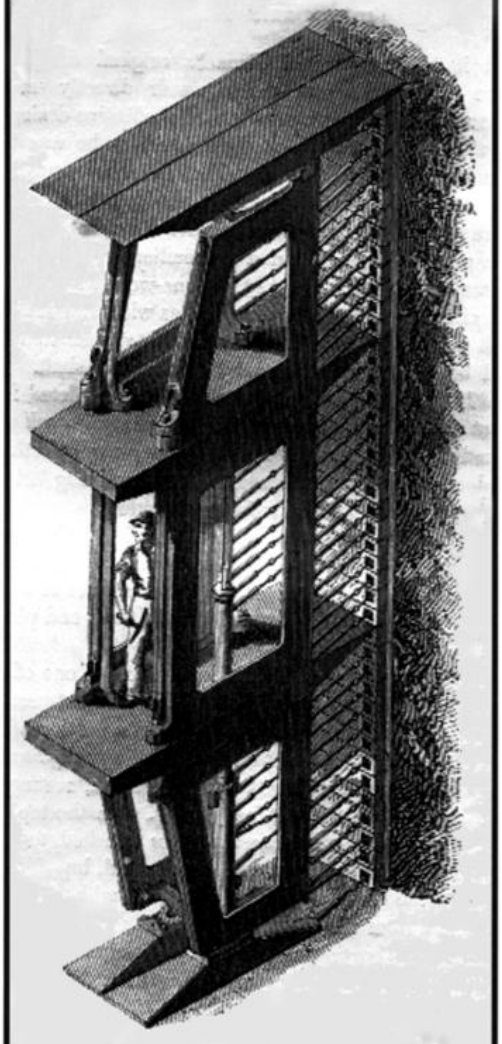
Brunel Museum



Introduction

This pack highlights the potential of the **Brunel Museum** and the **Thames Tunnel** as a stimulus for work at Key Stage 1 and 2 and provides teachers with all they need to involve pupils in a wide range of cross-curricular activities. The pack builds upon the models, prints, photographs and displays in the museum whilst offering opportunities to develop pupils' literacy and numeracy.

The pack aims to raise pupils' awareness of the **Brunel Museum** and the **Thames Tunnel**, the rich history of the local area and the ongoing influence of Brunel's early engineering genius.

To arrange a visit of the Brunel Museum in Rotherhithe, please complete the enclosed form. For further information, or to discuss specific requirements, please contact Education:
Robert Hulse 0774 0203119

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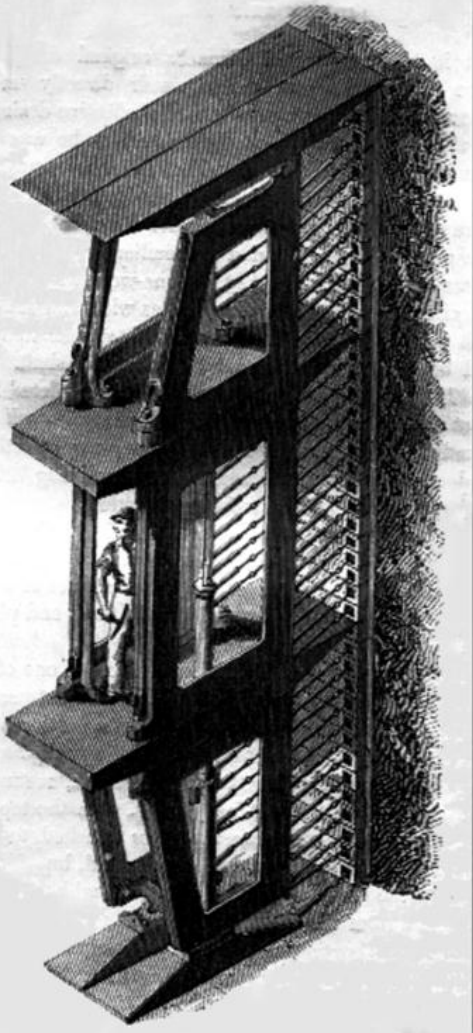

Contact Details + Booking Form

Brunel Museum, Railway Avenue,
Rotherhithe, London SE16 4LF
www. brunel-museum.org.uk

Messages: 020 7231 3840 Education: 0774 0203119
E-mail: education@brunel-museum.org.uk

Transport
Station: Rotherhithe (London Overground)
Buses: 381, 225, 188, 47

Bookings
School visits any day by prior arrangement.
Sessions can include a variety of activities, including actors playing either J J Collins, a miner who died in the tunnel flood, or Isambard Kingdom Brunel himself.
Sessions usually run for one hour.

Please complete the form below and return to the Brunel Museum.

Name of School . . . . . .

School Address . . . . . .
. . . . . .
. . . . . .
. . . . . .

Tel: . . . . . .

Date & Time of Proposed Visit . . . . . .

Reason for Visit . . . . . .

Activities you intend to use / do :
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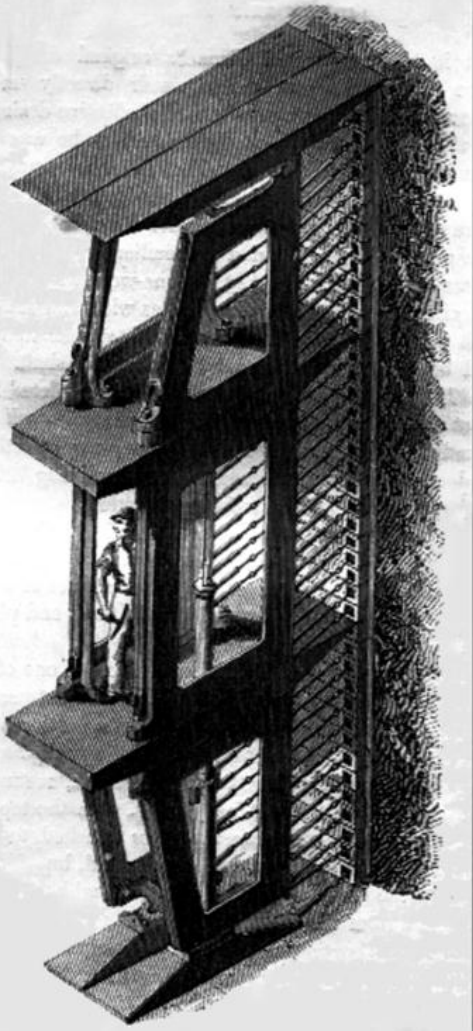
No. of children . . . . . No. of adults . . . . . .

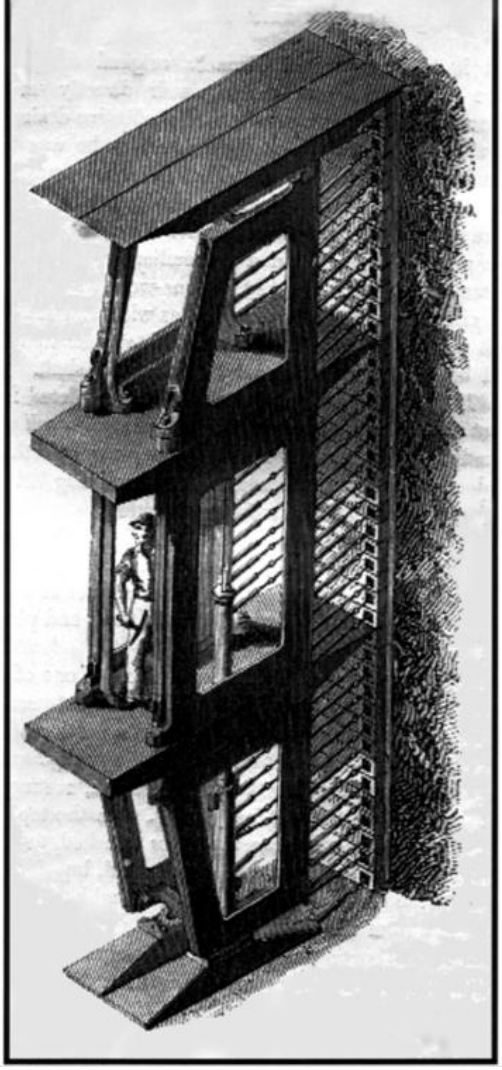
Brunel Museum



An Outline History of the Thames Tunnel

1798	Failed attempt by engineer Ralph Dodd to tunnel between Gravesend and Tilbury
1802-08	Failed attempt by Robert Vazie and Richard Trevithick to tunnel between Rotherhithe and Limehouse
1818-23	Marc Brunel patents and then develops his ideas for a device to be used to dig tunnels, known as a tunneling shield
1824	Marc Brunel secures Royal Assent to tunnel between Rotherhithe and Wapping
1825	Work on sinking the brick shaft at Rotherhithe is completed within seven weeks. The tunneling shield is installed and in November the digging of the Tunnel begins
1826	The engineer managing the project becomes ill and resigns; Isambard Kingdom Brunel, Marc Brunel's son is appointed resident engineer
1827	The Tunnel miners go on strike over cuts in their wages. Three weeks later, May 18, the Tunnel floods for the first time. By November the Tunnel is repaired and tunneling can restart. A celebration banquet is held in the tunnel itself
1828	January 12, the Tunnel floods for the second time with the loss of six lives; Isambard Brunel is badly injured and is unable to work for three months. In August, with insufficient funds to continue work, the Tunnel is bricked up
1834	A loan from the Government means the Tunnel can be prepared for further digging and a new tunnelling shield is installed
1835	Tunneling resumes
1837	August 23, the Tunnel floods for the third time with no loss of life. Tunnelling soon recommences but a fourth flood occurs on November 3 in which one miner dies
1838	March 20, the Tunnel floods for the fifth time
1839	In August the Tunnel reaches the low-water mark on the Wapping shore
1840	The northern Tunnel shaft is built at Wapping. Marc Brunel is knighted by Queen Victoria
1841	The Tunnel reaches the Wapping shaft
1843	The Thames Tunnel opens to pedestrian traffic

Brunel Museum



Why build a Tunnel under the Thames?

The need for a new river crossing

•As London Docks developed to become the largest and most advanced in Europe the volume of traffic on the roads increased, yet the nearest bridge crossing to the docks was the very old London Bridge (c12th Century), two miles away. With an estimated 4000 vehicles struggling to cross the bridge every day, congestion and long delays were inevitable. Blackfriars bridge, although a more modern construction (1769), was even further away from the Docks.

• River watermen ferried vast numbers across the river with up to 350 ferries working on the river every day. But this mode of transport was also slow and added to river congestion as watermen manoeuvred around and between huge cargo ships either anchored or sailing up or down the river.

• There were also considerable strategic military arguments for building a new Thames crossing to the east although there was no immediate threat of invasion since the demise of Napoleon at Waterloo (1815); the army would find it easier to repel potential invaders if it could reach the south and east coasts without the Thames being an obstacle.

Why not build a new bridge?

•Building a bridge high enough for the tall masts of ships to pass underneath would require enormous ascents which would not only be costly but also pose considerable difficulties for horse drawn traffic.

•Counterpoise or bascule bridges were in use in Europe but the steam engines of the time were not sufficiently powerful to cope with lifting bascules of the size needed to span the Thames.

• A lifting bridge would not have provided a real solution even if the technology had been available as it would have to be raised so frequently to allow ships to pass that it would have provided very erratic crossing possibilities for wheeled traffic.

•A tunnel seemed to be the best solution, if only engineering technology was sophisticated and advanced enough to meet the challenge.

Why build a tunnel between Rotherhithe and Wapping?

•The river Thames is narrow here so the tunnelling distance is shorter than at other points along the river.

•Rotherhithe was also the only site between London Bridge and Greenwich where such a project could be attempted without interfering with some of the great mercantile establishments on both sides of the river.

•This site was close to the expanding docks, and in a commercial and populous area. It was also well placed in relation to major London arteries: London Bridge (2m), the Old Kent Road (1.5m), Mile End Turnpike (1.25m).

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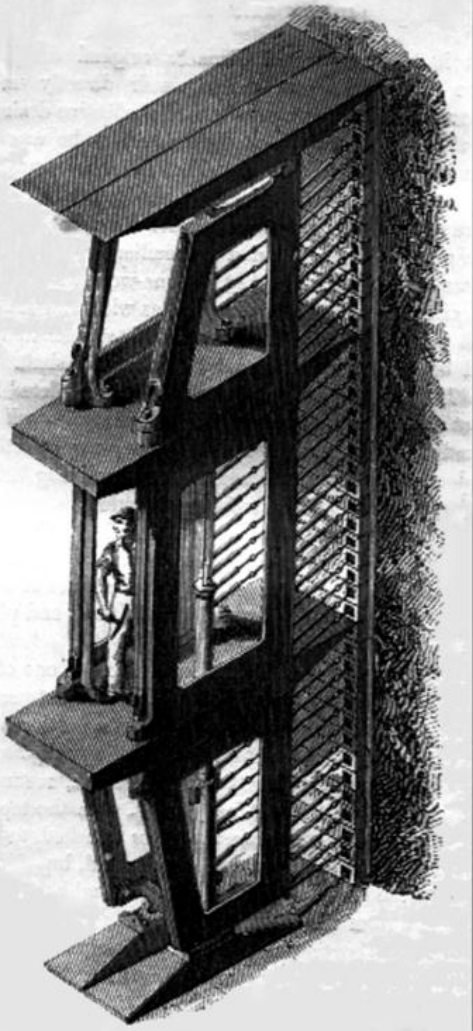


Preparations for digging

The area now surrounded by Rotherhithe Street to the North, Railway Avenue to the East and Tunnel Road to the West was once known as Cow Court.

After Rotherhithe and Cow Court had been selected as the starting point for the Thames Tunnel project, Marc Brunel set preparing the site.

Brick buildings were built as workshops for the carpenters and blacksmiths to work. Storerooms went up for the tools and special protective clothing given to the men who would work in the Tunnel. Offices too were constructed for the draughtsmen and accountants.

Within 100 metres of St Mary's Church some houses were demolished while others were done up to be used as accommodation for the engineers who would manage the project. Even Brunel and his family moved to Rotherhithe.

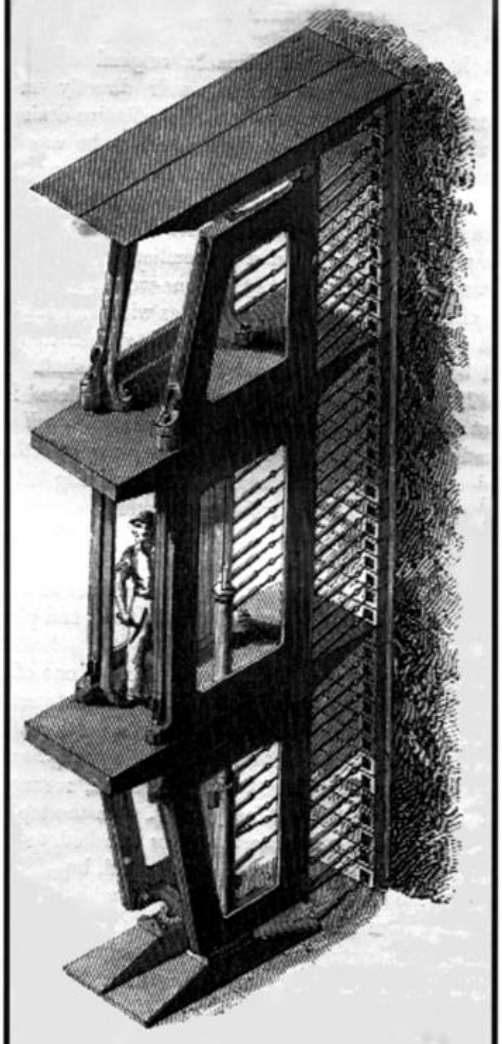
On the gabled end of one building Marc Brunel commissioned artists to produce a full-scale bas-relief of his shield in brick so that the visitors who were soon to arrive in great numbers at the tunnel excavation site, would be able to understand what was going on below.

All the labourers and miners who were hired to work on the Tunnel lived in the immediate neighbourhood, a huge bell was hung on a post in Cow Court which was rung to call the men to their shift.

In order to reach the place where the tunnelling would start deep in the river bank, Brunel built a round brick tower which was sunk gently into the soft soil under its own weight. This became the shaft down which the workmen could enter the Tunnel and the buckets of excavated earth could be brought up.

A powerful steam-engine was placed on the top of the shaft to pump any water out of the Tunnel and to bring up the earth in buckets. Later the steam-engine was moved into the building which we now call the Brunel Engine House and which now houses the Brunel Museum.

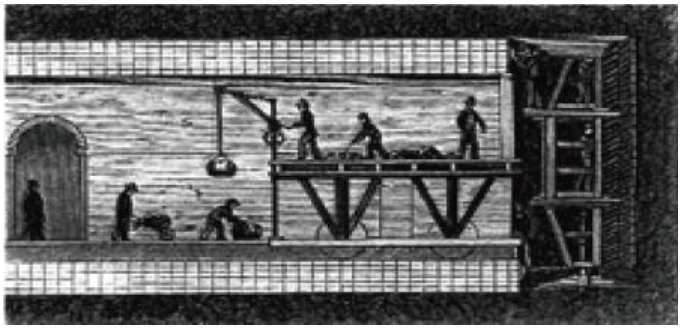
Brunel Museum



Tunnelling Genius

The world of the 19th century was shaped by engineers. Not only did they invent and develop the machines which enabled industry to flourish, but steam boats and trains, the railway, the bridges, the tunnels and stations constructed out of glass and steel which were used to distribute the new manufactured goods.

The Thames Tunnel was designed by one of the greatest engineers, Marc Isambard Brunel who worked on the project with his even more renowned son, the engineer Isambard Kingdom Brunel.



The Tunnel was very difficult to build. The earth under the river is mostly extremely soft with just a thin layer of stronger clay through which it was safe to dig the tunnel. This layer of strong blue clay is just 10 meters thick. Above the blue clay there is waterlogged gravel; beneath there is quicksand. Staying on course and within the seam of blue clay was therefore essential as digging up into the gravel or down into the quicksand would instantly let water pour into the Tunnel.

Marc Brunel invented a completely new technique and the necessary equipment to cope with the problems of digging through soft ground: the Tunnelling Shield.

The shield was a cast iron frame facing the direction of the Tunnel and divided into compartments within each one of which a miner could work at the Tunnel face. The area of the Tunnel face covered by each miner's compartment was covered by removable wooden boards.

A miner would remove only one board at a time, and dig out several inches of the blue clay behind it before replacing the board and repeating the process with the next board. Once several inches of clay had been dug out from behind of each of the boards, jacks at the back of the shield would shunt the miner's compartments forwards.

A team of bricklayers followed closely behind, lining the length of the Tunnel with brickwork 75cm thick.

Yet despite this ingenious Tunnelling Shield, Marc Brunel's careful calculations and Isambard Brunel's close supervision, water did seep continually into the tunnel and the Tunnel even flooded on five separate occasions during construction, with the loss of seven lives: the seam of blue clay was not continuous, giving way to crumbling gravel in many places. After each flood the damage was painstakingly repaired. The Tunnel was pumped empty of water and the silt and deposits from the Thames water were shovelled out (see Working conditions in the Tunnel), before tunnelling could resume.

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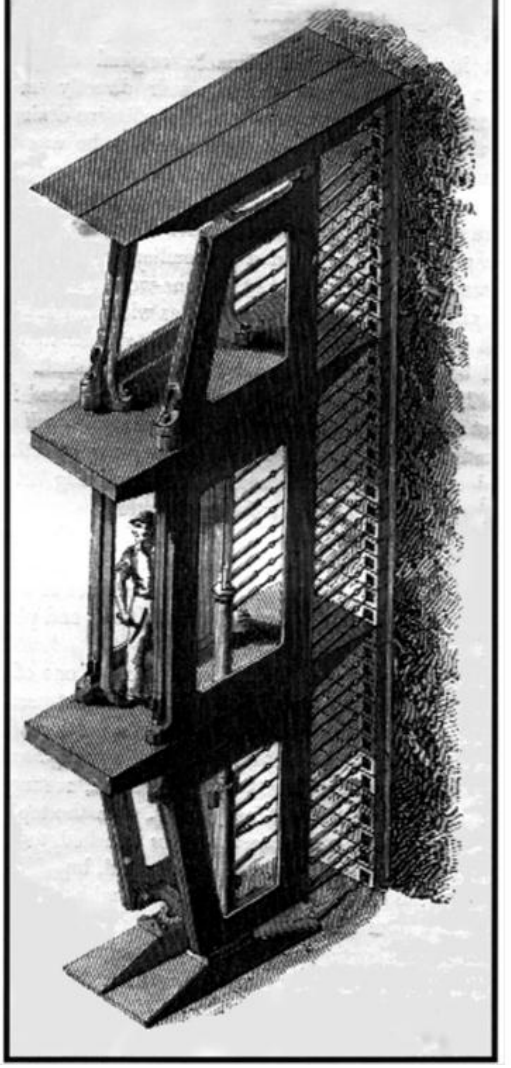


The Banquet in the Tunnel

On 10 November 1827 after the first major flood a banquet was held in the Tunnel itself. The aim was to restore confidence in the Tunnel project among not only the workforce but also the Company Directors and the general public.

The Tunnel was extensively prepared by the young Isambard Brunel for the occasion:

The floor was swept and carpeted.

Crimson velvet hung on the walls.

Tables were taken down into the Tunnel and covered with crisp white damask cloths.

The Tunnelling Shield was cleaned.

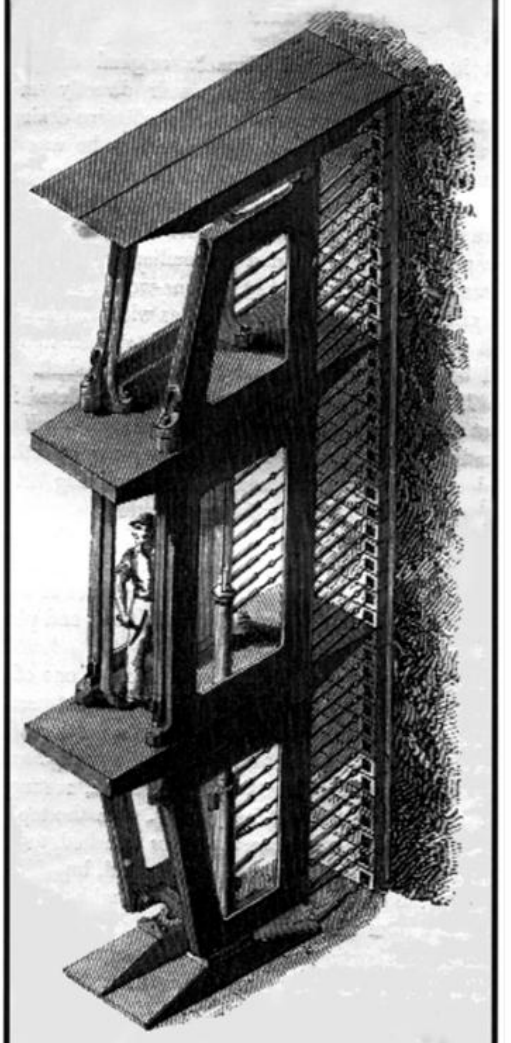
Gas candelabra were hung

At 8.30pm the band of the Coldstream Guards stood playing in full uniform at the foot of the Tunnelling Shield as 40 guests arrived and sat at a table in the west passage of the tunnel. 120 workmen sat at another table in the east passage. These men were the tunnellers, and bricklayers, overseers and foremen who were working deep in the tunnel.

Glasses were raised and toasts were drunk to the King, George IV. The workmen presented a pickaxe and a shovel, the tools they were using to dig, to Isambard Brunel and added a toast of their own: "*To our Tools!*"

The banquet has gone down in history as one of the more bizarre episodes in the story of the Thames Tunnel and added considerably to the growing notoriety of both Brunel and the Tunnel.

Brunel Museum



Working Conditions in the Tunnel

When the digging first started in 1825, a ventilation system brought cleaner air into the Tunnel helping the workforce to breathe. During the first flood this ventilation system was damaged. From then onwards the men were labouring in foul, stale air, which left a deposit of black grime around their nostrils.

But worse still was the filth, which came into the Tunnel with the floodwater from the Thames, leaving a thick and highly toxic deposit throughout the Tunnel. This made the air fouler and the already dangerous working conditions became lethal.

At the time no one understood the need for good drains, hygienic toilets and a clean water supply. Moreover, the discovery that germs caused diseases was not made until 1864. Many privies (crude toilets) and open drains emptied into the Thames itself.

This eye witness account printed in the pamphlet “The Dolphin” in 1827, paints a frightening picture of the Thames water:

> “The water taken up from the River Thames betwen Chelsea Hospital and London Bridge, for the use of the inhabitants of the Metropolis, being charged with the contents of more than 130 public common sewers, the drainings from the dung-hills and lay-stalls, the refuse of hospitals, slaughter-houses, colour, lead-gas and soap works, drug-mills, and manufacturies, and with all sorts of decomposed animal and vegetable substances, rendering the said water offensive and destructive to health...”

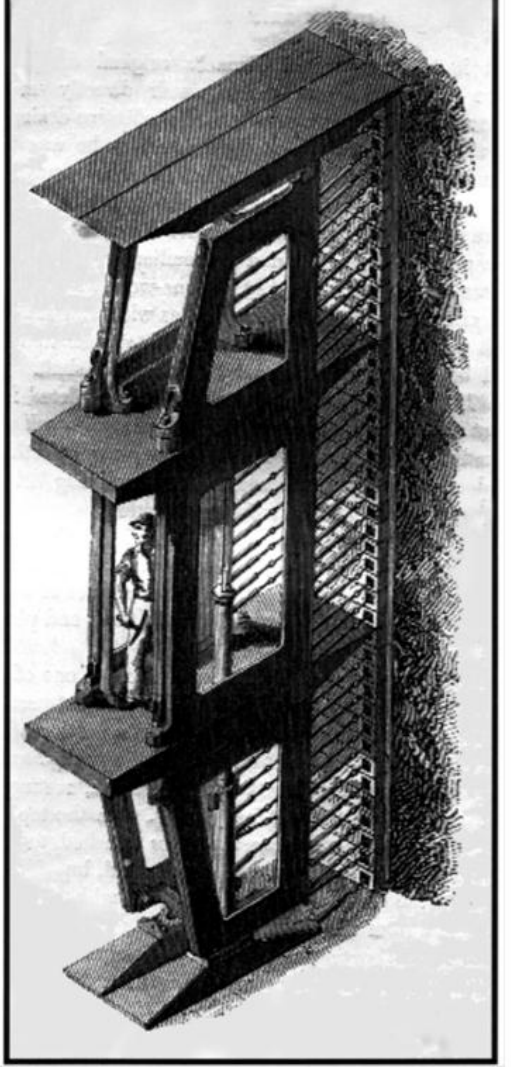
When the water burst into the tunnel it brought contaminated waste with it, covering the workmen and the Tunnel walls. The miners and bricklayers had to wade and swim to safety through this poisonous water. The gas lamps lighting the Tunnel were extinguished almost immediately by the incoming floodwater, plunging it into pitch darkness and making the scramble to reach the safety of the shaft even more difficult. Before tunnelling could recommence, all this sewage had to be shovelled out from the Tunnel by hand.

The water was also highly explosive because it contained gas knows as carburetted hydrogen or ‘fire damp’. Tha gas caused explosions which singed the men’s eyebrows, eyelashes and scarred their skin. Breathing in the gas also made the men ill with headaches, sickness, fainting and weakness. It also affected their eyes, blinding some workers. This was known as ‘ Tunnel sickness’. The more the water came into the Tunnel, the more they were affected by the disabling gas.

The gas lamps and the repeated fire damp explosions heated the air and the metal frame of the Tunnelling Shield could become as hot as an oven - the water sizzled when it dripped onto it. The Tunnel walls sweated and steamed until the air was saturated with water leaving the workforce gasping for air and collapsing unconscious. Progress was difficult and very slow as the poor conditions sapped the strength of the labourers. In one month, June 1837, the tunnel only moved forward 30 centimetres.

In addition to the recorded deaths from the floods, there were numerous casualties over the 18 years the Tunnel took to build. Many of the men were ferried upriver to Guy’s Hospital at London Bridge for treatment for Tunnel sickness; others died from its crippling effects. A few were luckier and made a good recovering after convalescing in Dover where the air was clean.

Brunel Museum



The Bazaar Years

The completed Thames Tunnel opened on 25 March 1843. For the next 15 years it became London's greatest tourist attraction - even though this was probably unintentional.

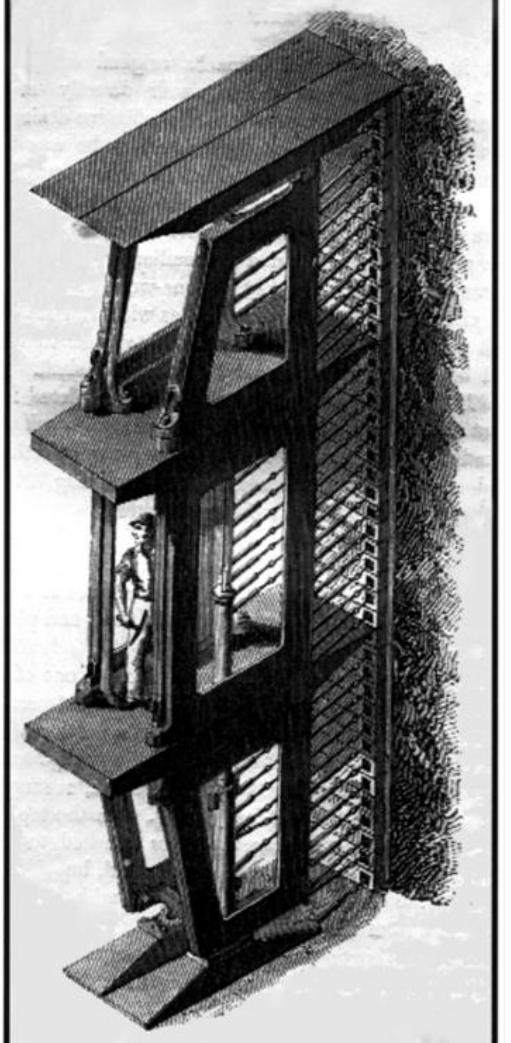
The Tunnel was decked out like a fair ground, brightly lit, filled with the sound of music and full of market stalls, side shows, exhibitions and performers.

There were 63 open arches running down the 360 metre length of the Tunnel each with at least one stall selling souvenirs, views, and models of the Tunnel, cheap jewellery, cakes and sweets, gingerbread, tea and coffee and other refreshments. There were demonstrations of new technology: machines for electrifying, lifting and weighing and other engineering novelties and inventions. There were also a glassblowing exhibition, a photographic studio in the Rotherhithe shaft and even a printing press set up by J.V.Quick to produce souvenir broadsheets. 'The Royal Thames Tunnel Commemorative Paper' provided in this pack was originally printed on the opening day by Quick in the Tunnel; Quick can be seen at his stall in the 'Mechanical Architectural Perspective' also provided in this pack.

Within 27 hours of the tunnel opening, 50,000 people had paid the flat rate of 1d, one old penny, to stroll through the Tunnel. Within 4 months of its opening 1 million tickets had been sold and even Queen Victoria came. This flow did not slacken. One year after its opening, in march 1844, 2 million people had passed through. In 1844 the population of London 2,250,000. Had nearly every Londoner really passed through the Tunnel, or were some Londoners using the Tunnel on a very regular basis? The Tunnel had a double pull as it not only attracted tourists but also those who wanted to cross the river quickly on foot. Either way the Tunnel was clearly an early success. Even 5 years later when the 1851 Great Exhibition opened in the Crystal Palace in Hyde Park, the number of one penny tickets did not noticeably drop in number. During August 1851 when the Great Exhibition was at its height, 220,250 people walked through the Tunnel - twice as many people as visited the Crystal Palace in the same month.

Every year in spring a Fair was held in the Tunnel lasting 3 or 4 days. As the Bazaar poster in this pack shows, this was a vast market and carnival to celebrate the Tunnel's anniversary. It was a cross between a market and a carnival with all sorts of exotic stalls and entertainment. Traders even came from abroad to set up stalls and performers came from Europe and beyond. In 1859, in the Tunnel's 16th anniversary, attractions included tight-rope walkers, puppet shows, magicians, 'Ethiopian serenaders' and Indian and Chinese exhibitors. Recently invented designs for imported gas lamps were also on display.

Brunel Museum



Postscript

Whilst an engineering triumph, and an initial success as a tourist curiosity, the Tunnel was never profitable. Without the planned spiral roadway approaches, designed for horse-drawn vehicles, the Tunnel could only be used by pedestrians, and the long stairways at each end made it less attractive to regular pedestrian users than the ferry boats.

Bustling with stalls and sightseers by day, at night the Tunnel was an altogether more dangerous place and soon gained a rather unsavoury reputation. Increasingly it became seen as a waste of money, which further discouraged the investment needed for its completion as a road tunnel.

In 1865 the Tunnel was closed and sold, at a substantial loss, to the East London Railway Company. Four years later steam trains began to run through it. The line was electrified in 1913, and during the Second World War carried enormous quantities of munitions and troops heading for the Normandy beaches – a military role that had been envisaged from the earliest days of the project!

In 1948 when the railways were nationalised, the Tunnel became part of London Transport's railway system. It now carries trains on the London Overground network and will form part of London's new orbital railway due to be completed in 2012.

By any standards the Thames Tunnel was a remarkable feat of engineering, and it remains one of Britain's most important civil engineering landmarks. Sir Marc Brunel pioneered the method by which many road, rail, sewer and other tunnels would be constructed to this day, ensuring that for over a hundred years following its completion British engineers would lead the world in the construction of tunnels.