C261 ARCHAEOLOGY EARLY EAST

Interim Statement

Archaeological Targeted and General Watching Brief at Limmo Peninsular Main and Auxiliary Shafts (XRW10)

Document Number: C261-MLA-X-RGN-CR140-50124

Document History:

Revision:	Date:	Prepared by:	Checked by:	Approved by:	Reason for Issue:
1.0	12.09.12	Daniel Harrison (MOLA)	Nicholas Elsden (MOLA)	Elaine Eastbury (MOLA)	For CRL Review

CROSSRAIL REVIEW AND ACCEPTANCE STATUS

This decal is to be used for submitted documents requiring acceptance by CRL.

☑	Code 1.	Accepted. Work May Proceed
☐	Code 2.	Not Accepted. Revise and resubmit. Work may proceed subject to incorporation of changes indicated
☐	Code 3.	Not Accepted. Revise and resubmit. Work may not proceed
☐	Code 4.	Received for information only. Receipt is confirmed

Reviewed/Accepted by:(signature)

Print Name: MIKE COURT Date: 20TH SEPT 2012

Acceptance by CRL does not relieve the designer/supplier from full compliance with their contractual obligations and does not constitute CRL approval of design, details, calculations, analyses, test methods or materials developed or selected by the designer/supplier.

Contents

Figures

(In Annex 1 at back of document)

List of Photos

Tables

1 Introduction

This Interim Statement covers an archaeological targeted watching brief carried out at the Limmo Peninsula, Main and Auxiliary Shafts shaft by the C261 Museum of London Archaeology (MOLA).

This was carried out between 18/01/12 and 19/03/12 and supervised by MOLA Senior Archaeologists Sam Pfizenmaier and Danny Harrison.

It was recorded under event code (sitecode) **XRW10**.

This document is an interim statement of the results of the fieldwork. More extensive background, results, and conclusions will be included the Fieldwork Report which will be submitted within six weeks of the end of fieldwork (Crossrail, *Archaeology, Specification for Evaluation & Mitigation (including Watching Brief, Doc. No. CR-PN-LWS-EN-SP-00001*, v. 5.0, 13.07.11).

All levels in this document are quoted in metres Above Tunnel Datum (m ATD). To convert Tunnel Datum to Ordnance Datum subtract 100m, ie 1m OD = 101m ATD.

The fieldwork was carried out in accordance with:

- A Crossrail **Site-specific Written Scheme of Investigation** (SS-WSI): *Limmo Peninsula Shaft Site-specific Written Scheme of Investigation,* doc. No. C123-JUL-T1-TPL-CR144_SH011_Z-00001, Rev. 9.1, 04/04/11. [WSI]
- An **Addendum to the WSI** (Addendum): *Addendum to: Limmo Peninsula Shaft Site Specific Written Scheme of investigation*, doc. no. *C123-JUL-T1-TPL-CR0144_Z-00001*, Rev. 9.1, 29/06/11. [Addendum]
- *C261 Archaeology Early East, Method Statement, Targeted and General Watching briefs at Limmo Shaft (XRW10),* doc. No. C261-MLA-X-RGN-CR140-50066 Revision 4.0, 01/02/12 [Method Statement]

2 Aims and Objectives

2.1 Relevant Regional Research Aims

In addition to the site specific research aims, the site has potential to address several regional research aims identified in the regional research agenda ‘A Research Framework for London Archaeology’, Museum of London, 2002. The regional research themes considered relevant to achieving an understanding are as follows (page numbers in brackets):

- The significance of geomorphology, ecology, ecosystems and climate, hydrology, and vegetation and faunal development, on human lives (p 79);
- London’s hydrology, river systems and tributaries particularly the role of the River Thames, as boundary, communication route, resource, ritual focus etc, in shaping London’s history, and the relationships between rivers and floodplains (p 79);

- The relationship between landscape, river and settlement, and the influences of the River Thames in particular on communications and social interaction (p 79); and
- The development of London's Docklands and Waterways (p 82).

2.2 Site Specific Research Aims

The objective of the archaeological investigations, as stated in the Addendum to the WSI (Crossrail 2011), is set out below:

The overall objective of the archaeological investigations is mitigation by means of *preservation by record*, in the form of archaeological Targeted Watching Brief to excavate and record archaeological deposits for analysis and dissemination.

The aim of the targeted watching brief will be to record the presence of any archaeological activity identified during the excavation of the Main and Auxiliary Shafts. The following objectives have been devised by MOLA (*C261 Archaeology Early East, Method Statement, Targeted and General Watching Briefs at Limmo Shaft (XRW10), doc no. C261-MLA-X-RGN-CR140-50066)* to guide the fieldwork:

- Identify and record any remains of the Thames Ironworks exposed during the relevant groundworks.
- Record the extent and nature of the floodplain sequence, with particular emphasis on the Allerod peat deposits.

In addition, the Aims and Objectives below, updated from the evaluation results, are specified in the WSI.

The following site specific research aims can be outlined for the investigations at the Limmo Peninsula shafts:

- Where possible, characterise the sedimentary sequence at the site in terms of lithology, agents of deposition, preservational environment and age of deposition.
- Where possible, sample and characterise the preservational environment within bodies of sediment for the recovery of palaeoenvironmental remains.
- Where possible, develop from the boreholes and previous geotechnical work, a first order sedimentary model for the site.
- Where possible, on the basis of assessment of palaeoenvironmental remains, if recovered, develop a first order model for palaeoenvironmental development at the site.
- What is the development of the local landscape and topography of the junction of the Lea and Thames floodplains from prehistory to the medieval period? Are any peat deposits present? If so, at what level(s) and at what date did they form? Is there evidence for river scour removing prehistoric alluvial deposits, or conversely, do they survive?
- Is there any evidence for prehistoric activity that has survived later river scouring? If prehistoric remains are present, what is their character and what can be learned about the exploitation of the floodplain by prehistoric groups? In particular, is there any evidence for Mesolithic activity at the base of the

Alluvium/surface of the sands? Is there any evidence for timber trackways or other structures of later prehistoric date?

- Is there any evidence for Roman activity, in particular for reclamation or flood defences, and marine transgression and regression?
- What can be learned about the process of land reclamation and management of the area from the medieval period until the construction of the shipyards and wharves in the mid nineteenth Century?
- What is the evidence for the development of the area in connection with the Thames Ironworks and other shipyards and wharves during the nineteenth century?
- Is there any below-ground or above-ground evidence for the nineteenth century Thames Ironworks, and other shipyards and wharves? In particular, is there evidence for the internal railway systems, dock structures, or slipways?

3 Provisional Results

See Fig 1 *for the shafts' locations*

Photo 1 *Main Shaft excavation*

3.1 Main Shaft

Fig 2, Fig 3, Fig 4, Fig 5, Photo 1, Photo 2, Photo 3, Photo 4, Photo 5	
Location	Limmo Peninsula, western side.
Dimensions	30.40m diameter circle
OS National grid coordinates	539416 180989
LSG grid coordinates	87948-35513
Modern Ground Level	(Previously excavated during evaluation phase in Trenches 1 and 2 from 105m ATD below DLR rubble dumps)
Modern subsurface deposits	(Previously excavated during evaluation phase in Trenches 1 and 2)
Level of base of archaeological deposits	Top of London Clay [89] at between

observed	93.50 and 94.80m ATD
Natural observed (not truncated)	Top of London Clay [89] at between 93.50 and 94.80m ATD
Extent of modern truncation (Base of modern overburden and 20th-century demolition deposits over Thames Ironworks structure as seen in Evaluation phase)	Evaluation Trench 1: Truncation to103.5m ATD (Trench 1 subsequently excavated to: 102.6m ATD, extended to 102.0m ATD within three small test pits at the west, centre and east of the trench). Evaluation Trench 2: Truncation to 103.4m ATD at the eastern end and 103.5m ATD at the western end (Trench 1 subsequently excavated to: 102.6m ATD, extended to 102.0m ATD within two small test pits at the west, by structure [31] and in the centre of the trench).
Archaeological remains	**Dating Evidence, Finds, and Samples**
Context [88] Gravels overlying natural London Clay [90]. Scant abraded ceramic was found in near the top of [88]. Gravels are likely Holocene and also possible Pleistocene. Between 94.80m and 96.35m ATD.	
Timber boat hull section [79] (Appendix 0) at 96.35m ATD found at the interface between the base of the estuarine alluvium [63] and the top of the underlying gravels [88].	12th-16th century (likely 13th-14th century)

Section 3: Probable channel gravels/ flood deposits [70] and [71]- gravels between 96.65m and the base of the slot at 95.89m ATD, going below the depth of the trench slot. Above the gravels were alluvial silts and overbank flood deposits: [65]-[69] inclusive between 98.33m and 96.65 ATD. Fig 4 *Section 3 (Main Shaft)* Section 4: Probable channel gravels/ flood deposits [72]-[76] inclusive, including a lump [78] of redeposited peat- gravels between 96.89m and the base of the slot at 96.49m ATD. Above the gravels was alluvial silt [77] between 97.39m ATD (machined to top) and 96.89m ATD. Fig 5 *Section 4 (Main Shaft)*	Section 3: Bulk samples: [65] sampled as <22,29,30,31> [66] sampled as <21> [69] sampled as <23,24,25,26> Section 4: Bulk sample: [78] sampled as <28> Monolith sample: <27> containing contexts: [72,78,77]
Deposits [62] and [63] are estuarine alluvial silts between 102.1m and 96.40m ATD. Wooden barrel lid found in [63].	
[47] 19th-century ground consolidation of clinker mixed with some silt between 102.6m ATD (Base of Trenches 1 and 2) and 102.1m ATD.	None
[45] 19th-century brick wall aligned north-west–south-east. Between 103.50m and 102.50m ATD. Wall [45] is greater than 0.85m wide- it goes beyond the limit of excavation to the north-east. The cut for the wall is [46].	
Interpretation and summary	
Deposit [88] represents all gravels seen between the alluvium [62 and 63] and the natural London Clay [89] below, apart from those more closely scrutinised in Sections 3 and 4. The gravels are likely very late Devensian or Holocene floodplain gravels (created within the last 10,000 years), though may also include intact earlier Pleistocene gravels lower down the deposit although this seems unlikely. It seems more likely that the gravel deposits observed represent deposition by various migrating channels, either tributaries of the Lea or the Thames, into the Holocene period, with all previous deposits scoured away. The higher, sandier gravels are certainly Holocene in date. The timber boat fragment [79] (Photo 4) was found at the interface between the	

base of the estuarine alluvium [63] and the top of the underlying gravels [88]. It was lying with the outer portion of the boat face down and was seen in section while machining. Due to slight truncation by the machine and also truncation by the concrete wall of the shaft, a portion only 1.66m x 1.01m remained in situ; however this was enough to gain a fairly good understanding of the boat with regards its possible age and construction. The fragment is a portion of the starboard side of a large boat or barge and is clinker built of radially cleft oak boards. The boat dates from between the 12th to 16th century and is more than likely 13th or 14th century. It seems likely that the fragment had been cut to reuse in a revetment although it may be a part of a disturbed wreck subsequently redeposited. The fragment has been reviewed by a timber specialist who provided these dates based on the typology and construction of the boat. The provisional results of the assessment, summarised above, are included in this report (see Appendix 0). Unfortunately no dating of wood samples from the timbers could be achieved by the dendrochronologist (tree ring) specialist. The Dendrochronology report is also included in the Appendix (6.2). Further dating via radiocarbon dating may be a viable way of achieving a narrower date range for the fragment.

The two sections (Photo 3, Fig 4 and Fig 5 *Section 4 (Main Shaft)*Fig 5) allowed a more detailed appraisal of the base of the alluvium and the tops of the gravels. It seems likely that the gravels represent various flood deposits from a migrating channel. The silts [69] and [77] deposited as alluvium showed episodes of turbulent deposition and redeposition and periods of slack deposition, with intercalated laminations of sand present within the alluvium, especially within [65] and [66], showing more energetic episodes. The lump of peat [78], though fairly large, is almost certainly redeposited, having been eroded from elsewhere and brought here by currents and tides. The results of the samples taken should hopefully yield more information regarding the age of deposits and environmental conditions.

Deposits [62] and [63] represent a period of steady accumulation of estuarine silt during the historic period; with increasingly stickier and less sandy silt the higher up (more recent) the sequence.

The 19th-century clinker dumping [47] had already been observed during the evaluation phase as [18] and [36]. It is a large dump of industrial waste laid down as a ground consolidation and hard standing for the construction of the Thames Ironworks.

The 19th-century brick wall [45] observed was possibly part of a small workshop or perhaps some kind of working platform with a chimney [13]. The internal spaces seen in [45] are likely due to a method of construction that saved cost on bricks. The bricks were of a frogged, yellow, London Stock type. No arches were seen in this wall. Correlation with the Charles Warner map (auction survey map of 1913) shows that this area was within the ‘Light Platers’ and it seems likely that these structures were still intact at the time of the map’s production. Fig 2 shows the outline of the Main Shaft with the digitised plans of the archaeological features recorded during the Evaluation and Targeted Watching briefs in 2011, overlaid with the Charles Warner map. The map was not available at the time of writing the Fieldwork Report, but we are now able to correlate the results of 2011 with named areas. The results of the 2011 investigations were discussed in depth in: *Crossrail, C261 Archaeology Early East, Fieldwork Report, Archaeological Watching Briefs and Evaluation, Limmo Peninsula Shaft (XRW10), doc. no: C261-XRL-X-XCS-CR140-50010*

Photo 2 *Main Shaft. Sterile estuarine alluvium between 102.0m ATD and 100.5m ATD below 19th-century clinker dumps. Looking east*

Photo 3 *Main Shaft. Section 3 is exposed and being recorded. The top of the gravels below the alluvium is visible in the base of the slot at right. Looking south*

Photo 4 *Main Shaft, medieval clinker boat fragment at 96.35m ATD, looking east (scale is 1m)*

Photo 5 *Main Shaft. Excavating the London Clay*

3.2 Auxiliary Shaft

Fig 6, Fig 7, Fig 8, Fig 9, Photo 6, Photo 7, Photo 8, Photo 9, Photo 10, Photo 11	
Location	Limmo Peninsula, eastern side.
Dimensions	28.60m diameter circle
OS National grid coordinates	539499 180980
LSG grid coordinates	89831-35502
Modern Ground Level	106m ATD
Modern subsurface deposits	Crushed concrete over 20th-century rubble from the levelling of the site post-demolition of the Thames Ironworks. The rubble was mixed with clinker industrial waste- probably from the Ironworks. 106,0-103.5 m ATD.
Level of base of archaeological deposits observed	Top of London Clay at between 95.25 and 94.52m ATD
Natural observed (not truncated)	Top of London Clay at between 95.25 and 94.52m ATD
Extent of modern truncation	No truncation other than the 20th-century demolition of the structure prior to the deposition of rubble, clinker and modern made ground over the remains.
Archaeological remains	**Dating Evidence, Finds, and Samples**
Above the London Clay [87] were floodplain and alluvial gravels [86] between 96.50m and 94.52m ATD.. The gravels were likely Holocene and also possible Pleistocene. A small peat deposit [90] at the base of a possible channel at the level of the interface (95.12-95.22m ATD) of the gravels and clay was sampled.	[90] Bulk sampled as <40>
A silted channel [85] filled with silty clay containing frequent chalk nodule inclusions was seen cutting the gravels [86]. Its base was at 96.00m ATD and its top was level with the surface of [86] at 96.50m ATD.	
Holocene river gravels [84] between 97.89 and 96.50m ATD. (Also in sections described below) An unworked piece of wood was sampled from [84] for possible dating.	

Section 5: Alluvial silts, overbank flood deposits and gravels: Gravel [84] between 97.89 and base of section at 96.69m ATD under probable channel deposit / overbank flooding [83] banded sand and silt- gravels between 97.69m ATD and 98.34m ATD. This was under [82] and [80] silt with frequent redeposited peat clasts and bands of gravel flood deposit and [81] large band of gravel deposit, all between 97.74m and 98.57m ATD. This was below [64] alluvial silt between 98.29m ATD and 98.58m ATD (top of section). Section 6: Alluvial silts, overbank flood deposits and gravels: Gravel [84] between 97.89 and base of section at 96.69m ATD under probable channel deposit / overbank flooding [83] banded sand and silt- gravels between 97.78m ATD and 98.38m ATD. This was under [82] and [80] silt with frequent redeposited peat clasts and bands of gravel flood deposit and [81] large gravel band deposit, all between 97.80m and 98.40m ATD. This was below [64] alluvial silt between 98.30m ATD and 98.57m ATD (top of section). Fig 9 Sections 5 and 6 (Auxiliary Shaft)	Section 5: Bulk samples: [80] sampled as <37 > top and <38 > bottom. Monolith sample: <39> containing contexts: [83 and 82] Section 6: Bulk sample: [82] sampled as <32> Monolith samples: <33> containing contexts: [83 and 81] <34> containing context: [82]
[64] Holocene alluvial silts 98.29m ATD-101.59m ATD	None
[61] 19th-century ground consolidation of clinker mixed with some silt between 101.59m ATD and 103.1m ATD.	None

Above the clinker were a variety of 19th-century structures. All are the bases of walls and in places associated timbers and floors. The tops of the wall bases are at approximately 103.1-103.5m ATD. All contexts are here grouped into 5 areas appearing to have separate specific uses. (See Fig 7 for comparison with the Charles Warner map). All the areas are probably roughly contemporary with each other. Within each area it is likely that the internal structures were fitted after the construction of the main delineating external walls. <u>Area 1:</u> Between walls [42] and [40] Surface [93] and wall [51] <u>Area 2:</u> North of wall [41] (with underwall timber piles [60]), containing [58/59] (a series of masonry brick structures) and brick structure [52]. Connected to Area 3 by wall [57] <u>Area 3:</u> Bounded by walls [41], [42] and [48] and containing walls [49], [52], [57], [94] Timber structures [50] and [56] Possible surface(s) [93] Other structures [92], <u>Area 4:</u> Bounded by walls [91] and [40]. Possible surfaces [93] with a brick lined drain [55]. <u>Area 5:</u> Bounded by walls [91] and [41]. Structures [53] and [54] (probably associated with a nearby furnace?) and walls [43] and [44].	Brick samples and number of bricks taken: [40] x4 [41] x4 [42] x4 [43] x4 [44] x4 [48] x4 [49] x4 [51] x4 [52] x4 [53] x4 [54] x4 [55] x4 [57] x4

Interpretation and summary

Deposit [86] represents all sands and gravels seen between the possible channel silting [85] and the underlying London Clay [89] (Photo 11). It was very difficult to differentiate between different areas or beds of gravel, however some kind of alignment on a very roughly northeast-southwest line was observed (Photo 10). The gravels are likely late Devensian or Holocene (created within the last 10,000 years), though may also include intact Pleistocene gravels (older than circa 12000 years) lower down the deposit although this appears unlikely. It seems more likely that the gravel deposits observed represent deposition by one or more migrating channels, either tributaries of the Lea or the Thames, into the Holocene period, with all previous deposits scoured away. It is likely that the sand seen as a band within [86] (Photo 10) may well signify at least a portion of one of these channels, and correlates roughly with a depression seen in the clay on the same alignment, possibly suggesting a channel course. Channel silting [85] (**Photo 9** Channel [85] (middle of photo, top left to bottom right) with frequent chalk nodule inclusions. Looking north-east**Photo 9**) may be a part of the same channel but is probably a different channel that cut into the gravels below and then silted up. It is unclear from what source the chalk lumps within [85] may have come.

Gravels [84] may also be part of the same channel(s) or may represent a later period of river scouring and deposition. It seems likely that the gravels [84] are part of a later channel than [85] and are probably associated with the deposits [80-83 inclusive] seen in Sections 5 and 6 (Fig 9 and Photo 8). These deposits were clearly deposited within a channel, and represent flood deposits and silting with episodes of more energetic flow seen as bands of gravel within the silting. The silt must have been laid down during a period of erosion elsewhere as there were large redeposited peat clasts within it. It was these peat clasts that prompted the excavation of a slot and the sections and sampling to be done. The samples may hopefully shed some light on the environmental conditions under which the channel deposits were laid down and potentially their age.

The channel deposits discussed above are capped over the entire trench by likely historic alluvium [64]. Above the alluvium there was a thick layer of 19th-century industrial waste clinker [61] presumably put down to raise the ground level higher to prevent flooding and at the same time consolidate the ground to create some kind of hard standing for the Thames Ironworks buildings to be sat on. Having said this, several very substantial 19th-century timber piles [60] were seen below masonry, so the layer of clinker may not have been deemed necessarily firm enough on its own over the soft alluvium [64].

Above the clinker were a variety of 19th-century structures, all demolished to different degrees and levels (Photo 6). All were part of the Thames Ironworks. On the basis of alignments of walls and types of masonry there appear to have been five different areas of building, although it is as yet unclear if these represent different phases of construction and activity (and if so their chronology and sequence) or were contemporary.

Area 1 is an industrial building:

Walls [40] and [42] were structural, probable external walls, with [51] having been attached to [42] at a later date. [93] was a layer of compacted clinker, possibly a surface.

Area 2 is within an industrial building:

Wall [41] was a very substantial arched foundation with the bases of each arch over the very deep timber piles [60] (over 5m in length). The heavy bases [58], [59] and [52] may correspond to an internal rail, perhaps for transporting loads into and out of the structure.

Area 3 is an industrial structure connected by [57] to Area 2:

This collection of walls and structures was very substantially constructed, with an added support [94] connecting walls [48] and [49]. The timber structures [50] and [56] and stone structures [92] are probably associated with engines or machinery.

Area 4 is likely an external area bounded by walls [40] (and associated drain) and to [91]. It was covered by a layer of compacted clinker, possibly a surface and crossed by a brick lined drain [55].

Area 5 is an industrial structure bounded by walls [44] and [91]:

The space contained two possible hot gas flues or structures for ironworking [53] and [54], lined with heat resistant refractory bricks and each bisected longitudinally by single skin refractory brick partitions. [53] and [54] are probably associated with a nearby furnace either destroyed or beyond the limits of excavation. The Charles Warner map states that this area was a Pipe workshop so the structures may have been directly related to metalworking with pipes. Wall [43] may have been associated with this structure.

Photo 6 *Auxiliary Shaft, 19th-century buildings associated with Thames Iron Works at 103.50m ATD - looking east*

Photo 7 *Auxiliary Shaft, showing trench excavated for investigation of the alluvial silt and gravel interface and section recording - looking south-west*

Photo 8 Auxiliary Shaft. The South West facing section of the excavated trench, showing the peat rich silty clays below the grey estuarine alluvium, overlying the sands with the gravels at the base

Photo 9 *Channel [85] (middle of photo, top left to bottom right) with frequent chalk nodule inclusions. Looking north-east*

Photo 10 *Auxiliary Shaft. Sand observed within [86] on a similar alignment to the channel silting [65] and [85]. Photo taken following reduction of the deposit to 95.52mATD*

Photo 11 *Auxiliary Shaft. Gravels (86) undulating at interface with London Clay (87) in east of shaft*

4 Summary and Conclusion

- All deposits observed between the London Clay and the base of the alluvium are likely late Devensian or Holocene in date, and are the result of several phases of erosion, deposition and silting by a number of channels cutting and reworking earlier floodplain deposits. These channels cut into the London Clay and have likely scoured away most, if not all, previous surfaces or deposits.
- The alluvium in both shafts: [62], [63] and [64] is likely to have been deposited within historic times. The medieval boat hull section in the Main Shaft dates the alluvium thus and while there were no currently available dates for finds from the Auxiliary Shaft it seems likely that the date range for the deposition of the silts is equivalent. It is significant that the bed of the river at this time was gravelly, the river perhaps not carrying as much fine silt sediment in the medieval period as it did later and continues to do to this day. The strength of current may also have been stronger at that time than it is today.
- The dendrochronology samples from the boat section have failed to provide an absolute date (see 6.2.2). Advice will be taken from the English Heritage Regional Science Advisor on radiocarbon dating.
- The thick layer of 19th-century industrial waste (clinker) [61] was presumably put down to raise the ground level higher to prevent flooding and at the same time consolidate the ground to create some kind of hard surface for the Thames Ironworks buildings to sit on. However, several very substantial 19th-century

timber piles [60] were seen below wall base [41] in the Auxiliary shaft, so the layer of clinker may not have been deemed necessarily firm enough on its own over the soft alluvium [64].

- A range of structures was identified from the Thames Ironworks, with provisional uses in the Auxiliary Shaft footprint being those of bases for a possible internal rail system in the 'Fitting Shop' indicated on the 1913 map (Fig 7), perhaps associated with the machine base structures seen in the area indicated on the same map as 'Engine House'. Possible hot air flues or areas for heating were seen in the area of the 'Pipe Shop'. Part of the structure of the 'Smith's Shop' was also uncovered. The structures in the Main Shaft seen complement those already discussed in the Evaluation Report (2012). They are likely parts of the structure indicated on the map of 1913 as 'Light Platers'.
- The demolition rubble and waste clinker covering the remains of the Ironworks was treated as a non-archaeological modern deposit, its formation occurring after 1912.

4.1 Significance of Results (provisional)

The Thames Ironworks played a hugely significant role in the development of shipbuilding into the modern era, taking orders for 144 warships and many other vessels during its existence- domestically and also for the navies of Japan, Portugal, Peru and Prussia, amongst others. The Thames Ironworks rose to become an internationally renowned centre for shipbuilding innovation. HMS Warrior, launched in 1860, was the world's first iron-hulled armoured frigate and also the world's largest warship at that time. The Ironworks also produced structural elements for internationally important engineering schemes such as Isambard Kingdom Brunel's Royal Albert Bridge over the Tamar, opened in the 1859.

The Ironworks was hugely important in the development of East London, being one of the driving forces, along with the Royal Victoria Dockyard, for the boom in the construction of residential settlements in the area of Canning Town. The Ironworks itself grew to be one of the largest employers in the East End of London. Its works team, set up in 1895, became the precursor to the modern day West Ham United Football Club.

It is unlikely that the underlying deposits will yield a large amount of new knowledge of the area with regards understanding the likely riverine/geological processes associated with the Thames, the Lea or any tributaries and mudflats. The exercise in this respect has been more useful as a means of confirming the absence of certain deposits (such as the Allerod) in the actual locations of both shafts. One potentially significant finding of the investigation of the silts and gravels was the fact that the boat fragment, dated to the later medieval period, was at such a great depth and also that it lay on a gravel bed at the base of the alluvium, suggesting that the alluvium- at least in the locality in which the fragment was found, was laid down at a much later date than originally thought. The area may yet yield further information with regards the surprisingly late formation of the thick alluvial silt deposits, if only perhaps to confirm the late date for the formation of this alluvium.

There is considerable potential to correlate the relatively well-preserved industrial structures uncovered in the fieldwork with historic maps and documents showing the internal layout, workings and functions of the buildings at the Thames Ironworks. Therefore, the results from Limmo Peninsula are assessed as being of **moderate importance**.

4.2 *Provisional* Assessment of Results against Aims and Objectives

- There has probably been a scouring away of any Allerod deposits and also most Pleistocene and early Holocene deposits. Due to the amount of later reworking of sediments by channels, the deposits seen between the London Clay and the base of the alluvium may not be as old as previously thought. It was very difficult to ascertain the ages of these deposits. Analysis of samples taken may suggest a date range.
- Samples were taken of several deposits including silt rich with peat clasts. The processing of these samples should yield useful information with regards the paleoenvironment and help to elucidate the different depositional processes during the earlier period of alluvial estuarine silt deposition and before. The estuarine alluvial silt has been shown (at least within the area of the shafts) to have been deposited no earlier than the 12th-century.
- Further analysis of the waterlain channel deposits sampled may help understanding of the ecosystems, climate, hydrology, and vegetational development, of the area.
- There is no evidence for Roman activity. Some ceramic found may be Roman, results pending the finds report; however the ceramic was very abraded and likely washed from elsewhere.
- There was no physical evidence for land reclamation and management of the area from the medieval period until the construction of the shipyards and wharves in the mid 19th-century. Initially it would seem that the area investigated in the two shafts was an unsettled and non-utilised area of river channels and mudflats and that this situation persisted right up until the ground levelling with the clinker in preparation for the building of the documented Thames Ironworks in the 19th-century. This does not however preclude the local area having been affected by modifications to the landscape beyond the window of investigation allowed by the shafts. Actions such as canalisation, ground level raising, changes of land use/agriculture or waterfront revetting nearby may well have had an effect on the depositional or erosional rates of the channel and mudflat environment discussed. Also, changes on a larger environmental scale still, such as the clearing of upland areas and intensification of farming may have contributed to greater quantities of silt being carried by the Thames. This may have led to the formation of the thick layers of alluvium after the medieval period in the study area.

In terms of carrying out the requirements of the fieldwork objectives:

- Evidence for the Thames Ironworks was discovered and the remains of structures were recorded in each shaft. In the Main Shaft the records and building material samples taken will augment those already amassed during the Evaluation phase.

The digitised plans have already been aligned with historic maps; helping to further elucidate the form of the ironworks.

- The excavation of all deposits was monitored throughout the reduction by machines in the two shafts. Deposits were recorded in sequence and were sampled where it was deemed further information might be viable through analysis off site. The sections recorded were selected at significant deposit interfaces and where peat was observed, maximising the potential for information to be gained and for the most useful samples to be taken. No Allerod deposits were observed anywhere on site. It may be that the peat seen during borehole investigation may have been an isolated lump within the gravels just above London Clay.

5 Future Deliverables

Deliverables will be determined by the Project Archaeologist on completion of all fieldwork at the Limmo Peninsula and Instone Wharf.

6 Appendix

6.1 Initial notes on the section of medieval clinker boat

By D M Goodburn, BA, PhD, AIFA Woodwork Specialist, MOLA.

March 2012

6.1.1 Background, waterfront archaeology and a corpus of evidence for different styles of plank built vessels

The archaeology of the historic port of London has been systematically investigated over the last 40 years producing evidence of waterfront structures and how they changed through time. These structures include; river walls, quay fronts, dock inlets, jetties, bridges, slip-ways, warehouses, tide mills and more rarely watercraft or reused or abandoned parts of vessels. Although finding sections of vessel hull, largely complete hulls or reused boat and ship timbers are not every day occurrences enough have been found in the London region and the near by parts of North-West Europe to provide a large corpus of material. This corpus of actual timbers and detailed records has been studied by several nautical archaeologists (including this writer for a PhD) and many features of planked boat and ship construction are now broadly datable. In due course tree-ring dating can often also be applied to provide more precise dates and indicate regional origins for timbers used. Finally, small technological details can also indicate the regional origins of some nautical finds in the absence of cargo.

6.1.2 Boat finds and nautical timbers from the Lea Valley

Civil engineering works and archaeology projects have revealed a small number of finds of near complete boats and barges dating from the early 20th-century at Waltham Abbey gunpowder works, back to late Saxon times at Clapton Park. These comprise several small dugout boats of early medieval date, and two capsized clinker built barges of early post-medieval date, a Georgian period rowing boat and several gunpowder punts of around 1900. Reused timbers were previously all post-medieval in date comprising sections of ‘Westcountry-style’ barge hull and parts of larger ‘carvel-built’ vessels. To this writer’s knowledge, no fragments of medieval plank built craft have previously been found, perhaps surprising in such a large waterlogged zone.

6.1.3 Provisional notes on the XRW 10 Str [79] boat hull section find

The discovery of the timbers:

The MOLA site team were observing works in a large, deep shaft being excavated as part of the Crossrail project on the Limmo Peninsula when clearly blackened boards with rivets along their edges were exposed by the excavating machine. Hand excavation took over and it became clear that the boards were partially over lapping

and still fastened together with distinctive iron rivets. These features were correctly taken as indicating that the timbers were once part of a clinker built vessel of some age. Clinker style construction was introduced to England by Germanic settlers coming from the east. The technique involves assembling a hull of partially overlapping boards most often riveted together along the overlaps. Into the hull shell of boards frame timbers were then inserted. The earliest dated evidence of the system of planked boat building found so far dates to around the 6th-century AD, and forms of the building technique are still occasionally used to the present day. However, there have been many detailed changes over the 1400 years or so of its use, and variations linked to the use and status of the vessel.

The site team were able to make records of the timbers in situ and carefully lift the section of hull that lay within the shaft. Further cleaning, recording and sampling were carried out by this writer assisted by L Goodman of MOLA Conservation.

The slightly trimmed down timbers are currently double wrapped and strapped to a padded, plywood bearer in MOLA stores awaiting decisions by Cross-Rail as to their conservation or discard.

Basic details of the hull section and probable dating evidence:

The lifted section of articulated clinker vessel side Str [79], totalled 1.65m long by 0.94 m wide but it is clear that originally the hull section was both longer and wider. It comprises parts of 5 courses or ‘strakes’ of planking, with 2 end to end or scarf joints and one repair patch or ‘tingle’. The oak hull boards are all heavily worn inboard and out, but it is clear that they were all radially cleft and axe trimmed to a maximum thickness of approximately 25mm. The over laps or ‘lands’ were waterproofed with rolls of tarred animal hair and the scarf joints with a matt of similar material. Only inside one of the scarf joints did axe marks survive. The direction of the two scarf joints shows that the section was part of the starboard side of the parent vessel. The position of three original frame timbers was indicated by the presence of empty holes for the special wooden pegs or ‘treenails’ that were used for fastening down the frames. They would have been set on centres approximately 0.40 to 0.45m apart. Most of the treenail holes were only approximately 20mm in diameter, ie relatively small.

Two features showed that the parent vessel was originally very cheaply built and used until it was worn out. Firstly, in much of the original planking a great deal of sapwood had been left on the edges, more than I have ever seen elsewhere. This is great for tree-ring dating but would have resulted in weak plank edges. Secondly, one of the original boards was worn all the way through and replaced by a very poorly fitted repair tingle that was very lightly fastened, risking rapid leaking with the slightest damage.

All the technological features above clearly indicate that the hull section was original part of a clinker built vessel of the broad period c. 11th-century to early 16th-century. However, the proportions of the planking form of scarves and type of waterproofing used suggests that a date range of c. late 12th to 15th-century is most likely. Additionally, the use of a mix of fast and slow grown oak is perhaps most typical of the 14th to 15th-century. The parent boat appears to have been of modest size; perhaps it was a small barge or fishing vessel.

(Four tree-ring samples were taken with near full sapwood rings and two of the tarred hair for species ID)

6.1.4 What was the hull section doing at 96mATD in the mouth of the Lea?

It is not certain what the remains of this vessel were doing in the mouth of the Lea. The lack of frame elements may suggest that the hull section was a slab of reused clinker planking from a river wall or similar structure dismantled or damaged by a storm event. This is probably the most likely explanation but we cannot rule out the hull section being part of a disturbed wreck. Work at the MOLA East Greenwich Tide mill site near by suggests that, at big spring tides, such a level may have been just reachable by people prepared to wade in, during the later medieval period.

6.2 Tree-ring spot dates from archaeological samples

by Ian Tyers

Five samples from boat timbers excavated at the Crossrail Limmo Peninsula excavations (sitecode XRW10, NGR c. TQ 3952 8101) were submitted for dendrochronological assessment and analysis. None of these timbers were successfully dated.

6.2.1 Methodology

The timbers were supplied as cross-sections. They were assessed for the wood type, the number of rings they contained and whether their sequences of ring widths could be reliably resolved. For dendrochronological analysis samples usually need to be oak (Quercus spp.), to contain 50 or more annual rings, and the sequence needs to be free of aberrant anatomical features such as those caused by physical damage to the tree whilst it was still alive. Standard dendrochronological analysis methods (see e.g. English Heritage 1998) were applied to both samples. The sequence of ring widths in these samples was revealed by preparing a surface equivalent to the original horizontal plane of the parent tree with a variety of bladed tools. The width of each successive annual growth ring was revealed by this preparation method. The complete sequence of the annual growth rings in the suitable samples was then measured to an accuracy of 0.01mm using a micro-computer based travelling stage. The sequences of ring widths were then plotted onto semi-log graph paper to enable visual comparisons to be made between the sequences and reference data. In addition cross-correlation algorithms (e.g. Baillie & Pilcher 1973) were employed to search for positions where the ring sequences were highly correlated. Highly correlated positions were checked using the graphs and where these were satisfactory, these locations were used to identify the calendar dates of the measured series.

Computer searches for cross-matching use the original CROS algorithm (Baillie & Pilcher, 1973). A t-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high t-values at the same relative or absolute position

needs to have been obtained from a range of independent sequences, and that these positions were supported by satisfactory visual matching.

The tree-ring analysis initially dates the rings present in the timber. The interpretation of these dates relies upon the nature of the final rings in the sequence. Oak timber contains two types of wood, heartwood and sapwood. The latter is on the outside of the tree and thus contains the most recent growth rings- this material is softer and is not always preserved under archaeological conditions. If the sample ends in the heartwood of the original tree, a terminus post quem (tpq) date for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings which are missing. This tpq may be many decades prior to the actual date that a tree was felled, particularly where poor preservation or other loss of outer heartwood has occurred. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a date range for the felling of a tree can be calculated by using the maximum and minimum number of sapwood rings likely to have been present. For this material the sapwood estimates used are a minimum of 10 and maximum of 46 annual rings, where these figures indicate the 95% confidence limits of the range.

6.2.2 Results

The submitted material comprised five oak (Quercus spp.) dendrochronological samples. Three of these contained measurable tree-ring sequences, and were measured successfully (Table 1). Sequences from these did not cross-match each other, nor with Roman or post-Roman tree-ring data from London, elsewhere in England, or elsewhere in northern Europe.

Context	Rings	Sap rings	Date of measured sequence	Interpreted result
79 A	~25	-	not analysed	-
79 B	79	21	not dated	-
79 C	58	22	not dated	-
79 D	~20	-	not analysed	-
79 E	114	-	not dated	-

Table 1 *Details of the oak (Quercus spp.) samples from reused boat timber from Crossrail Limmo Peninsula (XRW 10)*

6.2.3 Acknowledgements

The spot-dating of this material was funded by Crossrail. My thanks to James Andrews of MOLA for providing site details and for making the administrative arrangements.

6.2.4 References

Baillie, M G L & Pilcher, J R, 1973 A simple crossdating program for tree-ring research, Tree Ring Bulletin, 33, 7-14

English Heritage, 1998 Dendrochronology: guidelines on producing and interpreting dendrochronological dates, English Heritage

7 Annex 1 (Figures)

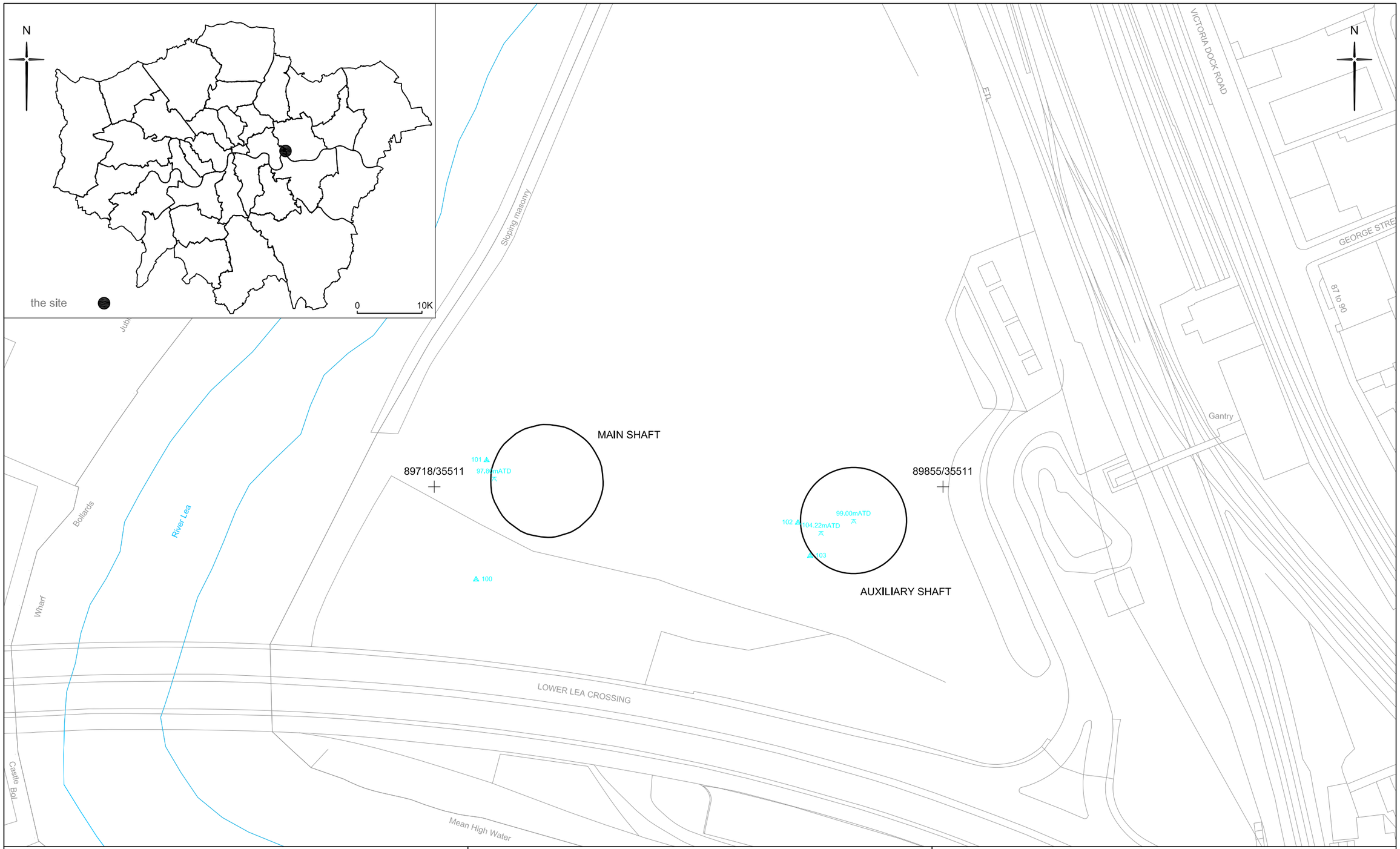


Fig 1 Access shaft location plan

Location of targeted watching brief areas

10.24mATD TBMs

100 GPS derived control

1:1000 @ A3

0 50m

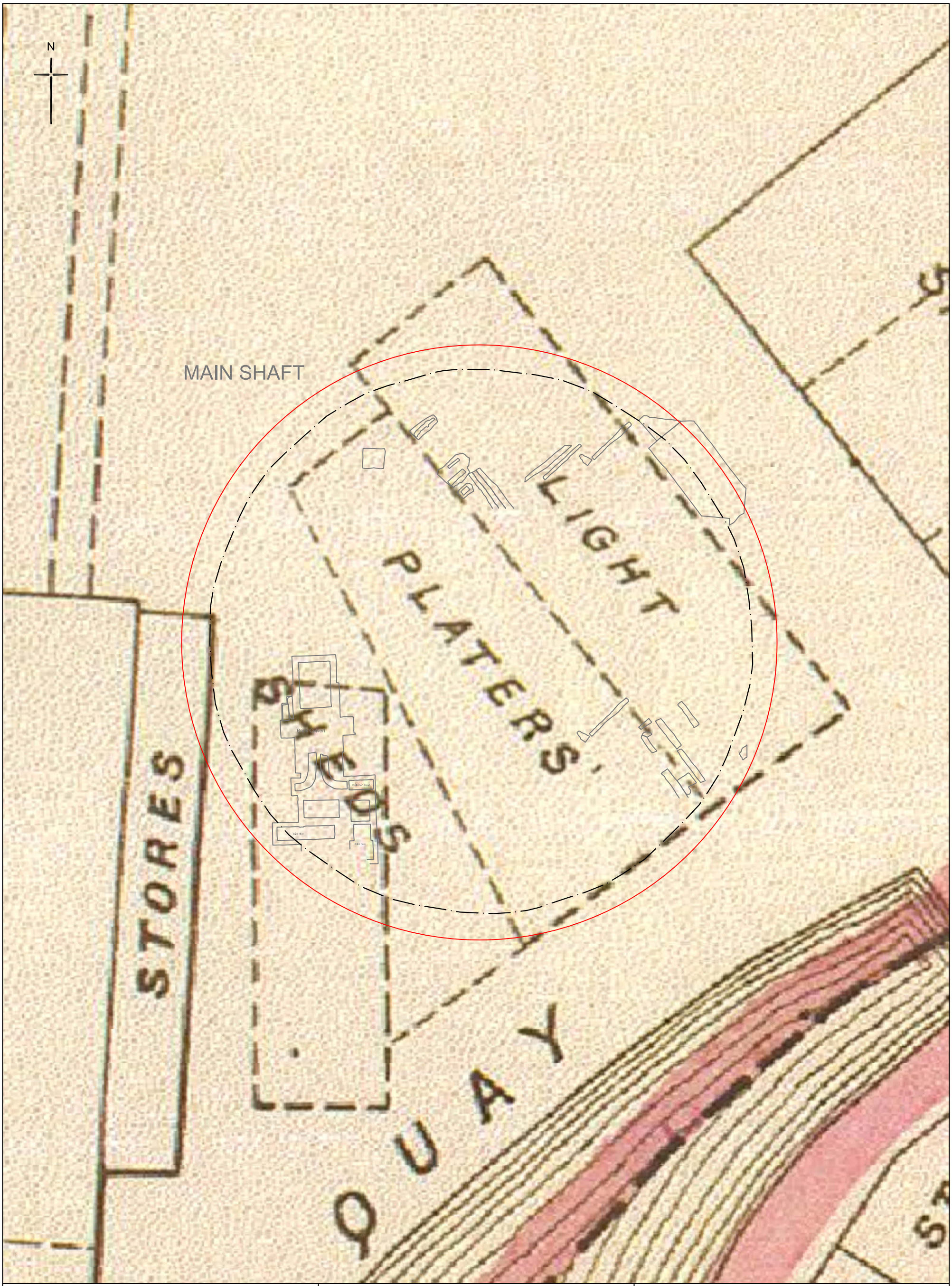


Fig 2 1913 Auction Survey (Charles Warner) with Main Shaft outline and Evaluation and Targeted Watching Brief overlaid

Shaft outline
Trench edge
Archaeological features

1:200 @ A3

0 10m

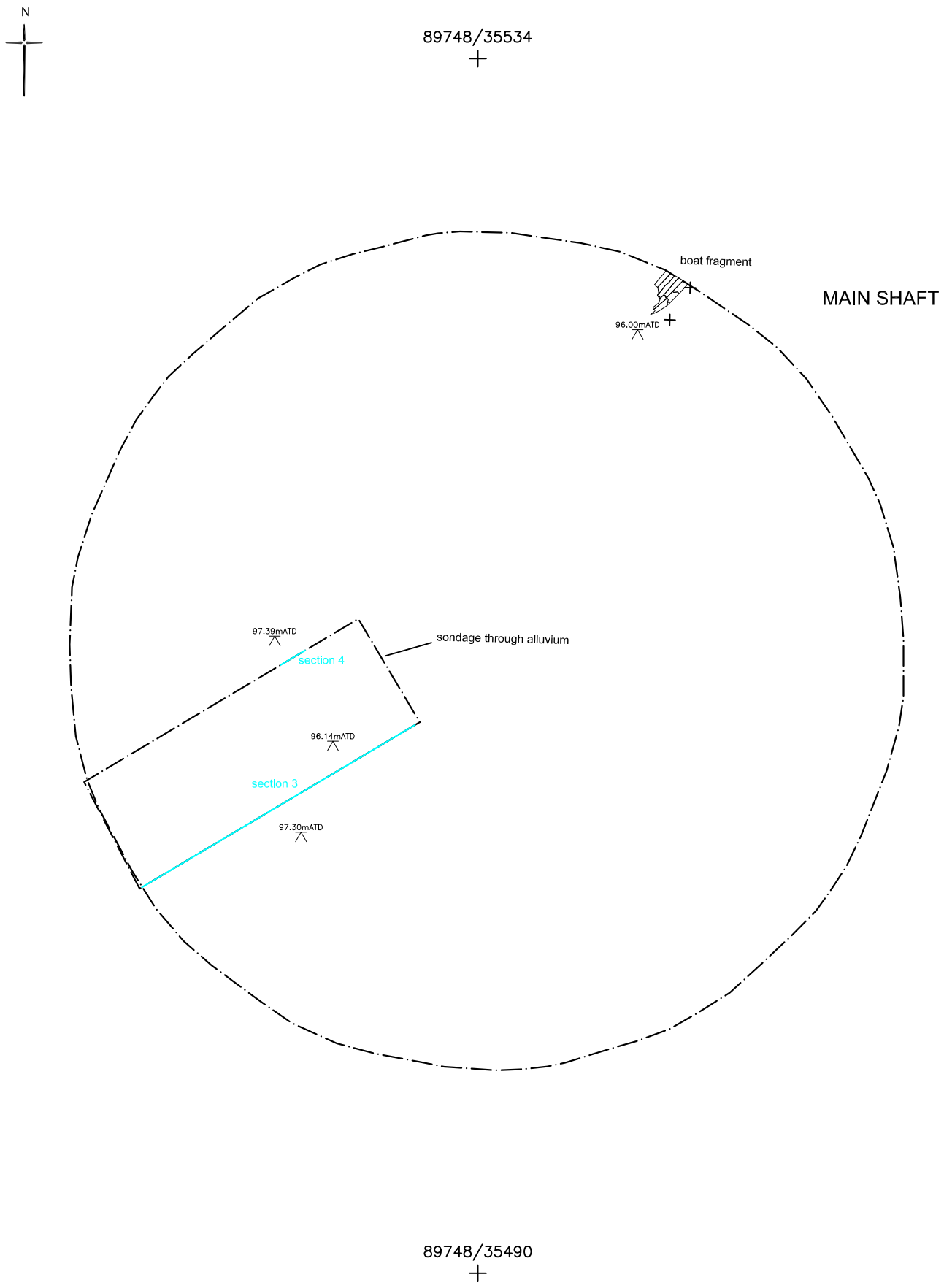
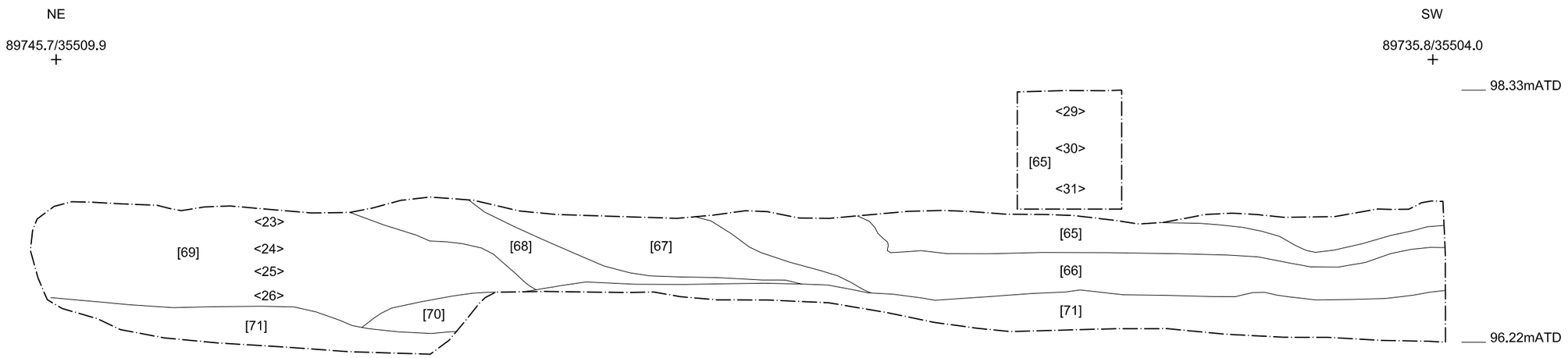


Fig 3 Plan of Main Shaft at the level of interface between alluvial silts and the underlying gravels

Trench edge
Archaeological features
Section line

1:200 @ A4

0 10m



[65] grey esturine alluvial silt with laminations of fine sand
[66] grey esturine alluvial silt with laminations of fine sand
[67] dark grey manganese stained alluvial silt
[68] grey silty sand
[69] grey silt and sandy silt showing signs of turbulence
[70] mixed dark grey clay and flinty gravel
[71] fairly fine sandy flinty gravel

Fig 4 Section 3, Main Shaft

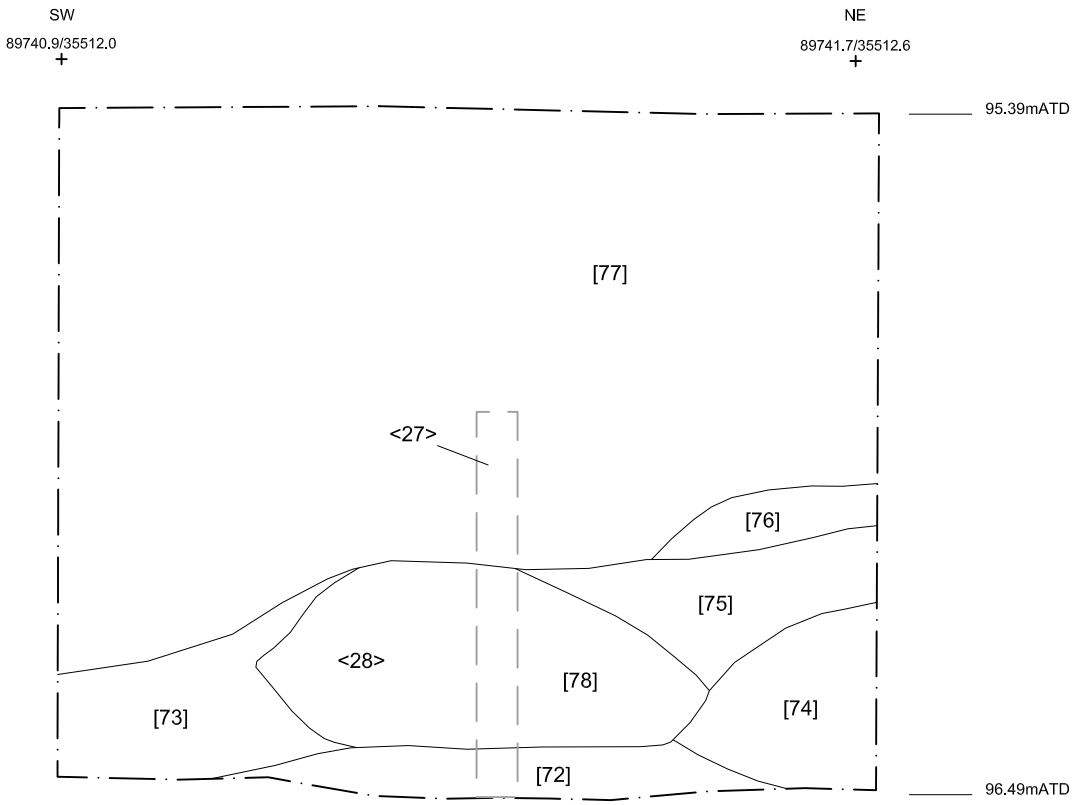
Limit of excavation

[65] Archaeological deposits

<23> Bulk samples

1:40 @ A3

0 2m



[72] very light brownish yellow coarse sand and fine gravel
[73] grey sandy pea gravel
[74] grey flinty gravel with coarse sand
[75] grey silty clay with occasional peat clasts
[76] grey sandy pea gravel
[77] grey silt and sandy silt showing signs of turbulence
[78] peat with laminations of clay to base

Fig 5 Section 4, Main Shaft

Limit of excavation
[72] Archaeological deposits
<28> Bulk samples

1:10 @ A4
0 0.5m

N

AUXILIARY SHAFT

89810/35502

89852/35502

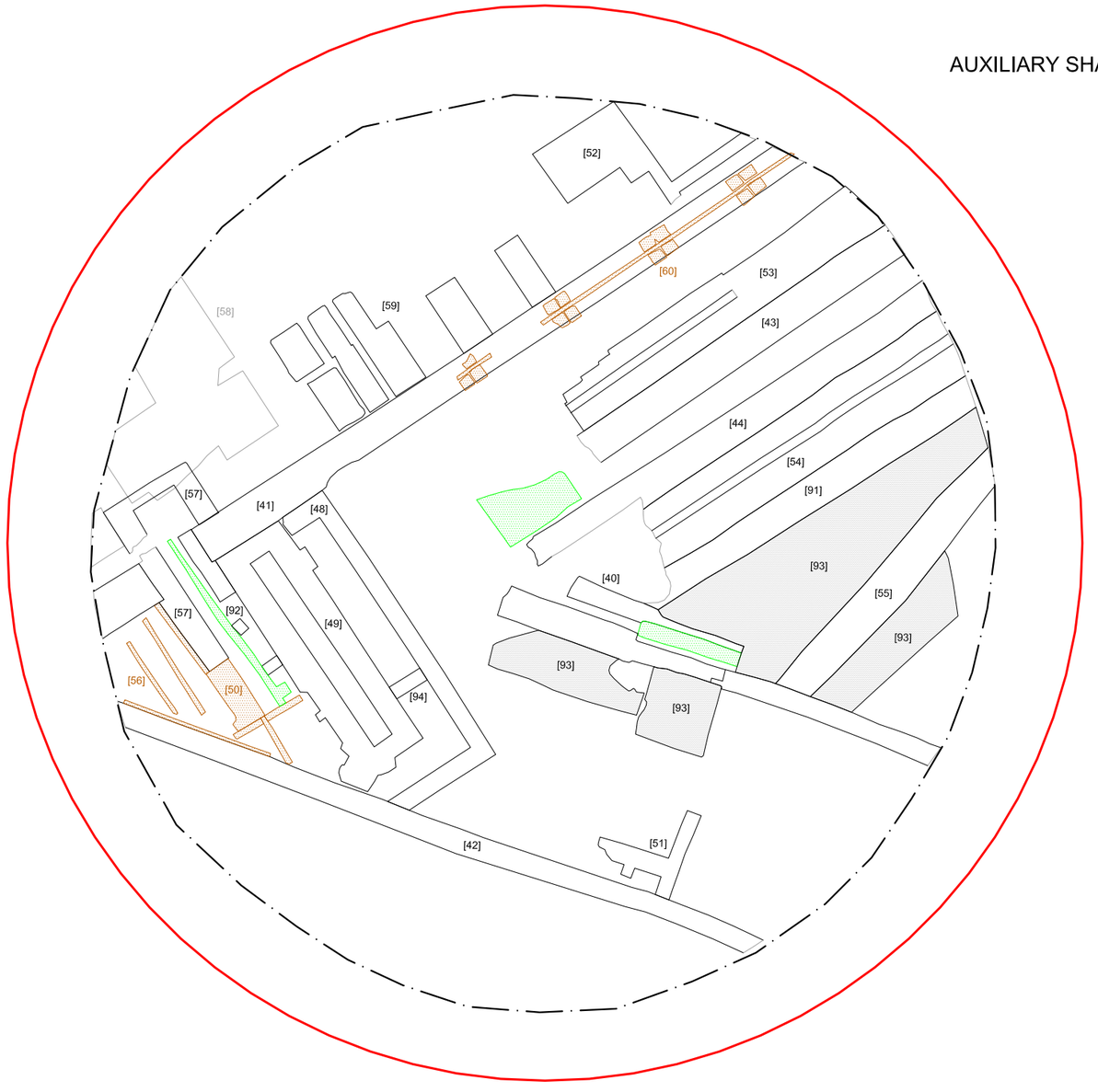


Fig 6 Plan of Auxiliary Shaft (Ironworks)

Shaft outline
Trench edge
Structures
Surfaces
Iron
Timber

1:150 @ A3

0 7.5m

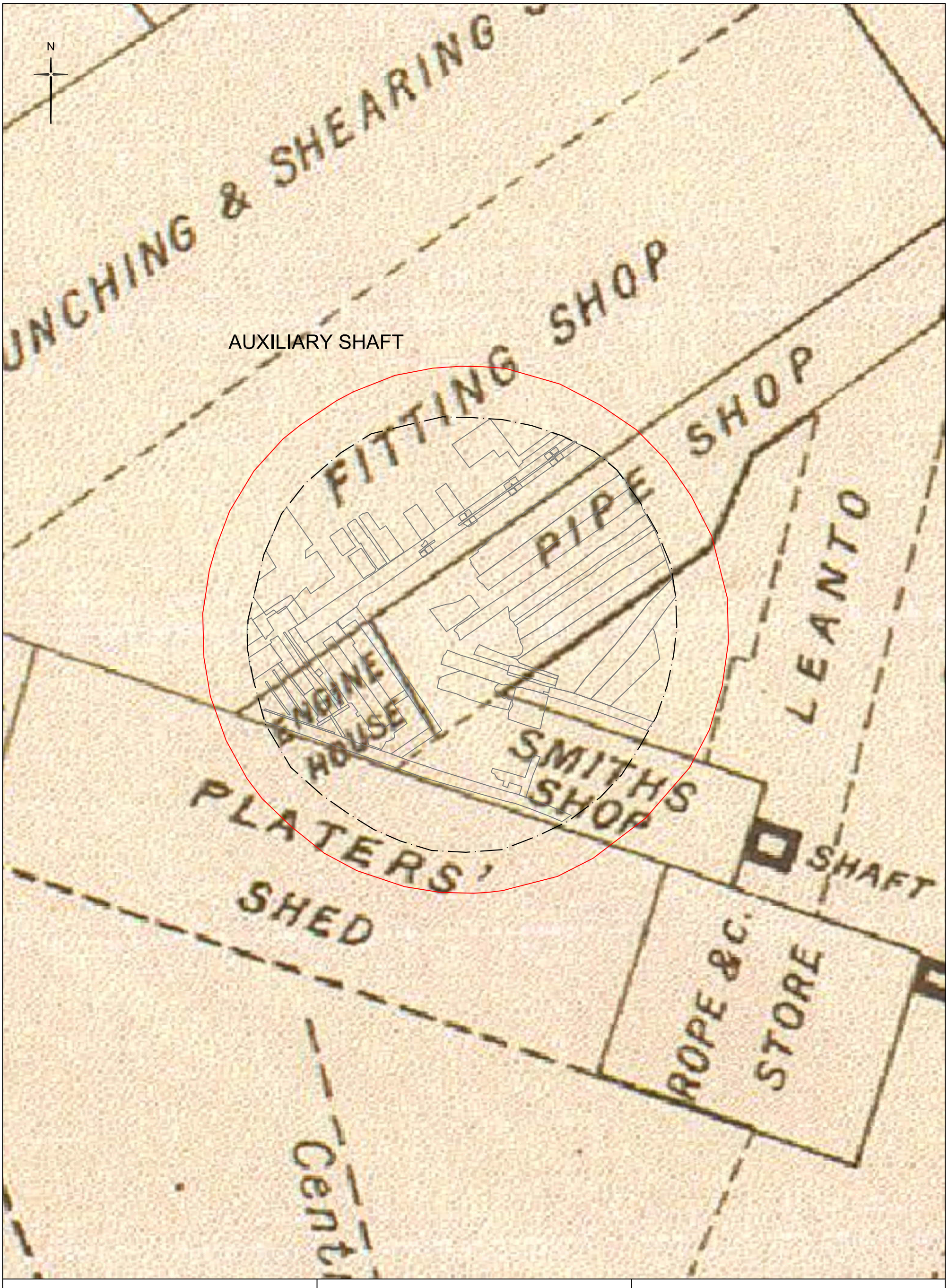


Fig 7 1913 Auction Survey (Charles Warner) with Auxiliary Shaft Targeted Watching Brief features overlaid

Shaft outline
Trench edge
Archaeological features

1:200 @ A3
0 10m

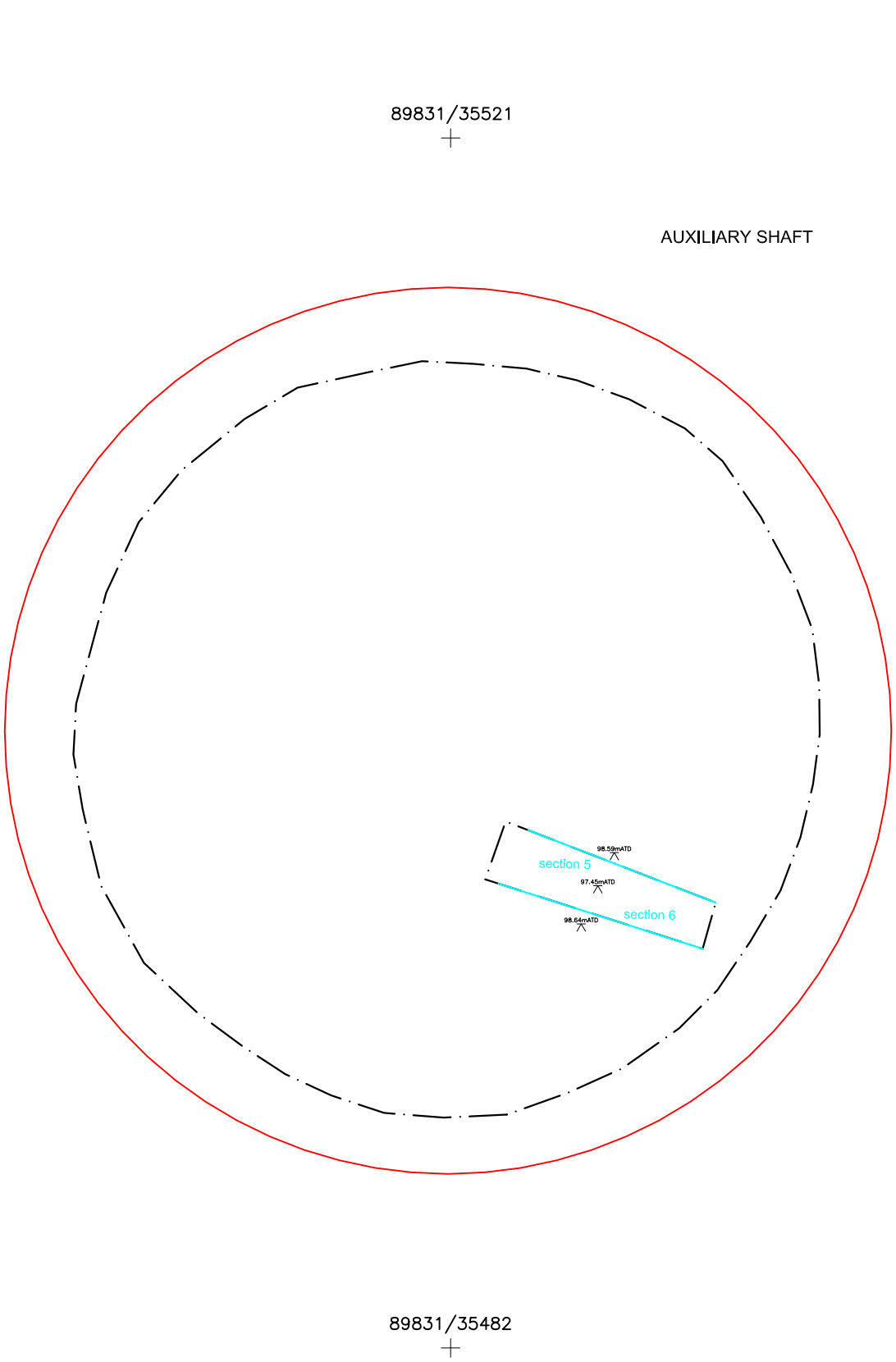
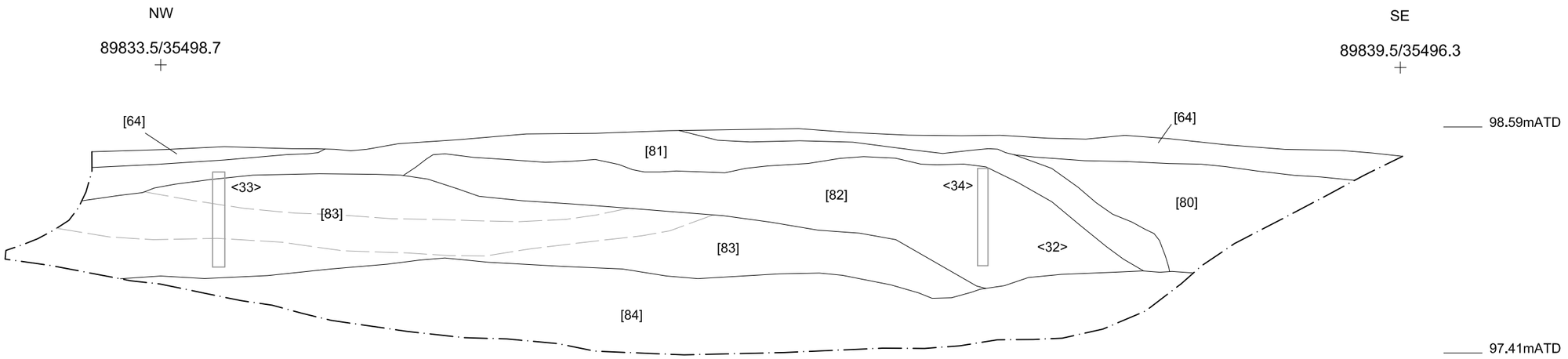


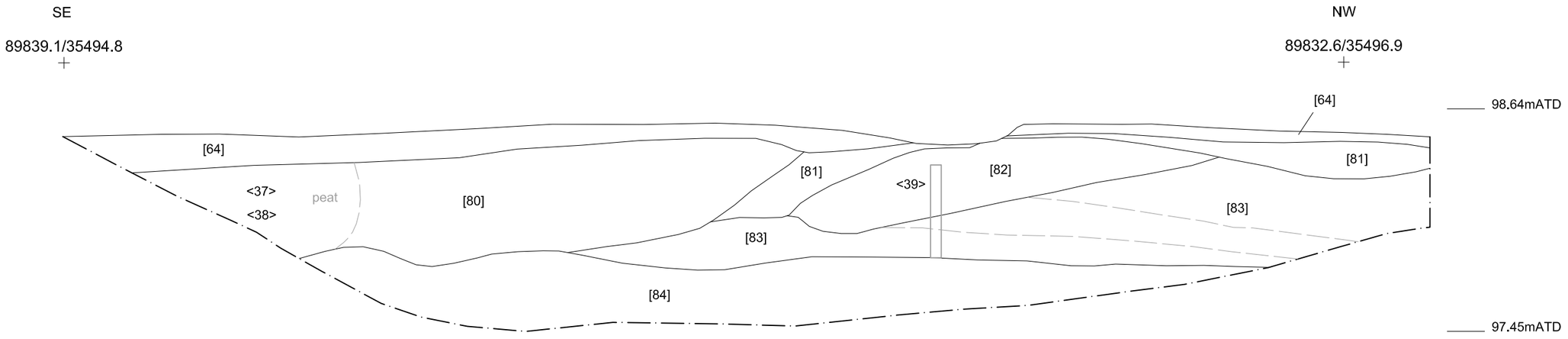
Fig 8 Plan of Auxiliary Shaft at the level of interface between alluvial silts and the underlying gravels

Shaft outline
Trench edge
Section
98.64mATD Level

1:200 @ A4

0 10m





[64] grey esturine alluvial silt with laminations of fine sand
[80] grey clay containing peat clasts and banded with gravel
[81] grey gravel band
[82] grey clay containing sizable peat clasts
[83] very fine light grey sand with laminations and bands of grey silt
[84] fairly fine sandy and gritty flinty gravel

Fig 9 Sections 5 and 6, Auxiliary Shaft

Limit of excavation
[64] Archaeological deposits
<37> Bulk Samples

1:25 @ A3
0 1.25m