Gasholder No.172

Admiralty Road, Great Yarmouth

Historic Building Investigation and Recording

(Phases 1 & 2)

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Gasholder No.172, Admiralty Road, Great Yarmouth

Historic Buildings Investigation and Recording

Contents

List of Figures 3
List of Plates 3
SUMMARY 7
1 INTRODUCTION 8
1.1 Project Background 8
1.2 Aims and Objectives 9
1.3 Location 9
1.4 Methodology 10
2 BACKGROUND HISTORY 12
2.1 Introduction 12
2.2 Early History of the Great Yarmouth Gasworks. 12
2.3 Construction of Holder 172 13
3 DESCRIPTION OF HOLDER 172 16
3.1 Introduction 16
3.2 Guide frame 16
3.3 Tank, bell and crown 19
3.4 Salvage 23
4 HERITAGE SIGNIFICANCE 24
4.1 Introduction 24
4.2 Summary Statement of Significance 24
5 SUMMARY AND CONCLUSIONS 26
APPENDIX A BIBLIOGRAPHY 27
APPENDIX B LISTED BUILDING DESCRIPTION 28
APPENDIX C A SUMMARY OF GASWORKS' PLANT AND PROCESSES 32

List of Figures

Figure 1: Site location map
Figure 2: Site plan showing location of buildings and key features
Figure 3: a) John Laing's map of 1867 a) Extract from 1886 6 inch OS Map
b) 1909 Fire Insurance (source: British Library)
c) 1927 OS Map d) Extract from 1970 OS Map
Figure 4: a) Aerial view of gasworks in 1928 (Britain from Above EPW021187)
b) View of gas works late 20th century (Gas Archives EA/DX/E/F/3)
c) Aerial view of gas works in late 20th century (Gas Archives xg2939)
Figure 5: Plan of gasholder station showing gas main connections (1966),
Figure 6: Elevation of gasholder 172
Figure 7: Plan of gasholder 172
Figure 8: Section through gasholder
Figure 9: Section through gasholder with columns from 3D model added to rear.
Figure 10: View of 3D model of overall gasholder.
Figure 11: Image from digital 3D model showing column base and makers plate

List of Plates

Plate 1: View of Gasholder 172 from west along Barrack Road
Plate 2: View from south along Admiralty Road
Plate 3: View from south along Admiralty Road
Plate 4: View from south within the site
Plate 5: South side of gasholder
Plate 6: South side of gasholder
Plate 7: General view of holder
Plate 8: General view from south-west
Plate 9: Upper tiers of columns
Plate 10: General view of holder
Plate 11: Detail of box junction
Plate 12: Typical section of side of holder
Plate 13: Upper part of holder
Plate 14: Tank
Plate 15: Tank
Plate 16: Vertical view showing tank and standards
Plate 17: Upper part of holder
Plate 18: Tank
Plate 19: General view of tank
Plate 20: Detail of column head and junction box
Plate 21: Detail of column head and junction box
Plate 22: Side of holder
Plate 23: makers stamp – S Cutler & Sons Contractors

Plate 24: makers stamp – RP Spice Engineer
Plate 25: Example of column base
Plate 26: Lower part of column
Plate 27: Detail of junction box
Plate 28: Side of holder
Plate 29: north-west side of holder
Plate 30: north-west side of holder
Plate 31: Example of walkway
Plate 32: Detail of gas gauge
Plate 33: Typical column
Plate 34: Typical column
Plate 35: View of column
Plate 36: Ladder on west side of holder
Plate 37: View showing curved girders
Plate 38: Ladder
Plate 39: Upper part of holder
Plate 40: Side of tank with bracing
Plate 41: View of junction box
Plate 42: View of side of tank with bracing
Plate 43: Bracing to side of tank
Plate 44: Bracing to side of tank
Plate 45: Covers over pits to north-west side of tank
Plate 46: Remedial plates to side of holder
Plate 47: Example of column base
Plate 48: Variant example of column base
Plate 49: Variant example of column base
Plate 50: Brace lock to side of holder
Plate 51: Brace lock to side of holder
Plate 52: Bracing straps to side of holder
Plate 53: Secondary brace holder
Plate 54: Primary brace lock
Plate 55: Detail of carriage roller taken from drone
Plate 56: View on top of crown taken from drone
Plate 57: Detail of vertical gauge taken from drone
Plate 58: Finial and paddon ties
Plate 69: Finial and paddon ties
Plate 60: Finial
Plate 61: Upper tier of columns
Plate 62: Aerial view of holder looking east
Plate 63: Aerial view of holder looking south
Plate 64: Aerial view of holder looking south-east
Plate 65: Vertical view from drone down onto crown

Plate 66: Finial to top of column, taken from drone
Plate 67: Detail at edge of crown, taken from drone
Plate 68: Detail of radial roller, taken from drone
Plate 69: Detail of radial roller, taken from drone
Plate 70: Detail on top of crown, showing inlet/outlet openings.
Plate 71: Detail of radial roller, taken from drone
Plate 72: Detail of radial roller, taken from drone
Plate 73: General view of tank, taken from drone
Plate 74: gas measuring gauge
Plate 75: Interior during de-sludging (taken by Geoffrey Frost of Erith)
Plate 76: Interior following de-sludging
Plate 77: View of roof and wall
Plate 78: General view of interior
Plate 79: Radial roof structure
Plate 80: Central column
Plate 81: Radial roof structure
Plate 82: Radial roof structure
Plate 83: General view of interior
Plate 84: Floor structure within tank
Plate 85: floor structure within tank
Plate 86: Detail of ridged floor
Plate 87: Central part of floor
Plate 88: Detail of floor panel
Plate 89: Number 4 cast into floor panel
Plate 90: Outer section of floor
Plate 91: Central part of floor around column
Plate 92: Exposed section of inner face of tank
Plate 93: Typical section of wall (ie inner lift)
Plate 94: Typical section of wall (ie inner lift)
Plate 95: Number 22 crudely written on wall
Plate 96: Section of wall within inlet/outlet pipes
Plate 97: Section of wall within inlet/outlet pipes
Plate 98: Head of inlet/outlet pipes
Plate 99: Detail of central shaft support
Plate 100: Detail of central shaft
Plate 101: Detail of opening in crown
Plate 102: Detail of underside of crown
Plate 103: Detail of underside of crown
Plate 104: Detail of radial truss
Plate 105: Detail of radial truss
Plate 106: Detail of radial truss
Plate 107: Detail through tank and lifts showing dip around inner lift

Plate 108: Detail through tank and lifts
Plate 109: Detail through tank and lifts
Plate 110: Section of brick wall to site boundary
Plate 111: Section of site wall to east of holder
Plate 112: Brick site wall to east of holder
Plate 113: Holder 172 with now demolished Holder 173 to rear (taken Dec 2022)

SUMMARY

Oxford Archaeology were commissioned by Montagu Evans LLP on behalf of National Grid to create an Historic Building Record of a redundant gasholder (No.172) and ancillary structures at a former gasworks at Admiralty Road, Great Yarmouth.

The gasholder is a Grade II listed building and consent has been granted for a series of works to it including the restoration of the main structural guide frame and the removal of the tank, bell and crown.

The gasworks in Admiralty Road was first established in the early 19th century and the holder which forms the focus of the current study was added to the site in 1884. However, structural issues with the foundations quickly became apparent and in 1885 the holder was dismantled and re-erected on a plot within the site immediately to the east.

The gradual nationwide switch to natural gas from the later 1960s led to the closure and demolition of many gasworks, including that at Great Yarmouth. Gasholder No.172 was retained for storage together with another holder from the 1960s (No.173) and the site converted to a gasholder station.

More recent changes in gas distribution have now rendered gasholders redundant and they have been isolated from the mains. The large majority of holders across the country are scheduled to be demolished (or have been already) but a small number are designated as listed buildings and are being retained for their heritage value.

A nationwide programme of recording is being undertaken prior to the demolition of the holders, including an unlisted holder at Great Yarmouth (No.173) in 2022-3. More detailed recording is now being undertaken of Holder 172, partly as an element of the overall programme of recording but also as a condition of listed building consent.

The recording of Holder 172 includes a laser-scan, a metric survey, detailed photographic survey, video footage and a photogrammetric 3D model.

The recording has been undertaken in a staged process: an initial phase was undertaken in October 2024 prior to the start of demolition works when the guide frame and the exterior of the tank were recorded. Further recording was then undertaken in January 2025, once access had been made possible inside the tank, when the internal structure was recorded.

1 INTRODUCTION

1.1 Project Background

1.1.1 Oxford Archaeology (OA) was commissioned by Montagu Evans, on behalf of National Grid, to undertake Historic Buildings Investigation and Recording on a decommissioned gasholder (known as holder 172) at a former gasworks site at Admiralty Road, Great Yarmouth in Norfolk (postcode: NR30 3DR). Gasholder 172 was constructed in 1884-5 and is a Grade II listed building.

1.1.2 Planning permission (ref: 06/23/0522/F) and listed building consent (ref: 06/23/0523/LB) have been granted by Great Yarmouth Council for works at the site including the refurbishment of the main frame and the removal of the tank, bell and crown. It is recognised that the removal of the tank will harm the heritage significance of the gasholder but it has been justified on the grounds of health and safety and making it easier to find a reuse for the site.

1.1.3 The work forms part of a wider, long-term programme being undertaken by Montagu Evans for National Grid, to address the large number of decommissioned gasholders around the country which have become redundant through changes to the gas industry. The vast majority of the holders are unlisted and are being dismantled. Although they are unlisted they do usually have some heritage value, having become distinctive and familiar structures in many localities, and due to this they have been subject to recording prior to (and during) their demolition. The nationwide programme of recording has been agreed between Historic England and National Grid to record gasholders even though the demolition of the holders does not normally require planning permission and therefore there are no formal planning conditions for recording.

1.1.4 Holder 172 in Great Yarmouth is of greater heritage significance, reflected in its listed status, and therefore it is being refurbished (and partly dismantled) rather than fully demolished. The level of recording is also higher than at most other holders.

1.1.5 In addition to forming part of the nationwide programme, the recording of Holder 172 is also required by Condition 5 of the planning permission and Condition 6 of the listed building consent which state:

> *No demolition shall take place until a Level 3 Historic Building Recording Survey relating to the listed Gasholder has first been undertaken and provided to the Local Planning Authority, in strict accordance with the details of a written Brief which shall be first submitted to and approved in writing by the Local Planning Authority.*
>
> *The Brief shall be proposed in accordance with Historic England's guidance (2019) 'Gasworks and Redundant Gasholders Guidelines for their Evaluation and Recording'. The Historic Building Recording shall be carried out in two phases: Phase 1 will record the existing site including recording of the internal crown trussing and bell prior to their dismantling and demolition; Phase 2 will also record the gasholder during the dismantling of the tank and bell; and both shall include*

production of time-lapse recording; and Phase 3 shall also include production of time-lapse recording and videos of the post-demolition restoration works. The Brief shall include a proposed timeframe for submission of each Phase of recording works.

The agreed Historic Building Recording shall be carried out in accordance with the Brief as approved and the reports of investigation and analysis shall be submitted to the relevant Historic Environment Record Service, Norfolk County Council Historic Environment Service, and the Great Yarmouth Museum Service, in accordance with the approved timescales for submission of each Phase of recording works.

Reason: To ensure the historic asset is appropriately recorded and verified and to ensure that record is deposited in suitable local records, in the interests of maintaining future understanding of the heritage value of the asset.

1.1.6 The recording has adopted a phased programme with the initial work being undertaken before the start of any demolition works to document the guide frame and the external shell of the tank. Further recording was then undertaken on the internal structure following dewatering, when access inside the tank had been made possible.

1.1.7 In 2022-3 Oxford Archaeology previously undertook recording on another gasholder (No.173) at the same Admiralty Road site prior to its demolition (ENF No: ENF153101). This holder was constructed in 1965 and was unlisted so its recording was undertaken at a lower level than Holder 172. (This demolition did not require planning permission but it was given a planning reference (06/22/0102/DM).

1.2 Aims and Objectives

1.2.1 The principal aim of this project is to record for posterity Gasholder 172 in terms of its structure, construction, history, alteration and use prior to its refurbishment/partial dismantling.

1.2.2 The recording will also highlight features proposed for demolition which have the potential to be salvaged for their heritage value.

1.2.3 The work will also aim to add to the wider understanding of the gas industry currently being gathered through the recording of gasholders across the country. The project will allow comparisons to be drawn between different sites and it will allow studies on the evolution of gasholders through the 19th and 20th centuries.

1.2.4 The information will be presented in the form of a written, illustrated report and archive.

1.3 Location

1.3.1 The former gasworks at Admiralty Road, hereafter referred to as 'the site', is situated to the south of Great Yarmouth town centre and to the east of the River Yare and to the west of Great Yarmouth pleasure beach (Figures 1 and 2).

1.4 Methodology

1.4.1 This report has been produced in accordance with the brief produced by Montagu Evans LLP on behalf of National Grid and is based upon on-site investigation and documentary research. As specified in the brief, a Level 3 survey was undertaken on Gasholder 172.

1.4.2 A level 3 survey is defined by Historic England in *Understanding Historic Buildings: A Descriptive Specification* thus:

> *Level [III] is an analytical record, and will comprise an introductory description followed by a systematic account of the building's origins, development and use. The record will include an account of the evidence on which the analysis has been based, allowing the validity of the record to be re-examined in detail. It will also include all drawn and photographic records that may be required to illustrate the building's appearance and structure and to support an historical analysis. The information contained in the record will for the most part have been obtained through an examination of the building itself.*

1.4.3 The work comprised three principal elements: a photographic, a drawn and a written record.

1.4.4 The general photographic record is intended to act as a general record of the structure and other features before and during their alteration and includes photographs of the exterior and interior, and details and fixtures. Digital photographs were taken using a camera with up to 24-megapixel capability.

1.4.5 For the drawn record a measured survey has been undertaken by Sumo Services using a laser scanner. A plan has been produced from this together with a cross section of a guide frame and other details.

1.4.6 The written record consists of field notes and annotations that complement the photographic and drawn records and add further analytical and descriptive detail.

1.4.7 Video footage has also been taken to add to the overall record using a drone. This will be added to the site archive. A 3D digital model has been created from the video footage.

1.4.8 The recording has also been informed by historical research. The National Gas Archives provided a series of drawings, *Gas Journal* articles and photographs of the site.

1.4.9 The holder was listed in 1998 and it was included in the *Monuments Protection Programme Step 3 report* from 2002 (Trueman M, 2002, discussed further in section 4 below). A number of other more recent studies have been undertaken on the Great Yarmouth holder and these have fed into the current project (see Bibliography at Appendix A).

1.4.10 The initial site visit to record the structures in their context prior to demolition works was carried out on 22 October 2024. This included video footage from a drone of the overall structure and laser scanning of the exterior. Further recording was undertaken on 20 January 2025 following the de-watering and de-sludging of the tank. An opening was made in the tank

to allow internal access and the internal structure was then photographed, described and surveyed by laser scanning. Following this a large ramp was formed to allow machines through the opening to begin the demolition works.

1.4.11 Elements of the structure with potential for salvage were identified at this stage and an agreed list of items was given to the demolition contractors to guide their work.

1.4.12 Although the planning condition refers to time-lapse photography this is not being undertaken by OA.

1.4.13 The digital archive will be deposited with the Archaeological Data Service.

2 BACKGROUND HISTORY

2.1 Introduction

2.1.1 As referred to above a number of studies of Gasholder 172 have been undertaken and the historical background below utilises these as well as information collected from the Gas Archive. Further information from historic newspapers has also been found on the *British Newspaper Archive*.

2.1.2 A general description of the most common gasworks processes and equipment is provided in Appendix C.

2.2 Early History of the Great Yarmouth Gasworks.

2.2.1 The origins of the gas industry in Great Yarmouth lie in the establishment of the *Great Yarmouth Gas Light and Coke Company* in 1824. The company was contracted by the Paving Commissioners to erect 121 public lamps and to supply these a gasworks was established on an area of waste land called the South Denes; this was between South Gates Road and the River Yare and it is shown on John Laing's plan of 1867 (Fig 3a). This site was a short distance to the west of the holder in the current project.

2.2.2 In 1845 the company was reconstructed and in 1846 it was registered under the Joint Stock Company's Act. In 1857 additional capital was raised.

2.2.3 A bill was passed in 1863 to formally incorporate the Great Yarmouth company, which had existed up to this point in an unincorporated form, and to make further provisions to supply gas to the locality. The site of the gasworks, which had been at least partially leasehold land, was to become freehold and further capital would be raised to allow the future development of the works[1].

2.2.4 The promoters of the bill spoke at the committee convened to discuss the proposal and they stated that although the company had always maintained good relations with customers there had been some disputes with the corporation (the Local Board of Health), who were responsible for the town's lighting. These disagreements related to the rate at which the company supplied the gas to the corporation. The promoters added that demand for gas had increased greatly since the works were first established and continued to do so.

2.2.5 In 1869 The Great Yarmouth Gas Company were obliged to surrender their lease and remove their gasworks from the original site between South Gates Road and the River Yare. They had bought a new site nearby from the council for their gasworks, located between South Denes Road and Admiralty Road, almost immediately east from the original site. They had already built a gasholder on this land by 1867, visible on the John Laing map of that date (Fig 3a). They also kept a site to the east the original gasworks on the corner of South Gates Road and Barrack Road, where two gasholders

[1] *Norfolk Chronicle* 13 June 1863

were located (Russell Thomas/National Grid, report forthcoming). These are again shown on John Laing's map of 1867.

2.2.6 The gasworks is shown on Ordnance Survey maps surveyed in 1883/4: 1:500 Town Plan, the 6 inch map (published 1886, see Fig 3b) and the 25 inch map. These were produced immediately before the construction of the gasholder in the current study. The maps show the gasworks at the southern end of the densely packed town, immediately west of the barracks and Royal Naval Hospital. The maps shows the site with two gasholders and an empty plot at the north-eastern corner where the holder was re-sited in 1885. There are also two further smaller holders on a separate nearby site, on the north side of Barrack Road.

2.3 Construction of Holder 172

2.3.1 In 1884 a new holder was constructed at the gasworks but the structure's foundations were rapidly found to be deficient and the water tank began to leak. A report in the *Norwich Mercury* from 8 April 1885 (p 3) states that the new holder had been *'under construction for the previous 12 months on the west side of the roadway, between that and the river. As soon as the holder was filled with water the leak was discovered'*.

2.3.2 This holder, which forms the focus of the current investigation, was dismantled the following year (1885) and re-erected on an adjacent, vacant plot on the corner between Barrack Road and Admiralty Road. The gas company had recently acquired this land from the council. Due to the ground conditions the re-erected holder was given an above ground water tank and bell.

2.3.3 The new holder was designed by the consulting engineer Robert Paulson Spice and constructed by the contractors Samuel Cutler & Sons of Millwall. Spice was a prominent figure in the gas industry in the 19th century, during a career that lasted for 50 years. He began working as a gas engineer in the 1840s, designing and erecting gasworks from c.1845-6, and he went on to hold prestigious positions in the industry's professional bodies and to provide specialist advice.[2] He died in 1889, aged 75 so the holder in Great Yarmouth was erected towards the end of his life.

2.3.4 An article from 1910 discussing a visit to the Great Yarmouth works states: *'The design, arrangement, and general details are all in the style of the late Mr RP Spice; and this was of interest to those younger engineers who have not been brought largely into contact with the work of this leader among gas engineers of a past generation'*. (*Journal of Gas Lighting*, May 10, 1910).

2.3.5 In this period coal arrived by sea from the Durham coalfield and prior to c.1898 it was manually unloaded before being carted to the nearby works in sacks. An article in the *Journal of Gas Lighting, Water Supply etc* from 1901

[2] Minutes of the Proceedings of the Institution of Civil Engineers Vol 97, issue 1889 pp 413-415.

details a new system for unloading the coal with a hydraulic crane on the quayside, and a set of tracks to transport the coal to the work stores.

2.3.6 The 1904 6-inch OS map (not reproduced) shows the gasholder at the north-eastern corner of the current site with two gasholders remaining on the original gasworks site to the west and a single gasholder on the plot to the north of Barrack Road. It can be seen that the new holder (No.172) was the largest at the site at this date.

2.3.7 The fire insurance plan of 1906 (Figure 9) shows gasholder 172 in more detail. Below the holder are oxide sheds and gas pipes and to the south of this is a separate plot connected with the processing of fish for C Stacy-Watson & Co Ltd who have further facilities which run on the northern side of Middle Road below the gasworks.

2.3.8 A further article from the *Journal of Gas Lighting, Water Supply etc* on the Great Yarmouth works, dated 27 April 1909 includes a photograph of Gasholder 172 (then numbered No.5) which shows the columns with Corinthian Capitals at each of the three levels. Presumably these were bolted around the flanged capitals but they no longer survive.

2.3.9 In the early 1920s large scale works were carried out to the site including the reconstruction of the retort bench, new gas station meter and the addition of an ammonia plant. A detailed plan of the gasworks in 1925 is included in a Gas Journal article and this shows the listed holder (then called No.5 holder) in position at the northern end of the current site and to the south of this is a small tar tank and a covered tar tank. It shows the holder with a capacity of 385,000 cubic feet, more than twice the capacity of the next largest holder.

2.3.10 The southern end of the site, formerly part of a fish processing facility, had by this date been incorporated into the gasworks and it included tanks, garage and a pitch bed.

2.3.11 The 1927 OS map (Figure 3c) and an aerial photograph dated 1928 (Fig 4a, Britain from Above EPW021187) show the extent of the site at this time. The upper two levels of columns are painted a light colour but the lowest level, adjacent to the tank, are darker. It appears that the Corinthian capitals are still in-situ at this date although the resolution is not clear enough to be certain.

2.3.12 The site appears relatively unchanged in the 1938 and 1946 OS maps.

2.3.13 The *Britain from Above* website contains another aerial photograph from 1947 (ref: EAW005068) and again, although it is not possible to be sure, it appears that the decorative capitals are still in-situ.

2.3.14 Under the Gas Act of 1948 the gas industry was nationalised and the following year the Great Yarmouth site formally became part of the Great Yarmouth Group of the Norwich Division of the Eastern Gas Board.

2.3.15 The 1956 OS map shows little change apart from the fact that the gasholder to the north of Barrack Road is not shown.

2.3.16 In 1966 a new spiral gasholder was constructed to the south of gasholder no. 5. A 1966 plan of the site (Figure 5, National Gas Archives ref: EA/NF/GRY/E/E/3) shows the new gasholder, referred to as no. 6, in position.

The remaining two gasholders are no. 4, located to the south west of the new holder, and no. 5, the listed holder to the north. A later amendment of the same plan from 1975 omits gas holder no.4 and shows a new fence running north to south (from Barrack Road to Sutton Road) to the west of the two remaining gasholders. This plan also shows a new insertion meter and governor facility to the south of gas holder no. 6.

2.3.17 Natural gas was discovered in the North Sea in 1965 and this prompted major changes to the industry over the next decade. Natural gas replaced coal gas (or town gas) and traditional gasworks including that in Great Yarmouth closed. Gasholders 4 and 5 (or 172 & 173) were retained to store the gas.

2.3.18 Two undated aerial photographs of the site (Figures 4b and c, National Gas Archives) show the gasholder site in the late 20th century. A new vehicle entrance with the gates recessed into the site has been added on Admiralty Road. A further opening in the brick wall surrounding the site can be seen to the north of this at the location of the electricity substation. The 1966 gasholder has the three lifts extended and the brick electricity room between the two gasholders can be seen. The booster insertion meter and governor building shown on 1966 plans can also be seen. The former western section of the gasworks site is being used for haulage.

2.3.19 By the end of the 20th century the gasholders had fallen out of use. The active gas site including the southern building now forms a separate part of the site.

3 DESCRIPTION OF HOLDER 172

3.1 Introduction

3.1.1 Gasholder 172 at Great Yarmouth is a triple-tier, column-guided holder which forms a prominent and visually impressive local landmark (Pl.1-2). The surrounding areas are flat and generally low rise, including terraced housing to north and east, and the holder forms a dominant feature within this landscape. Although it is an impressive structure it is now in poor condition with peeling paint and corroding ironwork. It is a relatively small holder, c.29m tall and c.29.8 m in diameter, with a capacity of c.380,000 cu ft[3] and an above-ground tank.

3.1.2 The main elements of the gasholder are the tall guide frame, which comprises a series of tubular cast-iron columns braced by rings of horizontal girders, together with the cylindrical tank which is enclosed by the frame. The tank houses a bell of telescopic lifts which would have risen and fallen as the holder inflated with gas. The movement would have been stabilised by carriage rollers engaging with rails fixed to the columns.

3.1.3 Each main element of the holder is described separately below.

3.2 Guide frame

3.2.1 *Columns (Pl.14-15)*

3.2.2 The guide frame comprises a ring of 14 triple-tiered, tubular, cast-iron columns each of which is bolted at three levels to junction boxes (or bolt boxes, Pl. 11) and braced by horizontal girders (Pl. 13, 17). The columns in each of the three tiers taper in diameter.

3.2.3 Each of the lower columns incorporates an oval maker's plate to its side, cast in relief, with either 'S CUTLER & SONS / CONTRACTORS LONDON / 1884' or 'RP SPICE / ENGINEER / LONDON/ 1884' (Plate 23-24). The columns are painted white (as is the whole guide frame) but much of this has come away to leave the bare ironwork exposed.

3.2.4 *Capitals (Plates 11, 20-21, 27)*

3.2.5 The columns have a stripped down or reduced classicism which roughly imitates the Tuscan order with a simple astragal band towards the top and above this a capital comprising a series of flanges (or stiffening feathers) which fan out to support a toroidal ring and the octagonal base of the junction box above. Between each flange there is a vertical bolt, passing vertically through the toroidal ring to secure the junction box.

3.2.6 As referred to above it appears that historically the columns would have had a more decorative appearance as there are a number of historic photographs, which appears to show the columns with Corinthian capitals.

[3] Several different capacities are given for the holder in different plans, ranging from 360,000 cu ft to 400,000.

The earliest of these photographs is from 1909. These must have been decorative capitals which were bolted around the heads of the columns but no evidence of these has been identified in the recording so far. It is assumed that they were primary features.

3.2.7 *Plinth (Plate 26)*

3.2.8 Towards the foot of each column is another astragal band immediately above another series of stiffening feathers fanning out to a toroidal ring and octagonal base with lip. Again there are vertical bolts between each flange securing the base of the column.

3.2.9 *Joint boxes (or bolt boxes) (Plate 20-21)*

3.2.10 Above each column is an octagonal joint box which connects to the horizontal girders to each side, as well as to the column or finial above. The joint boxes have a cast-iron octagonal base which sits directly on the head of the column below. It has not yet been possible to closely examine their structure but the boxes appear to comprise an octagonal frame with the main faces covered by a simple cast-iron panel which can be removed to provide access to the bolted fixings within.

3.2.11 *Finials (Plates 58-60)*

3.2.12 Each of the columns in the uppermost tier is surmounted by a decorative needle finial set on a tall oblong box with scrolls or volutes to each side incorporating a decorative radial. These are all set on an octagonal base fixed to the top of the uppermost columns.

3.2.13 *Guide rails (Plates 34, 55, 56)*

3.2.14 Each column in the upper two tiers has a channel-shaped vertical rail fixed to its inner side which would have engaged with a carriage roller fixed to the crown of the uppermost lift of the bell. These would have stabilised the telescopic bell as it inflated with gas and rose up the holder. The rails are secured by a total of thirteen brackets fixed to the columns and joint boxes. There are four brackets to the body of each main column, each of which is fan shaped and wrapped partly around the column with bolts to the column and guide rail. There are additional similar brackets fixed to the top and bottom of the joint boxes. The bracket at the very top of the guide rail also incorporates an additional cantilevered projection directly on top of it which supports the Paddon wind ties (discussed further below). There are additional curved plates to the sides of these cantilevered brackets which help add bracing.

3.2.15 The carriage rollers which would have engaged with the guide rails are described below in the section on the bell and crown.

3.2.16 *Column Base (Plates 25-26)*

3.2.17 The octagonal cast-iron plinth of each column is set on a broadly square base, just visible above the ground, with five large vertical bolts securing it to the ground. Each base has two bolts to the rear, immediately against the gasholder tank, and three to the front set in cast-iron bolt holes although there are three variations to how these bolts are arranged.

3.2.18 *Horizontal Girders (Plate 58, 61)*

3.2.19 The columns in each of the tiers are connected by three rings of horizontal box lattice girders, one at the same height as each of the junction boxes (upper, middle and lower girders). This provides the overall holder with strength and rigidity.

3.2.20 Each girder is of steel construction and it has narrow, box profile latticework members to top, bottom and both sides. The sides have a St Andrew's Cross (repeated four times) with flat section members and the corner members have an L-shaped profile.

3.2.21 At each end the girders are bolted to the octagonal joint boxes and extra strength is provided by riveted half-butterfly plates.

3.2.22 It is important to note that each girder curves to match the outline of the tank (Pl. 37). This is unusual and one of the more significant elements of the holder as at most sites such girders extend in a straight line between columns. It may be that the relatively small size of the tank straight girders would have conflicted with the curve of the tank (particularly towards its mid-point). This explanation was suggested by Malcolm Tucker in *London Gasholders Survey: The development of the gasholder in London in the later nineteenth century. Part A: General* (May 2014).

3.2.23 Paddon Wind ties (Plate 58-60)

3.2.24 At the top of the guide frame additional bracing was provided by intersecting ties which extend between every other column. These are simple in nature, comprising channels of iron (or steel), with each end resting on top of the uppermost girder, adjacent to a column. The midpoint of each tie is supported by the cantilevered bracket referred to above fixed to the top of the guide rail. Each tie intersects with one other and this junction is strengthened by an additional member to the underside.

3.2.25 These types of ties were commonly found on gasholders between c.1870 and 1930 and they are called Paddon wind ties named after the engineer John Birch Paddon (1825-1910) who introduced them.

3.2.26 Other features

3.2.27 Immediately inside from the lower girder is a walkway around the edge of the holder, between the crown and the curved girder. This is formed from an iron grille (detailed further below).

3.2.28 There are several ladders on the west side which would have provided access to the upper parts of the holder. One of these is a sloped ladder with simple safety enclosure (Pl. 38) which provided access from the ground to the walkway and there are two others in a similar area which allowed further access to the uppermost tiers. The oldest of these is vertical, extending in a straight line from the walkway to the top of the holder, and does not have any enclosure. The other ladder, which may have superseded it, does have a safety cage enclosing it, and it has a small platform at the same height as the middle girder.

3.2.29 One of the interesting features of the holder is a vertical gauge fixed to one of the columns in the central tier on the south-west sides of the holder (Pl.

57). This indicates the quantity of gas within the holder. The gauge is a tall, iron bar with numbers cast into its face, each one 5000 cu ft larger than the next. The lowest is 215,000 while the uppermost is 400,000. The gauge is close to the ladder referred to above with safety cage.

3.3 Tank, bell and crown

3.3.1 The outer face of the above-ground cylindrical tank is visible, set within the lower part of the guide frame. The water-filled tank houses the telescopic three-tier bell but this is currently entirely hidden within the tank. The crown, forming the top of the bell is also hidden from the ground but some recording photographs of this have been possible from the drone.

3.3.2 The tank is constructed from large plates of cast iron, of consistent heights, braced by a series of iron belts encircling the structure (Plates 12, 14, 5, 18).

3.3.3 The plates have numbers cast into their sides to indicate their level and from this we can see that a significant part of the tank is buried. The uppermost row of plates each have a number seven cast into their face, and the rows below show numbers 6, 5, 4 and 3. The row below 3 is partially buried (including the assumed number 2) and below this there is presumably another full row with number 1 cast to its face.

3.3.4 Each row is joined with a horizontal ridged seam and there are also regular vertical seams which are presumably indicative of the joints between each horizontal panel. Numerous repairs are visible to the tank with secondary plates bolted to the face to seal cracks or leaks.

3.3.5 At several points there are pairs of plates in the row No. 5 which incorporate cast iron lettering: 'S CUTLER & SONS CONTRACTORS LONDON' and 'RP SPICE ENGINEER LONDON 1884'.

3.3.6 The tank is braced by eight horizontal iron belts (eight visible) which wrap around the structure and rest on regular small, corbelled projections, cast to the faces of the iron plates.

3.3.7 The belts get progressively narrower towards the top of the holder and they divide into two main types. The lower four belts are secured by a series of cast-iron shoes which are wedged over junctions between sections of the belt (Pl. 51, 54). Each belt is formed by several lengths of plate, the ends of which have a lip and the shoes slide over the junction, holding them tightly together. One of these cast-iron shoes has failed and the belt here has come away exposing the lipped ends of the belt and the face of the tank beneath (Pl. 52).

3.3.8 The upper four belts are thinner and are again formed from several lengths of plate. These are jointed with a combination of simple oval welded plates (at some junctions) and plates with bolts to allow them to be tightened. There appear to be three welded plates for every bolted junction.

3.3.9 Although the two types of fixing are quite different to each other they both appear to be primary. There is a photograph of the holder from 1909 which appears to show the same arrangement of bands (although it's not clear enough to confirm whether they are identical).

3.3.10 On the south-eastern part of the holder there are four simple, evenly spaced loops cast to the fourth band from the base. This the only place where these are present and it is unclear what their function would have been.

3.3.11 The crown and upper part of the tank could not be seen from the recording undertaken from the ground but photographs have been taken with a drone and this has provided valuable information on these parts of the structure (Pl. 55-56, 65).

3.3.12 At the top of the tank there is walkway around the edge of the holder, which is partly comprised of a solid plate base (to the inner ring) and partly an iron grille. The solid base is directly over the telescopic bell of three lifts, enclosed within the tank, while the grille is immediately outside the tank.

3.3.13 The solid ring immediately surrounds the shallow domed crown and these are separated from each other by a simple guardrail around the edge of the tank comprising three horizontal bars supported by iron posts (L-section).

3.3.14 The crown is covered in concentric rings of metal sheets, riveted along each edge. The nature of the sheets are consistent and it they appear to be very largely primary. Towards the northwestern corner of the crown there are two circular holes adjacent to each other which would have been for inlet and outlet pipes.

3.3.15 The most significant features of the crown are 14 wrought iron carriage rollers, immediately adjacent to each of the columns, which would have engaged with the vertical guide rails to stabilise the structure as the bell inflated with gas and lifted within the guide frame (Pl. 55-56). Each carriage roller is riveted to the edge of the tank and it projects out beyond the tank with a cast-iron roller that sits within the channel guide rail. The carriage roller also incorporates two further smaller wheels, set at right angles to the main one, which would have run up and down the outer faces of the guide rail. This use of tangential rollers to support the main radial roller is unusual and they are described as French rollers (Tucker, 2014).

3.4 Interior of holder

3.4.1 Following the dewatering of the tank a large opening was created through the south side of the structure to allow full access to the interior. The floor was then desludged and the air quality checked before the structure was recorded. Although the main sludge was removed from the floor of the tank the ridged nature of the base made this more difficult than in other holders and some residue remained around some outer areas (Pl. 97).

3.4.2 The base of the tank is c.2 m below the external ground level and a ladder was therefore fixed adjacent to the opening.

3.4.3 *The crown* has a radial-truss form where the full supporting structure would have risen and descended as the holder was filled or emptied with gas (Pl. 75-83). The crown is supported by 14 principal trusses, extending from the central shaft to the outer edge (top curb) as well as 14 smaller intermediate trusses. Both the full and intermediate trusses are secured at the outer edge of the holder by a riveted triangular shaped plate above the vertical stanchion and strengthening the riveted top curb (Pl.98).

3.4.4 The top chord on each truss is an L-shaped member; those in the principal trusses extend to the centre of the crown while those in the intermediate trusses only extend two-thirds of the distance to a point where they meet a I-section ring girder (Pl. 79). The lower chord in the principal trusses is constructed from an iron rod in three sections, with the innermost sections being a pair of coupled rods with tension connectors close to the centre (Pl.100). Towards the centre of each full truss is a pair of vertical plates, again coupled to counter compressive forces from the crown (Pl.105). The truss also incorporates a series of other tension rods.

3.4.5 The intermediate trusses are much simpler with a lower chord of three tension rods and with two short rods extending up to the crown.

3.4.6 Between each radial truss there are diagonal members (I-section) which are arranged in a herringbone layout and which support the crown directly (Pl.102).

3.4.7 At the centre of the holder is a vertical shaft (Pl. 80) which incorporates pairs of iron discs at the top and bottom which secure the inner ends of the principal trusses (Pl. 82). This shaft would rise with the holder but when in its lowered position it rests on a further iron shaft with a wider diameter (62 cm) and a slightly pointed head. At the point where the disc of the upper shaft rests on the lower shaft it appears that a number of circular metal washers have been added; this may have been a minor adjustment to ensure the support was at the right height (Pl. 99).

3.4.8 This lower shaft has a flanged base and smaller flanges at the head. It is supported by four raking struts secured to the floor (Pl. 80).

3.4.9 As referred to above the crown is formed from rectangular metal sheets riveted together and from the underside it could be seen that thicker plates were used at the points around the edge at the outer end of each radial truss (Pl.102).

3.4.10 The crown is relatively consistent but there is one small rectangular 'feature' on the east side, with a frame around it, which has the appearance of being a sealed opening. It appears too regular to be a repair and is visible on the outer side of the crown (visible on drone images).

3.4.11 The bell: the vertical walls visible within the holder are those of the innermost lift, in its lowered position (Pl. 93-94). It is constructed from thin, welded sheets of cast iron (12 levels) braced by 28 vertical I-section steel stanchions. These stanchions are 3.05m apart and 19 cm x 10 cm in section. The stanchions are c.9 m in height.

3.4.12 The walls are broadly featureless although there is a distinct horizontal line just over half way up which indicates the waterline when the holder was filled. Below this line are a light orange colour from the corroded surface while above it they are a much darker colour.

3.4.13 Towards the northern side of the holder a distinctive number 22 had been written against the side of the tank, on the fourth level up from the base (Pl. 95). A similar No.20 could also be seen two bays away at the same height (although it was much less clear) suggesting that informal bay numbers had

been added during the construction phase. No such numbers in the other bays could be seen but this may be due to corrosion.

3.4.14 At its base the inner lift has a slight curved lip and it rests on widely spaced horizontal spurs extending out to the tank (Pl. 107). This creates a slight gap underneath the lip although this was partly obscured by sludge around the edge of the holder. The curved underside is part of the 'cup-and-dip' water seal whereby each lift in the bell would interconnect with the adjacent one to prevent gas escaping. The base of each lift incorporates a trough around its circumference which would fill with water and when the holder inflated it would connect with an inverted 'dip' around the top of the adjacent lift (see also Appendix C).

3.4.15 The other two lifts were largely hidden behind the innermost one but they could be seen in section at the recently formed opening (Pl.107-109).

3.4.16 The tank: The inner face of the tank wall was also largely hidden behind the lift but again a part of it could be seen at the new opening. It is constructed from individual cast-iron plates c.1.2 m tall, with ridges to the inner face to add strength. The lower rows have two horizontal ridges (other than those at the edge) but the upper ones have a single central ridge. The plates are bolted together through the edge ridges and they are significantly thicker than the plates used in the lifts.

3.4.17 The base of the holder is horizontal and it is formed from a series of concentric cast-iron rings extending out from the centre. Each ring is formed from individual, wedge-shaped cast-iron plates with ridges to each side to allow them to be bolted to the adjacent plate. The form of these plates is similar to that of the tank sides (although these do not have additional strengthening ridges) and they are bolted together at the perimeter of the holder. This forms a single vast, sealed vessel which houses the bell. The ridges around the edge of these base plates are c.10 cm tall.

3.4.18 There are nine concentric rings to the base although the outermost one, which is bolted to the side plates is directly beneath the three lifts so is only visible where the opening has been formed. Each plate is cast with a number showing which ring it is from and these numbers match those visible on the external face of the tank.

3.4.19 The base of the tank is unusual and different to all the other holders that OA has recorded. OA has seen many later holders with an iron-plate base but not ridged in this way. It is possible that the ridges gave the tank a particular strength and that this was considered necessary due to the issues with leaking which were previously encountered when the holder was constructed in 1884. Most other 19th-century holders seen by OA incorporate a hump-shaped dumpling.

3.4.20 As referred to above the cast-iron base is c.2m below the level of the surrounding ground and it has been decided to bury it insitu rather than removing it as had initially been the intention. This eases the practicalities of the demolition but it is also good from a heritage standpoint as it leaves the potential for further investigation of the base in the future.

3.4.21 Other

3.4.22 There are two large vertical inlet and outlet pipes on the western side of the holder which extend the full height from the base to the crown (Pl. 97). Each pipe is constructed from seven sections, with ridged flanges between and the overall structure is fixed to the floor with angled struts. Just below the crown each pipe widens with a wider circular tray and above this there is a slightly narrower section that rises to the crown. It has not been possible to examine this area closely but the uppermost section of each pipe appears to be fixed to the crown and presumably they would rise and fall with the crown. When lowered they would have sat in the circular tray, possibly sealed by water. The pipes would have had a lid in the crown which could be opened when the holder was deflated to allow an examination of the pipe.

3.5 Salvage

3.5.1 The current project will see the dismantling of the gasholder's tank and bell and this will allow the salvage of some items, principally for their heritage value but also for other purposes. Some items will be retained on site to allow them to potentially be incorporated into a future redevelopment of the site or for a previously unidentified interested party to come forward.

3.5.2 The carriage rollers also have good potential for salvage and they would help with understanding the way that the holder formerly functioned.

3.5.3 An assessment of the salvage potential of the structures has previously been made and recipients identified to take material. The list below outlines the items planned for salvage and their recipients.

- Two Guide wheels – one to the Science Museum and one to retain on site for potential future use;
- Makers Name Plate (Cutler) – retain for potential future use;
- Makers Name Plate (Spice) – one to Fakenham Gas Museum and one to be retained for potential future use;
- Tension band – one to Fakenham Gas Museum, two retained for potential future use;
- Tension band clutches - two retained for potential future use;
- Section of cup & dip (or grip) – retained for potential future use;
- Section through tank and lifts between columns (c.1-2 m in height) – retained for potential future use;
- Two tension straps – retained for potential future reuse;
- One tonne of steel and cast iron – for use by local artists;
- Two sections of tank – c.1 m x 1 m – retained for potential future use.

3.5.4 As outlined above it has been agreed to leave the base of the holder buried in-situ, c.2m below the height of the surrounding ground.

3.5.5 It would also be valuable to salvage a section of the ridged tank floor and possibly the crown of the crown (a circular section showing how the radial trusses meet).

4 HERITAGE SIGNIFICANCE

4.1 Introduction

4.1.1 The heritage significance of Gasholder 172 at Great Yarmouth gasholder has long been recognised, partly through the survey of the gas industry undertaken as part of English Heritage's Monuments Protection Programme (Trueman, 2002), written by Michael Trueman between c.1997 and 2002. It was listed at Grade II in 1998.

4.1.2 The MPP Step 1 report, providing an overview of the industry was produced in 1997 and the MPP Step 2 report was issued in 2000. This was then followed by the Step 3 report which identified 151 sites of heritage significance in the gas industry. Of these sites, 52 sites were considered to be of national significance (five +++ sites, 18 ++ sites and 29 + sites). Other sites were classed as being of regional significance.

4.1.3 The holder at Great Yarmouth was assessed as a ++ site of national significance and described thus:

At the Great Yarmouth Gasworks (Norfolk 3) is a fine example of a column-guided gasholder of 1884 by notable engineer, Robert Spice. This contrasts with Hendon no.3, again using external jointing but with 3 tiers and employing several unusual features that make it unique (including an above ground cast-iron tank, tangential rollers, and curved girders. It is listed grade II.

4.2 Summary Statement of Significance

4.2.1 Gasholder 172 at Great Yarmouth provides a good example of small, late Victorian holder with a number of unusual technical details. It is a prominent and widely recognised landmark within the town and is illustrative of Victorian engineering. The fact that it survives relatively intact, retaining all the principal features of a gasholder, adds to its interest.

4.2.2 Among its unusual or interesting features are the curved girders, above-ground tank and 'French' rollers which operate in a tangential direction in addition to the conventional radial rollers. The adaptation of the column bases and capitals to accommodate external bolts are also of note.

4.2.3 In *Gasholders, A History in Pictures* Russell Thomas refers to the structure as being 'Gothic-styled' and as 'one of the quirkier surviving gasholders'.

4.2.4 Classification of holder

4.2.5 A typology of gasholders was developed by Malcolm Tucker as part of his *London Gasholders Survey* and the holder in Great Yarmouth falls within the '*Multiple-Order cast-iron columns group'*. However, there have been different suggestions on exactly which type of holder within this group Great Yarmouth most resembles. Tucker suggested it was Type 17 while Michael Truman suggested it was a Type 15/17b variant). The list description suggests it is a Type 18 and this is supported by the current project brief.

4.2.6 Type 18 is defined as 'Giant Single-Order Cast iron column gasholder with externally flanged joints' and this does seem the closest match to the Great Yarmouth holder. It has Girders Type LL (lattice to top and lower).

4.2.7 Comparison with other later 19th-century gasholders

4.2.8 In common with most holders constructed between the 1840s and 1890s No.172 is column guided with a ring of cast-iron columns that would help stabilise the gas bell as it ascended and descended. It was common for these holders to incorporate ornate decoration such as lattice work or decorative roses and No.172 at Great Yarmouth appears to have had Corinthian capitals attached to the columns. These capitals are visible in some early 20th-century photographs but they were subsequently removed. They would have been intended to give the holder a classical character but it now has what Russell Thomas describes as a 'Gothic-styled' and quirky appearance. The Gothic character stems from the structure's height relative to its unusually small diameter, emphasised by finials on top of each column.

4.2.9 In comparison with other later 19th-century holders the structure appears heavily engineered, with the columns relatively closely spaced and with unusually large junction boxes.

4.2.10 No.172 lacks the lightness of structure found at some comparable column-guided holders (eg Salford and Carlisle) but this forms part of its distinctive character. Perhaps its most unusual feature is the use of girders **(?)** which follow the curve of the holder rather than being straight between each columns. Thus each horizontal ring is a perfect circle rather than a polygon (A *tetradecagon*).

4.2.11 Another feature is the lack of diagonal bracing ties between columns, as found at most comparable holders (eg those at Sunderland, Kensington, Blackfriars, Salford, Carlisle and Portsmouth).

5 SUMMARY AND CONCLUSIONS

5.1.1 Gasholder No.172 in Admiralty Road, Great Yarmouth is a Grade II listed building and a structure of considerable heritage significance. It was constructed in 1884, as an addition to the town's existing South Dene Gasworks but in the following year (1885) it was moved to an adjacent site at the gasworks due to structural issues. It now forms a prominent local landmark and an impressive illustration of late Victorian engineering.

5.1.2 It is an relatively small holder compared to many others from this period and it has a distinctive, heavily engineered character with heavy junction boxes, closely spaced columns and finials. Its most unusual feature is perhaps the use of curved horizontal girders between columns which together form perfect circular rings around the holder rather than the much more common use of straight girders between columns at other sites.

5.1.3 Although it is a listed building it is also the type of redundant structure which poses considerable challenges related to maintenance and health and safety. It is one of a very large number of holders across the country which have become disused due to changes in the gas industry. Its condition is slowly deteriorating and the paint which formerly covered it is slowly peeling away.

5.1.4 Most of the other redundant gasholders are slowly being fully demolished (often following recording) as part of a nationwide programme but this would not be appropriate for the structure at Great Yarmouth due to its listed status and heritage significance.

5.1.5 It is the type of structure that is obviously very difficult to reuse without major adaptations, especially one with an above ground tank, and permission has been granted for the removal of the tank and the telescopic bell which would have held the gas. These are historic elements of the holder so the work will impact on the structure's heritage value but permission has been granted on grounds of safety as well as making the site more marketable.

5.1.6 A programme of historic building recording is being undertaken as a condition of the planning permission including laser scanning, drone video recording and conventional photography. The recording has been commissioned by Montagu Evans, on behalf of National Grid, and it has been undertaken in a phased programme. The initial phase of recording was prior to any demolition works and this was followed by further recording after the start of demolition, when access into the holder was possible to record the internal structure.

5.1.7 The recording forms part of a wider programme to document the many gasholders that are largely being demolished across the country. This programme will allow comparisons to be made between the structures.

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APPENDIX B LISTED BUILDING DESCRIPTION

Gasholder Number 172 at former Great Yarmouth Gasworks
Admiralty Road, Great Yarmouth, NR30 3DR Norfolk
NGR: TG52732 06134
Grade II List Entry Number: 1096789
Date first listed: 26-Feb-1998 Most recent amendment: 08-Jun-2023

Summary

Gasholder, built in 1884 to the design of the consulting engineer Robert P Spice of London for the Great Yarmouth Gas Company by the contractors Samuel Cutler and Sons of Millwall, London. In 1885, after foundation settlement caused the water tank to leak, it was dismantled and re-erected on a site immediately to the east.

Reasons for Designation

Gasholder Number 172 at the former Great Yarmouth Gas Works, rebuilt in 1885 after being built in 1884 by Samuel Cutler and Sons of Millwall, London to designs by the consulting engineer Robert P Spice of London, is listed at Grade II for the following principal reasons:

Architectural interest:

* the composite guide frame is aesthetically distinguished and finely detailed with three orders of cast-iron columns with moulded bases, astragals and capitals, topped by decorative finials, as well as unusual curved steel box girders; a relatively early use of such steel girders; * as an increasingly rare example of a complete gasholder, with it being one of only seven intact designated examples to survive, and also one of three with an above-ground water tank and gas bell, the latter also likely to be one of no more than four nationally to be of trussed construction. * for its design by the noted gas engineer Robert Paulson Spice

Historic interest:

* as the sole surviving component of the former Great Yarmouth Gas Works, it stands testament to the scale of the Britain's pioneering gas industry and its contribution to the Industrial Revolution, marking a transition in the town, namely the introduction of gas into people's homes, giving warmth and light to the masses.

History

Gas lighting derived from coal was invented in the 1790s and from 1816 it took off in London and then spread nationally. Gasworks, which comprised coal stores, retort houses for the extraction of gas, plant to remove impurities, gasholders, and administrative buildings, were one of the most ubiquitous and widely distributed industrial complexes in the C19 and C20, often constructed in urban fringes, close to customers, and adjacent to rivers, canals and railways whence coal was delivered. The water-sealed type of gasholder, as at Great Yarmouth, was adopted from the earliest times, comprising a bell (gas vessel) open at the bottom and placed in a water-filled tank, so as to seal in the gas, rising or falling vertically according to the volume of gas being stored.

The origins of gas lighting in Great Yarmouth dates to 25 May 1824 when the town's Paving and Lighting Commissioners entered into an agreement with the Great Yarmouth Gas Light and Coke Company to erect 121 public lamps and a gasholder which was constructed in the South Denes area of the town. Further contracts between the two parties were signed on 31 August 1829, 7 November 1833 and 3 December 1835. An Act of Parliament incorporated the company formally in 1863 as the Great Yarmouth Gas Company and the gas works were inaugurated in 1869. By 1887, when the first edition 25-inch Ordnance Survey map of Great Yarmouth was published following a survey undertaken in 1883, Great Yarmouth Gasworks had developed into a considerable-sized industrial complex bounded by South Denes Road to the west, Barrack Road to the north, Middle Road (now Sutton Road) to the south and an empty plot of land fronting Admiralty Road to the east. Within the site stood several buildings housing plant for the production, purification and metering of gas along with two gasholders. A further two gasholders stood on a separate site on the north side of Barrack Road, connected by pipes under the road.

In 1884, the year after the Ordnance Survey mapped the town, construction of a new gasholder commenced to the designs of the consulting engineer Robert P Spice of London by the contractors Samuel Cutler and Sons of London. However, in April 1885, as reported in the Norwich Mercury (see Sources), foundation settlement as a result of variations in the subsoil caused the water tank to leak. Consequently, the gasholder was dismantled and re-erected on the vacant plot on Barrack Road to the east of the gasworks, which the Gas Company had acquired from the Council in August. Due to the poor load-bearing properties of the soil it was equipped with an above-ground water tank and gas bell.

The Goad Fire Insurance map of 1909 shows the gasworks in considerable detail. At this time the main site included three gasholders (labelled Numbers 3 to 5) along with a horizontal retort house, purifier house, coal store, coal bunker, meter house, governor house, laboratory, offices and an engine house with hydraulic accumulator tower. The separate gasholder station on the north side of Barrack Road, however, had lost one of its two gasholders by this date, with the surviving gasholder labelled as Number 1. An account of the gas works is given in the Journal of Gas Lighting, Water Supply, and Sanitary Improvement in 1910 (see Sources), describing it as occupying a four-acre site at the south end of the town, adjacent to the Fish Wharf, with the engineer Mr RP Spice of London being responsible for the design, arrangement and general details of the buildings and plant, and Samuel Cutler and Sons of Millwall their manufacture and later additions.

A photograph of the gasholder published in the Gas Journal in 1909 (see Sources) appears to show the guide-holder columns with Corinthian capitals whereas the capitals today broadly imitate the Tuscan order. As there is no known documentary evidence confirming that the capitals were replaced wholesale, particularly given the cost and disruption this would have caused, it is probable that the acanthus leaves were removed at an unknown date. It is possible that this was undertaken when a major reconstruction of the site was undertaken between 1919 and 1923.

The Gas Act of 1948 nationalised the 1,064 local gas undertakings, vesting them in twelve area gas boards. On Nationalisation in 1949 the undertaking became part of the Great Yarmouth Group of the Norwich Division of the Eastern Gas Board. Between 1949 and 1958 the number of gasworks nearly halved from 1,050 to 536 as the industry battled to remain

viable, thereby diminishing their ubiquitousness. Following the discovery of natural gas under the North Sea in 1965, the UK gas network underwent a massive process of conversion between 1967 and 1977. Coal gas stopped being utilised in favour of natural gas transported under high pressure in pipes, resulting in the immediate redundancy of much gas manufacturing equipment and the clearance of many traditional gas works sites, including Great Yarmouth Gasworks. The 1884/5 gasholder (labelled Number 5 on the Goad Map) was retained, along with a 1960s spiral-guided gasholder, to store natural gas. The 1884/5 gasholder has now been decommissioned and the 1960s gasholder was demolished in 2023.

Details

Gasholder, built in 1884 to the design of the consulting engineer Robert P Spice of London for the Great Yarmouth Gas Company by the contractors Samuel Cutler and Sons of Millwall, London. In 1885, after foundation settlement caused the water tank to leak, it was dismantled and re-erected on a site immediately to the east.

MATERIALS: the tank and bell are constructed of rivetted cast-iron plates while the composite guide frame is formed of cast-iron columns and steel box-lattice girders.

PLAN: it is circular on plan and measures around 29m in height and 29.8m in diameter. DETAILS: the gasholder is of a column-guided type and consists of three main components: a circular guide frame (Type 18 in Tucker's Typology of gasholders) along with an above-ground water tank and telescopic gas bell. The guide frame consists of three tiers of 14 cast-iron tubular columns joined by octagonal joint boxes to a triple tier of horizontal I-section curved steel box girders. The box girders have repeating St Andrew's cross latticework and end detailing while the top tier of girders are supported by Paddon wind ties. The columns broadly imitate Tuscan columns (although a 1909 photograph appears to show Corinthian capitals) with octagonal moulded bases, astragals and capitals, although the bases and capitals have been adapted to accommodate external bolts and stiffening feathers. Each lower column has an oval makers' plate with either 'S CUTLER & SONS / CONTRACTORS LONDON / 1884' or 'RP SPICE / ENGINEER / LONDON/ 1884' cast in relief. The top tier of columns are surmounted by needle finials set upon moulded bases with pierced volutes. Attached to the inside face of each column are guide rails for the wrought-iron carriage rollers upon which the three lifts of the telescopic bell of the gasholder rose as its was filled with gas or fell as it was emptied from its above-ground tank. The bell also bears makers' plates as described above. An access ladder is attached to one side of the guide frame.

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APPENDIX C A SUMMARY OF GASWORKS' PLANT AND PROCESSES

Introduction

This account of the general development of the gas industry and the functions of gasworks plant and gas holders is based largely on several articles and presentations available online by Professor Russell Thomas, particularly *The History and Operation of Gasworks (Manufactured Gas Plants),* as well as the Monuments Protection Programme Step 1 report and the London Gasholders Survey by Malcolm Tucker.

Gasworks followed a general form, however, the types of each building, plant and equipment and the layout of each site varied widely according to the location, type of coal available, the likely size of the supply required and the manufacturer of the plant. The advancement of technology and the continuous obsolescence and replacement of plant resulted in a regular rebuilding of many gasworks operations.

This appendix describes the general operation of a gasworks and the principal functions of its plant, however, it does not seek to describe every combination of plant available and research should be carried out when investigating each site.

DEVELOPMENT OF THE GAS INDUSTRY IN BRITAIN

General history

The origins of the use of gas for artificial lighting lie in the 1790s when William Murdoch first used coal gas to illuminate his house in Redruth, Cornwall. Murdoch produced the gas by burning coal in a small retort in his back yard. In the following years he continued to experiment with gas lighting by improving the technology and in the first decade of the 19th century his methods were used to illuminate various mills and industrial works.

Other important individuals were also helping to develop the industry in this period including Samuel Clegg, an engineer whose work led to several technical advances, and Frederick Winsor who established the Gas Light and Coke Company in 1812. Winsor's vision, which was for an industry where gas was supplied to many customers from a single large gasworks, differed from Murdoch's which was for individual smaller plants supplying single sites.

Initially, gas was used for streetlighting and to light industrial works and the homes of the wealthier population, although municipal operations became widespread and by 1820 the principal English and Scottish towns were lit by gas; by 1830, over 200 and by 1859 there were over 1000 public gasworks built across Britain. The industry developed in the later 19th century with various innovations such as the vertical retort plant, which allowed continuous operation and used gravity to create a process flow, the gas mantle light and the greater use of by-products from the gas production process.

The Second World War had a major impact on the industry, particularly through bomb damage and loss of workers to the war effort and in an attempt to rebuild the industry after the war the Labour Government passed the Gas Act of 1948 which nationalised the 1064 local gas undertakings into 12 area gas boards. The boards would subsequently merge in 1972 to form British Gas, which was privatised in 1986.

In the later 1960s it was decided that the United Kingdom would phase out gas produced from coal and would instead move to an industry based on natural gas, some imported, and some obtained from North Sea gas fields. This led to extensive works during the 1970s to clear redundant facilities from gasworks and adapt or convert other plant which was to be reused; this change also resulted in the physical conversion of every gas appliance in the country. By the mid-1970s there were very few surviving sites where town gas was still being produced; these were mainly in remote parts of Scotland and the last site closed in 1981.

Some gasworks were partially demolished to create a gasholder station to store the natural gas, removing the gas production buildings and equipment but retaining the gasholders, transmission plant and distribution network. By the early 2000s, gas distribution technology had improved which rendered even the gasholder stations redundant and a programme to dismantle the gasholders was commenced.

ELEMENTS OF A GASWORKS

Introduction

A typical gasworks where coal gas was produced comprised many different elements of plant and processes, and followed the same basic principle, although some of these may only have been included at the larger sites.

Not all coal was suitable for gas manufacture and some coal fields were more suited to different types of retorts and so the gasworks design would be adapted to the coal available. The transport of the coal was also important: the proximity of canals, and later the railways, or sometimes docks in coastal areas, was essential. Many gasworks had their own railway sidings.

The retort

The retort is fundamentally a sealed container where coal would be heated to drive off moisture, gases and various other by-products. The retort house held 'benches' of retorts and the retort construction advanced from cast iron to fireclay to silica giving improved performance and the ability to withstand higher temperatures.

Retorts went through several stages of design; early retorts were horizontal and heated by radiant heat from the furnace below at relatively low temperatures. The coal shrank as it was heated and the resulting coke was raked out of the retort and more coal put in; mechanical stoking equipment was introduced with through-retorts. Inclined retorts were angled at 32° to horizontal, in theory creating less wear and tear and easier to load and unload, but they could be difficult to operate and were only suitable for certain types of coal and so were short-lived.

Vertical retorts were attempted throughout the 19th century but became successful by the turn of the 20th century. There were several types, but the basic principle was that tapered continuous vertical retorts, filled by hoppers above the retort, were heated by burning gas from separate producers. These could carbonise the coal continuously as it descended and the coke was extracted at regular intervals from the bottom of the retort, the residual heat sometimes being used for other purposes. The coke and breeze (the finer ash) which was not needed for reuse on the site was sold as fuel to industrial and domestic customers.

The gas extracted from the coal rose through an offtake pipe at the top of the retort.

Condensers

There were numerous designs for condensers, some using air, some using water, but all of which were used to reduce the temperature of the gas and also begin the process to remove the tarry impurities.

Exhausters

Exhausters drew gas off the retorts and pushed it through the purification system. This was essential to prevent the building up of pressure in the retort.

Cleaning and purification

The gas produced by heating the coal had many impurities which had to be removed before it could be transferred to the gasholder, including, but not limited to, ammonia, tar, hydrogen, sulphide, benzole and hydrocyanic acid.

Numerous machines and systems were patented for this purpose. The method employed was used according to the impurity, and included passing the gas through water or oil in the form of bubbles (washing) or passing the gas over a large area covered in the solvent liquid (scrubbing); in the later part of the 19th century, the distinction between the two was lost and tended to be referred to simply as 'washing'.

Dry purification involved passing the gas through trays of granular lime or iron oxide.

The impurities extracted were often valuable as by-products, such as coal tar, sulphate of ammonia, sulphuric acid, benzole, hydrocyanic acid and the spent lime from the purification, and these were also sold to other industries.

Metering, storage and distribution

The amount of gas produced would then be measured by the station meter before being stored in the gasholder.

The gas was stored in gasholders to cope with peaks and troughs in demand and to ensure that there was always a ready supply; their form and function will be discussed in the following section.

The station governor maintained the pressure of the gas leaving the holder when distributing it into the gas mains. Using a similar principle to the gasholder, the pressure was controlled using weights set onto a floating bell, although as with most other gasworks equipment, designs varied. Booster pumps were later developed to increase the pressure of the gas flowing into the gas main and were particularly used when the area supplied was far from the gasworks or where a gasholder station was used for the storage of gas between the gasworks and the remote location.

GASHOLDERS

Introduction

The introduction of gasholders removed the need for continuous gas production, the storage also acted as a buffer for periods of high demand and during halts in production and contained enough gas supply for 24 to 36 hours.

The basic principle of a gasholder is that it consists of two parts: a tank containing water and a cylindrical vessel called a 'lift'. The water provided a seal to prevent the gas from escaping and acted as a resisting surface to the incoming and exiting gas; the lift held the gas, rising and lowering according to the volume. The weight of the lift determined the pressure of the gas in the mains - and the back pressure on the gas making plant if no exhauster was used. Weights could be added to the lift or lifts if additional pressure was required, such as at times of high demand.

History

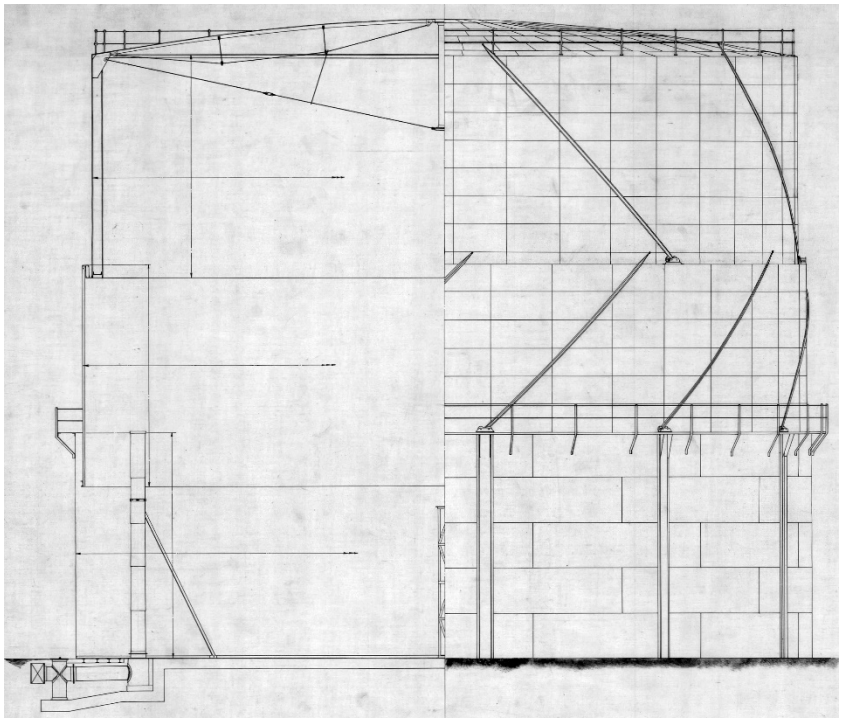
The earliest gasholders were small and built of iron or wood with the moving vessel guided by counter weights on chains. The wooden tanks particularly, sometimes repurposed from the brewing industry, were unreliable and prone to leaking.

From the early 19th century, the gas produced in retorts was stored in large holders and in the early phase of the industry these tended to be housed within separate buildings due to fears of explosion. In truth however the dangers of leaking gas becoming trapped and then exploding was considerably greater when the gasholder was enclosed by a separate building and this gradually led to the external cylindrical gasholder which became the most recognisable feature of any gasworks

By the time the industry became established, above ground tanks were usually made from steel on a circular concrete slab. The steel floor plate was laid on top of the slab and the steel plates forming the sides of the tank were attached to the floor plate using a steel curb. The sides of the tank were constructed from rows of steel sheets, the bottom row thicker than those above it which often decreased in thickness with the height of the tank. The plates were usually rivetted, although some later tanks were welded.

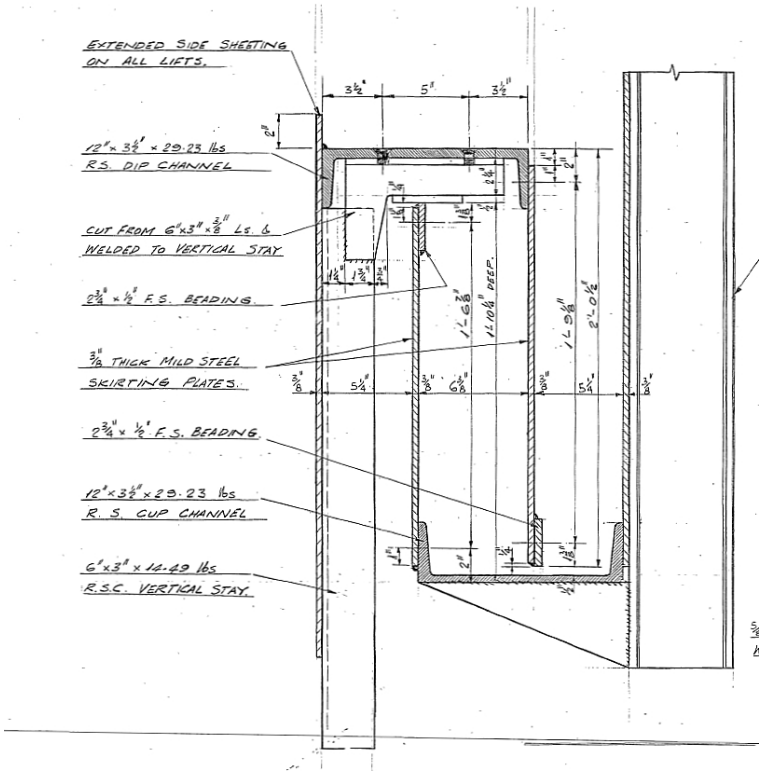
Below-ground tanks were also used, built of brick, stone or concrete and sometimes cut into bedrock if it was suitable; each method must be made watertight, usually using puddle clay or render. The centre of the tank need not be excavated, leaving a dumpling in the centre of the tank.

The gas was prevented from escaping by a water seal in the tank and around each lift. The top of the tank and each lift returned towards the centre of the gasholder, called a 'dip' and the base of the next lift returned towards the outer edge of the gasholder, called a 'cup' (Appendix Figure 2). When the lifts rose, the cup and dip, which contained water, would interlock and form a seal against the gas within the gasholder.



Appendix Figure 1: A section and elevation of an above-ground two-lift spiral guided gasholder

(Extract of drawing EA/SA/FEG/E/T/1 National Gas Archive)



Appendix Figure 2: A cross-section of the cup and dip seal of the lifts of a gasholder which would be filled with water when the gasholder was in use (Extract of drawing NW/MA/DNE/E/E/6 National Gas Archive)

Originally, gasholders used a single lift, but later the telescopic gasholder was invented whereby separate close fitting vessels would be located within one another so that each inner lift would rise when the outer one reached its capacity. This allowed increased storage on the same footprint.

Initially the upper lifts of the early types of telescopic holders were guided by columns or frames; guide rails on the inner face of the columns guided wheels on arms attached to the top of the lifts, keeping the lift in place as it rose and fell. A short-lived cable-guided gasholder was developed whereby the lift was guided by a system of wire ropes and pulleys, although their use was not widespread.

In the late 1880s the spirally-guided gasholder was invented comprising a series of lifts which would rotate and spiral up or down with each chamber guided by the one below. Each lift would have diagonal guide rails fixed to its side which would engage with roller carriages fixed to the top of the vessel beneath. These guide rails could rotate the lifts in alternating directions or in the same direction, according to the design.

Waterless or Dry Gasholders were developed in the early 20th century which used an internal piston which moved with the aid of guide rollers within a static tank and fixed roof; three main types were developed: the MAN gasholder used a tar or oil seal, the Klonne used a grease seal and the Wiggins used a rubber seal.

There were many styles of gasholders, but with the exception of the waterless gasholders, the chief distinction between the types was regarding the method of guiding and support of the lift or lifts.

The crown

The nature of the support for the domed crown is among the most interesting aspects of any gasholder and it is also an area where a variety of approaches evolved in the 19th century.

The interest is partly as a result of the structure being required to function under two quite different conditions. When a holder is inflated the crown is naturally supported by gas pressure so in this situation there is no need for a large superstructure but when the holder is empty the crown needs to be supported.

Early holders tended to have a trussed crown with radial structures where the dome was self-supporting, albeit with a fixed prop which could support the centre of the crown when the holder was lowered. These trussed crowns were often technologically sophisticated and in the middle decades of the 19th century the spans of the larger holders often rivalled or exceeded the largest spans of industrial sheds or railway stations. This is of course a misleading comparison because the structure was supported by pressure when the holder was inflated and when it was deflated there was a fixed stanchion at the centre to help support the crown.

However, in *c*1850 another approach, that of the 'untrussed crown' was introduced (Tucker, 2000) in which the crown was either supported by gas pressure (when the holder was inflated) or by a fixed 'rest frame' when the holder was empty. The frame, of either timber of ironwork would not rise with the crown when the holder inflated, and this type of holder was widely used in the 1860s and 1870s.

Another slightly different approach to the trussed crown was introduced in the 1870s with 'radial girders'. These were ribs with plates or lattice webs beneath and the central fixed prop as with trussed crowns. All three types of crown continued to be used into the 20th century (Tucker, 2000).

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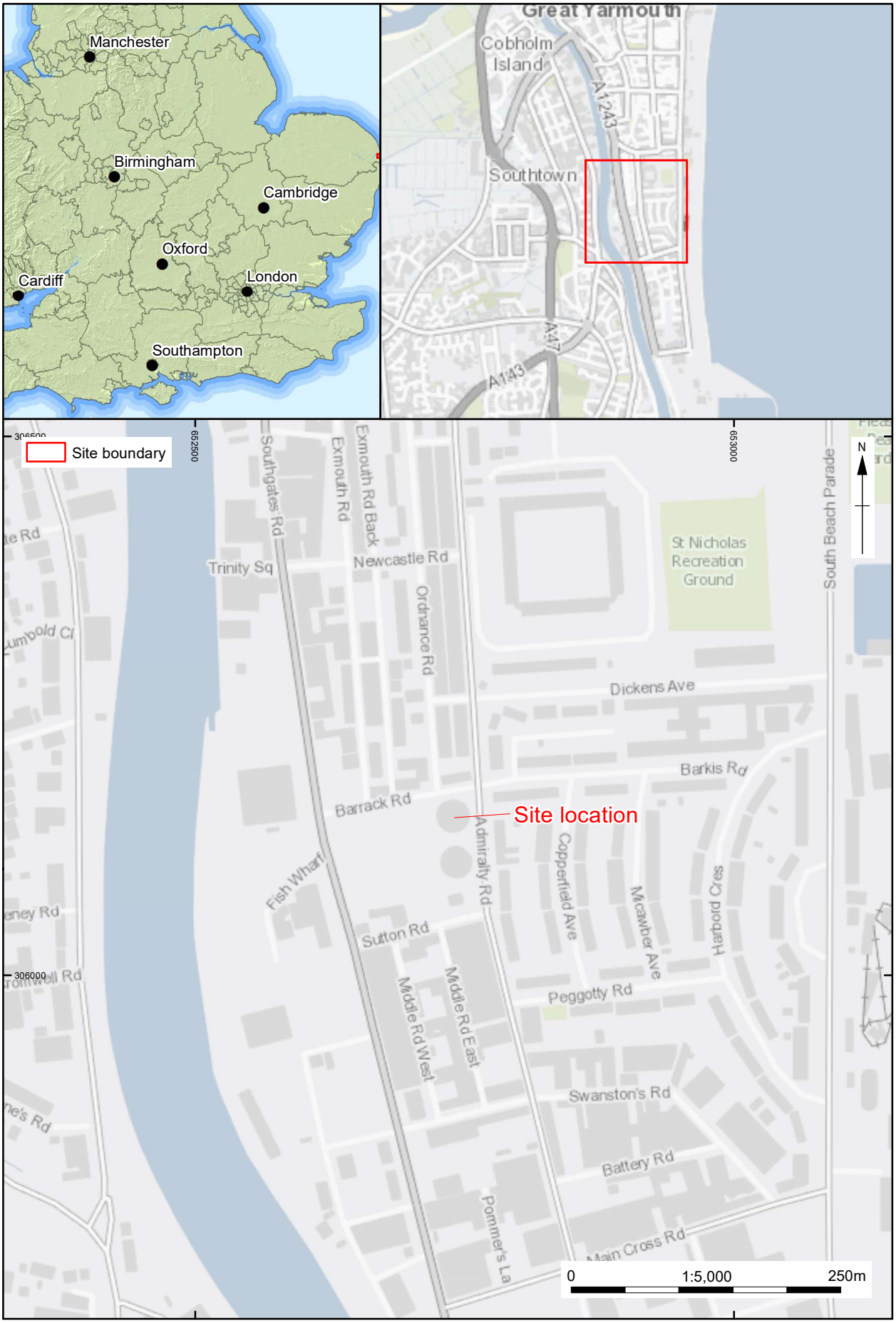

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Figure 1: Site location

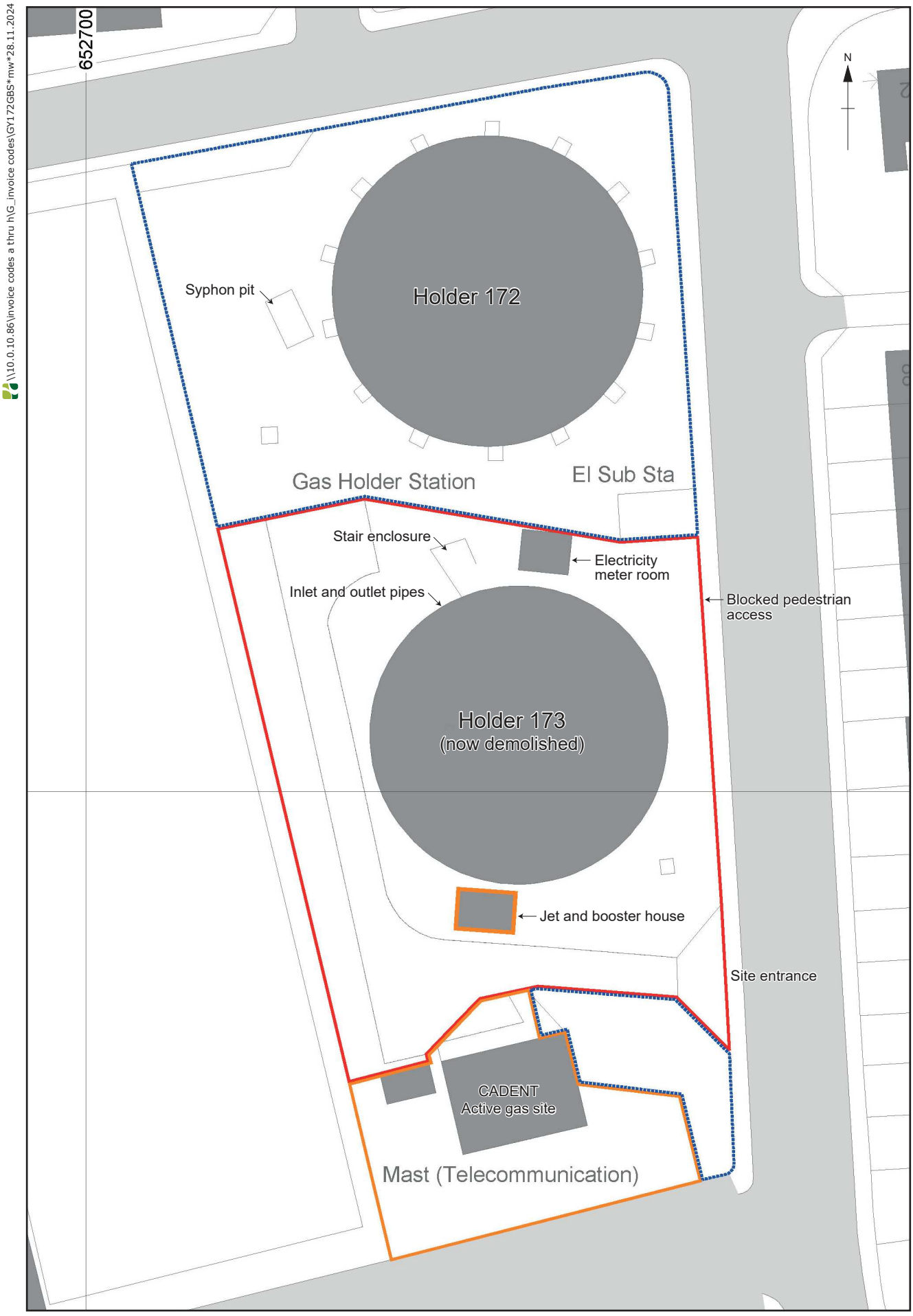
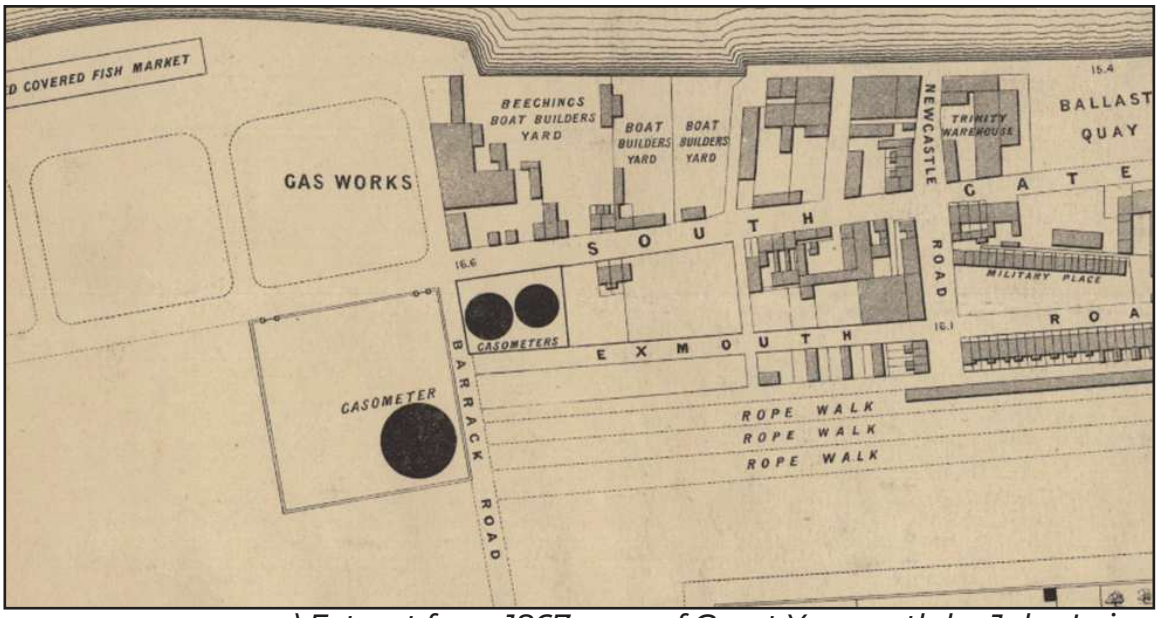
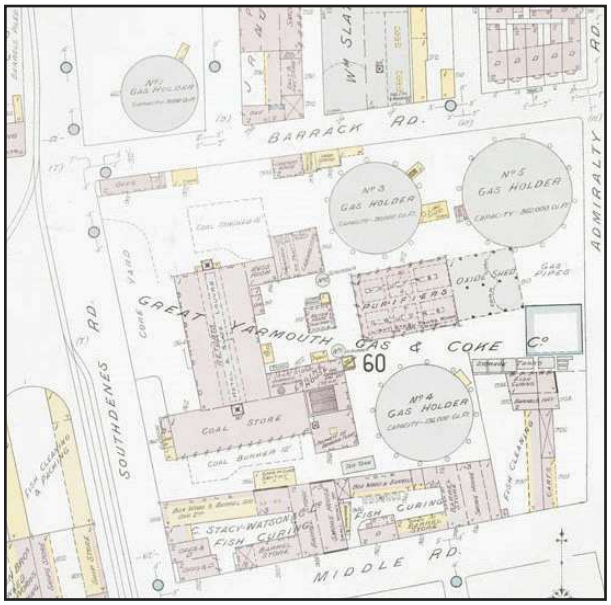


Figure 2: Site plan showing location of buildings and key features

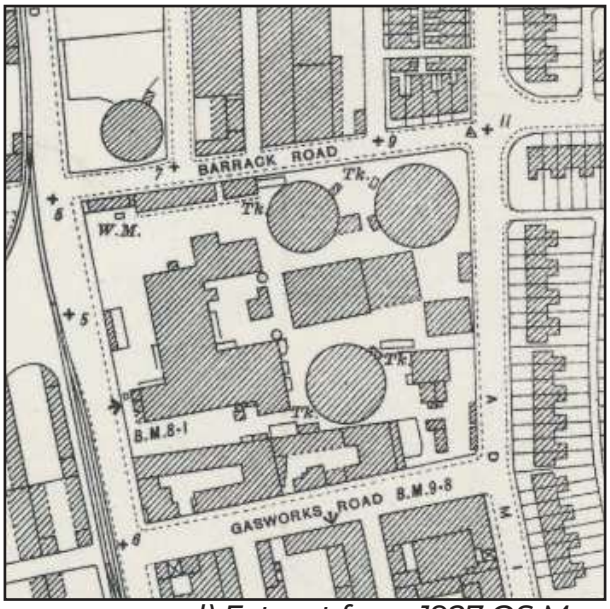


a) Extract from 1867 map of Great Yarmouth by John Laing

b) Extract from 1886 OS Map



c) Extract from 1909 Fire Insurance (source: British Library)

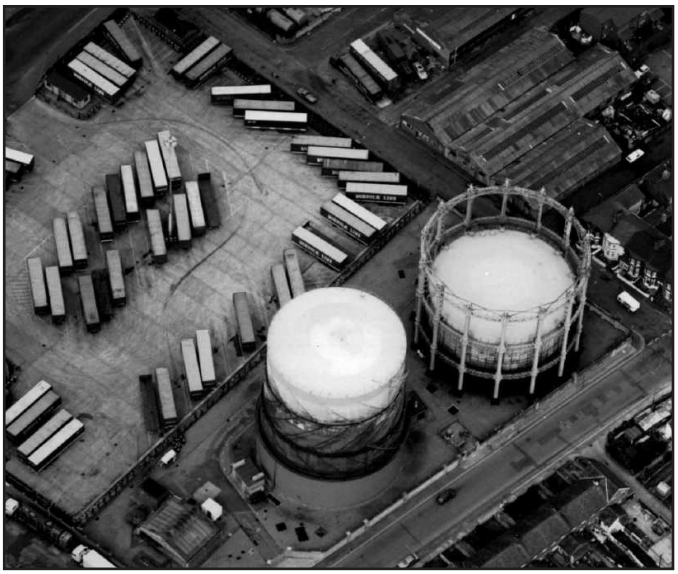


d) Extract from 1927 OS Map

e) Extract from 1970 OS Map

Figure 3

a) Aerial view of gasworks in 1928 (Britain From Above EPW021187)



b) Aerial view of gas works in late 20th century (National Gas Archives EA/DX/E/F/3)

c) Aerial view of gas works in late 20th century (National Gas Archives xg2939)

Figure 4

BARRACK ROAD

SOUTH DENES ROAD

ADMIRALTY ROAD

SUTTON ROAD

6" RELIEF GOVERNOR

6" SAFETY GOVERNOR
4" RELIEF VALVE
2-4" M.P GOVERNORS
8" VOLUMETRIC GOV.

18" STATION GOVERNOR
HOLMES CONNERSVILLE
12" x 36" METER
BRYAN DONKIN VT 60
1ST BOOSTER, ELECTRIC
DRIVEN L.H.T.D.
BRYAN DONKIN VT 60
1ST BOOSTER DIESEL
DRIVEN R.H.T.D.

18" AUTOMATIC HOLDER VALVE

No 5 COLUMN GUIDED GASHOLDER
DOUBLE LIFT, CAPACITY 400,000 FT³
PRESSURES:- 1ST LIFT 6.0" W.G.
2ND LIFT 8.0" W.G.

EASTERN ELECTRICITY SUB-STATION

18" AUTOMATIC HOLDER VALVE

No 6 SPIRAL GUIDED GASHOLDER
TREBLE LIFT, CAPACITY 500,000 FT³
PRESSURES:- 1ST LIFT 6.9" W.g.
2ND LIFT 11.3" W.g.
3RD LIFT 15.1" W.g.

No 4 COLUMN GUIDED GASHOLDER
SINGLE LIFT, CAPACITY 140,000 FT³
PRESSURE :- 4½" W.G.

SITE PLAN

EA/NF/GRY/E/E/3

GT. YAR 2

NOT

C			
B	6" RELIEF GOVERNOR ADDED	24/6/66	H.A.C.
A	4" RELIEF VALVE ADDED.	26/1/66	H.A.C.
	REVISION	DATE	INITIAL

SANCTION

KEY

ITEM	EXISTING	PROPOSED
H.P. GAS MAINS		
M.P. GAS MAINS		
L.P. GAS MAINS (6" & OVER)		
L.P. GAS MAINS (UNDER 6")		
DIAMETER CHANGE		
UNCONNECTED PIPES		
CONNECTED PIPES		
CHANGE IN FALL		
VALVE		
NON-RETURN VALVE		
SYPHON		
DIP		
ANODE		
BAG HOLE		
FILTER (SCREEN BOX)		
DISTRICT GOVERNOR		
SERVICE GOV. (DOMESTIC)		
SERVICE GOV. (NON-DOM.)		
KIOSK	k	
PIT	p	
BRICK OR OTHER HOUSE	h	
GOV. AUXILIARY SYSTEM	a	
GASHOLDER STATION		
EASEMENT		
SERVICE PIPE		
OVER 6" w.g. GREEN		
4"-6" w.g. YELLOW		
UNDER 4" w.g. RED		

Eastern GAS

NORFOLK REGION

DISTRIBUTION ENGINEER'S DEPARTMENT
THORPE LODGE, 1 YARMOUTH RD., NORWICH

DEPOT	SOUTH NORFOLK
DISTRICT	GREAT YARMOUTH

PLAN OF GASHOLDER STATION SHOWING GAS MAIN CONNECTIONS.

PROJECT No.	
LOCATION CODE	283/56
SECTION No.	

DRAWN	TRACED	PASSED
H.A.C.	H.A.C.	
JULY/1966	JULY/1966	

O.S. REF.	
GRID. REF.	527 061
SCALE	1/16 = 1 FOOT & 1/1250

DRAWING No. YA/380/22 B

Figure 5: Plan of gasholder station showing gas main connections (1966, National Gas Archives ref: EA/NF/GRY/E/E/3)

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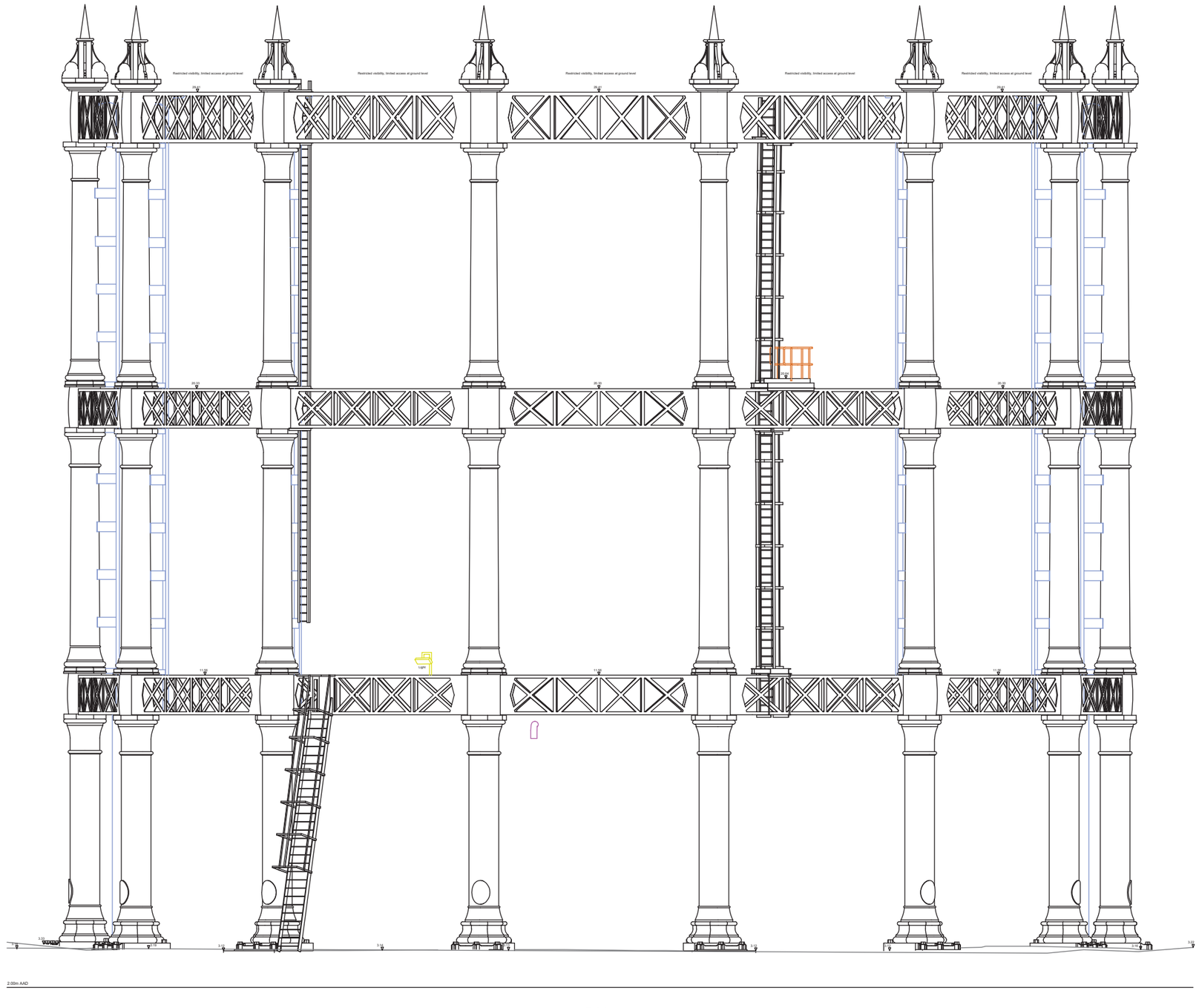

Elevation 1

Metres 05 0 05 10 Metres

STANDARD ABBREVIATIONS

A/C	Air Conditioner	HB	Hand Basin
AH	Arch Height	HR	Handrail
BGP	Break Glass Point	JB	Junction Box
Br	Brick	L	Light
BRW	Brick Retaining Wall	Max	Maximum
BW	Brick Wall	Min	Minimum
CBF	Close Boarded Fence	O/H	Overhead
CCTV	Closed Circuit Television	Rad	Radiator
Col	Column	RDM	Recessed Door Mat
Conc	Concrete	RSJ	Rolled Steel Joist
Cup	Cupboard	RWP	Rain Water Pipe
DP	Down Pipe	SH	Spring Height
EJB	Electrical Junction Box	SL	Sump Level
EM	Electricity Meter	Sk	Skylight
ESG	Electrical Switchgear	SO	Smoke Outlet
FA	Fire Alarm	SS	Security Sensor
FE	Fire Extinguisher	T	Telephone
FH	Fire Hydrant	Typ	Typical
FHR	Fire Hose Reel	V	Vent
Flt	Floodlight	VP	Vent Pipe
		WH	Water Heater

STANDARD LEGEND

Level +.50.00
Floor To Sill Dimension F/S 0.87
Floor To Head Dimension F/H 2.05
Window Sill Level WSL 36.05
Window Head Level WHL 40.55
Floor To Ceiling Height FC
Floor To False Ceiling Height FF
Ceiling Soffit Level CS 50
Beam Height Bm 0.45m
Beam Soffit Level BSL 52.00
Door Head Dimension DH 2.05
Arch Spring Height AS 2.55m
Arch Head Height AH 2.75m
Vault Spring Height VS 2.50m
Vault Head Height VH 2.75m
Arch Spring Level ASL 52.00
Arch Head Level AHL 52.05
Vault Spring Level VSL 52.00
Vault Head Level VHL 52.05
Room Area Area: 9.0A

All arrows point up unless otherwise stated on as-builts
Sloping ceiling arrows point up
Floorboard direction

TOPOGRAPHIC DETAILS

Barrier (symbol - sized)
Belisha Beacon (symbol)
Bollard (symbol)
Borehole (symbol)
British Telecoms IC BTMH
Building (incomplete detail)
Cable into Ground (symbol)
Cable TV Box (symbol) CTV
CCTV Camera
Cover Level in metres CL 50.00
Direction of Flow (Drainage)
Distribution Board (symbol) DB
Earth Rod (symbol) ER
Electric Cabinet EC
Electric Pole (symbol)
Electric Sign (symbol)
Embankment
Feeder Pillar FP
Fire Hydrant FH
Flag Pole (symbol)
Flat Roof Level in metres FRL 50.00
Flood Light (symbol)
Gas Valve (symbol) GV
Ground Level in metres GL 50.00
Gulley GU
Inspection Cover IC
Invert Level in metres IL 50.00
Junction Box - BT JB BT
Junction Box - Comms JB COM
Junction Box - Elec JB
Lamp Post (symbol - sized)
Light Bollard (symbol)
Light in ground (symbol)
Manhole MH
Manhole Capped Port
Parapet Level in metres PL 50.00
Pipe Diameter in millimetres 150
Pipe into Ground (symbol)
Post (symbol)
Rain Water Pipe (symbol) RWP
Road Sign (symbol) RS
Rodding Eye (symbol) RE
Sapling (symbol)
Sign Post (symbol) SP
Soak Away SA
Spot Light (symbol) 50.00
Spot Height
Stop Cock (symbol)
Stop Valve (symbol)
Survey Station (symbol)
Telephone Pole (symbol)
Telephone Box (symbol)
Traffic Bollard (symbol)
Tree (dimensions in metres - e.g.) Dia: 9.5 Top: 17.5 Ht: 20.0 Maple
Traffic Light (symbol)
Unknown Valve (symbol)
Vent Pipe (symbol) VP
Wall
Waste Pipe (symbol)
Water Meter (symbol) WM
Water Valve (symbol) WV
Building Canopy
Crash Barrier
Drainage Channel
Drop Kerb (level in metres) 50.00
Edge Detail (level in metres) 50.00
Footpath (level in metres) 50.00
Fence
Heras Fence
Kerb channel (level in metres) 50.00
Kerb top (level in metres) 50.00
Overhead Service Line
Pedestrian Railing

SHEET LAYOUT

Sheet 01

Rev	Notes	Drawn	Date

Notes:

Survey is referenced to OS Grid and Level Datum.

SUMO SERVICES Ltd
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FAX: 0845 408 0853
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Title: Elevation

Client: Oxford Archaeology

Project: Gasholder No.172,Admiralty Rd,Great Yarmouth

Date Completed:	04/11/2024	Post Code:	NR30 3DR
Surveyed:	DTT	Scale:	1/100 (A2 Sheet)
Drawn:	GP		
Checked:	CPM		
Dwg No:	SUMO-19047	Job No:	SUMO-19047
		Rev:	

Figure 6: Elevation of gasholder 172

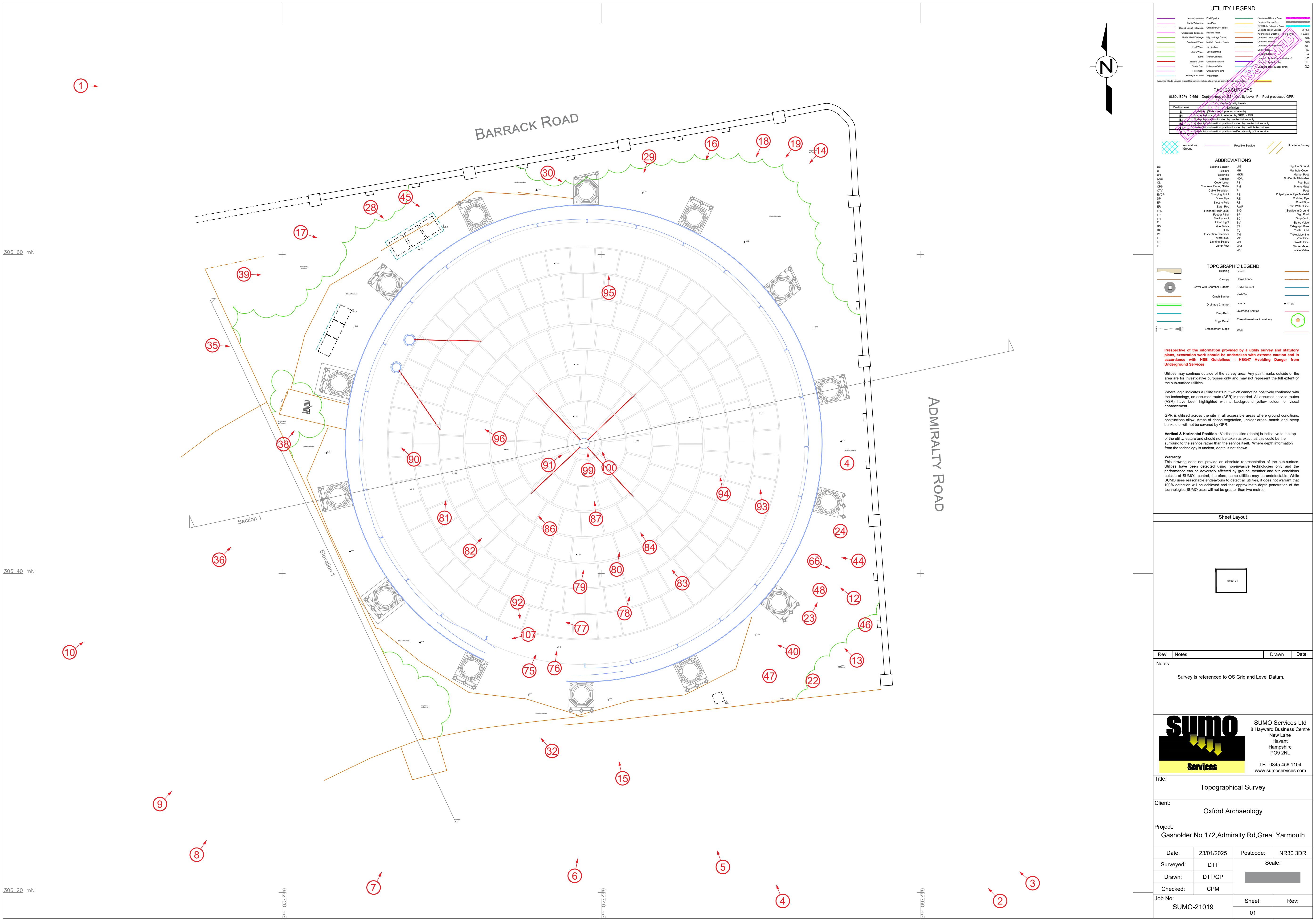
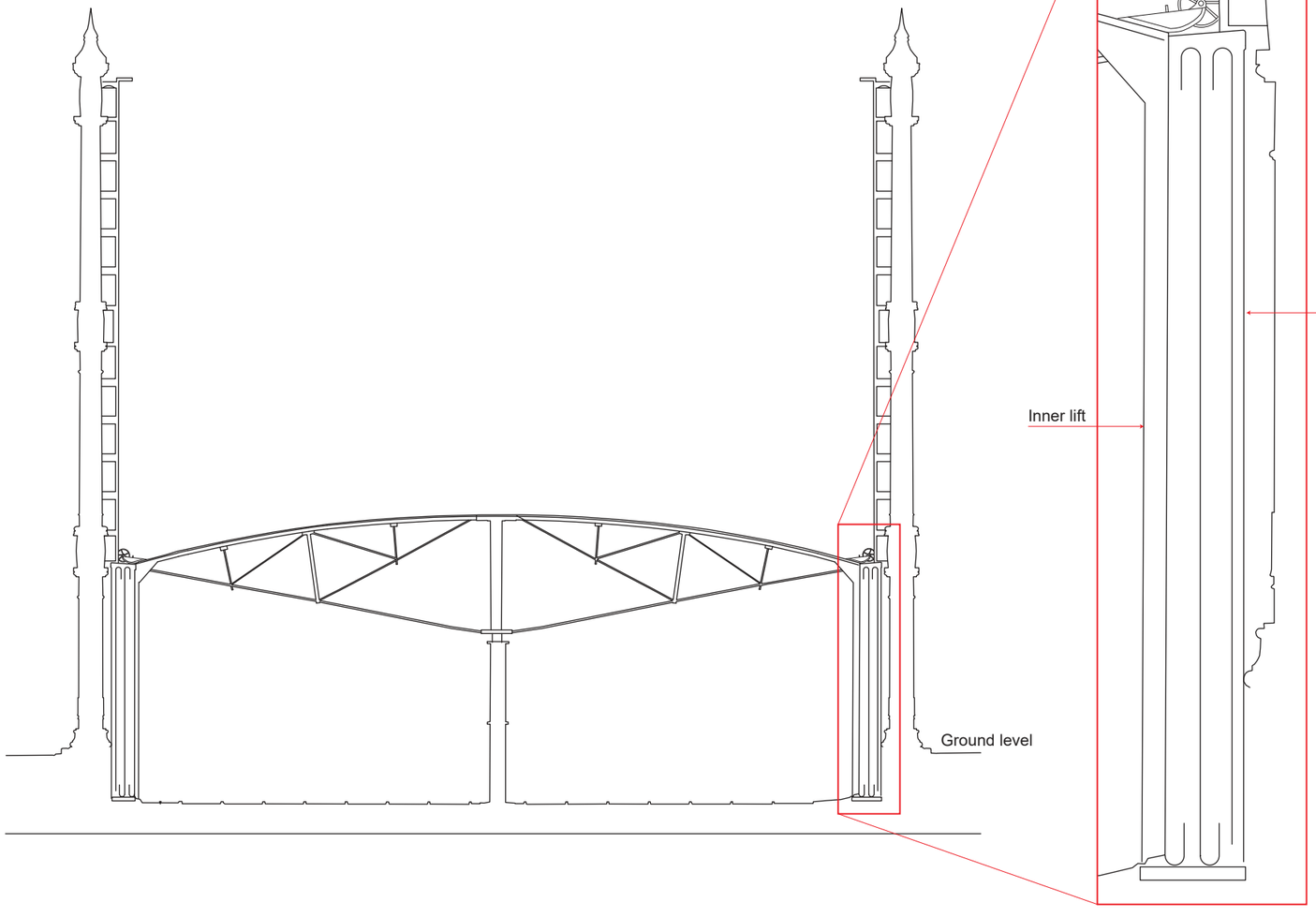


Figure 7: Plan of gasholder showing internal floor structure



UTILITY LEGEND

PAS128 SURVEYS

(0.60d B2P) 0.65d = Depth in metres, B2 = Quality Level, P = Post processed GPR

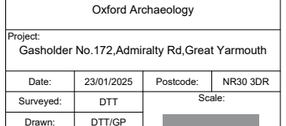
Key to Quality Levels	
Quality Level	Definition
D	Undefined (Data quality records search)
B4	Suspected to exist but not detected by GPR or EML
B3	Horizontal position located by one technique only
B2	Horizontal and vertical position located by one technique only
B1	Horizontal and vertical position located by multiple techniques
C	Horizontal and vertical position verified visually of the service

Anomalous Ground | GPR | Possible Service | Unable to Survey

ABBREVIATIONS

BB	Bellaire Beacon	LG	Light in Ground
	Bollard	MH	Manhole Cover
BH	Borehole	MKR	Marker Post
CAB	Cabinet	NDA	No Depth Attainable
CL	Cover Level	PB	Post Box
CPS	Concrete Paving Slabs	PM	Phone Mast
CTV	Cable Television	P	Post
EVCP	Charging Point	PE	Polyethylene Pipe Material
DP	Down Pipe	RE	Rodding Eye
EP	Electric Pole	RS	Road Sign
ER	Earth Rod	RWP	Rain Water Pipe
FFL	Finished Floor Level	SIG	Service in Ground
FP	Feeder Pillar	SP	Sign Post
FH	Fire Hydrant	SC	Stop Cock
FL	Flood Light	SV	Sluice Valve
GV	Gas Valve	TP	Telegraph Pole
GU	Gully	TL	Traffic Light
	Inspection Chamber	TM	Ticket Machine
	Invert Level	VP	Vent Pipe
LB	Lighting Bollard	WP	Waste Pipe
LP	Lamp Post	WM	Water Meter
		WV	Water Valve

TOPOGRAPHIC LEGEND



Irrespective of the information provided by a utility survey and statutory plans, excavation work should be undertaken with extreme caution and in accordance with HSE Guidelines - HSG47 Avoiding Danger from Underground Services

Utilities may continue outside of the survey area. Any paint marks outside of the area are for investigative purposes only and may not represent the full extent of the sub-surface utilities.

Where logic indicates a utility exists but which cannot be positively confirmed with the technology, an assumed route (ASR) is recorded. All assumed service routes (ASR) have been highlighted with a background yellow colour for visual enhancement.

GPR is utilised across the site in all accessible areas where ground conditions, obstructions allow. Areas of dense vegetation, unclear areas, marsh land, steep banks etc. will not be covered by GPR.

Vertical & Horizontal Position - Vertical position (depth) is indicative to the top of the utility/feature and should not be taken as exact, as this could be the surround to the service rather than the service itself. Where depth information from the technology is unclear, depth is not shown.

Warranty
This drawing does not provide an absolute representation of the sub-surface. Utilities have been detected using non-invasive technologies only and the performance can be adversely affected by ground, weather and site conditions outside of SUMO's control, therefore, some utilities may be undetectable. While SUMO uses reasonable endeavours to detect all utilities, it does not warrant that 100% detection will be achieved and that approximate depth penetration of the technologies SUMO uses will not be greater than two metres.

Sheet Layout

Rev	Notes	Drawn	Date

Notes:

Survey is referenced to OS Grid and Level Datum.

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Project: Gasholder No.172,Admiralty Rd,Great Yarmouth

Date:	23/01/2025	Postcode:	NR30 3DR
Surveyed:	DTT	Scale:	
Drawn:	DTT/GP		
Checked:	CPM		
Job No: SUMO-21019		Sheet: 02	Rev:

Figure 8: Section through gasholder 172

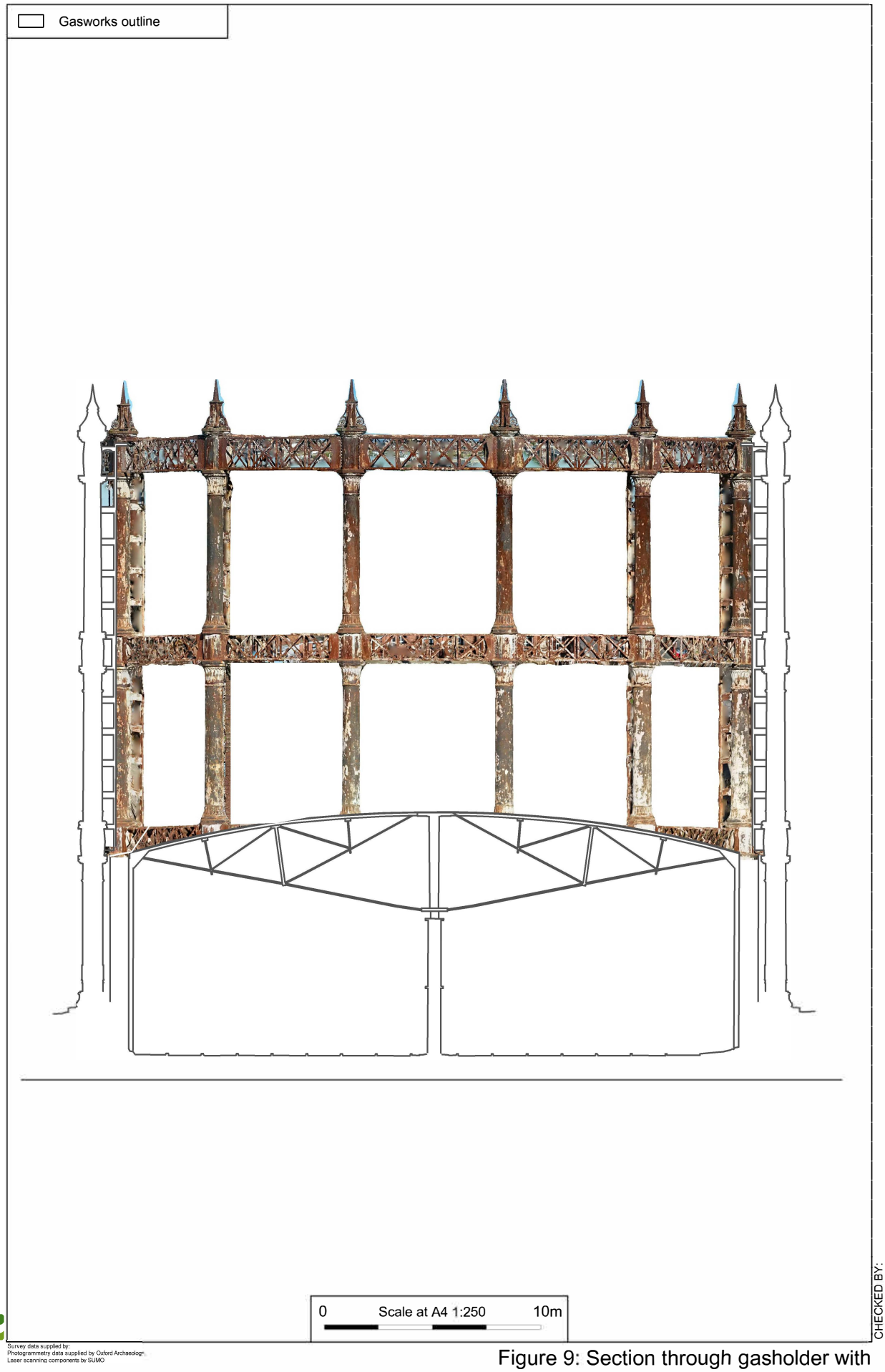

Figure 9: Section through gasholder with columns from 3D modeladded to rear

Not to scale

Survey data supplied by:
Photogrammetry data supplied by Oxford Archaeology
Laser scanning components by SUMO

Figure 10: View of 3D model of overall gasholder

CHECKED BY:

0 Scale at A4 1:25 1m

CHECKED BY:

Figure 11: Image from digital 3D model showing column base and makers plate

Plate 1: View of Gasholder 172 from west along Barrack Road

Plate 2: View from south along Admiralty Road

Plate 3: View from south along Admiralty Road

Plate 4: View from south within the site

Plate 5: South side of gasholder

Plate 6: South side of gasholder

Plate 7: General view of holder

Plate 8: General view from south-west

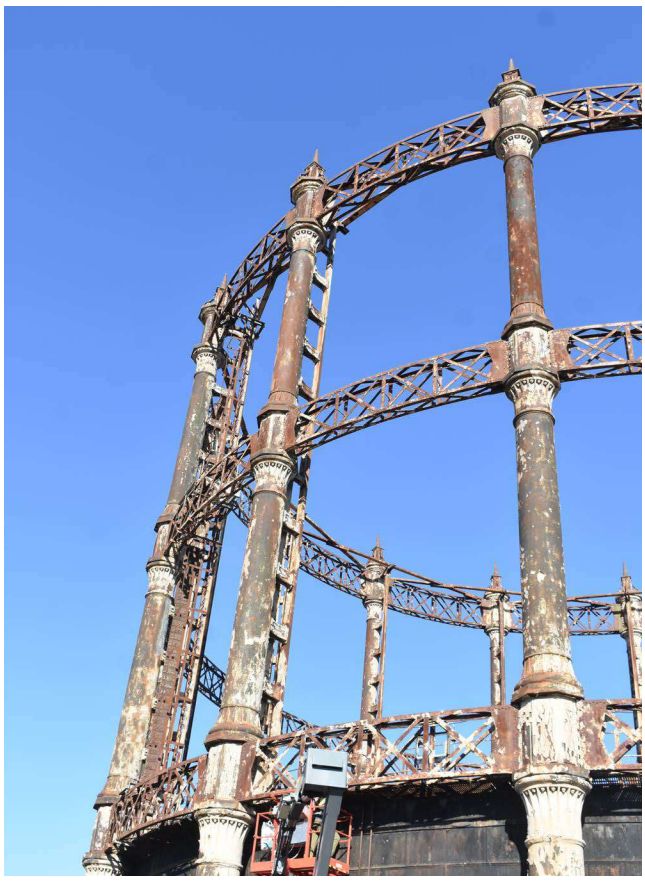

Plate 9: Upper tiers of columns

Plate 10: General view of holder

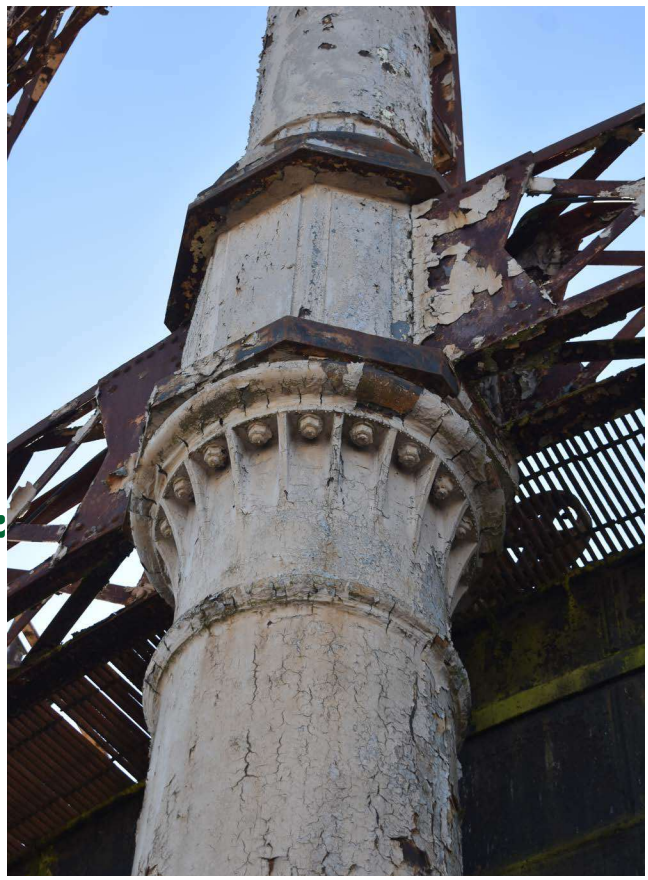

Plate 11: Detail of box junction

Plate 12: Typical section of side of holder

Plate 13: Upper part of holder

Plate 14: Tank

Plate 15: Tank

Plate 16: Vertical view showing tank and standards

Plate 17: Upper part of holder

Plate 17: Upper part of holder

Plate 19: General view of tank

Plate 20: Detail of column head and junction box

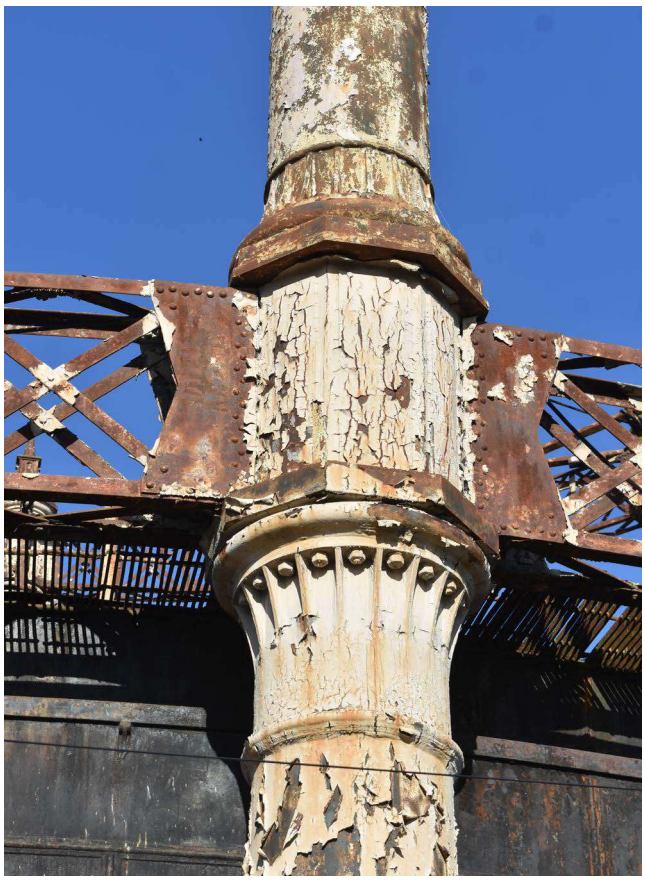

Plate 21: Detail of column head and junction box

Plate 22: Side of holder

Plate 23: Makers stamp – S Cutler & Sons Contractors

Plate 24: Makers stamp – RP Spice Engineer

Plate 25: Example of column base

Plate 26: Lower part of column

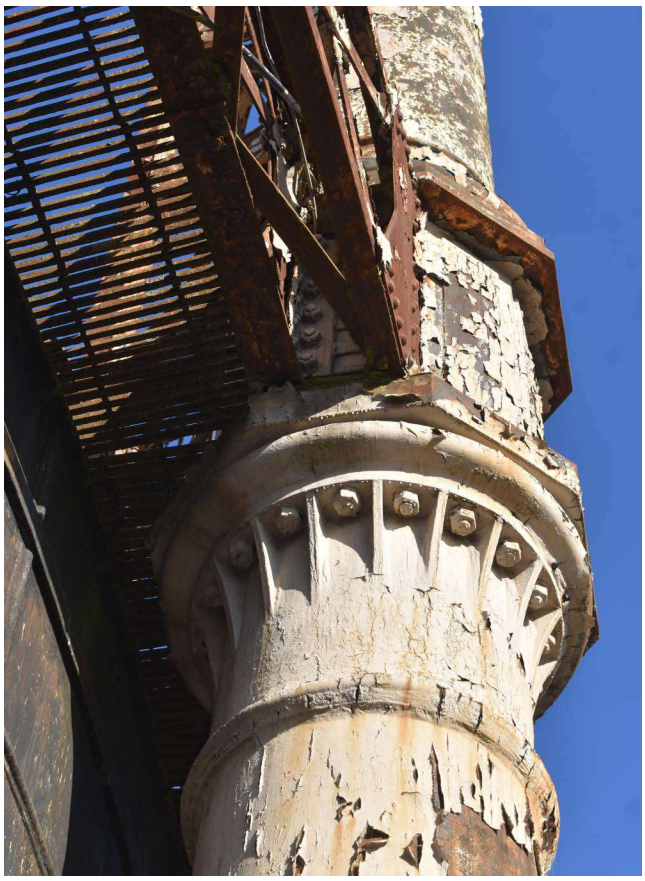

Plate 27: Detail of junction box

Plate 28: Side of holder

Plate 29: North-west side of holder

Plate 30: North-west side of holder

Plate 31: Example of walkway

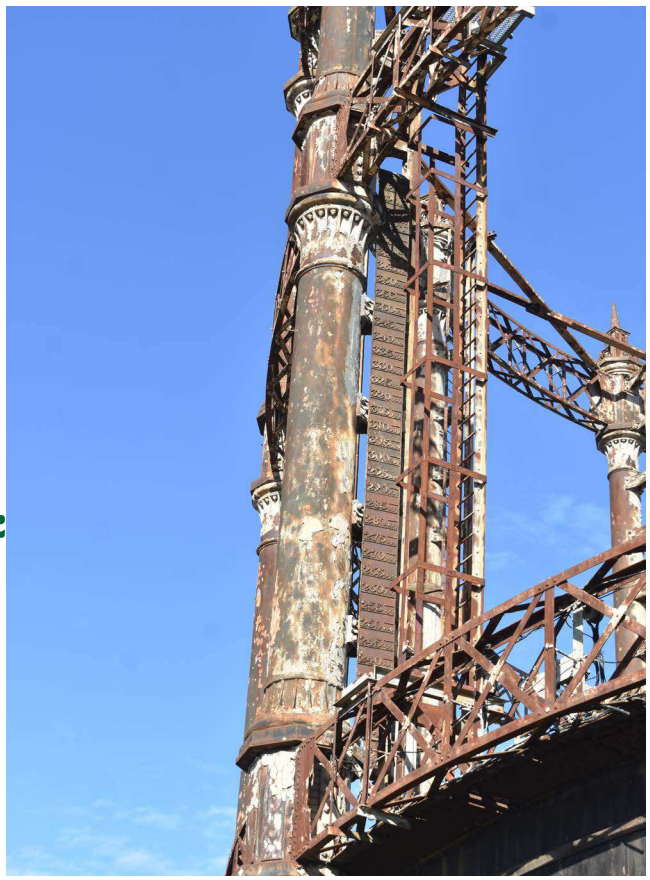

Plate 32: Detail of gas gauge

Plate 33: Typical column

Plate 34: Typical column

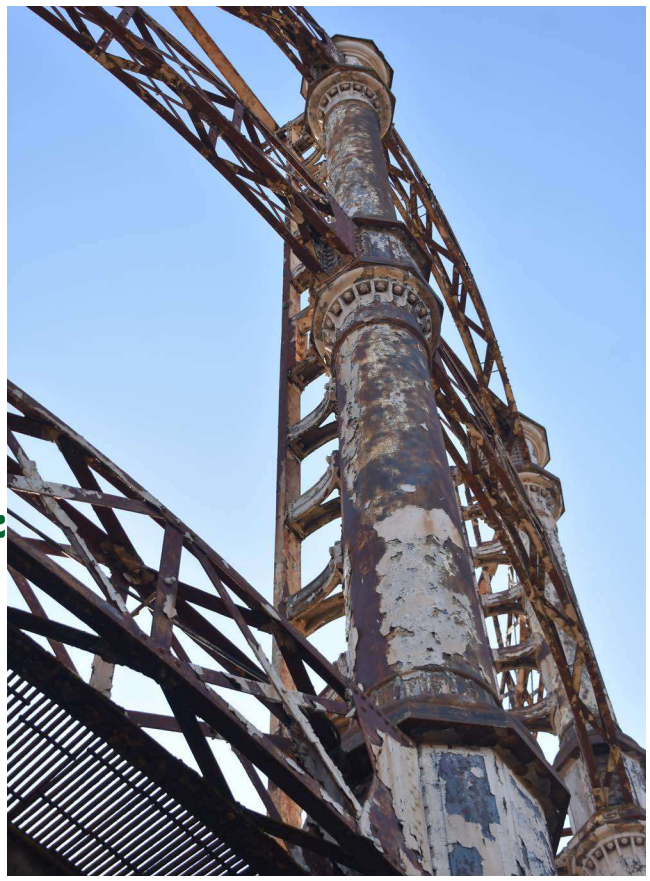

Plate 35: View of column

Plate 36: Ladder on west side of holder

Plate 37: View showing curved girders

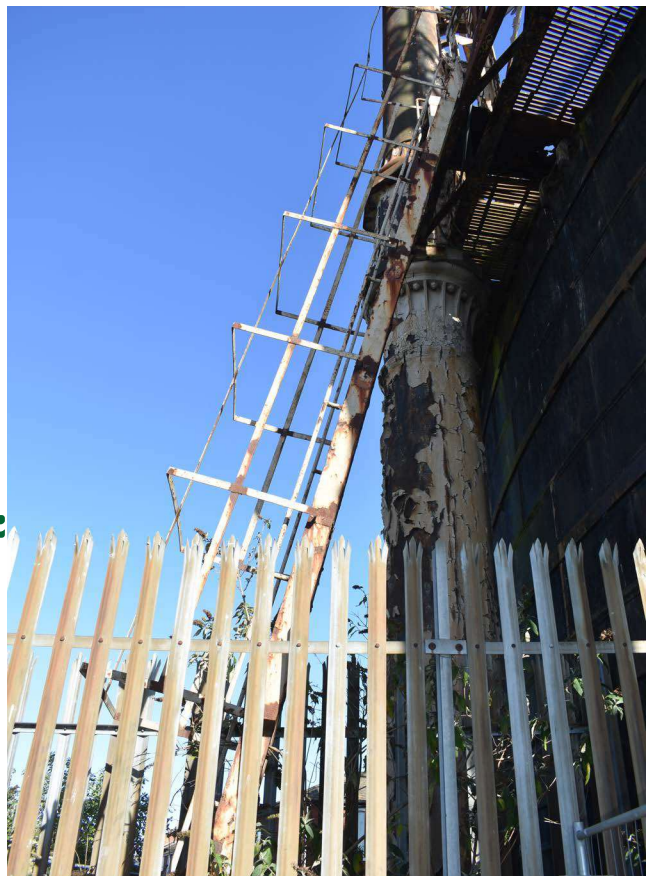

Plate 38: Ladder

Plate 39: Upper part of holder

Plate 40: Side of tank with bracing

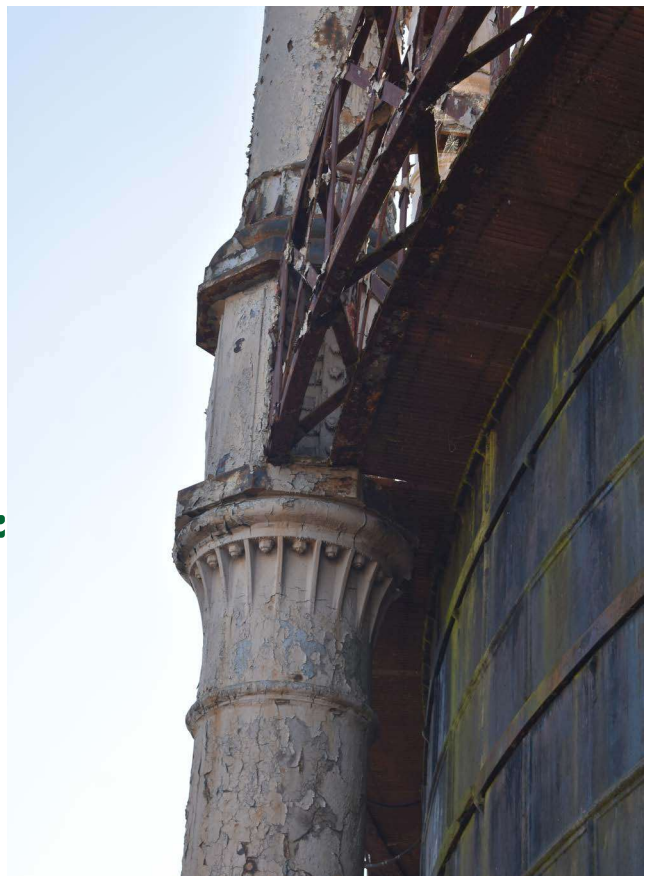

Plate 41: View of junction box

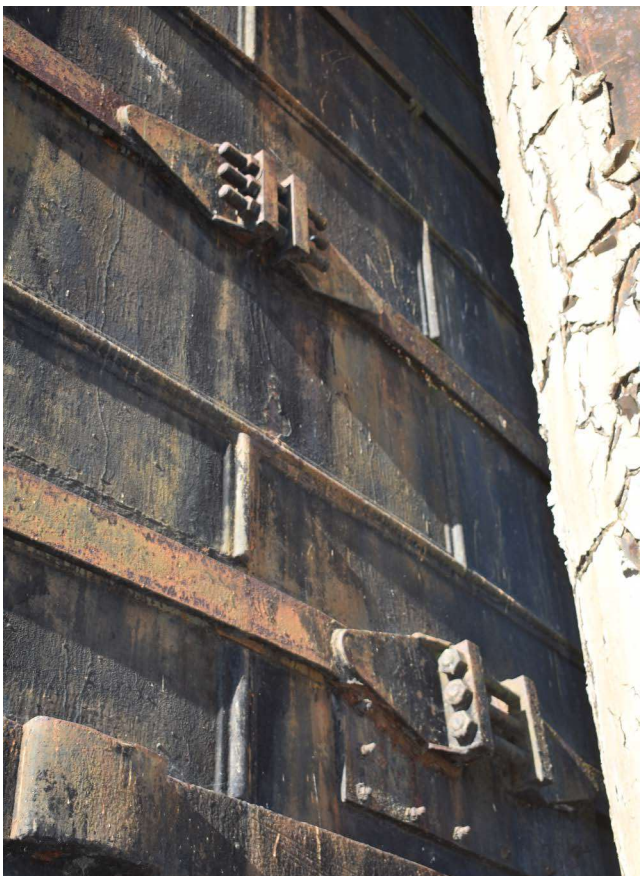

Plate 42: View of side of tank with bracing

Plate 43: Bracing to side of tank

Plate 44: Bracing to side of tank

Plate 45: Covers over pits to north-west side of tank

Plate 46: Remedial plates to side of holder

Plate 47: Example of column base

Plate 48: Variant example of column base

Plate 49: Variant example of column base

Plate 50: Brace lock to side of holder

Plate 51: Brace lock to side of holder

Plate 52: Bracing straps to side of holder

Plate 53: Secondary brace holder

Plate 54: Primary brace lock

Plate 55: Detail of carriage roller taken from drone

Plate 56: View on top of crown taken from drone

Plate 57: Detail of vertical gauge taken from drone

Plate 58: Finial and paddon ties

Plate 59: Finial and paddon ties

Plate 60: Finial

Plate 61: Upper tier of columns

Plate 62: Aerial view of holder looking east

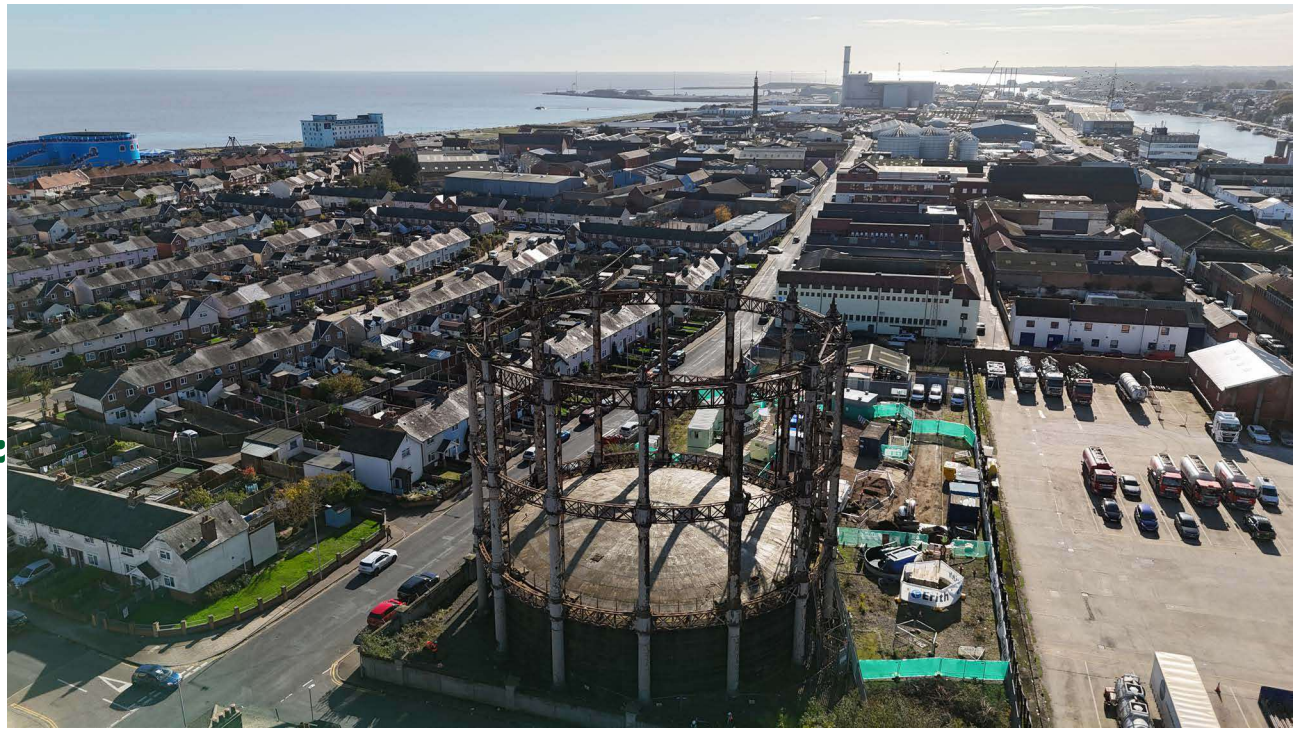

Plate 63: Aerial view of holder looking south

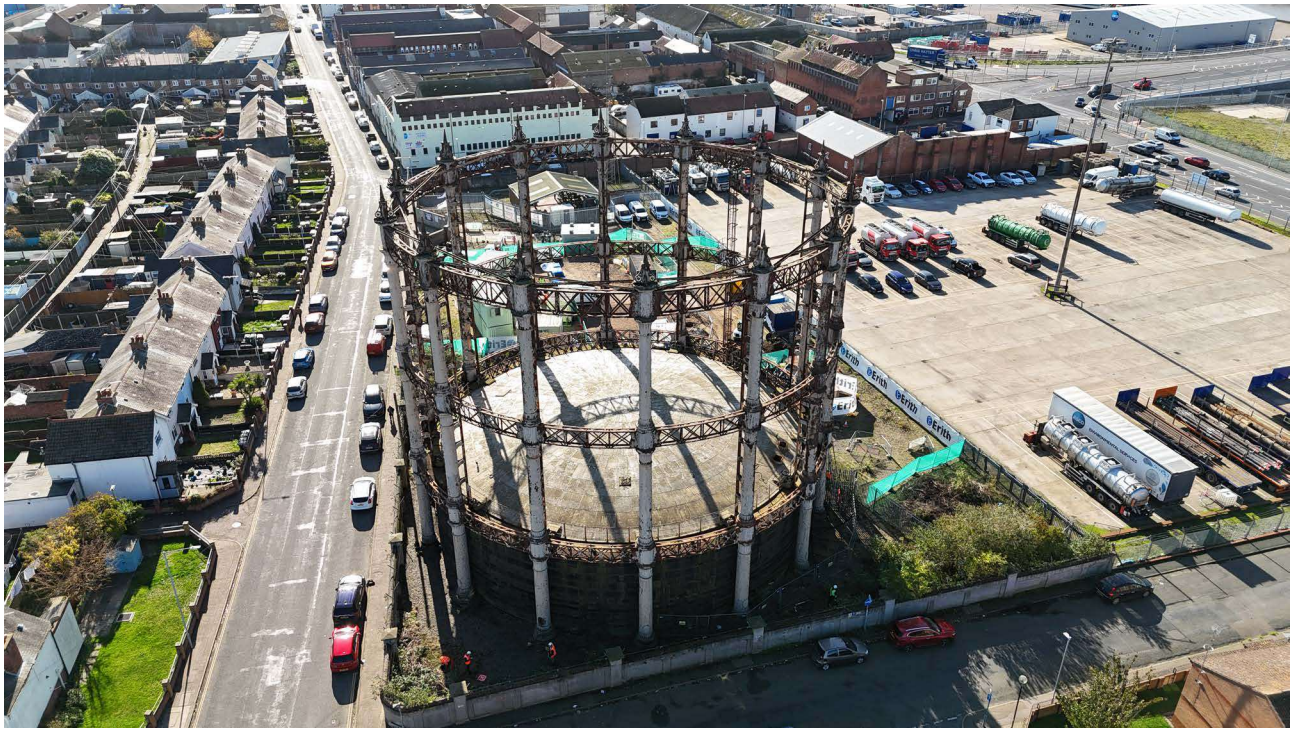

Plate 64: Aerial view of holder looking south-east

Plate 65: Vertical view from drone down onto crown

Plate 66: Finial to top of column, taken from drone

Plate 67: Detail at edge of crown, taken from drone

Plate 68: Detail of radial roller, taken from drone

Plate 69: Detail of radial roller, taken from drone

Plate 70: Detail on top of crown, showing inlet/outlet openings.

Plate 71: Detail of radial roller, taken from drone

Plate 72: Detail of radial roller, taken from drone

Plate 73: General view of tank, taken from drone

Plate 74: gas measuring gauge

Plate 75: Interior during de-sludging (taken by Geoffrey Frost of Erith)

Plate 76: Interior following de-sludging

Plate 77: View of roof and wall

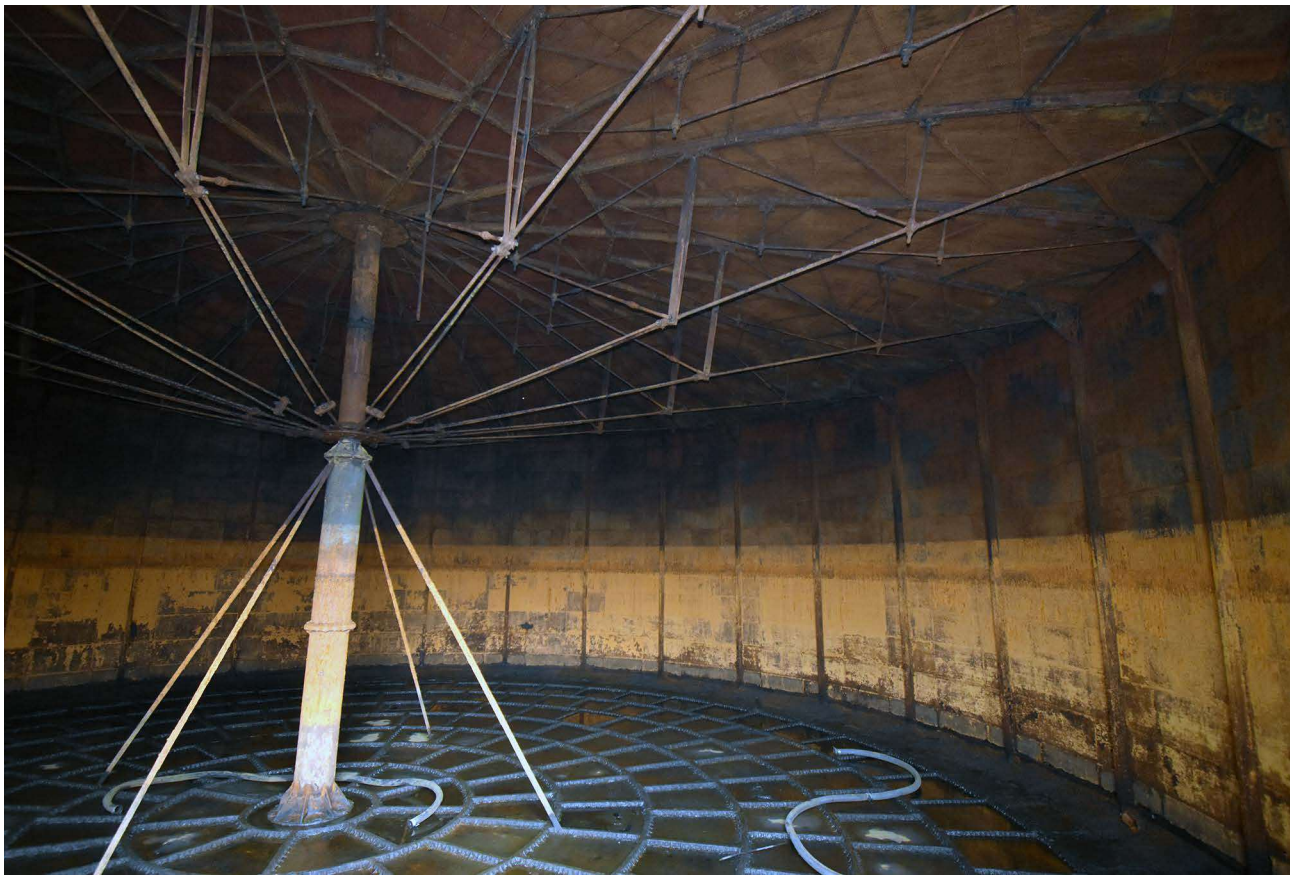

Plate 78: General view of interior

Plate 79: Radial roof structure

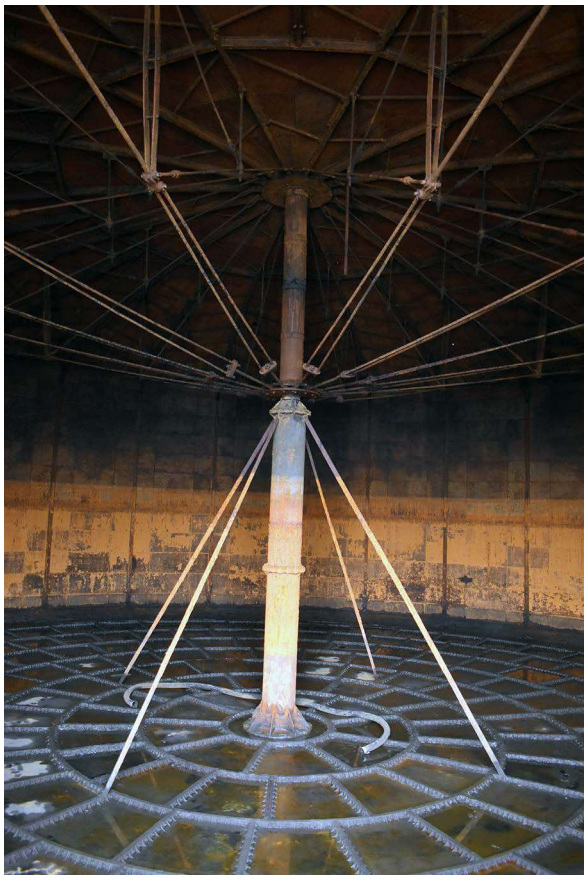

Plate 80: Central column

Plate 81: Radial roof structure

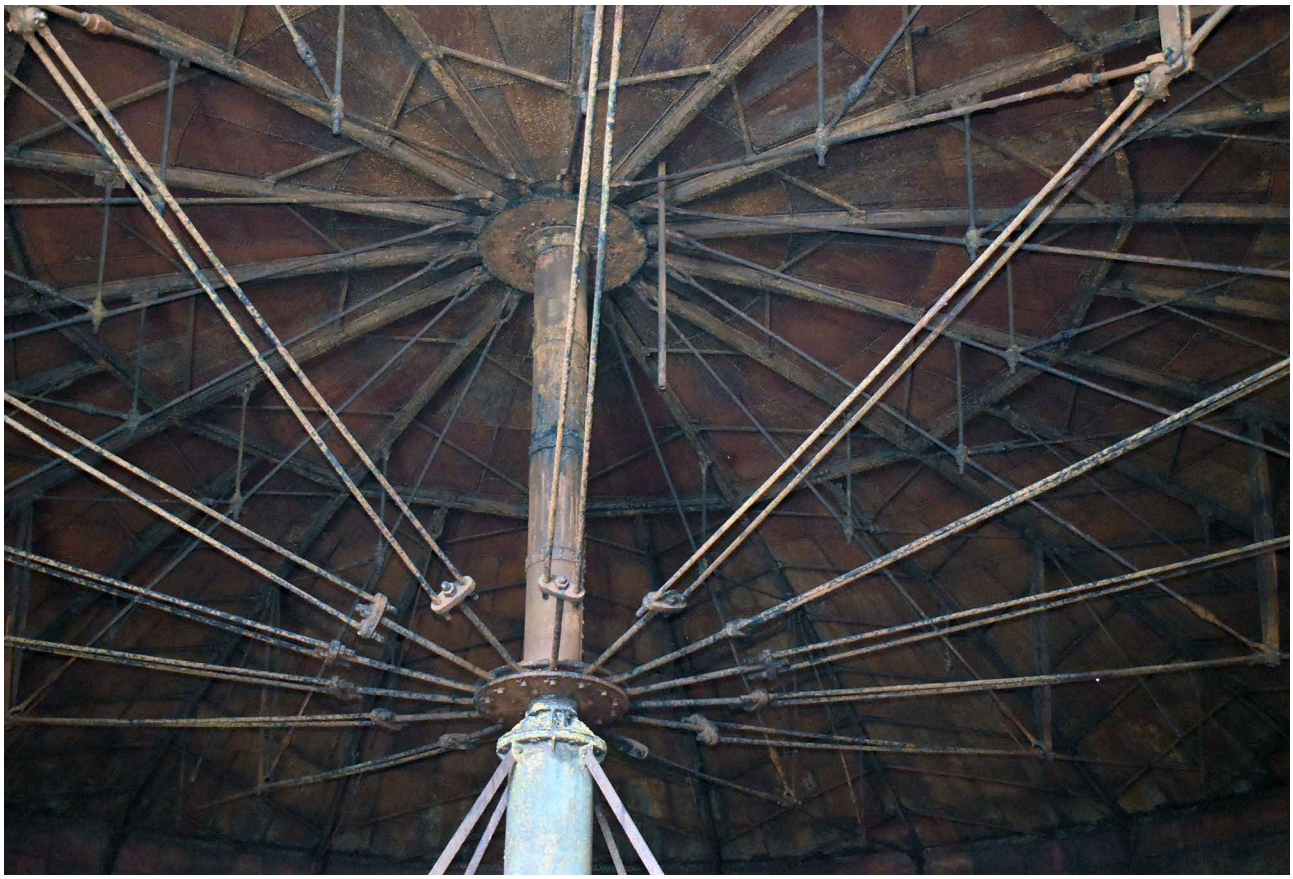

Plate 82: Radial roof structure

Plate 83: General view of interior

Plate 84: Floor structure within tank

Plate 85: floor structure within tank

Plate 86: Detail of ridged floor

Plate 87: Central part of floor

Plate 88: Detail of floor panel

Plate 89: Number 4 cast into floor panel

Plate 90: Outer section of floor

Plate 91: Central part of floor around column

Plate 92: Exposed section of inner face of tank

Plate 93: Typical section of wall (ie inner lift)

Plate 94: Typical section of wall (ie inner lift)

Plate 95: Number 22 crudely written on wall

Plate 96: Section of wall within inlet/outlet pipes

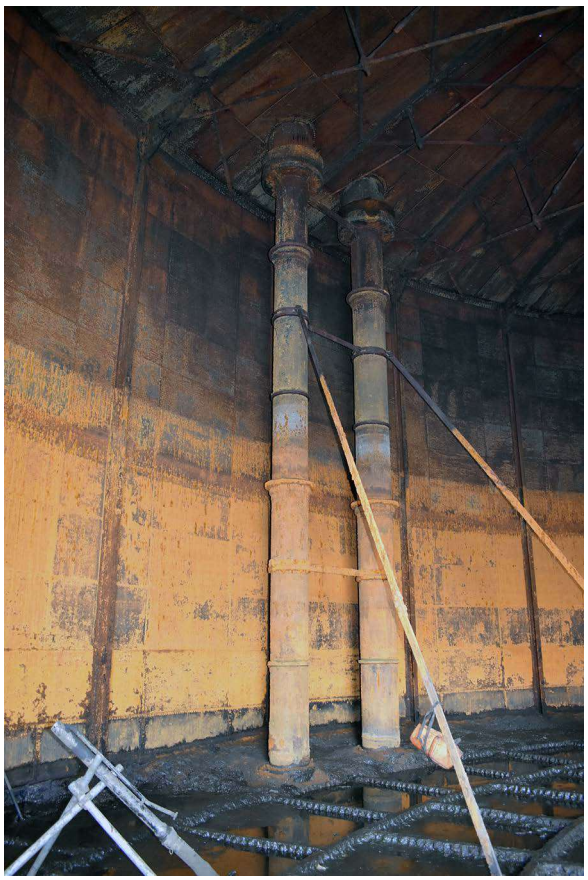

Plate 97: Section of wall within inlet/outlet pipes

Plate 98: Head of inlet/outlet pipes

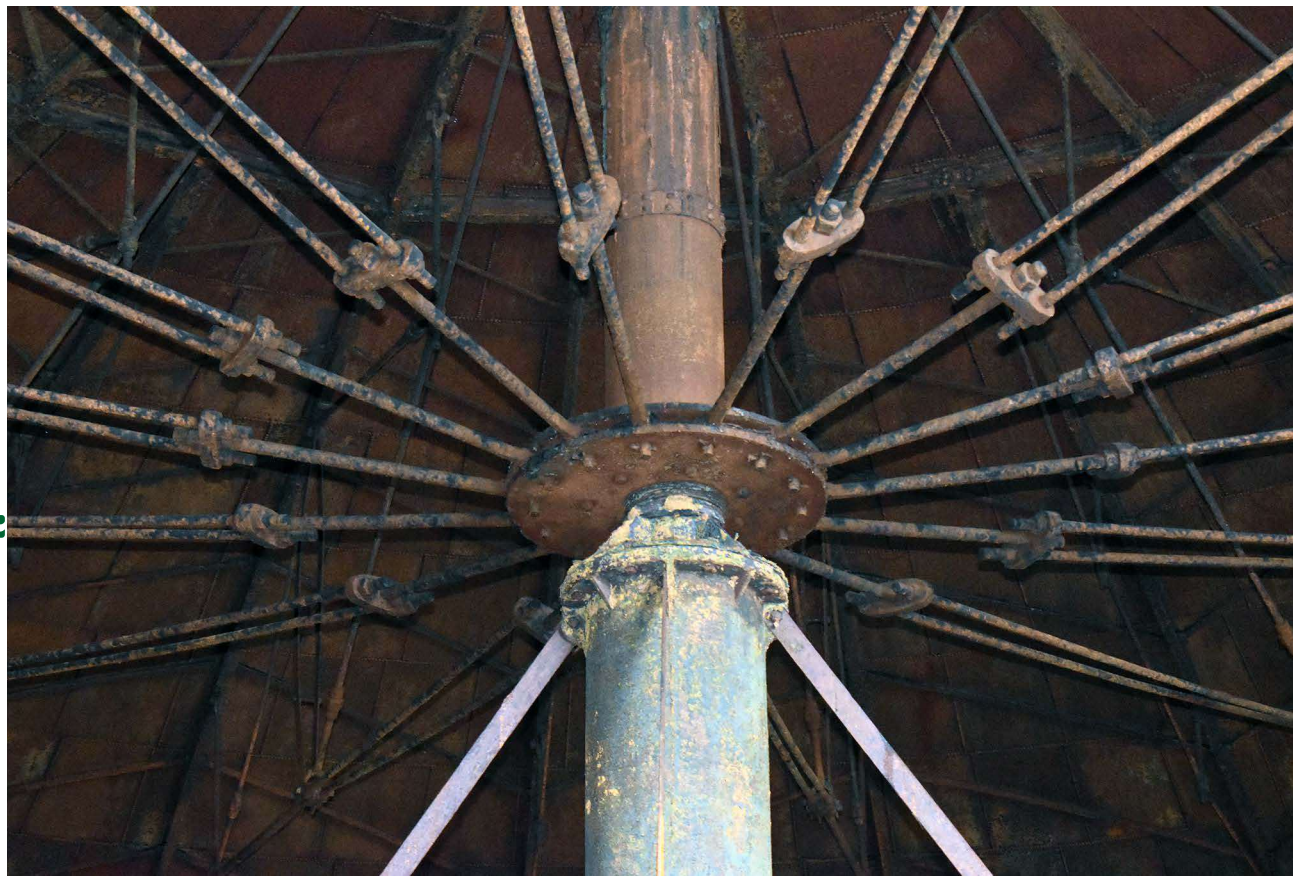

Plate 99: Detail of central shaft support

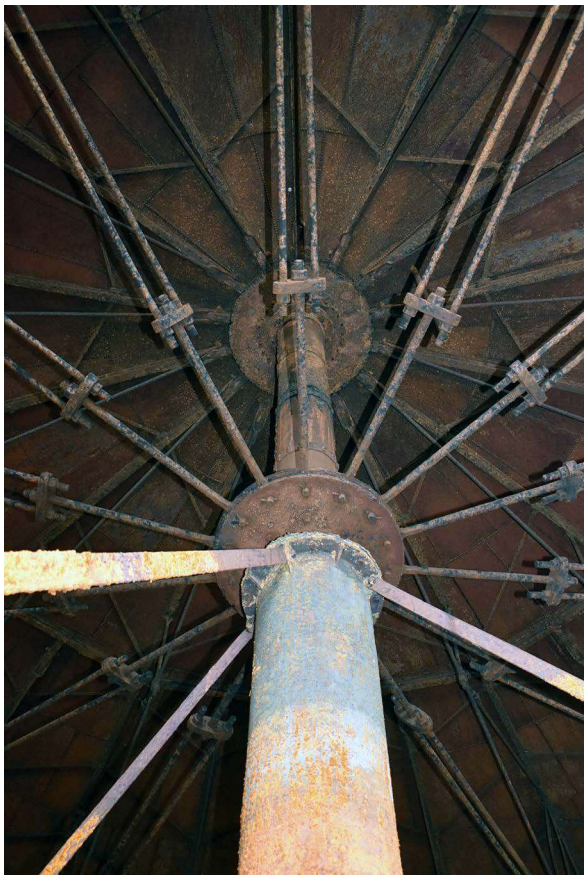

Plate 100: Detail of central shaft

Plate 101: Detail of opening in crown

Plate 102: Detail of underside of crown

Plate 103: Detail of underside of crown

Plate 104: Detail of radial truss

Plate 105: Detail of radial truss

Plate 106: Detail of radial truss

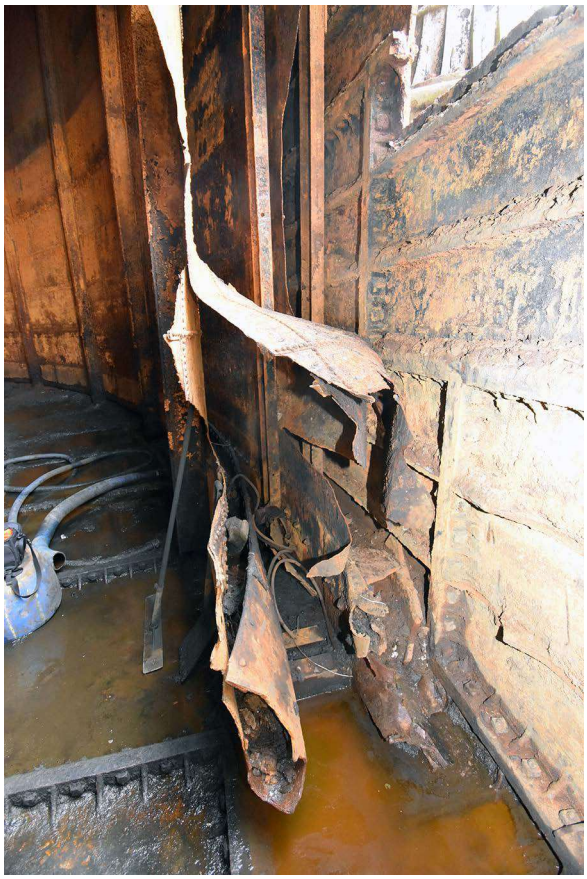

Plate 107: Detail through tank and lifts

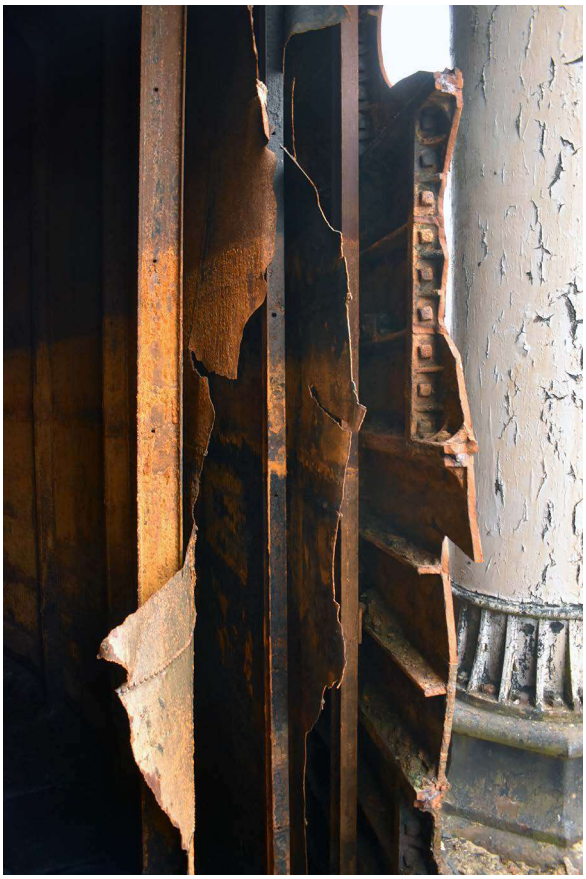

Plate 108: Detail through tank and lifts

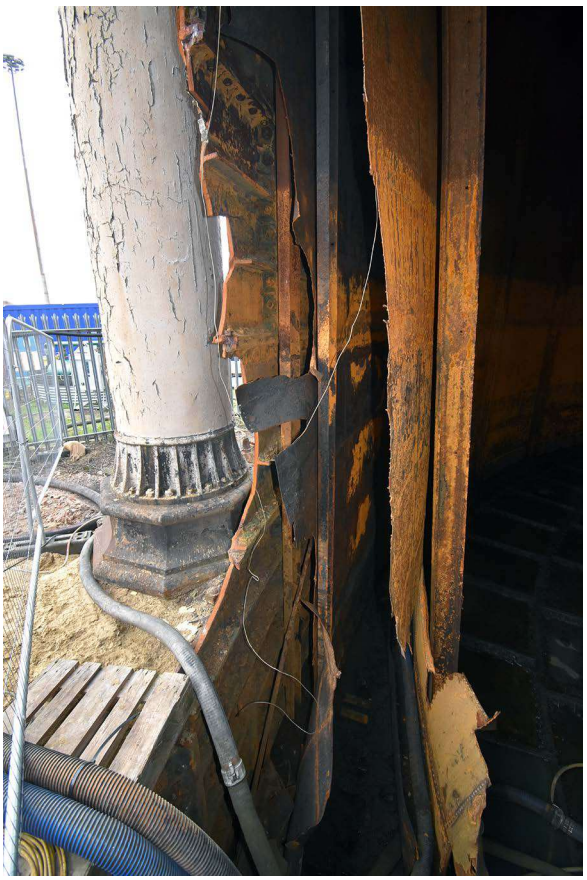

Plate 109: Detail through tank and lifts

Plate 110: Section of brick wall to site boundary

Plate 111: Section of site wall to east of holder

Plate 112: Brick site wall to east of holder

Plate 113: Holder 172 with now demolished Holder 173 to rear (taken Dec 2022)

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