



Car Dealerships, Meadowhall, Sheffield, South Yorkshire

Archaeological Evaluation - Final Report





**CAR DEALERSHIPS, MEADOWHALL
SHEFFIELD, SOUTH YORKSHIRE**

Archaeological Evaluation

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SHEFFIELD, SOUTH YORKSHIRE**

Archaeological Evaluation

Contents

Contents	iii
List of Figures and Plates	iv
Summary	v
Acknowledgements.....	vi
1 INTRODUCTION	1
1.1 Project Background	1
1.2 Site Description and Geology	1
2 ARCHAEOLOGICAL AND HISTORIC BACKGROUND	2
2.1 Introduction.....	2
2.2 Archaeological Background.....	2
2.3 Historic Development of the Site	3
2.4 The Imperial Steel Works	3
3 METHODOLOGY	5
3.1 Aims and Objectives.....	5
3.2 Methods.....	6
4 RESULTS	6
4.1 Introduction.....	6
4.2 Phase 1a – Eastern Range	7
4.3 Phase 1b – Western Range	8
4.4 Phase 2 – Casting Pits	9
4.5 Phase 3 – Machine Base.....	10
4.6 Phase 4 – Demolition	10
5 FINDS	11
5.1 Introduction.....	11
5.2 Assessment.....	11
5.3 Archaeometallurgical Analysis.....	12
6 DISCUSSION.....	14
6.1 Summary	14
6.2 Archaeological Potential.....	14
6.3 Recommendations for Further Work	15
7 ARCHIVE.....	15
7.1 Location and Deposition	15
7.2 Copyright	15
8 BIBLIOGRAPHY	16
APPENDIX 1: ARCHIVE INDEX	17
APPENDIX 2: CONTEXT SUMMARY	18
APPENDIX 3: SUMMARY OF FINDS ASSESSMENT	19

**CAR DEALERSHIPS, MEADOWHALL
SHEFFIELD, SOUTH YORKSHIRE**

Archaeological Evaluation

List of Figures and Plates

- Figure 1** Site location plan
- Figure 2** Trench plan
- Figure 3** Section through structure 103
- Figure 4** Section showing overburden
- Figure 5** Trench data overlain on 1923 edition Ordnance Survey map of the Works
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- Plate 1** Structure 103, showing metallic deposit 138.
- Plate 2** Screw threaded graphite object recovered from demolition deposit 107.
- Plate 3** Screw threaded graphite object recovered from demolition deposit 107.
- Plate 4** Unusually shaped 'nodule' of steel recovered from deposit 100.

Cover photo: Showing the excavation on the Imperial Steel Works building

Back photo: Showing the excavation in progress

CAR DEALERSHIPS, MEADOWHALL SHEFFIELD, SOUTH YORKSHIRE

Archaeological Evaluation

Summary

Wessex Archaeology was commissioned to undertake an archaeological evaluation of land at Meadowhall, Sheffield as a condition of planning consent to construct car showrooms (07/02074/FUL). The Site (NGR SK 393 905) was formerly occupied by buildings associated with the former Imperial Steel Works, which closed in 1988. The evaluation comprised the excavation and recording of a single 10m by 10m trench on the site of a proposed access road. Additional desk-based research and metallurgical analysis were carried out as part of the post-excavation work. Fieldwork was undertaken from 13th-21st July 2010.

The Imperial Steel Works, under the ownership of Edgar Allen & Co Ltd, was an important Sheffield steel producer specializing in castings, with an extensive international client list. The company was often at the forefront of technological innovation: the introduction of Tropenas furnaces in 1891-2 rivalled the standard Bessemer process and the world's first use of the Electric Induction Crucible Process for producing high speed steels was undertaken in 1927, probably within the building situated on the Site.

The evaluation demonstrated good archaeological preservation at 1.6m to 1.8m below the current ground surface, revealing substantial pier and panel internal walling and at least three brick and concrete lined casting pits. Cartographic evidence suggests that the building was probably constructed as two distinct ranges; the evaluation trench appears to have investigated part of the western range, close to the middle of the Works. Several distinct phases were evident and three casting pits were identified, demonstrating the activities carried out in this part of the building. Several graphite objects from a layer of demolition debris may be associated with the use of the Electric Induction Crucible Process. The area to the immediate west of the trench may have been involved in the transportation of metals, possibly in overhead cranes, and will have contained re-melting furnaces.

The importance of Sheffield's metal-production and metal-working heritage lends the Imperial Steel Works particular historic and archaeological significance. The level of archaeological preservation on the Site is sufficient to allow identification of specific processes and structural sub-divisions within the Works, and there is potential for the recovery of structures and finds associated with the use of innovative technology at the Site. The well-preserved remains within the evaluation trench indicate that a similar level of archaeological survival may be anticipated in other areas of the Works, which may be examined by future archaeological investigations in connection with further stages of development on the Site.

All relevant analyses of structural data and finds assemblages recovered during the evaluation have been completed during the course of preparation of this report, and no further work is recommended in this regard. The project archive is currently held at the offices of Wessex Archaeology, Sheffield, under the project code **74661**. It is proposed that the archive will be deposited in due course with Sheffield Museums Service.

**CAR DEALERSHIPS, MEADOWHALL
SHEFFIELD, SOUTH YORKSHIRE**

Archaeological Evaluation

Acknowledgements

This project was commissioned by British Land Company Ltd. The project was monitored by Jim McNeil from the South Yorkshire Advisory Service (SYAS).

The project was managed for Wessex Archaeology by Andrea Burgess. The fieldwork was directed by Neil Dransfield, with the assistance of Justin Wiles. This report was compiled by Neil Dransfield, with the assistance of Dr. Rod Mackenzie (finds and archaeometallurgy). The illustrations were prepared by Chris Swales.

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Archaeological Evaluation

1 INTRODUCTION

1.1 Project Background

1.1.1 Wessex Archaeology was commissioned by British Land Company Ltd to carry out a limited archaeological evaluation on land known as the Car Dealership Plot, Meadowhall, Sheffield ('the Site'). The evaluation forms part of a programme of archaeological works to be undertaken in response to Condition 14 attached to planning consent (07/02074/FUL) for the erection of four units for use as car dealerships, provision of car parking accommodation, and associated enabling works.

1.1.2 Previous desk-based assessment (Hughes 2007) established that the Site was formerly occupied by buildings associated with the former Imperial Steel Works, an important Sheffield steel producer specializing in castings and often at the forefront of technological innovation. The Works closed in 1988 and the buildings were demolished as part of the Meadowhall redevelopment. A series of geotechnical investigations on the Site (Peter Brett Associates 2006) confirmed the likely survival of *in situ* archaeological deposits relating to the Imperial steel Works buildings.

1.1.3 Development at the Site will be undertaken in stages, and the requirements of Condition 14 will accordingly be implemented at each stage. The first stage of development work at the Site is limited to the construction of a short length of access road in the northern part of the Site: no other development works are proposed at this time. This report presents the results of archaeological evaluation works undertaken in respect of this first stage of development.

1.1.4 The evaluation comprised the excavation and recording of a single 10m by 10m trench on the site of the proposed access road. Fieldwork was undertaken over seven days, from 13th July to 21st July 2010. All work was conducted in accordance with a Written Scheme of Investigation ('WSI') prepared by Wessex Archaeology (2010) and approved by Jim McNeil of the South Yorkshire Archaeology Service ('the Curator') on behalf of the local planning authority (Sheffield City Council). Methods followed current industry best practice and the Institute for Archaeologists' *Standard and Guidance for Archaeological Evaluation* (IfA 2008).

1.2 Site Description and Geology

1.2.1 The Site (centred on National Grid Reference SK 393 905) is located approximately 0.5km south-west of Junction 34 of the M1, and immediately south of the Meadowhall Shopping Centre (**Figure 1**). The total development site has an area of approximately 9 hectares.

- 1.2.2 The Site is bounded by Meadowhall Way, Vulcan Road, Sheffield Road and Weedon Street. A former railway embankment runs across the plot and bisects the Site. At the time of evaluation the land comprised hard standing with patches of grass and, in the southern half, a steel-framed shed. In the northern half of the Site, a former below-ground basement structure has been re-used for water storage and is now fenced off. The proposed access road lies in the northern part of the Site.
- 1.2.3 The Site lies within 0.5km of three rivers and canals. The River Don is approximately 400m to the north-east, with the Car Brook about 360m to the west and the Sheffield and Tinsley Canal about 300m to the east.
- 1.2.4 The underlying geology consists of alluvial deposits comprising grey clays and silts with some sand and gravel inclusions (0.7-2.5m thickness), above an orange/brown coarse sand and gravel (0.7-4.9m thickness). At a depth of between 7.4m to 9.2m below ground level, lies mudstone and sandstone deposits of the Middle Coal Measures (Peter Brett Associates 2006).

2 ARCHAEOLOGICAL AND HISTORIC BACKGROUND

2.1 Introduction

- 2.1.1 The archaeological background of the Site and its immediate environs can be found in the desk-based assessment (Hughes 2007) and the WSI (Wessex Archaeology 2010). A summary is presented here for completeness.
- 2.1.2 The historic development of the Site is presented below based on a review of Ordnance Survey mapping and the history of the Imperial Steel Works, including material previously included in the WSI and the results of additional desk-based research carried out at the Sheffield Archives in September 2010.

2.2 Archaeological Background

- 2.2.1 The earliest known archaeological remains in the area date to the prehistoric and Roman periods. The Iron Age hillfort known as 'Wincobank Camp' (Scheduled Ancient Monument no 314855; SK377909) and a linear earthwork known as 'Roman Rig' (Scheduled Ancient Monument no 1032958; SK 356880) both lie approximately 1.7km to the north-west of the Site.
- 2.2.2 The location of the Site close to Wincobank Camp and the River Don suggests that this area is likely to have been occupied from prehistoric times. However, the extensive industrial development of the Site during the late 19th and 20th centuries (2.3 below) is likely to have damaged or removed any earlier archaeological remains and the former Imperial Steel Works (2.4 below) is currently considered to represent the main archaeological potential of the Site.

2.3 Historic Development of the Site

2.3.1 The earliest evidence for activity within the Site itself dates to the late 19th century. The 1854 Ordnance Survey (OS) map shows the Site within enclosed fields at the edge of the built-up area of Sheffield. The fields may have been part of Holmes Farm, which lies just outside of the Site and predates the OS 1st Edition. The road to the south of the Site (now Weedon Street) was then known as Mill Lane and the main road to the east of the Site (now Sheffield Road) was the Sheffield and Tinsley [Turnpike] Trust. The Site itself remained undeveloped at this time and the land between the Site and the River Don is marked 'liable to flooding'. The Car Brook runs to the south of the Site along the line of Mill Lane.

2.3.2 By the 1892 OS map some areas around the Site had been developed, but the Site itself still lay within enclosed fields. The Sheffield Tramway Depot is shown immediately south of the Site. On the eastern side of Sheffield Road, the West Riding Wagon and Wheel Works is extant but disused. The British Steel Wire Mills are shown to the north of the Site.

2.3.3 Between 1896 and 1900 the Sheffield District Railway (Treeton to Brightside line) was constructed through the previously open fields of the Site. The 1906 OS map shows the railway, an embankment and sidings within the northern part of the Site. A small structure adjacent to the sidings is probably a goods shed, but could be part of the Imperial Steel Works; the main Works buildings are almost certainly located on the eastern side of Sheffield Road. (For a more detailed discussion of the Imperial Steel Works see section 2.4 below.) The Tinsley Road Station is located at the top of the embankment, and the Tinsley Brick and Tile Works is shown within the southern part the Site, as is the Sheffield Electric Tramway Depot. Just beyond the southern Site boundary, Car Brook still runs alongside what is now Weedon Street. An extensive (but unlabelled) steel works complex is shown beyond the northern boundary of the Site.

2.3.4 Eighteen years later, the 1924 OS map depicts an intensively developed industrial area. The Imperial Steel Works buildings on the eastern side of Sheffield Road had expanded and additional premises had been constructed adjacent to a railway siding within the northern part of the Site. Vulcan Road is now shown and the extensive works complex to the north of the Site is labelled as the East Hecla Works. The southern part of the Site, to the south of the railway, is completely developed and occupied by the Tinsley Steel Works, the Tramcar Depot, additional railway sidings and other (probably warehouse) buildings. Car Brook is no longer mapped along Weedon Street and appears to have been culverted or diverted.

2.3.5 The 1934 OS map shows no major changes within the Site, although the Tinsley Steel Works are now named as the Staybrite Works. The 1948 and 1955 OS maps also show little change from the 1924 edition.

2.4 The Imperial Steel Works

2.4.1 The Imperial Steel Works ('the Works') was owned by the Edgar Allen Company, founded in 1867. The business specialised in steel production and files, producing material for railways, foreign arsenals and dockyards for a client base in southern Europe (Sheffield Archives Ref MD 3169).

- 2.4.2 By the 1890s, Edgar Allen's works were known as the 'Imperial Steel Works' and were located at the Minerva Works on Cross George Street, Sheffield. The first 'Imperial Steel Works' premises appears to have been located on Attercliffe Road, Sheffield (Kelly's Directory 1892, p.110).
- 2.4.3 In 1889 the Imperial Steel Works re-located to Tinsley on the eastern side of the Rotherham to Sheffield Turnpike Road (now Sheffield Road). Premises were ready to hand at the deserted West Riding Wagon and Wheel Works. Later that year the Works took over the premises formerly owned by the British Steel & Wire Works to the north of the former wagon works (Sheffield Archives Ref MD 3169). The business turned to heavy manufacturing including castings for tram and rail, specialising in rail buffers, circular saws and steel plates (Sheffield Archives Ref MD 3169). About this time the Edgar Allen Company took limited status, with offices in Liverpool and London.
- 2.4.4 It was probably at the former British Steel & Wire Works premises that Allen experienced problems with the Roberts Furnaces and went into negotiations with Alexandre Tropenas to install Tropenas' experimental Acid Process (a variation on the Bessemer process). The first Tropenas converters were built at the Works in 1891-2, fed by two cupola furnaces. The initial capacity of 800lb of steel was so successful that a 2 ton-capacity converter was soon added (Simons 1940).
- 2.4.5 The Edgar Allen Co. Ltd was registered on the stock exchange in 1900. The success of the company is illustrated by the range of entries and full-page advertisements for the Imperial Steel Works in trade directories, not only in Sheffield but also, for example Manchester (Slater's Directory 1895, Part 2, p.207; Slater's Directory 1903, Part 3, p.1473), Worcester (Kelly's Directory 1892, p.110) and London (Post Office Directory 1895, Part 3, p.774).

Allen Edgar & Co Limited, manufacturers, merchants & exporters of steel, steel casings, files, saws, heavy hardware, edge & engineers' tools &c, & contractors to british and foreign governments & railway companies, Imperial steel works, Tinsley, Sheffield

Entry in 'White's Directory of Sheffield & Rotherham 1901', p.401

- 2.4.6 It appears that Edgar Allen & Co. Ltd may have purchased the land now occupied by the Site in around 1905. That year a planning application was submitted for sewage services connected to new offices, a pattern, point and engineering shop and urinals on land immediately to the west of the Site, between the new Vulcan Road and the railway to the south (Sheffield Archives Ref CA 206).
- 2.4.7 It is not clear when the building under investigation in this evaluation was constructed. The 1921 survey reproduced on the 1924 edition OS map shows buildings located in this part of the Site, but it may be that the building was constructed in the early part of the First World War: Simons (Sheffield Archives Ref MD 3169) notes that when the Ministry of Munitions took over the works during 1914-18, this led to a new foundry being built.
- 2.4.8 Historical information confirms that the Works was expanded and modified throughout its period of use from c.1900 to 1988. In 1912 two Héroult electric arc furnaces were installed to supply the foundry and to produce

ingots. It is reported that these Héroult furnaces were still working when the Works closed in 1988, but it is not clear which building these were located in.

- 2.4.9 In 1927 Edgar Allen & Co. Ltd introduced the first high frequency or “coreless” electric crucible steel (Electric Induction Crucible Process) furnace in the world. The process was introduced for continental clients for the manufacture of fine steel tools and represented the first serious challenge to the Huntsman (crucible) process of steel production (Simons 1940).
- 2.4.10 Various ledgers from 1913-34 (Sheffield Archives Ref MD 2296-2339) indicate an extensive client list amongst local (Sheffield, Rotherham and Leeds) steel manufacturers, to whom castings were sold. Other clients included the Admiralty and Electromotors Ltd of Openshaw, Manchester, who placed many orders for motor body castings, and an extensive list of overseas clients from Australia, Europe, Japan, Latin America, South Africa and the USA.
- 2.4.11 After the Second World War, a new block was constructed near to Sheffield Road to house laboratories for physical and chemical testing and metallographic analysis. During the 1960s, rationalisation of the Sheffield steel industry through mergers led to the Edgar Allen Co. Ltd buying Jessop Saville and Company. As part of the purchase, Jessop’s furnace was moved to the Tropenas melting shop within the main Imperial Steel Works complex.
- 2.4.12 The Works was closed in 1988 and the buildings were demolished to make way for the Meadowhall shopping centre complex.

3 METHODOLOGY

3.1 Aims and Objectives

3.1.1 The aims of the evaluation were:

- To enhance understanding of the development of the Site and the Imperial Steel Works, but also to have regard for potential earlier phases of activity on the Site.
- To record, as far as is reasonably possible, the location, extent, date, character, condition, significance and quality of any surviving archaeological remains observed.
- To provide sufficient information to enable an informed decision to be made about the need for additional archaeological mitigation required within the area affected by the initial construction works.
- To inform the preparation of an appropriate evaluation strategy for the remainder of the area covered by planning reference 07/02074/FUL.

3.1.2 The objectives of the evaluation were:

- To determine the phasing and degree of complexity of the horizontal and/or vertical stratigraphy present.
- To determine the approximate date or date range of the remains, by means of artefactual, stratigraphic or other evidence.
- To determine the condition, state of preservation and wider archaeological or historic significance of the remains.
- To prepare plans and documentation, sufficient to enable the Local Planning Authority and the South Yorkshire Archaeology Service to make an informed decision regarding the future treatment of any remains within the evaluated area.
- To collate the results of the evaluation and any detailed excavation and recording, including all necessary analyses, in a single report.

3.2 Methods

- 3.2.1 Full details of the evaluation methodology are contained in the Written Scheme of Investigation for Archaeological Evaluation (Wessex Archaeology 2010) and are summarised below.
- 3.2.2 A single 10m by 10m trench was excavated at the site of the proposed access road (**Figures 1 and 2**). This trench covered the whole footprint of the initial construction phase of work.
- 3.2.3 Initial breaking pout of hard surfaces and excavation of overburden/made ground was undertaken by mechanical excavator under the supervision of an experienced archaeologist. The mechanical excavation involved the removal of 1.6m – 1.8m of overburden to the top of the first archaeological horizon, where machine excavation ceased.
- 3.2.4 Archaeological features were hand cleaned and planned at an appropriate scale to demonstrate archaeological relationships and define individual features and deposits. Sufficient sondages were excavated to demonstrate archaeological relationships and hand-drawn section drawings and plans were prepared. A photographic record of archaeological features and deposits was made and each archaeological context was recorded using Wessex Archaeology's *pro-forma* recording system.
- 3.2.5 Archaeometallurgical samples were taken of appropriate *in-situ* deposits and a small assemblage of finds was retrieved for specialist analysis.

4 RESULTS

4.1 Introduction

- 4.1.1 This section describes the natural deposits encountered and the archaeological features and deposits recorded. All contexts (cuts, fills, deposits and structures) were assigned a unique number **100 to 144**. A detailed summary of the evaluation trench context information is included in **Appendix 2**.

4.1.2 The results from the excavation are outlined below within recognised phases and discussed in more detail in **Section 7** below.

4.2 Phase 1a – Eastern Range

4.2.1 The earliest identifiable features within the evaluation trench were connected to the construction of major structural elements of the early Imperial Steel Works building, in the form of drainage features, a pier and panel brick wall and a substantial iron stanchion. These structures were probably conceived as part of a single phase of builds.

4.2.2 The earliest of these features was a sub-rectangular brick drain base surround/manhole **108** which measured 1.45m x 1.2m, oriented north to south (**Figure 2**). At least three courses of brick were evident, bonded by a mixture of light pink and light grey cement mortar. The bricks were machine made, containing a very shallow rectangular frog which rose at each end to align with the surface of the brick. The bricks measured 0.23m x 0.175m x 0.075m and were of the same type uncovered in wall **101** (see **4.2.5** below). The south-east corner of the structure was splayed slightly to incorporate a pale yellow ceramic pipe (full dimensions not uncovered) entering the eastern wall of the manhole (**Figure 2**). The ceramic pipe was encased within concrete **109** which abutted the eastern external wall of the manhole.

4.2.3 Within the drain base/manhole **108** was a split level sloping brick surface **110** (**Figure 2**). The northern half of the surface was 0.26m higher than the southern half and joined to the lower surface by a line of sloping glazed bricks. The lower surface sloped gently down from east to west into a ceramic pipe which was incorporated within the western wall of **108**. The drain base/manhole was subsequently filled by a deposit of mid brown silty sand **111**.

4.2.4 Overlying and surrounding the bricks of manhole **108** was the eastern end of a long concrete raft **132**, forming the foundation of a pier and panel wall **101** and terminating in a raised plinth foundation for a cast iron double H-beam stanchion **134** (**Figure 2**). The concrete raft **132** measured at least 5m in length and varied in width from 0.7m to 2m where it underlay panels of piers within the overlying wall (**101**). The upper surface of the rafting was flat where it underlay the wall and terminated at the east in a rectangular raised plinth 0.15m higher than that of the wall. Evidence of a 0.3m diameter ceramic drain base **133** was preserved as a hollow in the raised plinth (**Figure 2**). A flat iron plate **134** (1m x 0.5m x 0.67m) was bolted to the raised concrete plinth and two vertical H-beams were fixed to the iron plate. Two iron plates were riveted to the outside of the H-beams to aid structural support.

4.2.5 Wall **101** was constructed from the same brick type as the manhole/drain base **108** and bonded by a light pinkish cement mortar. It was constructed in a pier and panel style measuring 8.6m long and consisted of a single upper course of bricks on a two-course stepped foundation (**Figure 2**). Two panels and two piers were evident. The two panels were only marginally different in length. The eastern panel measured 2.63m long, terminating to the east within the raised plinth of the underlying concrete raft. The complete panel to the west measured 2.75m (**Figure 2**). The two piers were also slightly

different in layout. Both piers appeared to be the same width (0.94m) but the more westerly pier was 1.38m long, compared to 1.04m of the eastern pier.

- 4.2.6 The pier and panel style of wall construction is typical of external walls of foundries – the piers acting as roofing supports whilst the panels are usually low, non load-bearing walls to allow air flow through the building itself. In this case, however, the wall appears to be located within the foundry building. The 1923 OS map shows the southern part of the Imperial Steel Works comprising a western and eastern range of buildings. It is possible that the excavated wall is an internal continuation of **Wall A** on **Figure 5** with the stanchion marking the wall's end, allowing access around the eastern end of the western range.
- 4.2.7 The material surrounding wall **101** was a brownish orange sand **128** containing pea grit and the occasional rubble fragment. No cuts were visible within the deposit and it was interpreted as a mixture of made ground and construction trample. The deposit was at least 0.15m deep and patches of it were also uncovered in the southern corner of the trench (**Figure 2**), implying that the deposit covered the entire area.

4.3 Phase 1b – Western Range

- 4.3.1 In the southern corner of the trench, three red brick walls **113**, **114** and **142** probably formed part of the earliest phase within the western range of the Imperial Steel Works building (**Figure 2**). A construction cut **143** truncated an earlier deposit **128** and was backfilled by a dark sandy material **144** containing fragments of ceramic building material. Cut **143** was irregular in plan, containing walls **113**, **114** and **142** within it. The walls consisted of at least four courses and were bonded together with a light pinkish cement mortar (similar to the pier and panel walling **101**). The bricks were machine made, contained shallow rectangular frogs with rounded corners, and measured 0.22m x 0.175m x 0.07m. Wall **113** was oriented north to south, measured 4m in length, terminating at the north with a return to the west **142**. Wall **114** was located 1.15m to the south of wall **142**, measuring 1.6m in length and extending beyond the south-western limit of excavation (**Figure 2**).
- 4.3.2 Together, wall **113** appears to form an eastern boundary with walls **114** and **142** forming a rectangular chamber to the west. It is not known whether further chambers were located to the south, as the later insertion of structure **115** has destroyed any evidence in that location (see **4.4.2** below).
- 4.3.3 A deposit of consolidated slag **112** overlay deposit **128** and abutted walls **113**, **114** and **142**. The deposit – an amalgamation of slag and waste material – was sampled for archaeometallurgical assessment (see **5.2** below). The deposit covered the majority of the south and eastern portion of the trench, to the south of wall **101** (**Figure 2**). The deposit was thickest (>0.4m) at the east of the trench, where it had accumulated or been deposited around drainage structure **109**, gradually petering out towards the west: where it abutted wall **113**, it was only 0.05m thick. It is possible that the deposit was purposively laid in this portion of the building range as consolidated flooring, and probably comprised waste material produced at the Works.

4.4 Phase 2 – Casting Pits

- 4.4.1 Three probable casting pits dominate this phase.
- 4.4.2 Set within walls **113** and **114** and abutting wall **113**, an L-shaped red brick wall **115** was partially revealed in the southern corner of the trench (**Figure 2**). Structure **115** measured 1.9m x 1.2m and consisted of an outer skin of machine made, shallow frogged red bricks (each 0.22m x 0.175m x 0.07m). Inside the structure, a skin of badly degraded fire brick surrounded a 0.12m-thick coarse reinforced concrete deposit **116** with a pink, heat-affected appearance, and a pinkish orange sand deposit **117** with mottled grey patches. The structure is interpreted as a casting pit containing casting sand.
- 4.4.3 An east-west aligned red brick wall **119** abutted the eastern side of wall **113** (**Figure 2**). A construction cut **136** truncated deposit **112** and was backfilled by a light grey sand **137** (**Figure 2**). The wall was covered with dark pinkish cement mortar, but impressions within the surface indicate that the missing bricks had been machine made, containing a shallow rectangular frog, (similar to those of wall **115**). Wall **119** was 2.7m long and the eastern end of the wall extended beyond the south-eastern limit of excavation. Bonded to the southern side of wall **119** was a pink, heat affected coarse reinforced concrete lining **120**, 0.18m thick. Abutting this lining was a deposit of pinkish orange coarse sand **121** containing patches of grey mottling. *In-situ* pieces of slag from **121** were retained for archaeo-metallurgical assessment (see **5.2** below). This structure is also interpreted as a casting pit containing casting sand.
- 4.4.4 To the north of wall **142** was a large rectangular structure **103** (**Figure 2, Plate 1**). A construction cut **140** truncated deposit **112** and appeared to have partially demolished the upper courses of Phase 1a walls **113** and **142** (**Figure 2**). The construction cut was backfilled with a mixed deposit of sand, clinker and brick fragments **141**. Structure **103** was constructed from machine made red bricks (each 0.22m x 0.175m x 0.0775m) with a shallow rectangular frog on one side and a shallow rounded frog on the other, bonded by a creamy grey/white cement mortar. The shallow frogging contained the manufacturer's stamp, "CUDWORTH". Structure **103** was aligned east to west, rectangular in plan and extended beyond the south-western limit of excavation. The entire structure measured 5.45m x 2m and was at least 1.26m deep, consisting of northern and southern external walling terminating at an eastern connecting wall. The northern and southern walls were constructed in a steep batter, widening towards the top (**Plate 1**). The eastern wall was vertical with varying degrees of thickening mortar to incorporate the angle of the north and south walls. Within the base of Structure **103**, coarse sand deposits **105** and **106** supported a series of at least four cast iron plates **104** (**Figures 2 and 3**). The plates were covered by a 0.38m deep deposit **139** comprising lenses of coarse sand of differing colour and compaction, which was shallower in the centre of the structure. Adhering to the brick walls of the structure was a heavily corroded metal deposit **138** (**Figure 3, Plate 1**), which was sampled for archaeo-metallurgical assessment (see **5.2** below). Interpreted as a bespoke casting pit during excavation, the results of the archaeo-metallurgical analysis confirm that Structure **103** was probably used to hold partially buried casting moulds, into which molten steel was poured (see **5.4** below).

4.4.5 The upper part of Structure **103** was later backfilled with a presumed demolition deposit comprising loose, dark brown/black silty sand **107** containing brick, concrete rubble and timber, and fragments of metal and slag (**Figure 3**). Two graphite objects (**Plates 2 and 3**) recovered from this deposit may be derived from the dismantling or demolition of structures associated with the electric arc and induction furnaces (see section **5.2** below). Structure **103** had clearly been damaged during demolition and had originally been deeper/higher.

4.4.6 To the south of Structure **103**, two mixed sand deposits **100** and **118** overlay Phase 1b interior walls **113**, **114** and **142** (**Figure 2**), suggesting that part of the western range had been demolished prior to the construction of Structure **103**. An unusually shaped nodule of steel (**Plate 4**) recovered from deposit **100** has been tentatively interpreted as a hand tool (see section **5.3.3** below). Deposits **100** and **118** are presumably a levelling layer associated with the construction of Structure **103**.

4.4.7 Structure **102**, a rectangular red brick surround measuring 0.95m x 0.85m, bonded by a grey, gritty cement mortar, was located within the southern face of wall **101** and abutted the westerly pier and panel of that wall (**Figure 2**). Within the brick surround was a 0.48m x 0.39m rectangular block of concrete, which appeared to have been poured into the central void. Although difficult to phase conclusively, Structure **102** clearly post-dated Phase 1a wall **101**; the function of the structure is unknown, but it may relate to structure **103**.

4.5 Phase 3 – Machine Base

4.5.1 A large modern concrete structure **130** lay in the north-western part of the trench. Construction cut **129** truncated deposit **112**, extending from the north-western to north-eastern limits of excavation (**Figure 2**). Structure **130** comprised of a squared block of concrete measuring at least 1.45m x 0.95m, with a series of recesses and channels in the upper surface. It was founded on a rectangular concrete block measuring 2m x 1.4m and was secured within the cut by a deposit of light grey sand **131**. The precise function of the structure is not known; it is assumed to be a machine base.

4.6 Phase 4 – Demolition

4.6.1 The demolition of foundry walls and structures resulted in the distribution of debris **127** on a generally level plane (**Figure 4**). The demolition event was overlain by a 0.55m thick blackish brown deposit **126** containing frequent brick and concrete rubble with timbers, rubber and iron objects. This was overlain by a 0.6m thick layer of mid-bluish grey clay **125**, which in turn was overlain by a 0.3m thick layer of dark yellowish brown sandy silt **124**, representing made ground. A 0.12m layer of hardcore **123** underlay the bluish grey gravel **122** of the existing car park surface.

5 FINDS

5.1 Introduction

5.1.1 A small assemblage of material comprising metal objects, slag and metal conglomerates and a ceramic bung was recovered from secure contexts (**Appendix 3**). No other finds or samples were recovered during the evaluation.

5.2 Assessment

5.2.1 An initial assessment was carried out by Dr Rod Mackenzie in order to identify any diagnostic items and to assess whether further analysis could add to existing knowledge of the Site and the processes carried out there.

5.2.2 Individual items within the assemblage were examined visually and, where relevant, tested magnetically. No chemical or metallurgical analysis of the items was carried out at this assessment stage. A brief description and provisional identification of the items from each context number is included in **Appendix 3**.

5.2.3 Following assessment, samples of slag were selected for retention in the site archive. The remaining items in the assemblage have been disposed of.

Metals assemblage

5.2.4 The metals assemblage includes off cuts and swarf that appear to be made from alloy and mild steel. The assemblage also contains some recognisable manufactured items, such as the piston and broken engine valve from **107** and **126**, although the identity or function of the unusual shaped stainless steel 'nodule' from **100** is less clear (**Plates 2, 3 and 4**). The latter may be a possible hand tool and will be referred to the staff at Sheffield Industrial Museums Trust (Hawley Collection) for identification.

5.2.5 The type and range of metal items recovered suggest that almost all of the items were scraps for re-melting and were left behind following redevelopment of the Site. The presence of re-melting scrap fits in with the type of furnaces that were in use at the Site. It is likely that scrap was bought in from elsewhere for re-melting; it is therefore extremely difficult to determine which items were produced at the Site.

5.2.6 The one piece of metal that does appear to have originated at the Site, is the 'scab' of ferrous metal **138** that was removed from the brick lining of the possible casting pit **103**. A sample of this material was selected for metallographic analysis to characterise the metal (see 5.3 below).

5.2.7 The majority of the slag in the assemblage appears to relate to the smelting or re-melting of cast iron, either in blast furnaces or cupola (re-melting) furnaces. Given the history of the Works, the slag is more likely to relate to the re-melting of iron in cupola furnaces. The pieces of slag recovered from **121** may relate to a different metallurgical process, such as steel melting, although further analysis would be required to investigate this.

5.2.8 Metallurgical analysis of the metal finds could, amongst other things, be used to find out what type of metal they are made from and whether they

were forged or rolled. However, this may not necessarily determine whether the pieces of metal were manufactured at the works, or scrap bought in for re-melting. The majority of the slag in the assemblage appears to relate to re-melting of iron in cupola furnaces, which is a process that is known to have been carried out at the Site. Further analysis of the 'cupola slag' would, therefore, not significantly add to existing knowledge of the site.

- 5.2.9 The 'scab' of metal from **138** does appear to directly relate to metal production at the Site. Further analysis could determine the type of metal and provide information that may be useful for the interpretation of structure **103**. The three pieces of more unusual slag recovered from **121** may be a by-product of steel-making at the Site. However, the nature of the slag and the context that it was found in suggests that it may have been re-deposited, which limits its potential somewhat.

Other materials

- 5.2.10 The two graphite objects from **107** probably relate to the use of the electric arc and induction furnaces that are thought to have been used at the Site. The objects were photographed for the archive (**Plates 2 and 3**).

5.3 Archaeometallurgical Analysis

- 5.3.1 A sample of the ferrous material **138** from the inside of structure **103** was analysed (**Figure 3; Plate 1**). The aim was to identify the type of metal present in the deposit and to establish how it was deposited. The results were used to interpret (a) the function of the structure that the deposit was recovered from; and (b) what type of metal was being produced in that area of the Site.
- 5.3.2 A specimen of **138** was removed for metallographic analysis and approximately 40 grams was removed for chemical analysis. Although only one specimen from the metallic deposit was analysed, its external appearance was typical of the larger sample that it was removed from.
- 5.3.3 The metallographic specimen was mounted in resin and ground and polished in the normal manner, as described by Vander Voort (1999). The final polishing stage was performed using 1µm diamond paste, and after initial inspection, the surface was etched with 2% Nital. The etched surface of the specimen was examined with a reflected light microscope. Chemical analysis of the specimen was carried out using a combination of inductively coupled plasma optical emission spectrometry (ICP-OES) and Combustion/Infrared analysis.
- 5.3.4 Examination of the metallographic specimen revealed a very heterogeneous microstructure. The specimen appears to be made up from spheroidal and irregular shaped globules of steel. The microstructure of each globule is slightly different, and some are separated by thin layers of what appears to be silicate slag and/or possible ferrous oxides.
- 5.3.5 The variety of microstructures and thin silicate/oxide boundary layers suggest that the deposit accumulated as successive layers over time. The shapes of individual globules within the microstructure suggest that the metal was deposited as spots or splashes of molten metal. Although all of the metal deposited appears to be steel, the type and variety of

microstructures present is indicative of different cooling rates, and possibly different amounts of alloying elements.

- 5.3.6 The results of the chemical analysis (**Table 1** below) suggest the deposit relates to the production of alloy steel(s). Although it is tempting to try and use the results of the chemical analysis to identify a specific type of alloy steel, it should be noted that the analysis was of a very 'mixed' deposit, which possibly contains a mixture of different steels, as well as surface contaminants. It is, therefore, potentially misleading to interpret the results of the chemical analysis too literally.

Element	Results (mean)	Results (variance)
Manganese	3.40%	2.81% low, 4.55% high
Carbon	0.93%	Not determined
Silicon	0.67%	0.21% low, 1.47% high
Aluminium	0.54%	0.11% low, 1.32% high
Nickel	0.26%	0.15% low, 0.35% high
Chromium	0.22%	0.11% low, 0.32% high
Sulphur	0.18%	Not determined
Copper	0.16%	0.13% low, 0.18% high
Magnesium	0.08%	0.03% low, 0.15% high
Molybdenum	0.08%	0.04% low, 0.10% high
Phosphorus	0.03%	0.02% low, 0.03% high
Zinc	0.03%	0.02% low, 0.03% high
Arsenic	0.02%	0.01% low, 0.02% high
Tin	0.02%	0.01% low, 0.02% high
Tungsten	0.02%	0.01% low, 0.02% high
Antimony	Not detected	
Bismuth	Not detected	
Cadmium	Not detected	
Cobalt	Not detected	
Lead	Not detected	
Niobium	Not detected	
Selenium	Not detected	
Tantalum	Not detected	
Titanium	Not detected	
Vanadium	Not detected	
Zirconium	Not detected	

Table 1: Results of chemical analysis of deposit **138**

- 5.3.7 The sample analysed was removed from a deposit that was adhering to the lining what has been interpreted as a possible casting pit **103**. The lining of the upper half of the pit was covered with this metallic deposit/concretion. The level of sand and 'clean' brickwork found in the lower half of the pit suggests that it was approximately half filled with sand during use.
- 5.3.8 In the author's opinion, the 'casting pit' was probably being used to hold partially buried casting moulds, into which molten steel was poured. The splashes and spots from the teeming process appear to have accumulated and solidified on the lining of the pit over time. From the evidence available and potential variables involved, it is impossible to be precise on the time-scale of the deposition, or exact positioning of the casting moulds. However,

the nature of the deposit suggests that it is likely that the height of the top of the moulds were at approximately floor level when the metal was teemed.

- 5.3.9 The external appearance, results of scientific analysis and archaeological context of the metallic deposit all suggest that it was formed by the successive build up of splashes and spots of metal from teeming alloy steel(s) into casting/ingot moulds that were set into a part sand filled 'casting/teeming pit'.

6 DISCUSSION

6.1 Summary

- 6.1.1 The results from the evaluation have met in full the aims and objectives of the project as outlined in **Section 3** above. Despite the relatively recent closure of the Works in 1988, the locations of the various processes within the majority of the Site were previously unknown and the results of the evaluation serve to enhance understanding of the development of the Site and the Imperial Steel Works.

Archaeological survival

- 6.1.2 The evaluation has showed that considerable depths of overburden of between 1.6m and 1.8m overlie archaeological remains in this part of the Site. Beneath this level the walls and internal structures of the Imperial Steel Works buildings survive in a good condition.

Development of the Site

- 6.1.3 Cartographic evidence from 1923 suggests that the evaluated building was probably constructed as two distinct ranges. The trench appears to have investigated part of the western range, close to the middle of the Works, and internal pier and panel walls were recorded. Several distinct phases were evident and three casting pits were identified, demonstrating the activities carried out in this part of the building. In addition, several graphite objects from a layer of demolition debris may be tentatively associated with the use of the Electric Induction Crucible Process on the Site.

Processes and process flows

- 6.1.4 With the identification of casting pits within the foundry, some limited interpretation of the process flow in the building is possible. The area to the immediate west of the trench may have been involved in the transportation of metals, possibly in overhead cranes, and will have contained re-melting furnaces – possibly connected to the documented Héroult furnaces or the high frequency 'coreless' Electric Induction Crucible Process.

6.2 Archaeological Potential

- 6.2.1 The importance of Sheffield's metal-production and metal-working heritage (and steel in particular) means that the Imperial Steel Works is of particular historic and archaeological significance. The Imperial Steel Works was at the forefront of technological innovation and Allen's introduction of the high frequency or 'coreless' Electric Induction Crucible Process for the production of high quality steel was the first use of this process in the world.

6.2.2 The level of archaeological preservation is sufficient to allow identification of specific processes and structural sub-divisions within the Works, and there is potential for the recovery of structures and finds associated with the use of innovative technology at the Site. The well-preserved remains within the evaluation trench indicate that a similar level of archaeological survival may be anticipated in other areas of the Works, particularly those closest to the evaluation trench, which may be examined by future archaeological investigations in connection with further stages of development on the Site.

6.3 Recommendations for Further Work

6.3.1 All relevant analyses of structural data and finds assemblages recovered during the evaluation have been completed during the course of preparation of this report and no further work is recommended in this regard. Any further analysis should be considered in conjunction with the results of future archaeological investigations on the Site.

7 ARCHIVE

7.1 Location and Deposition

7.1.1 The project archive has been compiled into a stable, fully cross-referenced and indexed archive in accordance with Appendix 6 of *Management of Archaeological Projects* (2nd Edition, English Heritage 1991). The archive is currently held at the offices of Wessex Archaeology, Sheffield, under the project code **74661**. The full list of the contents of this archive is detailed in **Appendix 1** of this report. It is proposed that the archive will be deposited in due course with Sheffield Museums Service. However, at the time of writing the Museums Service is not currently accepting archaeological archives, consequently the long-term storage location of the archive cannot be confirmed.

7.2 Copyright

7.2.1 This report, and the archive generally, may contain material that is non-Wessex Archaeology copyright (e.g. Ordnance Survey, British Geological Survey, Crown Copyright), or the intellectual property of third parties, which we are able to provide for limited reproduction under the terms of our own copyright licences, but for which copyright itself is non-transferrable by Wessex Archaeology. Users remain bound by the conditions of the Copyright, Designs and Patents Act 1988 with regard to multiple copying and electronic dissemination of the report.

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Sheffield Archive References

- Archive Ref MD 2296-2339 – Edgar Allen & Company Ltd. Order Books from 1913 -1934.
- Archive Ref MD 3167-3169 – Various notes taken by E.N. Simons for “The Story of a Great Steel Firm: Edgar Allen & Co. Ltd.” which appeared in Edgar Allen Magazine 1953.
- Archive Ref CA 206 – Microfiche slides of: planning application 2221c (ref 08279), 1905.
- Archive Ref 289.13 – 1923 edition of 1921 OS map.

APPENDIX 1: ARCHIVE INDEX

File No.	NAR Cat.	Details	Format	No. Sheets
1	-	Index to Archive	A4	1
1	A	Client Report	A4	?
1	A	W.S.I.	A4	15
1	B	Day Book (photocopy)	A4	3
1	B	Context Register	A4	2
1	B	Context Records	A4	44
1	B	Graphics Register	A4	1
1	B	Site Graphics	A4	3
1	B	Site Graphics	A3	1
1	D	Photographic Register	A4	2
1	D	Colour Contact Sheet	35mm	1
1	D	Colour Slide Discs	CD	1
1	D	B/W Contact Sheet	A4	1
1	D	B/W Negatives	Neg	36
1	D	Digital Images	CD	1
1	B	Trench Matrices	A4	1
FINDS	No. OF BOXES (1)			

APPENDIX 2: CONTEXT SUMMARY

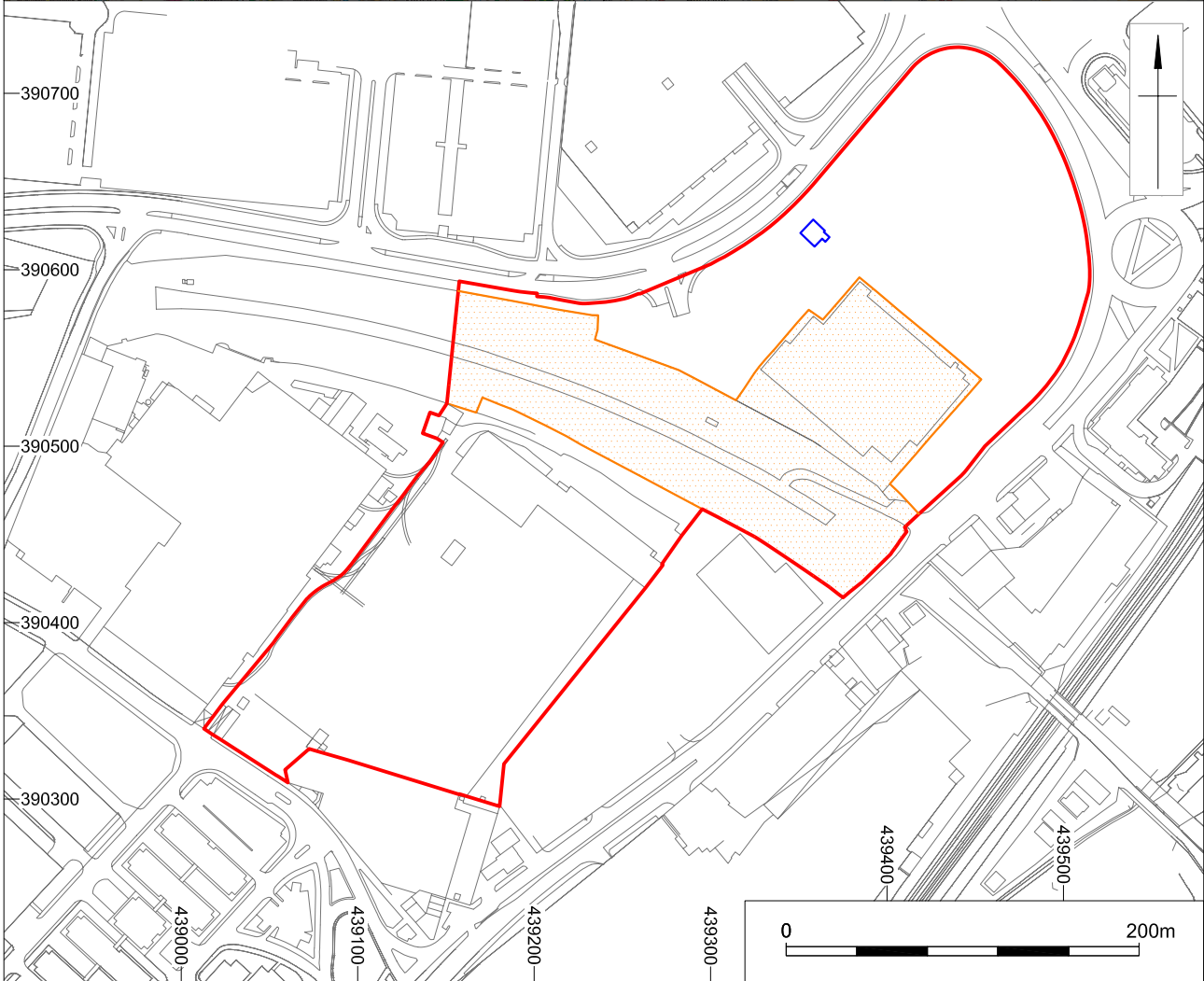
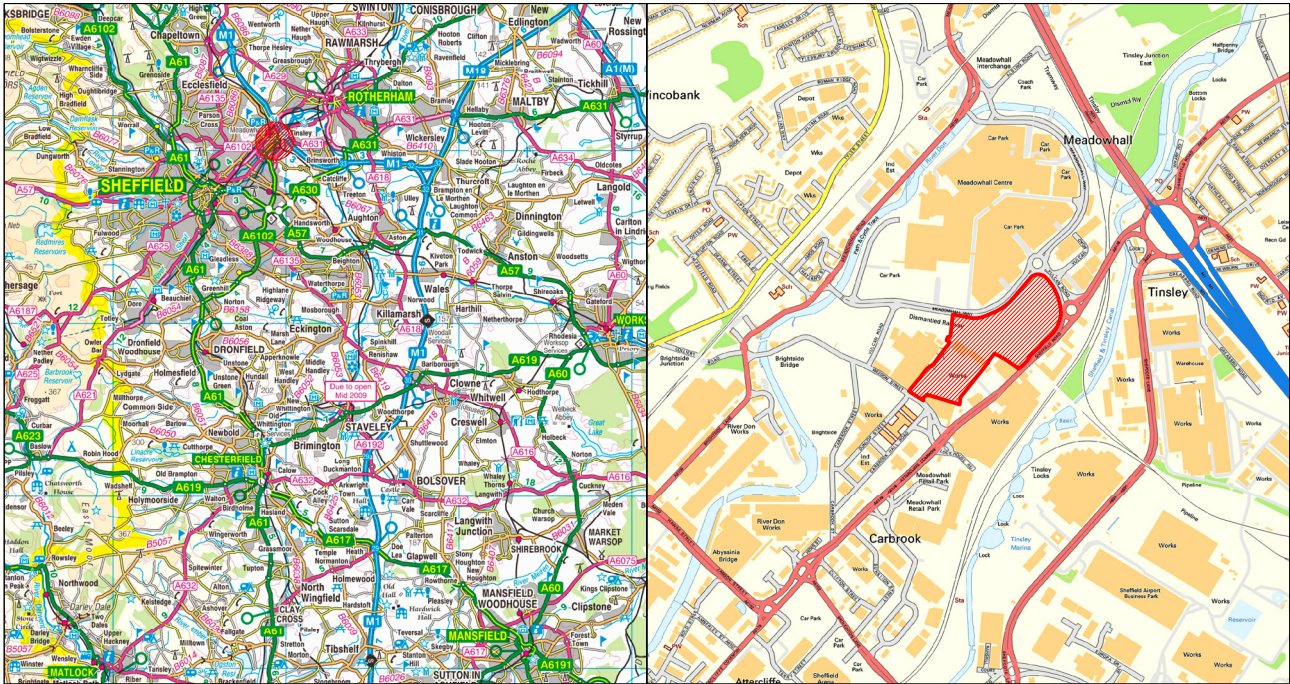
Fill	Cut	Type	Interpretation
100		deliberate backfill	Backfill between (115) and (103).
101		Wall	Possible 1st phase foundry wall.
102		Structure	Possible machine base.
103	140	Structure	Possible casting pit.
104		Structure	Ferrous plates within structure 103.
105		Deposit	Sandy layer within 103, bedding for 104.
106		Deposit	Sandy deposit within 103, bedding for 104.
107		deliberate backfill	Probably pre-demolition backfill of structure 103.
108		Structure	Brick drain base surround.
109		Structure	Concrete covering ceramic drain pipe.
110		Surface	Sloping concrete surface within 108.
111		Fill	Fill of drain 108.
112		Surface	Consolidated amalgamation of slags, possible 1st phase floor surface.
113	143	Wall	1st phase walling, east wall of possible casting pit.
114	143	Wall	1st phase walling, south wall of possible casting pit.
115		Wall	2nd phase. North and east wall of possible casting pit.
116		Structure	Casting pit lining.
117		Deposit	Possible casting pit sand.
118		Deposit	Made ground between walls 115 and 103.
119	136	Wall	2nd phase. North wall of possible casting pit.
120		Structure	Concreted casting pit lining.
121		Deposit	Possible casting pit sand.
122		Deposit	Modern gravel car park surface.
123		Deposit	Hardcore bedding for 122.
124		Deposit	Layer of soil above 125.
125		Deposit	Made ground after building demolition.
126	127	Deposit	Post demolition levelling rubble.
128		Deposit	Possible construction/trample material, 1st phase.
130	129	Structure	Possible machine base, phase 3
131	129	deliberate backfill	Backfill around structure 130.
132		Foundation	Concrete foundation for wall 101 and stanchion 134.
133		Structure	Ceramic drain base, possible from roof down pipe.
134		Structure	Stanchion.
135		Fill	VOID
137	136	deliberate backfill	Construction cut backfill.
138		Structure	Possible metal residue in structure 103.
139		Deposit	Possible casting sand in structure 103.
141	140	deliberate backfill	Construction cut backfill.
142	143	Wall	Possible north wall of 1st phase casting pit.
144	143	deliberate backfill	Construction cut backfill.

APPENDIX 3: SUMMARY OF FINDS ASSESSMENT

Context No.	Description & Provisional ID	Number of Pieces	Weight	Further Action required
100	Dense glassy slag - probable cupola furnace tap slag	1		No
100	Small rectangle of alloy steel (63mm x 25mm x 4mm) - undiagnostic	1	n/a	No
100	Unusual shaped 'nodule' of stainless steel – possible hand tool.	1	n/a	Yes, illustrate or photograph & refer to Ken Hawley
107	Bar of metal with numbers 5332 stamped on end (300mm x 30mm x 23mm) – possibly a test piece of alloy steel.	1	n/a	
107	Short length of round bar (110mm x 25mm dia.) – off cut of alloy steel bar, possibly '300 series' stainless steel.	1	n/a	No
107	Short length of partially machined round bar (56mm x 22mm dia.) – off cut of alloy steel bar, possibly '300 series' stainless steel.	1	n/a	No
107	Length of round bar (338mm x 60mm dia.) – off cut of alloy steel.	1	n/a	No
107	Alloy/Stainless steel swarf - waste from machine shop.	3	n/a	No
107	Short length of thin metal rod (120mm x 6mm dia.) – scrap off cut	1	n/a	No
107	Shorts lengths of iron/steel bar, partially forged – scrap off cuts	2	n/a	No
107	Valve from piston engine, with cracked head – damaged engine part, possibly relates to piston from [126].	1	n/a	No
107	Graphite objects – possibly relate to electric (arc/induction) furnaces.	2	n/a	Yes, illustrate or photograph
107	Short length of ferrous metal tube (75mm x 40mm dia.) – undiagnostic/scrap off cut	1	n/a	No
112	Glassy slag, dark to olive green in colour, two pieces have coke inclusions – slag from cupola furnace.	4	480g	Yes, selected samples for archive
112	Conglomerate of compacted crushed slag, sand and ash – debris from foundry floor	4	1660g	No
112	Porous 'drossy' slag, with coke inclusions – slag from cupola furnace.	3	440g	No
121	Porous olive green slag, slightly glassy texture with fine and evenly distributed vesicles. Possible steelmaking slag.	3	650g	Yes, retain for possible future analysis
126	Conglomerate of compacted crushed slag, sand and ash – debris from foundry floor	2	590g	No
126	Glassy dense slag, dark to olive green in colour – slag from cupola furnace.	2	25g	No
126	Very porous and relatively	1	2650g	No

Context No.	Description & Provisional ID	Number of Pieces	Weight	Further Action required
	inhomogeneous slag – relates to ferrous metal, but undiagnostic of production process.			
126	Internal combustion engine piston, with partially driven out connecting pin – scrap for remelting?	1	n/a	No
128	Steel bar (820mm x 30mm dia.), round in section but partially flattened into oval – possibly used as a pry-bar or lever, or scrap for remelting.	1	n/a	No
128	Refractory clay plug, c.140mm diameter. Discarded waste from foundry.	1	n/a	No
138	'Scab' of heavily corroded ferrous metal removed from brick surface of structure [103] – possible residue from teeming iron/steel.	1	n/a	Yes, metallurgical analysis

Figures and Plates



 Site boundary (07/02074/FUL)
 Archaeological trenching
 Area of no archaeological potential

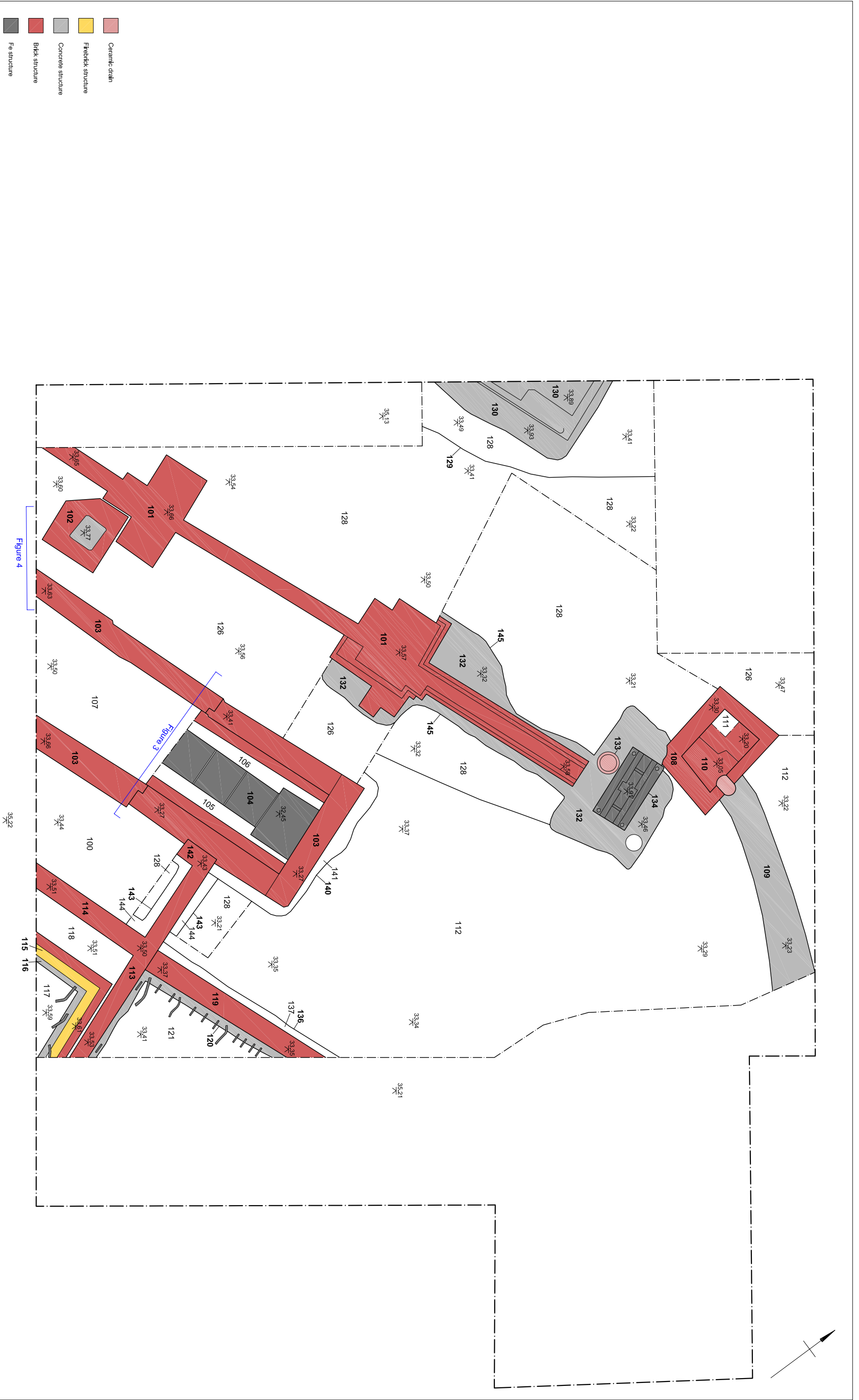


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Site and trench location

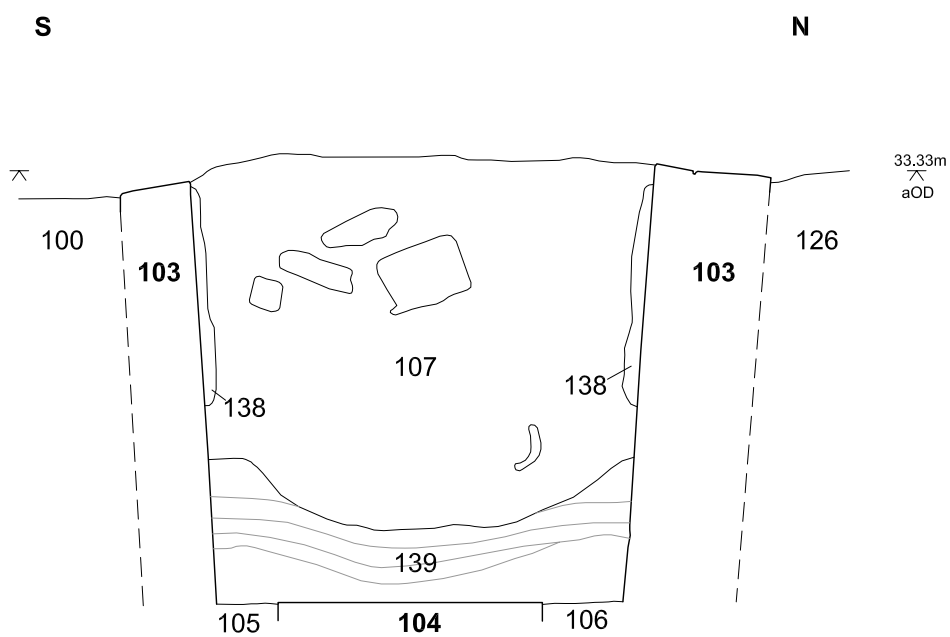
Figure 1



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Trench plan

Figure 2



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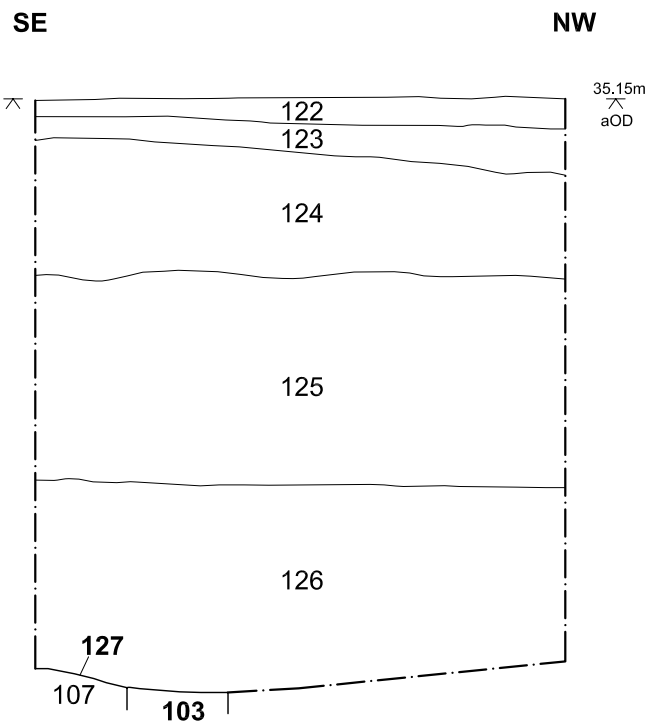
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Section through structure 103

Figure 3



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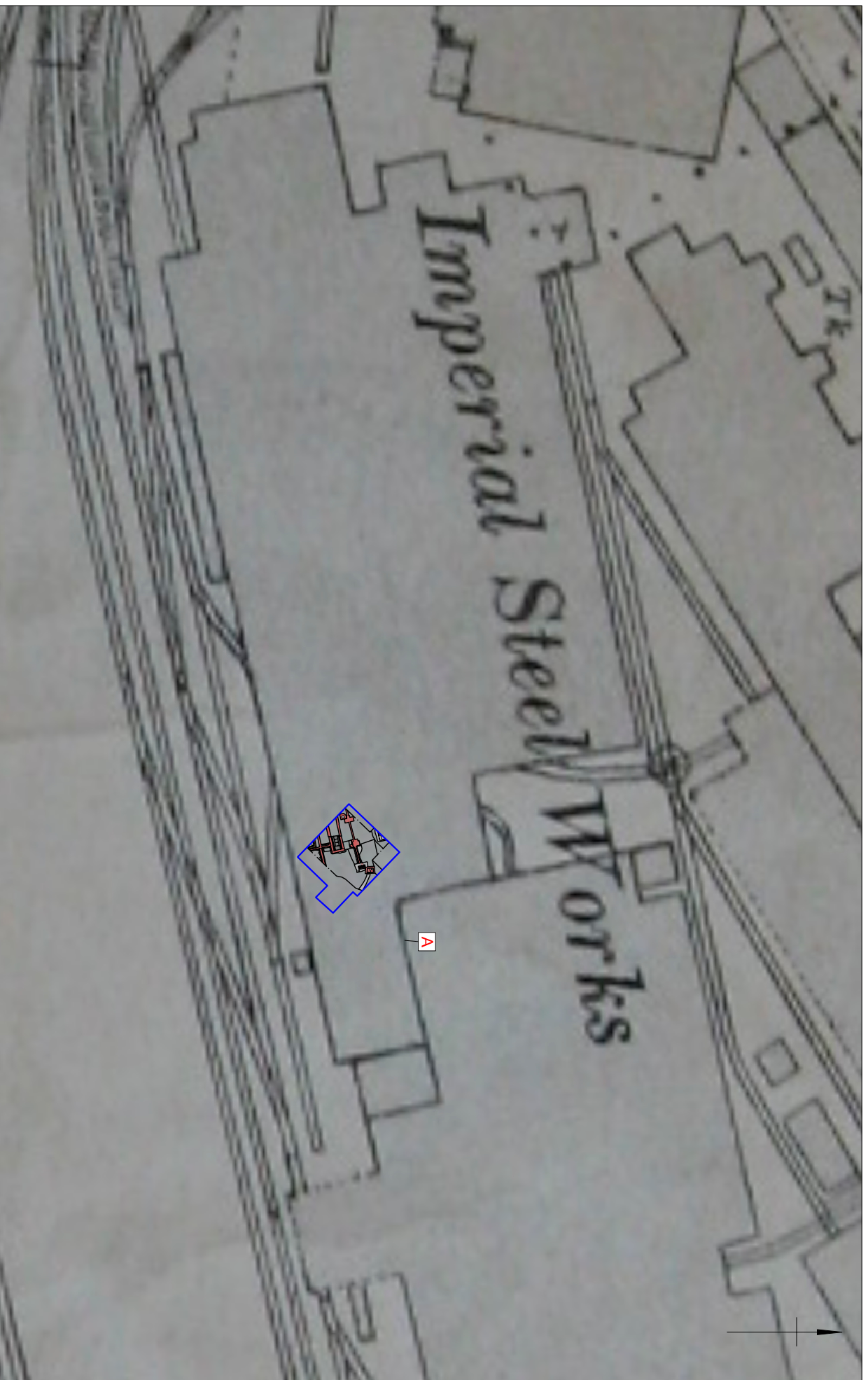
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Section through overburden

Figure 4



0 50m

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Trench data overlaying the 1923 OS map of the Works

Figure 5



Plate 1: Structure 103 , showing metallic deposit 138.



Plate 2: Screw threaded graphite object recovered from demolition deposit 107.

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Revision Number: 0

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Illustrator: CS

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Plate 3: Screw threaded graphite object recovered from demolition deposit 107.



Plate 4: Unusually shaped 'nodule' of steel recovered from deposit 100.

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