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Water at Prestongrange and Pumping it out

Ewan Wilson

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http://www.prestoungrange.org

FOREWORD

This series of books has been specifically developed to provided an authoritative briefing to all who seek to enjoy the Industrial Heritage Museum at the old Prestongrange Colliery site. They are complemented by learning guides for educational leaders. All are available on the Internet at http://www.prestoungrange.org the Baron Court's website.

They have been sponsored by the Baron Court of Prestoungrange which my family and I re-established when I was granted access to the feudal barony in 1998. But the credit for the scholarship involved and their timeous appearance is entirely attributable to the skill with which Annette MacTavish and Jane Bonnar of the Industrial Heritage Museum service found the excellent authors involved and managed the series through from conception to benefit in use with educational groups.

The Baron Court is delighted to be able to work with the Industrial Heritage Museum in this way. We thank the authors one and all for a job well done. It is one more practical contribution to the Museum's role in helping its visitors to lead their lives today and tomorrow with a better understanding of the lives of those who went before us all. For better and for worse, we stand on their shoulders as we view and enjoy our lives today, and as we in turn craft the world of tomorrow for our children. As we are enabled through this series to learn about the first millennium of the barony of Prestoungrange we can clearly see what sacrifices were made by those who worked, and how the fortunes of those who ruled rose and fell. Today's cast of characters may differ, and the specifics of working and ruling have surely changed, but the issues remain the same.

I mentioned above the benefit-in-use of this series. The Baron Court is adamant that it shall not be 'one more resource' that lies little used on the shelves. A comprehensive programme of onsite activities and feedback reports by users has been designed by Annette MacTavish and Jane Bonnar and is available at our website http://www.prestoungrange.org – and be sure to note the archaic use of the 'u' in the baronial name.

But we do also confidently expect that this series will arouse the interest of many who are not directly involved in educational or indeed museum services. Those who live locally and previously worked at Prestongrange, or had relatives and ancestors there (as I did in my maternal grandfather William Park who worked in the colliery), will surely find the information both fascinating and rewarding to read. It is very much for them also to benefit – and we hope they will.

Dr Gordon Prestoungrange
Baron of Prestoungrange
July 1st 2000

Ewan Wilson

Ewan graduated from University of Edinburgh with a Fine Art Degree and has written articles on art history. He currently works as Museum Assistant at Prestongrange Industrial Heritage Museum, a post he has held since 1998. A keen local historian, with a sound knowledge of Prestongrange Industrial History, he has researched for Museum exhibitions and produced contemporary images of the site.

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INTRODUCTION

COAL HAS BEEN worked on the site of Prestongrange for over seven hundred years. There is no question that the other industries that developed in and around the area owed their existence to its abundant presence. In order to tap the rich resource a solution had to be found to the major limiting factor – that of drainage.

This booklet briefly surveys the history of Prestongrange and its development. It then examines the development of the key machine that was to address the problems of drainage at Prestongrange, the Beam Engine. The history of is development and that of steam is addressed and then the history of Prestongranges Beam Engine is told.

This machine was extremely important to the site and today is now one of only four in the United Kingdom. It is a tribute to the importance of this huge machine that regardless of its immense size it was still considered as portable. Beam engines were transported all over the country and even exported to Europe and America.

Dorothy Wordsworth recorded in her 'A Tour of Scotland' the reaction she and the poets Coleridge and William Wordsworth on seeing a beam pumping engine in 1803 at Wanlockhead.

> "Our road turned to the right, and we saw, at the distance of less than a mile, a tall upright building of grey stone, with several men standing upon the roof, as if they were looking out over battlements. It stood beyond the village, upon higher ground, as if presiding over it – a kind of enchanter's castle, which it might have been, a place where Don Quixote would have gloried in. When we drew nearer, we saw coming out of the side of the building, a large machine lever, in appearance like a great forge-hammer, as we supposed for raising water out of the mines. It heaved upwards once in half a minute with a slow motion, and seamed to rest to take a breath at the bottom, its motion being accompanied with a sound between groan and 'jike'. There would have been something in this object very striking in any place, as it was impossible not to invest the machine with some faculty of intellect: it seemed to have made the first step

> from brute matter to life and purpose, showing its progress by great power. William made a remark to this effect, and Coleridge observed that it was like a giant with one idea. At all events, the object produced a stricking effect in that place, where everything was in unison with it".[1]

The beam engine at Prestongrange provided a solution to the problem of pumping the water out of the mines. Today it provides the site of Prestongrange with an inspiring building that houses an incredible piece of machinery. The relevence of the beam engine to Prestongrange remains as ever of great importance.

1 Spence Collection (Letter from Tindall, F P)

HISTORY OF THE SITE OF PRESTONGRANGE

Summary

1184	Cistercian Monks
1210–19	Coal working begins
1560	Reformation
1749	Coal production ceases
1829	Prestongrange Colliery sinks its first shaft
1874	Beam engine installed
1895	Site purchased by Summerlee & Co.
1947	Nationalisation
1954	Beam engine ceases
1962	Colliery closes

Early Developments

IN 1184 the Cistercian Monks of Newbattle were granted land at Prestongrange to expand their salt-panning trade. This development gave the town of Aldhammer as it was known its new name of Salt Preston. The land they received was a stretch of marshland, a stone quarry and a coal heugh. They were given this land as alms from Sehr de Quincy, the head of a prominent Anglo-Saxon family who owned land in both Mid and East Lothian.

The Monks quickly exhausted the exposed coastal outcrops of coal, which they were using to accelerate the evaporation process of seawater to produce salt. In order to help transport needed coal from Newbattle to their salt pans the Monks built the Salter's Road.

In 1210 and 1219 the Monks were granted rights to actively work the coal in the Prestongrange quarry and therefore they significantly expanded the scale of their salt panning activities in the area.

The advent of the Reformation resulted in the Monks tenure over Prestongrange ending by 1560. At the end of the Sixteenth Century landowners took control of both the salt pans and the mines.

Growth of Industry

> "Prestonpans…named Salt Preston at the beginning of the last century is the burgh of Barony, and a part of the

> custom – house…..It is noted for its extensive manufactures, particularly of salt, stone, and earthenware, of brick and tile. The revenue arising from the manufacture of salt in Prestonpans, Cockenzie and Cuthill amounts to 17,000 or 18,000 pounds per annum. A manufacture of oil vitriol, acquafortis, and spirits of salt is also carried on to a greater extent: and the same company manufactures great quantities of Glaubers salts"[2]

All of these industries were thriving in the area in this time, the 1800's. This was due to the geographical merits of the site of Prestonpans. The locality of Edinburgh was by then an established commercial market place and there was abundant local fireclay which could be used to produce brick. Prestonpans had men and women with the kind of entrepreneurial vision that so characterised the progressive age of the Industrial Revolution and also skilled tradesmen and labourers to provide the workforce for the new industries.

Extensive communication links were already fully in place in 1819. Prestonpans had long established sea links that dated back to at least the Sixteenth Century. In the spring of 1526 King James V paid a visit to Newbattle and whilst on this journey he granted a local land-owning family called Acheson the rights to build a port. The port went on to flourish and at a later date it was purchased by Morrison and renamed Morrisons Haven.

Morrison was responsible for amongst other things the production of Sulphuric acid (or Vitriol), glass made from local seaweed and salt that was panned which gives Prestonpans its name.

Through the renamed Morrisons Haven clay would arrive from Devonshire, flint from Gravesend and white and red clay from London and Hull. Exports would be steamed most commonly to Edinburgh, but also back down the East Coast of England. Without this safe port trade growth in the area would have been severely restricted.

> "The harbour of Prestonpans, called Morrisons Haven, has about ten feet of water at spring tides, but might be deepened so as to draw twelve: it is esteemed a safe harbour."[3]

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[2] Webster, D.

[3] Webster, D. p. 565

The site was developed by a series of owners who each expanded the site and sunk new pits. Matthias Dunn stated that in 1830 that 'he sank the Great Seam Pit'.[4] Ownership was then passed on to Sir George Suttie. An English company Brenton and Loam then managed the site from approximately 1868 to 1870.[5] The management of the site was soon taken over by Geares & Mills of Middlesborough who operated from around 1870/1874. Summerlee Coal and Iron Company then took over from Geares & Mills in 1895. Summerlee Iron Works was originally established in Coatbridge in 1837 under the name Messers Wilson & Co.[6]

A picture emerges at Prestongrange of one of Britain's earliest industrial estates being in rude health. In truth however things were less streamlined. Despite a long history of mining at Prestongrange coal from further afield was being imported into the area, this was costly in transport and tax but still more profitable.

The reason for the inaccessibility of the local raw coal was that the mineshafts had been flooded in 1749. In order to fulfil the potential of the area and enjoy the boom years and huge profit margins the resultant self-sufficiency would bring, a means had to be found to drain the water.

The solution to this problem was an example of one of the key features of the Industrial Revolution. This was an intensely fertile and competitive time, more than any other period in history, where necessity was the mother of invention. The problem of drainage was continually arising and being addressed at this time throughout the country. The developed solution would solve many similar problems of drainage as experienced at Prestongrange all over the country.

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4 Dott, G.
5 Ibid
6 Dott, G.

THE DEVELOPMENT OF THE BEAM ENGINE

The Cornish Beam Engine

IT IS EASY today to underestimate the impact the steam engine. Until its advent there were no other locomotive forces other than wind, water and muscle. Steam engines eventually drove mills, fed canals, operated docks, supplied water and opened up the country with the advent of rail. In examining statistical accounts it has been estimated that in or before 1800 there were approximately sixty-one Newcommen type or other steam engines in Scotland with approximately four or five in East Lothian.[7]

The invention of the steam engine revolutionised mining freeing exponentially more mineral and fossil fuel wealth, allowing a scale of development that was unprecedented. However it was a long road from the initial breakthrough which occurred while Queen Anne sat on the throne (1704–14), to the monument of craft and science in maturity that is the Cornish Beam Engine of Prestongrange.

The 'Cornish Boiler' and the 'Cornish Beam Engine' were so named because in that time of massive development nowhere outside Cornwall was developing faster or more comprehensively in the area of mining. There was a huge escalation in the demand for coal, tin, copper, tungsten and other mineral wealth. This created a demand from other areas of the country that wished to emulate these thriving Cornish industries. A market opened up in the production of such equipment that could be sold and was portable.

The so-called Cornish cycle utilised the high-pressure steam available along with the doubled-up power strokes of the 'parallel motion' innovations of James Watt. This produced enormous fuel savings on all that had come before.

> "The typical Cornish engine had it's huge beam mounted on the strength end wall of the engine house so that the mechanism was indoors, and the end of the beam with the pumprods extending down the mineshaft was in the open air. The pumprods were composed usually of Oregon pine, in section usually 18 inches square and

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7 Duckham

> often weighing in the case of a deep mine, up to a hundred tons. The first pump was in a sump at the bottom of the mine and the water was raised in lifts with intermediate tanks and pumps, worked from offsets on the same pumprods, every few hundred feet. It was not necessarily pumped to the surface, but often to a tunnel or adit driven to come out on a low ground miles away… What the engine did was to raise the pumprods and, with them, the plungers in the pumps, thus filling them with water. When the steam valve shut, the rods descended again under their own great weight, an 'equilibrium valve' opening at the right moment to allow the expanded steam to fill the space below the piston as it rose. Closure of this valve as the piston approached the top of it's stroke cushioned the descent of the rods, bringing them gently to rest so that the pumps could take the water at their own natural speed. This valve was invariably known to the engine-men of old as the 'Uncle Abram' valve. The engine then passed at the top of it's stroke until the cataract allowed the steam valve to open and repeat the cycle."[8]

Influential Inventors

Thomas Newcomen (1663–1729)

The road starts with a Dartmouth ironmonger and brass-founder, Thomas Newcomen. Newcomen however died in obscurity in 1729. His pivotal role in changing the world has gone unrecognised despite the fact that his engines began to spring up throughout Britain and Europe in the years before his death.

Newcomen's discoveries began when he realised that if an upright cylinder with a sliding piston was filled with steam that was then condensed, a vacuum would be formed and the pressure of the atmosphere would drive the piston down with force. Although his theory was sound and he knew that the pressure of the atmosphere was around fifteen pounds per square inch he struggled to get the steam to condense rapidly enough. It was chance that intervened after years of failure to solve the problem.

A tiny flaw in the brass cylinder he had been using allowed a tiny spray of water to leak into the inside. This provoked the

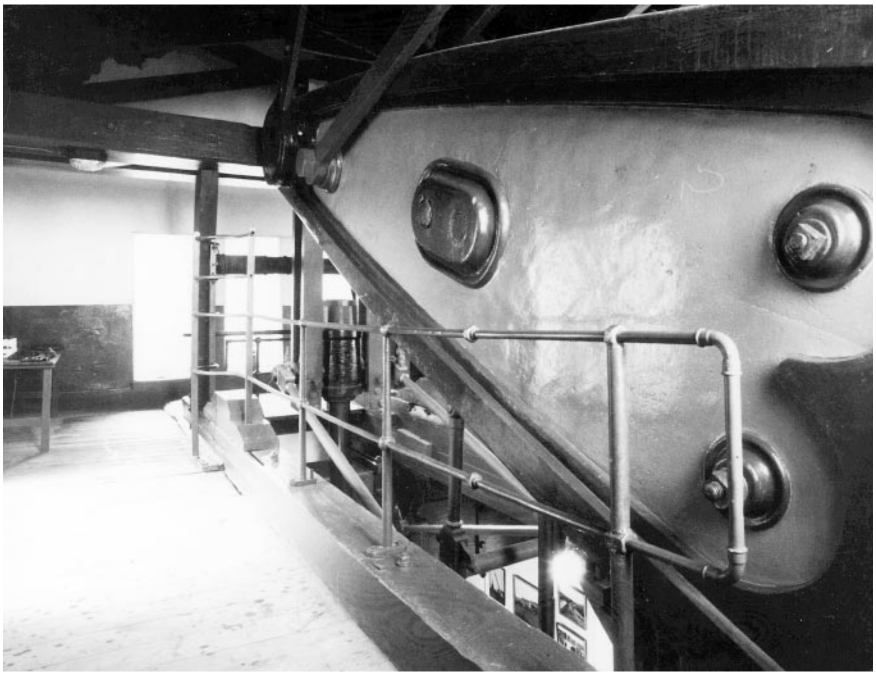
[8] Crowley, T.E.

James Watt at the Steam Engine by J.E. Lauder

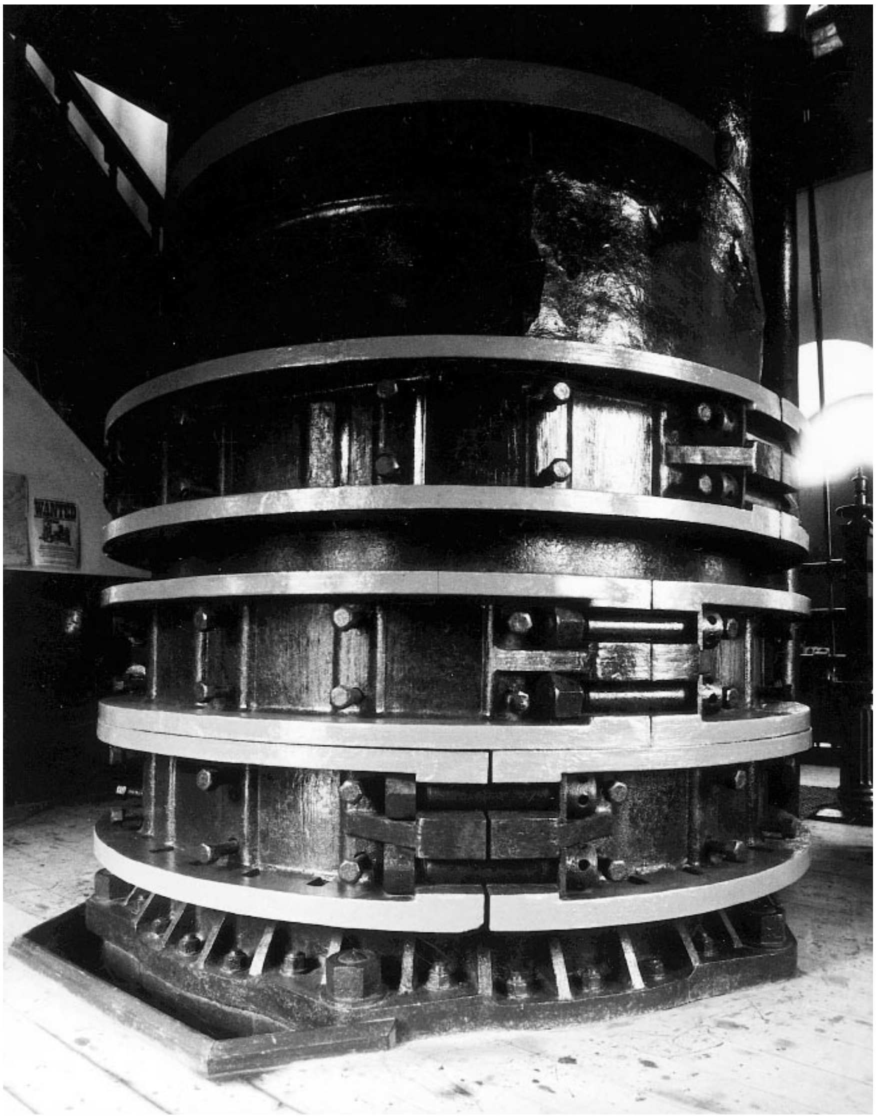
Courtesy of The Scottish National Portrait Gallery and the National Gallery of Scotland

Beam Engine exterior
East Lothian Council

Newly cast beam arrives
East Lothian Council, David Spence Collection



Beam Engine interior
Scottish Mining Museum Trust



Steam Cylinder
Scottish Mining Museum Trust

rapid condensing of steam that was sought and the piston then came down with an unprecedented speed and force. After this chance discovery he installed a tiny spray.

> "Newcomen arranged a great wooden beam, pivoted at the middle, on the specially strengthened wall of the engine-house, and to one end of the beam he attached the piston by length of a chain. The cylinder was mounted vertically mouth upward to the other end of the beam, again hanging by a chain. Newcomen attached the heavy rods fixed down the mineshaft to the pump at the lowest level. The weight of the rods pulled up the piston in the cylinder and sucked in the steam from the boiler mounted below; then the steam condensed by the water-jet, the piston descended to fill the vacuum and the pumprods were raised, pumping up the water. The valve admitting the steam to the cylinder and that controlling the water-jet were worked from a rod hung from the beam. Water covered the top of the piston to help seal the gap between the piston and cylinder since there was no machine tool available to produce a smooth cylinder bore that was sufficiently accurate".[9]

As early as 1762 there was an example of an engine with a seventy-four inch diameter cylinder in operation in England that was powered by four boilers. This is four inches larger than the far later Cornish Beam Engine of Prestongrange.[10] The cost however of installing one of Newcomens 'fire engines' was great and a deterrent to their use. The third engine of this type installed in Scotland at Edmonstone in 1726/27 was stated as costing £1008 without taking into account the cost of the engine house.[11] It became apparent therefore that Newcomen's 'fire engines' although great were in need of improvement and refining.

John Smeaton (1724–1794)

John Smeaton was the worthy successor in the long battle to pump water from one place to another. He took great steps in improving the steam engine which had previously been no

9 Crowley, T.E.
10 Crowley, T.E.
11 Duckham p 222

more sophisticated than the greater the burden, the larger the machine.

Smeaton had a background in iron forging and founded the Carrock Ironworks. This experience greatly aided his ability in improving the efficiency of steam engines. In 1760 he markedly improved the effectiveness of the machine by increasing the size of the steampipes.[12]

He also improved the controls of the machine in developing the 'cataract'. This was a weighed lever with a tin cup at one end which was enclosed in a water tank. Water was poured into the cup, which would be heavy enough when full to tilt the lever. This in turn would open the steam valve, which was attached to the other end of the lever, while at the other end the cup would empty. By regulating the speed with which the cup was refilled with water one could control the speed of the engine.[13]

Smeaton's other great contribution to the age of steam was the standardising of the capacity of the engine. This became important as the trade in Beam Engines began to expand. The buyers could outline their needs and receive a machine of the scale to meet their expectations. Smeaton's "duty" was the amount of water in millions of pounds that could be raised one foot high by a bushel of coal (94 pounds).

This move was indicative of the state of the changing times in two important ways. Firstly that the trade in industrial machinery had increased and was expanding and secondly that there was a move away from the trail and error engineering advances of the past towards a much more practical scientific approach.

James Watt 1736–1819

James Watt in 1765 invented the separate condenser, which was the next great breakthrough in the design of the Beam Engine. By this point in time the Beam Engine had been in manufacture and application for over sixty years.

Watt realised that the efficiency could be increased if the cylinder could be kept hot at all times rather than cooling every time water was admitted to condense the steam and provide a stroke. His solution was to design a separate condenser below the cylinder that was kept cool by emersion in water. The cylinder was equipped with an extra valve at its

[12] Crowley, T.E.
[13] Crowley, T.E.

bottom through which the exhausted steam could enter the condenser. There a water jet reduced it to water effecting a vacuum that enabled the engine to continue operation. Water was removed from the condenser by merit of a pump, which also removed the dead air resultant in the condensing of steam. This water often subsidised the boiler in itself which was rendered more economical as it was not required to heat it from cold.[14]

The cylinder was provided with an insulated case and a steam jacket to prevent it from cooling. Watt realised by closing the top of the cylinder that he could admit steam to the piston alternately at either side. This resulted in the doubling of the power strokes that the machine could produce. This change was impossible to put into place however while the beam remained attached to the piston within the cylinder by a chain. This was due to the fact that the piston would have to exert a positive push on the beam as well as the pull previously exerted. A rod would be required to work through the closed cylinder cover, however the problem with that was that the piston would move vertically up and down. At the same time the end of the beam to which it was attached must by necessity describe circles in the air as it rises and falls. The result of these actions would be the bending of the piston rod. Watts solution to the problem of guiding the rod inflexibly on the path that was required of it was known as ‘parallel motion’

> “The top of the rod was attached to the beam by a swinging link and two pairs of hinged rods were provided, one pair attached to either side of the top of the piston rod and the other pair attached to a part of the framing or the building itself. The movement of the guide rods is susceptible of a rather beautiful geometric solution, and it was the invention of which James Watt was said to have been most proud.”[15]

Watt went on to design the rotative engine where the beam was attached to a circular crank replacing at a chop the unpredictable water wheel as a source of power. This also removed the need for man power to bear the coal from the steam to the surface. With a series of rail trucks wound by the wheel on an endless rope the job could be done at a fraction of

[14] Crowley, T.E.
[15] Crowley, T.E.

the time and expense. These rotative engines were soon as widespread as pump engines. Watt and his partner Boulton patented all their designs and monopolised the industry until their patent expired in 1800.

After this cessation there came a renewed vigour in the search for greater efficiency and the upshot of this new found freedom came to be known as the Cornish Engine. Post 1800 timber disappeared from the engine framing. The beam and other moving parts were replaced almost over night by cast iron.

Richard Trevithick 1771–1883

Richard Trevithick with the advent of high-pressure steam made a major breakthrough in power and economy. This was made possible by what became known as 'the cornish boiler'. This was a cylindrical ensemble of riveted wrought iron with a fire grate cum flue down the middle. It could be mounted on wheels and afforded designers steam at fifty pounds per square inch. Previously the maximum available had only been four pounds per square inch.

All the inventors played a major part in the design and improvement of developing steam. The development of steam driven machinery was key to the invention of the beam engine that was to solve the problem of drainage at Prestongrange.

THE PRESTONGRANGE BEAM ENGINE

Why Prestongrange Needed a Beam Engine

SPORADIC WORKING of the coal seams continued on the site of Prestongrange for centuries in much the same fashion. The coal was simply dug out along the line of an outcrop at the base of a rise in the ground or along the coast where it was also to be found. If the seam was flat but shallow a vertical hole would enable access. When the coal supply became exhausted the particular hole would be abandoned and a new one begun elsewhere.

In the sixteenth century a new method of counteracting the drainage problem inherent in mining was introduced known as ‘pit-and-adit’. It was described in 1878 as a method where hewers

> “have driven thair awin coill to this time and with such like lavell (level) and shall cause the water to have passage fra the back of the coill callit the coill dammys (dams) In sic manner as they have draven the lave of thair coill and mak twa fute (foot) dry at the back of said coill dammys. And also they shall open the conductis (conduit) thereof and in such a manner as the level seruis to be driven of their awine (own) coill to the boundaries of Pinkie and Inveresk that the water may hae anis (one) passage to the sey (sea)”[16]

Put simply the ‘adit system’ allowed rudimentary shafts to be sunk and worked for longer. It disposed of the water by channels cut in the coalface that would lead to the ‘day-level’ (surface). From there the water would run to the sea or to another watercourse.[17]

Through this system hundreds of gallons of water were drained every minute into the Forth. Some of these ‘adits’ were for their time truly formidable feats of engineering and provided a temporary answer to the problem of drainage. As described in 1621

[16] Conrad-Patrick
[17] Conrad-Patrick

> "…the greatest of these Gaes (faults), that I know (runs) from Archison's Haven, which hath been cut by Preston Grange, for a level (adit) to his coal, and goes from that to Seton … and hath been cut at Seton, for serving the level of coal now wrought at Tranent"[18]

However still it was not unusual for the mines to be closed due to flooding because of faults in the seam.

By 1749 all easily accessible coal on the site had been used and there followed a gap in coal production as once again the volume of water became unmanageable for the technology of the day. Until the opening of the Prestongrange Colliery in 1829 coal was imported for use by the Prestongrange Industries from collieries such as Tranent and Inveresk at great expense. One of the brick and tile works needed 21 cart loads of coal and culm (dross) to fire 3000 bricks in their kiln.

Prestongrange was rich in coal but the shallowest untapped seam was four hundred feet underground. To cope with the enormous amount of water between them and it miners had to wait for the advent of steam and the beam engine.

The current Cornish Beam Engine was bought to replace the inadequate twenty-six inch cylinder pump and its auxiliaries that had been in place since the colliery had reopened in 1829. The colliery had been reopened by Matthias Dunn who had soon introduced the innovation of 'cast iron tubbing' that enabled the mine to access the 'Great Seam' which was to be found 420 feet below the surface. This seam was seven to nine feet in thickness and extremely rich.

'Cast iron tubbing' was a system of iron plates the circumference of the shaft. These were established at opportune points in areas where water pools invariably accompany a seam of impermeable stone. The 'tubs' are designed to hold the water back from the areas of the shaft being worked while the water is pumped away from the other side. If the iron plates begin below the water level and are fitted directly to the impermeable stone the water pressure seals them in place.

Dunn established three such tubs in the shaft. He estimated that as the water pressure naturally rises as the quantity of water held back increases, the bottom tub at three hundred and ten feet (52 fathoms) was sustaining a pressure the equivalent of six thousand three hundred and thirteen tons. The engine that was in place could barely cope with such a

[18] Sinclair

huge volume of water. As so often had happened on the colliery site the capacity for the mines to be open and worked became increasingly more erratic due to the problems of drainage.

History of Prestongrange's Beam Engine

The Cornish beam engine was purchased for use at Prestongrange Colliery in 1874. The engine is credited to the engineers Hocking and Loam and was purchased from Havey & Co's of Hayle. They were generally acknowledged to be the largest foundry in Cornwall. The seventy-inch cylinder machine was bought in 1874 then transported by sea and installed at Prestongrange.

By 1874 the boom time in Cornwall was past and competition from other areas, particularly the North of England, had ensured that they no longer had it their own way. Prestongrange was not the beam engine's first berth but there it remained operational for eighty years keeping the mines of that colliery pumped dry.

The Cornish Beam Engine of Prestongrange was built in 1853 by J.E Mare at the Plymouth foundry. It was originally sited on Porters shaft, Wheal Exmouth and Adams silver-lead mine at Christow in South Devon. It was then moved first to Wheal Neptune in Perranuthnoe in 1862 and again to another Great Western in 1869.

In 1873 it was purchased by Harvey & Co. who provided a new beam that shortened the shaft stroke from twelve foot to ten foot and lengthened the pistonrod. A year later in 1874 they sold the beam engine to Prestongrange Colliery. The beam engine was erected at Prestongrange by Matthew Loam of Liskard.

The beam engine made this long journey in part due to the long standing connections that existed between Cornwall and the Lothians. Thirty years before the beam engine was transferred Matthew Loam's father had purchased a Perran Foundry 60-inch engine from the Dolphiston pit, which is close to Prestongrange. Loam was also married to Patience Kitto who belonged to an influential Cornish family.

The beam engine was 'according to local residents, shipped in parts to Prestongrange'[19] into the adjacent Morrison's Haven and installed in the location where it still remains. This

[19] Spence Collection

was a considerable feet as the weight of the machine was in excess of thirty tons. It was raised into position by stages with a series of jacks whilst at the same time the engine house was constructed around it. The completed structure has a reinforced front wall seven feet thick in order to support the weight of the beam.

The beam engine with its newly shortened stroke improved things on the site. The average working speed was three and a half strokes per minute with a pumping capacity of 650 gallons per minute, or six million gallons per twenty-four hours.

In 1895 Summerlee Iron Company took over the management of the Prestongrange Colliery. In 1905 they decided to increase the capasity of the mine shaft pumps. In order to do this they installed twenty-eight inch diameter rams on the two top lifts 'at the Great seam level, and one about midway between that and the surface, raising the water in two stages'.[20] The other 'at the beggar level, below the great seam, was a pump 17 inches in diameter, which pumped to the Great seam lodgement'[21].

This work was carried out by Messers Andrew Barclay Sons & Co. Ltd. from Caledonia Works in Kilmarnock. New pump rods were also installed 'The pumprods, of Oregon pine, are 23 inches square from the surface to the top lift pump and the total weight of the pumprods, rams, crosshead and side rod, is about 105 tons'.[22]

In order to install the pumps and pumprods a 'steam driven worm geared winch'[23] was erected adjacent to the shaft 'the rope passing over a pulley mounted on a massive wood and steel frame erected over the pumping space in the shaft'.[24] This then became a permanent fixture allowing any further repairs to be made to the pumps and pumprods.

Due to the installation of these larger pumps a strengthening truss had to be added. This was required as calculations showed that the beam strength was no longer capable of bearing the increased load. The strengthening truss was designed and manufactured by the Summerlee Iron Company. The Chief Engineer of the company at the time was Mr Wm. Bryson.[25]

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20 Spence Collection
21 Spence Collection
22 Spence Collection
23 Spence Collection
24 Spence Collection
25 Spence Collection

In order to fit the strengthening truss a boring bar had to be designed that was driven by a small steam engine. This boring bar was used to drill the larger holes on the side of the beam. These holes then 'received the pins in the eyes of the tiebars'.[26] In order to ensure that the beam was not over stressed when tightening the 'tiebars' a series of levers were attached to the beam that measured the 'deflection'. All the work of installing the new additions was the responsibility of the mechanical engineer who was a Mr David Smellie.[27]

[26] Spence Collection
[27] Spence Collection

CONCLUSION

ONCE THE BEAM engine was in place at Prestongrange the colliery enjoyed a fruitful period of activity where the mine was kept drained and the technology and the techniques for the removal of coal moved on apace. This however was at the mercy of the efficiency and reliability of the beam engine and the drainage related apparatus. A defining feature of the question of drainage, mundane as it may seem, is that it is a problem that must be constantly addressed. The water will always come flooding in again as fast as it ever did if not always addressed and dealt with.

This was clearly illustrated in 1916 when a pistonrod fractured at the top of a stroke. In falling it broke the cylinder bottom and also cracked the cylinder wall. As a result of this incident the mining in the colliery had to be stopped until repairs could be made. A new bottom had to be cast and the wall sealed by caulking the cracks with red lead and linseed oil before then clamping them together. The mine was then reopened but only after the repairs had been made and the time it took to once again drain the rapidly filling mine. Stoppages for any reason were increasingly more costly due to the efficiency at which the coal could be harvested.

Apart from another similar event in 1938 the engine ran smoothly and admirably for The Summerlee Coal and Iron Company. It also maintained it record after nationalisation in 1947 for the National Coal Board. Problems with breakdowns from 1952 heralded the end of the pump's use. In 1952 the pump became fractured 'about 30 fathoms from the surface' this was due to the stress after continuous years of working.[28] In 1953 the discharge valve burst, this valve was approximately six foot in diameter. The repairs were carried out by Mr Armstrong.[29]

In 1954 a fracture appeared in the 'stool-pipe which supported the whole vertical column to the surface'.[30] Attempts were made to repair the machine and cast a replacement. The cost of producing a 'pattern for one pipe only' was viewed as

28 Spence Collection (Letter from Mr J. Close 1968)
29 Spence Collection (Letter from Mr J. Close 1968)
30 Spence Collection (Letter from Mr J. Close 1968)

too expensive and the 'Cornish Pump retired from active service'.[31]

In 1954 the beam engine was replaced by the vastly smaller but more efficient electrical pumps. The solution to drainage on the site became little more than a stopgap measure. Coal after this period was increasingly being supplanted with other fossil fuels. Open cast mines were being established that were able to undercut the price of coal from the deep mines. Most importantly the cost in manpower and the expense of bringing up the coal was become increasingly expensive. In the 1950's the mines ran for no less than two miles under the Firth of Forth causing increased problems of drainage and flooding. This added cost of draining the mine finally tipped the balance.

In 1962 the colliery closed its doors for the final time. Many of the other associated industries that had originally been attracted to the area as a result of the coal closed shortly after. These changes in the local industries changed the area forever. Drainage, the problem that had plagued every owner for seven hundred years remained.

[31] Spence Collection (Letter from Mr J. Close 1968)

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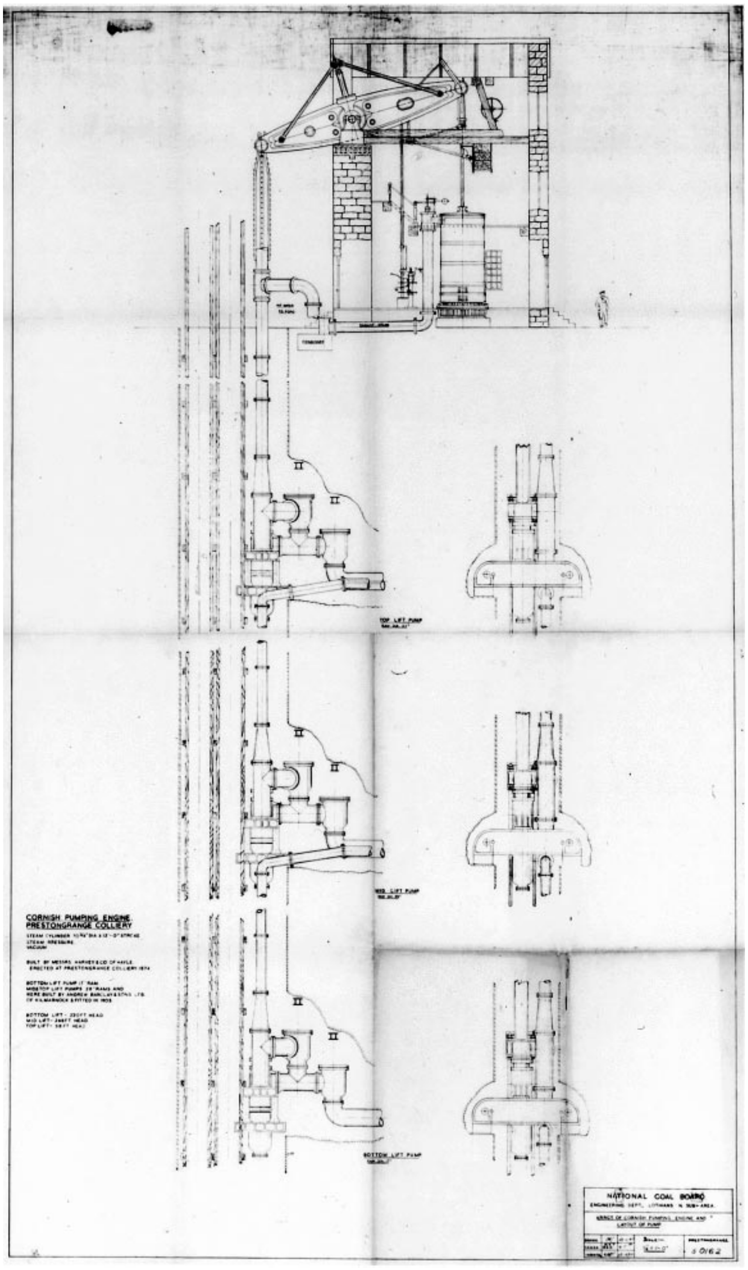

Diagram of Beam Engine workings

East Lothian Council, David Spence Collection