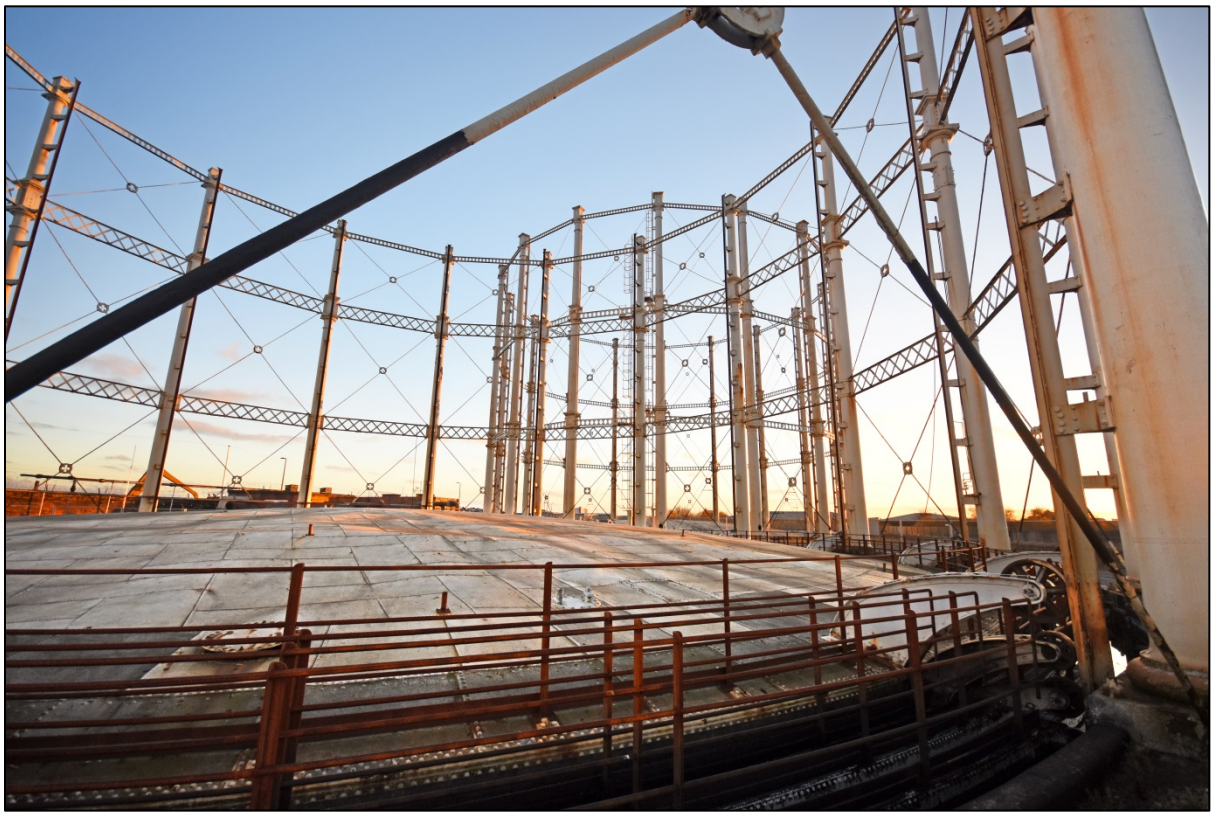

Historic building recording of gasholders at the former Liverpool Street Gasworks Salford, Greater Manchester

Report No. 19/64

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OASIS REPORT FORM

PROJECT DETAILS	**OASIS No: molanort1-** 355657	
Project title	Historic Building Recording of Gasholders at the former Liverpool Street Gasworks, Salford, Greater Manchester	
Short summary	MOLA (Museum of London Archaeology) carried out a programme of historic building recording of two Gasholders at the former Liverpool Street Gasworks, Salford, Greater Manchester. Both were mid-late 19th-century examples of cast iron column-guided gasholders. Gasholder 3 was constructed by Westwood and Wright in 1869 and was originally a single-order holder which was later enlarged by the addition of a fourth lift and heightened with an additional tier of columns. Gasholder 4 was built in 1879 by Thomas Piggot and Co and was a three-lift gasholder with triple-order columns. Archaeological recording was also carried out during the demolition of the holders and it was found that Gasholder 3 was untrussed and had a static wooden crown frame surviving within the tank. Gasholder 4 by contrast was trussed and had a central brick stanchion to support the crown frame when deflated.	
Project type	Historic Building Survey	
Site status	None	
Previous work	None	
Current land use	Decommissioned gas works	
Development type	Demolition	
Future work	None	
Monument type/period	Late 19th century gasholders	
Significant finds	None	
PROJECT LOCATION		
County	Greater Manchester	
Site address	Liverpool Street, Salford	
Postcode	-	
OS coordinates	SJ 81640 98200	
Area (sq m/ha)	0.35ha	
Height aOD	*c*30-40m aOD	
PROJECT CREATORS		
Organisation	MOLA (Museum of London Archaeology)	
Project Brief originator	Montagu Evans on behalf of National Grid	
Project Design originator	MOLA	
Project Director/ Manager	Amir Bassir and Anthony Maull	
Project Supervisor	Amir Bassir and Yvonne Wolframm-Murray	
Sponsor or funding body	Montagu Evans on behalf of National Grid	
PROJECT DATE		
Start date	November 2016	
End date	January 2019	
ARCHIVES	Location	Content
Physical		None
Digital		Digital Photographs and Report
Paper		plans, sections
BIBLIOGRAPHY	Journal/monograph or unpublished MOLA report	
Title	Historic Building Recording of Gasholders at the former Liverpool Street Gasworks, Salford, Greater Manchester	
Serial title & volume	MOLA Northampton Reports, 19/64	
Author(s)	Amir Bassir and Yvonne Wolframm-Murray	
Page numbers	57	
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Contents

Figures

Historic building recording of gasholders at the former Liverpool Street Gasworks Salford, Greater Manchester

Abstract

MOLA (Museum of London Archaeology) carried out a programme of historic building recording of two Gasholders at the former Liverpool Street Gasworks, Salford, Greater Manchester. Both were mid-late 19th-century examples of cast iron column-guided gasholders. Gasholder 3 was constructed by Westwood and Wright in 1869 and was originally a single-order holder which was later enlarged by the addition of a fourth lift and heightened with an additional tier of columns. Gasholder 4 was built in 1879 by Thomas Piggot and Co and was a three-lift gasholder with triple-order columns. Archaeological recording was also carried out during the demolition of the holders and it was found that Gasholder 3 was untrussed and had a static wooden crown frame surviving within the tank. Gasholder 4 by contrast was trussed and had a central brick stanchion to support the crown frame when deflated.

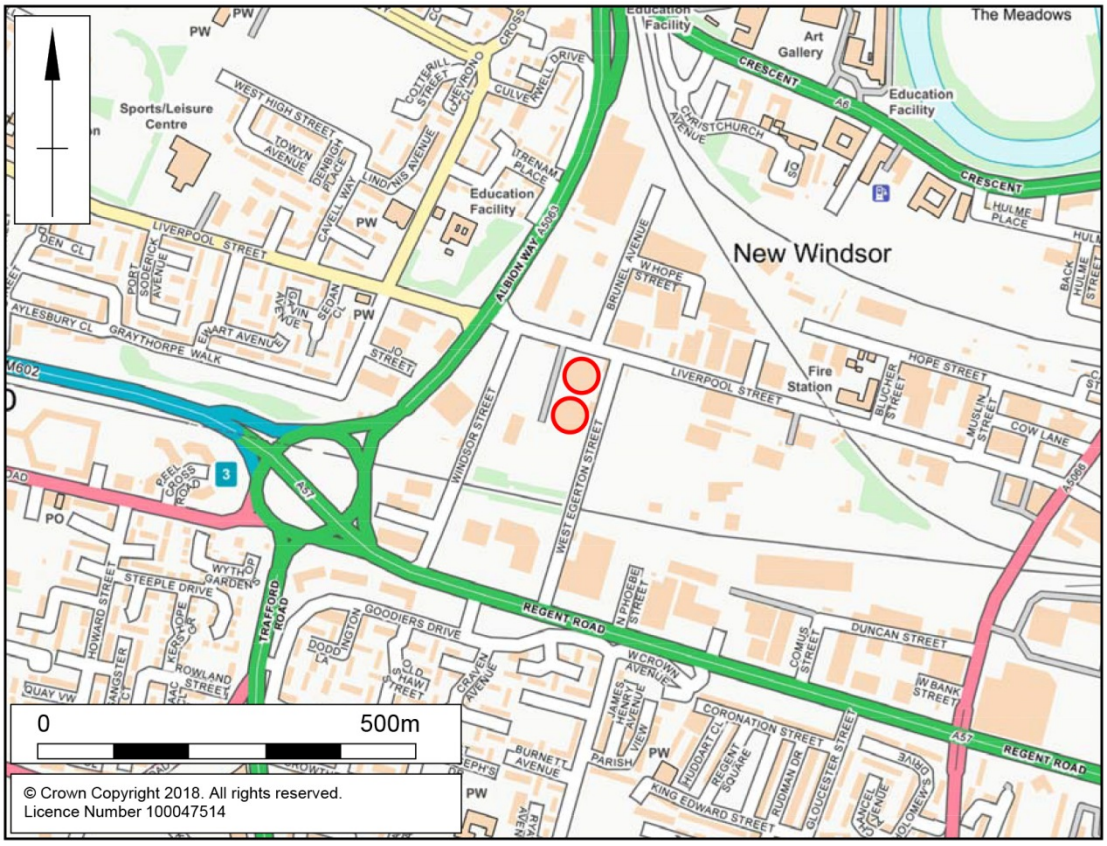
1 INTRODUCTION

MOLA (Museum of London Archaeology) was commissioned by Montagu Evans, acting on behalf of National Grid, to undertake a programme of historic building recording of Gasholders 3 and 4 at the former Liverpool Street Gasworks, Salford, Greater Manchester (NGR SJ 81640 98200, Figs 1 and 2).

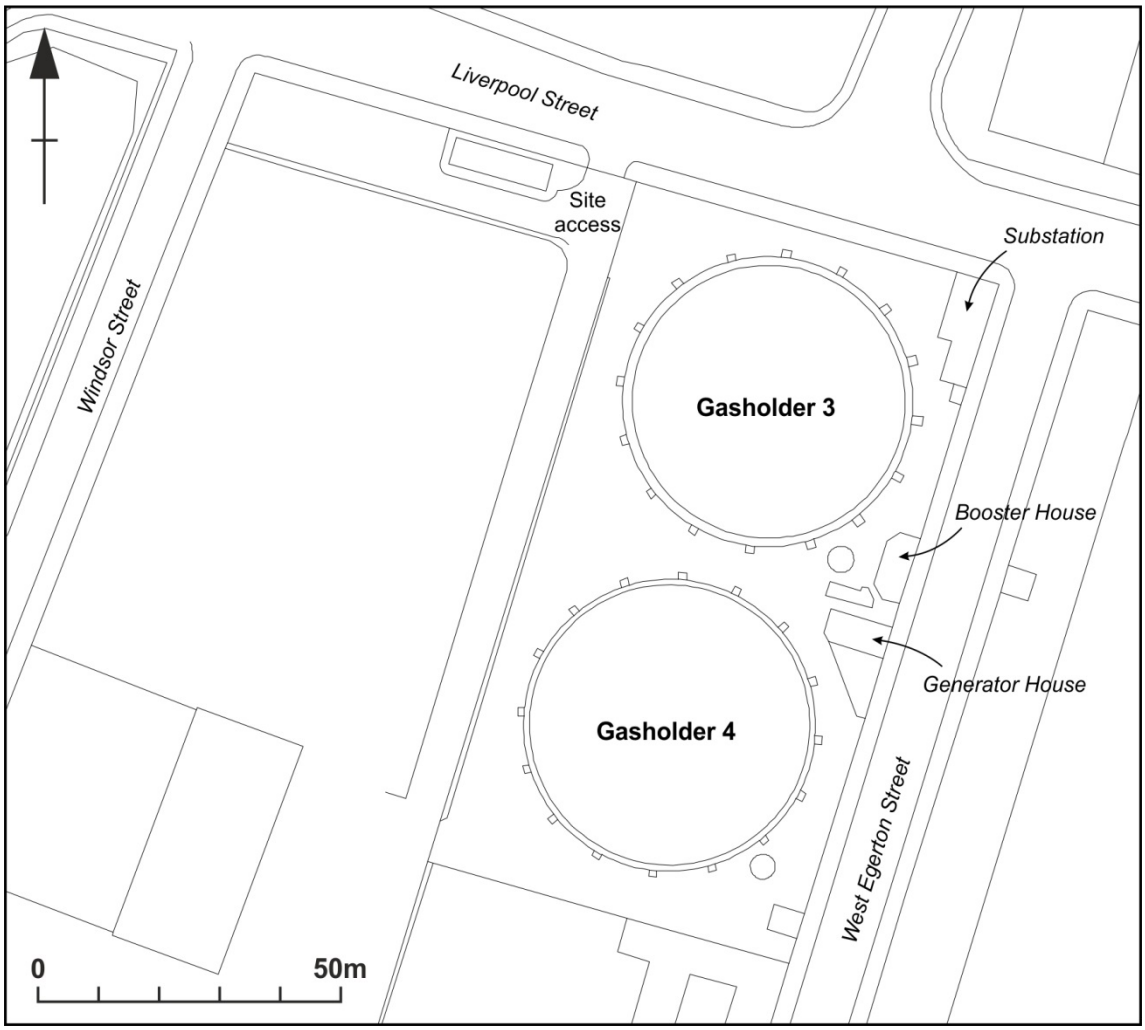
The survey is a voluntary exercise commissioned by National Grid as part of their commitment to the heritage of their broader estate. This report is in response to a Historic Building Recording brief by Montagu Evans (Montagu Evans 2015) and in accordance with current best archaeological practice as defined in the Chartered Institute for Archaeologists' *Standard and Guidance for the Archaeological Investigation and Recording of Standing Buildings or Structures* (CIfA 2014) and the Historic England procedural document *Management of Research Projects in the Historic Environment* (HE 2016). This report follows an agreed Written Scheme of Investigation (MOLA 2015).

The Liverpool Street Gasworks commenced operation in 1868 and the recorded gasholders were constructed in 1869 and 1879. Due to the age of the gasholders and their contribution to the local character they were deemed to have an inherent heritage value and were deemed to meet the criteria for local listing (Montagu Evans 2015); both gasholders were exempted from Statutory Listing in a national context (HE 2015a and HE 2015b). A requirement for recording was placed upon both structures, to be carried out at 'Level 2' according to Historic England best practice guidance (HE 2016) with additional requirements by Montagu Evans (ME 2015), referred to as 'Enhanced Level 2'.

In addition to the historic building recording herein, the gasholders have also been documented by architectural photography. The architectural photography, prepared by Ben Murphy, will be archived alongside this report.



Site location Fig 1



The recording area Fig 2

2 OBJECTIVES AND METHODOLOGY

The objectives of this survey as set out in the brief were to:

- Produce an illustrated, written document detailing the fabric, appearance and form of the gasholders and associated structures and pipework. Due to the safety constraints associated with gasholders, access was limited to the exterior of the structures;
- Provide historical survey drawings (or sketches) for comparable investigation relating to building form and function, identification of fixtures and fittings where visible or accessible, and to;
- Provide an account of historic fixtures, fittings and architectural features where visible or accessible;
- Provide a photographic record of the structures in context.

The level of recording was specified as Enhanced Level 2 – a descriptive record (H E 2016; Montague Evans 2015). This is defined as:

- A systematic account of the gasholders' origins, development and use, and;
- A drawn and photographic record to illustrate the gasholder's appearance and structure as well as measured drawings of specific elements of historic or architectural interest.

Recording was carried out in two phases. Phase I comprised pre-demolition recording of the extant elements of the site whilst Phase II comprised recording of any areas not visible or safely accessible during Phase I.

Phase I recording was carried out in November 2016 during which the site was photographically recorded to include general views of the site and structures, placing them within their wider context, and detailed views of any structural, historic and architectural details that would be lost during demolition. Measured drawings were produced of an example column footing from each gasholder.

Additional site visits were carried out in June and July 2018 in order to undertake recording during the demolition of the gasholders. Supplementary photographs were provided by the demolitions contractor Erith Group.

Two further visits to the site were undertaken 13th November 2018 and 28th January 2019 to produce measured drawings of a sample column each from Gasholders 3 and 4 after demolition.

Photography was carried out using a Nikon D7200 DSLR equipped with Sigma 17-35mm and Nikon 18-70mm lenses. Additional photography was carried out using a Panasonic Lumix FZ1000.

A photogrammatic model was produced of an example column footing of Gasholder 4 and is included as a digital appendix to this report (requires Adobe Acrobat to view).

A glossary of common architectural terms used when describing gasholders is included in Appendix III.

3 HISTORICAL BACKGROUND

Medieval Salford was a small market town whose primary industry was agricultural (GMAU 2010). The town's post-medieval growth was linked to a rise in domestic-based textile manufacture including wool and linen and later cotton. The 16th and 17th centuries saw a gradual rise of the town's population which increased more rapidly in the 18th century as the textile industry expanded to a larger scale. This period saw the westward expansion of the town to accommodate new business and housing for the new populace which developed along new street and comprised back-to-back terraced houses with yards and workshops.

> *The effect, in the 19th century, of the industrial revolution on Salford was phenomenal. Factories were substituted for homeworkers and the population which was 12,000 in 1812, rose in 30 years to 70,244, and by the end of the century to 220,000. The rapid increase, hardly exceeded anywhere in the country, was reflected in the vast areas of poor quality housing that were built throughout the Victorian period when overcrowding created real social problems* (Salford Community Leisure 2017).

> *Mid 19th century mapping depicted Salford as an established and densely packed town core with rapid suburban expansion into surrounding rural areas. Short-lived 'brick fields', brick manufacturing sites for the construction industry, were frequently depicted* (GMAU 2010).

Ordnance Survey maps of 1848 and 1850 (OS County Series 25", and OS Town Plan 1:1056, not reproduced) show that the major infrastructure to the south of Salford was in place by this time and Regent Road delineated the extent of southward industrial development. Between this road and the River Irwell to the south and east there remained enclosed agricultural fields and a number of brick fields. Liverpool Street, Windsor Street and Regent Street, as well as the other roads in the surrounding grid were also present, with a few small terraced blocks interspersed with brick fields, a cattle market and cotton mills. The site of the gasworks at this time comprised a brick field divided to each side of the Liverpool to Manchester Railway which had been opened in 1830. The brick fields extended in a strip from Windsor Street to Oldfield Road at the east, largely keeping to the north of the railway.

The public supply of gas in Salford had its origins in the prior use of gas-lighting in cotton mills. Salford provides the earliest example of this early deployment of gas plant with Philips & Lee having placed the first contract in 1805, and by 1807 were also supplying gas lamps in Chapel Street (Wilson 1991, 27). Salford's gas supply was expanded in 1819 when a group of entrepreneurs, Messers. Appleby, Brian, Fisher, and Clay set up a gasworks at Clowes Street. By 1820 Salford was receiving a continuous supply however this undertaking was limited in scope and among the smallest in the region.

> *An 1830 Act of Parliament allowed the [Police] Commissioners of Salford to purchase the works in Clowes Street in 1831. By 1836 these works were replaced by a new gasworks at Lamb Lane, later known as Bloom Street. In 1844 a Charter of Incorporation was granted to the town and the gas works came under the control of the Salford Corporation…New works were constructed in Salford at Regent Road in 1858, Liverpool Street in 1868, Albion Street in 1893 and west Egerton Street in 1912* (NA 2017).

The site at Regent Street occupied a rectangular block bound to the north by railway lines, to the west by Windsor Street, to the west by West Egerton Street and to the south by East Taylor Street. The works comprised two gasholders: Gasholder 1, a 9-column-guided gasholder of 100' diameter and 400,000 cu. ft capacity, and Gasholder 2, which was 16-column-guided with a diameter of 150' and capacity of 1,915,000 cu.ft. The gas plant such as purifiers, condensers, exhausters etc were

arranged around the gasholders as space allowed. Detailed drawings of these gasholders are held by the National Grid Archive (NWSAC/E/P/2-7).

The land for the Liverpool Street Works had been purchased by 1858 with the intention of expanding the Regent Road Works. This land occupied the area to the north of the railway lines. The site's uneven topography necessitated the creation of a level platform at the north-east corner of the site to house the gasholders and the plant was arranged in the remainder of the space. The site was accessed by a central ramped roadway leading to Liverpool Street. Gasholder 3 was the first of the two gasholders to be constructed and it was completed in 1869, followed by Gasholder 4 in 1879.

In the north-east corner, adjacent to Gasholder 3 was a substation and boosters were located against the eastern enclosure wall between the gasholders. To the south of the gasholders was an L-plan range comprising laboratory, purifier house, exhausters and compressors. Pumps and water cooling towers were located to adjacent to the buildings. Sidings branched off from the main rail line and allowed rail access to both the Regent Road and Liverpool Street Works which had cranes located alongside the tracks.

The area to the east of the gasworks remained in use as brick works until the early 20th-century. The surrounding railway had increased in capacity from the mid 19th-century with new sidings crossing the southern extent of the brick fields. To the north, the Lancashire and Yorkshire Railway had also been expanded to the northern edge of Liverpool Street opposite to the gasworks where a coal yard was located. Between 1893 and 1908 a rail tunnel was constructed adjacent to and running parallel with the eastern side of West Egerton Street, connecting the Lancashire and Yorkshire Railway to the Salford Docks to the south.

Following the First World War, there was an increasing attitude in favour of nationalisation and coalescing of the fragmentary gas industry. These plans were temporarily halted by the outbreak of war in 1939; however, in the post-war years the movement gained impetus and plans were put into place for the nationalisation of coal mines, electricity, transport and gas.

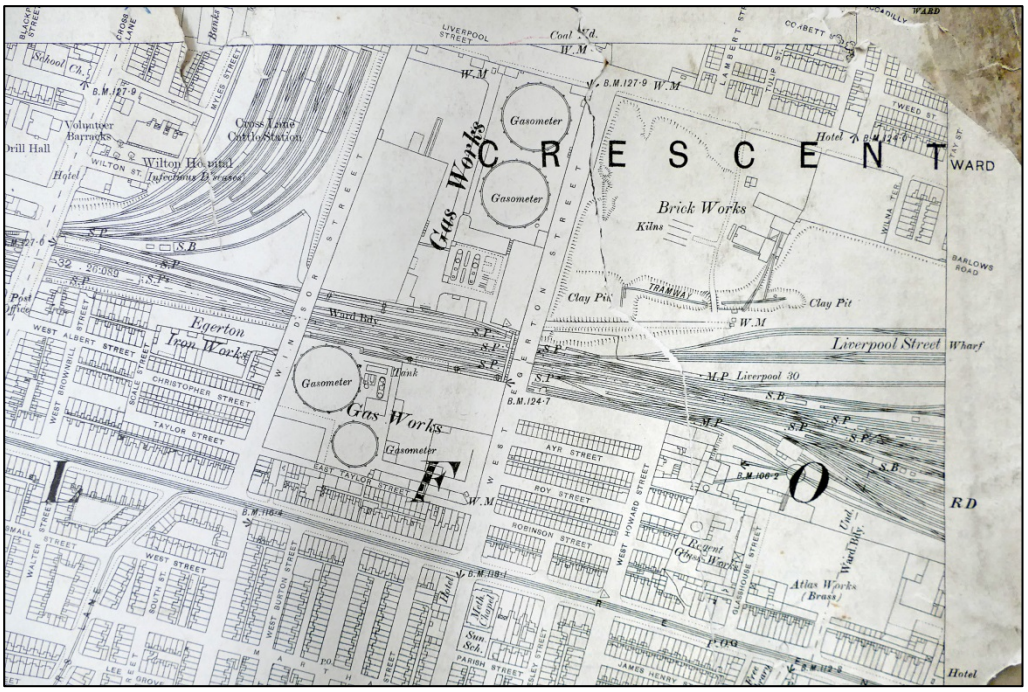
> *Nationalisation was the greatest single event in the history of the gas industry in the first century and a half of its existence…Further; it provided the framework for the remarkable renaissance of the industry that followed the discovery of North Sea gas, a renaissance made possible only by the availability of large and well-organised technological and financial resources* (Williams 1981, 103).

Of the 12 area districts which were set up under the Gas Act of 1948, Salford fell into the jurisdiction of the North-Western Gas Board. From the 1950s onwards there was an increased drive to prospect for and exploit natural gas resources. The discovery of North Sea gas in the early 1960s triggered a rapid switch to natural gas and a nationwide investment in new distribution plant and appliances which was declared complete by September 1977. The conversion programme was accompanied by the development of a national transmission system of high pressure pipelines, compressor stations and terminals in order to store and distribute the gas. This effectively rendered the former gas manufacturing plant redundant, with the exception of the gasholders and governors.

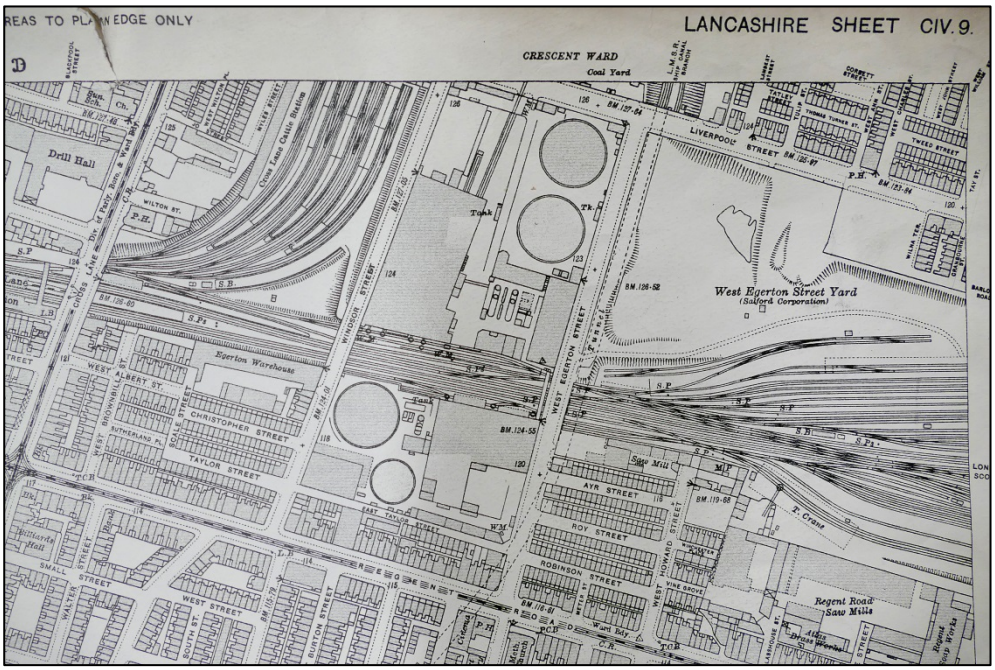
In the 1950s plans for two new gasholders, one on the Liverpool Street works and one on the Regent Street works were drawn up (NW/MA/E/E/5). Both were intended to be spiral guided gasholders, 212' in diameter, and rising to a height of 206' and their construction would have required the clearance of obsolete gas manufacturing plant. These plans did not come to fruition and in 1964 the majority of the plant and building remained in situ, though Gasholder 1 had been dismantled by this time. By

1968 the former purifier house to the south of Gasholder 4 had been demolished and a range of new plant including boilers, scrubber and control building had been installed in the north-west corner of the site (NW/MA/SAL/E/E/28). At the same time, by 1968, the Regent Road works had been almost completely cleared of plant and buildings, except for the governor house at the south edge of the site adjacent to East Taylor Street. By the late 1970s the remaining plant and buildings at Liverpool Street Works had also been largely cleared.

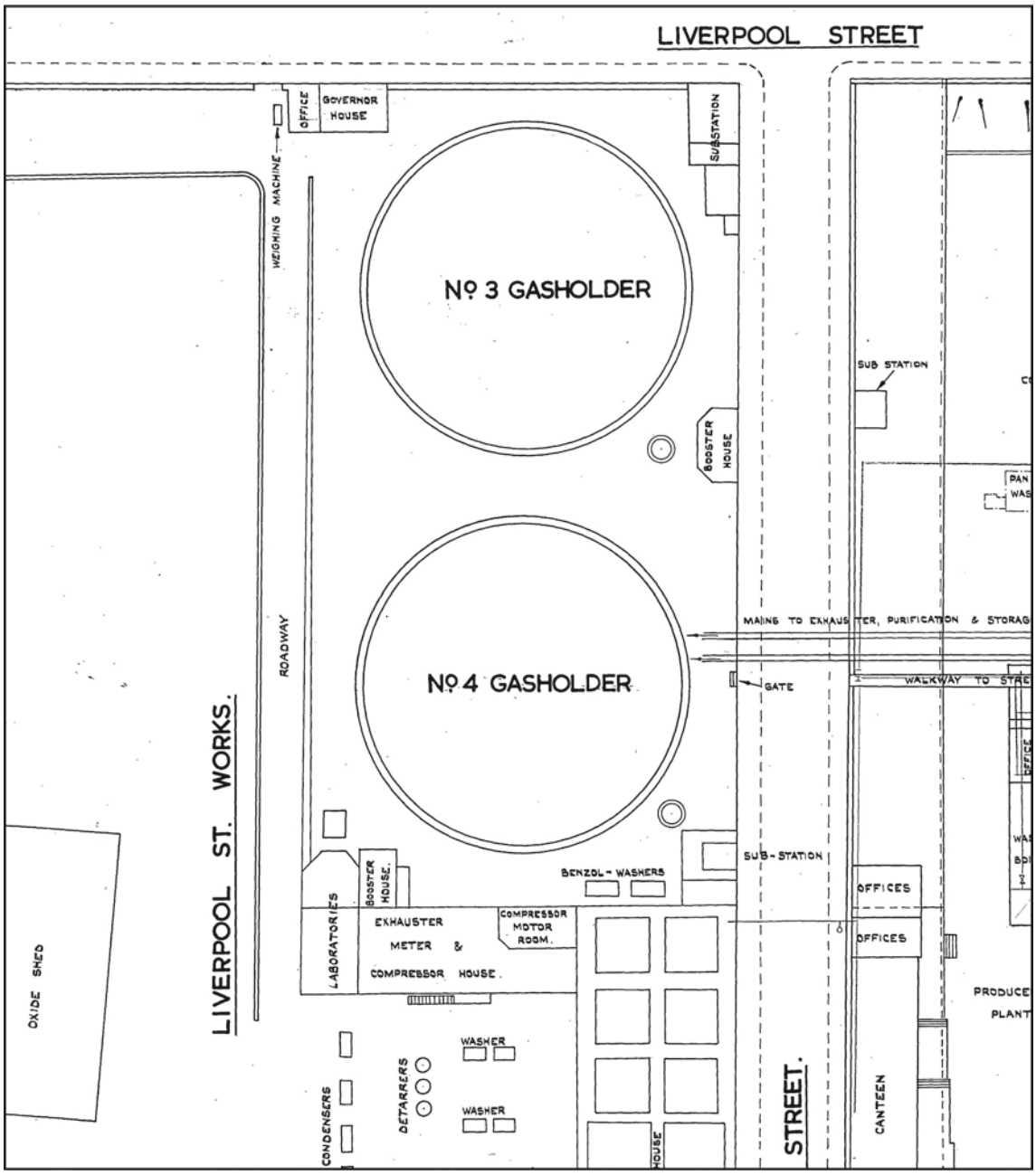
Plans to further extend the gasworks eastwards onto the adjacent brick works which was located on land formerly belonging to the Earl of Ellesmere, had been in place since the 1890s (Fig 3) and by the 1920s the brick works had been cleared and the clay pits infilled and levelled (Fig 4). Plans of this period indicate that it was intended to construct a new gasholder in the north-east corner of this land (NWSAC/E/E/228). In the early 1940s the gasworks extension, referred to as the West Egerton Street Works, housed a boiler house, vertical chamber ovens and coal and coke handling plant, as well as space for coke-dumps, with lines of conveyors crossing the site (NWSAC/E/E/26). By 1951 the site had been rearranged with the construction of a new vertical retort house with attached boiler room, pump room and staff facilities, and the old boiler house partitioned to include offices (NW/MA/SAL/E/E/1). The new gasholder which was originally planned for was not built. The works continued to be rearranged and extended and by 1957 included new a workshop and stores, a small office and miscellaneous store rooms and workshops at the north-eastern corner of the site (NW/MA/SAL/E/E/5). Alongside the rail sidings were new loading facilities to the coal conveyors and a new coke screening plant had been installed on the former coke-dump. At the west of the site, adjacent to West Egerton Street was a new block containing canteen and offices. By the mid 1960s the gas manufacturing plant had been cleared from the West Egerton Works and four large PFD tanks built in their place (Fig 5). These remained in place until the late 1970s and were incrementally cleared by the late 1990s.



Ordnance Survey map of 1896 Fig 3



Ordnance Survey map of 1932 Fig 4



Extract from a plan of the site dated 1964, showing the layout of plant (NW/MA/SAL/E/E/7) Fig 5

4 HISTORIC BUILDING RECORDING

4.1 Gasholder No. 3 (Figs 8-30, 60-64)

Gasholder 3 is the northernmost of the two gasholders and was constructed in 1869 by Westwood and Wright Ltd of Staffordshire, manufacturers of gasholders, gas apparatus and structure iron and steel founders (Grace's Guide 2018). The brick tank was built by William Healey. Prior to 1890 William Healey operated as a Partnership with Joseph Healey and a notice of the dissolution of this partnership was given in the London Gazette (August 1, 1890), in which they were described as Brickmakers, Contractors, and Builders, operating from or with offices at 24 Hulme Street, Manchester, where incidentally was also located the Gaythorn Gas Works (The London Gazette 1890, 4244).

The gasholder was a column-guided structure with sixteen cast iron columns and three tiers of girders. It had three lifts and a flying lift and when fully inflated, allowed a storage capacity of 55,687 cu. m. or 1,967,740 cu. ft. The overall height when raised is given as 38.4m (126' 0") on some plans of the site (NW/MA/SAL/E/E/8).

The columns were in two parts, the first two tiers comprising giant order members, with a single tier of columns added at a later date to increase the height of the gasholder to a total of 26.2m (85' 10") (Type 18, Tucker 2000a). The column bases were set at a distance of *c*8m from each other and comprised square cast iron footings over concrete blocks, with anchor bolts fixing the footings to plates embedded in the tank sides at a depth of perhaps 4m. The columns were formed of cast iron drums joined by internal bolted flanges. The columns had toroidal bases which concealed an internal ring of bolts. The toroidal bases were a separate element to the columns and a vertical lip above each basal unit concealed internal flanged and bolted joints. Each column has a round removable panel near the base, by which the interior could be accessed for inspection. The column diameter above the base was measured at 0.9m. Column 8 formerly had a commemorative plaque bearing the inscription 'W. Mabon & Co. / Ardwick Iron Works / 1870 / Manchester' but this had been removed prior to this survey and was not found on site.

The joints between the basal column drums and the next highest drums were at a uniform height of 1m from the top of the footings. Each joint had a stamped assembly mark comprising a capital letter and a number, and a cross which overlay the join and which ensured correct assembly of the drums by necessitating the two halves of the cross be correctly aligned. The letters were unique to each column and formed a continuous sequence from A to Q, beginning in the north-east quadrant and increasing in a counter-clockwise direction. Other assembly marks were noted on the higher drum joints and showed a numbered sequence allowing correct assembly of drums at the required heights. Each column also had a stencil sprayed numerical designation which was not synchronised to the column assembly designations. These numbers began at the south-east and increased clockwise.

The columns had a continuous taper to a height of 18.5m (60'-8") and terminated at collars and Tuscan-style capitals above which were hollow, rectangular junction boxes with simple cornices. The upper columns, being later additions to raise the height of the gasholder, were of a similar design to the earlier columns, and had toroidal bases and Tuscan-style capitals and were similarly crowned with rectangular junction boxes.

At the rear of the columns were T-profile roller guides held at a short distance from the columns by triangular brackets. The roller guides formed a continuous span from the tank to the top of the upper columns and were a replacement of the earlier shorter roller guides. The guides were bent outwards and flared slightly at the top of the gasholder in order to catch the rollers of the flying lift.

The first two tiers of girders were of wrought iron with a riveted I-section lattice design (Type G). They were formed of T-profile double-angle stringers with a lattice of flat bars. The first tier girders were joined to the columns by beams of paired collars with bolted flanges and the second tier girders were bolted to the sides of the entablature junction boxes. The third tier girders were of an I-section castellated design with the upper and lower halves being welded together (Type U). Photographs held at the Local Studies and Archive show that these are post-1988 replacements of former latticed girders. The defunct bolts of the former girders were still visible at the sides of the junction boxes.

The gasholder frame was braced by tie rods spanning diagonally between the columns and girders and meeting at central circular couplers. The lowest tie rods rose from ground level and are anchored to iron rings bolted to the concrete column footings. At the opposing corners the rods attached to tethering points on the underside of the girders adjacent to the column collars.

The lifts comprised riveted wrought iron sheets of which examples were measured at 1.36m (4' 5") x 0.7m (2' 3 ½"). The top row sheets were thicker at ½" and the bottom rooms were 3/8" and the intermediate rows were 11 BG. The lifts had square profile cup and grips, 250mm (10") x c470mm (20"), with the channel measurements given as 9 7/8" x 3 ½". At the top curb the lift and crown join was stiffened by means of a 6" x 6" angle and triangular gusset plates were bolted to full height RSJs which were interspersed between the smaller channel stiffeners.

The lifts were guided by means of cantilevered goose-neck roller carriages. Each was formed of pairs of curving side plates which tapered from the baseplates towards the rollers. The carriage sides were connected at the top and bottom by a lattice of crossed and perpendicular flat steel bars which were riveted through L-section plates to the sides. The roller wheels diminished in size with the upper most rollers, those attached to the flying lift, being 500mm in diameter. The innermost roller wheels and the bottom rollers were simply held between pairs of wrought iron plates bolted to the edge of the lifts.

Access to the lifts when raised was via a vertical ladder at the south side of the gasholder. The ladder was in three staggered sections with landings or rest platforms at each tier and was enclosed by safety rails and back-guards. Each lift had a short projecting platform which allowed safe access from the ladder to the edge of each lift.

The crown surface was formed of a staggered linear patchwork of overlapping steel sheets, riveted at the edges. The top curb comprised two concentric rings of riveted sheets. The crown surface displayed significant warping and rippling and a number of welded and riveted repairs could be seen scattered across the crown. Unlike Gasholder 4, and the majority of gasholders surveyed by the author, the crown sheeting pattern was not arranged in concentric rings but rather was more reminiscent of the method in which above-ground spiral guided gasholder tanks were floored. Since the flying lift is a later addition, the crown is not original to the gasholder and the choice of sheeting pattern may reflect both this and the lack of crown trusses.

The outer crown sheets had a thickness of 19mm (3/4") compared to the slightly thinner majority of sheets which were 16mm (5/8") in thickness. The crown rise was 1.9m (6'3"). There were three 24" diameter and two 18" diameter manholes in the crown as well as a central 2" vent at the centre.

Since the crown was un-trussed, when deflated it was supported on a fixed timber-frame crown rest comprising pine beams set on edge and radiating from the crown centre and connected by transverse members in concentric rings. Upright posts were set at the intersections of the frame and the timbers were joined by means of four-way post and beam brackets. It was not possible to closely examine the timbers since

they had become contaminated and saturated with toxic substances. However, it was apparent that the timbers were conifer species (N European or N American) and were boxed quartered; examined pieces showed circular saw marks on the side faces. The posts did not constitute single spans of timber but in all instances the upper part of the posts were separate pieces joined to the main posts by nibbed scarf joints and the join braced by bolted fishplates. In many instances there were short wooden brackets or cleats fixed to the sides of the scarf joins but their function was unclear; one possibility is that they relate to former struts which have been removed. At their bases the posts were set into iron footings embedded in the tank floor. The outer rings of posts were cross-braced by square-section timbers mortice jointed into the main posts and supported by cleats. The cross-braces were lapped over each other at the centre of each bay of the framing. Since the gasholder was modified to raise its height and had an additional flying lift added, it is probable that the timber frame was likely modified and may explain the splicing of additional pieces to the top of each of the supporting posts.

At the centre of the tank was a square-plan brick column, wider at the base and reducing in width at a height of *c*3m. At the top of the column was a stone block to which was bolted an iron pipe. The pipe was in two pieces joined by external bolted flanges and the top of the pipe was a ring or collar that supported the ends of the timber beams of the crown rest.

An elevated platform of planks laid over a pair of Rolled Steed Channels (RSCs) was located at the north-west side of the gasholder and another at the south-east was located adjacent to the inlet and outlet pipes. The RSCs were bolted to the framing posts and supported by flat iron bars cross-braced between the posts and the channels. Two circular manholes at the north-west side of the gasholder allowed access to the platform from the crown and a metal ladder was fixed to the side of the platform to allow access to the tank.

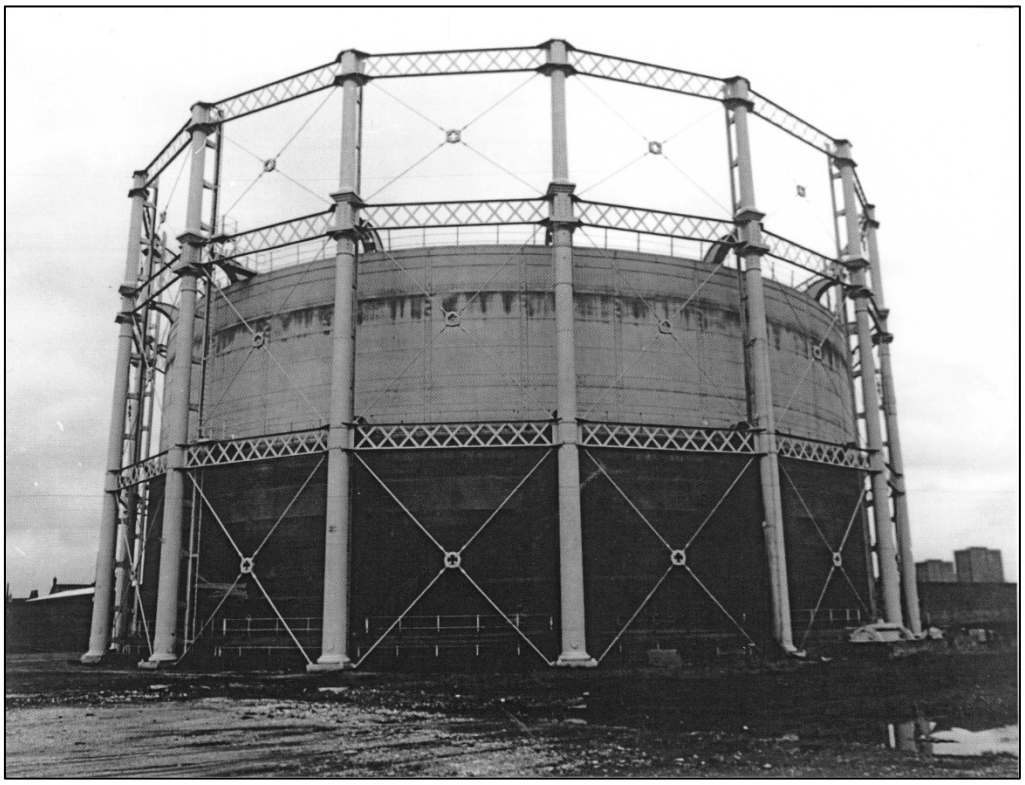
The tank had a diameter of 46.4m (152’ 4”) and was 9.3m (30’-6”) deep. The tank walls were constructed of brick in English bond with stone coping and a raised stone kerb was installed around the circumference of the tank. Examples of the bricks were measured as 220mm x 110mm x 70mm. The tank base was roughly flat with a gradual central rise and was covered with stone slabs comprising blue-grey bedded silt or sandstone. Examples of the slabs were measured as 700mm x 600mm and 600mm x 600mm.

The gasholder presented the standard array of telemetry, holder height controls and high and low alarm switches installed around the perimeter of the tank as well as oil applicators located at the edge of the crown.

A Booster House was located at the east side of the site, between the two gasholders and from here the 24” inlet and 30” outlet pipes entered the gasholders from the south-east. The pipes were located together and rose to the height of the tank edge and an iron-frame gantry was constructed around the pipes to brace them. The gasholder used a steam antifreeze system and elevated pipes were carried around and south, east and north-east sides of the gasholder. A circular dry well with pump was located over the inlet pipe

Table 1: Gasholder 3, detail of the tank and lifts

	Tank	1st lift (inner / top)	2nd lift	3rd lift	4th lift (outer)
Diameter	46.4m (152’ 4”)	43.3m (142’ 2”)	44.1m (144’ 8”)	44.9m (147’ 2”)	45.6m (149’ 8”)
Depth	9.3m (30’ 6”)	9.1m (30’ 0”)	9.1m (30’ 0”)	9.1m (30’ 0”)	9.1m (30’ 0”)



Gasholder 3, photograph *c*1988; note lattice girders at the upper level (Manchester Archives ref 725-4) Fig 6

4.2 Gasholder No. 4 (Figs 31-60, 65-67)

Gasholder 4 was constructed by Thomas Piggot and Co of Birmingham in 1879 and was a three-lift column-guided gasholder with a maximum capacity of 59,208 cu. m. or 2,092,164 cu. ft. Despite having fewer lifts than Gasholder 3, the increased capacity of Gasholder 4 was due to its slightly wider tank diameter of 47.2m (155' 0", given as 161' on NW/MA/SAL/E/E/8) and increased depth of the tank and lifts at 12.2m (40' 0").

The gasholder's sixteen triple-order columns each comprised three tiers of cast iron columns with toroidal bases and Tuscan-style capitals, with square junction boxes at the intersections (Type 15, Tucker 2000a). The columns had a total height of 35.8m (117'6", the height of the gasholder is given as 130' on MW/MA/SAL/E/E/8) and each column segment was approximately 11m in height. The toroidal bases were a separate element to the basal column drums and from the footings to the next drum joint was a height of 5.5m. The columns of Gasholder 4 had a wider diameter than those of Gasholder 3 and above the base were *c*1.1m in diameter. A later, smaller example of column-guided gasholder by Thomas Piggot and Co was recorded at Ribbleton Lane, Preston, and was found to have similar Tuscan style columns and entablature boxes as well as lattice girders with florets (Bassir 2018).

The columns of Gasholder 4 lacked the assembly marks noted on the columns of Gasholder 3 but had stencil-painted numerical designation beginning in the south-east and increasing clockwise. The columns had round inspection panels above the footings and most of these were plain except for on columns 3 and 5 which were stamped commemorative plaques. On these were the Salford coat of arms surmounted by W. ROBINSON MAYOR, with W. SHARP-CHAIRMAN below. The plaques on columns 4 and 2 read ERECTED BY THOs PIGGOT & CO BIRMINGHAM, 1879. At the rear of the columns were spans of T-profile, square channel roller guides which rose from the tanks to the top of the gasholder at which point they were cut to fit. The gasholder frame was braced by diagonal circular-profile tie rods spanning between the intersections of the columns and girders and meeting at circular couplers.

There were three tiers of castellated steel girders. The upper tier girders were of an earlier date to those of the lower tiers though all were replacements of earlier lattice girders. A photograph of 1983 (Fig 7) shows that the lower tier lattice girders were still in place at this time but the upper castellated girders had already been installed. The original girders were wider than their replacements and the tie rods were of insufficient length to reach the new, narrower girders. In order to accommodate this, small pieces of halved girders were double-stacked at the intersections with the columns.

The gasholder used cantilevered goose-neck roller carriages of a similar but not identical design to those on Gasholder 3. The difference in design was most obvious on the smaller carriages which on Gasholder 4 were more angular with straighter edges, compared to the more rounded designs on Gasholder 3.

The crown rise was 2.4m (8' 0") and in contrast to Gasholder 3 the crown surface sheeting comprised concentric rings of staggered and tapered sheets, overlapping and riveted at the edges. The sheets were primarily 11BG thick and 3/8" at the outer curb. There were three 24" and four 18" x 24" diameter manholes and at the centre of the crown was a 6" vent, and two 2" vents were located at the south-east side of the crown. An example of the crown sheets was measured as 670mm at its widest width, tapering to 630mm width and was 1070mm in length; closely spaced rivets were set along on the 30mm sheet overlaps and the rivet heads were measured at 20mm diameter.

Access to the lifts was provided by a vertical ladder with rest platforms located at the north side of the gasholder.

The cup and grips were of the rounded, 10" x 3/8" pressed-plate design forming a channel 10" x 20". The roller carriages were seated on curved footings which wrapped around the curved grips and were bolted through. The lifts were formed of fairly small-sized riveted steel sheets. The sheeting thickness is given in the Basic Record form as 11BG for the intermediate rows and 3/8" for the top and bottom rows. Vertical stiffeners in the form of 200mm x 60mm Rolled Steel Channels were set at regular intervals around the inside face of each lift and spanned the full height of each lift and into the grips. Each stiffener was comprised of two lengths of RSC and these were joined by riveted overlap / flange plates. The vertical stiffeners were aligned so that one underlay each of the crown roller carriages and brackets projected out from each stiffener in order to brace the roller carriages. At least two manhole access lids were noted at the bottom of the lifts.

The tank had a diameter of 47.25m (155') and was 12.2m (40') deep. The upper edge / kerb comprised stone blocks and the tank was faced with bricks set in English Bond, i.e. alternating courses of headers and stretchers. The roller guide channels set at the back of the columns continued down to the base of the tank and were interspersed with additional guide channels spanning the height of the tank.

The dumpling was fairly shallow, with a gentle curving profile rising from the *c*2m wide annulus to a flattened apex. At the centre of the dumpling was a tapered, square-plan brick stanchion *c*2m x 2m and standing to a height of perhaps 5m. The stanchion brickwork was in English Garden Wall bond, i.e. courses of headers set between five stretcher courses. A stone block was set on top of the brickwork as a capping piece.

Gasholder 4 had a markedly different crown support to Gasholder 3 since the latter was untrussed and relied upon a fixed framing structure to support the crown sheets when the gasholder was deflated. Gasholder 4, in contrast, had a trussed crown in which the crown sheets were supported on a frame that rose and fell with the crown lift.

The crown frame comprised a central pipe with collars at the top and bottom from which radiated the primary rafters and lower tensioning chords. The pipe comprised a number of riveted drums, each in turn formed of riveted semi-circular plates. The lower chords radiated from a collar or ring at the base of the pipe and spanned to the top curb where they joined the relevant vertical stiffener. The primary rafters comprised sixteen 4" x 6" x ½" tees joined by concentric rings of tie bars and with shorter, intermediate rafters spanning from the top curb to mid-distance of the crown. The rafters and bottom chords were joined by vertically set flat bars and diagonal bracing rods.

The 24" and 30" inlet and outlet pipes were located together at the south-east side of the gasholder where their external rise was marked by a circular brick-lined dry-well. Internally the pipes rose within the annulus and reached the height of the tank edge. One of the pipes had a vertical rise while the other was angled at mid-height to increase the distance between the pipes. Circular manholes on the crown allowed access to the pipes when the gasholder was deflated.

Table 2: Gasholder 4, detail of the tank and lifts

	Tank	1st lift (inner / top)	2nd lift	3rd lift
Diameter	47.2m (155’ 0”)	44.8m (147’ 0”)	45.5m (149’ 6”)	46.3m (152’ 0”)
Depth	12.2m (40’ 0”)	12.2m (40’ 0”)	12.2m (40’ 0”)	12.2m (40’ 0”)

Gasholder 4, photograph *c*1983 (Manchester Archive ref 665-7) Fig 7

4.3 Miscellaneous buildings

Ordnance Survey mapping shows that the Booster House was built between 1932 and 1954, pre-dating the adjacent Governor House which was built in the late 1960s. Both were simple brick-built structures with flat roofs, each comprising an open room housing valves and plant, and with pipes passing in and out of the buildings either below-ground or elevated through the walls. The Booster House measured c10m x 5m and had angled corners in order to allow for an additional two windows towards the west. Entrance was through a double door centrally in the west wall and flanked by two windows. The windows were of matching proportions with twelve-light wooden frames with mesh over and concrete sills and lintels. Two wooden louvers were located on the flat roof. The Governor House occupied a rectangular footprint with one angled corner and measured c10m x 5m. It was not entered during this survey but plans suggest that it housed four sets of valves set in series. A shallow linear well was located adjacent to the building in which were a series of gas mains and valves.

In the north-east corner of the site, at the intersection of Liverpool Street and West Egerton Street were a group of plain brick structures housing water meter and electric substations. An office was formerly located to the north-west of Gasholder 3, adjacent to the site entrance where a weighing machine was also formerly located.

Another Booster House containing a Turbo-Booster was formerly located to the south-west of Gasholder 4 but had been demolished prior to this survey.

5 DISCUSSION

The gasholders were good examples of mid to late 19th-century column-guided holders and demonstrated an evolution in the approach to design during this period. Gasholder 3 was completed in 1869 by Westwood and Wright Ltd of Staffordshire with a capacity of 55,687 cu. m. or 1,967,740 cu. ft. and Gasholder 4 by Thomas Piggot and Co of Birmingham in 1879 with a maximum capacity of 59,208 cu. m. or 2,092,164 cu. ft.

The site was assessed as part of the Gas Industry Step 3 Report and was graded as R/+, i.e. a site of regional importance but of lesser priority for resource allocation and to be managed through the planning process (note: the site is referred to as the Regents Road Gasworks in that document) (Trueman 2002).

The site was described as follows

> *Prominent gasholders of two column-guided types, both with 20th-century replacement girders. No., of 1870, is one of 4 examples of enlarged single-order (type 18), with replaced upper tier. Uncertainty over original single-order form, may have been single-tier (type 11, with added lower girder or double tier (type 12) – there are no firmly identified examples of this latter type. No.4 holder of 1879 is triple-order, triple tier (type 15) that appears less refined architecturally than other surviving examples.*

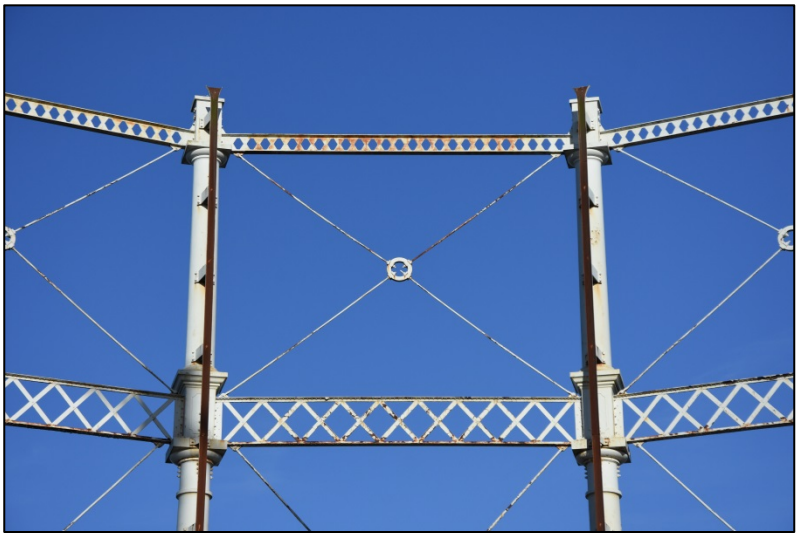
Gasholder 3 fits in with type 18 in the Tucker typology, more specifically it is type 18b as the top tier has been added rather than inserted. They are later additions, added when the gasholder was heightened, in order to increase the frame's stability. The girders are held in place using collars rather than being fixed directly to the columns; this would also imply that the second-tier girders replace earlier ones and that the diagonal tie-rods are also part of this phase of alteration. A single-order, single-tier gasholder of 1885 at Ribbleton Lane, Preston did not have tie-rods and the columns were joined only by girders between the entablature boxes (Bassir 2018). The castellated upper girders are typical of mid-20th century girder design.

The crown frame of Gasholder 3 was untrussed, resting on a frame when deflated, whereas Gasholder 4 was trussed; it had a support frame that rose and fell with the crown lift.

Gasholder 4 was described as a triple tier, type 15 in the Tucker typology as it included bracing ties. The replacement of lattice girders with castellated steel girders was undertaken over time, first of the upper tier. The roller channel was partially cut away on the back to accommodate the entablature box.

Supply of gas for gas-lighting in Salford is an early example with a gas plant contract by Phillips & Lee in 1805 and expanded by 1807 with further gas-lighting. This saw further expansion in 1819 by a group of entrepreneurs. The 1830s saw the construction of new gas works, including Liverpool Street in 1868. After the First World War a nationalisation and coalescing of the gas industry was considered. After the Second World War the Gas Act of 1948 saw Salford placed in the North-Western Gas board jurisdiction. The gas manufacturing plant became redundant after the discovery of North Sea Gas in the 1960s and once the conversion programme completed in 1977.The plant and building were mostly gone by the late 1970s.

General view of Gasholder 3, looking north-east Fig 8



View of the inner face of the upper framing of Gasholder 3 Fig 9

Example of the Gasholder 3 column bases (column 9) Fig 10

Detail of assembly marks on the column drums (column 14) Fig 11

Internal view of column footing flanged joint Fig 12

Example of the topmost entablature boxes and girders Fig 13

Example of the middle tier junctions, showing entablature box and girders Fig 14

Example of the first tier girder collars Fig 15

The roller carriages, also showing the tank kerb and lifts Fig 16

View of the roller carriages and section of the top curb Fig 17

General view of the crown, looking north-west Fig 18

Manholes over inlet and outlet pipes at the south-east side of the crown Fig 19

Manholes at the north-west side of the crown Fig 20

The exposed timber crown support, looking south-east Fig 21

Detail of the central support Fig 22

The crown support, looking east; note elevated platform Fig 23

View of the brick tank and guide rails Fig 24

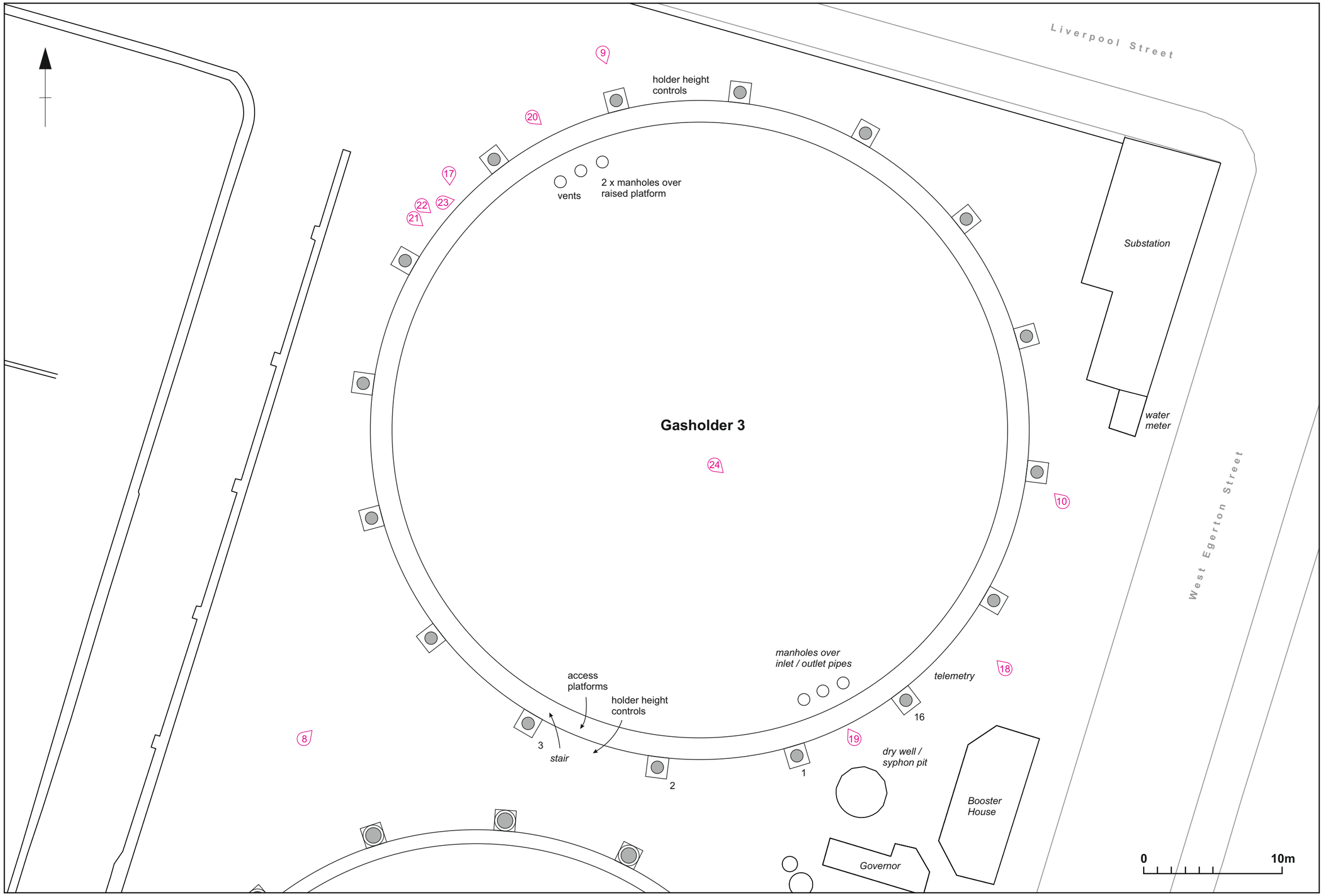
Example of the removed lift sheets Fig 25

Cap on top of columns Fig 26

Example of top column and girder section Fig 27

Lower column and girder Fig 28

Underneath the base of the column Fig 29



Scale 1:250 (A3)

Plan of Gasholder 3, showing photograph locations Fig 30

General view of Gasholder 4, looking north-east Fig 31

Example of the Gasholder 4 columns Fig 32

Example of the topmost entablature boxes Fig 33

Example of the first-tier entablature boxes; note the stacked girders Fig 34

The castellated girders, also showing the roller guide channels Fig 35

Example of the column footings with commemorative plaque Fig 36

Examples of the commemorative plaques Fig 37

View of the internally flanged column / footing joins Fig 38

Example of the roller carriage sets, also showing cross-section of the lifts and pressed-plate grips Fig 39

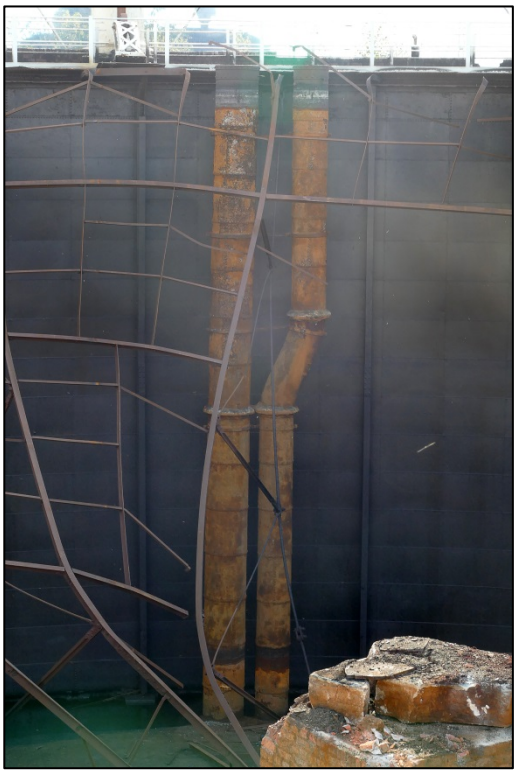
View of the tank kerb and the lift walkways and handrails Fig 40

View of the crown with walkway Fig 41

Valve on the crown apex Fig 42

Paired flat lids and adjacent manhole over the inlet and outlet pipes Fig 43

The inlet and outlet pipes, valves, and dry well at the south-east side of Gasholder 4 Fig 44



The inlet and outlet pipes Fig 45

View of the crown frame and central stanchion Fig 46

Detail of the brick stanchion Fig 47

The central pipe with primary rafters and tie bars Fig 48

Detail of vertical stiffener with top curb brace Fig 49

View of the lift sheeting with vertical stiffeners Fig 50

View of the pressed plate grips Fig 51

View of the tank brickwork and kerb Fig 52

The Booster House and Generator House, looking east Fig 53

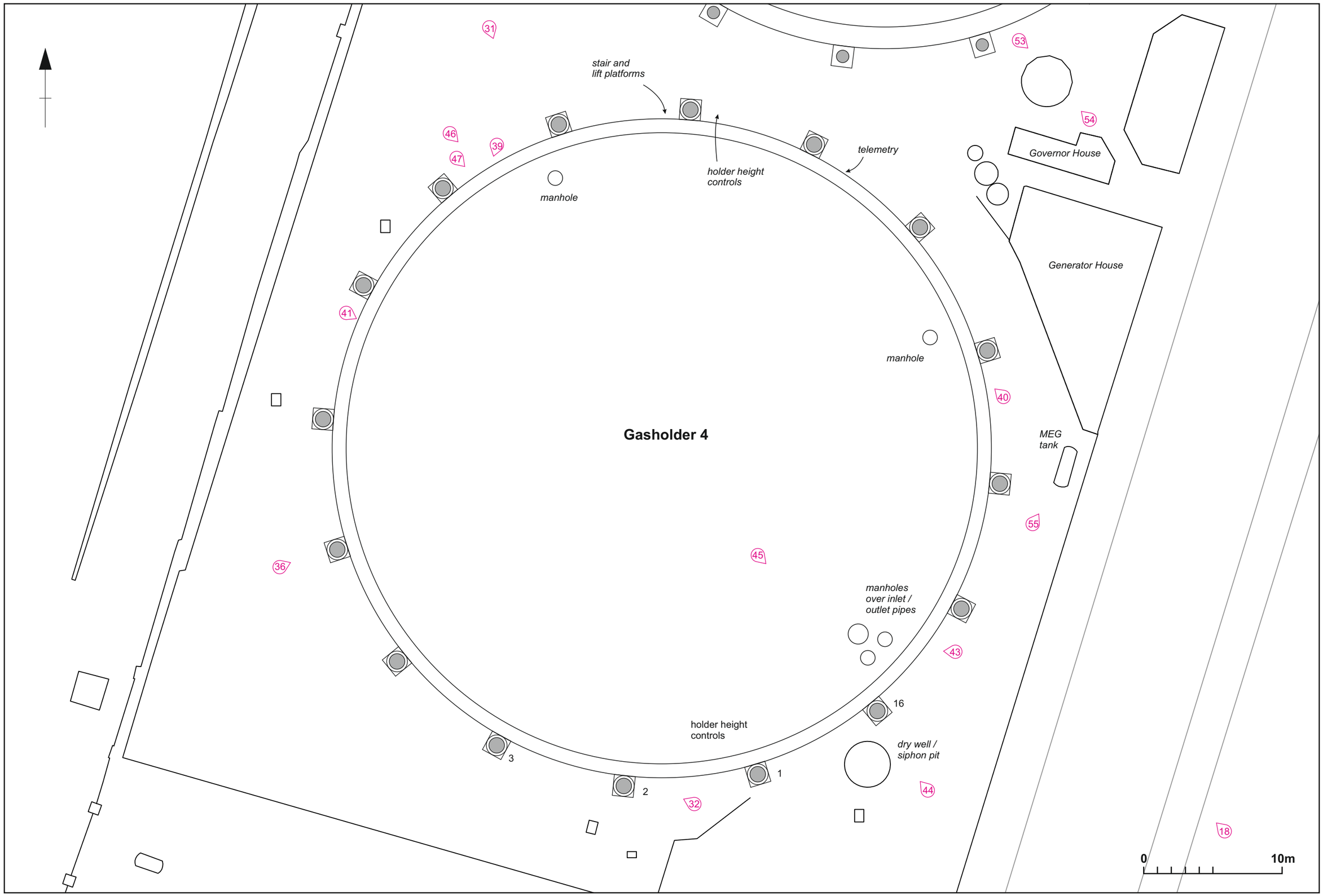
Gasholder 3 dry well Fig 54

View of pipework and Generator House with MEG tank in foreground Fig 55

Joint of column with internal bars Fig 56

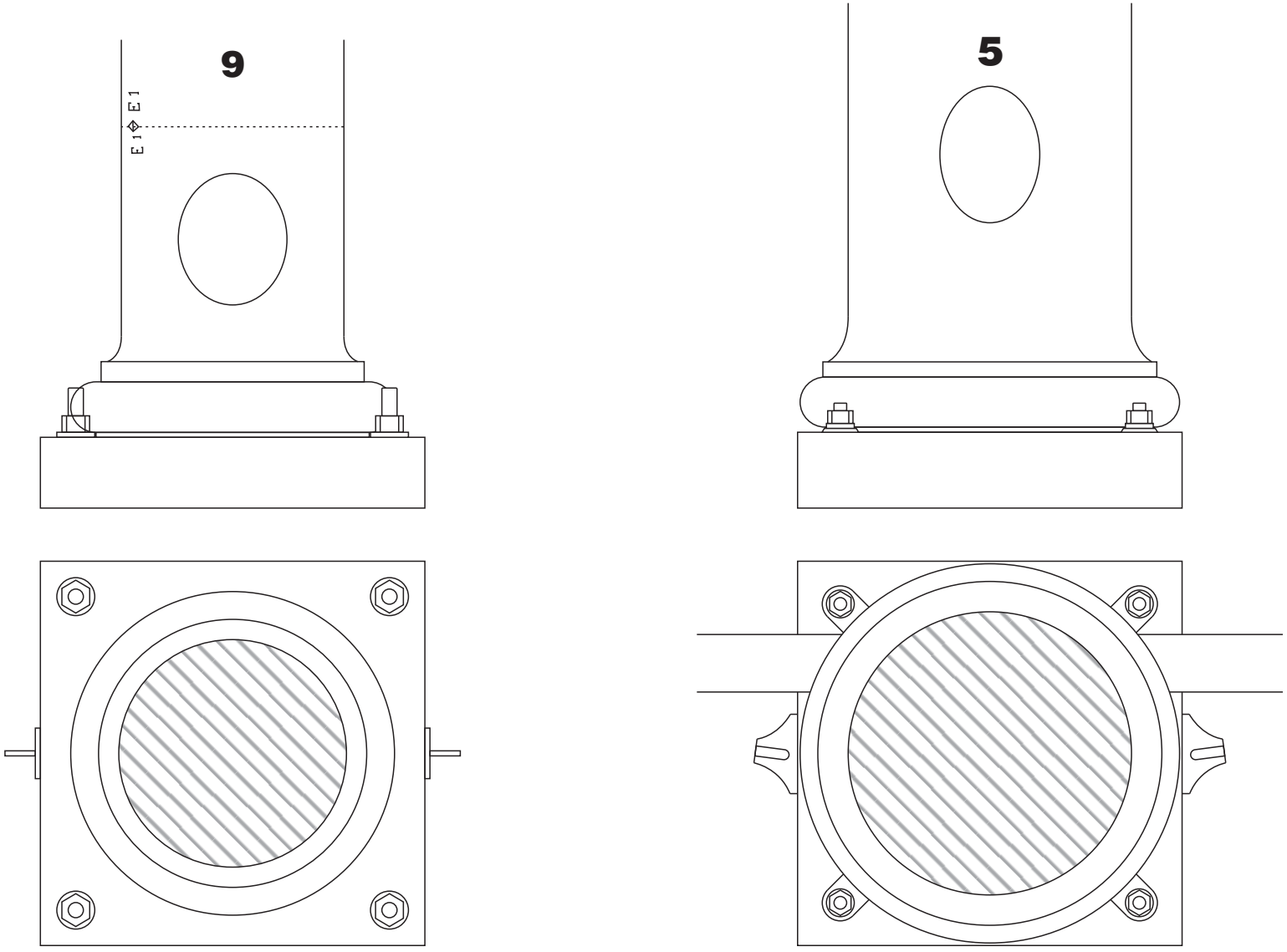
Base of a column Fig 57

Cut-out of roller guide channel Fig 58



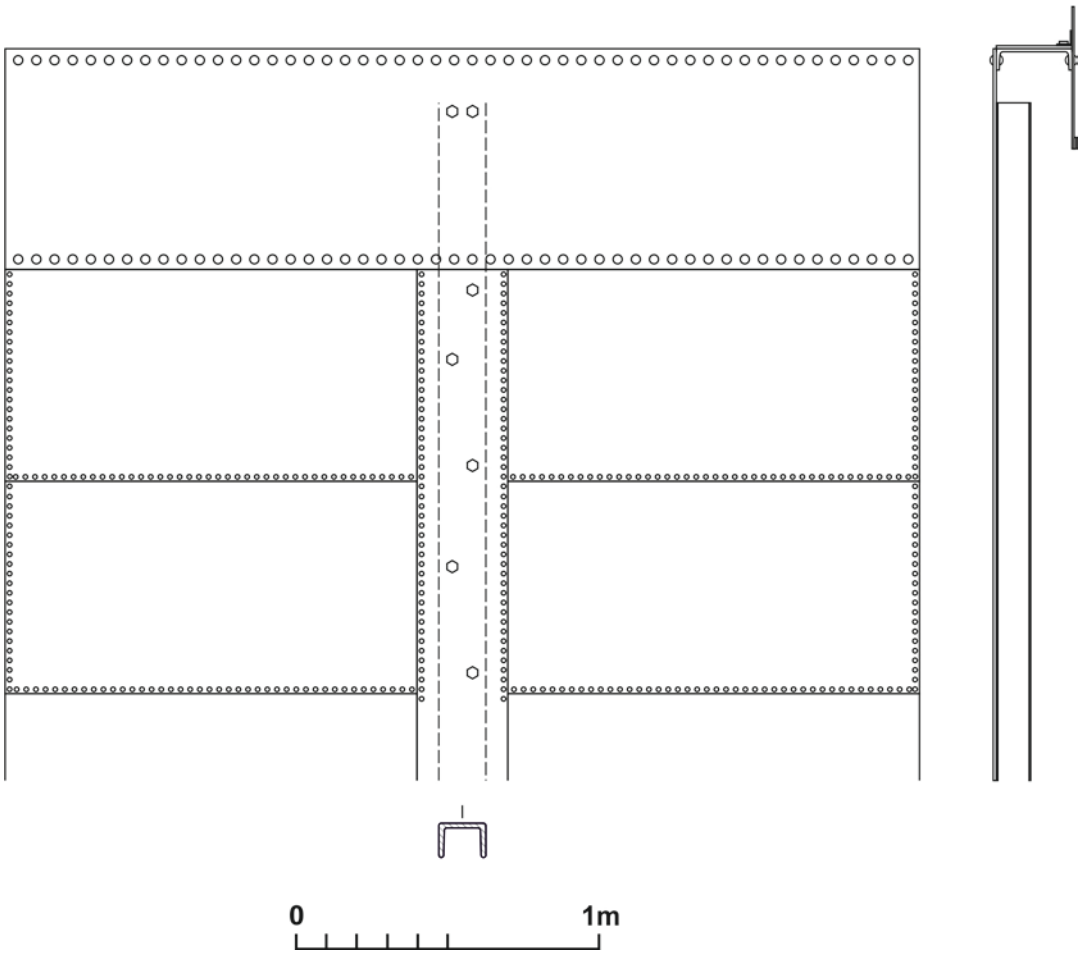
Scale 1:250 (A3)

Plan of Gasholder 4, showing photograph locations Fig 59

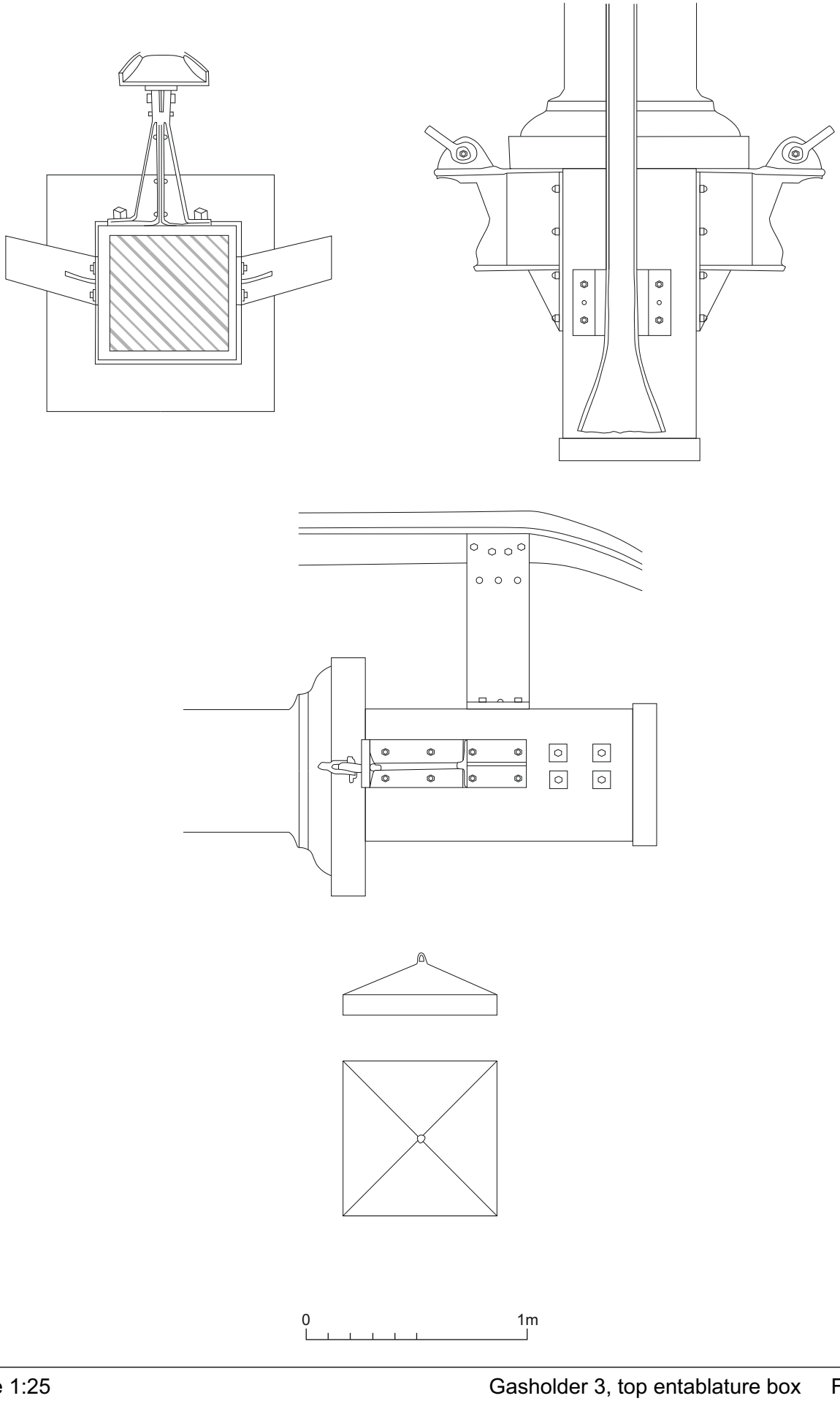


Scale 1:25

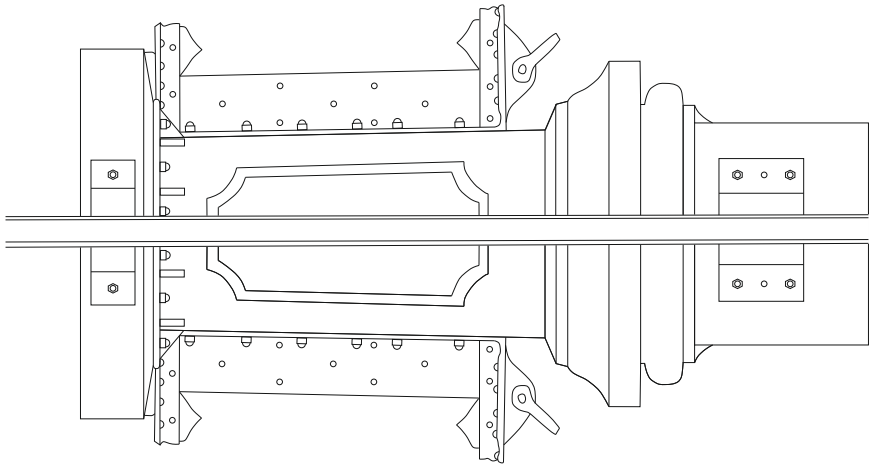
Detail of column bases Fig 60

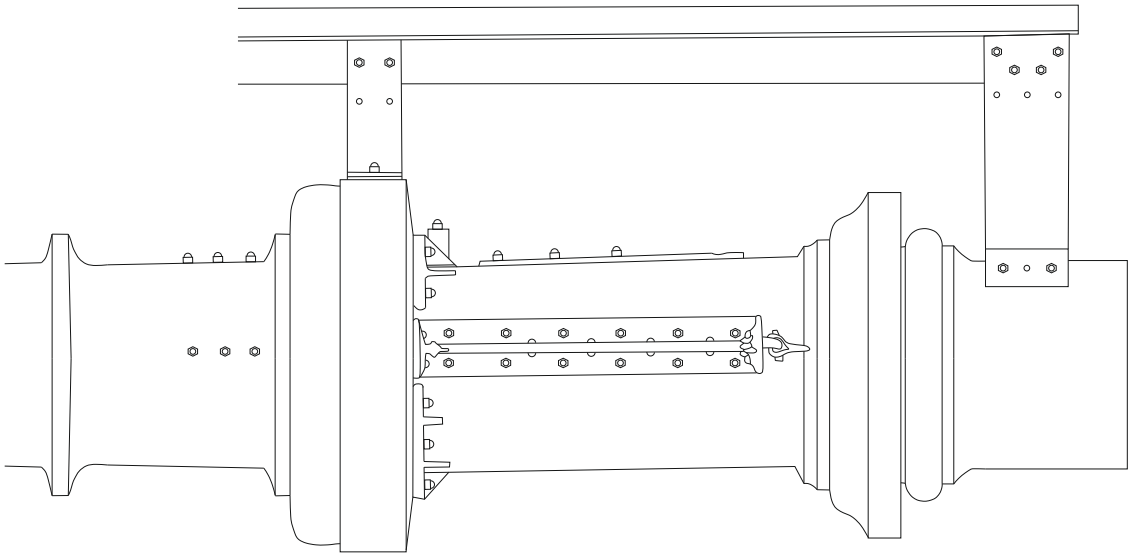


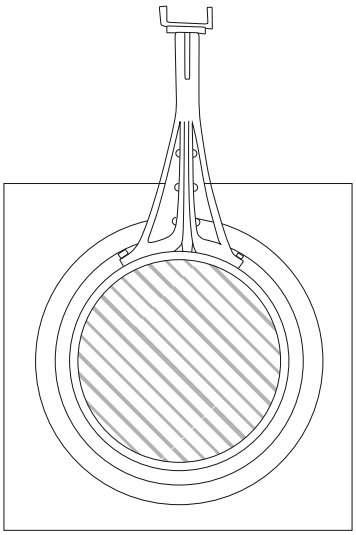
Detail of Gasholder 3 sheets Fig 61



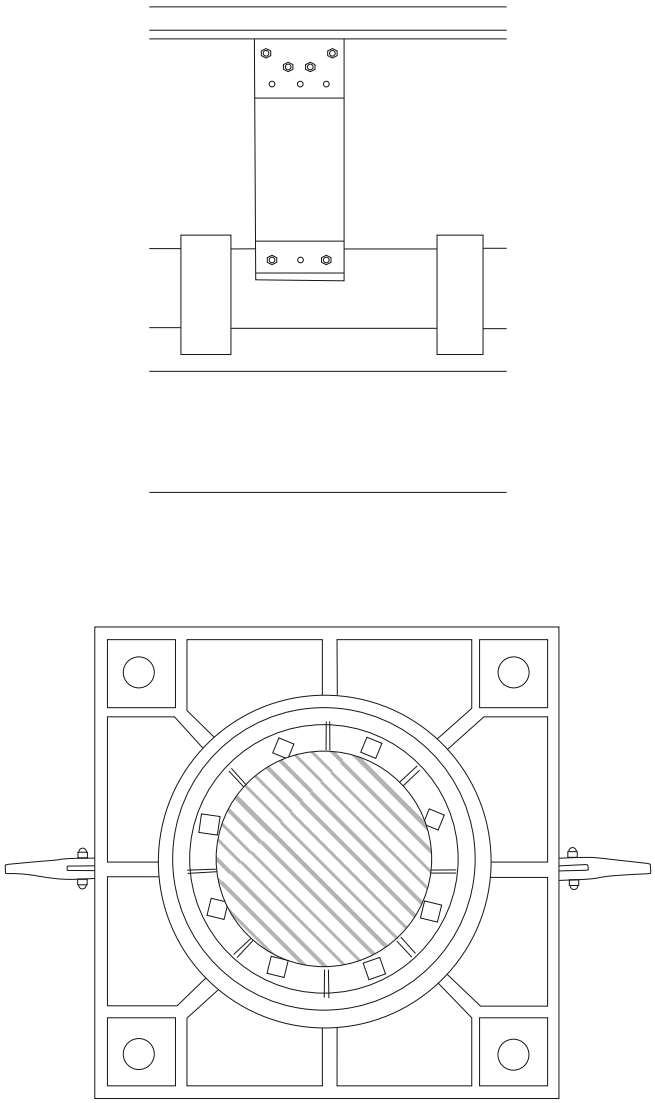
Scale 1:25 Gasholder 3, top entablature box Fig 62



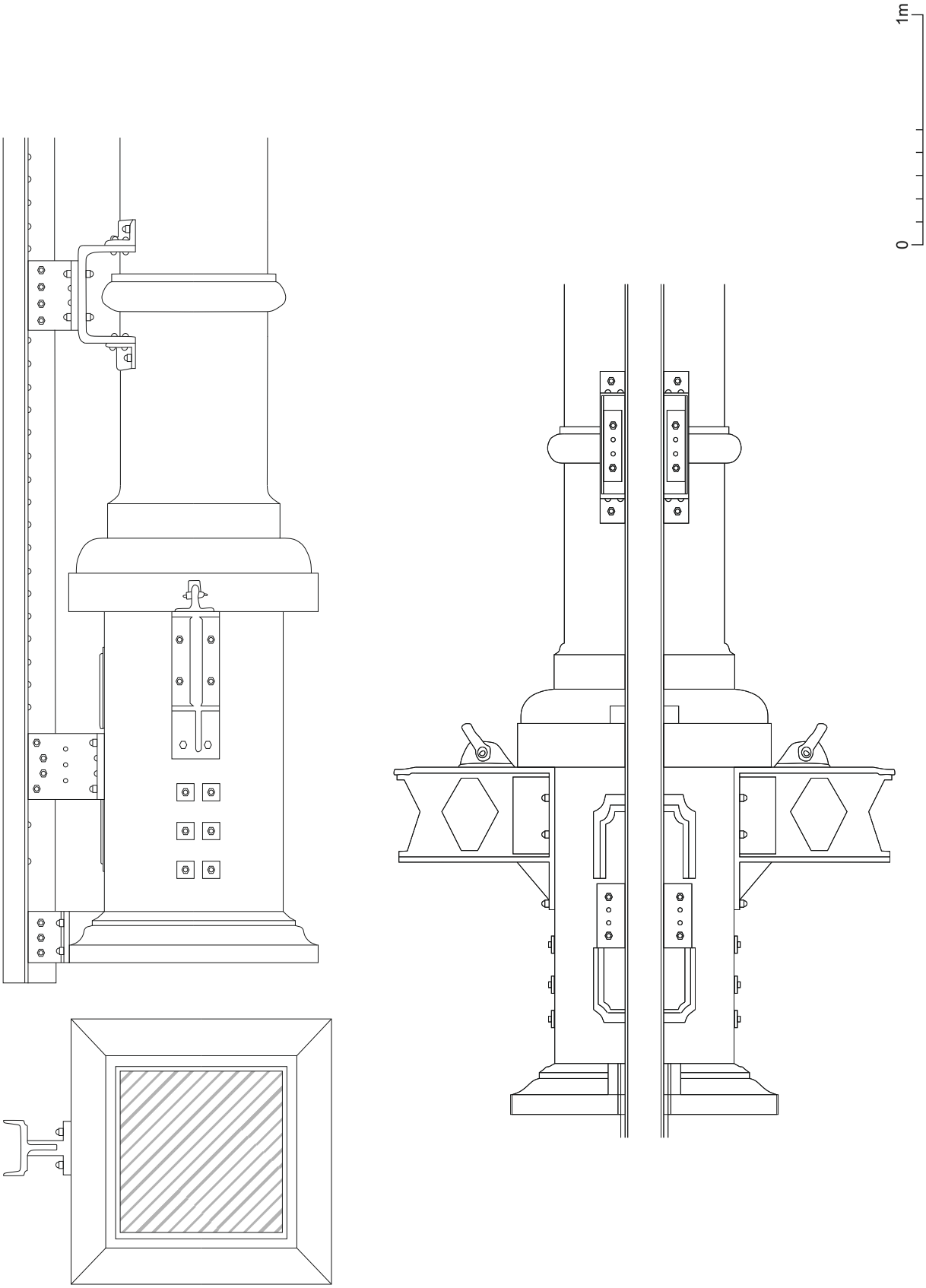




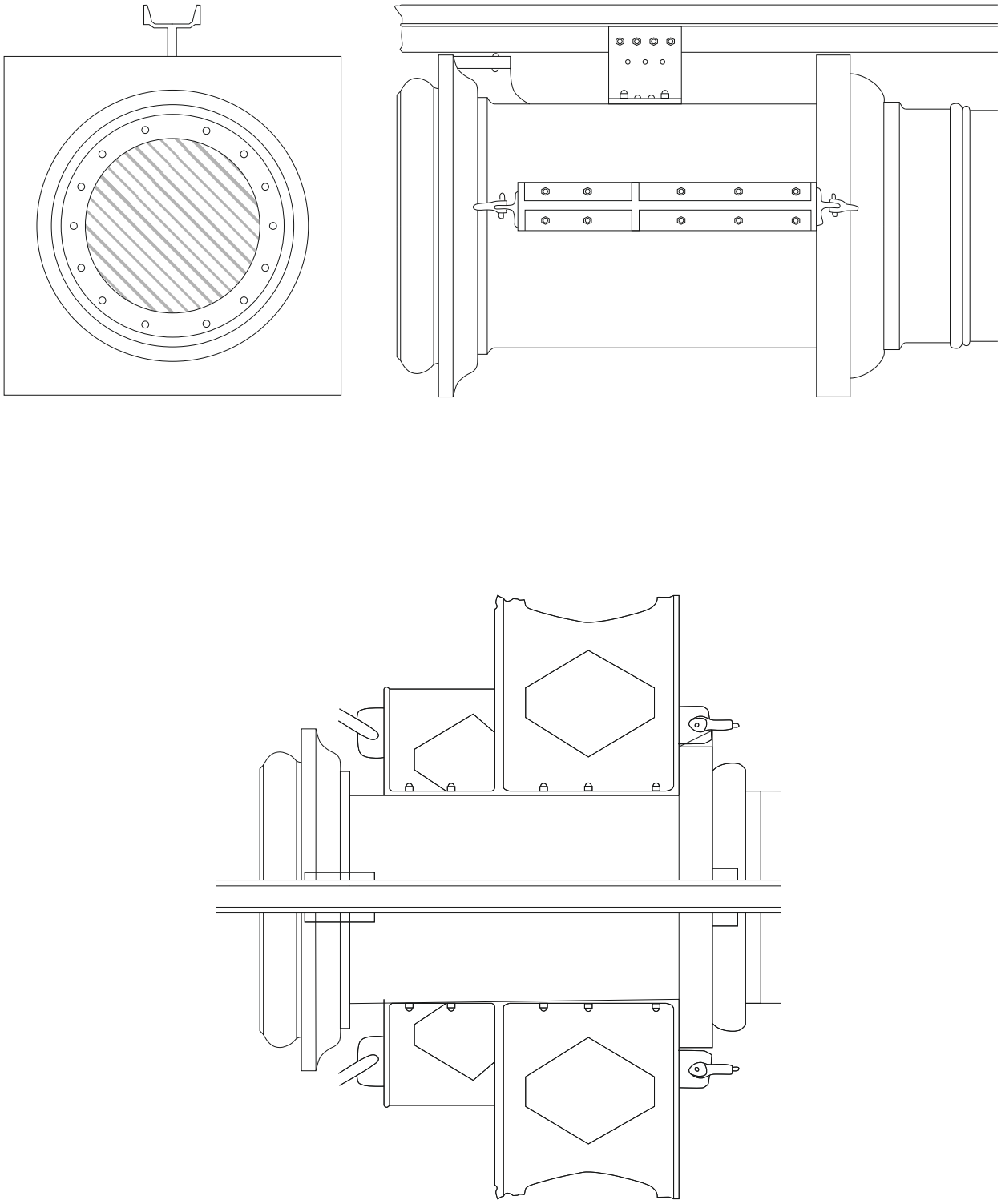
Scale 1:25 Gasholder 3, middle entablature box Fig 63



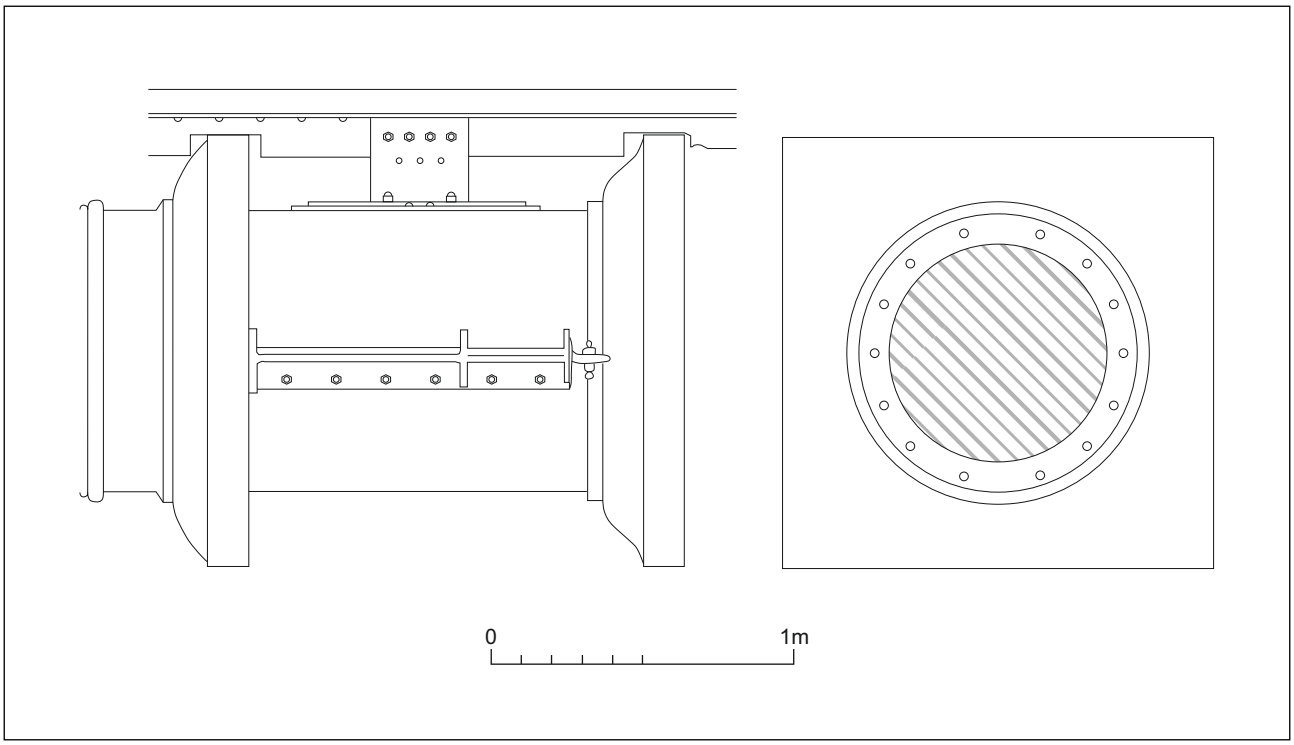
Scale 1:25 Gasholder 3, entablature box and base of column Fig 64



Scale 1:25 Gasholder 4, topmost entablature box Fig 65



Scale 1:25 Gasholder 4, first-tier entablature box Fig 66



Scale 1:25 Gasholder 4, lower-tier entablature box Fig 67

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MOLA Northampton
28 August 2019

Appendix I – Gasholder Basic Record Forms

Gasholder 3

COPY SENT TO AREA ON :

BRITISH GAS

REGIONAL PLANT DEPT.

REPORT OF EXAMINATION OF GASHOLDER
WATER-SEALED TYPE — BASIC RECORD

NAME: British Gas North Western EAST AREA

LOCATION: Liverpool Street, Salford M54LQ

GASHOLDER No.: 3 Date of inspection:

SITUATION: -

HOLDER BUILT BY: Westwood & Wright Ltd Date of completion: 1869

TANK BUILT BY: William Healey Date of completion: 1869

LIFT ADDED BY: - Date of completion: -

TYPE (i.e. Column, Spiral or Rope Guided): Column guided with flying lift

CAPACITY (exclusive of Crown): 1,918,000 cu.ft. (54,279 cu.metres)

CAPACITY OF CROWN: 49,740 cu.ft. (1,408 cu.metres)

LIFTS

	Top	Second	Third	Fourth	Fifth
Diameter	142'-2"	144'-8"	147'-2"	149'-8"	
Depth	30'-8"	30'	30'	30'	
Pressure (in. w.g.)/~~(mbar)~~	4.2	6.2	8.6	9.7	
No. of Columns Spiral Guides or Ropes	16	16	16	16	

GUIDE FRAMING (General Description): 16 cast iron columns 85'-10" high with two rows of wrought iron lattice cross girders and 1 row of castellated beams.

CROWN—RISE: 6'-3"

Number and Type of Manholes: 3 x 24" Ø 2 - 18" x 24"

Position and Number of Gas and Air Vents: 1 x 2" in centre

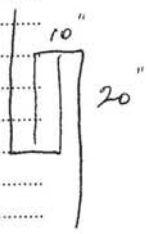
SHEETING THICKNESS

Crown: Outer Row: $\frac{3}{4}$" Other Rows: $\frac{5}{8}$" and 10 BG

Sides: Top Row: $\frac{1}{2}$" Intermediate Rows: 11 BG

Bottom Row: $\frac{3}{8}$"

CUPS & GRIPS (Size and construction, with sketch): $9\frac{7}{8}$" x $3\frac{1}{2}$" channel



TOP CURB & CROWN FRAMING (Construction—See Sketch Sheet): Top curb 6" x 6" x $\frac{3}{4}$" angle Fixed timber crown support

TYPE OF LADDER: Vertical ladder with backguards and rest platforms attached to framing

TANK

Diameter: 152'-4" Depth: 30'-6" Construction: Brick

Position in Relation to Ground Level: Top curb at ground level

Rest Blocks: Not known Number: Not known Size: Not known

MATERIAL USED FOR CONSTRUCTION OF

Gasholder: Wrought Iron Riveted

Tank: Brick & Puddled Clay

INLET & OUTLET CONNECTIONS

Size: 24" inlet 30" outlet

Position of Each: S. East Together or separated: Together

TYPE OF SAFETY SEAL

On Inlet Connection: None

On Outlet Connection: None

SIGNATURE *DATE*

CG.455 7/83 FORM No. 751/65

Gasholder 3, Basic Record Form

Gasholder 4

COPY SENT TO AREA ON :

BRITISH GAS

REGIONAL PLANT DEPT.

REPORT OF EXAMINATION OF GASHOLDER
WATER-SEALED TYPE — BASIC RECORD

NAME British Gas North Western EAST AREA

LOCATION Liverpool St., Salford M5 4LQ

GASHOLDER No. 4 Date of inspection

SITUATION -

HOLDER BUILT BY Thomas Piggot & Co Date of completion 1879

TANK BUILT BY Unknown Date of completion Unknown

LIFT ADDED BY - Date of completion -

TYPE (i.e. Column, Spiral or Rope Guided) 3 lift column guided

CAPACITY (exclusive of Crown) 2,024,000 cu.ft. (57,279 cu.metres)

CAPACITY OF CROWN 68,164 cu.ft. (1,929 cu.metres)

LIFTS

	Top	Second	Third	Fourth	Fifth
Diameter	147'	149'-6"	152'		
Depth	40'	40'	40'		
Pressure (in. w.g.)/(~~max~~)	5.7	7.9	9.9		
No. of Columns ~~Spiral Guides or Ropes~~	16	16	16		

GUIDE FRAMING (General Description) 16 cast iron columns 117'-6" high x 5'-0" dia. base. 2 tiers of latticed girders and 1 tier of castellated beams, top and middle 28'-6" long, bottom 28'-0" long, diagonal wind bracing.

CROWN—RISE 8'-0"

Number and Type of Manholes 3 x 24" dia. + 4 - 18" x 24"

Position and Number of Gas and Air Vents 1 x 6" in centre 2 x 2" outer

SHEETING THICKNESS

Crown: Outer Row $\frac{3}{8}$" Other Rows 10 BG

Sides: Top Row $\frac{3}{8}$" Intermediate Rows 11 BG

Bottom Row $\frac{3}{8}$"

CUPS & GRIPS (Size and construction, with sketch) 10" x $\frac{3}{8}$" pressed plate

TOP CURB & CROWN FRAMING (Construction—See Sketch Sheet) Top curb 5½" x 4½" x ¾" angle. Main bars 4" x 6" x ½" tees with tie bars and bracings.

TYPE OF LADDER Steel ladder with backguards and rest platforms attached to framing.

TANK

Diameter 155'-0" Depth 40'-0" Construction Brick

Position in Relation to Ground Level: Top curb at ground level

Rest Blocks: Not known Number: Not known Size: Not known

MATERIAL USED FOR CONSTRUCTION OF

Gasholder Wrought iron and steel Riveted

Tank Brick and puddled clay

INLET & OUTLET CONNECTIONS

Size: 24" and 30"

Position of Each: S. East Together or separated: Together

TYPE OF SAFETY SEAL

On Inlet Connection: Not known

On Outlet Connection: Not known

SIGNATURE *DATE*

CG.455 7/83 FORM No. 751/65

Gasholder 4, Basic Record Form

Appendix II – Photogrammatic Model: Gasholder 4, Column 5
(electronic copies of report only, requires Adobe Acrobat to view)

Salford, Liverpool St, Gasholder 4

APPENDIX III – Glossary of terminology

All term descriptions were written using the *London Gasholder Survey: The development of the Gasholder in London in the later nineteenth century* (Tucker 2000), Ching 1995, and *Recording timber-framed buildings: An illustrated glossary (*Alcock 1996).

Term	Description
Anchor bolts	Any of the various rods or bolts embedded in masonry or concrete to hold, secure, or support a structural member.
Bell	The sheet-metal cylinder with a closed top which contains the gas in all water-sealed holders. It is the moveable part of the gasholder, rising and falling according to the volume of gas stored within it at the time and descending into the tank as it empties.
Capital	The uppermost part of a column, pillar or pier.
Cleat	A block attached to a surface to restrain or support another element.
Column-guided	A type of gasholder referring to the use of circular cast-iron columns for the guide-frame supports. The column-guided type has the four main components of tank, lift, bell and guide-frame.
Cross-brace	Diagonal bracing with a circular tension ring at the centre providing the point of adjustment.
Crown	The slightly domed roof of the bell.
Curb	The top and bottom edges of the bell. The top edge is of thicker metal for strength.
Drums	A cylindrical or faceted construction supporting the crown.
Entablature junction box	The horizontal section at the head of the order that rests on the columns, providing attachment for the girders, and tie-rods.
Fish plate	A metal plate bolted to secure two abutting members.
Flanges	A ridge projecting at a right angle forms the edge of the member in order to strengthen or stiffen it. They were cast on to the side of the columns (internally or externally), to which the girders and bracing rods were fixed with external bolts, this allowed bolts to be more readily tightened and inspected. Adopted post-1870s.
Flying lift	An additional lift designed to rise above the top of the guide-frame for extra capacity. More common from the late-nineteenth and early-twentieth centuries.
Gasholder	Means of storing large amounts of gas at ambient temperature.
Gasworks	Site for the industrial production of gas.
Girders	A ring of girders was used to stabilise the tops of columns and, in later examples, girders at intermediate levels were used extensively. One of the functions of girders is as a tie, holding all the columns together in contact with the top guide rollers of the bell.
Guide-frame	The circular metal structure of vertical columns or standards linked by horizontal girders and, sometimes, diagonal bracing, built around the perimeter of the tank. It is designed to resist the wind forces on the gasholder.
Gusset plate	Connects the girders to the standards and can be simply or

Term	Description
	elaborately emphasised.
Inlet and outlet pipes	Pipework that allowed the flow of gas into/out of the tank.
Lift	The telescopic sections between the tank and bell, allowing the bell to ascend, each one being of similar depth to the tank.
Lift cup and grip	The elements that allow a water seal between each lift. The cup, belonging to the upper lift, scoops water from the tank as it rises, and the grip to the lower lift provides the seal.
Roller guide	The mechanism by which the bell or lift is held in place as it ascends. Depending on the type of gasholder these may be mounted at the top of each lift and bear against rails mounted on the guide-frame. In the spiral-guided type there is no guide-frame and rails fixed helically to each lift of the bell are gripped by rollers mounted on the lift or tank below it. The rollers are usually mounted radially, but tangential rollers are also used in very large holders.
Scarf joint	The meeting between two members touching end-to-end.
Spiral-guided	A type of gasholder with no guide-frame. Instead each lift is guided by a track within the lift below, rotating as it ascends. The spiral-guided type has three main components of tank, lift, and bell.
Standard-guided	A type of gasholder referring to the use of vertical members of any other form then columns for the guide-frame supports. The standard-guided type has the four main components of tank, lift, bell and guide-frame.
Tank	The open-topped vessel into which the bell and lifts descend when empty of gas, and it is filled with water to provide a seal.
Tie-rods	A metal member designed to keep two structural elements from spreading or separating.
Toroidal	A convex, semi-circular moulding, or a doughnut-shaped surface, commonly found directly above the plinth of the base of a column.

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