Early water pumping technology in Australia

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SUMMARY: The supply of water for mining and pastoral stations was vital to the development of the Australian economy. There is very little remaining fabric of the early technology and a study has been made of the stationary equipment designed and manufactured by the early foundries in Adelaide from 1843 who supplied pumps, engines and pump sets to increase the capacity of station stockholdings and productivity of the land in SA and NSW. Whilst wind power was available, 1830’s steam technology from England was developed for the Australian environment and purchased by landowners eager to capitalise their properties and improve capacity and profits. These pump sets were operating until the introduction of oil engines in the 1890’s, and were substantial installations in their own right requiring site staff to operate and maintain them, and a supply of spare parts. There is sufficient archaeology from remote pastoral stations and wells to establish the significance of the engineering heritage and record this technology which has not been published to date.

1. DEMAND FOR WATER PUMPING

From the early days of settlement, water supply for people and livestock was critical to urbanisation and the development of Australia’s mining and pastoral industries while the removal of water (dewatering) was critical to operations such as mining and the construction of barrages and locks.

The first engineers were employed servants of the British Government (Colonial Engineers). They were skilled artisans with expertise in the design and manufacture of water pumps who emigrated from the 1830s onwards. The health of many settlers was adversely affected by contaminated water while the exploration and development of new pastoral lands were inhibited by the availability of water. The skills of the engineers were therefore initially employed in the supply of water to developing towns: this included pumping, storage and attempts at filtering contaminated water.

The engineering of municipal waterworks and Cornish mine pumping are reasonably well documented but this paper explores the development of early water pumping technology in pastoralism, some of which still survives today. Fortunately there are enough relics to enable an analysis of the principal engineers who supplied equipment in northern South Australia and western NSW.

1.1 Sources of water

Some naturally-occurring supplies such as waterholes and mound springs in the Lower Eyre South Drainage Basin were available at first. However, the main sources of water were underground and well sinkers were employed by the Government and pastoral lease holders on a contract basis. It wasn’t until the 1880’s that Artesian bores were developed using cable tool drilling technology imported from the USA one of the most common being built by Keystone.

Figure 1: Cable tool rig at Tonsley Station, 1890s

Australia’s first artesian bore was drilled in WA at Kelmscott under the advice of H Y L Brown, the famous Government geologist (1). From the 1920s earthmoving equipment started becoming available to build dams and many wells were replaced with surface water storage. It is important to note that well-sinking was not very cost effective: the water was often too salty for consumption and many wells did not find water at all.

Artesian water drilling became more important from the 1880’s when the drilling technology was reasonably developed and the extent of the Artesian Basin widely recognised. At the same time this drought proofed many stations and made the deep ground well pumping less relevant.

1.2 Development of water pumping technology

The development of water pumping technology was driven by a number of concurrent factors including

- Natural water supply in Australia pastoral areas is unreliable because landscape features may not include natural catchments while rainfall in some areas is erratic or insufficient
The growth in the Colonies and the urbanisation of the population required reliable and larger capacity water supplies for human consumption.

Driven by the rising price of copper and wool, mining and pastoral production required water supplies of ever increasing capacity.

Stock routes between stations or to ports required regular watering points and, from the 1880s, Governments employed well sinkers and cable tool drillers to exploit groundwater.

2. WATER PUMPING TECHNOLOGY

The new model below (Figure 2) demonstrates the range of pump types, motive power and drives used over the years to hydraulically transport water from deep wells to a trough or tank for the watering of stock.

![Figure 2: Pump types, motive power and drives](image)

There are no definitive dates on the phase out of the various technologies employed. However, there are relics left today which indicate that multiple methods were used at some locations such as Mt Victoria Well on Bimbowie Station (Figure 3). The wooden structure leaning over in the foreground is a whim. On the left of this picture can be seen a vertical steam engine with pulley which would have driven a force pump submerged in the well. At some time from the 1880s this was replaced or supplemented by a windmill, an oil engine and electric motor drives – is Acraman Well on Yardea Station, near Minnipa.

John Acraman immigrated to Australia in 1847 and was renowned for being the father of football, importing seven balls into Adelaide. He took up land on Eyre Peninsula in 1858 where his company invested 50,000 pounds in well-sinking, fencing and other improvements, some of which survive today.

2.1 Bucket pumps

Groundwater wells were up to 50 metres deep which was the depth a man could work to without suffocating. The earliest supply methods used buckets of about 10 gallon (45 litre) capacity lifted by manually-operated windlasses or, in some cases, levers (similar to the Egyptian shadouf).

Animal power was harnessed in a whip or a whim. A single whip had a horse pulling a rope over a pulley to raise and lower a bucket; with a nominal 20 gallon bucket (90 litre), this had a productivity similar to that of an average windmill (2). A double whip had a loop of rope and two buckets: as one was being pulled to the trough, the other was lowered into the well.

A whim consisted of a vertical capstan on which a rope was wound by a horse or other animal walking in a circle (Figure 4). Comparing the length of the arm driven by the horse to the radius of the capstan shows the significant increase in the torque applied and hence the lifting capacity of the whim. Horse works are a variant of the whim and used a bevel gear to convert the rotary motion of the capstan to a horizontal rotating shaft and a belt drive.
Whims powered by horses, bullocks or even camels (depending on the location) were used by pastoralists and miners until horses were phased out with the introduction of internal combustion engines.

2.2 Mechanical pumps
There are two basic types of mechanical pumps: force pumps, in which a piston draws water into a chamber and then expels it under pressure (Figure 5), and lift pumps, in which water drawn into the pump chamber passes through a valve in the piston on the down stroke and is then lifted to an outlet spout on the upstroke. These pumps can be operated by hand (as in the familiar lever-operated water pump) or by an engine and vary in size from small pumps providing domestic water supply to large pumps capable of dewatering a mine.

Early force pumps were manufactured in Adelaide by iron founders and millwrights John Wyatt and later on Andrew Jones. These are discussed further in Section 3.

Lift pumps were common for garden use and where the hydraulic lift is limited to 9 metres or less. They were also used in combination with force pumps and Cornish beam engines to dewater mines at significantly higher flow rates.

Where steam is available, two other variants use the steam directly to pump water: Pulsometer pumps and direct acting pumps such as those made by Worthington or Tangye Cameron.

Pulsometer pumps were used for dewatering and barrage building in the early 1900s and were eventually replaced by centrifugal pumps. The Pulsometer worked by alternately introducing and then condensing steam in the two chambers of the pump. Once admitted, the steam condensed which drew water into the chamber; meanwhile the other chamber had filled with water and a burst of steam then forced it out. The alternating action was likened to a beating heart, hence the name. Because of the high heat losses, the pump was not very efficient; however, one example of this pump type, patented by Ellison in 1898 (Figure 6), was used to dewater the Goolwa barrage during construction. A similar pump was patented by Savery.

In a direct acting pump the driving piston of the steam engine is directly coupled to the pump piston by a rod. There is no crank or flywheel involved.

2.3 Oil engines
The oil engine was progressively imported and built in Australia from the 1890s and became the prime power source for centrifugal pumps, particularly on remote pastoral wells. There was no need to spend time and resources sourcing wood fuel and the boiler could be brought up to working pressure quite quickly. Once an oil engine was started it could be left relatively unattended for hours.

Some more modern steam engines driving deep well pumps were in use up until the 1930s; for example on Alexandria Station in the Northern Territory. They were only replaced by oil engines when the landscape was completely denuded of firewood (12).

2.4 Windmill pumps
Windmill pumps were installed from the 1880s and were built by firms such as Alstons in Victoria, and Griffiths in Toowoomba (13). This technology combined with low cost earth dams became common throughout Australia and is still relevant today.
The locations described (Mt Victoria Well and Acraman Well) all indicate that Jones-type steam pump technology (see section 3.) co-existed with wind power in close proximity for a period of at least 30 years. The value of having a buffer supply of water in a dam supplied by a windmill pump would have been far greater than the cost of sourcing firewood for boilers in landscapes now devoid of heavy timber and the resultant relatively high cost of operating a steam pump.

3. STEAM FORCE PUMPS
Two Adelaide engineering businesses built and supplied a number of steam pump installations. The two businesses eventually merged when Andrew Jones took over the works of John Wyatt after the latter’s death.

3.1 John Wyatt
John Wyatt arrived in SA in 1838 and from at least 1840 was in business as a consulting engineer to the SA Company providing advice on flour mill construction and water pumping to the new colony. In 1843 he established a steam engine manufactory on North Terrace in Adelaide and began supplying steam-powered pumps. Some were imported from England while others were built within the works. (This engineering capability also existed in Melbourne (Fultons) and Sydney.) His first engine (3 hp, kW) was called the Cyclops.

Force pumps built about the same time included those installed at:
- Burra Burra mine 40,000 gph (50 litres/sec)
- Patent Copper Company
- Wheal Margaret pumps, diameter 66 inches (1676 mm) (6)

Wyatt was an experienced millwright and draftsman and was formerly a Superintendent at the Cottam and Hallens works in London (who, incidentally, built Dr Kent’s beam engine for his Adelaide flour mill in 1840). The Wyatt name is well connected with the firm of Boulton and Watt with several different Wyatts employed as foremen of the works (although no direct relationship with John Wyatt has been established).

Prior to 1847 Wyatt had proposed a pumping system to supply Adelaide with one million gallons of water per day (52 litres/second) from the River Torrens. He would use a 20 hp (90 kW) steam engine driving a two throw pump with 12” (305 mm) cylinders and 6 ft (1829 mm) stroke (4). [Note hp and NHP were used interchangeably in the period and were based on piston size. Approximate kilowatt values have been given for NHP.] Wyatt approached both Governor Grey and Governor Robe about the scheme but the plan lapsed.

In 1847 Wyatt sank a well at his foundry which was “the envy of many Adelaidians” (5). His business grew with the demand from mining operations requiring dewatering, the increase in steam flour mills following the growth in corn production, and the need to repair paddle steamers employed to transport corn and flour on the River Murray.

Wyatt’s sons George and Joseph took over management of the foundry from 1849 with John staying on as a draughtsman. They could produce castings in the order of 4 tons (4.1 tonnes) and there were two cranes capable of lifting five and three tons. The foundry had two cupolas and a large drying stove. In the smith’s shop there was a 2 cwt (90 kg) steam hammer with a 2 ft (610 mm) stroke for forging shafts. In the fitting shop were four lathes with centre distances up to 10 feet (3048 mm) and capable of turning pump casings up to 48 inches (1220 mm) in diameter. There were also smaller lathes, two drilling machines, and screw cutting and planing machines (7).

Wyatt’s earliest extant work is a bell made in 1851 for the SA Mining Association, owners of the Burra Burra Mine. It was installed at Schneider’s engine house until 1925 and is now located near Morphett’s engine house (Figure 7).

Wyatt built steam engines up to 8 NHP in 1844 and in 1849 was advertising engines from 2 to 20 NHP (9 to 90 kW approximately). That year the price of an engine complete with boilers was quoted to the South Australia Company at 300 pounds. Boilers were priced at 5 pounds per (nominal) horsepower (9).

George Wyatt was also advertising water raising machinery including steam engines, pumps, whips and whims – ie, the whole plant (8). Because force pumps were heavy castings and subject to a harsh corrosive environment, often submerged in salty water, few examples survive today. However, Figure 8 shows a pump by George Wyatt dating between 1849 and 1877; Figure 9 shows the detail of the engine cylinder and flywheel.

It is a single-acting single-throw force pump with a cylinder diameter of approximately 150 mm. Note the clear builder’s identification. Nearby is the relic of a steam engine of very early design including a cast iron bed, flat cross head guide, and wrought flywheel.
spokes. Other features to note are the use of through bolting rather than studs, the lack of symmetry in the bolted joints, and limited use of brass material.

![Figure 8: Wyatt pump](image1)

![Figure 9: Wyatt steam engine cylinder (top) and flywheel (above)](image2)

In summary at least 18 steam engines are known to have been built by Wyatt:

**Mill and Mine engines**

<table>
<thead>
<tr>
<th>Year</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1844</td>
<td>3 hp (13 kW) Randall flour mill, Gumeracha</td>
</tr>
<tr>
<td>1844</td>
<td>Noarlunga Horseshoe mill</td>
</tr>
<tr>
<td>1845</td>
<td>Gawler Town flour mill 4 hp (18 kW) later 30 hp (135 kW), 17 ft (5.2 m) flywheel</td>
</tr>
<tr>
<td>c1850</td>
<td>Acraman well</td>
</tr>
<tr>
<td>1851</td>
<td>Tungkillo Reedy Creek mine, 16 NHP (72 kW)*</td>
</tr>
<tr>
<td>1858</td>
<td>Charlton mine, 16” bore (406 mm)*</td>
</tr>
<tr>
<td>1860</td>
<td>Light Square mill, 12 NHP (54 kW)</td>
</tr>
<tr>
<td>&gt;1864</td>
<td>8 hp (36 kW) engine for machine shop</td>
</tr>
<tr>
<td>1869</td>
<td>Alamanda silver mine</td>
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</tbody>
</table>

* Later moved to Nuccaleena Mine

**Paddlesteamers and barges**

<table>
<thead>
<tr>
<th>Year</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1855</td>
<td>* PS Gemini * 25 hp (112 kW)</td>
</tr>
<tr>
<td>1858</td>
<td>* PS Bunyip * 2 cylinder oscillating, 20 hp (90 kW)</td>
</tr>
<tr>
<td>1864</td>
<td>Kennedy barge 60 hp (270 kW)</td>
</tr>
<tr>
<td>1865</td>
<td>* PS Culgoa * 30 hp (135 kW)</td>
</tr>
<tr>
<td>1866</td>
<td>* PS Jolly Miller * 16 NHP (72 kW)</td>
</tr>
<tr>
<td>1869</td>
<td>* Nil Desperandum * barge 17” x 48” 30 hp (in partnership with Jones)</td>
</tr>
</tbody>
</table>

Building marine engines such as the latter was another common industry in SA, NSW, Victoria and Queensland that depended on the Murray and Darling river systems. Before the railways were developed, grain, corn and goods were transported by paddle steamer between pastoral stations, flour mills, farms and traders. Hence Wyatt was in a critical position of supply and influence to the transport trade, mining Captains, municipal engineers and pastoralists.

### 3.2 Pappin and Jones

This Iron and Brass foundry was founded by Joseph Pappin and Andrew Jones. They commenced business in Blyth Street, off North Terrace, Adelaide in 1855, advertising engineering and millwright services. Today there is very little evidence of the contribution it made to the pastoral industry other than some relics which have close design features to later Jones steam engines.

Figure 10 shows one reasonably complete engine which was reconstructed, by the late Kev Rohrlach for his Angaston museum (now closed). Some of its key features include:

- Semi circular cross section flywheel with wrought spokes, flywheel diameter 1194 mm
- Self contained grey cast iron bedplate
- Pitchfork connecting link
- Forged bent crankshaft, stroke 200 mm, bore 100 mm
- Low pressure steam chest (few bolts)
- Wrought iron boiler
- Spur gear drive at the end of the crankshaft for the water pump drive
- Through bolting
There are no identifying marks on this engine and no pumps survive. However, it has similar design features to later Jones engines and the original installed location supports the claim that this is one of their engines. Engine relics have also been identified at Roxby Downs Station and Moorabin Well.

3.3 Andrew Jones and Sons

Pappin and Jones changed their trading name to Andrew Jones and Sons, Adelaide Foundry in 1872 following the death of Pappin. In 1878 they purchasing the estate of John Wyatt and moved their business to North Terrace (Figure 11).

Jones’ expertise as an engineer and mine smith was in building steam pumps for pastoral stations, and flumes and troughs for stock watering. Other works included paddle steamer engines, flour mill engines, and fence railing. They advertised annually “appliances for raising water”, including windmill pumps.

Principal mining machinery (assumed to be pumps) was built for the Moonta, Wallaroo, Hamley and Prince Alfred mines in the 1870s (10) and flour mill machinery for the Port Pirie flour mill owned by John Dunn in 1877. In 1881 Jones built a 15 hp (67 kW) engine for the Minlaton flour mill and in the following year a pumping engine for the Blinman mine.

Key features of a Jones engine include:

- Pitchfork connecting link
- Identical circular cross section flywheel for pump and engine
- Grey cast iron bedplate
- Wrought iron boiler best and best grade
- Piston diameter 144 mm
- Stroke 250 mm
- Flywheel diameter 1500 mm
- Spur gear drive to pump crankshaft

The boilers are of the vertical type, 2200 mm high and 1000 mm diameter.

Based on a nominal speed of 100 rpm for this engine size, the estimated capacity of the single acting pump is 440 litres/min. Typical stone tanks were built with a capacity of 20,000 gallons (90,000 litres) and filled once a week or fortnight in 3.5 hours. This capacity would support nominally 1000 sheep or 150 head of cattle (1). However, the pump capacity is a conservative estimate as more modern steam engines of this size operated at up to 180 rpm.

The pump crankshaft was up to 3 or 4 metres long and was designed to traverse the well resulting in a pump and engine layout of considerably size (Figure 12).

Based on the archaeological fabric at the remaining sites, the possible layout of a typical station pump set is shown in Figure 13. The station-hand figure gives an idea of the imposing size of these installations with their two large contra rotating flywheels. The engineering feat of commissioning these pump sets in such remote locations is also remarkable.

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**Figure 10:** Pappin and Jones engine, c 1856

**Figure 11:** A Jones & Sons

**Figure 12:** Pumpshaft, flywheel and spur gear from a Jones pump
Other relics also indicate a flat belt drive was sometimes employed which would have been simpler to install (Figure 14).

John Ragless a former miller, established the Yalpara run and in corresponding with Jones expressed his concern about supply of parts: “I sent the message to Jones last week, he is an old humbug, as if he had measured the old rings he would have been right, as they were kept in the right places by two pieces of copper ... I am afraid to leave the station until I get the piston from Jones. As soon as they are here and the engine works I will start for Adelaide ... There has been no work done the glass stuck at 134 degrees F ....”

Such wear would indicate these engines pumped water for many hours and with little lubrication! There is some remaining fabric to indicate that Jones engines and pumps were built for:
- Murnpeowie Station
- Yalpara Station
- Mt Fitton Station, Trinity Well
- Roxby Downs Station
- Yatala Station, Fowlers Bay
- Yardea Station, Acraman Well
- Quininbuy Station, Tilcha Well (near Broken Hill)
- Tiverton Station, Pats Well (near Broken Hill)
- Koonamore Station
- Wilcannia, Moorabin Well
- Mt Vivian Station, Mt Vivian Well

In total at least eleven engines and pumps were built, given the age of these machines it is likely many more were built. The remaining fabric of these machines are typically buried in dams, or wells as shown in Figure 15 with two flywheels, the engine and pump crankshaft in the foreground of the boiler.

Jones also built marine engines including (11):

<table>
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<tbody>
<tr>
<td>1864</td>
<td>PS Moolgewanke steeple 20 hp (90 kW)</td>
</tr>
<tr>
<td>1873</td>
<td>PS Gertrude 16 hp (72 kW)</td>
</tr>
<tr>
<td>1878</td>
<td>Kennedy barge replacement engines 35 hp (158 kW)</td>
</tr>
<tr>
<td>1878</td>
<td>South Australian barge 60 hp (270 kW)</td>
</tr>
</tbody>
</table>

Jones employed up to 40 men building steam pumps but this business declined in the early years of the twentieth century as pastoralists adopted dams and light windmills. The business slowed down with employment reduced to 10 men in 1912 when the business closed.

In retirement Jones remarked: “I think [the future] is very bright at present in regard to the volume of work required. In that respect it probably has never been more active. On the industrial question our experience with our men has all been satisfactory. We have always endeavoured to meet our employees in fair spirit, and their attitude to ourselves was evidently corresponding. Generally speaking however the same can hardly be said now that unions are taking such a strong hand in everything. They somewhat alter the aspect of the position between employer and employee, who are less likely to understand one another and get along amicably.
with outside interference than they would be left in a direct relationship” (10).

Why did Jones and Sons shut down their business in 1912? There were a number of reasons other than impending potential union labour problems. The Jones pump set was based on 1840s technology and had not been developed in the period 1872 to 1912 (40 years). More modern and efficient steam engines were being imported such as the Tangye from England; larger engines were also equipped with variable expansion gear and more efficient boiler designs. The mechanical efficiency of the geared crank designs with multiple connecting links reduced efficiency.

Alternative direct acting steam pump designs such as the Tangye Cameron steam pump employed steam piped directly to the pump and had minimal relative mechanical losses with less capital cost.

4. CONCLUSIONS

The fabric remaining today of the steam powered deep well pumps are significant historically as the builders were connected to important people who built the economy of the colony such as the wealthy squatters. Whilst the design technology was relatively primitive at the time, the foundries and engineering works were significant engineering works in their own right. The designs are unique in Australia and relatively rare. The pump sets were imposing in appearance with two contra-rotating flywheels; installed in very remote locations, they would have been impressive in operation. There are no complete engine pump sets in existence and it is hoped that this paper will record for posterity the significance of the people who built and operated them, and their unusual design within the context of the large range of early pumping technology employed in mining and pastoral stations.

5. ACKNOWLEDGMENTS

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6. REFERENCES

2. Yelland L. Pads, tracks and waters, South Australia's pastoral stock routes. 1st ed: Primary Industries and Resources South Australia; 2002.
7. The North Terrace Foundry. The Register 1864 15 March 1864; Sect. 2.