Reconstruction of Morphetts enginehouse, Burra.

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Burra was the largest metalliferous mine in Australia between 1845 and 1860 and employed as many as 1000 men and boys. The workforce was predominantly Cornish, Burra being the first concentration of Cornish folk in Australia. The surface and underground mining operations were typically Cornish and virtually all positions of responsibility were held by Cornishmen. Beam pumping and winding engines were imported from Cornwall and housed in traditional Cornish enginehouses.

Burra had the first significant number of beam engines in Australia: six were installed between 1849 and 1861. These engines, ranging in size from 20 inches to 80 inches in diameter, were used for pumping, hauling, and driving Cornish roll crushers and dressing machinery.

Derelict enginehouses of the great beam engines are a striking reminder of former mining activity in Cornwall and South Australia. In South Australia about 35 enginehouses were erected between 1848 and 1887, of which eight still remain, three of them at Burra (Figure 1). These remain as a tangible link with the Industrial Revolution.

Morphetts enginehouse was reconstructed in 1986 as a Jubilee 150 project, the first such reconstruction anywhere in the world. The South Australian Department of Mines and Energy has been a major contributor to this unique project which has consisted of four components:

- reconstruction of the enginehouse
- retimbering of the upper part of the engine shaft
- excavation and retimbering of a drainage adit
- interpretive signposting and display.

Reconstruction of the enginehouse

History of the building

Morphetts enginehouse originally housed an 80-inch Cornish beam pumping engine (Figure 2), which raised up to three million gallons of water per day from the mine, via the adjacent shaft. It was built in 1858 by two Cornish stonemasons, Ambrose Harris and Thomas Paynter, and named after John Morphett, a prominent early South Australian and director of the South Australian Mining Association from 1854 until 1861.

The engine commenced operations in 1860 and worked until the mine closed in 1877. Somewhere around 1916 the machinery was removed for scrap, a process which damaged part of the engine bedstone which fell into the cockpit. In 1925 the building was gutted by fire and remained as a shell until reconstruction commenced in 1986.

Details of the engine

<table>
<thead>
<tr>
<th>Maker</th>
<th>Perran Foundry, Perranarworthal, Cornwall</th>
</tr>
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<tbody>
<tr>
<td>Cylinder</td>
<td>80 inches</td>
</tr>
<tr>
<td>Beam</td>
<td>17 feet indoors</td>
</tr>
<tr>
<td></td>
<td>15.5 feet outdoors</td>
</tr>
<tr>
<td>Power</td>
<td>Total weight about 30 tons</td>
</tr>
<tr>
<td>Stroke rate</td>
<td>250 horsepower</td>
</tr>
<tr>
<td>Pumping capacity</td>
<td>6 to 8 per minute</td>
</tr>
<tr>
<td></td>
<td>up to 3 million gallons per day</td>
</tr>
</tbody>
</table>

History of the project

The concept of reconstruction was first promoted in 1973 by R.D. Byles of SAMIN, a company which was reworking the mine, in conjunction with Burra historian I.L. Auhl. However no funding was forthcoming at that time.

Following a recommendation by Mr Auhl, the Morphett Shaft Restoration Committee was formed in 1979 and in July 1980 a grant was made to the project by the State Heritage Branch of the Department of Environment and Planning; this was used to purchase slate and scaffolding.

In 1983 further funds from the Jubilee 150 Board were allocated to complete the reroofing of the enginehouse as part of a total package known as the Burra Heritage Town Project. Other components of the project were the restoration of an additional wing of Paxton Square cottages, restoration of the Bon Accord Mine buildings and construction of a Copper Interpretive Centre.

In mid-1985 an alternative proposal to the Copper Interpretive Centre was made by the author.
Figure 1 Burra Mine historic site.
Figure 2 Perran Foundry drawing of an 80-inch beam engine built in 1853. Morphets engine built in 1858 was identical to this engine (Country Record Office, Truro, Cornwall.) The engine consisted of a cylinder with a piston inside. The piston was connected to one end (indoor end) of a massive cast iron beam or bob. The other (outdoor) end of the beam was positioned directly over the shaft and connected to the pump rod which extended down the shaft. The engine lifted the pump rod which then fell by its own weight pumping water. Attached to the pump rod by a series of offsets were plunger pumps. The first pump in a sump at the bottom of the shaft was a suction pump. This raised water to the first cistern on the upstroke of the pump rod. On the downstroke the various plungers offset from it were lowered into the barrels of the working pumps thus pushing a column of water up the rising main.
This involved reconstruction of the boilerhouse adjacent to Morphetts enginehouse to house an interpretive centre, and the reallocation of additional funds to complete the reconstruction of Morphetts. Unfortunately funding for the Copper Interpretive Centre was withdrawn by the Jubilee 150 Board, although additional funds were now allocated to Morphetts and supplemented by funding from the Department of Mines and Energy and the Department of Tourism.

Working plans were then drawn up by the project architect, R.J. Shannon Pty Ltd, in conjunction with the technical advisors: the author, and J. Connell (engineer) and J. McCarthy—(historical archaeologist) both of the Department of Environment and Planning.

Information used in the development of the working plans was gathered from four main sources:

- the building itself—there was adequate physical evidence of the location of floors, bearers, stairs, window frames and roof structure.

- historical photographs—good quality historic photographs, taken from various positions and at various dates, provided evidence for windows, doors, the bob platform and balustrades, and roof structure.

- documentary evidence—records of the South Australian Mining Association included the original order for Morphetts engine (Appendix). This gave the sizes as ordered for the spring beams and side beams which form the bob platform.

- existing enginehouses in Cornwall—Robinsons 80-inch enginehouse in Redruth, which operated until 1956, still contains its engine and was visited by the author in 1985. Measurements from this enginehouse were used to supplement and/or confirm internal details for stairs, doors and windows at Morphetts.

The basic philosophy adopted for reconstruction was that voids would be left where the original machinery was located to allow appropriate interpretation and the possibility of a replica engine in the future. Handrails around these voids are of modern materials. Reconstruction has been as close as possible to the original structure with a few minor variations due to the modern building code (flooring boards for instance are 75 mm thick).

The original terminology, as would have been used by the Cornish engineers and engine drivers for the various components, has been strictly adhered to throughout the building.

Figure 3 shows simplified reconstruction plans based on the architect’s working drawings. These

Plate 1 1858. This shows the enginehouse shortly after erection but prior to commencement of pumping in 1860; taken from a painting by William Bentley (Collection: National Trust of South Australia, Adelaide).
(a) Top chamber containing the massive cast iron beam or 'bob' supported on the bob wall. The outdoor end of the bob was connected to the pump rod in the shaft and the indoor end to the top of the piston rod. The bob is fitted with a catch wing to arrest the piston rod and stop it smashing the cylinder below if the rod should break.

(b) Middle chamber showing cylinder cover with piston rod disappearing up to the bob above. Behind was the valve chest and above can be seen the spring beams and massive bulk of timber known as the girder.

(c) Bottom chamber with valve gear in front of the 90-inch cylinder encased in polished wood for insulation. The engine driver operated the valves by hand at starting. Once started, the three valves were worked automatically by valve gear operated by plug rods hung from the bob.

Plate 2 Taylors Enginehouse, Redruth, Cornwall, 1985.
Plate 3 1875. Morphetts engine in operation. Water pumped from the shaft flowed along the launder (wooden trough) to the dressing tower or to be stored in Morphetts pool. The horse whim (left foreground) raised rock as the shaft was deepened. The tall shears with man operated capstan were used for maintenance of pump rods and pipes. The boilerhouse (right) contained six Cornish boilers (Government Records Office).

Plate 4 1906. The engine is still in place and the shears and capstan appear in reasonable condition but the launders have gone (Collection: R.J. Noye). Note opening in mullock dump wall, originally thought to have been the adit entrance.
Plate 5 c. 1910. Boilerhouse is still intact but horse whim and head-frame have disappeared and capstan is dilapidated (Collection: J.L. Auht).

Plate 6 c. 1920. Engine and boilers have been stripped from their houses. Shears with Johnny Green still stand but capstan has gone. Most windows and doors have deteriorated (Photo: D.G. Radford).
Figure 3 The reconstructed enginehouse.
show the enginehouse divided into three levels or chambers as the Cornish referred to them. These are: the bottom (or engine), middle, and top (or bob) chambers, which were constructed solely for the purpose of allowing access to the original machinery. For comparison Plate 2 showing the three chambers in Taylors enginehouse, Cornwall, illustrates the original appearance of the interior of Morphets enginehouse. Plates 3 to 6 are a series of historic photographs of Morphets enginehouse.

Plates 7 to 28 show the stages of reconstruction between May and October 1986.

Retimming the shaft

Immediately adjacent to Morphets enginehouse is the engine or pump shaft in which was located the pumping equipment or 'pitwork'. Morphets shaft was 183 m deep with seven levels connecting it to main underground workings to the north (Figure 4). Water drained to a sump at the bottom of the shaft and was pumped to the surface.

The shaft was originally divided into three compartments by timberwork (Figure 5): a pumping compartment containing the pump rod and rising main; a ladderway for sumpmen (miners) and pitmen; and a hauling compartment for kibbles. Shaft timbers carried the hauling and pumping gear and of course provided ground support.

The fire which gutted the enginehouse in 1925 also destroyed the shaft timbering down to water level (46 m) where it is now blocked.

It was clear that the shaft was an integral part of the development concept and its restoration fundamental to the project. It had to be made safe but also constituted significant tourist and heritage value. Accordingly the author proposed in mid-1985 to retimber the top 8 m of the shaft and provide access into the timberwork through an adit 5 m below the surface. The Department of Mines and Energy provided the initial engineering expertise and allocated funds to complete the project.

The original timbering was carried out as the shaft was sunk, pre-cut timbers being lowered and tightened into position by draw bolts and wedges. The new timbering however required quite a different engineering approach.

Figure 6 shows simplified engineering details of the shaft retimming and Plates 29 to 39 show progress during retimming in September and October 1986.

The timberwork was erected in the traditional style as a column 8 m high adjacent to the shaft and then lowered by crane onto three steel beams supported on concrete pads set into the sides of the shaft. Once in position three additional beams were set onto concrete pads above the timberwork and tied to the lower beams by long steel rods through the timberwork. The timber column was subsequently wedged against the shaft walls, lagging boards fixed, and the void backfilled to prevent any rock movement around the timberwork.

The retimming project was probably the first major shaft timbering in Australia in more than half a century and the method is possibly unique.

Excavation and retimming of the adit

The opening, 5 m below the surface on the eastern wall of Morphets Shaft (Plate 40), was initially thought to have connected with an opening in the mullock dump shown in the 1906 photograph (Plate 4). This opening was located about 40 m to the northeast of the shaft but no evidence remained. There was no documentary evidence for the existence of the adit nor its purpose but it was suggested that it was the miners' entrance way to the shaft and the term 'miners' adit' has since been used.

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![Figure 4 Longitudinal section of Burra Mine.](image-url)
Figure 5 Typical engine shaft of the period (after Earl, 1968).
Figure 6 The reconstructed Morphetts shaft.
The adit was excavated and retimbered concurrently with shaft development to allow underground access to the shaft timberwork onto a platform where a ladder would return the visitor to the surface 5 m above. Excavation was carried out under the direction of the site archaeologist with volunteer labour provided by the Apex Club of Burra.

Initial excavation for the presumed entrance 40 m from the shaft proved fruitless until it was found that the adit was still below original ground level at that point and a trapdoor discovered (Plate 42) which would have provided access probably via the opening in the 1906 photograph.

The adit however was completely filled up with silt presumably caused by a blockage to the northeast. When excavated it contained original timbers and lagging boards (although in a very fragile condition) and timber flooring on which could be clearly seen the outline of a wooden trough (Plate 43). This evidence now indicated that this was a drainage adit almost certainly to remove the large volumes of water used in the condenser pit in front of the enginehouse and from the boilerhouse. The adit continues underground to the northeast probably connecting with other underground drains.

As excavation proceeded towards the enginehouse, the adit was retimbered using handpicked old mine timbers for the supports and new jarrah lagging boards (Plate 45). Two branches off the adit, presumably used for drainage, were encountered during excavation but have not been excavated to date. Lighting for public access completed the project.

Interpretive signposting and display

The three floors within the enginehouse contain display panels which interpret the Cornish beam engine (Plate 25). Themes include: the history and development of the engine, its method of operation, Cornish enginehouses in South Australia, Burra Mine and its enginehouses and the reconstruction of Morphetts enginehouse. These panels were researched, designed and funded by the Department of Mines and Energy.

A number of vitreous enamel interpretive signs were erected on a walking trail near the enginehouse. Similar signs on the mine tourist drive complete the interpretation of the mine area.

Conclusion

This project has been without doubt one of the most ambitious and exciting mining restoration projects in Australia, presenting the only reconstructed Cornish enginehouse and shaft anywhere in the world. Situated in Australia's oldest mining town with its magnificent collection of historic buildings, the project has significant heritage, educational and tourist value.

The completion of this project marks only the first stage in the establishment of the site as a major mining heritage site in Australia. The erection of the massive shears over the shaft, construction of a horse whim and man capstan, reconstruction of the boilerhouse and the adjacent winding house, and the addition of a replica beam engine are still to be achieved.

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- David Bannar, site archaeologist
- Keith Johns, Director-General of the Department of Mines and Energy for his enthusiastic and enlightened support
- Bob Shannon (project architect) and James Elliot (builder).

BIBLIOGRAPHY

Plate 7 1985. Scaffolding was erected and slate purchased in 1980. Due to lack of funds the project was deferred until the reconstruction project commenced in May 1986.
Plate 8 Bedstones and cylinder bolts. Three of the original five cylinder bolts set into large sandstone blocks or bedstones were still intact. Two of the bolts were destroyed and one bedstone damaged when the engine was removed about 1916. Behind is the bob wall with plug door opening. The interior walls were originally whitewashed and the fabric clearly revealed the location of floors and stairways.

Plate 9 Cockpit. The damaged bedstone was located in the cockpit immediately in front of the bedstones.

Plate 10 Bottom chamber. Flooring has been placed over the cockpit and the damaged bedstone has been lifted awaiting resetting. New flooring joists are being fitted to existing wall pockets.
Plate 11 Spring beams. SAM. records gave the size of the original spring beams as 24 x 15 inches (610 x 380 mm) whilst pictorial evidence showed that the beams had an S shape (ogee) at the outer end.

Plate 12 Lifting the spring beams. The two spring beams weigh about 2 t and are about 14 m long. The timber is Oregon and was imported from Canada as timber of these dimensions could not be machined in Australia.

Plate 13 The lift completed. The beams were manoeuvred into the original holes or pockets in the south wall and levelled on the bob wall. Flooring timbers were then lifted ready for fitting.
Plate 14 Roof. Design of the new roof structure was based on physical and pictorial evidence. Photographs provided details of trusses and roof cladding. Physical inspection verified the number and placement of trusses and presence of slate tiles. The modern building code required that more rafters of larger dimension be used in reconstruction than were originally fitted.

Plate 15 Top chamber. This shows the roofing detail and bob wall infill. The vertical board timber infill was based on pictorial evidence. Note the slot for the original beam has not yet been cut in the floor.

Plate 16 Roof timbers completed. The timber framing is complete and awaiting slate tiles. The original slate was probably from Wales but the new slate was imported from South Africa in 1980. Floor boards have been nailed to the spring beams but have not yet been trimmed.
Plate 17 Reroofing completed. Roof work is complete and the classical lines of a Cornish enginehouse are evident.

Plate 18 Bob wall infill. Cladding of the stud wall framing with western red cedar is nearing completion.

Plate 19 North wall. The vertical board wall is complete with its two doors in place. The platforms are complete except for the balustrades. The plug door and boilerhouse door have been fitted and painting has commenced.
Plate 20 Middle chamber. The completed stairs are awaiting balustrades and the slot in the floor above where the massive beam pivoted has been cut.

Plate 21 Top chamber. The top chamber is finished awaiting fixing of balustrades on platforms and around the slot.
Plate 22 Reconstruction completed. The ornate hand rails have been fixed and the traditional red paintwork completed. Balustrade details were based on pictorial evidence.

Plate 23 Reconstruction completed. The southern side of the building shows its elegant cylinder doorway and 16-pane windows.

Plate 24 Opening Day, 5 October 1986. The reconstruction project was officially opened by Mr. R.K. Johns, Director General of the Department of Mines and Energy.
Plate 25 Bottom chamber completed (c.f. Plate 8). The circular metal handrail represents the position of the original cylinder and above is the circular cylinder opening. Note the interpretive panels.

Plate 26 Middle chamber completed (c.f. Plate 2b). Both the bottom and middle chambers have been whitewashed in traditional style.
Plate 27 Top chamber completed (c.f. Plate 2a). Note the slot for the engine beam. Walls have been left in natural state to show what the fabric of the building was like after 60 years exposure to the elements.

Plate 28 View down from top chamber through beam slot and cylinder opening.
Plate 29 Morphets shaft prior to retimbering photographed from the bob platform. Shaft originally measured 10 x 16 feet in the clear. Stonework at the bottom of the picture contained the condenser cistern and at right is the slot for the balance weight beam which connected with the pump rod.

Plate 30 Balance weight pit adjacent to Morphets shaft which contained a weighted box used to counterbalance the excess weight of the pump rod.

Plate 31 Concrete pads for the top three steel beams.
Plate 32 Cutting the sides of the shaft for the concrete pads which support the lower steel beams.

Plate 33 Erection of the timber column adjacent to the enginehouse. Treated oregon pre-cut to original sizes was assembled and tightened together by draw bolts.
Plate 34 Completion of the timber work. The spacing between each set is 5 feet (1.52 m).

Plate 35 Lifting the timber work with safety mesh fixed to the base. This was lowered onto the three steel beams set into the sides of the shaft.
Plate 36 Positioning timber work over the shaft.
Plate 37 View from bob platform showing timber work being lowered down shaft.

Plate 38 Timber work in position ready for the three steel beams to be placed across the top.

Plate 39 Retimbering completed. The top steel beams have been placed in position. Note the timber platform in the shaft at adit level. Backfilling, stonework repair, fencing, safety mesh and lighting completed the project.
Plate 40 *The near surface adit prior to retimbering of Morphetts shaft. The stonework was for the balance weight beam.*

Plate 41 *Searching for the entrance to the adit under supervision of site archaeologist David Bannear. The bulldozer is removing mullock to reveal original ground level.*
Plate 42 The adit entrance revealed. Timbers to the left of the burrow form a trapdoor which allowed access to the adit below ground level.

Plate 43 Excavating the adit. The adit had completely silted up over a century but remnants of the original timber still remain. Note the timber flooring on which the outline of a wooden trough can still be seen.

Plate 44 Replacing the mulllock dump over the refitted adit.
Plate 45 The adit interior after retimbering. Original mine timbers were handpicked for supports but new jarrah lagging boards were used.
Particulars of Pumping Engine required for the Burra Burra Mines, South Australia (12 June 1857).

Length of Beam: Longest end from centre of centre hole to centre of end hole seventeen feet. Shortest end from centre of centre hole to centre of end hole fifteen feet six inches. Length of stroke in cylinder eleven feet. Length of stroke in pump ten feet. Cylinder eighty inches in diameter. The holes for holding down the cylinder bottom to be cast strictly in accordance with the annexed diagram. A governor valve independent of the top steam. Four new boilers complete made of best Shropshire Iron, to be from thirty two to thirty four feet in length—weighing about eleven tons each in pieces of about four tons each. The doors and frames for fire to be two feet ten inches by two feet four inches for burning wood (the ordinary frames and doors are too small). Gudgeon, Cap pieces, strapping plates, staples and all other work complete for Balance Bob. A wrought iron Gudgeon for the main Bob with spare brasses, and duplicate brasses for all such as wear fast. Spare set of steam valves and seatings. A spare piston and rod. A spare piston rod cap. A spare air pump, bucket, rod and valves. A spare floating cover for air pump. One spare main loop. One double set of Fire Bars and bearers. Fifty boiler plates same size as the boilers are made of seven cwt of Rivetts a Counter.

Pitwork: Thirty two fathoms twenty inch plunger lifts complete. Windbores to be six feet six inches long. Clacks and seals complete. The clacks to be axe-mouthed or halfmoon with guides over them. Seatings to be brass and the valves to be wrought iron, one and one-quarter inch and two sets of the same. Eleven twenty one inch pumps, one twenty inch door piece for drawing lifts with clacks complete and guides over. One windbore nine feet long, not more than ten holes for flange-pins in each pump. Two twenty inch buckets joints complete. One twelve feet twenty inches working barrel. Three six feet twenty one inch pumps. Three three feet twenty one inch pumps (10 holes in each flange).

For capstan: One iron axle with centre piece, pullies, gudgeons and brasses for a sixteen inch rope complete. Twelve arms. One sixteen inch rope, 170 fathoms in length for engine capstan to be manufactured from best Europe hemp. Special instructions must be given as to this rope being of the best quality and great care must be taken in packing it so as to protect it from damage by sea water.

Timber required: Two spring beams not less than forty seven feet long, twenty four inches by fifteen inches thick. Two side beams forty seven feet long, either fourteen inches by seven inches or one piece fourteen inches square.

(Signed)
H. Ayres, Secretary

(Mortlock Library BRG 22/960)