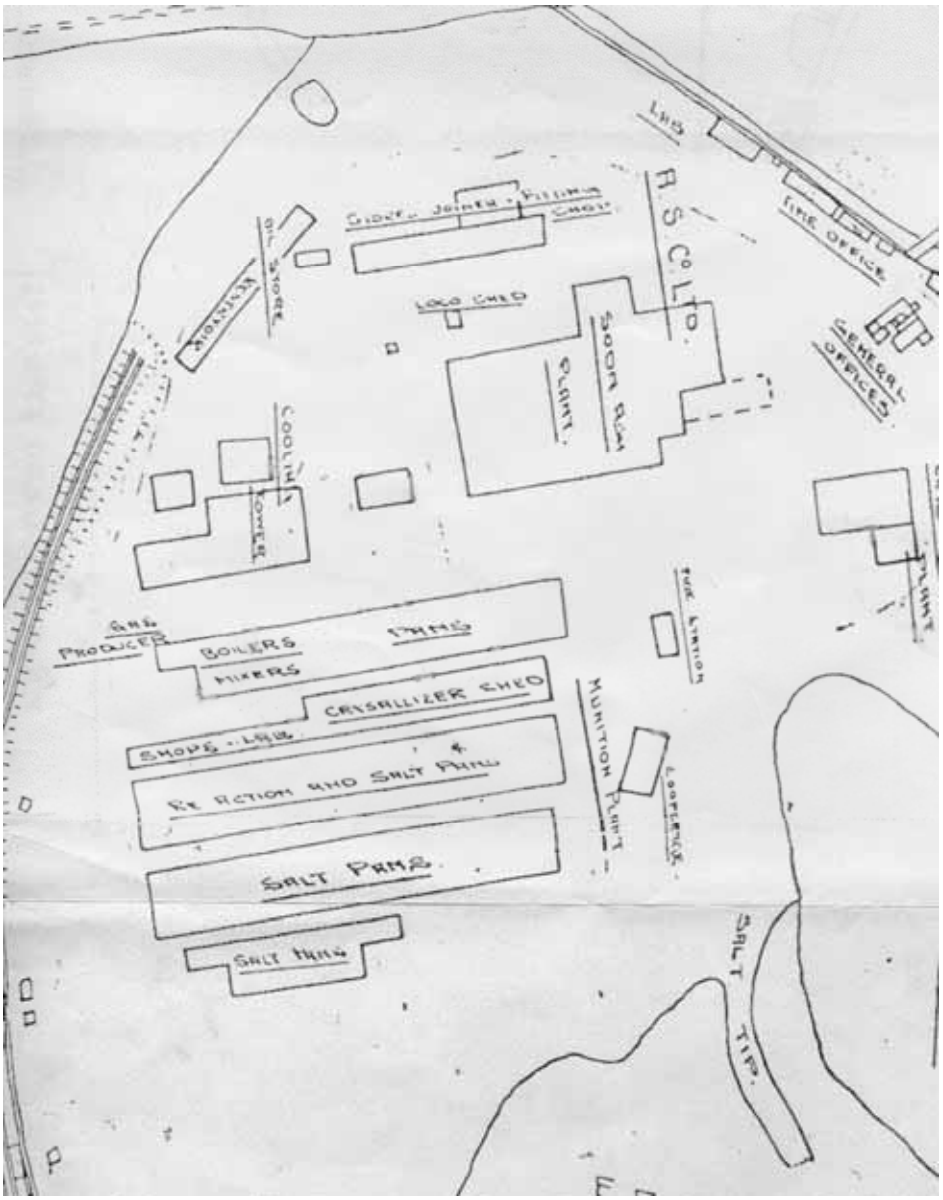
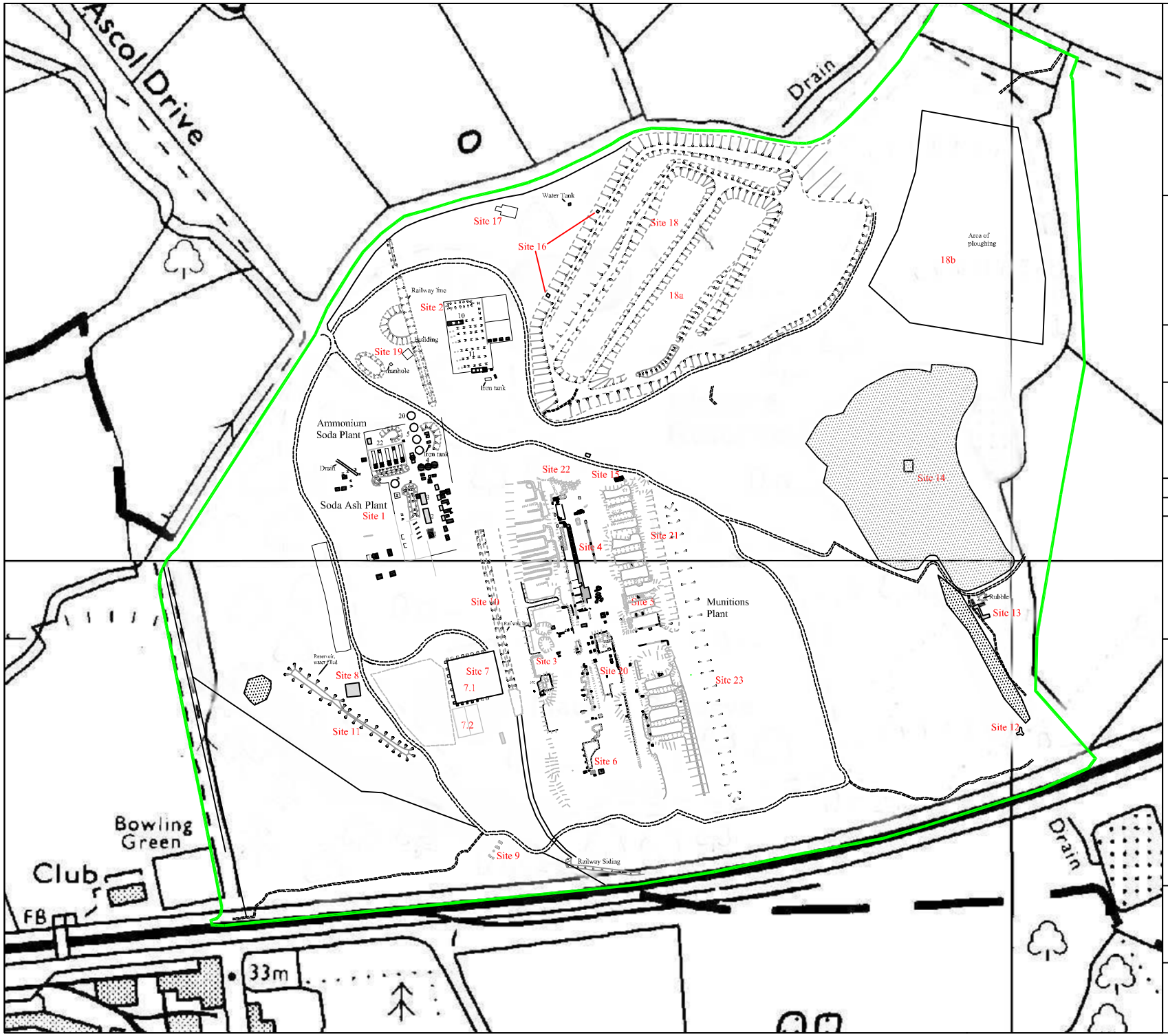


Fig 3 1918 Site Plan: a schematic plan of the plants annotated with the functions of the structures

Fig 4: 1918 Site Drainage Plan showing the layout of the ASCOL and Munitions plants



Oxford Archaeology North
Storey Institute
Meeting House Lane
Lancaster
LA1 1TF

Tel 01524 848666
Fax 01524 848606

PROJECT:

Plumley Limebeds Survey

DRAWING No: 5

0 100m

Scale 1:2500

DRAWN BY: A.S.

DATE: January 2002

LOCATION:

N

KEY

- Concrete
- Wall
- Original Survey
- Inspection Survey
- Path
- Probable Wall
- Pond
- Study Area Boundary

TITLE:

Inspection and Detail Survey Results

COMMISSIONED BY:

Cheshire County Council

Fig 5: Topographic Survey Map of the Plumley Limebeds

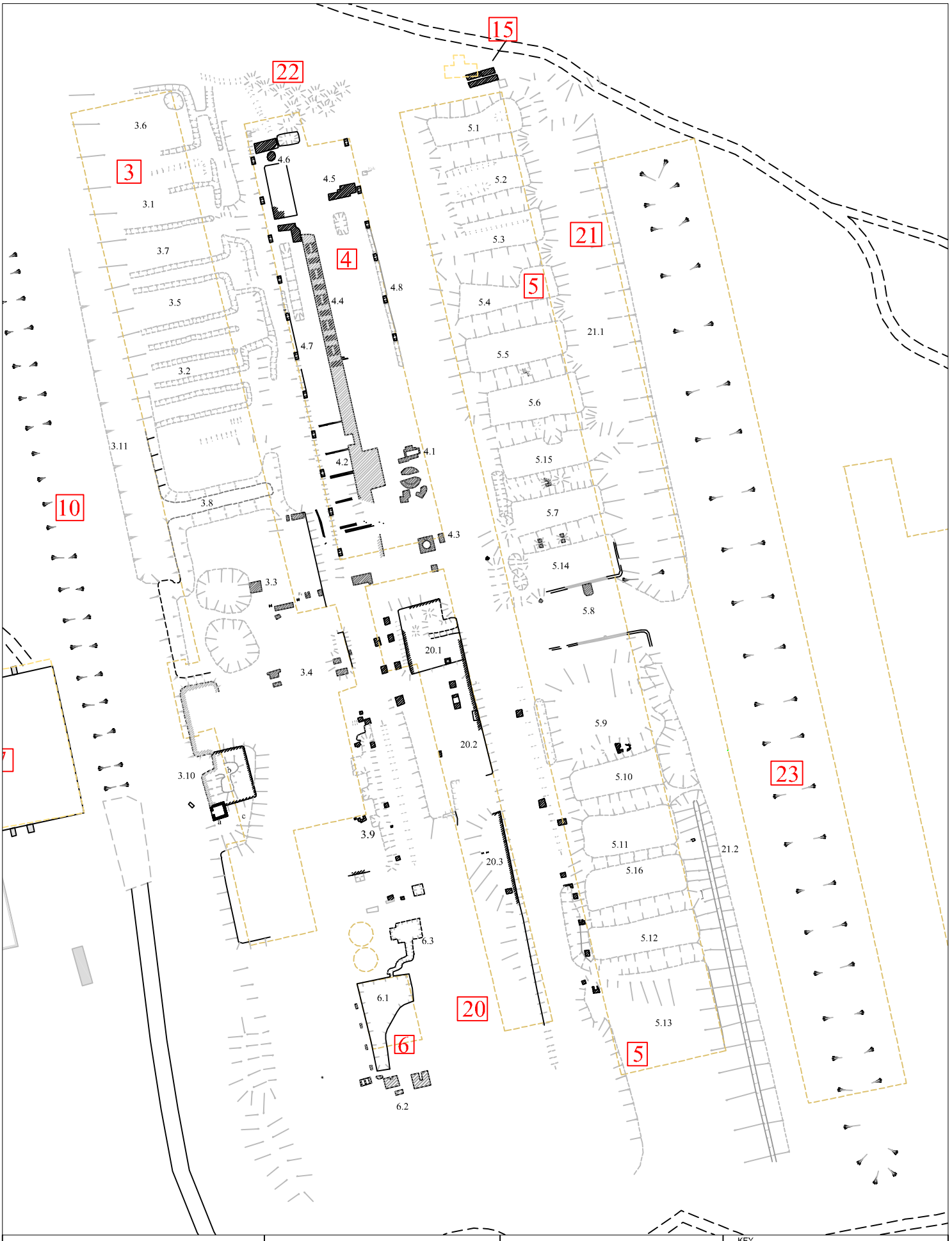
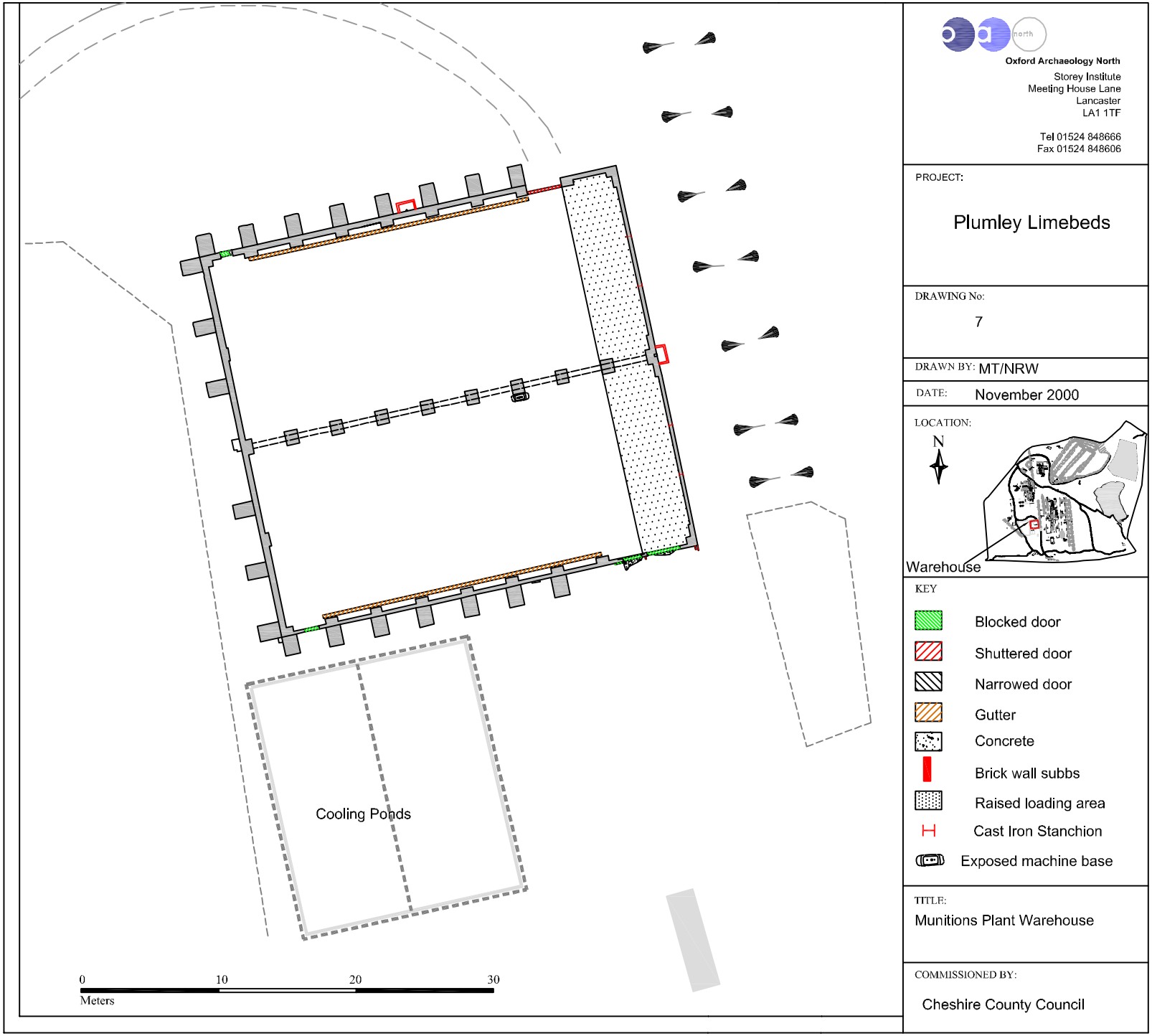


Figure 6: Munition Plant: Detailed Survey Plan



Oxford Archaeology North
Storey Institute
Meeting House Lane
Lancaster
LA1 1TF

Tel 01524 848666
Fax 01524 848606

PROJECT:

Plumley Limebeds

DRAWING No:

7

DRAWN BY: MT/NRW

DATE: November 2000

LOCATION:

N

Warehouse

KEY

- Blocked door
- Shuttered door
- Narrowed door
- Gutter
- Concrete
- Brick wall subbs
- Raised loading area
- Cast Iron Stanchion
- Exposed machine base

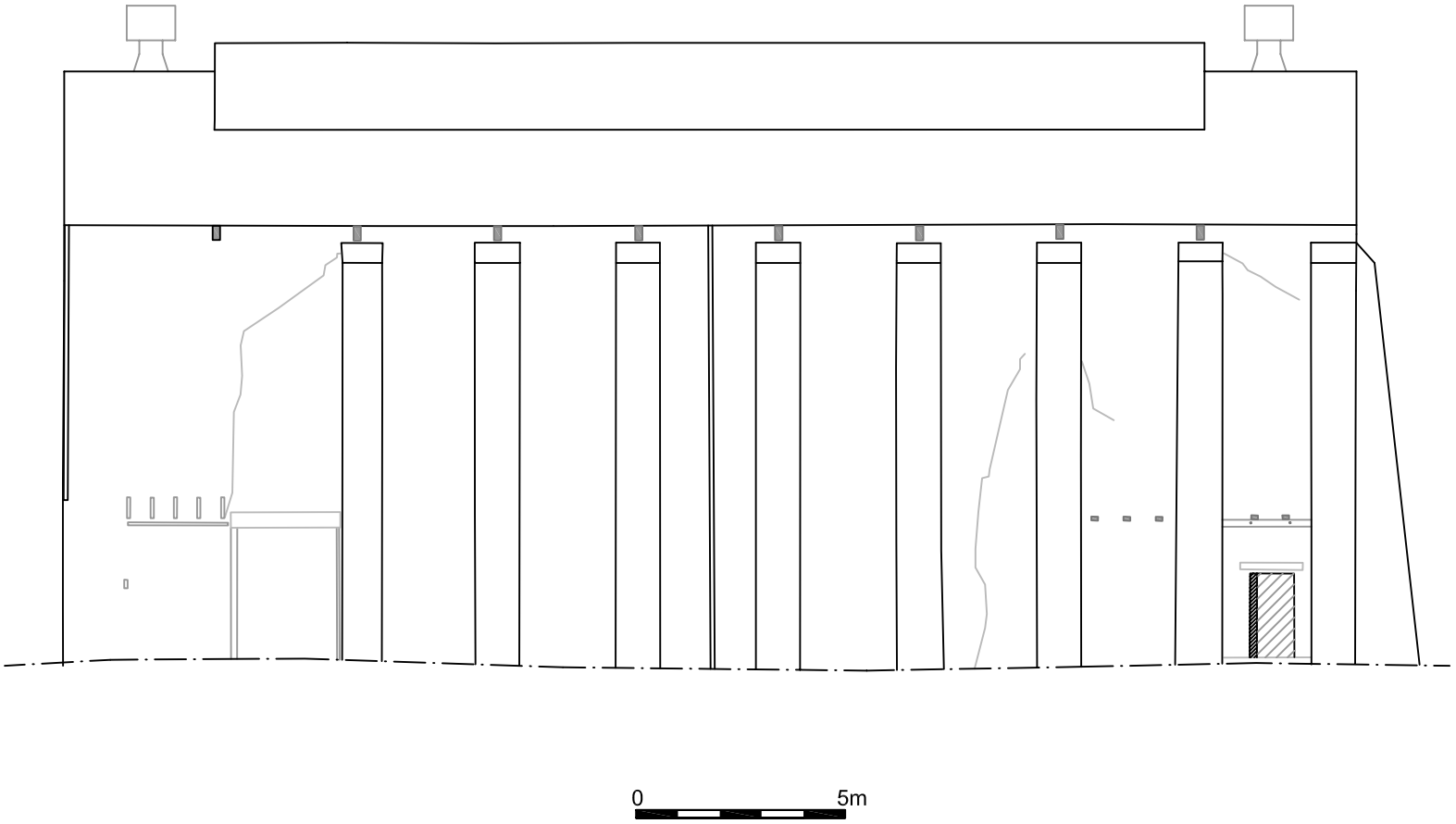
TITLE:

Munitions Plant Warehouse

COMMISSIONED BY:

Cheshire County Council

Fig 7: Warehouse Plan



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Storey Institute
Meeting House Lane
Lancaster
LA1 1TF

Tel 01524 848666
Fax 01524 848606

PROJECT:

Plumley Limebeds

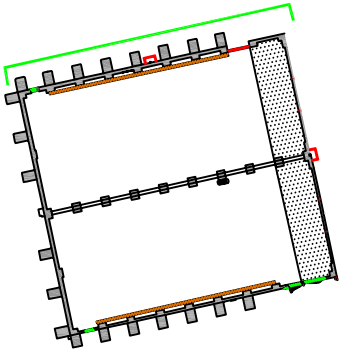
DRAWING No:

8

DRAWN BY: CW and EC

DATE: 2 / 2002

LOCATION:



KEY

- Phase 2
- Metal
- Sandstone
- Area of Blocking
- Projected Line of Wall
- Limit of Survey

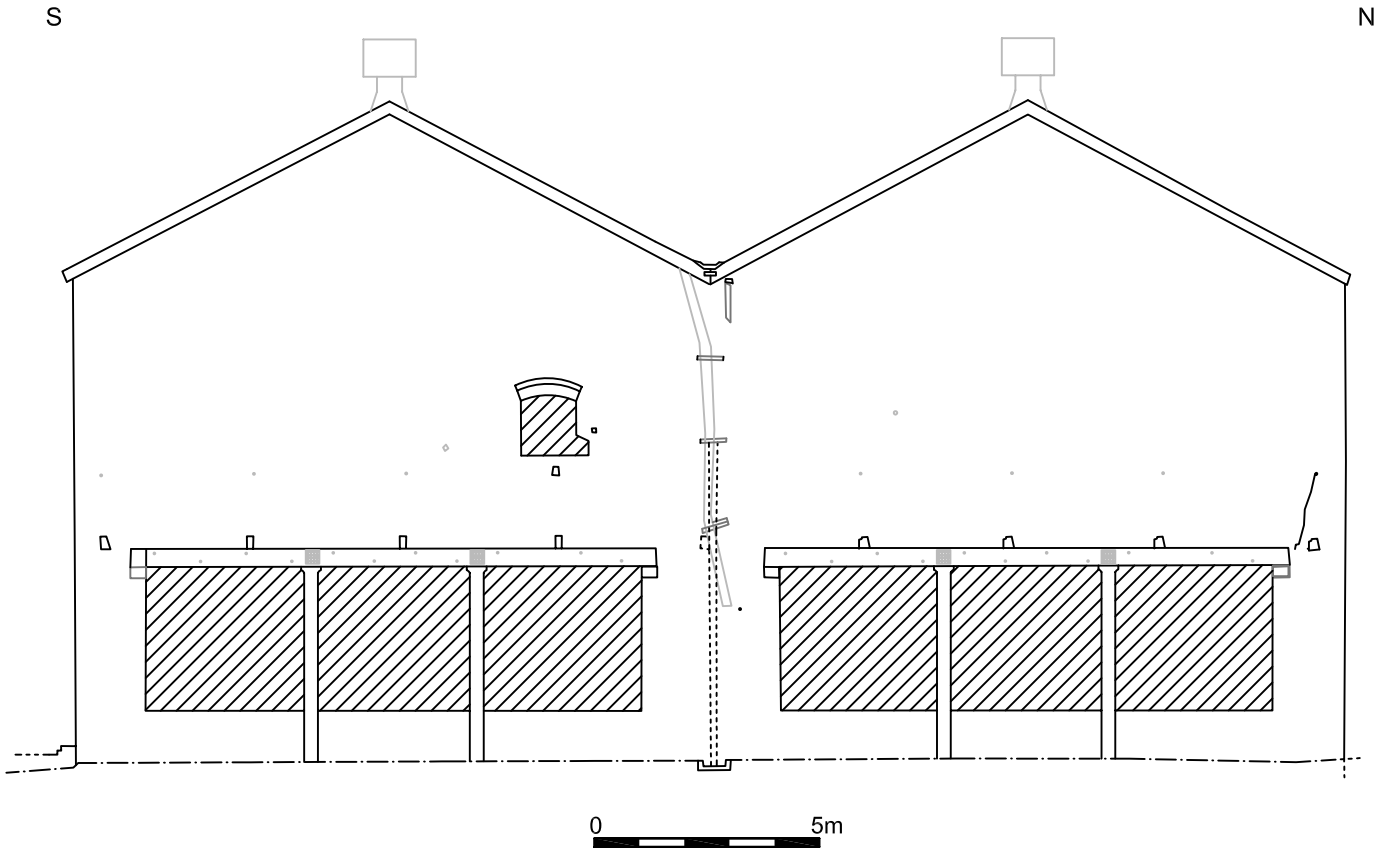
TITLE:

Northern External Elevation

COMMISSIONED BY:

Cheshire County Council

Figure 8: Northern External Elevation of the Warehouse



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Storey Institute
Meeting House Lane
Lancaster
LA1 1TF

Tel 01524 848666
Fax 01524 848606

PROJECT:

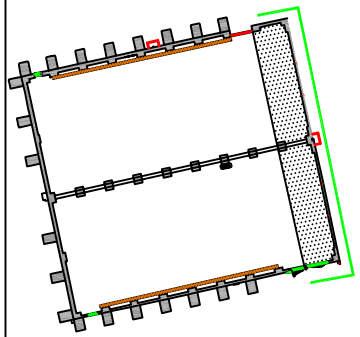
Plumley Lime Beds Survey

DRAWING No: 9

DRAWN BY: C.W and E.C

DATE: 2 / 2002

LOCATION:



KEY

- Phase 2
- Metal
- Sandstone
- Area of Blocking
- Projected Line of Wall
- Limit of Survey

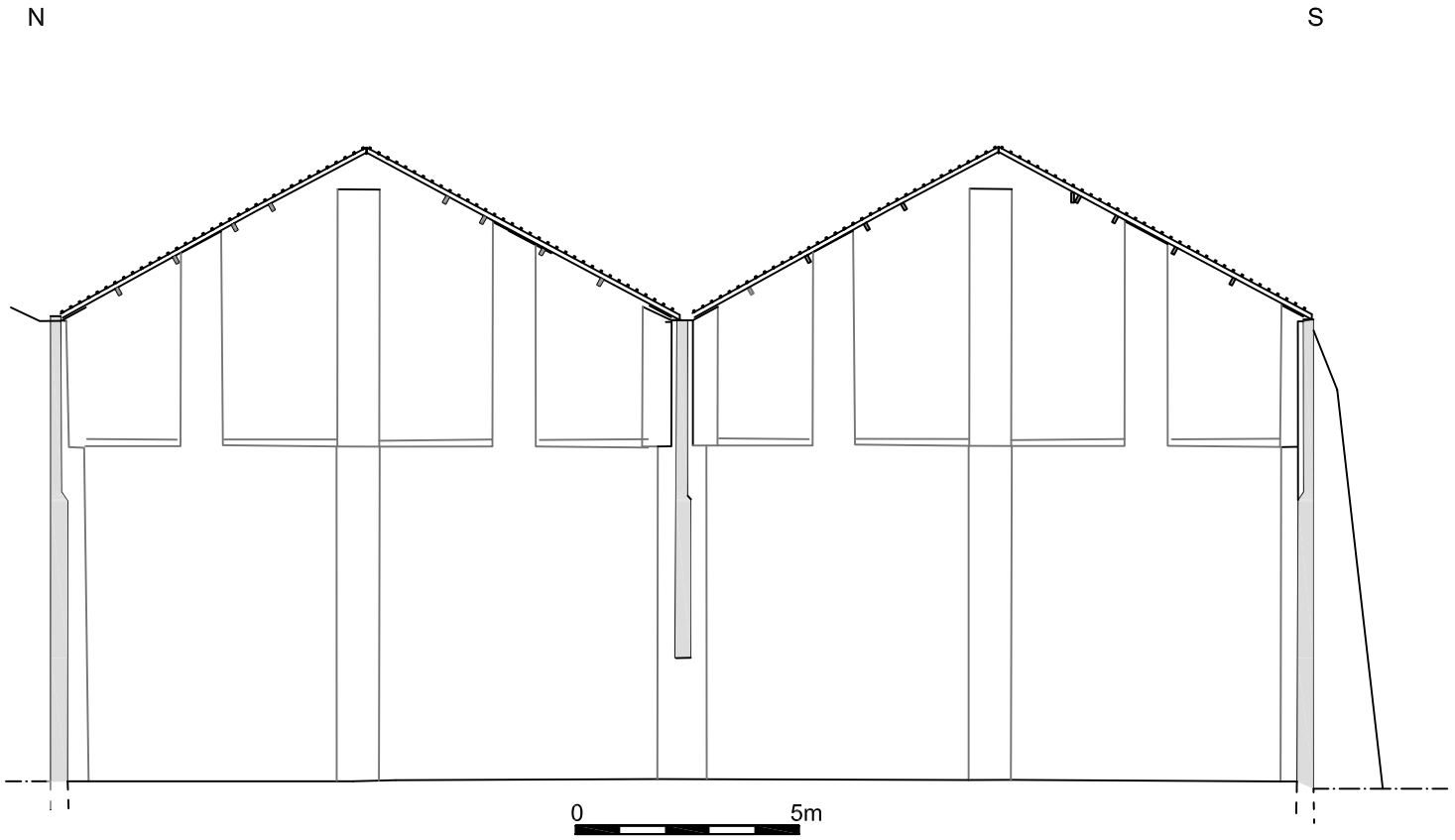
TITLE:

Eastern External Elevation

COMMISSIONED BY:

Cheshire County Council

Figure 9: Eastern External Elevation of the Warehouse



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Storey Institute
Meeting House Lane
Lancaster
LA1 1TF

Tel 01524 848666
Fax 01524 848606

PROJECT:

Plumley Lime Beds Survey

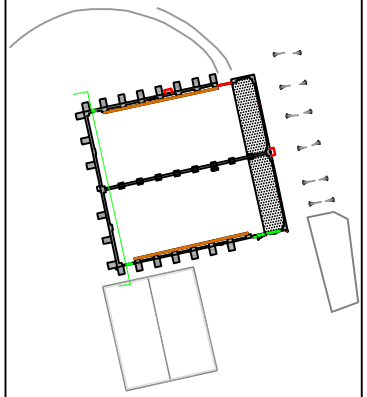
DRAWING No:

10

DRAWN BY: CW and EC

DATE: 2 / 2002

LOCATION:



KEY

- Phase 2
- Metal
- Sandstone
- Area of Blocking
- Projected Line of Wall
- Limit of Survey

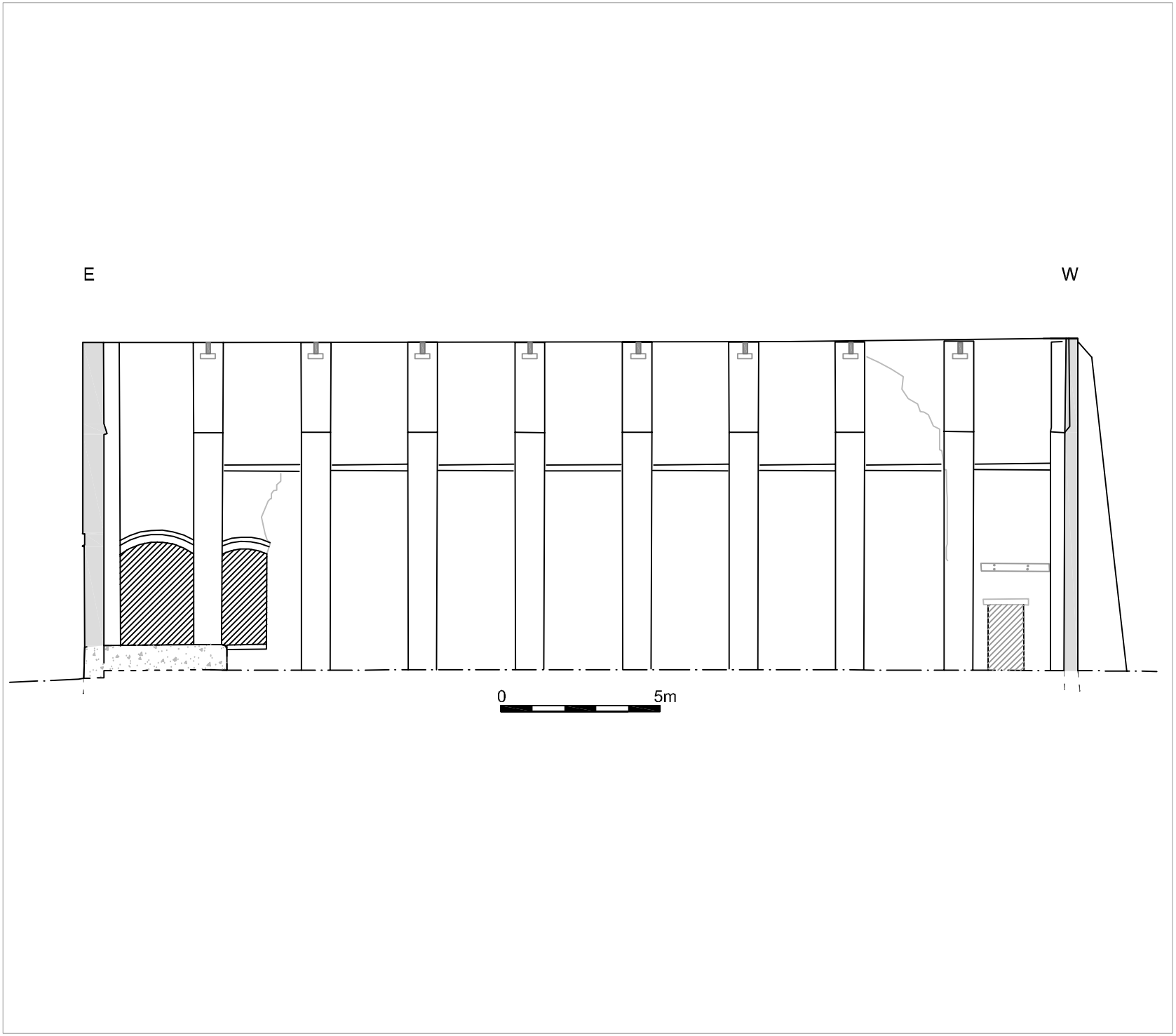
TITLE:

Western Internal Elevation

COMMISSIONED BY:

Cheshire County Council

Figure 10: Western Internal Elevation of the Warehouse



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Storey Institute
Meeting House Lane
Lancaster
LA1 1TF

Tel 01524 848666
Fax 01524 848606

PROJECT:

Plumley Lime Beds Survey

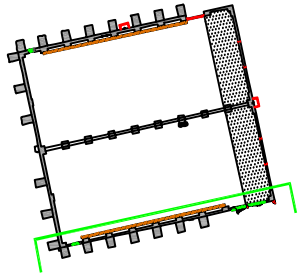
DRAWING No:

11

DRAWN BY: CW and EC

DATE: 2 / 2002

LOCATION:



KEY

Phase 2

Metal

Sandstone

Area of Blocking

Projected Line of Wall

Limit of Survey

TITLE:

South Internal Elevation

COMMISSIONED BY:

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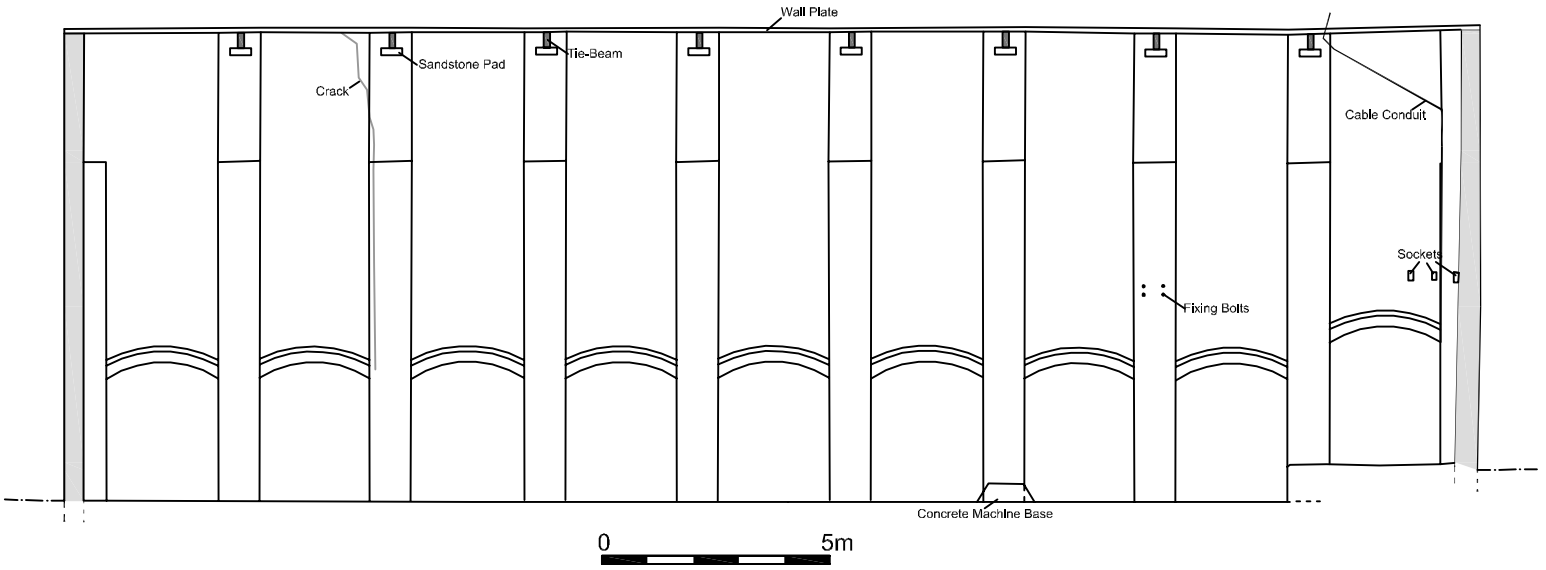
Figure 11: Southern Internal Elevation of the Warehouse



Oxford Archaeology North
Storey Institute
Meeting House Lane
Lancaster
LA1 1TF

Tel 01524 848666
Fax 01524 848606

PROJECT:

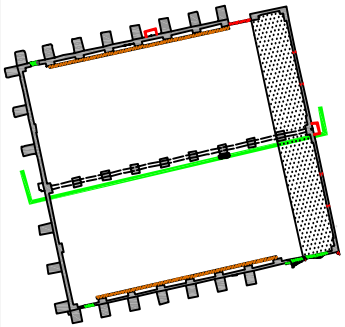
Plumley Lime Beds

DRAWING No: 12

DRAWN BY: E.C./C.W

DATE: 2 / 2002

LOCATION:



KEY

- Phase 2
- Metal
- Sandstone
- Area of Blocking
- Projected Line of Wall
- Limit of Survey

TITLE:

South Face of the Intrnal Partition Wall

COMMISSIONED BY:

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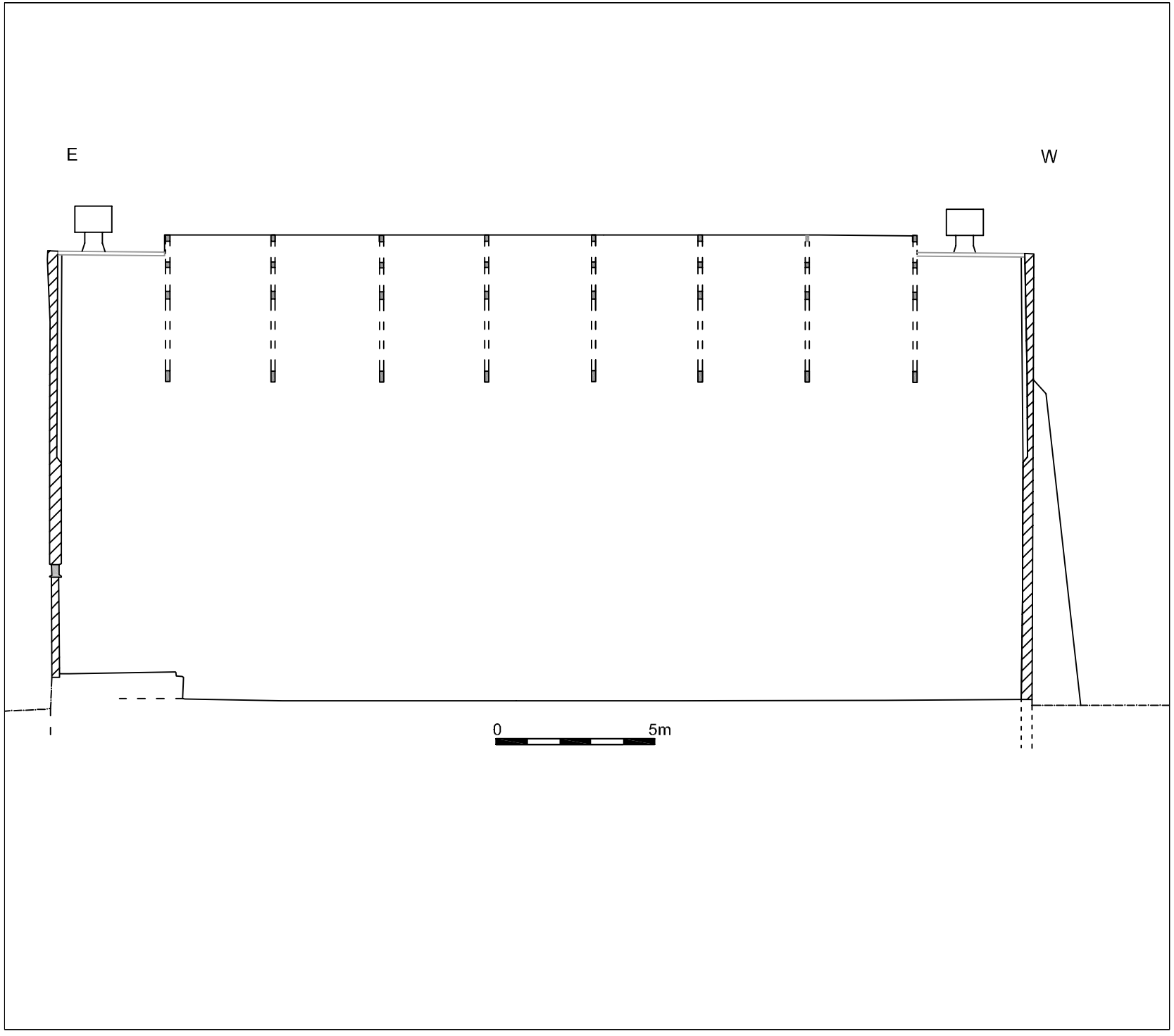
Figure 12: South Face of the Internal Partition Wall



Oxford Archaeology North
Storey Institute
Meeting House Lane
Lancaster
LA1 1TF

Tel 01524 848666
Fax 01524 848606

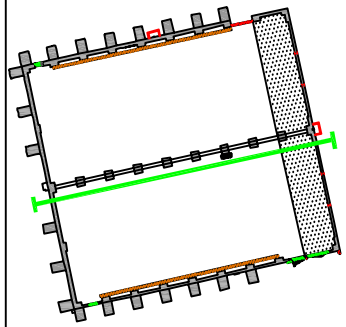
PROJECT:
Plumley Lime Beds

DRAWING No:
13

DRAWN BY: A.S.

DATE: 2/2002

LOCATION:



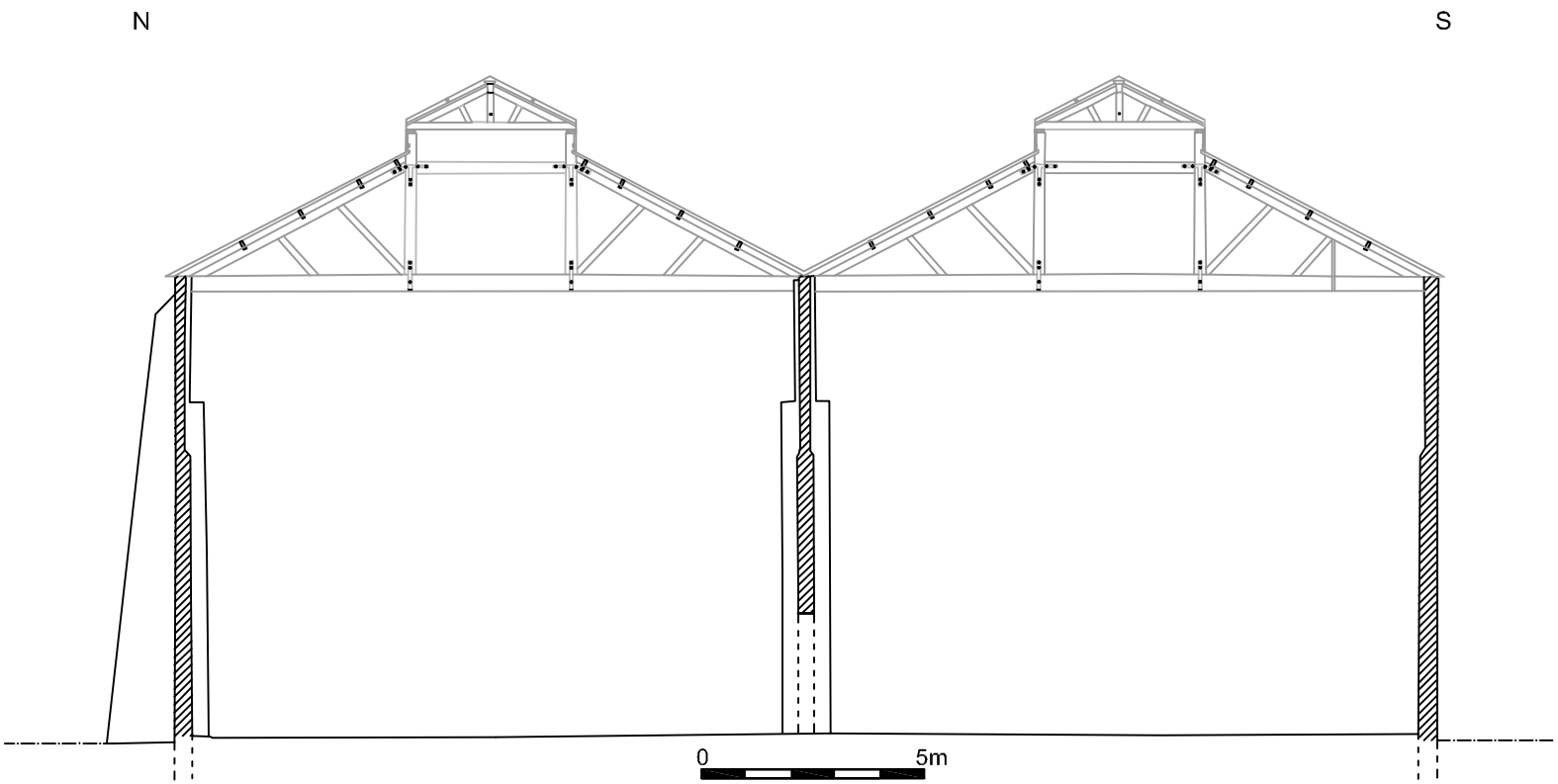
KEY

- Phase 2
- Metal
- Sandstone
- Area of Blocking
- Projected Line of Wall
- Limit of Survey

TITLE:
East / West Cross Section

COMMISSIONED BY:
Cheshire County Council

Figure 13: East / West Cross-section through the Warehouse



Oxford Archaeology North
Storey Institute
Meeting House Lane
Lancaster
LA1 1TF

Tel 01524 848666
Fax 01524 848606

PROJECT:

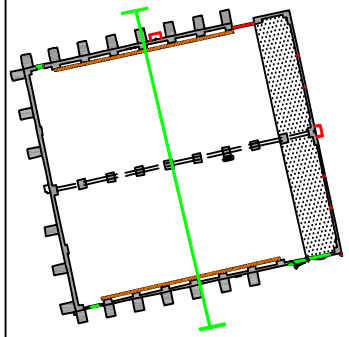
Plumley Lime Beds Survey

DRAWING No: 14

DRAWN BY: A.S.

DATE: 2 / 2002

LOCATION:



KEY

- Phase 2
- Metal
- Sandstone
- Area of Blocking
- Projected Line of Wall
- Limit of Survey

TITLE:

North / South Cross Section

COMMISSIONED BY:

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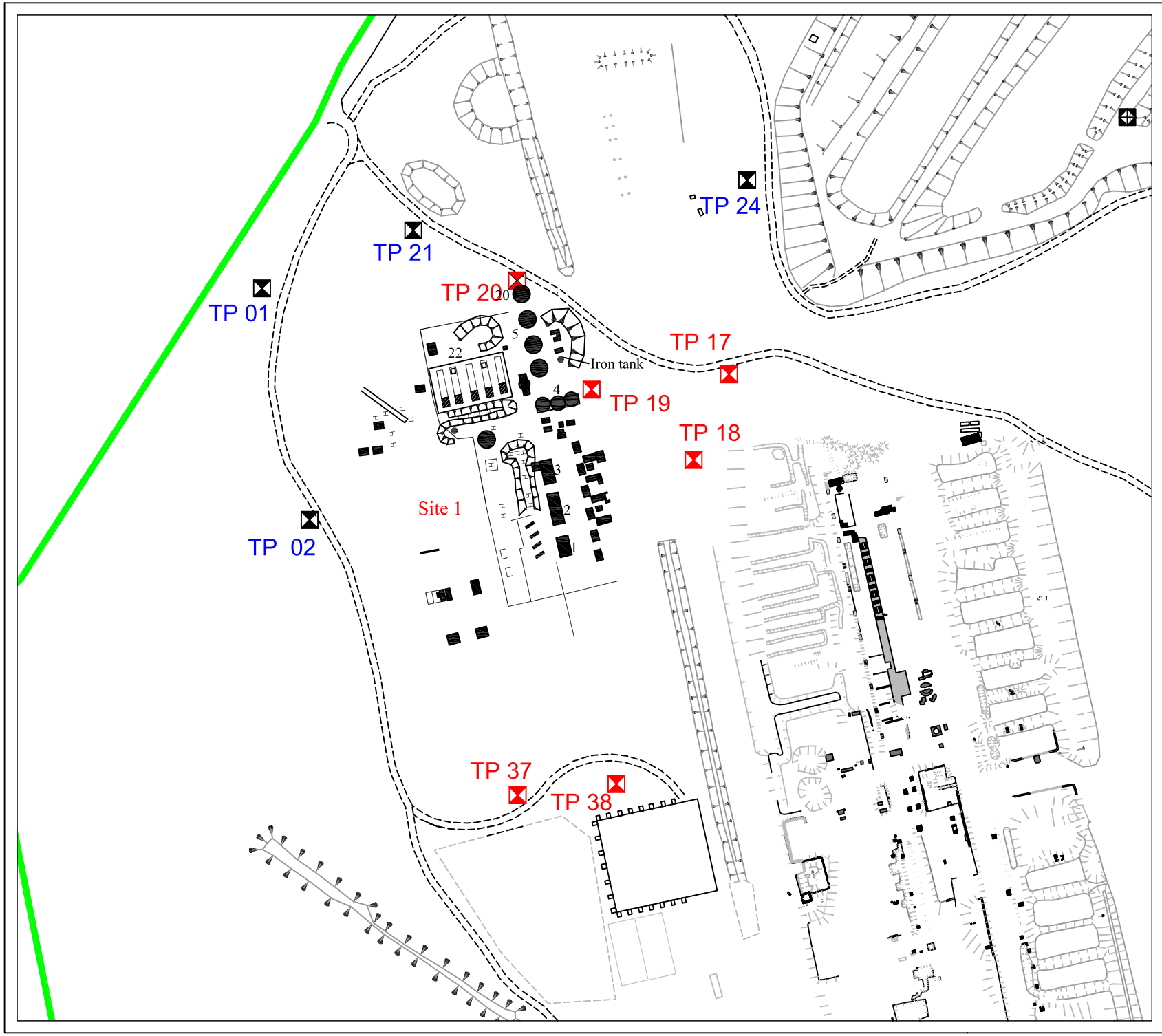
Figure 14: North / South Cross-section through the Warehouse



Oxford Archaeology North
Storey Institute
Meeting House Lane
Lancaster
LA1 1TF

Tel 01524 848666
Fax 01524 848606

PROJECT:

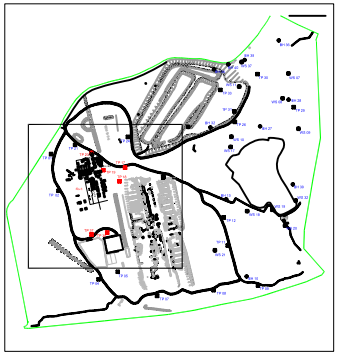
Plumley Lime Beds

DRAWING No: 15

DRAWN BY: CW / JQ

DATE: 2 / 2002

LOCATION:



KEY

Test Pit subject to watching brief

Test Pit not subject to watching brief

Site Boundary

TITLE:

Location of Test Pits Subject to Watching Brief

COMMISSIONED BY:

Cheshire County Council

Figure 15: Location plan of the test pits that have been subject to a watching brief

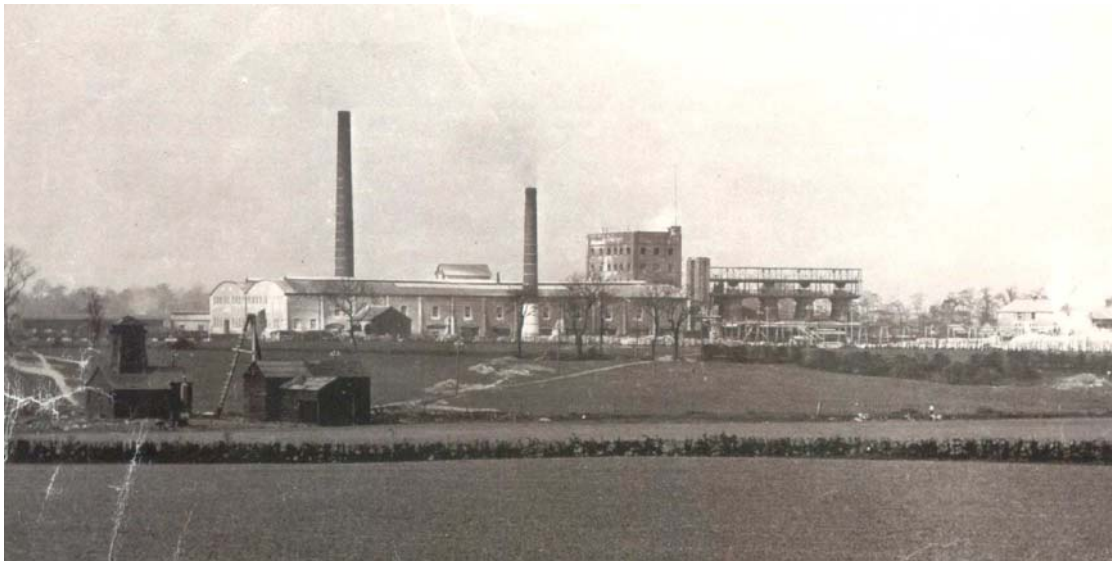


Plate 1: Photograph of the Soda Ash Plant dated *c*1910 looking north-west

Plate 2: Vertical air photograph of the Plumley site, taken in 1946

Plate 3 Revetment walls and concrete support structure (5.8) which divide Building 5 - looking east

Plate 4: Concrete Pillar (4.4) in the northern part of the Crystalliser Building – looking west

Plate 5: Concrete structre, putative silo (4.3), at the southern end of the Crystalliser Building – looking north

Plate 6: Steel joists for a raised floor (4.2) in the south-eastern part of the Crystalliser Building – looking south

Plate 7: Example of stanchion supports and adjacent ditch (4.7) forming the western edge of the Crystalliser Building - looking south

Plate 8: Pond (6.1) for the putative gas producer building (Site 6) – looking north

Plate 9: Central arched wall in the interior of the warehouse, looking south-east

Plate 10: North-cell of the warehouse, showing bricked-up loading bays, looking east

Plate 11: South external elevation of warehouse, showing blocked doorways and roof scars in the south-east corner

Plate 12: North and east elevations of the warehouse, showing shuttered door and bricked-up loading bays

Plate 13 North internal elevation of the warehouse looking north-east

Plate 14 South-eastern corner of the south external elevation of the warehouse

Plate 15 East external elevation of the warehouse showing blocked loading bays

Plate 16 Entrance in north-east corner of the north elevation of the warehouse