

**NITRO-GLYCERINE WASHING HOUSE, SOUTH SITE, WALTHAM
ABBAY ROYAL GUNPOWDER FACTORY, ESSEX**

SURVEY REPORT

JUNE 1996

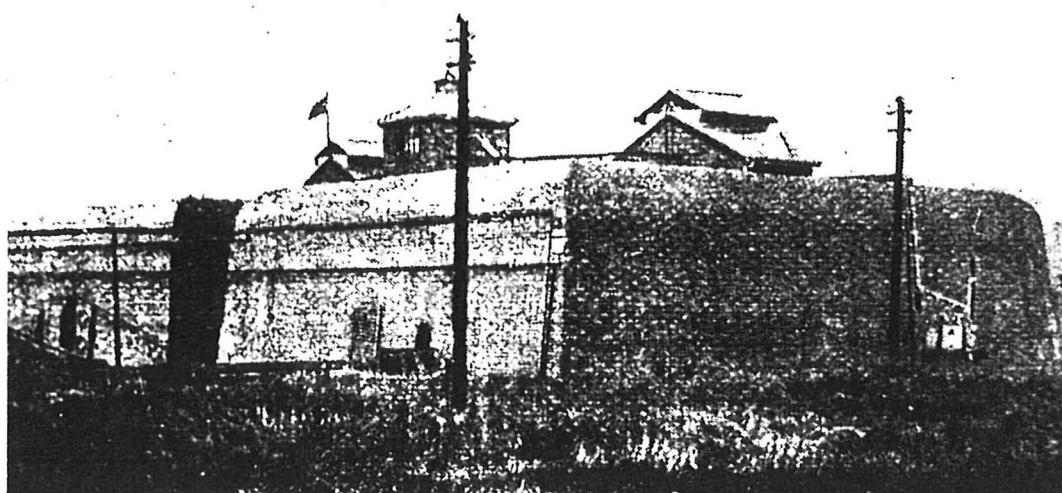


**Essex County Council
Planning**

FIELD ARCHAEOLOGY GROUP



Earliest photograph of cordite workers, 1891 (MOD photograph).



WHERE NITRO-GLYCERINE IS MADE.
This building once blew up with terrible results.

View of the Quinton Hill Nitrating houses, taken at the turn of the century. In fact, it was the Washing House and Nitro-glycerine Store which blew up. The gutter leading to the Washing House is visible on the extreme left of the picture (MOD photograph)

Front cover: Cordite workers posing with an acid bogie(late 19th century?) (MOD photograph)

CONTENTS

1.0	INTRODUCTION
2.0	SURVEY METHOD
3.0	HISTORY OF THE SITE
3.1	The history of chemical explosives in the late 19th century: Guncotton, nitro-glycerine and cordite
3.2	Nitro-glycerine and its manufacture at Waltham Abbey RPF
3.3	The nitrating process
3.4	The washing and filtering processes
3.5	The history of the South Site (Quinton Hill) Nitro-glycerine Factory.
4.0	DESCRIPTION OF THE WASHING HOUSE
5.0	DISCUSSION
	ACKNOWLEDGEMENTS
	BIBLIOGRAPHY
	THE PLATES
	Appendices:
A1	Photographic Registers
A2	Archive Contents
A3	Essex Sites and Monuments Record summary sheet

FIGURES

- Fig.1 Nitro-glycerine Washing House, South Site, Waltham Abbey Royal Gunpowder Factory, Essex. Site location
- Fig.2 Nitro-glycerine Factory. Schematic diagram of manufacturing plant.
- Fig.3 Nitro-glycerine wash house. Building plan, reduced from 1:50 survey plot
- Fig.4 Nitro-glycerine Wash House. Section A-A1
- Fig.5 Nitro-glycerine Wash House. Section B1-B3
- Fig.6 Nitro-glycerine washing tank

LIST OF PLATES

- Plate 1 Damage to the original Washing House (built in 1891) in the aftermath of the explosion of 7th May 1894 (looking north). In the background are the two Nitrating Houses, with the Charge House mounted between them, on top of the brick traverses (MOD photograph)
- Plate 2 Damage to the Wash Water Settling House, in the aftermath of the explosion of 7th May 1894 (looking SE). Part of the gutter used to carry the wash waters from the Washing House can be seen on the extreme right of the picture (MOD photograph)
- Plate 3 View of the Washing House exterior (looking north-west)
- Plate 4 The Washing House entrance passage (looking north-east)
- Plate 5 Detail of the door hinge on the east side of the entrance passage
- Plate 6 Detail of the electric light fitting at the south-west end of the entrance passage
- Plate 7 View of the Washing House 'shoe room' (looking south-east)
- Plate 8 Detail of the viewing window, inside the 'shoe room'
- Plate 9 Detail of the coat hooks inside the 'shoe room'
- Plate 10 The roundhouse door (looking north-east)
- Plate 11 Interior of the roundhouse (looking east)

- Plate 12 Interior of the roundhouse (looking west)
- Plate 13 Interior of the roundhouse, (looking north)
- Plate 14 Interior of the roundhouse (looking south)
- Plate 15 Asbestos covered pipe and stop cock. Probably connected with the Washing House steam heating system
- Plate 16 Radiator heater unit, no longer connected but close to its original position
- Plate 17 Detail of the roundhouse doorway showing the remains of the footplate (foreground) and debris from the collapsed 'shoeroom' roof (background) (looking west)
- Plate 18 The Washing House roof, viewed from below (at a north facing oblique angle), showing roof windows, danger building lights and ventilation chimney
- Plate 19 Exterior view of the ventilation chimney (looking W)
- Plate 20 Detail of a danger building electric light fitting, showing a water-filled glass bowl, lined with brass chicken wire
- Plate 21 Detail showing the cast iron switch box connecting the lights to the overhead power supply. Mounted on top of the traverse to the north
- Plate 22 View of the raised platforms at the N end of the washing House from above (looking E). The platforms were formerly at two levels, the upper supporting the washing tank, the lower the filtration tank
- Plate 23 Detail of a wooden window prop. The prop is hinged at the bottom on a single brass screw
- Plate 24 View of a washing tank set against the south-west wall of the roundhouse (not *in situ*)
- Plate 25 Detail of a washing tank, showing a pipe rest, cut into the rim of the barrel
- Plate 26 Detail of a shaped wooden block of uncertain function, found inside one of the washing tanks (not necessarily *in situ*)
- Plate 27 Interior detail of the washing tank, showing nitroglycerine and wash water drainage outlets, and grooves in the base of the tank. The lead lining has been removed

- Plate 28 The terminal of the nitroglycerine gutter. A lead pipe passed through the hole drilled in the base, connecting the gutter to a fixed socket inside the Washing House
- Plate 29 Detail of a surviving section of the lead pipe that connected the gutter terminal with a fixed socket inside the Washing House
- Plate 30 Detail of the fixed brass socket mounted on the Washing House wall at the level of the roof plate
- Plate 31 A section of the nitroglycerine gutter at the junction of the tunnels from the nitrating houses (looking south-east). The surviving section of canvas gutter cover seen here, protected the gutter from the elements in the gap between the traverse revetment wall and the Washing House
- Plate 32 Detail of a lead eye, passing through the wall at roof level. This probably carried the skimmer dish pulley rope to a counterweight outside the Washing House
- Plate 33 Detail of chalkboard found in the Washing House (not *in situ*)
- Plate 34 Detail of the gutter shelf at the junction of the tunnels from the nitrating houses (looking south-east), showing a surviving section of canvas gutter cover. One of the straps by which one side of the cover was laced down, can be seen in the foreground
- Plate 35 View along the north-west conduit tunnel (looking north-west), showing the nitroglycerine gutter attached to the north wall. The wooden shelf rests on iron brackets set into the brickwork
- Plate 36 View along the southern conduit tunnel (looking south), showing the row of iron brackets that formerly supported the nitroglycerine gutter
- Plate 37 Detail of an iron hook attached to the southern conduit tunnel. It is part of a row of identical hooks, running along the east wall of the tunnel, possibly intended to carry a water pipe
- Plate 38 Detail of the southern conduit tunnel exit
- Plate 39 The southern conduit tunnel exit (looking north)
- Plate 40 Entrance to the north-east conduit tunnel (looking south)
- Plate 41 Entrance to the north-west conduit tunnel (looking south-east)

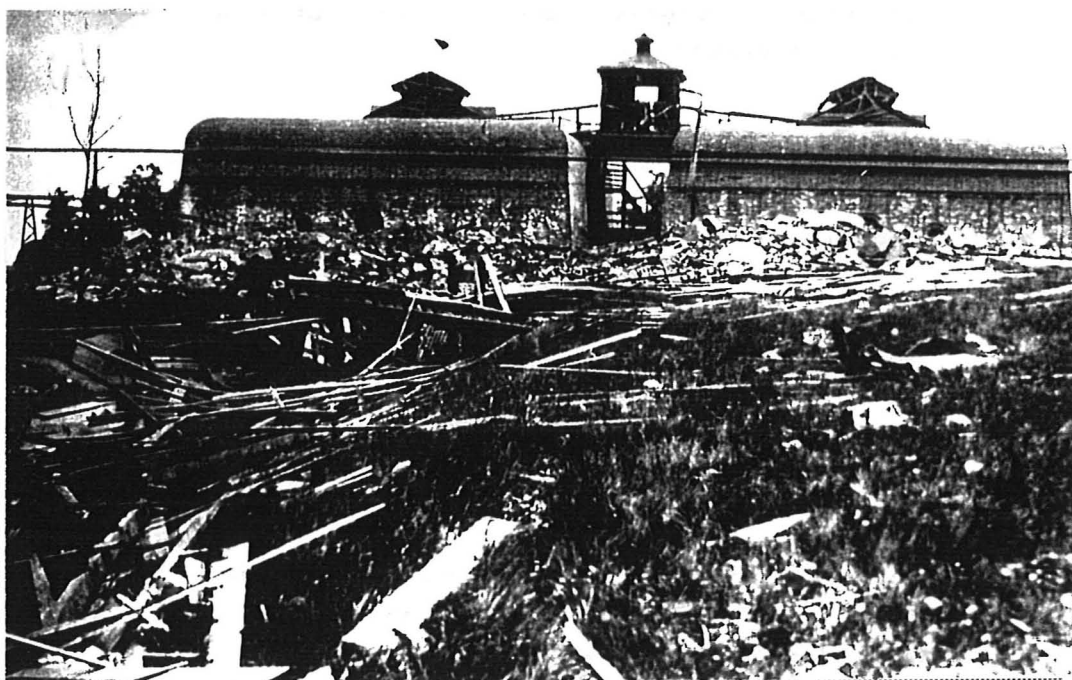


Plate 1

Damage to the original Washing House (built 1891), in the aftermath of the explosion of 7th May 1894 (looking north). In the background are the two Nitrating Houses, with the Charge House mounted between them, on top of the brick traverses. The original Washing House was surrounded by a similar traverse. When the Washing House was rebuilt after the explosion, the brick traverse was replaced by an earthwork one (MOD photograph).

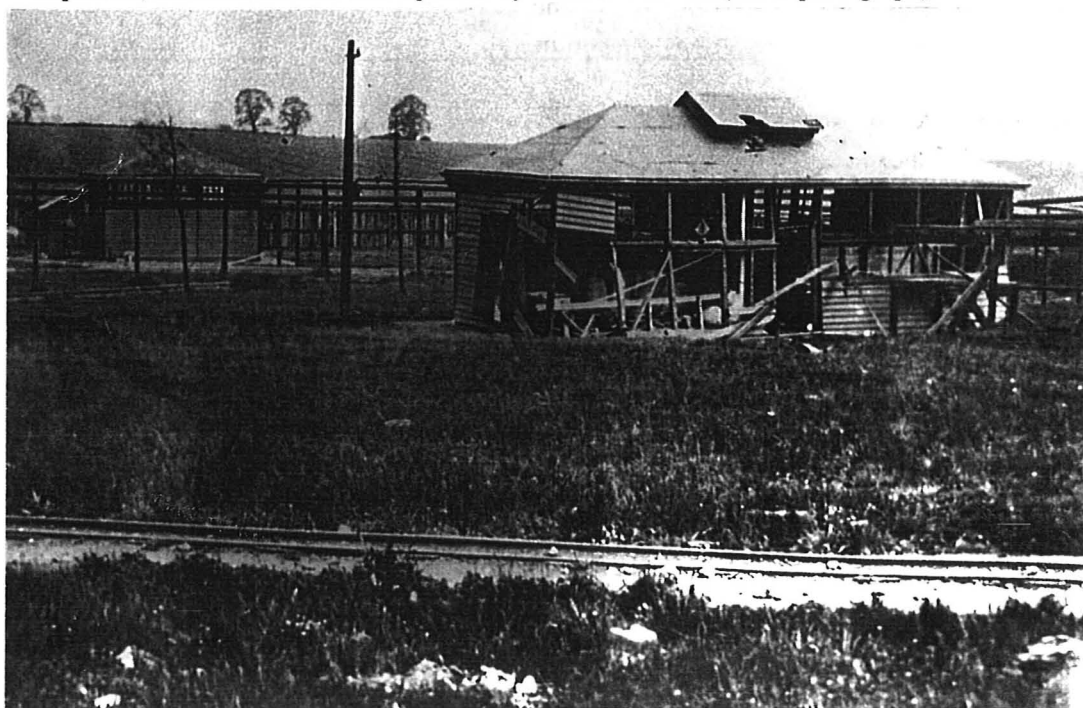


Plate 2

Damage to the Wash Water Settling House, in the aftermath of the explosion of 7th May 1894 (looking SE). Part of the guttering used to carry the wash waters from the Washing House can be seen on the extreme right of the picture. (MOD photograph).

NITRO-GLYCERINE WASHING HOUSE SOUTH SITE WALTHAM ABBEY ROYAL GUNPOWDER FACTORY ESSEX

A survey by the Field Archaeology Group Essex County Council

Client: ECC Archaeology Section funded project

NGR: TQ 38319960

Site Code: WASS 96

Project No: 244

Dates of Fieldwork: 27th February - March 4th 1996

1.0 INTRODUCTION

Waltham Abbey Royal Gunpowder Factory (RGPF) was finally closed on June 30 1991. It is hoped that a museum use will be found for North Site, a large area of which is scheduled as an ancient monument, but it is expected that South Site will be sold for private development purposes. The decontamination process is likely to result in the firing and removal of many of the process buildings. a ✓

Given this potential threat, the Archaeology Section of Essex County Council (ECC) has provided funds to carry out a plan and photographic survey of the exceptionally well preserved nitro-glycerine Washing House, which formed part of the South Site (Quinton Hill) cordite factory at the turn of the century. The survey was carried out by ECC Field Archaeology Group, in response to a brief prepared by ECC Planning Department's Archaeological Advisory Group, who also monitored the work. This report draws heavily on fieldwork and research conducted by staff of the Royal Commission on the Historic Monuments of England (RCHME 1993). Although the work of RCHME at Waltham Abbey RGPF has been mainly concerned with North Site, some work has been carried out on the South Site, including a low level survey of the nitro-glycerine washing house. This as yet unpublished material includes a textual report on the washing house, a plan of the internal features, a section through the building (Fig.4), and a photographic archive.

This report provides a more detailed record of the building, complementing the RCHME survey, and placing the structure in its wider context. A copy of the report, and copies of the 1:50 building plan and sections, will be held in the Essex Sites and Monuments Record (ESMR). b ✓

2.0 SURVEY METHOD

The Washing House was surveyed in plan and section using a Zeiss Rec Elta 15 total station theodolite. Detail points were plotted and drawn at a scale of 1:50. Cross-sections of the entrance tunnel and each conduit tunnel were drawn at a scale of 1:10. This report includes reduced versions of the 1:50 survey plots (Figs.3, 5), a cross- c

-section through the north-west conduit tunnel (Fig.5, inset) and the RCHME cross-section A-A1 (Fig.4). The RCHME plan is not reproduced here, as it is superseded by the present survey.

Professional photographic coverage of the interior and exterior of the building including video footage (by N.Macbeth), was commissioned to complement the existing RCHME photographic archive (RCHME National Monuments Record, National Library of Air Photographs). A selection of the photographs (Plates 1, 4-41), and full photographic registers are reproduced in this report (Appendix 1).

All archive drawings, digital data and photographic material will be held in Epping Forest District Museum, with copies provided to the ESMR.

3.0 HISTORY OF THE SITE

The Royal Gunpowder Factory at Waltham Abbey (Fig.1) was a centre of gunpowder production, and latterly chemical-based explosives manufacture, for more than 300 years. There is documentary evidence that gunpowder was being produced at North Site by the mid-1660's. The mills were acquired by the government in 1787, and expanded greatly as a result of the demand for powder generated by the Napoleonic wars. After a period of retrenchment from the 1820's, the RGPF returned to prominence in the second half of the 19th century, playing a leading role in technical innovation, meeting demand for cannon powders for guns of ever-increasing size, and manufacturing moulded powders in large quantities (RCHME 1993).

In the later 19th century, experiments with chemical-based explosives revolutionised military propellants. The most important new explosives of this period were guncotton, and later cordite, which was a blend of guncotton with nitro-glycerine. The greatly increased power of guns using nitro-cellulose and nitro-glycerine based explosives led to gunpowder being largely replaced by these materials by the end of the century. Waltham Abbey RGPF in the late 19th and early 20th centuries was a centre of innovation. Senior staff at the factory produced a number of technical papers and official manuals at this time which had a world-wide influence on explosives manufacture. (*Ibid.*).

3.1 The history of chemical explosives: Guncotton nitro-glycerine and cordite

Guncotton, which is created by the action of a mixture of nitric and sulphuric acid on cotton (Simmons 1963: p.39) was discovered by Professor Schöbein of Basle University in 1846. It was investigated by Sir Frederick Abel as a potential British service explosive from 1863, and was first manufactured on a large scale at Waltham Abbey from 1872. By the 1880's, the military demand for guncotton could no longer be met by the original facilities on North Site. In order to increase production capacity, a new, purpose-built factory was established on land purchased on Quinton Hill in 1885, known as South Site. The factory was complete by 1889, and began production in 1890 (RCHME 1993).

21 The explosive properties of nitro-glycerine were first discovered in 1847 by the Italian chemist Professor Ascanio Sobrero, who called it piro-glycerine. In 1863, Alfred Nobel introduced it to Norway as a blasting agent, but it proved too dangerous in liquid state for practical purposes. After a long series of experiments, Nobel discovered that when blended with a suitable stable absorbent material, nitro-glycerine could be stored and used safely. Nitro-glycerine blended with 'kieselguhr' was patented as 'Dynamite'. Nobel later succeeded in replacing the kieselguhr with an explosive absorbent and in 1875 he patented 'blasting gelatine', the most powerful form of which consisted of 93% by weight of nitro-glycerine and 7% by weight of soluble nitrated cellulose (gelatinised) (Nathan and Rintoul 1908)

g2 In 1889, Abel and Dewar patented a new explosive, 'Cordite', which was a blend consisting of 58% nitro-glycerine, 37% guncotton and 5% mineral jelly (RCHME 1993). Only two years later, in 1891, Cordite was adopted as the propellant for the .303 cartridge for the British Army's new Lee-Enfield rifle (Hogg 1963), and rapidly replaced gunpowder in large bore armaments (RCHME 1993).

3.2 Nitro-glycerine manufacture at Waltham Abbey RGPF

h The following account briefly summarises the processes of nitro-glycerine manufacture in use at Waltham Abbey RGPF at the turn of the century, covering the washing and filtration processes in more detail. The manufacturing process is usefully summarised by Figure 3, which is a schematic diagram of the Edmonsey nitro-glycerine plant on North Site, before its conversion to the Nathan-Rintoul design, redrawn from the War Office 'Treatise on Service Explosives' (1900). The only major difference between this plant and the Quinton Hill Factory is that the elevation required to run the nitro-glycerine between the houses by gravity, was gained by use of a lift, rather than the natural slope of the ground. More complete accounts can be found in the technical papers and official manuals written at the turn of the century, on which this description is based (e.g. Nathan and Rintoul 1908, War Office 1895, War Office 1900), and in the recent RCHME report on North Site (RCHME 1993). The descriptive section of this report includes a detailed discussion of the plant surviving in the Washing House.

3.3 The Nitrating Process

o The nitro-glycerine is formed by the nitration of glycerine in a mixture of nitric and sulphuric acid. A mixture of these two acids was first moved by compressed air from the 'acid egg' into a tank in the Charge House. A second tank in the Charge House contained glycerine. A charge consisting of 1054lb of nitric and 1785lb of sulphuric acid were run down by gravity into the lead nitrating vessel, where the acid mixture was cooled to 16°C by passing water or brine through coils in the base of the vessel. The glycerine was then sprayed into the base of the nitrating vessel. As there was a danger of explosion if the temperature of the mixture was too high, a 'drowning tank' filled with cold water was placed below the nitrating apparatus, into which the charge could be emptied if the temperature rose above 22°C (Nathan and Rintoul 1908).

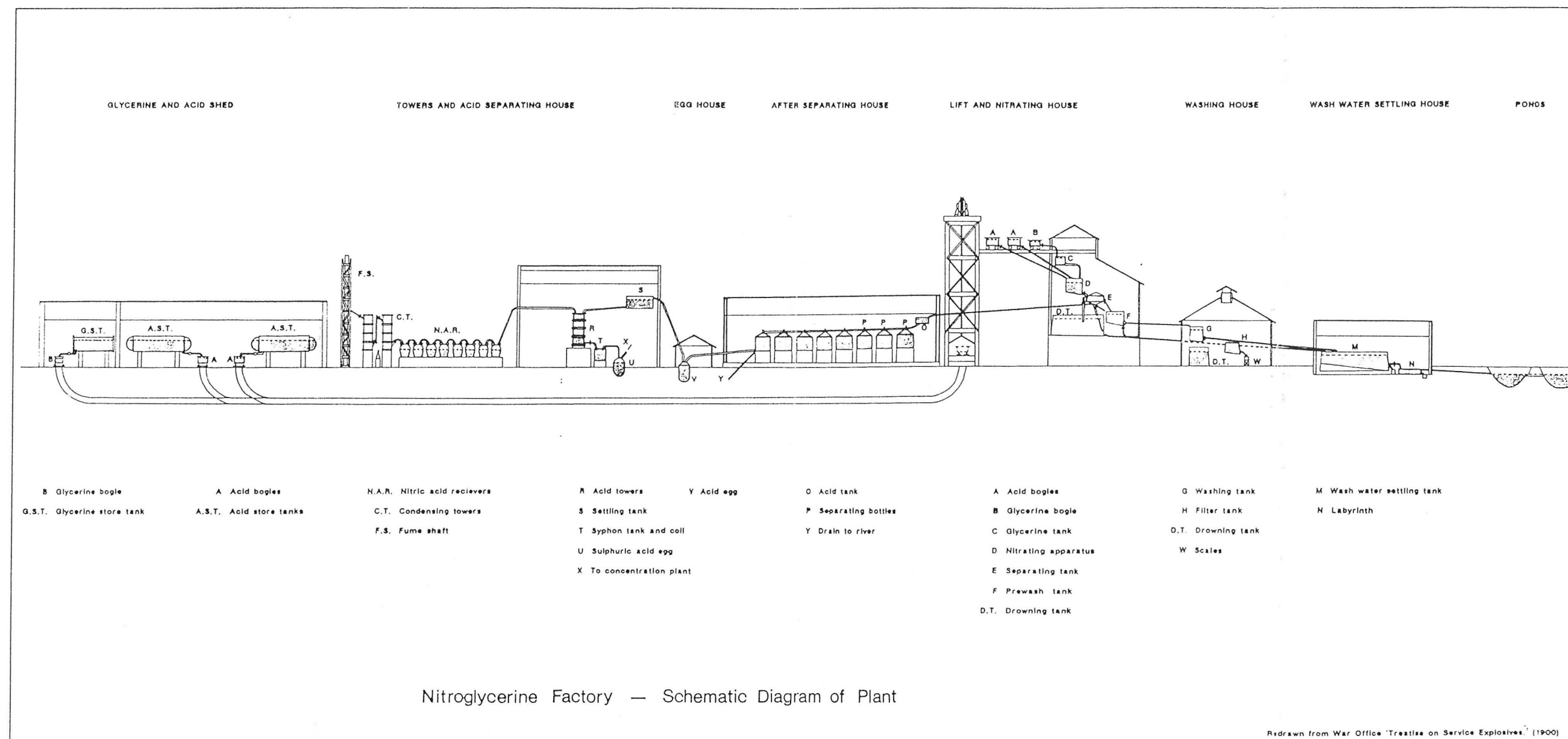


Fig.2 Nitroglycerine Factory. Schematic diagram of manufacturing plant This diagram is based on the Edmonsey plant in 1900 (RGPF North Site). The Nobel designed plant is very similar to that at Quinton Hill, except that the elevation necessary to run the nitroglycerine between houses by gravity, was achieved by use of a lift, rather than the natural slope of the ground.

After nitration, the charge was drawn off through an earthenware cock, into a 'separation tank', where the nitro-glycerine was allowed to displace to the surface, forming a layer about 4.5 inches (0.11m) thick. The waste acids were drawn off from the base of the tank through a second earthenware cock, and run down to the 'After Separating House' for recycling.

In 1901, a minor explosion occurred in an earthenware cock in No.2 nitration house at the South Site plant. Although little damage was done, the incident encouraged the plant superintendent, Sir Frederick Nathan, and others, to develop safer manufacturing methods. The resulting 'Nathan, Thomson and Rintoul process' introduced a number of important changes including substantial changes to the nitrating apparatus. i (cont)

The Nathan-Rintoul plant installed in No.1 Nitration House at Quinton Hill in 1903 was designed with the aim of simplifying the production process and removing the more dangerous operations entirely wherever possible. In particular, it had always been recognised that the use of earthenware cocks for drawing off separated liquids at various stages of the production process, was a source of considerable danger 'owing to the possibility of friction being set up between the body of the cock and the key, when the latter was manipulated, should any foreign gritty substance be present' [Nathan and Rintoul 1908: p.199]. A new separation technique was devised in which the nitro-glycerine was floated to the top of the separation tank on the surface of an inert, heavier liquid. Waste acid was used for this purpose. The nitro-glycerine was thus pushed over the edge of the tank and into a gutter connecting the 'nitrator-separator' to the pre-wash tank.

After nitration, the nitro-glycerine was run into the pre-wash tank and washed four times in water, the last time using warm soda solution. The pre-wash waters were run off to the 'Wash Water Settling House' (Plate 3) where any residual nitro-glycerine was removed and returned by hand to the pre-wash tank (Nathan and Rintoul 1908).

3.4 The Washing and Filtering Process

The pre-washed nitro-glycerine charge of about 750lb was run, by gravity, down lead-lined gutters to the Washing House, where two batches could be washed at a time. The gutter rested on wooden trestles where it crossed open ground. It consisted of an inner and outer lead jacket, between which warm water could be run when necessary, to prevent the nitro-glycerine from freezing. Early gutters were protected from the weather and dirt by a V-shaped timber cover, but this was later replaced with a canvas cover, permanently attached on one side and laced down the other to allow access for cleaning. The scrupulously observed safety regulations demanded that after a charge had been run down the gutter, its full length should be wiped down with a flannel cloth, in the direction of the Washing House, to remove any traces of nitro-glycerine (Engelbach 1900, Nathan and Rintoul 1908: Diagram No.7).

The washing was carried out in two lead lined wooden barrels, supported on raised platforms in the Washing House (Fig.6, Plates 13, 22). Before the charge was run down, some warm soda solution was sent down the gutter from the Nitration House to the washing tanks. This was immediately followed by the nitro-glycerine charge, and

then by some more warm soda solution. The nitro-glycerine was washed three times using warm, weak soda solution, and once using water, to remove any remaining traces of acid. The wash water was kept constantly agitated by means of compressed air, injected into the tank through a movable pipe, laid around the bottom. The warm soda solution, and softened and filtered water used in the washing process, were supplied from the main supply tanks in the Charge House (Nathan and Rintoul 1908, RCHME 1993).

The washing tanks were provided with two cocks; one at the base for drawing off the nitro-glycerine and one at a slightly higher level for draining the wash-water. The wash-water was drained off using a saucer-shaped 'skimmer dish' connected by a rubber pipe to the wash-water drainage cock. The skimmer dish was raised and lowered by hand, using a counterweight pulley system attached to the outside of the building. Earlier types were of lead, but later designs were made of lighter materials, such as brass, covered with rubber cloth.

9 feet
In the early factory, lead splash screens were fitted around the tops of the washing tanks (Sandhurst 1894). By 1908, hoods of rubber cloth were provided instead, each connected to a funnel passing out through a hole in the roof. A compressed air jet could be inserted into the funnel to force the fumes out of the building. A rectangular drowning tank, kept filled with cold water, was placed below the washing tanks. If the wash waters exceeded 50°C, the charge could be made safe by releasing it into the tank (Nathan and Rintoul 1908).

After washing, the nitro-glycerine charge was filtered to remove any remaining water or flocculent matter. This process was usually carried out in the Washing House. The nitro-glycerine was run by gravity from the washing tanks, via an earthenware cock and an india-rubber connecting tube, into a lead lined wooden filtration tank. The filtration tank was supported on a platform at a lower level than the washing tanks. It had a cover, pierced by a brass tube with the top end open. The bottom end of the tube was sealed with a wire gauze attached to a solid metal ring. A flannel bag filled with salt was placed on top of the gauze to act as a filter. The nitro-glycerine was run into the top of the tube and through the salt in order to absorb any moisture, and filter out flocculent matter. It then passed into the body of the tank, from where it could be drawn off through an earthenware cock. The salt bag was replaced daily, or more often if necessary (*Ibid.*).

Procedures for dealing with the nitro-glycerine charge after filtration seem to have undergone some change between 1894 and 1904. Before the disastrous explosion of 1894 (see below), the nitro-glycerine was run down a lead-lined gutter from the Washing House to the Nitro-glycerine Store, where it was kept in a tank until required for blending with guncotton. After the explosion, however, the practise at Quinton Hill was changed so that liquid nitro-glycerine would no longer have to be stored. Instead, the charge was run down a gutter to the Weighing House, where it was weighed and immediately 'poured-on' a charge of guncotton contained in a tin box (Fitzgerald 1895, War Office 1895). The resulting 'cordite dough' could be stored in relative safety, once it had passed the Abel heat test for stability. By 1900, the nitro-glycerine was drawn directly from the filtration tank into a suitable vessel placed on scales for

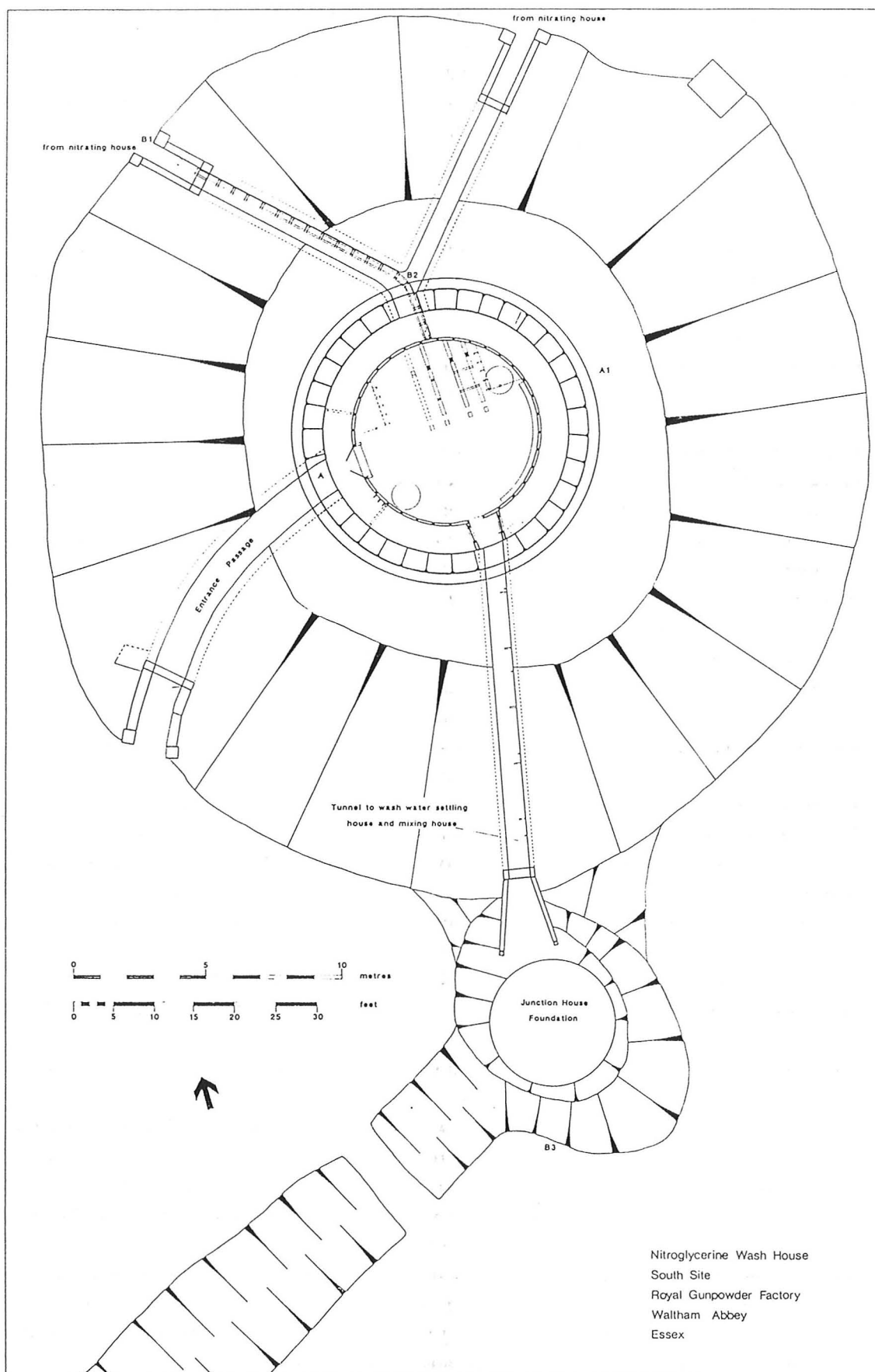


Fig.3 Nitroglycerine wash house. Building plan, reduced from 1:50 survey plot

weighing. The charge was then run down to the Mixing House, and immediately 'poured-on' guncotton (War Office 1900, Nathan and Rintoul 1908).

g (cont.)
The Nathan-Rintoul method, adopted in 1903, moved the filtration process out of the Washing House and into the Mixing House. A new type of plain lead filtration tank was introduced. It had a perforated, fixed false bottom, and used sponges sewn up in flannel instead of the salt-filled filter bag. The use of a burette to draw off the nitroglycerine from the filtration tank, in place of the dangerous earthenware cock, allowed the charge to be accurately measured rather than weighed. It also meant that the nitroglycerine could be poured directly from the filtration tank onto the guncotton charge. By this date, the guncotton was carried to the mixing house in rubber-lined canvas bags rather than tin boxes (Nathan and Rintoul 1908). Nitration plant of the Nathan-Rintoul design was installed in No.1 Nitration House in 1903 (Macdonald 1991), but it is not clear whether the new filtration plant was ever used in the Washing House at Quinton Hill.

Contaminated wash waters were drained from the washing tanks into a lead-lined gutter, and run by gravity to the Wash Water Settling House, where any residual nitroglycerine was allowed to settle to the bottom. This was then drawn off into rubber buckets and returned to the preliminary washing tank in the Nitrating House. The mud from the settling tank was removed each week, washed to remove any remaining nitroglycerine, then mixed with paraffin and burnt (Nathan and Rintoul 1908). The wash waters were drained into a large settling pond, which served all of the nitro-glycerine houses, and which was blown up every Saturday with a dynamite charge (Fitzgerald 1895).

3.5 History of the South Site (Quinton Hill) Nitro-glycerine Factory

k
In order to allow large scale manufacture of cordite, nitro-glycerine production facilities were constructed on Quinton Hill in 1891, to complement the newly built guncotton works (in production from 1890). During the early 1890's, Waltham Abbey RGPF (South Site) was the only cordite factory in the country, though private manufacturers were producing the explosive under license from 1894 (RCHME 1993).

The nitro-glycerine plant was based on the Nobel factory at Oplagen, near Cologne, and the manufacturing plant was also imported from Germany (*Ibid.*). Some alterations were made to the German plant, based on the experience of the superintendent of the Nobel plant at Ardeer, in Scotland, where nitro-glycerine had been made since 1873.

Two Nitrating Houses (numbered 1 and 2) were built on the summit of Quinton Hill, adjacent to one another, but separated by brick traverses (Plate 2). Only one house was to be used at a time, allowing maintenance work to be carried out on the other. The two houses shared a Charge House on top of one of the traverses. The Nitrating Houses were constructed on top of the hill, so that the nitro-glycerine could be run down to the Washing House by gravity. The Nitro-glycerine Store was adjacent to, but separated from, a building intended to be used as a Dry Guncotton Store. The latter was never used as such however, and was converted into an additional Nitro-glycerine Store in 1894. All of the nitro-glycerine houses, except for the After Separating House and the Wash Water Settling House, were protected by high brick traverses, filled with

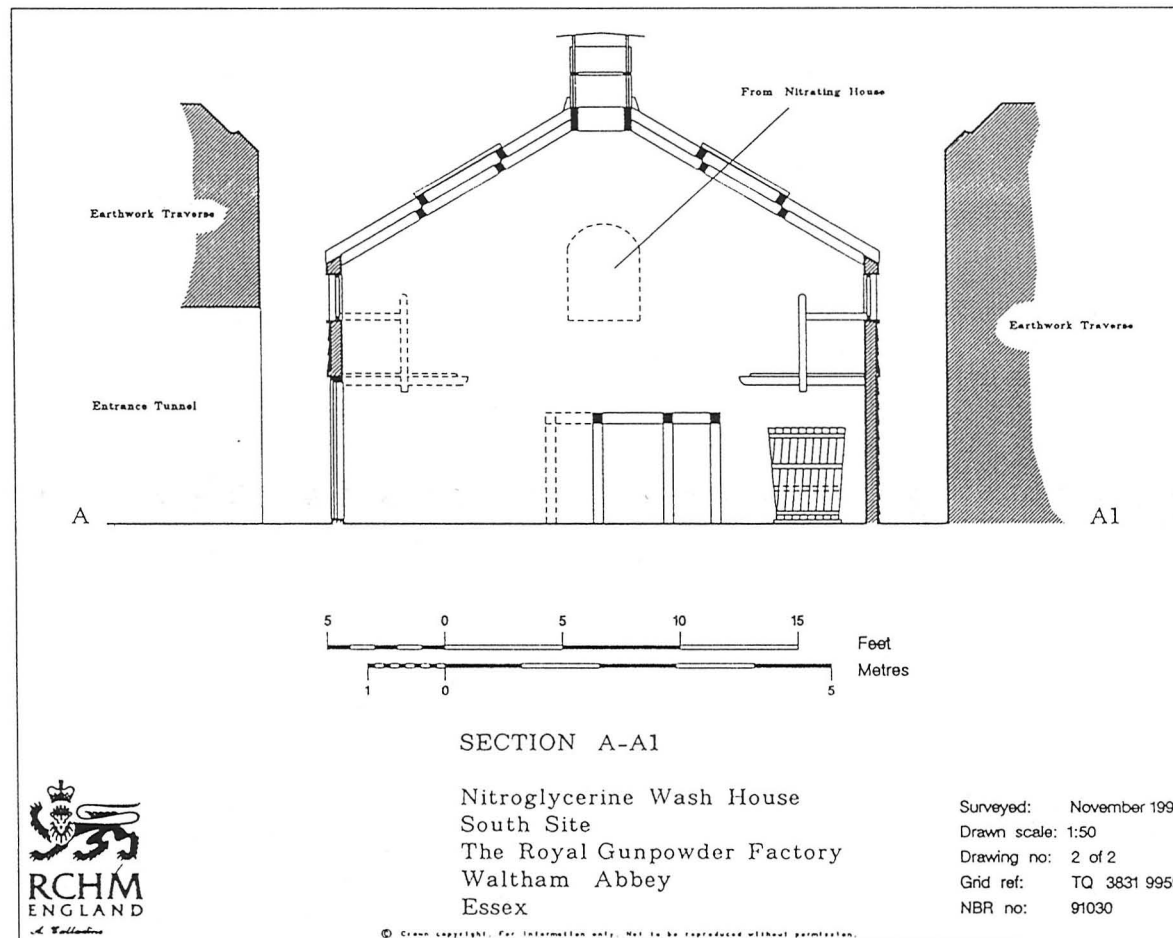


Fig.4 Nitroglycerine wash house. Section A-A1

earth and rubble, similar to those used to surround gunpowder buildings (Macdonald 1991) (Plate 1).

At eight minutes past four on Monday 7th May 1894, there was a disastrous explosion at the plant, in which both the Washing House and the Nitro-glycerine Store blew up (Plates 2 and 3). The processman working in the Washing House was killed, together with the chemist-in-charge, the Foreman of the nitro-glycerine plant and the Foreman plumber, who were apparently approaching the Washing House entrance at the time. Other buildings in the area were extensively damaged, particularly No.2 Nitration House, where a nitration was in process. The chemist-in-charge of the guncotton factory, despite being injured, entered the Nitration House and with the two processmen working in the building, saw the charge safely drowned before seeking medical attention. A carpenter and boy working on the new guttering between the converted Dry Guncotton Store and the Washing House, miraculously escaped serious injury, despite being between the two exploding buildings (*Ibid.*).

K (cont)
As the Nitro-Glycerine store was locked and unoccupied at the time of the explosion, the subsequent court of enquiry concluded that the Washing House had blown up first. Although no definite cause could be found, a number of working practises were immediately changed, and the explosion added impetus to the search for safer production processes (Macdonald 1991, RCHME 1993).

The destroyed process buildings were quickly rebuilt after the 1894 explosion. As the South Site plant was still the only cordite factory in the country at this time, military necessity demanded that it be brought rapidly back into commission (RCHME 1993). In the interests of speed, the same site was used, overriding the Court of Enquiry recommendation that the nitro-glycerine plant should be placed at a greater distance from the South Site guncotton and cordite works (Macdonald 1991).

The original nitrating plant was retained and the Washing House was rebuilt using a new design, including a circular wooden structure, partly sunk into the ground. The brick revetted traverses surrounding the destroyed nitro-glycerine houses, which had proved unsatisfactory for containing the explosions, and had in fact added to the quantity of flying debris, were replaced on the new washing house with an earthwork traverse, revetted with brick on the inside. The court of enquiry recommended this change as earthwork traverses had successfully contained nitro-glycerine explosions in the plant at Ardeer. The brick traverses surrounding the Nitrating Houses remained in use (Macdonald 1991, RCHME 1993).

The loss of production caused by the explosion highlighted the danger of concentrating cordite manufacture on a single site. On the recommendations of the court of enquiry, a new factory was constructed at Edmonsey, on the North Site, in 1898, with much of the cordite incorporating and pressing plant being installed in converted gunpowder buildings. The new factory was supplied with guncotton from the existing South Site plant. Whereas nitric and sulphuric acid, required for the manufacture of both guncotton and nitro-glycerine, had previously been acquired from outside sources, the new North Site cordite factory included a purpose-built acid plant. Glycerine continued to be supplied from commercial sources (RCHME 1993).



Plate 3

View of the Washing House in March 1996 (looking north-west). This building, which was constructed in 1894, was built on the site of the original Washing House, following the disastrous explosion of the same year.

The new Nathan-Rintoul designed plant (see above) was installed in No.1 Nitration House at Quinton Hill in 1903, and the Edmonsey Hill factory in 1904 (Macdonald 1991, RCHME 1993). No.2 Nitration House continued to use the old Nobel designed plant.

At around the same time, the proportion of nitro-glycerine used in cordite was reduced from 58% to 30%, as the old Mark I cordite was causing excessive erosion to gun barrels. The consequent reduction in demand for nitro-glycerine allowed the Quinton Hill plant to be put in reserve in August 1903. At about the same time, the Nitrating House at Edmonsey was designated 'No.1', while those at Quinton Hill were renumbered '2' and '3' respectively.

Nitrating House No.2 at Quinton Hill was briefly brought back into service between April and December 1904, while the Edmonsey plant was being converted to the Nathan-Rintoul design, but went back into reserve in January 1905. Nitrating House No.3 was demolished in 1907-8, along with the After Separating House, which was not required in the Nathan-Rintoul process (Macdonald 1991).

Of the original 1891 factory buildings, Nitrating House No.2 survived relatively intact until its demolition in 1992. Of the buildings built after the 1894 explosion, the Washing House, Junction House and Mixing House were all present in 1991 (Macdonald 1991). At the time of writing, the Washing House survives in a good state of preservation, the Mixing House is present, but in a poor state of preservation, and the Junction House foundation is visible only as a circular, brick-lined pit.

4.0 DESCRIPTION OF THE WASHING HOUSE

The Washing House consists of a circular timber roundhouse, surrounded by an earthwork traverse (Plate 1). The traverse, which has an external diameter of c.32m, and an internal diameter of 9.05m, is revetted on the inside by a brick wall, capped with concrete. It is pierced by four brick-vaulted tunnels, including the entrance passage, and three conduit tunnels (Fig.3).

The building is entered from the south-west along a curving, brick-vaulted passage, passing through the traverse. The western side of the entrance appears to be braced by a sloping concrete feature, partly buried by the earth mound (Fig.3, Plate 4). The sides of the entrance beyond the end of the tunnel are revetted by brick walls, sloping at the same angle as the traverse slope and terminating in low brick plinths (Plate 4).

The building was (until recently) closed at the entrance by a wooden, slatted door with an iron lock, which is still on site, but is no longer in place. Traces of paint adhering to the door indicate that it was originally coloured red, as was usual for danger building doors (RCHME 1993). Attached to the door is an unpainted wooden notice board, with black, stencilled lettering which reads:

N.G. VAPOUR MAY BE PRESENT
ENSURE ADEQUATE VENTILATION

The door formerly hung from large iron hinges, which remain *in situ* on the eastern side of the entrance, and show that the door opened outwards (Plate 5). An iron hook, attached to the brickwork on the same side, was used to hold the door open.

The entrance passage is floored with asphalt. Electric light fittings are suspended from the brickwork at either end of the passage, linked by wires encased in small diameter wrought iron pipes which run along the full length of the passage. The light fitting at the entrance consists of a circular iron plate, holding the remains of a protective glass globe. A brass bulb socket passes through the centre of the plate (Plate 6).

Access to the timber roundhouse is via the 'shoe room'. This feature was incorporated into danger building designs after the 1894 explosion, to ensure that workmen changed their footwear or put on overshoes before entering the building, in case grit attached to shoe soles should cause a spark (Plate 7). The shoe room occupied the 1.0m gap between the traverse revetment wall and the roundhouse door. This area is now open to the sky, but was formerly covered by a short length of timber and galvanised metal roofing, extending c. 2.25m on either side of the roundhouse door. The roof was supported on wooden half-walls, with the lower sections left open to allow access into the gap between the roundhouse and the revetment wall. Remains of the collapsed roof lie on the floor below its original position. Three wooden coat hooks are attached to the exterior of the roundhouse wall on the southern side of the door (Plate 9). Below the coat hooks is a small, rectangular, glazed window, providing a view of the roundhouse interior from the shoe room (Plate 8). Between the roundhouse door jambs at floor level is the remains of a wooden toe-board, which served as a physical dividing line between the 'clean' roundhouse interior, and the 'dirty' shoe room floor. Traces of red paint adhering to the toe-board indicate its original colour, which served to emphasise this dividing line (Plate 17) (RCHME 1993, RCHME n.d.). The roundhouse is entered from the shoe room through panelled double doors hung on brass butterfly hinges (Plate 10). Brass was used in preference to iron fixtures and fittings wherever possible, to reduce the risk of sparks causing an explosion.

The Washing House was served by a Y-shaped arrangement of conduit tunnels, passing through the traverse on the north side of the building, and forming a right angle at their junction. The western branch led from No.1 Nitrating House, the eastern branch from No.2 Nitrating House. Nitro-glycerine and soda water were fed downhill from the active Nitrating House along a 60 yard (54m) length of lead gutter. This was supported on wooden trestles across open ground, and on iron brackets set into the brickwork where it passed through the conduit tunnel (Plates 35 and 36). The gutter itself no longer survives, but the plank shelf and shaped blocks on which it was carried survive *in situ* in the north-western conduit tunnel. The shelf is attached to the northern wall of the tunnel (Fig.5). The level of the gutter drops 0.37m over a distance of 11.55m (a slope of c.1:30).

Remains of a short length of canvas cover survive at the junction of the northern conduit tunnels, still attached to the gutter shelf (Plate 34). This cover protected the gutter at the point where it crossed the gap between the traverse wall and the roundhouse, which was open to the sky. It is undoubtedly of the same type as the later form of cover used to protect the guttering in the open ground between the Nitrating and Washing Houses (see above) (Nathan and Rintoul 1908, diagram no.7). In

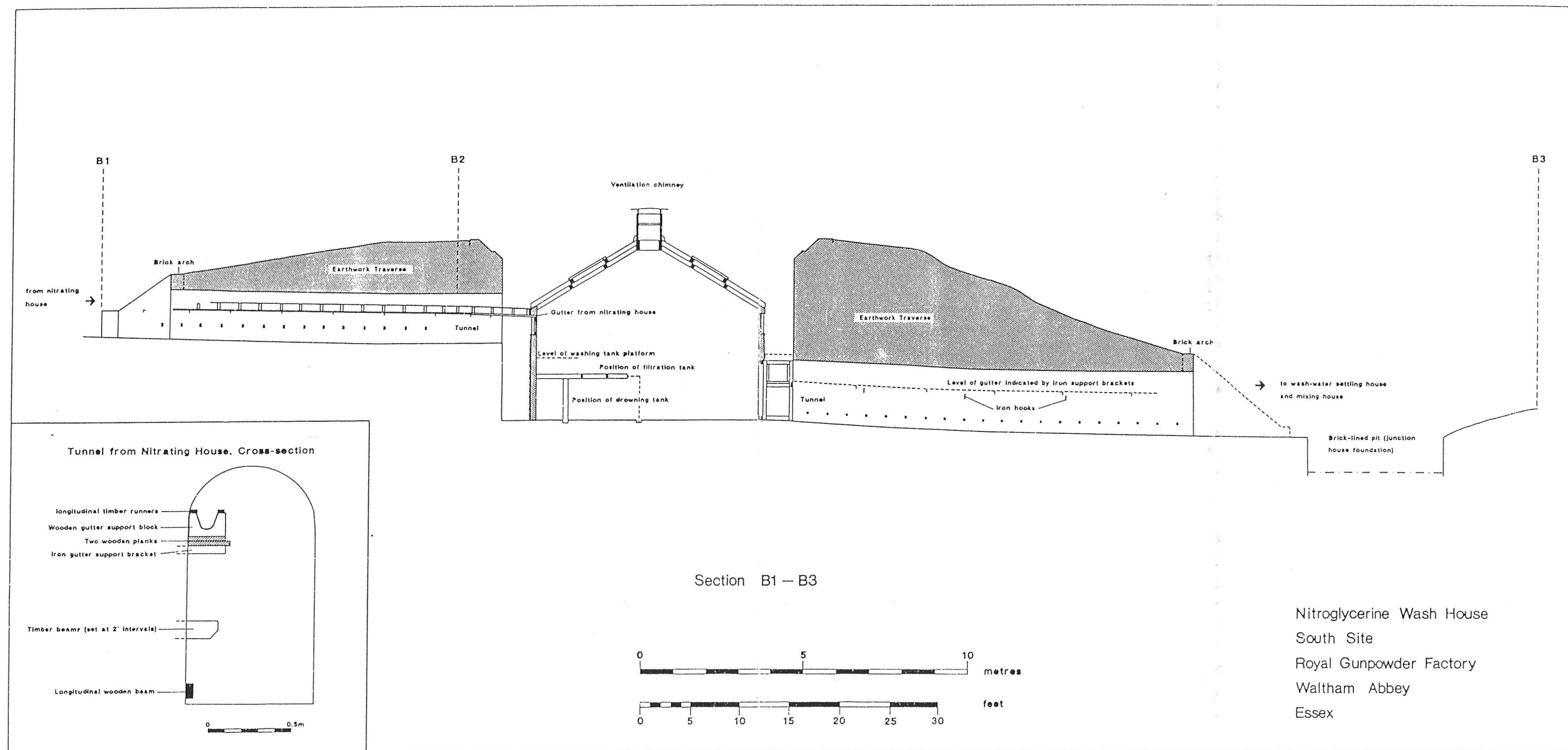


Fig.5 Nitro-glycerine Wash House. Section B1-B3

addition to the gutter fittings, a row of rectangular sectioned wooden beams are embedded in the brickwork along the full length of the tunnel, 0.47m above the floor. The beams are spaced 0.61m (2ft) apart and have their lower corners sawn off. Some of them have been sawn off at the wall. The function of the beams is uncertain, though they might perhaps have supported pipe-work connected with the mains water supply. Mains water was required in the Washing House to maintain the flow of water to the drowning tank, to cool or warm the nitro-glycerine as necessary during the washing process, and for general cleaning purposes (Nathan and Rintoul 1908).

The absence of surviving gutter fittings in the north-eastern conduit tunnel may date from the demolition of Nitration house No.2 in 1907-8 (Macdonald 1991, RCHME n.d.). A row of square sectioned beams, embedded in the brickwork and sawn off at the wall, 0.45m above the floor, probably served a similar function to the rectangular sectioned beams in the western tunnel, possibly as pipe supports. It should be noted that there is no indication of iron wall brackets in the north-eastern tunnel, suggesting that the gutter support arrangements surviving in the north-western tunnel are a late adaptation, post-dating the demolition of Nitrating House No.2 in 1903.

The 1.0m wide gap separating the roundhouse wall from the traverse revetment wall housed any fittings that could not safely be installed inside the building, including electrical wiring for the internal lighting. A vertical iron pipe and stop-cock attached to the revetment wall on the northern side is connected with the steam heating system (Plate 15).

The roundhouse is of timber frame construction with a weather-boarded exterior. The interior of the wall is lined by vertical wooden boards. The upright posts of the timber frame are set 0.61m apart (2ft). The roof is timber boarded and covered externally by galvanised metal sheeting. The rafters rest directly on the wall plate, joining in a crown at the apex of the roof, and are braced against any lateral movement by short spacing timbers (RCHME n.d.). The relatively flimsy construction of the roundhouse was designed to provide minimal resistance to an explosion (RCHME 1993).

The building is lit by small, square windows around the top of the wall, hinged at the top and held open by wooden props when required for ventilation (Plate 23). There are also two five-light roof windows (Plate 18). Artificial lighting was provided by four electric lights set into the roof, of which one survives intact (Plate 20), and one set into the wall above the entrance to the southern conduit tunnel. The lights were protected by glass globes within chicken wire. The bottom of the glass globes would originally have been filled with water, mixed with a small amount of glycerine to prevent freezing. This design was specifically intended for use around danger buildings and was probably first introduced to the RGPF in the 1880's (RCHME 1993). The wires for the lights, which are protected by small bore wrought iron pipes, run outside the roundhouse at roof level, attached to the traverse revetment wall by iron loops. They are connected to a cast iron switch box formerly mounted on an iron pole on top of the mound, to the north, which was connected to the overhead power supply by Cordeaux type insulators with a single groove on the side and top, by Bullers Ltd., London (Plate 21) (RCHME n.d.).

The internal diameter of the Washing House is 6.7m. At the north end of the building is a raised wooden platform with two levels, formerly used to support the washing and filtration tanks (Plates 13 and 22). The horizontal supports of the platform pass through the roundhouse wall and are set into the brickwork revetment. The upper level, which is raised 1.89m above the floor, survives in part on the north-east side of the building. It is fitted with a handrail, suggesting that this part of the platform allowed processmen access to the washing and filtration tanks. A series of wall sockets on the north-western side of the roundhouse indicate that a similar platform, no longer extant, was once located there, at the same level. There is some evidence, in the form of attachment marks on the wall, that these two platforms were originally linked. The washing tanks were almost certainly supported in some way at this level, against the northern wall of the building (see below).

The lower level of the platform is raised 1.40m above the floor surface. It was originally supported on four pairs of upright timbers (of which three posts remain *in situ*). The filtration tank was probably supported at this level, close to the southern edge of the platform.

The original positioning of the washing and filtration tanks can be determined with some certainty by comparison of the relative levels of the platforms with the known depth of the washing tanks, and the position of the fittings associated with the washing tank skimmer dish. The latter include two circular marks on the roof, with four brass screws remaining *in situ* on each, indicating the former position of fixed points from which the skimmer dish for each washing tank was suspended (Plate 13). There are also two circular holes, protected by lead 'eyes' (Plate 32), located just below the wall plate, through which the skimmer dish pulley cables were carried outside the roundhouse to a counterweight (Fig.6).

The washing tanks were supported at a higher level than the filtration tank, directly below the skimmer dish suspension points. This places them close together, against the north wall of the roundhouse. They were originally linked to the gutter from the Nitrating House by an india-rubber pipe which connected to a fixed brass socket on the inside of the roundhouse wall, just below the level of the wall plate. The socket remains *in situ*, c.0.6m west of the gutter terminal (plate 30). It passes through the roundhouse wall and is connected to a broken lead pipe (Plate 29). The pipe presumably linked to the gutter terminal via a 0.05m diameter hole drilled through the bottom of the gutter shelf (Plate 28). The square mark on the interior wall of the roundhouse, immediately above the brass socket, probably marks the position of a nitro-glycerine warning sign.

Two wooden, stave-built barrels, bound by iron hoops fixed with copper nails, are preserved inside the building. Both are undoubtedly washing tanks, though neither is *in situ*, and both have had their lead lining removed. One tank, set against the south-west side of the building, has a height of 1.22m and an internal diameter of 0.98m (Plate 24). The other, now located against the north-east side of the building, is identical, except for an internal diameter of 0.96m (Plate 13). The barrels each have two drain holes; one at the base, for drawing off the nitro-glycerine, and one 0.15m up from the bottom, for draining the wash waters (Fig.6, Plate 27). Part of a small bore lead pipe passes through the barrel side at the base. Compressed air, fed into the tank to agitate

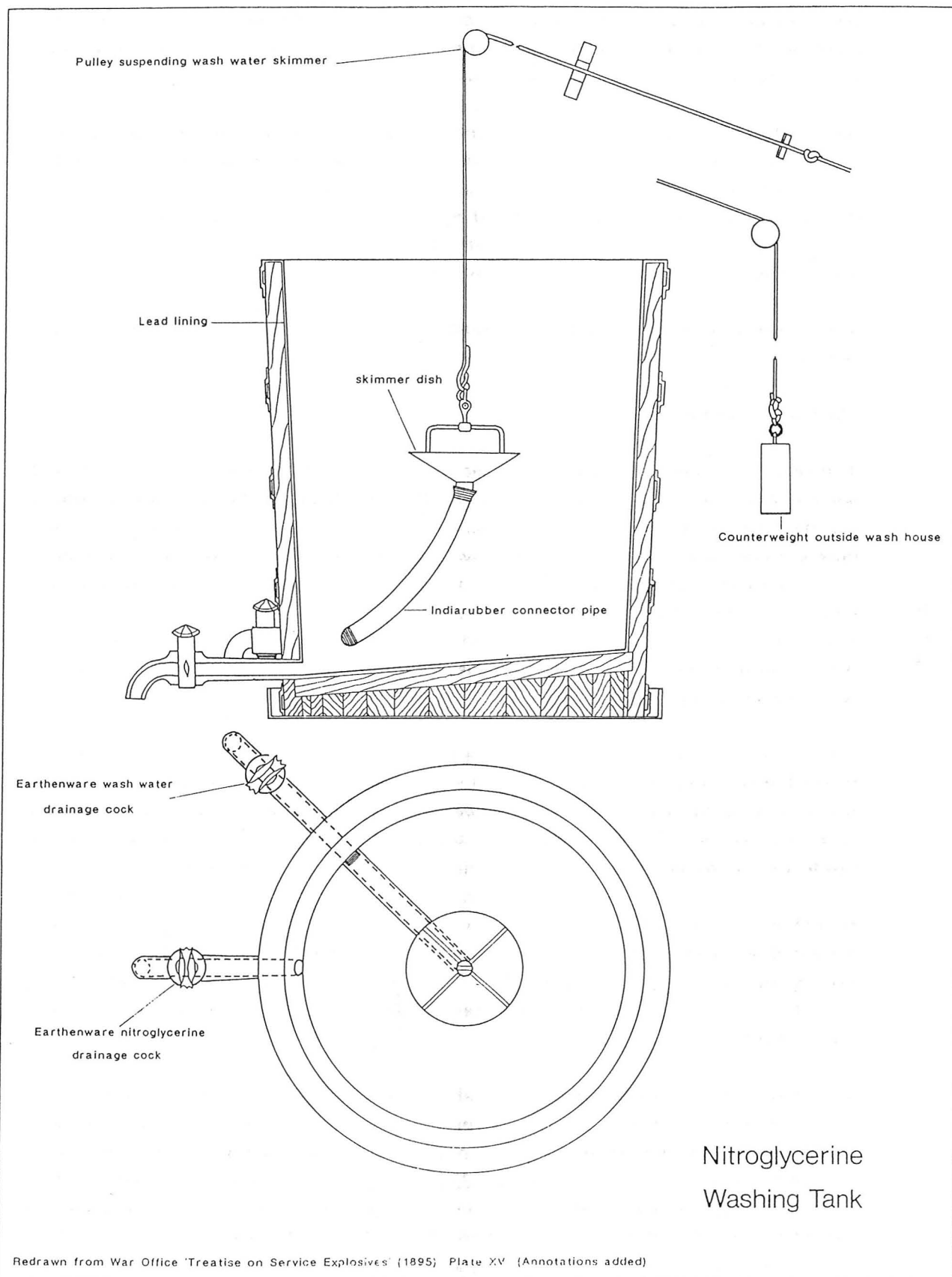


Fig.6 Nitroglycerine washing tank

the wash waters, was probably injected through this pipe. The base of each tank slopes down towards the nitro-glycerine drainage cock. A groove, running around, and bisecting the base of the tank, was probably intended to facilitate drainage of the nitro-glycerine, but may also have housed the movable pipe through which compressed air was injected into the wash waters (Plate 27).

Around the lip of the barrels are a series of small pegs that were probably used to secure the hood by which the fumes were contained. During the washing process, the temperature of the wash water could be varied by pouring in warm or cold water over the side of the tank. A shallow, curving groove, cut into the top edge of each barrel may have served as a pipe rest during this operation (Plate 25). It may also have been used to steady the india-rubber connector pipe, linking the nitro-glycerine gutter with the washing tank. If the barrels were placed at the higher platform level, as discussed above, their tops would have been at the same level as the gutter terminal socket (Plate 30).

The location of the filtration tank in the washing house is uncertain, and the tank itself is missing. It was probably close to the southern edge of the lower level platform, with its base c.0.5m lower than the base of the washing tank. This would be consistent with the evidence from a schematic section through the Quinton Hill nitro-glycerine plant in the 'Treatise on Service Explosives' of 1895, which suggests that the height of the filtration tank was approximately half that of the washing tanks, and that it was placed so that its rim was just below the level of the nitro-glycerine drainage cocks on the washing tanks (War Office 1895).

A lead-lined, wooden, rectangular drowning tank, kept full of cold water, would originally have been placed below the raised platforms, although no trace of it now survives (Nathan and Rintoul 1908, War Office 1895).

A loose wooden chalk board was found loose inside the Washing House. The writing surface is divided into a table with headed columns, and rows numbered down the left hand side. The board was used to keep track of the weight, temperature and settling times of each charge (Plate 33).

[illegible]

Two large radiator pipes originally ran around the inside of the roundhouse on the east side (Plate 11). The cast iron heater unit, which is no longer connected, is located adjacent to the southern conduit tunnel, in the gap between the traverse revetment and the roundhouse, close to its original position (Plate 16). The original position of the radiator pipes is indicated by a rectangular mark on the roundhouse wall, indicating the presence of a cover, and by a circular hole in the roundhouse wall, by which the pipes were connected to the heater unit.

A conduit tunnel on the south side of the building housed the lead gutter used to carry away the washed and filtered nitro-glycerine and the contaminated wash waters (Plate 36). Neither the gutter nor its timber shelf survive, though the iron brackets on which it rested are still *in situ*. The level of the tunnel floor drops by 0.48m from north to south along its 13.1m length. The level of the gutter supports drops by 0.45m over a similar distance (a slope of c.1:30). A row of iron hooks are attached to the brickwork at a level slightly below the gutter support brackets and may originally have supported a water pipe (Plate 37). This tunnel also contains two rows of square sectioned beams, embedded in the brickwork at 0.61m (2ft.) intervals, all of which have been sawn off at the wall. One row runs 1.22m up from the base of the tunnel, on the west side, the other 0.36m from the bottom of the tunnel on the east side. These features perhaps reflect successive changes to the guttering and pipe-work in the tunnel. At the mouth of the tunnel is a stencilled sign identical to that found on the Washing House door, warning of nitro-glycerine fumes (Plate 38).

Immediately to the south of the tunnel exit is a circular, brick-lined pit, 4.65m in diameter, which is all that remains of the Junction House built after the 1894 explosion. It is thought that the Junction House contained some means of diverting the nitro-glycerine to the Mixing House, and the wash waters to the Wash Water Settling House, though the contemporary technical manuals give no details as to how this was achieved (Cockcroft (RCHME) pers.comm.).

To the south of the Washing House, a telegraph pole had a strand of brass barbed wire attached to it. This unusual feature is another example of the precautions taken to avoid sparking in the vicinity of danger buildings, by using non-ferrous metals for fixtures and fittings wherever possible.

On the north-east edge of the traverse is a small, hollow rectangular brick structure, open on the south-east side and lined with iron plates. It is thought to post-date the closure of the nitro-glycerine plant and is of uncertain function.

5.0 DISCUSSION

The Quinton Hill plant formed part of the first cordite factory in the world. As one of only two buildings surviving from the early factory, the Washing House is a historic building of national importance. The survival of many internal fittings from the turn of the century make the Washing House unique in Britain. The building has scarcely been touched since it went into reserve in 1907-8, except to strip out most of the extensive lead fixtures and fittings. The excellent state of preservation has largely been due to continuous government ownership of the site, ensuring restricted public access and protection from redevelopment.

The primary sources of information about nitro-glycerine manufacture at the turn of the century are the technical papers of the time. These also provide specific information about buildings and equipment in use at Waltham Abbey, which was used as a model factory, by private manufacturers as well as government establishments. Also of specific relevance to the Washing House survey is the Sandhurst committee report on the explosion of 1894, which includes a plan and section of the proposed design for reconstructing the Washing House and Nitroglycerine Store. There are significant differences between this design and the structure finally built. The present survey has highlighted a good deal of otherwise unrecorded detail, such as the original positioning of the washing tanks, the actual slope of the nitro-glycerine gutter and the means by which the nitro-glycerine was transferred from the gutter into the washing tanks. It is clear that the plant was subject to constant adaptation and improvement during its period of use, and some of these changes are apparent in the surviving structure. Most notably, the rows of wooden beams embedded in the brickwork of the conduit tunnels, hint at earlier forms of guttering than that surviving in the north-west conduit tunnel.

The survey has also recorded many ancillary features not directly related to the production processes, such as the danger building light fittings, the heating system and the shoe room. The design of the building demonstrates an overriding concern with health and safety. Many of the features incorporated into the rebuilt Washing House after the explosion of 1894, such as the use of an earthwork traverse instead of a brick one, reflect the lessons learned specifically from that disaster. Other features, such as the widespread use of brass, instead of iron, for making screws, barbed wire and numerous other fittings, in order to reduce the risk of sparks, were the culmination of several centuries of experience working with gunpowder at Waltham Abbey RGPF.

Highly visible warning signs, red painted doors, and lists of regulations were a common feature of danger buildings. By 1908, for instance, it was considered vital to keep heavy or hard loose tools out of the nitro-glycerine houses. As an aid to enforcement 'Use Lists' of permitted equipment were posted by the entrance to each building. The only articles permitted in the Washing House were 6 rubber buckets, 6 gutta-percha bucket covers, 3 flannels, 3 pairs of rubber overshoes and 3 thermometers. The same board also listed the quantity of explosives and the number of men allowed inside the building in accordance with safety regulations laid down by 'His Majesty's Inspectors of Explosives' (Nathan and Rintoul 1908).

It is hoped that a museum use will be found for Waltham Abbey RGPF North Site. If so, this report and the RCHME archive material will be a valuable source of detailed information for any future reconstruction of the Washing House.

ACKNOWLEDGEMENTS

I would like to acknowledge the considerable assistance of the following people in compiling this report. Shane Gould (ECC AAG) wrote the project brief. Wayne Cockcroft (RCHME) provided a copy of the RCHME report on the North Site and copies of documentary material relating to the South Site. He also visited the site during the survey, providing valuable advice. Lynn Lennard (Royal Ordnance) kindly arranged access to the site. Thanks are also due to Epping Forest District Museum and RCHME (National Monuments Record and National Library of Air Photographs) for allowing access to archive photographs, and to the Ministry of Defence for their generous permission to publish a selection of RGPF archive photographs without charge. The photographic survey was carried out by Nigel Macbeth and Phil Heskett-Smith. The plan survey was carried out by Steve Membrey and the author.

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Appendix 1: Photographic Registers

FILM 1		Monochrome Print		120mm	
Shot Number	Subject	Direction of view	Scale	Exposure numbers	
1	Entrance arch (exterior).	NE	-	1	
2	Main entrance gate hinge	E	0.5m	2	
3	Doors into roundhouse	NE	0.5m	3	
4	Washing tank (not in situ)	SW	-	4-6	
5	Wall-mounted number plate ('6') beside door into round-house (interior).	SW	0.2m	7	
6	Doorway leading to lower conduit tunnel, showing radiator connection point, and danger building light fitting.	S	-	8-10	
7	Washing tank (not in situ)	NE	-	11-12	
8	Roof from below showing skylights, ventilation chimney and danger building light fittings	vertical			

FILM 2		Monochrome Print		35mm	
Shot Number	Subject	Direction of view	Scale	Exposure numbers	
1	Entrance passage door lock	NW	0.2m	1	
2	Fallen roof, formerly covering gap between entrance passage and round house door.	SE	0.5m	2, 3, 4	
3	Round house door handle (brass)	NE	0.2m	5, 6	
4	Washing tank platform: Broken beam end showing carpentry joint	N	0.2m	9, 10	
5	Washing tank platform: Carpentry joint	N	0.2m	11, 12	
6	Washing tank (not in situ)	NE	0.5m	13, 14, 15	
7	Round house exterior: Platform brace support.	-	0.2m	16, 17, 18, 19, 20, 21	
8	Wooden gutter support shelf between the traverse revetment and the round house wall.	NW	-	22, 23, 24	
9	Leather strap attached to round house wall (interior)	S	0.2m	25, 26	
10	Lead strap fitting at junction of the eastern raised platform with the side wall.	NE	0.2m	27, 28	
11	Gutter from the nitrating house entering the wash house.	N	-	29, 30, 31	
12	Lower conduit tunnel to wash water settling house and NG store.	S	-	32, 33, 34	
13	Traverse revetment wall and end of roof covering entrance door into round house.	S	-	37	

Nitroglycerine Washing House, Waltham Abbey Royal Gunpowder Factory
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FILM 3		Monochrome Print	35mm		
Shot Number	Subject	Direction of view	Scale	Exposure numbers	
1	Brick entrance arch. (exterior).	NE	2m/ 1m	2,3,4,5	
2	General view of the wash house.	NE	2m	6, 7, 8, 9	
3	Wash water drainage channel	NE	2m	10, 11, 12, 13	
4	Drainage channel, with circular junction house foundation in foreground.	SW	2m	14, 15, 16, 17	
5	Lower conduit tunnel exit arch, with junction house foundation in foreground.	N	2m	18, 19, 20, 21	
6	Junction house foundation	SE	2m	22, 23, 24, 25	
7	Brick entrance arch from the side, showing concrete support	E	2m	26, 27, 28, 29	
8	Eastern upper conduit tunnel: Entrance arch	SW	2m	30, 31, 32, 33	
9	Western upper conduit tunnel: Entrance arch	SE	2m	34, 35, 36	

FILM 4		Monochrome Print	35mm	
Shot Number	Subject	Direction of view	Scale	Exposure numbers
1	Door from entrance passage (not in situ)	-	2m	1, 2
2	Southern conduit tunnel exit	N	-	3, 4
3	Ventilation chimney	W	-	5, 6
4	NE conduit tunnel entrance	SW	1m	7, 8
5	NW conduit tunnel entrance	SE	-	9, 10
6	Junction House foundation (obscured by plant debris)	S	-	11, 12
7	Entrance passage (side view showing concrete brace)	E	-	13, 14
8	General exterior view of the Washing House	N	-	15, 16
9	Detail of higher butterfly hinge from the roundhouse double doors	-	0.1m	17, 18
10	Radiator connection point and pipes. The imprint of a box covering the radiator can be seen on the wall behind the pipes. The radiator heater unit is located outside the roundhouse close to the connection point, though it is no longer connected	SE	0.5m	19, 20
11	Junction of the two upper conduit tunnels from the direction of the Washing House	N	-	21
12	View along the north-western conduit tunnel, showing the in situ gutter support shelf.	NW	-	22
13	View along the north-eastern conduit tunnel	NE	-	23
14	View along the southern conduit tunnel	N	-	24
15	Detail of two matching shaped blocks of unknown function (not in situ)	-	0.5m	25
16	Interior of washing tank from above	down	-	26
17	Detail of post-socket in the asphalt floor, which formerly	-	0.5m	27, 28

*Nitroglycerine Washing House, Waltham Abbey Royal Gunpowder Factory
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	supported part of the washing tank platform			
18	View of the Washing House floor	N	0.5m	30
19	Detail of gutter support bracket, set into the brickwork on the east side of the southern conduit tunnel	-	0.2m	31
20	Detail of iron hook, attached to the east side of the southern conduit tunnel	-	0.2m	32
21	View of the entrance passage	N	-	34, 35

FILM 5		Colour Print		35mm	
Shot Number	Subject	Direction of view	Scale	Exposure numbers	
1	Entrance passage	NE	0.5m	3	
2	Entrance gate hinge (detail)	E	0.5m	4	
3	Light fitting at SW end of the entrance passage (detail)	NE	0.2m	5	
4	Coat hooks in the shoe room (detail)	SE	0.2m	6, 7	
5	The roundhouse entrance (with one door closed)	NE	0.5m	8, 9, 10	
6	Enamelled number plate ('6') mounted on the interior of the roundhouse wall, adjacent to the door on the S side (detail)	SW	0.2m	11, 12	
7	Viewing window set in the roundhouse wall in the shoe room (detail)	SW	0.2m	13, 14	
8	Washing tank (not in situ), placed against the SW side of the roundhouse	SW	0.5m	15, 16, 17	
9	Incomplete danger building light fitting, located above the entrance to the southern conduit tunnel	S	0.2m	18, 19	
10	The entrance to the southern conduit tunnel, leading down hill to the junction house	S	0.5m	20, 21, 22	
11	View of a washing tank (not in situ) and part of the washing tank platform	NE	0.5m	23, 24, 25	
12	View of the washing and filtration tank platform	NE	0.5m	26, 27, 28	
13	View of a roof window from below	-	-	29, 30, 31	
14	Wall sockets indicating the level of the washing tank platform on the W side of the roundhouse	W	0.5m	32, 33, 34	
15	Washing tank detail, showing a groove in the rim, probably serving as a pipe rest	SW	0.2m	35, 36	
16	Detail of an iron hook attached to the E wall of the southern conduit tunnel. Part of a row of identical hooks, probably originally carrying a pipe.	-	0.2m	37	

Number 6 was omitted from the film numbering sequence

FILM 7		Colour Print		120mm	
Shot Number	Subject	Direction of view	Scale	Exposure numbers	
1	Entrance gate (not in situ) showing warning sign: 'N.G. VAPOURS MAY BE PRESENT. ENSURE ADEQUATE VENTILATION'	N	2.0m	1	
2	Southern conduit tunnel exit.	N	-	3	
3	North-east conduit tunnel entrance	SW	-	4	
4	North-west conduit tunnel entrance	SE	-	5	
5	View of the entrance passage	S	-	6	

Nitroglycerine Washing House, Waltham Abbey Royal Gunpowder Factory
Field Archaeology Group

FILM 8		Colour Print	120mm		
Shot Number	Subject	Direction of view	Scale	Exposure numbers	
1	Exterior view of the Washing House, showing the earthwork traverse	N	-	1	
2	The Washing House entrance passage	NE	0.5m	3	
3	Detail of lead strap, screwed to the roundhouse wall and the washing tank platform	NE	0.2m	4, 5	
4	Interior of a washing tank	-	-	6	
5	Leather strap attached to the roundhouse wall on the southern side	S	0.2m	8, 9	
6	Detail of an incomplete danger building light fitting, located above the entrance to the southern conduit tunnel	S	0.2m	10, 11, 13	
7	Viewing window between the shoe room and the round house interior	SW	0.2m	14, 15	
8	Enamelled number plate ('6') attached to the inside wall of the roundhouse.	SW	0.2m	16, 17	
9	Detail of a washing tank, showing a groove cut into its rim, probably for use as a pipe rest	SW	0.2m	18	

FILM 9		Colour slides	35mm		
Shot Number	Subject	Direction of view	Scale	Exposure numbers	
1	North-east conduit tunnel entrance	SW	1m	1,2	
2	Detail of brass butterfly hinge on south side of roundhouse door	SE	0.2m	3,4	
3	Southern conduit tunnel exit	N	-	5, 6, 7	
4	North-west conduit tunnel entrance	SE	-	8, 9	
5	Ventilation chimney	W	-	10, 11	
6	The Washing House door (not in situ), showing warning sign: N.G. VAPOURS MAY BE PRESENT. ENSURE ADEQUATE VENTILATION	N	2m	12, 13	
7	Detail of iron gutter support bracket, set into the brickwork of the southern conduit tunnel	NE	0.2m	14, 15, 16	
8	Detail of iron hook attached to the east wall of the southern conduit tunnel	NE	0.2m	17	
9	View of the drainage channel, looking towards the junction house	NE	-	18	
10	View along the NW conduit tunnel, showing the nitro-glycerine gutter shelf in situ	NW	-	19	
11	Interior of a nitro-glycerine washing tank	down	-	20	
12	Junction of the two upper conduit tunnels, from the direction of the washing house	N	-	21	
13	View along the southern conduit tunnel	N	-	22	
14	View of the junction house foundation (obscured by plant debris)	S	-	23, 24	
15	View along the north-east conduit tunnel	NE	-	25	
16	Detail of two shaped blocks of wood of unknown function (not in situ)	-	0.5m	26	
17	The Washing House entrance passage	E	-	27, 28	
18	Detail of radiator pipes	SE	0.5m	29, 30	
19	General exterior view of the Washing House	NE	-	31	

FILM 10		Colour slides	35mm		
Shot Number	Subject	Direction of view	Scale	Exposure numbers	
1	Washing House entrance passage	NE	2m	1, 2, 3, 4	
2	General view of the Washing House exterior	N	-	5, 6, 7, 8	
3	View along the drainage channel, looking towards the Junction House	NE	2m	10, 11, 12	
4	View along the drainage channel from the Junction House	SW	2m	13, 14, 15, 16	
5	The southern conduit tunnel exit, with the Junction House foundation in the foreground	NW	-	17, 18, 19, 20	
6	View of the Junction House foundation (obscured by plant debris)	S	2m	21, 22, 23, 24	
7	Side view of the Washing House entrance passage, showing the concrete brace	SE	2m	25, 26, 27, 28	
8	Entrance to the NW conduit tunnel	SE	2m	29, 30, 31, 32,	
9	Entrance to the NE conduit tunnel	SW	2m	33, 34, 35, 36	

FILM 11		Monochrome print	35mm		
Shot Number	Subject	Direction of view	Scale	Exposure numbers	
1	General interior view of the Washing House	NE	1m	1	
2	General interior view of the Washing House	W	1m	2	
3	General interior view of the Washing House	E	1m	3	
4	General interior view of the Washing House	N	1m	4	
5	General interior view of the Washing House	S	1m	5	
6	Detail of chalkboard	-	0.5m	6	
7	Washing House roof, oblique view	N	-	7	
8	Washing House roof, vertical view	-	-	8	
9	Detail of intact , roof mounted danger building light fitting	-	-	9	
10	Detail of radiator unit	-	0.5m	10	
11	Detail of pipe-work and stop cock	-	0.5m	11	
12	Detail of gutter terminal socket mounted on round house wall	-	-	12	
13	Detail of lead lined eye hole for skimmer dish suspension rope	-	-	13	
14	Detail of hole drilled in the base of gutter shelf	-	-	14	
15	Detail of lead pipe connecting gutter with terminal socket inside the Washing House	-	-	15	
16	Detail of grooved block found washing tank	-	0.5m	16	
17	View of Washing House shoe room	SE	1m	17	
18	Canvas gutter cover at junction of upper conduit tunnels	-	1m	18	
19	View along NW conduit tunnel	NW	1m	19	
20	General view of washing tank platform	E	1m	20	
21	Detail of window prop	-	-	21	
22	Detail of washing tank base (interior)	-	-	22	
23	View along southern conduit tunnel	S	-	23	

FILM 12		Monochrome print	35mm		
Shot Number	Subject	Direction of view	Scale	Exposure numbers	
1	Detail of sign at the entrance to the southern conduit tunnel	-	1m	1	
2	General view of the Washing House from top of adjacent building	NW	-	2, 3	
3	Detail of ventilation chimney	W	-	4	
4	Detail of switch box on top of the traverse	W	-	5	
5	Entrance passage	NE	1m	6, 7	
6	General shots of exterior	-	-	8-16	

FILM 13		Colour print	35mm		
Shot Number	Subject	Direction of view	Scale	Exposure numbers	
1	General interior view of the Washing House	NE	1m	1, 2	
2	General interior view of the Washing House	W	1m	3	
3	General interior view of the Washing House	E	1m	4	
4	General interior view of the Washing House	N	1m	5, 6	
5	General interior view of the Washing House	S	1m	7	
6	Detail of chalkboard	-	0.5m	8	
7	Washing House roof, oblique view	N	-	9	
8	Washing House roof, vertical view	-	-	10	
9	Detail of intact , roof mounted danger building light fitting	-	-	11	
10	Detail of radiator unit	-	0.5m	12	
11	Detail of pipe-work and stop cock	-	0.5m	13	
12	Detail of gutter terminal socket mounted on round house wall	-	-	14	
13	Detail of lead lined eye hole for skimmer dish suspension rope	-	-	15	
14	Detail of hole drilled in the base of gutter shelf	-	-	16	
15	Detail of lead pipe connecting gutter with terminal socket inside the Washing House	-	-	17	
16	Detail of grooved block found washing tank	-	0.5m	18	
17	View of Washing House shoe room	SE	1m	19	
18	Canvas gutter cover at junction of upper conduit tunnels	-	1m	20	
19	View along NW conduit tunnel	NW	1m	21	
20	General view of washing tank platform	E	1m	22	
21	Detail of window prop	-	-	23	
22	Detail of washing tank base (interior)	-	-	24	
23	View along southern conduit tunnel	S	-	25	
1	Detail of sign at the entrance to the southern conduit tunnel	-	1m	26	
2	General view of the Washing House from top of adjacent building	NW	-	27, 28	
3	Detail of ventilation chimney	W	-	29	
4	Detail of switch box on top of the traverse	W	-	30	
5	Entrance passage	NE	1m	31	
	General shots of exterior	-	-	32-36	

Appendix 2: Archive Contents

Survey plot of the Washing House at 1:50 (1 x A1+ sheet)
Surveyed section through the Washing House at 1:50 (1 x A1+ sheet)
Site drawings: Sections of the entrance and conduit tunnels at 1:10 (1 x A1 sheet)
Archive drawings: Cross-sections through the three conduit tunnels and the entrance passage at 1:10 (1 x A1 sheet)
Copies of RCHME plan and sections of the roundhouse at 1:50 (2 X A1 sheets)
Unedited and edited survey data (1 x disc and hard copy)
Bound copy of typescript report
6 x monochrome print films (1 x 120mm, 5 x 35mm): Negatives and prints
4 x colour print films (2 x 120mm, 2 x 35mm): Negatives and prints
2 x colour transparency films (35mm): Slides
5 x photocopies of archive photographs held by RCHME (National Monuments record)
5 x Monochrome prints of historic photographs selected from MOD archive (WASC), held at Epping Forest District Museum
List of aerial photographs held by RCHME (National Library of Air Photographs)

Appendix 3: Essex Sites and Monuments Record

Summary sheet

Site name/Address: Nitroglycerine Washing House, South Site (Quinton Hill), Waltham Abbey Royal Gunpowder Factory, Essex	
Parish: Waltham Abbey	District: Epping Forest
NGR: TQ 3830 9960	Site Code: WASS 96
Type of Work: Building record/ survey	Site Director/Group: Stuart Foreman / Field Archaeology Group
Date of Work: 27/2/96 - 4/3/96	Size of Area Investigated: -
Location of Finds/Curating Museum: Epping Forest District Museum	Funding source: ECC Archaeology Section
Further Seasons Anticipated?: Further recording work possible, prior to development of South Site	Related SMR Nos: -
Final Report: .	
Periods Represented: 1894 to 1908	
<p>SUMMARY OF FIELDWORK RESULTS:</p> <p>A recording brief, carried out on the Washing House of the Quinton Hill nitro-glycerine factory, included a survey of the building in plan and section, and detailed photographic and video coverage.</p> <p>The Quinton Hill plant was built in 1891, largely copying the design of the Nobel plant at Oplagen, near Cologne, and using plant imported from Germany. It formed part of the first cordite factory in the world. As one of only two buildings surviving from the early factory, the Washing House is a historic building of national importance. It is exceptionally well-preserved, retaining many fixtures and fittings from the turn of the century, though most of the extensive lead fittings have been stripped out. The present structure was built in 1894, after a disastrous explosion in May of that year destroyed the original Washing House. The building went into reserve for the last time in 1908.</p> <p>The Washing House consists of a free-standing, circular, timber building, surrounded by an earthwork traverse, revetted on the inside by a brick wall. The traverse is pierced by a brick-vaulted entrance tunnel and three smaller conduit tunnels. The two tunnels to the north carried nitro-glycerine from the two nitrating houses along lead-lined gutters to the washing tanks. A section of the wooden shelf on which the gutter was carried survives in the north-west conduit tunnel. Both washing tanks have survived inside the Washing House, though neither is <i>in situ</i>, and their lead lining has been removed. Immediately to the south of the Washing House is a circular, brick-lined pit, thought to be the foundations of the Junction House, built after the 1894 explosion.</p>	
Previous Summaries/Reports: -	
Author of Summary: S.Foreman	Date of Summary: 21/5/96



Plate 4
Washing House entrance passage (looking NE)



Plate 5
Detail of door hinge on the E side of the entrance passage



Plate 6
Detail of electric light fitting at the SW end of the entrance passage

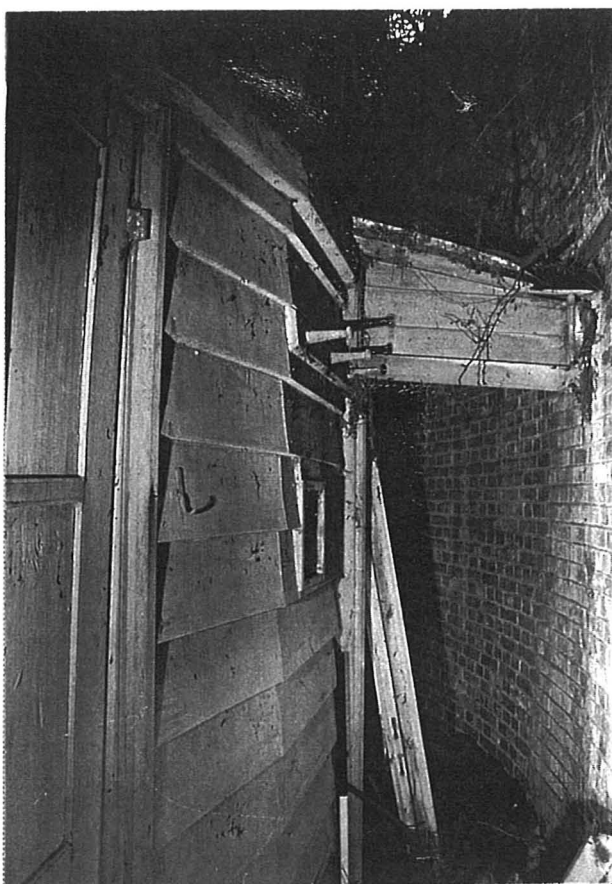


Plate 7
View of the Washing House shoeroom (looking SE)

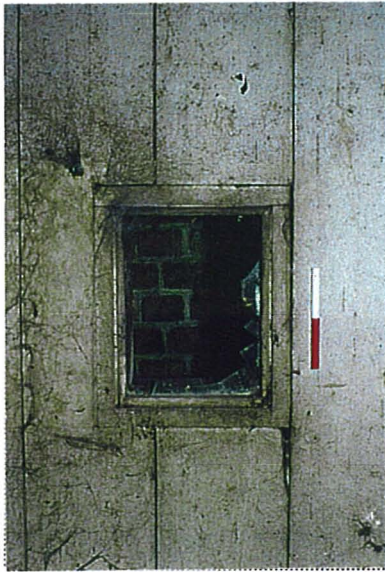


Plate 8
Detail of the viewing window
from the shoeroom

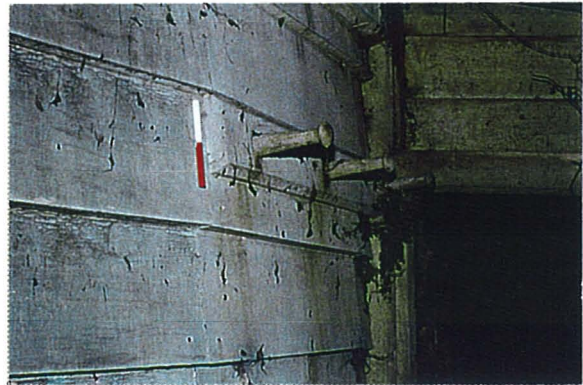


Plate 9
Detail of the coat hooks in the shoeroom

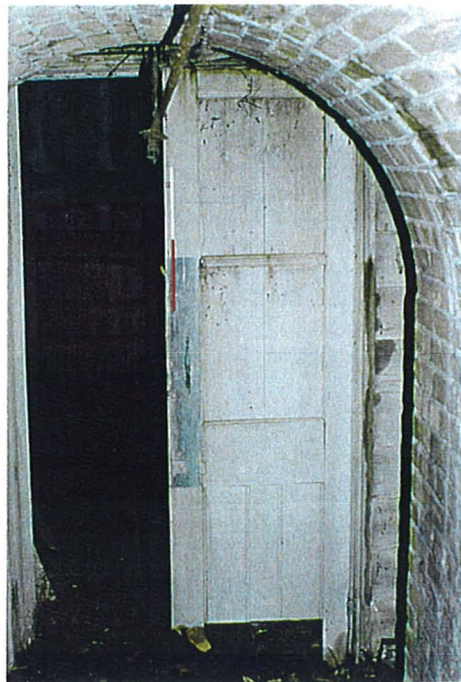


Plate 10
The roundhouse door, (looking NE)

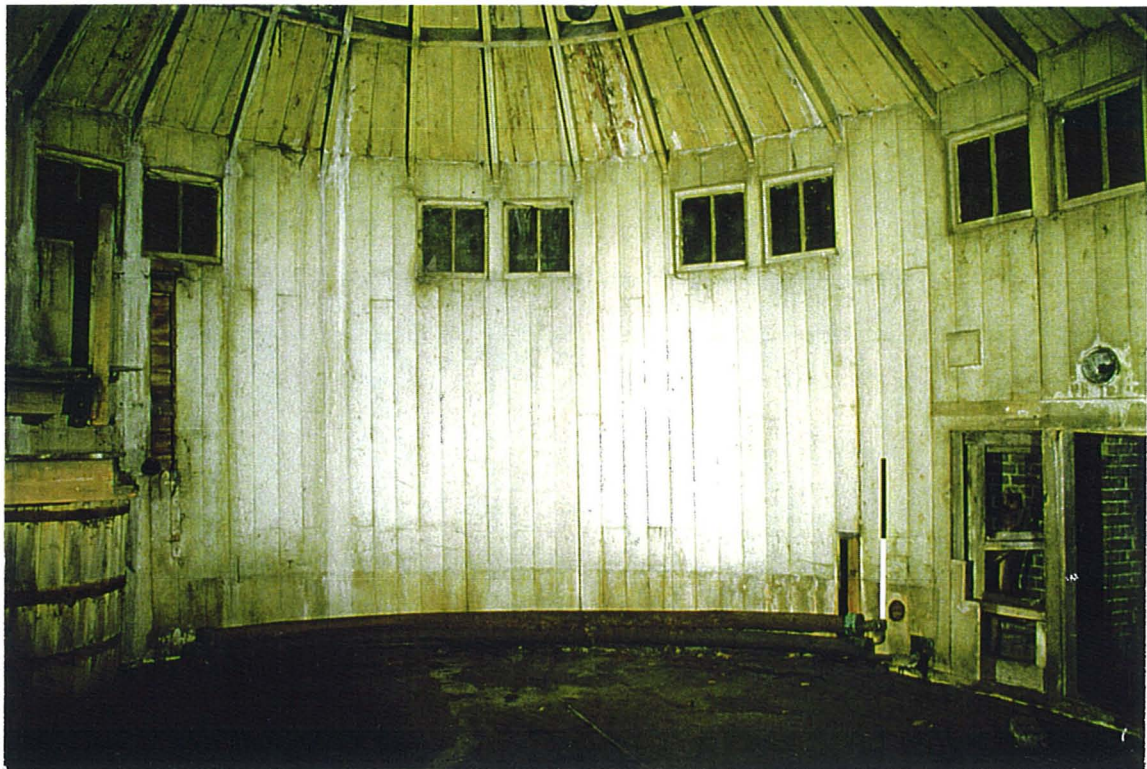


Plate 11
Interior of the Washing House (looking E)

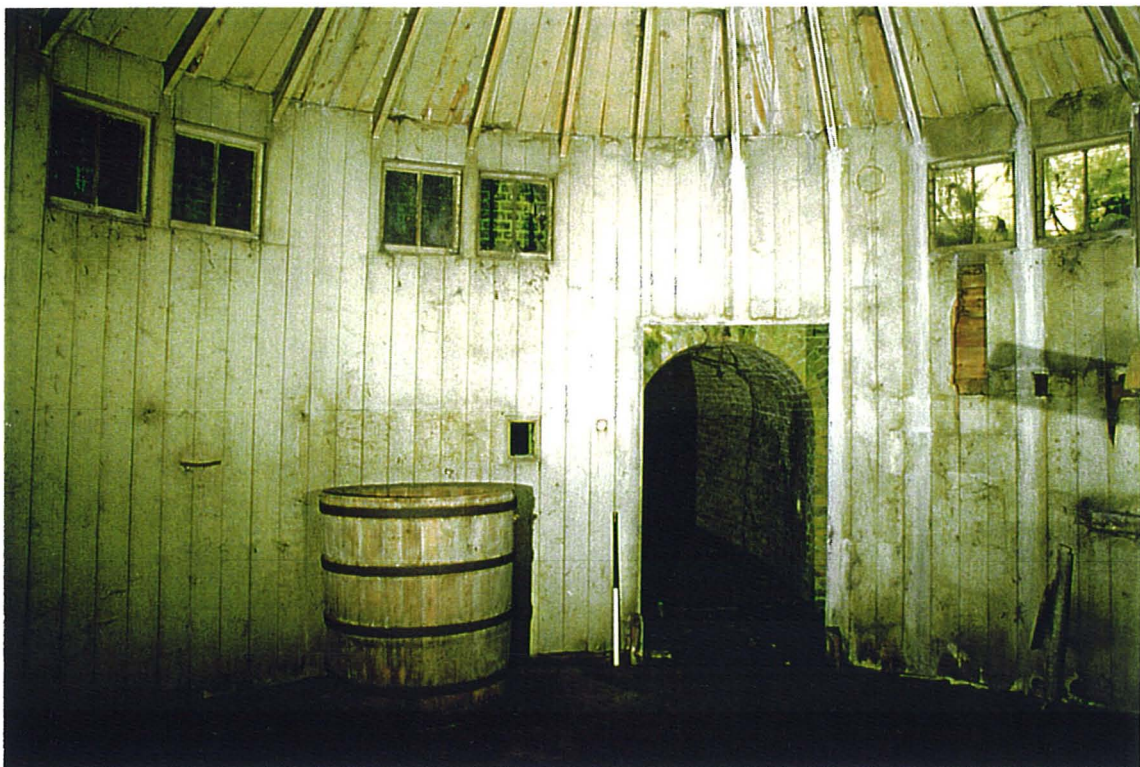


Plate 12
Interior of the Washing House (looking W)



Plate 13
Interior of the Washing House (looking N)

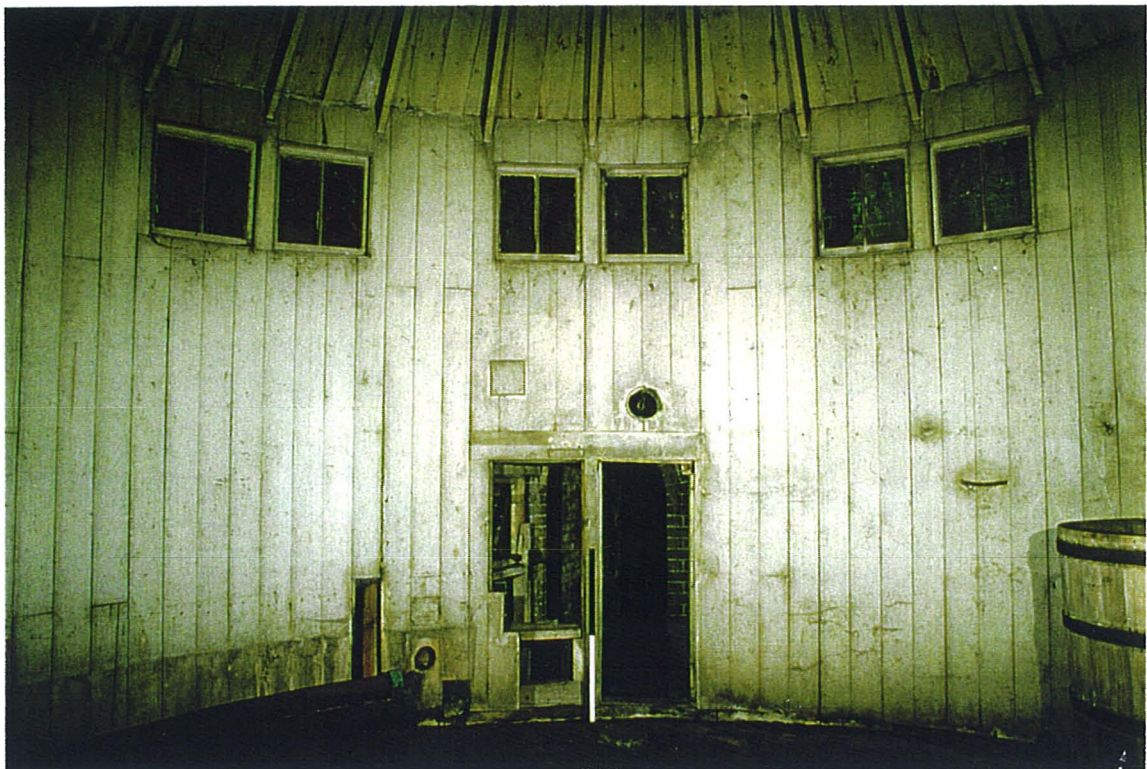


Plate 14
Interior of the Washing House (looking S)



Plate 15
Asbestos covered pipe and stop cock,
probably connected to the Washing
House steam heating system



Plate 16
Radiator heater unit, no longer
connected, but close to its original
position



Plate 17
Detail of the roundhouse doorway (looking west), showing
the remains of the footplate (foreground) and debris from the
collapsed shoeroom roof (background)



Plate 18

The Washing House roof, viewed from below at a N facing oblique angle, showing roof windows, danger building lights and ventilation chimney



Plate 19

Exterior view of the ventilation chimney

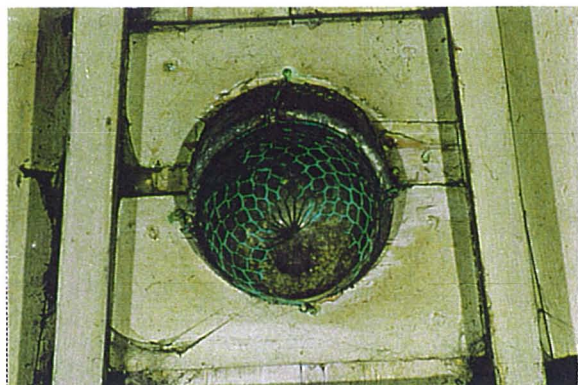


Plate 20

Detail of a danger building electric light fitting, showing a water-filled glass bowl, lined with brass chicken wire



Plate 21

Detail of the switch box mounted on top of the traverse, connecting the lights to the overhead power supply

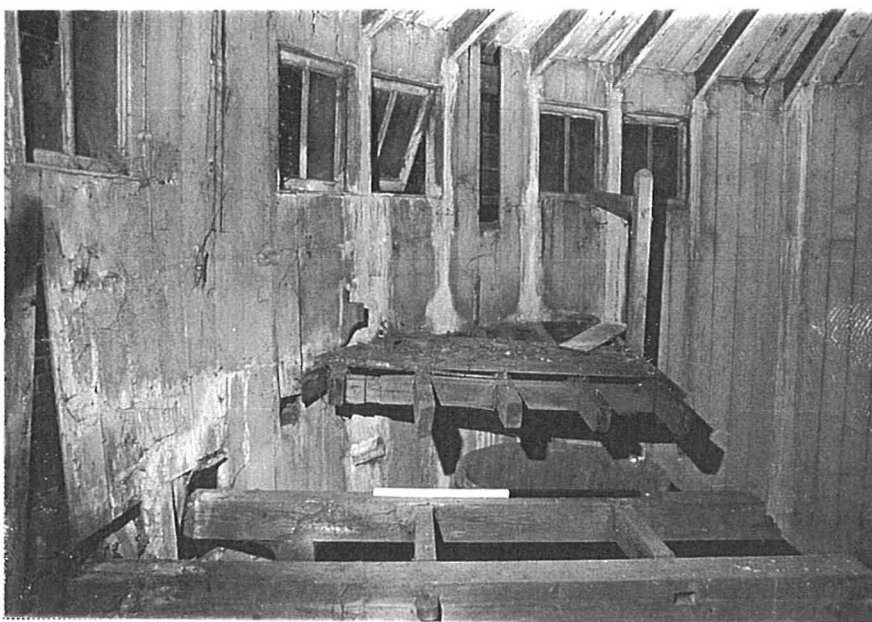


Plate 22

View of the raised platforms at the N end of the Washing House from above (looking E). The platforms were formerly at two levels, the upper supporting the washing tank, the lower the Filtration tank

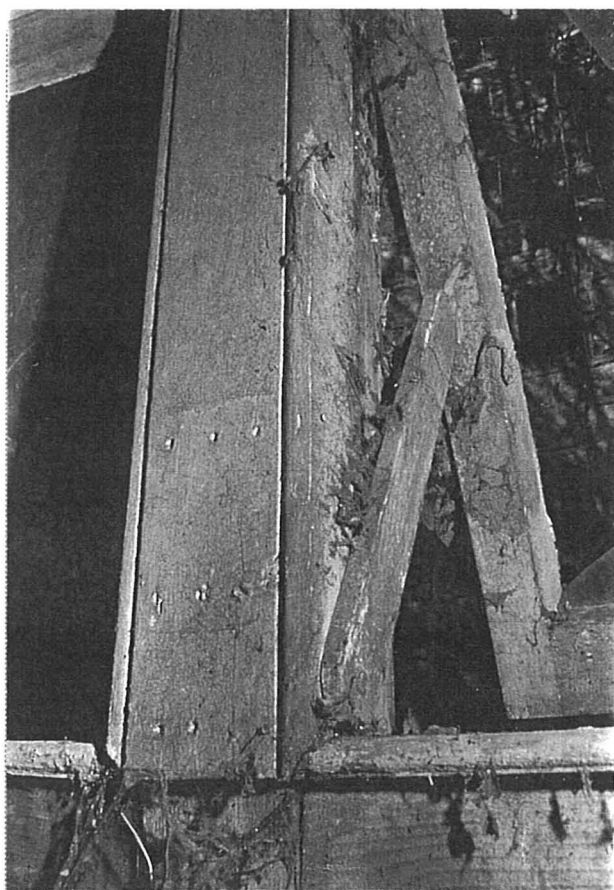


Plate 23

Detail of a wooden window prop. The prop is hinged at the bottom on a single brass screw



Plate 24
View of a washing tank, set against the
SW wall of the roundhouse (not *in situ*)

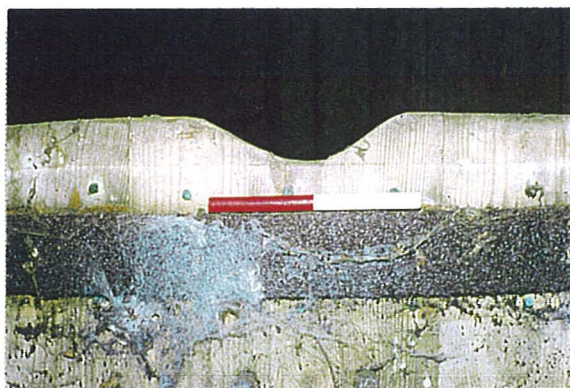


Plate 25
Detail of a washing tank, showing a pipe rest cut
into the rim of the barrel

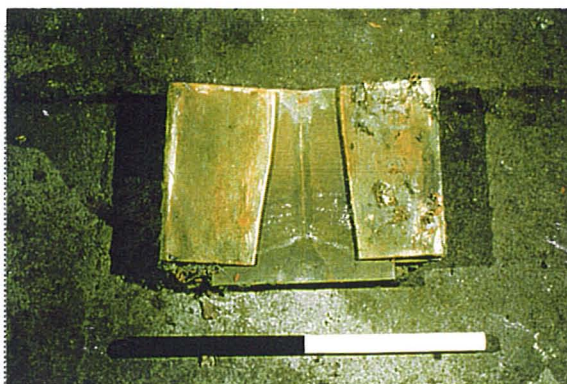


Plate 26
Detail of a shaped wooden block, found loose
inside one of the washing tanks (not necessarily *in situ*)



Plate 27
Interior detail of a washing tank, showing nitroglycerine
and wash water drainage outlets and grooves in the base of
the tank. The lead lining has been removed



Plate 28

Terminal of the nitroglycerine gutter. A lead pipe passed through the drilled hole in the gutter shelf, connecting the gutter to a fixed socket, inside the Washing House



Plate 29

Detail of a surviving section of the lead pipe that connected the gutter terminal with a fixed socket inside the Washing House



Plate 30

Detail of a fixed brass socket mounted on the Washing House wall at the level of the wall plate, from which the nitroglycerine was passed to the Washing tanks via a moveable indiarubber pipe.

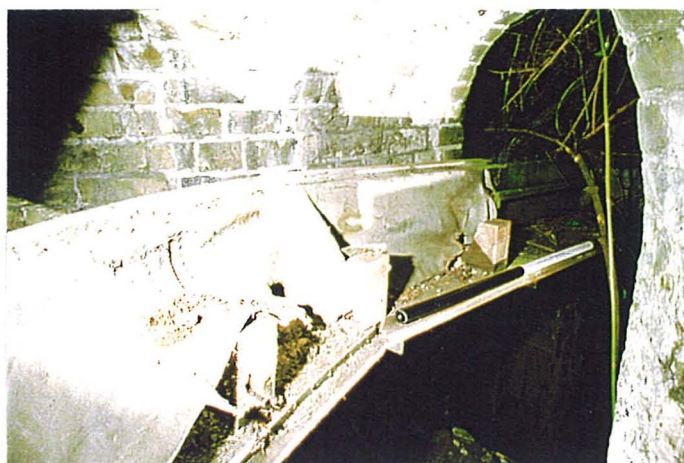


Plate 31

A section of the nitroglycerine gutter at the junction of the tunnels from the nitrating houses (looking SE). The surviving section of canvas gutter cover seen here, protected the gutter from the elements in the gap between the traverse revetment wall and the Washing House



Plate 32

Detail of a lead lined eye, passing through the wall at roof level. This probably carried the rope suspending the skimmer dish to a counterweight outside the Washing House



Plate 33

Detail of a chalk board found in the Washing House (not *in situ*)

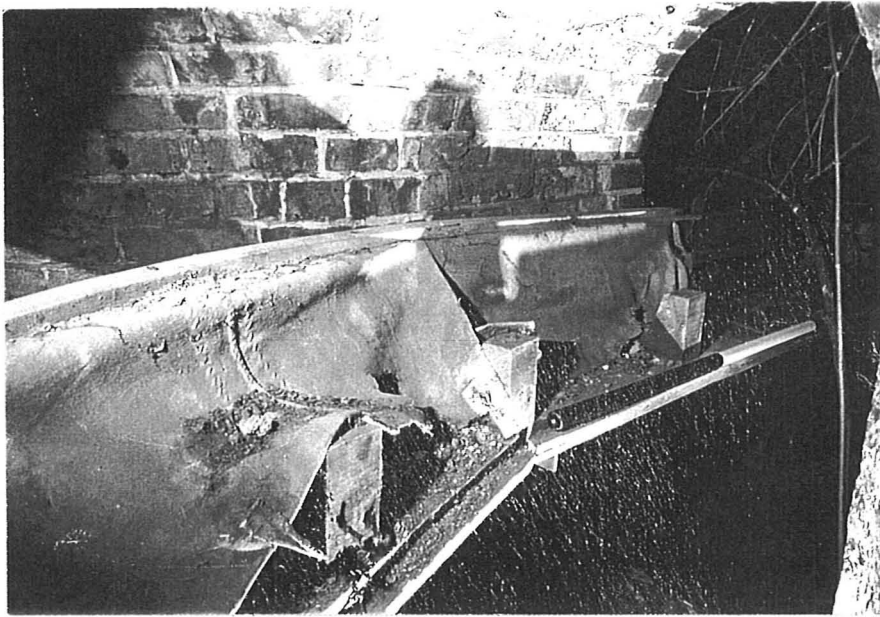


Plate 34

Detail of gutter shelf at the junction of the tunnels from the nitrating houses (looking SE), showing a surviving section of canvas gutter cover. One of the straps by which one side of the cover was laced down can be seen in the foreground

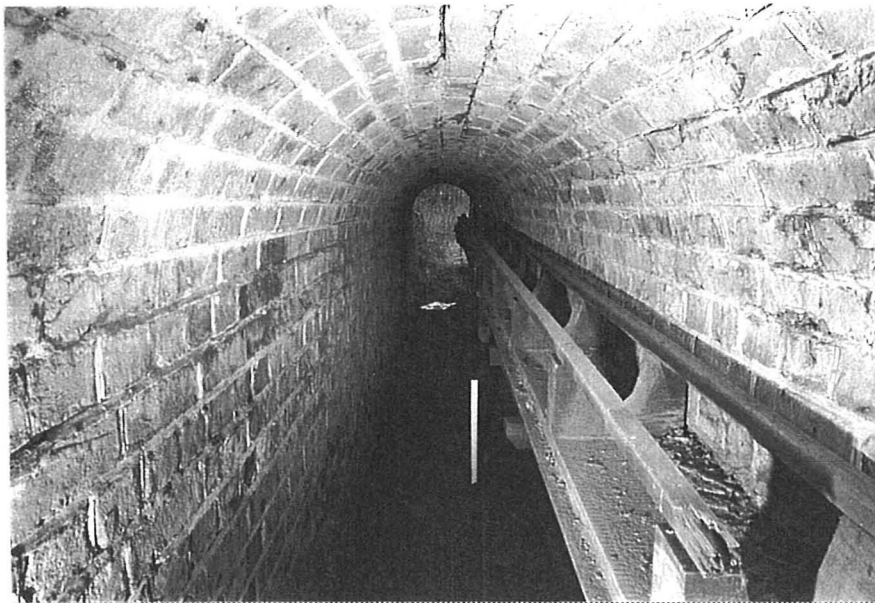


Plate 35

View along the NW conduit tunnel (looking NW), showing the nitroglycerine gutter attached to the N wall. The wooden shelf rests on iron brackets set into the brickwork



Plate 36
View along the southern conduit tunnel (looking S). The row of iron brackets set into the E wall formerly supported the nitroglycerine gutter



Plate 37
Detail of an iron hook attached to the wall of the southern conduit tunnel. It is one of a row of identical hooks running along the E side of the tunnel, probably intended to carry a water pipe.



Plate 38
Detail of the southern conduit tunnel exit



Plate 39
The southern conduit tunnel exit (looking N)



Plate 40
Entrance to the NE conduit tunnel (looking S)



Plate 41
Entrance to the NW conduit tunnel
(looking SE)

